

August 2, 2019

***GULF OF ALASKA
OIL AND GAS
EXPLORATION LICENSE***

Preliminary Written Finding of the Director



Alaska Department of
**NATURAL
RESOURCES**
DIVISION OF OIL & GAS

Recommended citation:

DNR (Alaska Department of Natural Resources). 2018. Gulf of Alaska oil and gas exploration license. Preliminary written finding of the director. August 2, 2019.

Questions or comments about this preliminary finding should be directed to:

Alaska Department of Natural Resources
Division of Oil and Gas
550 W. 7th Ave., Suite 1100
Anchorage, AK 99501-3560
Phone 907-269-8800

The Alaska Department of Natural Resources (DNR) administers all programs and activities free from discrimination based on race, color, national origin, age, sex, religion, marital status, pregnancy, parenthood, or disability. The department administers all programs and activities in compliance with Title VI of the Civil Rights Act of 1964, Section 504 of the Rehabilitation Act of 1973, Title II of the Americans with Disabilities Act (ADA) of 1990, the Age Discrimination Act of 1975, and Title IX of the Education Amendments of 1972.

If you believe you have been discriminated against in any program, activity, or facility please write to:

Alaska Department of Natural Resources ADA Coordinator
P.O. Box 111000
Juneau AK 99811-1000

The department's ADA Coordinator can be reached via phone at the following numbers:

(VOICE) 907-465-2400,
(Statewide Telecommunication Device for the Deaf) 1-800-770-8973, or
(FAX) 907-465-3886

For information on alternative formats and questions on this publication, please contact:

DNR, Division of Oil and Gas
550 W. 7th Ave., Suite 1100
Anchorage, AK 99501-3560
Phone 907-269-8800.

*GULF OF ALASKA
OIL AND GAS
EXPLORATION LICENSE*

Preliminary Written Finding of the Director

*Prepared by:
Alaska Department of Natural Resources
Division of Oil and Gas*

August 2, 2019

Contents

	Page
Chapter One: Director’s Preliminary Written Finding and Decision	
A. Director’s Preliminary Written Finding.....	1-1
B. Gulf of Alaska Application and Exploration License	1-3
C. Preliminary Decision: Request for Public Comment	1-4
Chapter Two: Authority and Scope of Review	
A. Constitutional and Statutory Authority	2-1
B. Written Findings	2-2
C. Review by Phase	2-4
D. Licensing Process	2-6
Chapter Three: Description and Location of the License Area	
A. Property Location and General Description.....	3-1
B. Land and Mineral Ownership.....	3-1
C. History and Cultural Resources	3-5
D. Local Communities.....	3-6
E. Climate	3-10
F. Natural Hazards.....	3-11
G. References.....	3-15
Chapter Four: Habitats, Fish, and Wildlife	
A. Major Habitats of the Area	4-1
B. Fish and Wildlife Populations.....	4-4
C. References.....	4-25
Chapter Five: Current and Projected Uses	
A. State Game Refuges, Critical Habitat Areas, and Other Designated Areas.....	5-1
B. Current and Projected Uses in the License Area.....	5-2
C. References.....	5-14
Chapter Six: Petroleum Potential and the Likely Methods of Oil and Gas Transportation in the License Area	
A. Geology.....	6-1
B. Phases of Oil and Gas Development.....	6-4
C. Oil and Gas Exploration, Development, and Production Activities.....	6-6
D. Likely Methods of Oil and Gas Transportation in the License Area	6-11
E. Spill Risk, Prevention, and Response.....	6-14
F. References	6-26
Chapter Seven: Governmental Powers to Regulate Oil and Gas	
A. State of Alaska	7-1
B. Federal.....	7-11
C. Other Federal and State Regulatory Considerations	7-14
D. References.....	7-16
Chapter Eight: Reasonably Foreseeable Effects of Licensing and Subsequent Activity	
A. Introduction.....	8-1
B. Reasonably Foreseeable Cumulative Effects on Air.....	8-2
C. Reasonably Foreseeable Cumulative Effect on Water Resources and Water Quality	8-3

D. Reasonably Foreseeable Cumulative Effects on Terrestrial and Freshwater Habitats and Fish and Wildlife Populations	8-7
E. Reasonably Foreseeable Cumulative Effects on Coastal and Marine Habitats and Fish and Wildlife Populations	8-14
F. Reasonably Foreseeable Cumulative Effects on Fish and Wildlife Uses	8-25
G. Reasonably Foreseeable Cumulative Effects on Historic and Cultural Resources	8-28
H. Reasonably Foreseeable Fiscal Effects of the Disposal and Subsequent Activity on the State and Affected Municipalities and Communities	8-29
I. Other Reasonably Foreseeable Effects on Municipalities and Communities Near the License Area	8-33
J. References	8-35
Chapter Nine: Mitigation Measures	
A. Mitigation Measures	9-1
B. Definitions	9-8
Appendix A: Summary of Comments and Responses	
Appendix B: Gulf of Alaska Sample Exploration License	
Appendix C: Gulf of Alaska Sample Lease	

Tables

	Page
Table 2.1. Topics required by AS 38.05.035(g)(1)(B)	2-4
Table 5.1. Nominal Prince William Sound permit values, 2000-2016	5-7
Table 5.2. Nominal total Prince William Sound permit earnings, 2000-2016	5-8
Table 5.3. Economic impact of sport fishing in Alaska in 2001, 2003, 2006, 2011	5-10

Figures

	Page
Figure 3.1. Gulf of Alaska Area Map	3-3
Figure 3.2. Gulf of Alaska Land Status Map	3-4
Figure 5.1. Critical Habitat Area and Anadromous Rivers in and adjacent to the License Area	5-2
Figure 5.2. Gulf of Alaska Game Management Units	5-12

Chapter One: Director’s Preliminary Written Finding and Decision

Contents

	Page
A. Director’s Preliminary Written Finding.....	1-1
B. Gulf of Alaska Application and Exploration License	1-3
C. Preliminary Decision: Request for Public Comment	1-4

Chapter One: Director’s Preliminary Written Finding and Decision

The State of Alaska encourages oil and gas exploration through the issuance of oil and gas exploration licenses on state lands outside known hydrocarbon basins under AS 38.05.131–134. This preliminary finding is the director of the Alaska Department of Natural Resources (DNR) Division of Oil and Gas’ (DO&G) decision under AS 38.05.133(f) that, after considering the matters required by AS 38.05.035(e) and (g), the state’s best interests would be served by issuing the Gulf of Alaska oil and gas exploration license (License or License Area) to Cassandra Energy Corporation (Licensee) as described in this preliminary written finding.

Issuing the license gives the licensee the exclusive right to explore for deposits of oil and gas subject to the terms of the license (AS 38.05.132(b)(1)). If the licensee accepts the license and meets the work commitment obligations described in the license (Appendix B), the licensee may request a conversion of the license to a lease with no other written finding required. Therefore, any language referring to the “License” or “licensing” in this written finding will also refer to any subsequent leases.

All relevant facts and issues within the scope of review that were known or made known to the director were reviewed. The director established the scope of the administrative review and finding to be the reasonably foreseeable significant effects of the uses proposed to be authorized by the disposal (AS 38.05.035(e)(1)(A)). Conditions for phasing are met under AS 38.05.035(e)(1)(C). See discussion in Chapter Two and Chapter Six for additional details on phasing.

A. Director’s Preliminary Written Finding

In making this preliminary finding, the director considered applicable laws and regulations, weighed the facts and public comments received during public review that address the matters required by AS 38.05.035(g) and balanced positive and negative effects of potential oil and gas activities. The discussion of these matters is set out in the accompanying chapters of this preliminary written finding. Based on consideration and discussion of the information contained herein, the director preliminarily finds:

- The Alaska Constitution directs the state “to encourage... the development of its resources by making them available for maximum use consistent with the public interest” (Alaska Constitution, art. VIII § 1).
- The people of Alaska have an interest in developing the state’s oil and gas resources and maximizing the economic and physical recovery of those resources (AS 38.05.180(a)).
- AS 38.05.035(e)(1)(A) allows the director to establish the scope of the administrative review on which the director’s determination is based, and the scope of the written finding supporting that determination.
- AS 38.05.035(e)(1)(B) allows the director to limit the scope of an administrative review and finding for a proposed disposal to a review of applicable statutes and regulations, and

facts pertaining to the land, resources, property, or interest in them that the director finds are material to the written finding and are known or available to the director during the administrative review. AS 38.05.035(h) provides that in preparing a written finding under AS 38.05.035(e)(1), the director may not be required to speculate about possible future effects subject to future permitting that cannot reasonably be determined until the project or proposed use for which a written finding is required is more specifically defined.

- The intent of the oil and gas licensing program (AS 38.05.131–134) is to encourage exploration in areas far from existing infrastructure, with relatively low or unknown hydrocarbon potential, and where there is a higher investment risk to the operator.
- On April 23, 2015, DO&G received a timely exploration license application from Cassandra Energy Corporation.
- On May 21, 2015, DO&G published a notice of intent to evaluate the exploration license proposal, request for comments on exploration within the solicitation area, and request for competing proposals.
- On May 21, 2015, DO&G requested agency information on proposed oil and gas exploration in the area. Information submissions were due by July 20, 2015.
- On June 8, 2015, DO&G extended the public comment period. Comments were due by August 3, 2015. Competing proposals were due by July 20, 2015.
- DO&G did not receive any competing proposals in the allotted time.
- DO&G received 26 timely responses to the request for agency information and call for comments. These comments are addressed, and information incorporated throughout this finding. Comments are summarized with DNR responses in Appendix A.
- On May 9, 2016, DO&G issued the Final Director's Determination of State Lands Subject to Oil and Gas Exploration Licensing for the Southcentral Region of Alaska which includes the Gulf of Alaska License Area. The Final Determination stated that all state-owned acreage in the Southcentral determination area will be available for oil and gas exploration licensing subject to the provisions of AS 38.05.132.
- The Final Determination was appealed on May 27, 2016, and the appeal was resolved by the DNR commissioner on December 22, 2017.
- AS 38.05.133(f) requires a written finding addressing all matters set out in AS 38.05.035(e) and (g), except for AS 38.05.035(g)(1)(B)(xi), after considering proposals and public comment on the proposals.
- AS 38.05.035(e)(1)(C) allows the director to limit a written finding to the disposal phase, which is the issuance of an exploration license, and oil and gas leases if the license is converted.
- Oil and gas activities conducted under an exploration license or oil and gas lease are subject to all applicable laws and regulations.
- Potential effects of activities after licensing can be both positive and negative.
- Fish and wildlife species that could be affected by license activities include but are not limited to salmon and other fish species, waterfowl, black bear, brown bear, moose, and

several species of marine mammal. Salmon are more sensitive to blasting from seismic testing, and salmon eggs are extremely sensitive to the shock caused by blasting. Mitigation measures include and address disturbance avoidance, seismic activities, and siting of facilities.

- Several other important subsistence, sport, personal use, and commercial uses of fish and wildlife could be affected by the license as well. Mitigation measures address harvest interference avoidance, public access, road construction, and oil spill prevention.
- Discharges of oil, gas, and hazardous substances into the land, water, and air can harm habitats and fish and wildlife populations. Improved design, construction, operating techniques, proper handling, storage, spill prevention measures, and disposal of such substances can mitigate impacts.
- Increased use of the area for oil and gas activities could affect subsistence uses. However, potential negative effects may be outweighed by potential positive effects such as higher incomes that offset equipment costs and other subsistence activities. Roads and transportation corridors may also lead to increased access for hunting, fishing, and trapping, which could have both negative and positive effects.
- Communities near the License Area such as Cordova, Chenega Bay, Tatitlek, and Valdez could see economic benefits through jobs, increased property taxes, and associated business opportunities and patronage. Royalty and rental payment benefit all Alaska residents through payments to the General Fund and Permanent Fund.
- Most potentially negative effects of oil and gas activities on fish and wildlife species, habitats, and their uses; on local uses, residents, and property owners; and on local communities, if not adequately addressed by federal or state law, may be mitigated through measures imposed on the exploration license and subsequent lease activities.
- DNR possesses a body of knowledge covering oil and gas activities within and outside Alaska which demonstrates the potential cumulative effects that could occur in the License Area because of exploration and development activities.
- In accordance with AS 38.05.035(g)(2), The director has weighed the facts and issues known at this time and has set out preliminary findings. The director considered applicable laws and regulations and balanced the potential positive and negative effects given the mitigation measures and other regulatory protections and has preliminarily determined that issuing the Gulf of Alaska exploration license is in the state's best interest.

B. Gulf of Alaska Application and Exploration License

Following the public notice and comment period, DO&G began developing its preliminary written finding. To ensure confidentiality under AS 38.05.035(a)(8), and at the applicant's request under AS 38.05.133(e), DO&G kept confidential the name of the applicant throughout the comment period. Because this preliminary finding concludes that the state's best interests would be served by issuing an exploration license, this finding must identify the prospective licensee (AS 38.05.133(f)). The initial applicant was Cassandra Energy Corporation.

C. Preliminary Decision: Request for Public Comment

The director has made a preliminary finding that the potential benefits of issuing the exploration license outweighs the potential negative effects, and that the Gulf of Alaska Oil and Gas Exploration License issuance will best serve the interests of the state of Alaska. The director has weighed the facts and issues known at this time and has set out preliminary findings. The director considered applicable laws and regulations and balanced the potential positive and negative effects given the mitigation measures and other regulatory protections. The director determined that a term for the license of ten years, is in the state's best interests to encourage efficient exploration of the state resources covered by the license. Additionally, the director established a \$1,000,000 work commitment for this exploration license to reflect the work proposed by the licensee.

The state is sufficiently empowered through constitutional, statutory, and regulatory authority, and its interests are bolstered through the exploration license, and plans of operations to ensure that the licensee conducts their activities safely and in a manner that protects the environment and maintains opportunities for existing and anticipated uses.

Pursuant to AS 38.05.133(g), the Licensee will have 30 days from the issuance of a subsequent final finding to accept or reject the Exploration License, as limited and conditioned by the terms of this finding. The Licensees' acceptance or rejection of the Exploration License must be submitted in writing.

This preliminary finding is subject to revision based on comments received by DO&G during the period set out for receipt of public comment, as provided in AS 38.05.035(e)(5)(A). Members of the public are encouraged to comment on any part of this preliminary finding. In commenting, please be as specific as possible.

Comments must be in writing and received by October 4, 2019, in order to be considered and must be sent to Best Interest Findings:

By mail: Alaska Department of Natural Resources
Division of Oil and Gas
550 W 7th Ave, Suite 1100
Anchorage AK 99501-3560

By fax: 907-269-8938

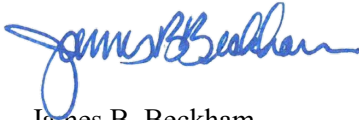
By email: dog.bif@alaska.gov

The DO&G complies with Title II of the Americans with Disabilities Act of 1990. This publication will be made available in alternate communication formats upon request. Please contact the Best Interest Findings Group at (907) 269-8800 or dog.bif@alaska.gov. Requests for assistance must be received at least 96 hours prior to the comment deadline to ensure necessary accommodations can be provided.

Following review of comments on this preliminary written finding and any additional available information, the director will make a final determination whether disposal of oil and gas resources in the Gulf of Alaska Exploration License Area is in the best interest of the state and will issue a

Chapter One: Director's Preliminary Written Finding and Decision

final finding and decision. To be eligible to file an appeal to the DNR commissioner under AS 38.05.035(i), a person must provide written comments during the comment period set out in the previous paragraph or have provided comments during the original solicitation for comments and competing proposals in 2015. Additional information regarding the public comment process and requests for reconsideration and appeals can be found in Chapter Two. A copy of the final decision can be sent to any person commenting on the preliminary decision and will include an explanation of the appeal process.



James B. Beckham
Acting Director, Division of Oil and Gas

August 2, 2019

Date

Chapter Two: Authority and Scope of Review

Contents

	Page
A. Constitutional and Statutory Authority	2-1
B. Written Findings	2-2
1. Applicable Law and Facts	2-2
2. Scope of Review	2-3
a. Reasonably Foreseeable Effects	2-3
b. Matters Considered and Discussed	2-3
C. Review by Phase	2-4
D. Licensing Process	2-6
1. Licensing Proposal	2-6
2. License Proposal Notice and Preliminary Finding	2-7
3. Term and Work Commitment.....	2-7
4. Appeal.....	2-8
5. Exploration License Issuance and Conversion to Lease.....	2-8

Tables

	Page
Table 2.1. Topics required by AS 38.05.035(g)(1)(B).....	2-4

Chapter Two: Authority and Scope of Review

The Alaska Department of Natural Resources (DNR), Division of Oil and Gas (DO&G) is preliminarily offering the Gulf of Alaska oil and gas exploration license to Cassandra Energy Corporation.

Exploration licensing is a program intended to encourage oil and gas exploration in areas far from existing infrastructure with unknown potential and that are outside of the known oil and gas provinces of the Beaufort Sea, North Slope, and Cook Inlet regions. The Gulf of Alaska exploration license covers approximately 65,773 acres located onshore and offshore surrounding Kanak Island from Point Martin south to the Okalee Spit in Controller Bay. The License Area consists of state-owned, unencumbered land within Township 19-21 S., Range 5-8 E., Copper River Meridian. Only free and unencumbered state-owned subsurface mineral estates are included in the oil and gas exploration license. The exploration license grants the licensee the exclusive right to explore for oil and gas and could subsequently be converted to an oil and gas lease or leases. A more detailed description of the License Area is found in Chapter Three.

This Preliminary Written Finding of the Director is written under the authority of the Alaska Constitution, statutes, and regulations that authorize disposal of oil and gas. As required by AS 38.05.035(e), this chapter establishes the scope of the administrative review and scope of the preliminary written finding for the License Area.

A. Constitutional and Statutory Authority

The Alaska Constitution provides that the general policy of the state is “to encourage... the development of its resources by making them available for maximum use consistent with the public interest” and that the “legislature shall provide for the utilization, development, and conservation of all natural resources belonging to the State... for the maximum benefit of its people” (Alaska Constitution, Article VIII, §§ 1 and 2). The legislature has been empowered to make all policy decisions to carry out these general goals, as well as to provide the policies and procedure for the lease, sale, and granting of state-owned land (Alaska Constitution Article VIII, §§ 8, 9, and 12). The Alaska Land Act guides the land management and disposal policy of the state. The Act, codified at AS 38.05, provides the commissioner of DNR the authority to select, manage, and dispose of state lands, and directs DNR to implement the requisite statutes. The commissioner has delegated authority for these disposals to the director of DO&G under DNR department order 003.

Title 38 of the Alaska Lands Act states the people of the state “have an interest in the development of the state’s oil and gas resources to maximize the economic and physical recovery of the resources” (AS 38.05.180(a)(1)(A)). Further, the legislature found that it is in the state’s best interests to “minimize the adverse impact of exploration, development, production and transportation activity,” and “to offer acreage for oil and gas leases or for gas only leases.” (AS 38.05.180(a)(2)(A)(ii); AS 38.05.180(a)(2)(B)).

AS 38.05.180(a)(2) further provides it is in the state’s best interest to encourage an assessment of its oil and gas resources; allow the maximum flexibility in the methods of issuing leases to recognize the many varied geographical regions of the state and the different costs of exploring for oil and gas in these regions and minimize the adverse impact of exploration, development, production, and transportation activity; and to offer acreage for oil and gas leases. AS 38.05.133(g) states that the prospective licensee has 30 days after issuance of the exploration license to accept or reject the issuance of the exploration license, as limited, changed, or conditioned by the terms contained within the finding. A discussion of the license’s term and work commitment is detailed in Section D-3 of this chapter.

B. Written Findings

Alaska statutes govern the disposal of state-owned mineral interests. Under AS 38.05.035(e), the director may, with the consent of the commissioner, dispose of state land, resources, property, or interests after determining in a written finding that such action will serve the best interests of the state. The written finding is known as a “best interest finding” and describes the proposed License Area, considers and discusses the potential effects of the license, describes measures to mitigate those effects, and constitutes the director’s determination whether the interests of the state will be best served by the disposal. DO&G provided one opportunity for public comment during the solicitation for public comments and competing proposals. DO&G is issuing both a preliminary written finding and a final written finding, providing additional opportunity for public comment after the preliminary finding is released. The final written finding will include a discussion of material issues raised during the public comment period, as well as a summary of the comments received. The preliminary written finding includes a discussion of material issues raised during the initial public comment period, as well as a summary of, and responses to the comments received (See Appendix A).

1. Applicable Law and Facts

The best interest finding requirements outlined in AS 38.05.035 provide DNR with procedures to ensure Alaska’s resources are developed for the maximum benefit of the state as mandated by article VIII, § 2 of the Alaska Constitution. The authorities applicable to this written finding include the requirements and procedures set out in AS 38.05.035(e)–(m), and Alaska case law applicable to the disposal phase.

Under AS 38.05.035(e), the director may not dispose of state land, resources, or property, or interests therein, unless the director first determines in a written finding that such action will serve the best interests of the state. The provisions in AS 38.05.035(e) set out the scope of review and process for the written finding.

The statute also expressly empowers DNR to review projects in phases, allowing the analysis of proposed licensing or leasing to focus on the issues pertaining to the disposal phase and the reasonably foreseeable significant effects of licensing or leasing. (AS 38.05.035(e)(1)(C)). Further explanation of the statutory direction is provided in the sections below. The regulatory authorities governing exploration, development, production, and transportation of oil and gas development are discussed further in Chapter Six.

2. Scope of Review

As required by AS 38.05.035(e)(1)(A)–(C), the director, in the written finding:

- shall establish the scope of the administrative review on which the director’s determination is based, the scope of the written finding supporting that determination, and the scope of the administrative review and finding may only address reasonably foreseeable, significant effects of the uses proposed to be authorized by the disposal;
- may limit the scope of an administrative review and finding for a proposed disposal to a review of: (1) applicable statutes and regulations; (2) facts pertaining to the land, resources or property, or interest in them that are material to the determination and known to the director or knowledge of which is made available to the director during the administrative review; and (3) issues that, based on the applicable statutes, regulations, facts, and the nature of the uses sought to be authorized by the disposal the director finds are material to the determination of whether the proposed disposal will serve the best interests of the state; and
- may, if the project for which the proposed disposal is sought is a multi-phased development, limit the scope of an administrative review and finding for the proposed disposal to the applicable statutes, and regulations, facts and issues that pertain solely to the disposal phase of a project when the conditions of AS 38.05.035(e)(1)(C)(i)–(iv) are met.

a. Reasonably Foreseeable Effects

The scope of this administrative review and preliminary written finding addresses only the reasonably foreseeable, significant effects of the uses proposed to be authorized by the disposal (AS 38.05.035(e)(1)(A)).

A detailed discussion of the possible effects of unknown future exploration, development, and production activities is not within the scope of this best interest finding. Therefore, the director has limited the scope of this preliminary written finding to the applicable statutes and regulations, facts, and issues pertaining solely to the License Area, and the reasonably foreseeable significant effects of the license disposal. However, this finding does discuss the potential cumulative effects, in general terms, that may occur with oil and gas activities related to exploration, development, production, and transportation within the License Area and any mitigation measures as required by AS 38.05.035(g)(1) and (2).

b. Matters Considered and Discussed

Pursuant to AS 38.05.133(f), a written finding issued in support of an exploration license, must consider and discuss facts related to topics set out under AS 38.05.035(g)(1)(B)(i)–(x) that are known at the time the finding is being prepared. The director must also consider public comments during the public comment period and within the scope of review set out in Sections A and B.1–2 of this Chapter.

To aid those interested in reviewing and commenting on this preliminary best interest finding, this document is organized for ease of reading and reviewing and does not necessarily follow the order as found in AS 38.05.035(g)(1)(B) (Table 2.1).

Table 2.1. Topics required by AS 38.05.035(g)(1)(B).

AS 38.05.035(g)(1)(B) subsection number	Description	Location in this document
i	Property descriptions and locations	Chapter Three
ii	Petroleum potential in general terms	Chapter Six
iii	Fish and wildlife species and their habitats in the area	Chapter Four
iv	Current and projected uses in the area; including uses and value of fish and wildlife	Chapter Five
v	Governmental powers to regulate the exploration, development, production, and the transportation of oil and gas or of gas only	Chapter Seven
vi	Reasonably foreseeable cumulative effects of exploration, development, production, and transportation for oil and gas or for gas only on the License Area, including effects on subsistence uses; fish and wildlife habitat and populations and their uses, and historic and cultural resources	Chapter Eight
vii	Stipulations and mitigation measures, including any measures to prevent and mitigate releases of oil and hazardous substances, to be included in the license, and a discussion of the protections offered by these measures	Chapter Nine
viii	Method or methods most likely to be used to transport oil or gas from the License Area, and the advantages, disadvantages, and relative risks of each	Chapter Six
ix	Reasonably foreseeable fiscal effects of the license disposal and the subsequent activity on the state and affected municipalities and communities	Chapter Eight
x	Reasonably foreseeable effects of exploration, development, production, and transportation involving oil and gas or gas only on municipalities and communities within or adjacent to the License Area	Chapter Eight

The facts and issues under consideration in this finding may address only reasonably foreseeable, significant effects of the uses proposed to be authorized by any future disposals in the License Area (AS 38.05.035(g); AS 38.05.035(e)(1)(A)). The director may not be required to speculate about possible future effects subject to future permitting that cannot reasonably be determined until the proposed use subject to the best interest finding is more specifically defined (AS 38.05.035(h)).

C. Review by Phase

The director may limit the scope of an administrative review and finding for a proposed disposal when the director has sufficient information and data available upon which to make a reasoned decision. A discussion of phases of oil and gas activities is contained in Chapter Six.

Under AS 38.05.035(e)(1)(C), if the project for which the proposed disposal is sought is a multi-phased development, the director may limit the scope of an administrative review and finding for

the proposed disposal to the applicable statutes and regulations, facts, and issues that pertain solely to the disposal phase of the project under the following conditions:

- (i) the only uses to be authorized by the disposal are part of that phase;
- (ii) the disposal is a disposal of oil and gas, or of gas only, and, before the next phase of the project may proceed, public notice and the opportunity to comment are provided under regulations adopted by the department;
- (iii) the department's approval is required before the next phase may proceed; and
- (iv) the department describes its reasons for a decision to phase.

Phased review is appropriate for exploration licensing. Although the licensee may propose specific exploration activities in an application, the issuance of a license does not authorize any oil or gas activities in the license area without further permits from DNR and other agencies.

The director has met condition (i) because the only uses authorized are part of the disposal phase. The disposal phase is the issuance of the exploration license. As defined in *Kachemak Bay Conservation Society v. State, Department of Natural Resources* disposal is a catch all term for all alienations of state land and interests in state land¹. In *Northern Alaska Environmental Center v. State, Department of Natural Resources*, the court further held that a disposal was a conveyance of a property right². For an oil and gas development project, the exploration license, and subsequent conversion to leases, is the only conveyance of property rights DNR approves. The license gives the licensee, and potentially the subsequent lessee, subject to the provisions of the license and lease(s), and applicable laws and statutes, the exclusive right to drill for, extract, remove, clean, process, and dispose of oil, gas, and associated substances, as well as the nonexclusive right to conduct within the licensed area geological and geophysical exploration for oil, gas, associated substances, and if converted to leases, the nonexclusive right to install pipelines and build structures on any converted leased area to find, produce, save, store, treat, process, transport, take care of, and market all oil and gas and associated substances, and to house and board employees in its operations on the lease area. While the licensee has these property rights upon entering into the license, the license itself does not authorize any oil and gas activities on the licensed lands without further permits from DNR and other agencies. There are no additional property rights to be conveyed at later phases.

Condition (ii) is met because (1) the disposal is for the license of available land or an interest in land, for oil and gas, or for gas only, scheduled under AS 38.05.180(b), and (2) public notice and opportunity to comment are provided before each subsequent phase of the project may proceed. Public notice and the opportunity to comment on the disposal phase of this license was provided through the solicitation for public comments under AS 38.05.035(e)(5), AS 38.05.945, AS 38.05.133(d) and 11 AAC 82.918, and again through this preliminary written finding. Subsequent post-disposal phases may not proceed unless public notice and the opportunity to comment are provided under regulations adopted by DNR. DNR provides public notice and opportunity to comment for plans of operation that initiate a new phase under 11 AAC 83 as authorized by AS 38.05.

¹ 6 P.3d 270, 278 n.21 (Alaska 2000).

² 2 P.3d 629, 635-36 (Alaska 2000).

Condition (iii) is met because DNR’s approval is required before the next phase may proceed.

Condition (iv) is met by the findings in Chapters One, Six, and Eight discussing the speculative nature of current information on where future activity in the License Area may be located, what future development projects and methods may be proposed that would require post-disposal authorizations; and what permit conditions and mitigation requirements will be appropriate for authorizations at later phases.

This preliminary written finding satisfies the statutory requirements for phased review under AS 38.05.035(e)(1)(C).

D. Licensing Process

1. Licensing Proposal

Prior to reviewing applications for exploration licensing, DO&G must first make a preliminary and final determination of lands subject to exploration licensing. The preliminary determination must be given public notice, and following the comment period, and evaluation of the comments received, a final written determination must be published. On February 2, 2016, under AS 38.05.131(c), the director made a preliminary written determination of state land for Southcentral Alaska. On May 9, 2016, DO&G issued the Final Director’s Determination of State Lands Subject to Oil and Gas Exploration Licensing for the Southcentral Region of Alaska which includes the Gulf of Alaska License Area³. The Final Determination grants that all state-owned acreage in the Southcentral determination area will be available for oil and gas exploration licensing subject to the provisions of AS 38.05.132.

The state’s exploration licensing program⁴ supplements the state’s conventional oil and gas leasing program by targeting areas outside known oil and gas reserves.⁵ The licensing program encourages exploration in areas far from existing infrastructure, with relatively low or unknown hydrocarbon potential, and where there is a higher investment risk to the operator. Through exploration licensing, the state will receive subsurface geologic information about these regions. Furthermore, if production occurs after exploration, the state will also receive additional revenue through royalties and taxes.

The licensing process begins in one of two ways:

³ The Final Director’s Determination of State Lands Subject to Oil and Gas Exploration Licensing for the Southcentral Region of Alaska was appealed on May 27, 2016 and the DNR commissioner resolved the appeal on December 22, 2017.

⁴ AS 38.05.131 provides that the oil and gas exploration licenses statutes (AS 38.05.132–.134) do not apply to land:

- 1) north of the Umiat baseline, and
- 2) in the vicinity of Cook Inlet that is within the area bounded by
 - A) the north boundary of Township 17 North, Seward Meridian;
 - B) the Seward Meridian;
 - C) the south boundary of Township 7 South, Seward Meridian; and
 - D) the west boundary of Range 19 West, Seward Meridian.

⁵ Known oil and gas reserves include the North Slope, Beaufort Sea, and Cook Inlet areas.

1. Annually in April, applicants may submit to the commissioner a proposal for exploratory activity within an area they have specified (11 AAC 82.909(d)); or
2. The commissioner can request proposals anytime to explore areas determined to be subject to the provisions of AS 38.05.132.

Any proposal received by the commissioner must designate how much money the applicant will spend on exploration (the work commitment), the amount and location of acreage desired for licensing, and the term (duration) of the license. An exploration license area may range from 10,000 to 500,000 acres and must be reasonably compact and contiguous (AS 38.05.132(c)(2)). The exploration license term may not exceed 10 years (AS 38.05.132(b)(1)). The proposal need not describe the type of exploration activity, although direct exploration expenditures must meet the requirements of AS 38.05.132(f)(1). However, before any exploration license may be granted or any exploration activity may occur, the proposed activity must first go through the authorization processes required by statute.

2. License Proposal Notice and Preliminary Finding

The Gulf of Alaska exploration license process was initiated on April 23, 2015 when DO&G received a timely exploration license application from Cassandra Energy Corporation. Agency review and public comments were requested and reviewed as part of the adjudication process for this exploration license proposal. Summaries of the comments received and responses to those comments are included in Appendix A. Chapter 1 contains a more thorough review of the timeline and process for reviewing the license proposal and requesting public comments.

The process for receiving public input begins with a request for information from state and federal agencies, and local governments. DO&G requests information and data about the region's property ownership status, peoples, economy, current uses, subsistence, historic and cultural resources, fish and wildlife, and other natural resource values. Using this information and other relevant information that becomes available, DO&G develops a preliminary written finding and releases it for public comment (AS 38.05.035(e)(7)(A)).

Once a preliminary written finding is issued, DO&G follows AS 38.05.945(a)(3)(A)-(b)(2) to obtain public comments on the preliminary written finding. Public comments assist in developing information for the final written finding. Information provided by agencies and the public assists the director in determining which facts and issues are material to the decision of whether the exploration license is in the state's best interest, and in determining the reasonably foreseeable, significant effects of the exploration license. After receiving public comments on the preliminary best interest finding, DO&G reviews all comments and incorporates additional relevant information and issues into the final written finding. DO&G will also include a summary of, and responses to comments received during the public comment period. Public comments on this preliminary written finding must be received in writing by October 4, 2019.

3. Term and Work Commitment

In accordance with 11 AAC 82.906, the director set a 10-year term for the exploration license. The exploration license application included a proposal with the maximum possible term for an

exploration license – 10 years. Recent exploration licenses have been shortened to terms of four to five years in order to encourage timely exploration and to expedite the gathering and return of data regarding the state’s resources. However, due to the remote location on the Gulf of Alaska coast, and the potential difficulty involved in permitting and performing nearshore and offshore exploration work, the license was granted a term of 10 years.

The work commitment amount in the initial proposal was for \$1,000,000. The proposed amount was accepted because it reflects the current economic climate and likely costs to conduct a field program sufficient to realize usable data. Costs of the proposed activities described in the proposal were considered, including remote sensing; geological, geochemical, and geophysical studies; and exploration drilling. The director determined that a \$1,000,000 work commitment is compatible with the proposal.

4. Appeal

A person affected by the final written finding who provided timely written comment on this decision may appeal in accordance with 11 AAC 02. Any appeal must be received within 20 calendar days after the date of “issuance” of this decision, as defined in 11 AAC 02.040(c) and (d) and include the appropriate fee. An appeal may be mailed or delivered to Commissioner, Department of Natural Resources, 550 W. 7th Avenue, Suite 1400, Anchorage, Alaska 99501; faxed to 1-907-269-8918; or sent by electronic mail to dnr.appeals@alaska.gov.

An eligible person must first appeal the final written finding in accordance with 11 AAC 02 before appealing that decision to Superior Court. If the commissioner does not act on an appeal within 30 days after issuance of that decision, the appeal is considered denied and this decision becomes a final administrative order and decision by the 31st day after issuance for the purposes of an appeal to Superior Court. A copy of 11 AAC 02 may be obtained from any regional information office of DNR.

5. Exploration License Issuance and Conversion to Lease

After a license is issued, the licensee must pay a one-time, \$1.00 per acre license fee (AS 38.05.132(c)(6)). The licensee must annually post a bond equal to the work commitment, less the cumulative expended, divided by the years of the remaining license term (AS 38.05.132(c)(4)). There are no additional charges during the term of the license. Upon fulfilling the work commitment, the bond is released. If the work commitment is not fulfilled, the bond is forfeited to the state.

An annual report for the license is due on or before the anniversary date of the effective date of the license. The annual report satisfies statutory, regulatory, and exploration requirements for:

- Reporting direct expenditures as requested under 11 AAC 82.960 and defined by AS 38.05.132(f);
- Calculating annual bond as required by the license Schedule 2;
- Annual bonding as required by AS 38.05.132(c)(4)(A) and 11 AAC 82.945(c); and

- Submitting geologic or geophysical data as required by 11 AAC 82.981.

The exploration license will be terminated, and the remainder of the security will be forfeited to the state, if the licensee has not completed at least 25 percent of the total work commitment by the fourth anniversary of the exploration license (AS 38.05.132(d)(1)). Twenty-five percent of the licensed area would be relinquished if the licensee has completed less than 50 percent of the total work commitment, and an additional 10 percent relinquished each successive year until half of the original acreage has been relinquished (AS 38.05.132(d)(2)).

The commissioner will convert all or a portion of the License Area to a standard oil and gas lease or leases once the work commitment has been met and if the licensee requests conversion (AS 38.05.134). If the exploration license issued was for exploration for and recovery of oil and gas, then the lease issued shall be limited to exploration for and recovery of oil and gas (AS 38.05.180(d)(2)(E)). For these reasons, this preliminary written finding contemplates that the exploration license may be converted to a lease or leases.

Chapter Three: Description and Location of the License Area

Contents

	Page
A. Property Location and General Description.....	3-1
B. Land and Mineral Ownership.....	3-1
C. History and Cultural Resources	3-5
D. Local Communities.....	3-6
1. Cordova	3-6
2. Chenega	3-7
3. Tatitlek.....	3-7
4. Valdez.....	3-8
5. City and Borough of Yakutat.....	3-9
E. Climate	3-10
F. Natural Hazards	3-11
1. Earthquakes and Faulting	3-11
2. Tsunamis.....	3-13
3. Mass Wasting and Avalanches	3-13
4. Glaciers, Icebergs, and Outburst Flooding	3-14
5. Mitigation Measures	3-14
G. References.....	3-15

Figures

	Page
Figure 3.1. Gulf of Alaska Area Map.....	3-3
Figure 3.2. Gulf of Alaska Land Status Map.....	3-4

Chapter Three: Description and Location of the License Area

AS 38.05.035(g)(1)(B)(i) requires that the director consider and discuss the property descriptions and locations of the License Area. The following overview includes the property descriptions and locations of the License Area and other information material to the director’s written finding that the exploration license will best serve the state’s interest (AS 38.05.035(e)(1)(B)(iii)).

A. Property Location and General Description

The Gulf of Alaska exploration license area (License Area) consists of approximately 65,773 acres approximately 40 miles east of Cordova. The License Area consists of state-owned, unencumbered land within Township 19-21 S., Range 5-8 E., Copper River Meridian. The License Area includes state land and water in and around Controller Bay from north of the Okalee Spit northwest to Katalla Bay and Point Martin. The License Area boundary includes the eastern edge of the Copper River Delta State Critical Habitat Area. The License Area also includes Kanak Island and waters around the mouths of the Bering, Nichawak, Campbell, and Edwards rivers (Figures 3.1 and 3.2). The primary access route to the License Area is by marine vessel. It is not located within a specific borough.

B. Land and Mineral Ownership

The Alaska Statehood Act granted to the State of Alaska the right to select from the federal public domain 102.5 million acres of land to serve as an economic base for the new state. The Statehood Act also granted to Alaska the right to all minerals underlying these selections and specifically required the state to retain this mineral interest when conveying its interests in the land (AS 38.05.125). Accordingly, when state land is conveyed to an individual, local government, or other entity, state law requires that the deed reserve the mineral rights for the state unless there is a prior, valid claim. Furthermore, state law reserves to the state the right to reasonable access to the surface for purposes of exploring for, developing, and producing the reserved mineral.

The Alaska Statehood Act also provided for the U.S. Submerged Lands Act to apply to Alaska. The U.S. Submerged Lands Act of May 22, 1953 states that all lands permanently or periodically covered by tidal waters up to, but not above, the line of mean high tide and seaward to a line three miles from the coast mean low tide line is owned by the state. The U.S. Submerged Lands Act sought to return title of submerged lands to the states and promote exploration and development of oil and gas in coastal waters.

On March 31, 1992, DNR and the U.S. Department of Agriculture, Forest Service entered into a Memorandum of Agreement (MOA) regarding lands within and adjacent to the License Area in the Chugach and Tongass National Forests. The agencies signed the MOA because of the significant changes to the landscape and shifting of the substrate along the Gulf of Alaska coast and along the coastline of the License Area resulting from the 1964 Great Alaska Earthquake. Lands were uplifted to become uplands that were once submerged tidelands within the License Area during and

following the massive earthquake. In the MOA, the Forest Service has management responsibility over lands that are above the current mean high tide line, and DNR manages lands that are below the mean high tide line. In the License Area, these coastal lands are generally uplifted lands that were previously state-owned submerged lands granting management responsibility for those lands to the Forest Service. The agreement requires that the agencies will notify each other before making commitments to land uses in excess of two years and will require concurrence for the commitment of land uses over ten years until the Forest Service and DNR reach a longer-term resolution or otherwise terminate the agreement. This exploration license contains approximately 4,822 acres of the coastal lands defined in the MOA. The award of this acreage is pending the state acquiring quiet title to those lands. As the title is acquired, then that acreage will become part of the License Area.

The Alaska Native Claims Settlement Act (ANCSA), passed by Congress in 1971, also granted newly created regional Native corporations the right to select and obtain the land and mineral estates within the regional Native corporation boundaries from the federal domain. It also allowed Native village corporations and individual Alaskan Natives to receive land estate interests. However, overlapping selections created conflicts and delays in conveying the land from the federal government, and some selected lands have yet to be conveyed. Native-owned lands are present adjacent to the License Area in uplands along the shores of Controller Bay.

Titles conveyed under ANCSA and the Alaska Native Allotment Act are held in restricted status, and the surface estate cannot be alienated or encumbered without approval from the Bureau of Indian Affairs (BIA) (43 CFR 2561.3). However, some allottees have successfully applied to the BIA to have the restrictions removed and were issued a patent in fee which vested all management authority in the allottee. Should lands wherein the surface is owned by an entity other than the state be offered and licensed or leased by the State of Alaska, rights to exploration and development of the oil and gas resources may not be exercised until the licensees make provisions to compensate the landowner for full payment for all damages sustained by the owner, by reason of entering upon the land, as required by the license, subsequent leases and AS 38.05.130 as applicable. Mineral closing orders, which are commonly associated with surface land disposal, do not apply to oil and gas leasing.

Figure 3.1. Gulf of Alaska Area Map

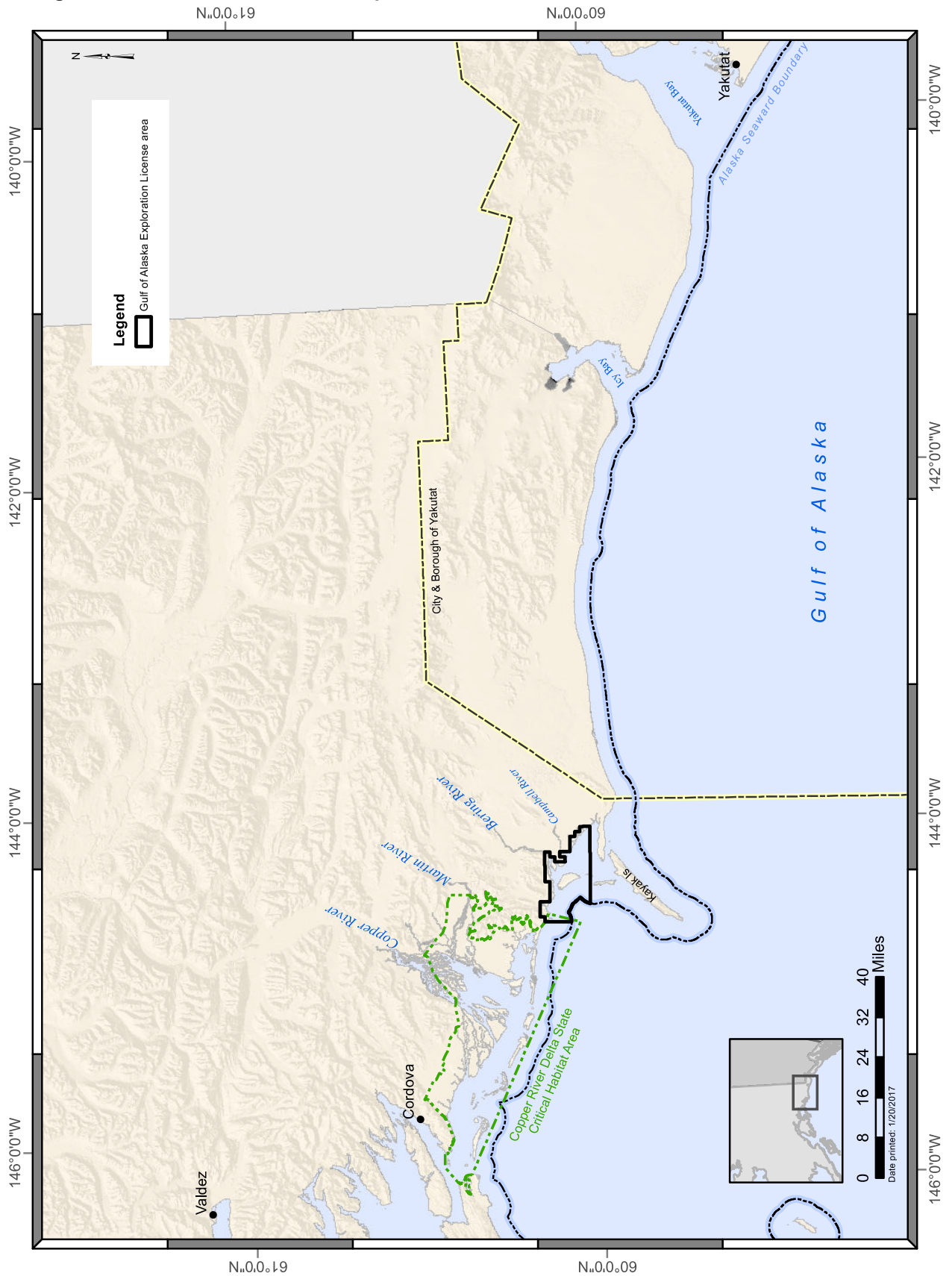
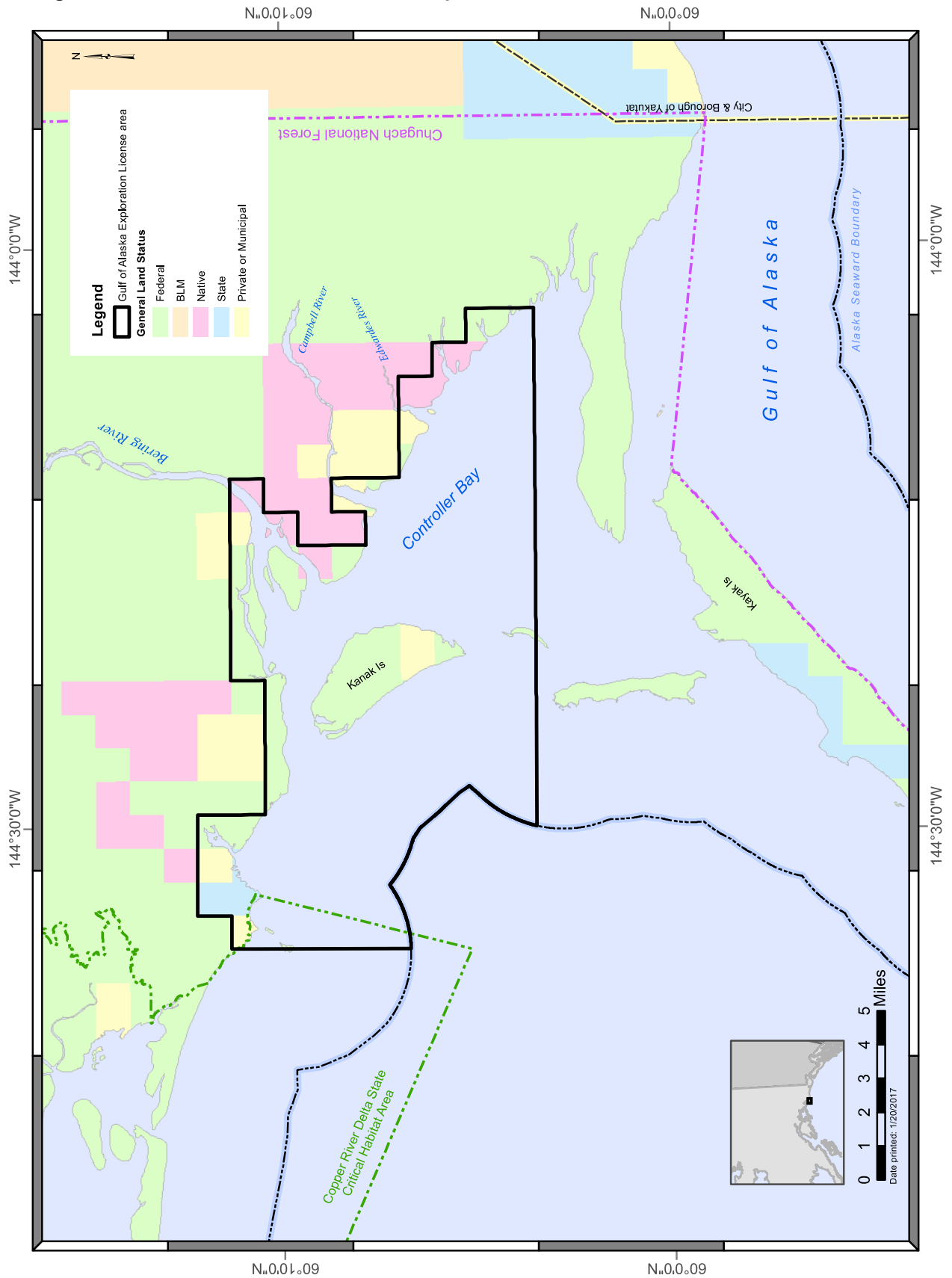


Figure 3.2. Gulf of Alaska Land Status Map



C. History and Cultural Resources

Historic and cultural resources can include a range of sites, deposits, structures, ruins, buildings, graves, artifacts, fossils, and objects of antiquity which provide information pertaining to the historical or prehistoric culture of people in the state, as well as to the natural history of the state.

The Alaska Heritage Resources Survey database indicates that there are cultural resource sites within the License Area. Only a small portion of the state has been surveyed for cultural resources and previously unidentified resources may be located within the License Area. Specific historical accounts for the License Area are unknown, therefore, historical context for the License Area, in general, is provided (AHRS 2018).

The Alaska Heritage Resources Survey database indicates that there are 126 reported cultural resource sites within the solicitation area for this license and 21 reported cultural resource sites within the License Area. The resource types include paleontological sites, prehistoric sites, Russian-era occupation sites, and early 20th century era sites (AHRS 2017).

Archaeological records show the Controller Bay area was inhabited approximately 6,000 years ago. The area defines the boundary for several different Alaska Native cultures. The Eskimo or Alutiiq from the west, the Athabaskan natives from the interior and the Tlinkit from the southeast all have the extents of their territories near the License Area. In 1741, Russian explorer Vitus Bering arrived in Controller Bay on Kayak Island with naturalist Georg Steller and they were the first Europeans known to encounter the coastal region near the License Area (Katalla 2018). Captain James Cook also landed on the northwest tip of Kayak Island in 1778, a few miles south of where Steller and Bering landed. The Bering Steller Land Site has been declared a National Landmark and is sometimes referred to as the Plymouth Rock of Alaska (DNR 1988).

Throughout the maritime history of the Gulf of Alaska, numerous shipwrecks occurred; the highest density of which were within 50 nautical miles of shore and at depths of 650 feet and greater. Dozens of shipwrecks have been documented along the coastline and within the 12-mile nautical limit from Cape Yakataga to and around Prince William Sound; there are two documented shipwrecks just south of the License Area boundary (NOAA 2018; Commander US Pacific Fleet 2011).

In September 1902, the Alaska Development Company, also known as the English Co., discovered commercial quantities of oil at Katalla. The New York Times reported the discovery of oil at Katalla, and inaccurately stated that the English Co. had struck a gusher of oil spewing 200 feet into the air (Katalla 2018). With word of the discovery in the national news, the population of Katalla expanded to 5,000 people by 1908 (Brown 2016).

Between 1902 and 1931, there were 28 oil wells drilled in the Katalla oil field and 44 wells drilled in the area (AOGCC 2005). Initially, oil was stored in pits dug into the ground; storage tanks were constructed subsequently (Katalla 2018). In total, 154,000 barrels of oil were produced and refined in a small refinery that was completed in 1911 at the Katalla oil field until it burned down in 1933 (AOGCC 2005). The refinery was never rebuilt, and people began leaving the area. Katalla's post office closed in 1943 as the area became a ghost town. The site of the former Chilkat Oil Company refinery was named to the National Register of Historic Places in 1974 (Brown 2016).

D. Local Communities

There are no communities within the License Area and the License Area does not coincide with any borough boundaries. The City of Cordova, located approximately 35 miles west of the License Area's western boundary, is the closest community. Anchorage is located approximately 175 miles to the northwest of the License Area. Other towns and villages in the broad vicinity of the License Area include Chenega Bay, Tatitlek, Valdez, and Yakutat (Figure 3.1).

1. Cordova

Cordova is a home rule city 150 miles southeast of Anchorage at the southeastern edge of Prince William Sound. In 2017, it had a population of 2,279. Between 2000 and 2010, the population increased 8 percent. Since 2010, it has increased another 2 percent. Cordova's population in 2010 was 70.3 percent Caucasian, 10.9 percent Asian, 8.8 percent American Indian or Alaska Native, and about 9 percent identified themselves as multiracial (DOLWD 2018).

In 2016, about 29 percent of the Cordova workforce was employed in state and local government, 20 percent worked in trade, transportation, and utilities, 16 percent worked in manufacturing, 10 percent worked in professional and business services, and 6 percent worked in leisure and hospitality (DOLWD 2018).

Cordova supports a large fishing fleet for Prince William Sound and the Copper River delta and there are six onshore fish processing plants (City of Cordova 2018). In 2017, 337 residents held commercial fishing permits. Between 2010 and 2014, the estimated per capita income was \$39,828, median household income was \$93,750, and median family income was \$117,793. In 2017, about 2.4 percent of the population was below the poverty level (DCCED 2018).

The city's power is supplied by the Cordova Electric Cooperative. In 2015, the residential rate was \$0.2217 per kWh if using more than 500 kWh per month (Cordova Electric Cooperative 2018).

Cordova is accessible by plane or boat, is linked to the North Pacific Ocean shipping lanes through the Gulf of Alaska and receives barge and state ferry services all year (City of Cordova 2018).

There is a state operated airport with a 7,500-foot asphalt runway and 1,899-foot gravel crosswind runway. The Cordova Municipal Airport, which is owned by the state and operated by the city, has a 1,800 foot gravel runway. There is also a private airstrip owned by Eyak Corporation. Daily scheduled jet flights and air taxis are available. Float planes land at the Lake Eyak seaplane base or at the boat harbor (DCCED 2018).

The City of Cordova operates the port, which includes three large docks. Harbor facilities include a small boat harbor that can accommodate 727 vessels, two launch ramps, a boat haul-out, a 150-ton travel lift, and a shipyard with marine repair services (City of Cordova 2018). A 48-mile gravel road provides access to the Copper River delta to the east (DCCED 2018).

Cordova has a city school district with an elementary school, an alternative school for kindergarten through twelfth grade, and a combined middle and high school. In 2017, 329 students attended school. There is a community medical center, a volunteer fire department with emergency medical and ambulance services, a recreation center, and swimming pool (DCCED 2018). The federally

recognized tribe Native Village of Eyak is based in Cordova. The tribe operates a community health center, a cultural center, and provides social services to tribal members (Eyak 2018).

2. Chenega

Chenega, also known as Chenega Bay, is an unincorporated town in southwest Prince William Sound, 104 air miles southeast of Anchorage, and approximately 130 miles west of the License Area. In 2017, Chenega Bay had a population of 69 (DCCED 2018).

According to the 2010 census, the population was 52.6 percent American Indian or Alaska Native, 39.5 percent Caucasian, and 7.9 percent multiracial (DOLWD 2018). Between 2000 and 2010, the population declined 3 percent. The Native Village of Chenega is the community's federally recognized tribe (DCCED 2018).

In 2017, about 53 percent of the Chenega Bay workforce was employed in state and local government, 12 percent worked in financial activities, 6 percent in education and health services, 6 percent in natural resources and mining, and 6 percent in professional and business services. Commercial fishing and subsistence activities also contribute to the economy (DOLWD 2018).

Chenega Bay has a small boat harbor and dock. The state maintains a 3,000-foot gravel runway, and there is an area for float plane landings. Chenega Bay is also served by the Alaska Marine Highway Ferry system. The Native Village of Chenega operates the power plant in the village. In 2015, it provided power for \$0.17 per kWh subsidized by the state Power Cost Equalization (PCE) program (DCCED 2018).

There is one school in the community. In 2017, it was attended by 16 students. Primary health care is provided by the Arch Priest Nicholas Kompkoff Clinic. Chenega Bay has a fire department that also provides emergency medical services (DCCED 2018).

3. Tatitlek

Tatitlek is an unincorporated community about 30 miles northwest of Cordova in Prince William Sound, and approximately 90 miles northwest of the License Area. In 2017, it had a population of 93 (DCCED 2018). Its 2010 population was 60.2 percent American Indian or Alaska Native, 30.7 percent Caucasian, 5.7 percent multiracial, 1.1 percent Asian, and 1.1 percent Pacific Islander (DOLWD 2018).

In 2017, about 62 percent of the Tatitlek workforce was employed in local government, 9.5 percent in professional and business services, and 9.5 percent in trade, transportation, and utilities, (DOLWD 2018). One resident held a commercial fishing permit. Between 2010 and 2014, the estimated per capita income was \$25,738, median household income was \$35,833, and median family income was \$40,000. In 2017, about 16 percent of the population was below the poverty level (DCCED 2018).

The Tatitlek Indian Reorganization Act Village Council operates the Tatitlek Electric Utility. In 2017, it provided power for \$0.34 per kWh with a state subsidy. There is one school located in the community. In 2017, it was attended by 17 students. The Tatitlek Clinic provides basic health care.

The state maintains an airport with one 3,700-foot runway. The community is also served by the Alaska Marine Highway Ferry system (DCCED 2018).

4. Valdez

Valdez is a home rule city about 300 road miles east of Anchorage, and approximately 95 air miles northwest of the License Area. In 2017, Valdez had a population of 3,937. Valdez is on the north shore of Port Valdez, a deep-water fjord in Prince William Sound (DCCED 2018). In 2016, about 81.5 percent of the population is Caucasian, 8.2 percent American Indian or Alaska Native, 6.3 percent multiracial, and 1.9 percent Asian (DOLWD 2018).

The Valdez economy was transformed in the late 1970s when the city was selected to be the terminus for the Trans-Alaska Pipeline. The population boomed with construction of the marine terminal and, after it was built, the city's population settled to levels six to eight times what it had historically been before the pipeline. Valdez has the second-highest municipal tax base in the state because of its position as the southern terminus and offloading point for the Trans-Alaska Pipeline System (DCCED 2018).

In 2017, 90 percent of the local tax revenues come from the Valdez marine terminal, Petro Star's Valdez refinery, and other TAPS pipeline facilities. Approximately 440 employees of the refinery, Alyeska Pipeline or the Marine Terminal, and oil and gas support service company employees live in Valdez (McDowell Group 2017). Two fish processing plants operate in Valdez. In addition, the Valdez Fisheries Development Association operates the Valdez Fish Hatchery all year and a processing plant during fishing season. Several cruise ships dock in Valdez each year (DCCED 2018).

In 2017, about 22 percent of Valdez jobs were in state and local government, 27 percent of the jobs were in transportation, trade, and utilities, 12 percent worked in education and health services, 11 percent worked in leisure and hospitality, 8 percent of the workforce was in manufacturing and construction, and 6 percent worked in natural resources and mining (DOLWD 2018). In 2017, there were 33 commercial fishing permits in Valdez. Between 2009 and 2013, the estimated per capita income between 2010 and 2014 was \$35,032, median household income was \$99,973, and median family income was \$101,786. In 2017, about 8 percent of the population lived below the poverty level (DCCED 2018).

Valdez is connected to the state road system by the Richardson Highway and is also on the Alaska Marine Highway System. There is a state airport with a 6,500-foot paved runway, a floatplane lake northwest of town, and two heliports. The harbor is ice free all year (DCCED 2018).

Valdez has a small boat harbor with 511 slips, vessel maintenance facilities, and a boat yard with a 75-ton travel lift and an all tide launching ramp (City of Valdez 2018). The Alyeska Pipeline Service Company owns and operates the Valdez Marine Terminal, which is the end of the Trans-Alaska Pipeline and occupies more than 1,000 acres of land. There are 14 storage tanks in service, facilities to measure the incoming oil, two functional loading berths, and a power plant at the terminal (Alyeska Pipeline Service Company 2018).

The City of Valdez operates a municipal water supply system that draws from four wells and is stored in reservoirs and a sewage treatment plant. The city has a Class II municipal landfill with an oil and hazardous waste recycling center (City of Valdez 2018). Power is provided by the Copper Valley Electric Authority from the Solomon Gulch Hydroelectric Project and from a cogeneration plant built with Petro Star, which runs an oil refinery in Valdez. In 2017, the residential cost of power in Valdez was \$0.28 per kWh (DCCED 2018).

Other municipal services include a library, museum, civic center, police, fire and emergency medical services. There is a hospital and mental health services available in Valdez. There is a city school district with three schools and one correspondence school. In 2017, there were 654 students among the four schools (DCCED 2018).

5. City and Borough of Yakutat

Yakutat is a home rule borough 220 miles southeast of Cordova, and approximately 165 air miles east southeast of the License Area. In 2017, it had a population of 552 people (DCCED 2018). The City of Yakutat is on the Gulf of Alaska at the mouth of Yakutat Bay. According to the 2010 census, Yakutat's population was 42.4 percent Caucasian, 35.8 percent American Indian or Alaska Native, 15.4 percent multiracial, 4.1 percent Asian, and 1.8 percent Pacific Islander. (DOLWD 2018).

In 2016, about 47 percent of the working population was employed in state and local government, 16 percent worked in trade, transportation, and utilities, 13 percent worked in leisure and hospitality, and 8 percent worked in manufacturing (DOLWD 2018). Between 2010 and 2014, the estimated per capita income was \$33,475, median household income was \$69,306, and median family income was \$76,000. In 2016, about 4 percent of the population was below the poverty level (DCCED 2018).

Yakutat is accessible by air and water. There are scheduled jet flights, air taxis and float plane services to Yakutat. The state maintains two runways large enough to accommodate jets. The U.S. Forest Service owns five airstrips in the vicinity, and the National Park Service operates one airstrip at East Alsek River (DCCED 2018).

The City and Borough of Yakutat operates a public water system, a power system, and the landfill. Water is treated and piped to all homes and schools in the community. A private firm collects refuse, and the borough operates an unpermitted landfill. Barges deliver goods monthly during the winter, and more frequently in summer. Yakutat is on the Alaska Marine Highway Ferry system. The borough operates the small boat harbor, which has a dedicated seaplane float (DCCED 2018).

There is one public school and one correspondence school in Yakutat. In 2017, a total of 93 students attended both schools through 12th grade. Emergency medical service is provided by volunteers. The federally recognized Yakutat Tlingit Tribe and the Yakutat Native Association are based in Yakutat (DCCED 2018).

E. Climate

The climate of the License Area and surrounding Gulf of Alaska is influenced by the Aleutian low, a semi-permanent low-pressure center that originates in the northern Gulf of Alaska, which controls atmospheric circulation in the region. The Aleutian low generates storms and migratory lows and is most active in late fall to spring. The Pacific storm track generated by the Aleutian low terminates in Southeast Alaska and the eastern Gulf of Alaska, leading to abundant precipitation. Much of the precipitation that falls runs back into the ocean because of the steep topography. This runoff drives the Alaska current and the Alaska coastal current, which is thought to bring warm water from the south along the Alaska coast (Mix et al. 2003).

The North Pacific high-pressure system dominates summer weather from its origins in the northeast Pacific Ocean when the Aleutian low is weaker. It leads to cooler summers on average in the Gulf of Alaska than in the continental zone (Mix et al. 2003).

The License Area falls within the Gulf Coast maritime climate zone with persistent rain and fog. The area is characterized by long cold winters and mild summers; however, the area does not experience long periods of freezing weather at the lower altitudes. During 2014 and 2015 approximately 93.1 inches of precipitation fell in the town of Cordova, with 17 inches of snow. The maximum daily temperature recorded was 82 °F and the minimum daily temperature recorded was 2 °F (DCCED 2018)

Specific data for the License Area is not readily available, therefore, weather data for Cordova, Alaska generally are used to represent weather patterns that are likely to occur in the License Area. On average, July 31 is the hottest day of the year, with temperatures ranging from 49 °F to 62 °F and January 15 is normally the coldest day of the year with a temperature range of 21 °F to 32 °F. The wetter season lasts from the end of May through the middle of October, with July and August being the rainiest months, and March and April being the driest months (Weatherspark 2018).

Temperature and precipitation records from 1949 to 2014 show annual and seasonal mean temperature increases throughout Alaska. The average temperature increased in Alaska 3.0 °F from 1949 to 2014, although the temperature changes varied greatly across the state. Most of the change occurred in winter and spring months and the least amount in fall (ACRC 2017). According to an ongoing temperature analysis conducted by scientists at NASA's Goddard Institute for Space Studies, the average global temperature increased by about 0.8 °C (1.4 °F) since 1880. Two-thirds of the warming occurred since 1975, at a rate of roughly 0.15–0.20 °C per decade (Carlowicz 2017).

The global temperature record represents an average over the entire surface of the planet because temperatures vary significantly by region and shifts in temperature did not occur uniformly across all regions. Global temperature mainly depends on how much energy the planet receives from the sun and how much energy it radiates back into space. Whereas, local or regional temperatures fluctuate substantially due to predictable cyclical events, like night and day, summer and winter, and variable, sometimes hard-to-predict, wind and precipitation patterns (Carlowicz 2017).

Temperatures are increasing in Alaska more rapidly than in other parts of the country leading it to be identified as the forefront for climate change in the United States. It is estimated that

infrastructure will be damaged by the increasing temperatures and projected rising sea levels costing up to \$270 million dollars annually for the associated repairs. Climate change may lead to higher ground temperatures and relative sea level rise which could cause increased frequency of flooding and accelerate erosion in some regions of the state causing changes to the landscape and habitats (Berman et al. 2018).

Temperature and precipitation records from 1949 to 2014 show annual and seasonal mean temperature increases throughout Alaska. The average temperature increase in Alaska from 1949 to 2014 was 3.0°F, although the temperature changes varied from one climactic zone to another as well as seasonally (ACRA 2016). The average global temperature of the earth has increased by approximately 1.4°F since 1880, with the greatest increase occurring since 1975 at a rate of approximately 0.27°F to 0.36°F per decade. The global temperature record represents an average over the entire surface of the planet because temperatures vary significantly by region and shifts in temperature did not occur uniformly across all regions. Global temperature mainly depends on how much energy the planet receives from the sun and how much energy it radiates back into space. Whereas, local or regional temperatures fluctuate substantially due to predictable cyclical events, like night and day, summer and winter, and variable, sometimes hard-to-predict, wind and precipitation patterns (Carlowicz 2017; NRC 2015). Taken in isolation, local or regional temperatures generally, do not provide a complete representation of global climate change historically or provide a sound basis for predicting future changes on a global scale. However, the physical changes related to increasing temperatures include melting permafrost, sea ice, and glaciers are more evident and have generally occurred faster in the arctic than any other region (NRC 2015; Smith et al. 2017).

Governor Bill Walker established an Alaska Climate Change Strategy and Climate Action leadership team by Administrative Order 289. The Strategy was built upon previous climate policy initiatives in the state to develop innovative solutions to the challenges of a rapidly changing climate. Governor Michael J. Dunleavy rescinded Administrative Order 289 on February 22, 2019 by Administrative Order 309.

F. Natural Hazards

Natural hazards include geological, meteorological, and other naturally occurring phenomena that may have a negative effect on people or the environment. Natural hazards may impose constraints on oil and gas exploration, development, production, and transportation activities. There are four major categories of natural hazards within the License Area, including earthquakes and faulting; tsunamis; mass wasting and avalanche; and glaciers, icebergs, and outburst flooding.

1. Earthquakes and Faulting

Every day scores of earthquakes register on seismic stations around Alaska. On average since 1900, Alaska has been struck by one earthquake of magnitude 8 or greater every 13 years one magnitude 7 to 8 earthquake every two years, and six magnitude 6 to 7 earthquakes every year (ASHSC 2018). Between the Queen Charlotte-Fairweather fault system to the east and the Alaska-Aleutian megathrust subduction zone to the west, the Gulf of Alaska is an area of complicated and highly active plate tectonics. There are three primary tectonic plates interacting near the northeastern Gulf

of Alaska coast: 1) the Pacific plate, which is being forced beneath the 2) North American plate, and the 3) Yakutat microplate, a terrane stuck to the back of the Pacific plate that is complicating the subduction. The Alaska-Aleutian megathrust fault system is responsible for the second-largest earthquake ever recorded throughout the world (magnitude 9.2, the 1964 Great Alaska earthquake) (Freymueller et al. 2008).

The Queen Charlotte-Fairweather fault is a right-lateral strike-slip system that is essentially parallel to and coincident with the Southeast Alaska coastline. The Alaska-Aleutian megathrust (i.e. the subduction zone) extends from the Gulf of Alaska westward for over 2,000 miles towards Russia. A transition fault cuts the ocean floor near the back edge of the Yakutat microplate and connects the Alaska-Aleutian megathrust with the Fairweather fault. The Yakutat terrane is beneath this section of the Gulf of Alaska and measures 372 miles by 124 miles. The Pacific plate moves relative to the North American plate at more than 2 inches per year, and the Yakutat microplate is largely responsible for the rapid growth of mountains at the northeast edge of the Gulf of Alaska (Plafker and Berg 1994).

The Yakataga seismic gap lies between the Queen Charlotte-Fairweather fault and the Alaska-Aleutian trench and is an area with notably less earthquake activity than neighboring regions (Plafker and Berg 1994). This is an area of significant plate convergence, though the details of the faulting are not well understood. In this area there have been only two significant earthquakes, in 1899 and 1979 (Hansen and Combellick 1998). The magnitude 6.9 1979 earthquake caused slight damage in Valdez, Haines, and Juneau; and was felt over a 500,000 square mile area (USGS 2018). The magnitude 8.2 1899 earthquake generated a 32-foot tsunami in Yakutat Bay (Hansen and Combellick 1998). Researchers have noted evidence of right-lateral slip of about 0.6 inches per year north of Cape Yakataga (Wesson et al. 2007), and uplifted terraces inland of Yakutat suggest that significant earthquakes along the Yakataga seismic gap that cause vertical motions that occur every 500 to 1400 years (Hansen and Combellick 1998).

The Queen Charlotte-Fairweather fault system has generated four large earthquakes in the 20th century. One of them, though centered 183 miles south of Yakutat at Chichagof Island, had a total rupture length of 310 miles. In 1958, another large earthquake with magnitude 7.8 occurred approximately 275 miles farther south, ruptured approximately 217 miles of the fault, and caused lateral displacements up to 21 feet. This earthquake triggered a landslide in Lituya Bay and the largest tsunami wave ever recorded and is discussed in more detail in the tsunami section to follow (Hansen and Combellick 1998). Near Yakutat, between 1893 and 1975, there were five earthquakes with magnitudes ranging from 7.0 to 8.6 and at least 110 smaller earthquakes (Yehle 1979).

The 1964 Great Alaska earthquake's epicenter was approximately 56 miles west of Valdez, and the total rupture area extended down the Alaska-Aleutian megathrust to the southwest edge of Kodiak Island. The massive magnitude 9.2 earthquake caused distributed regional subsidence (down-dropping) and uplift from Kodiak Island to parts of the Copper River Delta. The Copper River delta stratigraphy preserves a history of repeated vertical deformation from large earthquakes. Paleoseismic work there identified 9-10 major events over a 5,600-year period suggesting an average recurrence interval of 600-700 years between large events (Koehler and Carver 2018).

The 1964 earthquake caused significant shifting of lands in and around the License Area. Lands that were previously submerged below the high tide line were uplifted causing thousands of acres of

submerged lands along the shoreline of the License Area to become uplands. Uplifted areas in Controller Bay rendered the existing channels and harbors to become unusable (Plafker et al. 1969)

2. Tsunamis

The Alaska-Aleutian megathrust has the potential to generate the largest earthquakes in the world and consequently communities on Alaska's Pacific coast are at risk of earthquake induced tsunamis. Large seismic events in the Gulf of Alaska have very high potential to generate local and Pacific-wide tsunamis (Suleimani et al. 2005). Thirteen tsunamis were recorded between 1845 and 1968 along the northern Gulf of Alaska (Yehle 1979).

A large earthquake involving offshore seafloor displacement in the Gulf of Alaska could generate a tsunami large enough to destroy coastal facilities in Alaska and affect communities across the Pacific Ocean. The tsunami created by the 1964 earthquake in Prince William Sound destroyed the city of Valdez and the village of Chenega and caused fatalities on the west coast of the United States, but it did not affect the Gulf of Alaska east of Prince William Sound (Combellick 1993). Extended ruptures of the Yakataga seismic gap, however, could cause tsunamis in the Gulf of Alaska (Shennan et al. 2008).

Other large waves of different origins have been recorded – likely caused by calving glaciers and underwater landslides, both of which can be triggered by large earthquakes or volcanic activity. The world's largest recorded tsunami originated approximately 250 miles southeast of the License Area in Lituya Bay. On July 10, 1958, a magnitude 7.7 earthquake along the Fairweather fault caused a large rockslide at the head of the bay. Over 2-billion cubic feet of rock fell approximately 2,000 feet down into the head of the bay and caused a 1,720-foot-tall wave that scoured the walls of the narrow inlet. The wave poured out of the bay moving 100 miles per hour, and 5 people died as a result of the tsunami (WSSPC 2018; Miller 1960).

3. Mass Wasting and Avalanches

Landslides and slope movement can be caused by geologic factors other than seismic activity. The steep coastal slopes are often susceptible to landslides. The Tongass National Forest landslide inventory documents hundreds of landslides in southeast Alaska. The Alaska Department of Transportation has documented a number of landslides near Cordova as well (ADOT 2018; USFS 2018). The continental shelf of the Gulf of Alaska seafloor has numerous areas of unstable sediment and large submarine slides south of Icy Bay and west of Kayak Island were likely triggered by earthquakes. Surface or near-surface faults have been identified south of Cape Yakataga and parallel to the southeastern shore of Kayak Island (Combellick 1993).

Snow avalanche conditions generally occur in steep terrain, with high winds and heavy snow loading contributing to their development. Snow avalanches can be released by a high and rapid rate of precipitation, which can influence the balance between stress and strength of the snowpack, by wind transporting snow to a slope, and by changes in air temperature, which can affect snow stability (Schweizer et al. 2003). Once snow conditions are in place avalanches can also be triggered by nearby earthquakes or volcanoes (Combellick 1993).

4. Glaciers, Icebergs, and Outburst Flooding

Icebergs and glacial outburst flooding have occurred in the Gulf of Alaska area. Between 1980 and 1992, the Columbia Glacier in Prince William Sound has retreated 6 miles, producing large numbers of icebergs that have created a navigational hazard. More than 700 tankers move through Prince William Sound annually, often at night and in reduced visibility. In 1994, an empty oil tanker hit an iceberg that gouged a hole 20 feet wide in the ship. If the Columbia Glacier continues its retreat, at some point it will no longer be in tidewater and will cease calving into the sound; however, several other calving glaciers have entered the fjord (Tangborn and Post 1998; USGS 1996).

A Prince William Sound risk assessment in the mid-1990s identified icebergs in tanker lanes as among the most significant risks to crude oil tankers. A later study estimated the volume of icebergs calving from Columbia Glacier had increased fivefold and that the trend was likely to continue or intensify (Merrick et al. 2002).

Outburst floods occur when a body of water held back by a glacier is suddenly released. Areas affected by outburst flooding are subjected to serious damage. Wide flood plains are inundated to unusual depths and the high rate of discharge produces rapid erosion, deposition and changes in the stream channel. The Bering, Yakataga and White River glaciers all impound lakes with the potential to drain catastrophically as the physical characteristics of the glaciers change. The White River and Yakataga rivers are to the southeast of the License Area. The Bering River lowlands, which are within the License Area, are especially vulnerable to flooding from Berg Lake, which is impounded by the Steller lobe of the Bering Glacier and has a history of flooding (Combellick 1993). Beach ridges are visible several hundred feet above the current lake level and peak flow from another flood could exceed 1 million cubic feet per second (Post and Mayo 1971). Between 1993 and 1995, three outburst floods released pressurized water from subglacial conduits beneath the Bering Glacier during the glacier's surge (Fleisher et al. 2010). Other streams vulnerable to outburst flooding are Campbell and Seal rivers (Combellick 1993).

5. Mitigation Measures

Several natural hazards exist in the License Area that could pose potential risks to oil and gas installations and are discussed above.

Detailed site-specific studies may be necessary to identify any specific earthquake hazards for any specific site within the area. The risks from earthquake damage can be mitigated by siting facilities away from potentially active faults and unstable areas, and by designing them to meet or exceed national standards and International Building Code seismic specifications for Alaska. Additionally, mitigation measures requiring the siting of facilities away from waterbodies and fish bearing rivers are included in this license to reduce the potential for flood damage to facilities and the resulting effects on the environment.

Although natural hazards could damage oil and gas infrastructure, measures in this best interest finding, regulations, in addition to design and construction standards, are expected to mitigate those hazards. Mitigation measures in this finding address siting of facilities and design and construction of pipelines. A complete listing of mitigation measures is found in Chapter Nine.

G. References

- ACRA (The Alaska Climate Research Center). 2016. Temperature changes in Alaska. Geophysical Institute, University of Fairbanks.
<http://climate.gi.alaska.edu/climtrends/change/tempchange.html> (Accessed May 18, 2017).
- ACRC (Alaska Climate Research Center). 2017. Temperature changes in Alaska.
<http://climate.gi.alaska.edu/ClimTrends/Change/TempChange.html> (Accessed March 13, 2017).
- ADOT (Alaska Department of Transportation). 2018. GAM Event Tracker Geoform Basemap.
<http://akdot.maps.arcgis.com/home/webmap/viewer.html?webmap=ee1ad659cc89480a86584a3c90416465&extent=-150.2046,60.8235,-149.0764,61.1545> (Accessed December 5, 2018).
- AHRS (Alaska Heritage Resources Survey). 2017. Data Repository of the Alaska Heritage Resources Survey. Alaska Department of Natural Resources, Division of Parks and Recreation, Office of History and Archaeology. <https://dnr.alaska.gov/ohasecurity/portal> (Accessed September 28, 2017).
- AHRS (Alaska Heritage Resources Survey). 2018. Overview of the Alaska Heritage Resource Survey. Office of History and Archaeology. <http://dnr.alaska.gov/parks/oha/ahrs/ahrs.htm> (Accessed April 26, 2018).
- Alyeska Pipeline Service Company. 2018. Valdez Marine Terminal. Valdez Marine Terminal & Tankers. 40 years of fueling AK. The Valdez Marine Terminal. TAPS. <http://www.alyeska-pipe.com/TAPS/ValdezTerminalAndTankers> (Accessed October 17, 2018).
- AOGCC (Alaska Oil and Gas Conservation Commission). 2005. AOGCC pool statistics: Katalla Field, Katalla oil pool. Annual Reports Pool statistics - 2004: updated 11 July 2005.
<http://doa.alaska.gov/ogc/annual/2004/PoolsPDF/Oil-Katalla-Katalla.pdf> (Accessed June 24, 2016).
- ASHSC (Alaska Seismic Hazards Safety Commission). 2018. Alaska earthquake statistics. Earthquake risk in Alaska. http://seismic.alaska.gov/earthquake_risk.html (Accessed October 17, 2018).
- Berman, Matthew, Laura Eerkes-Medrano, Thomas Hennessey, Henry P. Huntington, Jeremy Littell, Molly McCammon, Richard Thoman, and Sarah Trainor. 2018. Fourth National Climate Assessment. Pages Chapter 26, Alaska. United States Global Change Research Program.
- Brown, T. 2016. Katalla: Alaska's First Oil Well. Industry/Oil and Gas.
http://www.litsitealaska.org/documents_litsite/Katalla-Alaska's%20First%20Oil%20Well.pdf (Accessed August 27, 2018).
- Carlowicz, M. 2017. World of change: Global temperatures. National Aeronautics and Space Administration. NASA Earth Observatory.
<https://earthobservatory.nasa.gov/Features/WorldOfChange/decadaltemp.php> (Accessed March 13, 2017).
- City of Cordova. 2018. Welcome to Cordova. City of Cordova Alaska.
<http://www.cityofcordova.net/> (Accessed February 22, 2018).
- City of Valdez. 2018. Valdez Alaska. Departments. City of Valdez, Alaska.
<http://www.ci.valdez.ak.us/index.aspx?nid=8> (Accessed October 17, 2018).

Chapter Three: Description and Location of the License Area

- Combellick, R. A. 1993. Geological hazards in and near proposed state of Alaska oil and gas lease sale 79 (Cape Yakataga). Page 11. Alaska Division of Geological & Geophysical Surveys, Public Data File 93-81. Fairbanks.
http://pubs.dggsalaskagov.us/webpubs/dggs/pdf/text/pdf1993_081.pdf (Accessed September 11, 2015).
- Commander US Pacific Fleet. 2011. Gulf of Alaska Navy training activities preliminary final environmental impact statement/overseas environmental impact statement, Appendices A-I, Volume 2. Pearl Harbor, Hawaii.
http://www.goaeis.com/Portals/GOAEIS/files/EIS/GOA_FEIS_Volume_I.pdf (Accessed 8/29/2018).
- Cordova Electric Cooperative, Inc. 2018. Cordova Electric Cooperative rates, effective 03/1/15. The Cooperative. Cordova, Alaska. <https://www.cordovaelectric.com/rates-payment/> (Accessed February 22, 2018).
- DCCED (Department of Commerce, Community and Economic Development). 2018. Community and regional affairs: Community database online.
<https://www.commerce.alaska.gov/dcra/DCRAExternal> (Accessed February 27, 2018).
- DNR (Alaska Department of Natural Resources). 1988. Prince William Sound Area Plan for State Lands.
http://dnr.alaska.gov/mlw/planning/areaplans/prince/pdf/prince_william_sound_area_plan_for_state_lands.pdf (Accessed August 29, 2018).
- DOLWD (Department of Labor and Workforce Development). 2018. Alaska local and regional information. <http://live.laborstats.alaska.gov/alari/index.cfm?r=0&b=0&p=0&goplace=go> (Accessed April 27, 2018).
- Eyak, Native Village of. 2018. Native Village of Eyak Tribal Family Services.
<http://nveyak.com/about/> (Accessed August 29, 2018).
- Fleisher, P. Jay, Palmer K. Bailey, Eric M. Natel, and Andrew J. Russell. 2010. Subglacial hydraulic scouring and deposition during surge-related outburst floods, Bering Glacier, Alaska. *Quaternary Science Reviews* Volume 29(Issues 17-18): 2261-2270.
- Freymueller, Jeffrey T., Hillary Woodard, Steven C. Cohen, Ryan Cross, Julie Elliott, Christopher F. Larsen, Sigrun Hreinsdottir, and Chris Zweck. 2008. Active Deformation Processes in Alaska Based on 15 Years of GPS Measurements.
http://gps.alaska.edu/jeff/Papers/AGU_Freymueller_CH02.pdf (Accessed October 17, 2018).
- Hansen, Roger A. and Rodney A. Combellick. 1998. Planning Scenario Earthquakes for Southeast Alaska. State of Alaska, Department of Natural Resources, Division of Geological and Geophysical Surveys. <http://dggs.alaska.gov/webpubs/dggs/mp/text/mp034.pdf> (Accessed October 17, 2018).
- Katalla. 2018. The Katalla and Controller Bay Alaska Project. <http://katallaproject.tripod.com/> (Accessed October 15, 2018).
- Koehler, R. D. and G. A. Carver. 2018. Active Faulting and Seismic Hazards in Alaska. Alaska Department of Natural Resources, Division of Geological and Geophysical Surveys, Miscellaneous Publication 160. Fairbanks, AK.
<http://dggs.alaska.gov/webpubs/dggs/mp/text/mp160.pdf> (Accessed December 7, 2018).

- McDowell Group. 2017. The role of the oil and gas industry in Alaska's economy. Alaska Oil and Gas Association. Anchorage, Alaska.
http://www.aoga.org/sites/default/files/news/final_mcdowell_group_aoga_report_7.5.17.pdf (Accessed July 26, 2017).
- Merrick, Jason R. W., J. Rene van Dorp, Thomas Mazzuchi, John R. Harrald, John E. Spahn, and Martha Grabowski. 2002. THE Prince William Sound Risk Assessment. Interfaces.
<https://www2.gwu.edu/~icdrm/publications/Interfaces2002.pdf> (Accessed October 22, 2018).
- Miller, Don J. 1960. Giant Waves in Lituya Bay, Alaska. United States Government Printing Office, Washington, DC. <http://pubs.dggsalaskagov.us/webpubs/usgs/p/text/p0354c.pdf> (Accessed October 22, 2018).
- Mix, A., J. Galewsky, B. Hallet, J. Jaeger, P. Koons, K. Kreutz, D. Lawson, E. B. Leopold, A. Meigs, R. Motyka, E. Osterberg, G. Pavlis, T. Pavlis, R. Powell, J. Sauber-Rosenberg, L. Serpa, D. Sharp, L. Reinink-Smith, and S. Zellers. 2003. The interplay of collisional tectonics and late Cenozoic glacial climate in Alaska and the northeastern Pacific Ocean. Continental Dynamics Program. Edited by S. Gulick and J. Jaeger. Earth Sciences Division, National Science Foundations, Joint Oceanographic Institutions, and US Science Support Program, Austin, Texas.
http://users.clas.ufl.edu/jmjaeger/joi_cd/alaska_science_plan_lowres.pdf (Accessed October 23, 2018).
- NOAA (National Oceanic and Atmospheric Administration). 2018. Wrecks and obstructions database. Office of Coast Survey. <https://nauticalcharts.noaa.gov/data/wrecks-and-obstructions.html> (Accessed July 17, 2018).
- NRC (National Research Council). 2015. Arctic matters: The global connection to changes in the Arctic. The National Academies Press. Washington, DC.
<https://www.nap.edu/catalog/21717/arctic-matters-the-global-connection-to-changes-in-the-arctic> (Accessed September 12, 2017).
- Plafker, G. and H. Berg, editors. 1994. The geology of Alaska. The Geological Society of America, The geology of North America Volume G-1. Boulder, Colorado.
http://pubs.dggsalaskagov.us/webpubs/outside/text/dnag_complete.pdf (Accessed October 17, 2018).
- Plafker, G., R. Kachadoorian, E. B. Eckel, and L. R. Mayo. 1969. Effects of the earthquake of March 27, 1964, on various communities. The Alaska earthquake, March 27, 1964: Effects on communities. US Department of the Interior, Geological Survey, Geological Survey Professional Paper 542-G. Washington, DC.
- Post, Austin and Lawrence R. Mayo. 1971. Glacier Dammed Lakes and Outburst Floods in Alaska. United States Geological Survey. <http://pubs.dggsalaskagov.us/webpubs/usgs/ha/text/ha-0455.pdf> (Accessed October 22, 2018).
- Schweizer, Jurg, J. Bruce Jamieson, and Martin Schneebeli. 2003. Snow Avalanche Formation. Review of Geophysics 41(4).
- Shennan, Ian, Ronald Bruhn, and George Plafker. 2008. Multi-segment earthquakes and tsunami potential of the Aleutian megathrust. Quaternary Science Reviews: 1-7.
- Smith, M. A., M. S. Goldman, E. J. Knight, and J. J. Warrenchuk. 2017. Ecological atlas of the Bering, Chukchi, and Beaufort seas. 2nd edition. Audubon Alaska, Anchorage, Alaska.

- <http://ak.audubon.org/conservation/ecological-atlas-bering-chukchi-and-beaufort-seas>
(Accessed August 30, 2017).
- Suleimani, E. N., R. A. Combellick, D. Marriott, R. A. Hansen, A. J. Venturato, and J. C. Newman. 2005. Tsunami Hazard Maps of the Homer and Seldovia Areas, Alaska. Alaska Department of Natural Resources, Division of Geological and Geophysical Surveys, Fairbanks, AK. http://pubs.dggsalaskagov.us/webpubs/dggs/ri/text/ri2005_002.pdf (Accessed October 17, 2018).
- Tangborn, W. and A. Post. 1998. Iceberg prediction model to reduce navigation hazards: Columbia Glacier, Alaska. Ice in Surface Waters Volume 1. Proceedings of the 14th International Symposium on Ice: 231-236.
- USFS (United States Forest Service). 2018. Forest Service Geodata Clearinghouse. <https://data.fs.usda.gov/geodata/edw/datasets.php?dsetCategory=geoscientificinformation>
(Accessed December 5, 2018).
- USGS (United States Geological Survey). 1996. Columbia Glacier, Alaska, Research on Tidewater Glaciers. <https://pubs.usgs.gov/fs/1996/0091/report.pdf> (Accessed October 22, 2018).
- USGS (US Geological Survey). 2018. Earthquakes hazard program, significant earthquakes of the world, 1979. <https://earthquake.usgs.gov/earthquakes/browse/significant.php?year=1979>
(Accessed October 17, 2018).
- Weatherspark. 2018. Weather in Cordova, Alaska. <https://weatherspark.com/m/277/4/Average-Weather-in-April-in-Cordova-Alaska-United-States#Sections-Rain> (Accessed October 23, 2018).
- Wesson, R. L., O. S. Boyd, C. S. Mueller, C. G. Bufe, A. D. Frankel, and M. D. Petersen. 2007. Revision of time-independent probabilistic seismic hazard maps for Alaska. US Geological Survey, Open-File Report 2007-1043. https://pubs.usgs.gov/of/2007/1043/pdf/of07-1043_508.pdf (Accessed May 15, 2017).
- WSSPC (Western States Seismic Policy Council). 2018. 1958 Lituya Bay Tsunami. <https://www.wsspc.org/resources-reports/tsunami-center/significant-tsunami-events/1958-lituya-bay-tsunami/> (Accessed October 17, 2018).
- Yehle, Lynn A. . 1979. Reconnaissance engineering geology of the Yakutat Area, Alaska, with emphasis on evaluation of earthquake and other geologic hazards. United States Department of the Interior, Geological Survey, Geological Survey Professional Paper 1074. Washington, D. C. <https://pubs.usgs.gov/pp/1074/report.pdf> (Accessed October 17, 2018).

Chapter Four: Habitats, Fish, and Wildlife

Contents

	Page
A. Major Habitats of the Area	4-1
1. Marine and Coastal Habitats.....	4-1
2. Intertidal	4-2
a. Intertidal Mudflats.....	4-2
b. Estuaries	4-3
3. Barrier Islands	4-3
4. Freshwater Habitats	4-3
5. Wetlands	4-3
B. Fish and Wildlife Populations.....	4-4
1. Fish.....	4-4
a. Salmon.....	4-5
i. Chinook (King) Salmon.....	4-5
ii. Sockeye (Red) Salmon.....	4-5
iii. Chum (Dog) Salmon.....	4-6
iv. Coho (Silver) Salmon.....	4-6
v. Pink Salmon	4-7
b. Other Anadromous and Freshwater Fish Species	4-7
i. Dolly Varden.....	4-7
ii. Rainbow Trout	4-8
iii. Steelhead.....	4-8
iv. Cutthroat Trout.....	4-9
v. Eulachon.....	4-9
c. Saltwater Fish.....	4-10
i. Pacific Halibut.....	4-10
ii. Rockfish.....	4-10
iii. Pacific Herring.....	4-11
iv. Capelin	4-11
v. Pacific Sand Lance	4-11
vi. Flathead Sole.....	4-11
d. Marine Invertebrates	4-12
i. Clams	4-12
ii. Scallops.....	4-12
iii. Dungeness Crabs.....	4-12
2. Birds	4-13
a. Bald Eagles.....	4-13
b. Trumpeter Swan.....	4-14
c. Aleutian Tern.....	4-14
d. Dusky Canada Geese.....	4-15
e. Western Sandpipers.....	4-15
f. Dunlins.....	4-15
g. Short-Tailed Albatross	4-16
h. Marbled Murrelet	4-16
i. Kittlitz’s Murrelet	4-17
j. Pigeon Guillemot	4-17

Chapter Four: Habitats, Fish, and Wildlife

3. Terrestrial Mammals.....	4-18
a. Black and Brown Bear	4-18
b. Moose.....	4-19
c. Furbearers.....	4-19
4. Marine Mammals.....	4-20
a. Steller Sea Lions.....	4-20
b. Harbor Seals.....	4-21
c. Sea Otters	4-21
d. Orcas	4-22
e. Pacific White-Sided Dolphin.....	4-22
f. Harbor Porpoises.....	4-23
g. Gray Whales.....	4-23
h. Humpback Whales	4-23
C. References.....	4-25

Chapter Four: Habitats, Fish, and Wildlife

This chapter considers and discusses the Gulf of Alaska exploration license area's (License Area's) habitats and fish and wildlife populations, as required by AS 38.05.035(g)(iii). This chapter is not intended to be an exhaustive examination of all habitats and fish and wildlife species of the area, but rather, the director limited the scope of the administrative review and finding to considering and discussing those habitats and fish and wildlife species that have subsistence, recreational, or commercial value and that are material to the finding of whether the exploration license will best serve the interests of the state (AS 38.05.035(e)(1)(B)).

A. Major Habitats of the Area

The landforms, vegetation types, waterbodies, and wetlands of the License Area provide habitat for fish, birds, and wildlife. Some of the fish and wildlife of particular importance are salmon, black and brown bears, several furbearer species, and the marine mammals that are present in the offshore environment. The License Area and surrounding area also contains important habitat for numerous migratory bird species.

The License Area lies within the Gulf of Alaska Coast ecoregion. The ecoregions were developed cooperatively by the United States Forest Service (USFS), United States Geological Survey (USGS), National Park Service, and private organizations. An ecoregion is a major ecosystem defined by distinctive geography and that has characteristic flora and fauna and distinct amounts of moisture and solar radiation. The ecoregion that the License Area is located in is described as a temperate rain forest that includes open wetlands and hemlock and spruce forests with persistent snow at sea level that remains present for long periods of time (Nowacki et al. 2001). Additionally, the Environmental Protection Agency (EPA) defines the various ecological regions, and the License Area is located in the Coastal Western Hemlock-Sitka Spruce Forests region (EPA 2018). The forests of this ecoregion are dominated by hemlock and spruce with open wetlands that are present along the coast (Gallant et al. 1995). In this region, a coastal foreland and associated shoreline features extend southeast from the Copper River Delta to Icy Point (Nowacki et al. 2001).

Most of the acreage of the License Area is offshore in the marine environment within Controller Bay in the Gulf of Alaska. Freshwater habitats in the License Area include the outlets of several streams and rivers originating in the Ragged Mountains and Don Miller Hills; and ice fields including the Bering, Steller, and Martin River Glaciers. The rivers and streams in the License Area include Kahuntla Creek, Clear Creek, Katalla River, Arvesta Creek, Redwood Creek, Mary's Creek, Puffy Creek, Barrett Creek, Burls Creek, Chilkat Creek, Bering River, Nichawak River, Campbell River, and Edwardes River (Johnson, J. and Blossom 2018).

1. Marine and Coastal Habitats

The Gulf of Alaska coastline encompasses a range of habitats that include rocky shorelines, sandy beaches, mud flats, and coastal mountains. The entire coastline is backed by the Chugach and

Robinson mountain ranges. Weather patterns and water circulation in the North Pacific influence the region's habitat diversity. From the east, coastal ocean currents flow into Prince William Sound, an estuarine embayment of the Gulf of Alaska, and flow out through the west, resulting in a monthly water exchange. Circulation varies seasonally, and researchers estimate that as much as 40 percent of the volume of Prince William Sound to a depth of 100 meters is exchanged in the summer, and 200 percent is exchanged in winter (Schoch and McCammon 2012).

The Gulf of Alaska coast is about 152 miles long, from Gravel Point south of Cordova to Ocean Point on the Phipps Peninsula northwest of Yakutat. Along the Gulf of Alaska to the northeast, are the Yakataga, Malaspina, and Yakutat forelands. Currents circulating through and around the Gulf of Alaska contribute to the rich Gulf of Alaska ecosystem and variations in these nearshore flows and eddies affect much of the coast's biological variability. The Alaska gyre, an eastward flowing, subarctic current system at 50 ° north latitude, and the Alaska Coastal Current, flow counter-clockwise along the northern Gulf of Alaska (Ladd et al. 2004). The Alaska Coastal Current, further offshore at the boundary of the continental shelf and deeper water, runs northwest, and the Alaska Stream runs southwestward along the western edge of the boundary. Among them, they support open ocean circulation on a regional scale (Miller et al. 2005).

One theory that may explain why the Gulf of Alaska supports such a rich ecosystem is cross-shelf exchange. Researchers found that streams emptying from shore and into the Gulf of Alaska are low in nitrates and that the Gulf of Alaska basin is rich in nitrates (Miller et al. 2005). The large gyre in the deep waters to the west of Controller Bay attract large schools of herring and capelin which provide food for larger predators (NWF 2005). The exchange mechanism for the different nitrate levels could be an exchange across the shelf, or an exchange at the basin and shelf, that involves periodic upwelling eddies, tidal mixing, and changes in direction caused by varying depths in the Gulf of Alaska. Eddies form during the winter near Yakutat, propagate along the shelf break, and migrate west to an area east of Kodiak Island (Ladd et al. 2004).

2. Intertidal

a. Intertidal Mudflats

Intertidal mudflats are coastal wetlands that provide sources of energy in coastal food webs as migrating birds, demersal fish, and crustaceans forage on them for macroinvertebrates. Additionally, harbor seals haul out on mudflats and protected beaches, which are also nursery and spawning habitat for herring and crabs (ADF&G 2006).

Only four species of benthic organisms in the substrate of the Copper River delta account for the majority of animals and comprise more than 80% of the biomass. These benthic organisms include, *Macoma balthica*, *Mya arenaria*, *Corophium salmonis*, and *Eteone*. These species live in or on the bottom sediments of the License Area's waterbodies and are important prey for shorebirds, ducks, crabs, and fish. The Copper River delta mudflats are a vital stopover habitat for migrating birds. The Baltic macoma, a small clam found there, can provide up to 30% of a migrating shorebird's diet. Waterfowl also take advantage of the clam's abundance and feed on these mudflats throughout the winter. Out-migrating salmon smolt likely feed on the Copper River delta's copepods and amphipods, which are a significant portion of a smolt's diet (ADF&G 2006; Powers et al. 2006).

b. Estuaries

An estuary is a coastal body of brackish water that is partially enclosed where rivers and streams flow in and ocean water can flow in and out. Estuaries are some of the world's most productive ecosystems and are typically located where rivers flow into the ocean. They are home to unique communities of plants and animals that are specially adapted to the mix of saltwater and freshwater. They serve as natural nurseries for many species of birds and fish. Eelgrass beds exist in the Gulf of Alaska in shallow water and near shore. Juvenile salmon use them as nurseries, and herring for spawning, where they lay as many as three million eggs per eelgrass blade in the spring. The eggs attract seabirds and fish; some ducks and geese feed on the plant directly (ADF&G 2006). Between 1999 and 2010, researchers collected 54 species of fish in the region. Pacific herring, saffron cod, pink salmon and capelin accounted for 90 percent of the catch (Johnson, S. W. et al. 2012).

3. Barrier Islands

Barrier islands are dune-dominated ecosystems created by wind, wave, and transport of sand and silt along the shore. These are highly dynamic, unstable, sandy, elongate islands separated from the mainland by an estuary or bay. Barrier islands and spits form a discontinuous line across the width of the Copper River delta. Barrier islands within or adjacent to the License Area include Kanak Island and Okalee Spit. Barrier islands can be up to one-mile wide and eight miles long and are typically less than 30 feet in elevation (Boggs 2000) Harbor seals use the barrier islands to haul out and raise their pups. In the spring, millions of shorebirds gather on the barrier islands along the Copper River Delta as a stopover on their way to nesting grounds further north (ADF&G 2018f).

4. Freshwater Habitats

The License Area's waterways, riparian zones, and ponds sustain fish and wildlife populations. Water provides migratory routes, spawning and rearing habitats, and overwintering habitats for aquatic species. Terrestrial wildlife uses the water and areas surrounding them for nesting and breeding areas and for seasonal or transportation corridors. Species of birds that overwinter elsewhere in the country, or in other habitats within Alaska, spend their summers in ponds and lakes for the summer mating, nesting, and rearing season (ADF&G 2006).

Riparian zones are the interface between terrestrial and aquatic habitats. Among their several functions is to provide leaf litter, filter sediments and pollution, reduce wind, and regulate water temperature through shading and heat retention. Their root systems provide stream bank and floodplain integrity and stability (ADF&G 2006).

5. Wetlands

Wetlands are characterized by poor soil drainage and represent a transitional zone between aquatic and terrestrial habitats. They are inundated or saturated by surface water or groundwater at a frequency or duration sufficient to support a prevalence of vegetation that is adapted for life in saturated soil. Wetlands are present in the License Area. Bogs, salt marshes, freshwater grass, and freshwater sedge are all types of wetlands, and wetland habitats are heavily used as summer staging and breeding grounds for large numbers of migratory birds (ADF&G 2006).

Grass wetlands are composed of 50% or more water-tolerant grass species such as Pacific reed grass, red fescue, and blue-joint small bedstraw. They may occur in clumps or tussocks and may be intermixed with pure stands of sedges. In addition to providing wildlife habitat, grass wetlands are groundwater recharge areas that store storm and floodwaters and maintain minimum base flows for downstream aquatic resources (ADF&G 2006).

Salt marshes are intertidal wetlands vegetated with sedges, goosetongue, and other salt-tolerant plants. They are typically at the mouths of rivers, behind barrier islands, coves, spits, and on tide flats with low-energy wave action and elevated land. Zooplankton, copepods, amphipods, and other foods low on the food chain but important to the food web for larger animals, are found here. Salt marshes also provide spawning and nursery habitat for marine invertebrates and forage fishes (ADF&G 2006).

Most of the wetlands in the Gulf of Alaska are in the Copper River delta. The delta is a discontinuous series of coastal wetlands that parallel the Gulf of Alaska coastline for 75 miles and have a maximum width of 37 miles. The sediment load deposited by the Copper River is estimated to be 97 million metric tons annually. The delta forms where the river meets the ocean, the current slows, and the sediments precipitate out. Wetland ecosystems dominate the delta and are of primary importance for fish, waterfowl, and moose (ADF&G 2018f).

The predominant types of wetland in the eastern Copper River delta are both tidal and non-tidal wetlands. These are dominated by trees and shrubs in a complex that includes uplifted marshes, wet meadows, fens, and small, shallow ponds. About 5,000 acres of marine wetlands exist along the coastlines of Okalee Spit, Kanak Island, within the License Area, and Softuk Bar, which is just west of the License Area boundary (Kesti et al. 2004).

B. Fish and Wildlife Populations

The diversity of the landforms and vegetation types and the abundance of streams and wetlands in the License Area provide habitat for a wide variety of Alaska's fish and wildlife. The scope of review for the fish and wildlife includes species that are important to subsistence, sport, commercial, or other fishing; hunting; trapping; and species of concern.

1. Fish

Rivers and streams within the License Area are important spawning areas for a number of anadromous fish species, including Chinook (king), sockeye (red), chum (dog), pink (humpback), and coho (silver) salmon. Steelhead trout, cutthroat trout, Dolly Varden, and eulachon are also present in the License Area's rivers and streams. Water bodies that provide habitat for anadromous fish in the License Area include Kahuntla Creek, Clear Creek, Katalla River, Arvesta Creek, Redwood Creek, Mary's Creek, Puffy Creek, Barrett Creek, Burls Creek, Chilkat Creek, Bering River, Nichawak River, Campbell River, and the Edwardes River. These water bodies provide spawning, rearing, and overwintering sites for both anadromous and resident fish (Johnson, J. and Blossom 2018).

a. Salmon

The region's Chinook and sockeye salmon, specifically in the Copper River and its tributaries, are some of the earliest runs of these species in Alaska. They are considered to be high quality, and thus valuable for fish markets throughout the United States and the world (ADF&G 2018f). The License Area overlaps essential fish habitat for all five species of Pacific Salmon. However, there are no habitat areas of particular concern in the License Area, and none of the essential fish habitat areas for salmon restrict fishing (NOAA Fisheries 2018).

i. Chinook (King) Salmon

Spawning populations of Chinook salmon are found in streams and rivers within the License Area. Chinook salmon are the largest of the Pacific salmon species at maturity and can exceed 30 pounds. Adult Chinook salmon have irregular black spotting on the back and dorsal fins and on both lobes of the tail fin. Chinook salmon hatch in fresh water and rear in rivers for one year, feeding on plankton and insects. The following spring the smolt migrate to an estuary before migrating to the open ocean, where they spend from one to five years feeding on herring, pilchard, sand lance, squid, and crustaceans. They return to their natal streams to spawn in fresh water between May and July, and they do not feed once they enter the freshwater for spawning. The females lay between 3,000 and 14,000 eggs in gravel nests. (ADF&G 2008).

In Alaska, Chinook salmon are considered relatively uncommon but not rare. There is some cause for long-term concern because of recent population declines (ADF&G 2008). Chinook salmon are stocked by ADF&G and the Prince William Sound Aquaculture Corporation. There is one hatchery permitted to produce Chinook salmon eggs in the Gulf of Alaska area and it is northwest of the License Area. The Wally Noerenberg Hatchery, about 20 miles east of Whittier on Esther Island in Prince William Sound, produces up to four million Chinook salmon eggs annually. These fish begin returning to spawn in mid to late May through mid-June (PWSAC 2018). ADF&G has released between 43,000 and 150,000 Chinook smolt annually since 1999 in Cordova, Valdez, and Whittier with the objective to create additional angler opportunities in the region (ADF&G 2018n). In the License Area, Chinook salmon are present in the Bering River (Johnson, J. and Blossom 2018).

ii. Sockeye (Red) Salmon

Spawning populations of sockeye salmon are found in streams and rivers within the License Area. Sockeye salmon are one of the smaller species of Pacific salmon; adult sockeye salmon measure 18 to 31 inches long and weigh 4 to 15 pounds. They have distinct silver sides, a white belly, and metallic green-blue back. They spend one to three years in the ocean before returning to their natal streams to spawn. They typically return to spawn in June and July in rivers and streams with lakes as their headwaters. The females lay between 2,000-5,000 eggs in redds on the shores of the rivers, or lakes where they return. Eggs hatch during the winter and the alevins remain in the gravel until spring, when they emerge as fry and move to rearing areas. Juveniles spend one to three years in fresh water and feed on zooplankton and small crustaceans before migrating to sea. While at sea, sockeye feed on zooplankton, larval and small adult fishes, and squid (ADF&G 2008).

There is one hatchery permitted to produce sockeye salmon eggs in the area. In western Prince William Sound, the Main Bay Hatchery produces up to 12.4 million eggs annually. It was the first sockeye smolt-producing hatchery in the world, and up to six sockeye salmon stocks are reared

from this one hatchery (PWSAC 2018). Martin, Little Martin, Bering, Kushatka, and Tokun lakes are particularly important sockeye rearing habitats found between the Copper River Delta and Bering Glacier (Kesti et al. 2004). In the License Area, sockeye salmon are present in the Edwardes, Campbell, and Bering Rivers (Johnson, J. and Blossom 2018).

iii. Chum (Dog) Salmon

Chum salmon are found in the License Area along the Gulf of Alaska coast east of the Copper River, in the east Copper River delta, and in the Bering and Controller Bay watersheds. They appear in lesser numbers in the Katalla, Martin, and North river watersheds (Kesti et al. 2004). Adult chum salmon average 24 to 28 inches long and weigh 10 to 13 pounds. They are the most widely distributed of all Pacific salmon and have metallic bluish green on their back with many tiny speckles often present. Their tail is highly forked and has silver streaks along their fin rays (ADF&G 2018e).

Chum salmon spawn in September and October. They prefer to spawn in small to medium, slow-flowing side channels, though they also will spawn in large, muddy rivers, in cold and clear headwaters, and in the mouths of rivers below the high tide line. Eggs hatch after three to four months and the alevin remain in the gravel for an additional 60 to 90 days, after which they begin their migration to the sea within days or weeks. While migrating within rivers, they feed on insect larvae. When they reach the sea, they stay in the estuary and feed on crustaceans, insects, and young herring before forming schools and moving to salt water, when they feed on zooplankton. In and around the Gulf of Alaska, wild chum salmon stocks have increased in size with the onset of the hatchery program (ADF&G 2018e).

The East River which is near Yakutat and to the east of the License Area, produces the most chum salmon in the area, although the run has declined over the past decade. (Woods and Zeiser 2013). In the License Area, chum salmon are present in the Katalla and Bering Rivers (Johnson, J. and Blossom 2018).

iv. Coho (Silver) Salmon

Coho salmon are present in the License Area and are the most widely distributed of the Pacific salmon species in the eastern Copper River delta. The eastern Copper River delta, Bering and Controller Bay watersheds produce the most coho salmon along the coast between Copper River and Kayak Island (Kesti et al. 2004).

Adult coho salmon typically weigh 8 to 12 pounds and are 24 to 30 inches long. They are bright silver with small black spots on their back and on the upper lobe of their tail fin. Spawning adults of both sexes have dark heads and backs and their sides turn maroon to red in color. Coho salmon spawn from July to November. The eggs develop over the winter and hatch in early spring. The alevins stay in the gravel until they emerge in May or June. In the autumn, juveniles move out of the main channel to pass the winter, which protects them from the effects of flooding. Some coho salmon leave fresh water in the spring to rear in brackish, estuarine ponds, and return to fresh water in the autumn. They spend one to three winters in streams and may spend up to five winters in lakes before migrating to sea. Most coho salmon stay at sea 18 months, feeding on small fishes, before returning to fresh water to spawn. Coho salmon populations in Alaska are healthy and expected to remain strong (ADF&G 2008).

The Wally Noerenberg Hatchery is the only hatchery in the Gulf of Alaska region that is permitted to produce coho salmon eggs, producing up to four million coho salmon eggs annually (PWSAC 2018). Several rivers along the gulf coast, east of Copper River, support strong coho salmon runs. The Tsiu River coho salmon run lasts for six to eight weeks from August to early October (Woods and Zeiser 2013). In the License Area, coho salmon have rearing populations in the Katalla River and Slough, Arvesta Creek; spawning and rearing populations in the Campbell and Edwardes Rivers; and they are present in the Bering and Okalee Rivers (Johnson, J. and Blossom 2018).

v. Pink Salmon

Pink salmon are found throughout the License Area and generally spawn in small rivers near the coast and in estuaries at the mouths of rivers. Adult pink salmon weigh between 3 and 5 pounds and average 20 to 25 inches long. They are bright greenish-blue on their backs and their sides are silver in color with large dark spots on their backs and tail. Pink salmon spawn between late June and mid-October. When they reach their spawning streams, the males turn brown to black on their backs and the females turn olive green. Once they have entered the freshwater, the males develop a large hump on their back and hooked shaped jaws (ADF&G 2008).

Pink salmon mature and complete their life cycle in two years. As soon as they emerge from their gravel spawning grounds they migrate to the ocean, where they begin to feed on plankton, larval fishes, and aquatic insects. They return to spawn 18 months later, between late June and mid-October. Pink salmon populations in Alaska are stable and well managed (ADF&G 2008).

The Gulf of Alaska has hundreds of streams with pink salmon spawning habitat; in Prince William Sound alone, there are more than 200 pink salmon spawning streams. Additionally, four hatcheries in Prince William Sound produce pink salmon fry (PWSAC 2018). On the eastern side of the Copper River delta Pink Salmon are present in Copper River tributary streams and are also associated with major clear streams along the coast (Kesti et al. 2004). In the License Area they are present in Kahuntla and Arvesta Creeks, and the Katalla, Bering Rivers (Johnson, J. and Blossom 2018).

b. Other Anadromous and Freshwater Fish Species

Several other fish species including Dolly Varden, rainbow, steelhead, and cutthroat trout, and eulachon are present within the License Area.

i. Dolly Varden

Only the southern form of Dolly Varden are present in the License Area. They are closely related to Arctic char and distinguishing between the two requires close examination. Generally, Dolly Varden have more numerous spots that are smaller in size, whereas Arctic char have a more deeply-forked tail, and a narrower caudal peduncle (the area before the tail fin) than Dolly Varden. Freshwater and sea-run Dolly Varden occur in in the License Area. Freshwater Dolly Varden tend to be a much smaller fish, measuring 3 to 6 inches, and are found in small headwater streams, or in land-locked lakes and ponds (ADF&G 2018h).

Along the Gulf of Alaska, the southern form of Dolly Varden inhabits the east Copper River delta, Controller Bay, and Bering River regions of the coast (Kesti et al. 2004). In the License Area, Dolly Varden are present in the Bering, Campbell, and Edwardes Rivers (Johnson, J. and Blossom 2018).

The sea-run Dolly Varden reaches sexual maturity in five to six years, grows to a length of 12 to 16 inches, and lives less than eight years (ADF&G 2008). Sea-run fish return to spawn annually in late August to November and will spawn more than once in their lives, but rarely more than three times (ADF&G 2018h). Alevins remain in the gravel, absorbing their yolk sacs, for 60 to 70 days before emerging in April and May. The young fish feed on insects and, later, annelids, fish eggs, and other small fish. After two to four years in freshwater, the fish begin to migrate to saltwater in May or June, where they will spend the summer feeding before returning to freshwater to spawn and spend the winter (ADF&G 2008). In general, Dolly Varden are abundant and populations are stable in Alaska (ADF&G 2018h).

ii. Rainbow Trout

Rainbow trout are present in the License Area. Rainbow and steelhead trout are the same species, accordingly, there are no major physical difference between them. Rainbow trout are a resident form that generally stays in freshwater, while steelhead are anadromous that migrates to the ocean and returns to freshwater streams to spawn. They have a streamlined salmonid form but can range from slender to thick. They seek shallow gravel riffles in clear-water streams to spawn in late winter or early spring. Spawning begins in late March and lasts through early July. Eggs hatch a few weeks to four months after spawning, depending on water temperature. By mid-summer, fry emerge from the gravel to feed on crustaceans, plant material, and aquatic insects and their larvae. Resident rainbow trout move into lakes and streams after two or three years and eat fish, salmon carcasses, eggs, and small mammals. Rainbow trout mature in two or three years. Wild populations of rainbow trout are considered healthy in Alaska (ADF&G 2018p).

iii. Steelhead

Steelhead are found in streams along the Gulf of Alaska coast, making them the northernmost wild stock in North America. Similar to other stocks at the edge of their distribution, they are relatively sparse and unproductive (Savereide 2008). Steelhead migrate through the upper Copper River from mid-August to mid-October (ADF&G 2018p). The Situk River, east of Yakutat and southeast of the License Area, is the largest known steelhead producer in Southeast Alaska (Harding and Coyle 2011).

Steelhead juveniles are not distinguishable from juvenile rainbow trout, but once they reach adulthood, they have small spots scattered on their backs and on top of their head. They will spend two to five years rearing in freshwater before going to the ocean, where they will feed on crustaceans, squid, small fish, and large zooplankton. They return to spawn in spring, summer, and fall and seek shallow gravel riffles in clear-water streams. The spring run returns between March and early June and summer-run fish are rare. Little information is available for steelhead stock status in Southcentral Alaska, but wild populations are considered to be stable (ADF&G 2018p, 2008).

iv. Cutthroat Trout

Cutthroat trout are either sea-run or freshwater-resident in streams and lakes along the Gulf of Alaska coast to Prince William Sound. Cutthroat trout are present in numerous streams and lakes throughout Prince William Sound, though the extent of their distribution and abundance is unknown (Hochhalter et al. 2011). The Clear Martin, Glacial Martin, and Green rivers of the eastern Copper River delta host sea-run cutthroat trout populations (Marston et al. 2011). The Kushtaka and Bering Rivers host a sea run of cutthroat trout which drain in to Katalla and Controller bays respectively in the License Area (Johnson, J. and Blossom 2018; Kesti et al. 2004). Prince William Sound is the northern range of cutthroat trout distribution (Marston et al. 2011).

The freshwater form of cutthroat trout lives in headwater tributaries, bog ponds, large lakes, and rivers. Sea-run cutthroat trout prefer river or stream systems with accessible lakes (ADF&G 2008). Adult coloration varies with habitat as freshwater resident fish are larger than the sea-run relatives and have a golden yellow coloring and red markings under their jaw. Sea-run cutthroat trout generally do not exceed 18 inches long and have bluish silver coloring and less spotting on their backs. Their life history traits vary within drainages and among populations; resident and anadromous forms can exist within populations, and individuals may have both traits (Marston et al. 2011).

Cutthroat trout spawn from April to early June in gravel beds in small isolated headwater streams. Their eggs remain in the gravel for six to seven weeks before hatching. Newly hatched fish remain in the gravel an additional one to two weeks before emerging as juveniles. Juveniles disperse to the rearing habitat of ponds, lakes, and backwaters where they feed on insects and small fish (ADF&G 2018g).

Sea-run cutthroat trout will stay in fresh water three to four years before their first migration to sea in April. They may stay for a few days to as many as 100 days at sea. Their return to freshwater begins as early as mid-summer and peaks from September to October. Once in their home stream, they feed on young salmon and amphipods (ADF&G 2008). Population trends are difficult to determine because of the lack of long-term information, but for sea-run populations, where long-term trend information exists, their numbers are declining (ADF&G 2018g).

v. Eulachon

Eulachon are a small fish that grows up to 10 inches in length and are blue-silver colored in salt water and turn gray-brown and green when they move into freshwater to spawn. They are seasonally abundant in the Copper River delta of the Gulf of Alaska area near the License Area. Eulachon are anadromous fish that spawn and hatch in fresh water streams. Female eulachon can produce up to 30,000 eggs and they normally die after spawning. Eggs hatch in 21 - 40 days and the young are carried by the river to saltwater. There, they feed on copepod larvae and other plankton. After three to six years they return to spawn. Little information is available on the population status of eulachon in Alaska and the strength of their returns is variable (ADF&G 2008, 2018i)

c. Saltwater Fish

i. Pacific Halibut

Pacific halibut are found throughout the Gulf of Alaska in and around the License Area. They are the largest flatfish in the family Pleuronectidae. The upper side is normally gray or brown with spots so that they blend with the sandy ocean floor. Both eyes are located on the upper side of the body. Their bottom side is white. Most male halibut mature sexually by age eight and females by age 12 or older, and they can live for 55 years. They spawn in offshore waters between November and March at depths of 300 to 1,500 feet. Halibut generally migrate eastward and southward against the Gulf of Alaska coastal current moving opposite of the westward drifting eggs and larvae (ADF&G 2018k).

Female halibut release a few thousand to several million eggs, which are fertilized externally. About 15 days later, eggs hatch and the larvae drift on deep currents. As they mature, they move higher in the water column and ride surface currents to shallower and more nutrient-rich coastal waters. Halibut feed on plankton their first year, then on euphysiids and small fish between ages one and three, and feed mostly on fish as they grow larger. Adult halibut eat herring, sand lance, capelin, smelt, pollock, sablefish, cod, and rockfish. Their preferred habitat is in waters between 20 and 1,000 feet and water temperatures of 37° to 46° F (ADF&G 2008).

The International Halibut Commission assesses the status of halibut of the northeast Pacific Ocean, an area that extends from northern California to the Aleutian Islands and the Bering Sea. Their stock assessments are not specific to the License Area, but the 2018 assessment indicates the stock has been declining through the last decade and is projected to decrease gradually in the two years following the assessment. Decreased size of the fish at spawning age and declining recruitment trends are factors in the decline in recent stock numbers (Stewart and Hicks 2018).

ii. Rockfish

There are 25 species of rockfish in the Gulf of Alaska region near the License Area, and nearby deep waters accommodate range preferences among the many species. They prefer rocky habitats with high relief and strong currents (Kline 2007). Black and yelloweye rockfish are two commercially important rockfish species. (ADF&G 2018j).

Yelloweye rockfish stay close to the bottom in rocky areas (ADF&G 2008). They release live larval young between February and September. Their larvae feed on algae and other single-celled organisms and on small crustaceans. When they grow to adulthood, their prey shifts to other rockfish, sand lance, herring, flatfishes, and crustaceans. Yelloweye rockfish occupy steep rocky areas with lots of shelter and they typically live between 300 and 600 feet below the surface (ADF&G 2018j).

Black rockfish congregate in large schools throughout the water column, above or around rocky pinnacles (ADF&G 2008). Adults weigh up to 11 pounds and reach 27 inches in length. Males reach sexual maturity around age 18 and females around 22. Black rockfish release larvae from January to May. They feed on zooplankton, Dungeness crab larvae, herring, and sand lance. Black rockfish occupy the continental shelf at the surface to depths of 1,200 feet but usually are found in about 500 feet of water. There are no stock assessments for black rockfish in the License Area, but

their population appears to be stable. Yelloweye rockfish stocks are considered healthy (ADF&G 2018j).

iii. Pacific Herring

Pacific herring are the most abundant forage fish present in and around the License Area; providing high quality prey for birds, marine mammals, and other fish. Herring become sexually mature at three to four years and spawn annually after that. They spawn in spring in shallow, vegetated areas in intertidal and sub tidal zones. Eggs hatch about two weeks after being fertilized and the larvae drift in the current. After reaching the juvenile stage they rear in sheltered bays and inlets. Schools of juveniles move offshore in the autumn, where they spend the next two to three years feeding on crustaceans, decapods, and mollusk larvae; adults eat mostly large crustaceans and small fish. Population trends for Pacific herring are dynamic and subject to environmental changes (ADF&G 2018j).

iv. Capelin

Capelin is an important forage fish found in the Gulf of Alaska in and around the License Area. They play a key role in the marine food web as high energy food sources for fish, whales, and sea birds. Capelin are historically abundant in Alaska, and the Gulf of Alaska stocks peaked in 1980, but by the mid-1990s had disappeared from survey catches. More recent biomass estimates indicate a return to stable populations numbers with large spawning numbers (ADF&G 2018j).

Capelin spend most of their lives offshore. They reach sexual maturity at ages two and three and spawn during mid-May to late July on coarse sand or gravel beaches. They come close to the shore only to spawn. They feed on planktonic crustaceans, copepods, euphausiids, amphipods, marine worms, and small fishes. Capelin stocks appear to be rebounding in Prince William Sound and the Gulf of Alaska. They are protected from targeted fisheries and cannot comprise more than 2 percent of commercial bycatch (ADF&G 2018j).

v. Pacific Sand Lance

The Pacific sand lance is a key forage fish for seabirds, fish, and marine mammals in and around the License Area. Sand lance prefer nearshore and intertidal environments. They burrow in fine sand and gravel free of mud where there is a strong bottom current. They are most common at depths less than 165 feet (ADF&G 2018j).

Sand lance do not migrate for spawning but rather move from their offshore habitat to the intertidal zone and spawn once a year from late August through October. Eggs develop in up to 67 days. Larvae feed on phytoplankton and early zooplankton stages. Adults feed in schools and eat mostly copepods. In autumn and winter, sand lance incorporate invertebrates, herring larvae, and eggs into their diet. Sand lance are considered common to abundant with large population fluctuations observed every few years (ADF&G 2018j).

vi. Flathead Sole

The License Area overlaps an identified essential fish habitat for the flathead sole. However, no habitat areas of particular concern are in the License Area, and fishing is not restricted in the essential fish habitat area for flathead sole. Habitat areas of particular concern are essential fish

habitat that merit special attention from NOAA Fisheries and include some coastal estuaries, shallow corals, or rocky reefs (NOAA Fisheries 2018).

Flathead sole are a flatfish with both eyes on the right side of their heads; and they are white on the bottom with brown blotchy coloring on the top. They can live up to 34 years and grow up to 1.8 feet long. They can breed at 6 years old in the colder waters of the License Area and the females can lay up to 600,000 eggs. They feed on benthic invertebrates, some smaller fish and squid (NOAA 2018a). Flathead sole are abundant in Alaska and the population is above the target levels for sustaining the stock. They are not overfished or subject to overfishing (Turnock et al. 2017).

d. Marine Invertebrates

i. Clams

Littleneck and razor clams are found in and around the License Area. Spawn timing depends on water temperature. Littleneck clams are believed to begin spawning in May for one four-month period. After fertilization, eggs grow rapidly and within 12 hours become larvae. Larvae drift before they metamorphose and begin eating phytoplankton. Littlenecks mature at age three or four and are roughly 1 to 2 inches long. They can live 10 to 13 years along rocky shorelines or in small patches on large beaches, favoring coarse sand or fine gravel mixed with mud (ADF&G 2018l).

Razor clams reach sexual maturity as soon as the end of their third year and all are mature by the seventh year. They breed between May and September, stimulated by increasing water temperatures. They spawn hundreds of thousands of larvae, which are free swimming for five to 16 weeks, during which time the shells begin to grow. Young clams then alight on sand, where they remain, feeding on plankton. They are found from four feet above mean low water to depths of 180 feet (ADF&G 2018l). ADF&G does not assess razor clam abundance but reports from non-commercial diggers indicate that abundance is low in the eastern Copper River Delta, Katalla, and Controller Bay areas compared to past surveys (Rumble et al. 2016).

ii. Scallops

Weathervane scallops are found in and around the License Area. Scallops usually mature around age three or four and reproduce by congregating and then releasing clouds of eggs and sperm, which are fertilized in the water column. Increasing water temperatures appear to be the trigger, and spawning occurs in May and June. Fertilized eggs settle to the bottom, where they develop into larvae. The larvae then feed in the water column for about three weeks and then settle to the bottom again to begin life as benthic filter feeders. They live to a maximum age of 28 years, prefer mud, clay, sand, or gravel substrate in depths of 120 to 390 feet, and amass in dense beds (ADF&G 2018l). Scallop biomass estimates and abundance levels are down compared to the levels when they were first surveyed in the 1990s. Between 2004 and 2010 the abundance decreased to all time low levels, largely because of inconsistent survey methodology and inclement weather (Gustafson and Goldman 2012)

iii. Dungeness Crabs

Dungeness crab inhabit bays, estuaries, and the nearshore coast of Alaska in the Copper River Delta and Controller Bay areas in and around the License Area. They have a broad oval shaped body

covered by a smooth hard shell with 4 pairs of short walking legs and a pair of small pinching claws. Dungeness crab mate from spring through fall but the female will store the sperm in internal pouches until her shell hardens. Fertilization then occurs about one month after mating. A large female can carry up to 2.5 million eggs; after hatching, the plankton-like larvae drift away. A crab has six successive larval stages before molting into its first juvenile stage. The larvae develop over four months and sometimes for up to a year. They reach sexual maturity at three years. Dungeness crabs are both scavenger and predator, and eat bivalves, worms, shrimp, fish, and small crab (ADF&G 2018).

Dungeness once supported fisheries in and near Cordova, along the eastern portion of the Copper River Delta, Controller Bay and in Yakutat. The Orca Inlet fishery closed in 1980, the Copper River fishery in 1992 and the Yakutat fishery in 2000. Abundance remains low despite long term fishery closures (Rumble et al. 2016; ADF&G 2016). The Dungeness crab sport fishery in Yakutat closed in 2005. The stocks does not appear to be rebuilding potentially due to bycatch by the salmon gillnet fleet (ADF&G 2016; Rumble et al. 2016).

2. Birds

Waterfowl, passerines, raptors, shorebirds, and seabirds use the region surrounding the License Area for breeding, rearing, and feeding. Numerous species are present in the area because of the habitat diversity. An estimated 12 million shorebirds, from 36 species stop along the Copper River Delta each spring on their way to nesting grounds. (ADF&G 2018f). The Copper River Delta and the Bering River Delta support the largest spring concentration of shorebirds in the Western Hemisphere. (ADF&G 2006).

The License Area is located mostly within the National Audubon Society's Copper River Delta Important Bird Area, and a small portion of the License Area's northeast corner is located within the East Copper River Delta Colonies Important Bird Area, both of which have been categorized as global priorities (Audubon Alaska 2015).

a. Bald Eagles

Bald eagles are widely distributed along coastlines and inland waterways and are present throughout the License Area. Up to 1,500 eagles congregate on the Copper River Delta during eulachon spawning (Bowman 1999). The bald eagle is characterized by a white head and tail, yellow beak, and dark brown bodies. They are the largest resident bird of prey in Alaska weighing between 8 and 14 pounds. They prefer to nest in Sitka spruce, western hemlock, and yellow cedar near the coast. Inland they typically nest in cottonwoods and white spruce near rivers and lakes (ADF&G 2008).

Bald eagles begin building nests in March and April. Eagles lay one to three eggs in mid to late April. Bald eagles nest in trees that are close to water, with a clear view of the surrounding area, often in old cottonwoods. Incubation lasts 35 days and begins when the first egg is laid. Chicks fledge after about 75 days. Bald eagles reach sexual maturity at about four or five years of age. Eagles primarily eat fish but will scavenge for a variety of prey. They prey on snowshoe hares, ducks, geese, gulls, kittiwakes, young sea otters, and seals. In 2007 the bald eagle was removed from the threatened and endangered species list and Alaska's population of bald eagles remains

healthy (ADF&G 2018b). Both bald eagles and golden eagles are protected by the federal Bald Eagle Act of 1940, which makes possession of an eagle, either alive or dead, illegal (16 U.S.C. 668–668c).

b. Trumpeter Swan

Trumpeter swans are found in and around the License Area. Trumpeter swans are large, all-white birds, with an angular wedge-shaped head and a black bill. Males average 28 pounds and females average 22 pounds. Trumpeter swans mate for life and begin breeding during their third, fourth, or fifth year of life. Nesting begins in early spring, typically in an undisturbed marsh or a small lake. Cygnets hatch after a 30 to 35-day incubation period, and they fledge after 11 to 15 weeks. Both the male and female swans guard the nest during this critical time. A young swan eats a high protein diet of aquatic invertebrates and will weigh 21 to 30 pounds as an adult. Trumpeter swans eat foliage, seeds, and tubers of various marsh plants during the summer, and they feed on crops and seeds from agricultural fields on their wintering grounds in the continental United States (ADF&G 2018q)

Trumpeter adult and sub-adult swan population trends in the Copper River Delta decreased nine percent between 2006 and 2007 but were still 35 percent above the previous 28-year mean. The population is shown to fluctuate between 500 and 1,300 birds since the surveys began in 1968. A 1990 census indicated that more than 80 percent of the world’s population of trumpeter swans comes to Alaska. Statewide, trumpeter swan populations increased seven percent between surveys in 2005 and 2010 as they began to occupy previously unoccupied breeding grounds (USFWS 2017, 2012).

The total North American population of trumpeter swans reached a record high during the most recent survey taken in 2015. In 2015, the total number of trumpeter swans in the Alaskan flock was 22,015 swans compared to 19,638 swans recorded in the 2010 survey. In North America, there was a significant increase in the abundance estimates of the trumpeter swan from 34,249 in 2010 to 63,016 in 2015. The Alaskan flock may be approaching its carrying capacity in some parts of its range. However, growth rates remained high in areas where substantial amounts of previously unoccupied habitat were available (USFWS 2017).

c. Aleutian Tern

Aleutian terns are found along the coast from Siberia and the Chukchi Sea down to the Gulf of Alaska in the vicinity of the License Area. In Alaska, they often associate with the Arctic tern, and the two species are difficult to differentiate. Aleutian terns are small gray birds with a black top of their head and black stripe through their eyes extending from their black pointed beak. They construct nests in a depression in vegetation on the ground in a variety of habitats including grass and sedge meadows, coastal marshes, and on islands. In 2006, the American Ornithologists Union reclassified the species in the genus *Onychoprion* which includes three other brown-backed tern species (USFWS 2018a).

Aleutian terns breed in the summer months between May through August and lay 1 to 3 eggs. They incubate their eggs between 20 to 29 days. They feed on fish, invertebrates, and insects. It is largely unknown where the Aleutian tern spend the winters, but they have been observed in and around coastal waters near Singapore, Indonesia, and Hong Kong. The main natural predators of eggs and

chicks are mink, bears, and several other bird species. Some chicks are also preyed upon by Arctic terns. Aleutian tern populations are not well monitored; however, their populations are believed to be declining (USFWS 2018a).

d. Dusky Canada Geese

The dusky Canada goose is a subspecies of the Canada goose that only breeds in the Copper River Delta area, Prince William Sound, and islands in and around the License Area. They represent one of the smallest subspecies populations of geese in North America. They are a medium-sized Canada goose subspecies with a dark brown breast and back, black head, and white strap below their eye and beaks. They winter in Oregon and Washington and migrate to the Gulf of Alaska coast to breed. They feed on nutrient rich grasses (USFWS 2018b).

The 1964 Great Alaska Earthquake caused significant uplift in the Copper River Delta altering the habitat which previously consisted of low-lying salt marshes and wetlands. The uplift caused changes to the drainage, thus increasing predators' access to the nesting sites and resulting in a population decline. In 1984, ADF&G along with the USFS, U. S. Fish and Wildlife Service (USFWS), USGS, and Ducks Unlimited created an artificial nest island program in the Copper River Delta. Over 330 artificial nests were constructed in the area and they are twice as productive as the natural mainland sites (ADF&G 2018r). The dusky Canada goose prefers habitat that are enclosed including small ponds and fields lined with trees. Because of this specific preference of habitat and restricted range, it is susceptible to environmental changes and the population status and future is uncertain (Warren 2006).

e. Western Sandpipers

Nearly the entire Pacific coast population of western sandpipers migrate through the License Area and the Copper River Delta on their way to northern nesting grounds (ADF&G 2018f). They congregate in enormous flock and an estimated 6,500,000 Western sandpipers congregate and pass through the Copper River Delta each spring. They are a small, thick-bodied shorebird that has a long black bill. They are approximately six inches long and weigh around one ounce. They are varying in coloring depending on the season and if they are breeding. They breed in coastal sedge-dwarf tundra in Northwestern Alaska and nest on the ground. Western sandpipers typically lay three to five eggs in a nest. They are ground foragers and feed on aquatic invertebrates in coastal mudflats. Western sandpipers are considered common and their populations are stable (CLO 2014)

f. Dunlins

The vast majority of the Pacific coast population of dunlin migrate through and rest on the Copper River Delta and the wetlands in and around the License Area on their way to their northern nesting grounds (ADF&G 2018f). Dunlins are a type of sandpiper and a common shorebird with a reddish-black belly and a long drooping bill. They are approximately seven inches long and weigh around two ounces. They breed in coastal sedge-dwarf tundra in northern Alaska and on the Arctic coast of Canada and nest on the ground. Dunlin typically lay three to five eggs in a nest. They are ground foragers and feed on aquatic invertebrates in coastal mudflats. Dunlin are considered common and their populations are stable (Cornell 2018).

g. Short-Tailed Albatross

The License Area overlaps the range of the Short-tailed albatross. However, it would be extremely unlikely to encounter one so close to the shore in this region. It is the largest seabird in the North Pacific with a wingspan of over seven feet. They are distinguished by their large pink bill with a blue tip. They have a tremendous range extending across the North Pacific Ocean. They can be found in islands near Japan during their breeding season and are present in and around the License Area and Gulf of Alaska. They spend the majority of their time flying low over the ocean, and only come on land to nest (ADF&G 2018o; USFWS 2018d).

Short-tailed albatross mate for life once they form a pair. They reach sexual maturity at approximately six to eight years old. They nest on the ground in areas with sparse vegetation typically on the slopes of volcanoes in the ash, and pairs typically return to the same nest location annually. They feed from the surface of the ocean and typically eat crustaceans, squid, and fish. They can live up to 45 years of age, and nesting pairs only produce one egg per year (ADF&G 2018b).

The State of Alaska placed the short-tailed albatross on the State endangered species list in 1972 as the species was harvested by feather hunters to near extinction in the early 1900s. However, currently there is not a specific critical habitat area designated for this species (ADF&G 2018o). The USFWS listed the short-tailed albatross as endangered throughout its range on July 31, 2000. As of June 2008, populations of the birds were estimated at 2,400 birds including up to 500 breeding pairs. Although these are not necessarily threats within the License Area, current threats to the populations include volcanic activity near their breeding grounds, commercial fishing, ocean contaminants, predations from sharks in the ocean, and crows on land, and competition for food from other species (USFWS 2008b).

h. Marbled Murrelet

The marbled murrelet is a member of the alcid family, along with puffins, murres, and guillemots. The marbled murrelet is found throughout the Gulf of Alaska region in the vicinity of the License Area, with concentrations in Prince William Sound. They are a small, plump waterbird with black and white marbled coloring. They are approximately 9.5 inches long and weigh around 10 ounces (USFWS 2018c).

Beginning in early April, marbled murrelets migrate from wintering areas to coastal inlets and bays for breeding. Nesting typically begins in May. They nest on the moss-covered limbs of immature coniferous trees, though some nests in Alaska have been found on moss covered rock ledges. The female lays one egg and she and the male take turns incubating it for 28 to 30 days. After hatching the parents feed the chicks three to five times a day over the next month. They are primarily nearshore foragers at depths to 100 feet and eat capelin, Pacific herring, Pacific sand lance, and crustaceans. Young murrelets begin fledging in July and peak fledging occurs around the first week of August. Once the summer is over, juveniles remain in nearshore waters, but researchers do not know for how long or whether they leave at all during their first winter. Surveys show that about 25 percent of the summer population is present in March; researchers do not know where most of the birds go to molt and spend the winter. Marbled murrelets live an average of 10 to 15 years (USFWS 2018c).

The Prince William Sound population of marbled murrelets had been declining since the 1970s, most likely because of large scale ecological changes in the Gulf of Alaska affecting its prey and has continued to decline since the Exxon-Valdez oil spill. (EVOSTC 2014). Though the federal government lists the marbled murrelet as threatened in Washington, Oregon, and California, it is relatively abundant in Alaska. The marbled murrelet is a priority bird species for the USFWS in Alaska (USFWS 2018c). Loss of old-growth forest in the southern half of its range is thought to be the most significant threat to its populations (ADF&G 2018b).

i. Kittlitz's Murrelet

The Kittlitz's murrelet is a small seabird that breeds in the Gulf of Alaska area in and around the License Area and is present from June through August (ADF&G 2008). Core breeding areas in the area include Icy Bay, Yakutat Bay, the Malaspina Forelands, and Prince William Sound. Kittlitz's murrelets spend their summers in nearshore waters and breed on exposed slopes above the ocean. They nest on steep, unvegetated mountainsides, or on slopes above the timberline near glaciers adjacent to glaciated fjords in Prince William Sound (Day et al. 2002). They lay one egg in June, the eggs hatch in July, and the young fledge in August. They feed on fish, euphausiids, amphipods, and small crustaceans. Key prey species are Pacific sand lance, Pacific herring, capelin, and Pacific sandfish. They leave the region in early fall, though researchers do not clearly understand where they spend the winter (ADF&G 2018b).

Kittlitz's murrelet, with an estimated population range between 9,000 to 25,000 birds, is found only in Alaska and the Russian Far East (USFWS 2006); 95 percent of the world's population breeds in Alaska. The population of Kittlitz's murrelets declined 80 percent between 1972 and 2004 (EVOSTC 2014). The bird is a candidate for listing as threatened or endangered under the Endangered Species Act, though recent studies suggest population numbers have stabilized and the Kittlitz's murrelet remains unlisted. The Kittlitz's murrelet is a priority bird species for the U.S. Fish and Wildlife Service in Alaska (USFWS 2006; ADF&G 2018b).

j. Pigeon Guillemot

The pigeon guillemot is a medium-sized diving seabird found in the Gulf of Alaska region in the vicinity of the License Area. They are a medium sized waterbird with a thin straight bill. They are approximately 12 inches long and weigh around 17 ounces. Pigeon guillemots nest along rocky coastlines. They begin returning to their Alaskan breeding grounds in April and begin courtship by May. Their breeding season is May through August, and they will nest both onshore and on islands, laying one to two eggs. Full time incubation begins around three days after laying and lasts 26 to 33 days. The young birds fledge between 29 and 54 days. Pigeon guillemots feed in nearshore waters on sand lance, herring, smelt, shrimp, blennies, sculpins, and gadoids. Unlike the murrelets they dive to the seafloor to feed. They also have difficulty taking off and to avoid potential predators, they are more likely to dive than to fly away. They typically feed in water depths of less than 65 feet (USFWS 2008a; Woodford 2008).

Pigeon guillemot populations were in decline before the 1989 *Exxon-Valdez* oil spill and continued to decline after. Since the 1970s their population declined 67 percent. Approximately 30 percent of the Prince William Sound guillemot population nests on Naked Island, northwest of the License

Area (USFWS 2008a). Any reduction in Pacific sand lance and Pacific herring abundance, is thought to be one reason for the decline (Pearson et al. 2013).

3. Terrestrial Mammals

ADF&G manages wildlife resources through game management units (GMUs). The Gulf of Alaska License Area lies within ADF&G's GMU 6A. Numerous terrestrial mammals inhabit the License Area. Several species of particular importance, due to their subsistence and recreational uses, include black and brown bears, moose, wolves, and several furbearer species (ADF&G 2006).

a. Black and Brown Bear

Black bear

Black bears are the most abundant and widely distributed of North America's three species of bears and are present in the License Area (ADF&G 2008). They are also the smallest of the three species of bear. They stand approximately 29 inches tall at the shoulder and are around 60 inches long from snout to tail. They weigh between 200 and 500 pounds. Black bears coloring can range from jet black to white, though black is the most common color. They can be distinguished from brown bears by its straight facial profile and shorter claws (ADF&G 2018c)

Black bears are found along rivers and lakes during the spring and summer and in upland areas during the fall. They take advantage of the varied vegetation types and abundant prey especially in riparian and wetlands areas (ADF&G 2006). Black bears hibernate in the winter for seven to eight months. They make their dens in a variety of locations ranging from sea level to alpine regions. When black bears emerge from hibernation, they increase their weight by as much as 20 percent by autumn (ADF&G 2018c).

Mating takes place during the months of June and July, and cubs are born in dens usually in January or February. Black bears breed every two to three years and commonly give birth to two cubs at a time. Black bears have a varied diet comprised of green vegetation, small mammals, newborn moose and caribou, salmon, berries, ants, grubs, and insects. Other bears, usually brown, are the primary predators of black bears (ADF&G 2018c). In the Gulf of Alaska, the highest black bear densities are in western Prince William Sound. Along the Northern Gulf of Alaska Coast, near the License Area, the densities are slightly lower and estimated at 300 bears per 1,000 square kilometers (ADF&G 2014).

Brown bear

Brown bears (classified as the same species as grizzlies) are present in the License Area. Brown bears remain on the Copper River Delta all summer after descending from dens in the mountains in spring when new vegetation emerges (ADF&G 2018f). Brown bears are larger than black bears and can similarly vary in the color of their coat. They have a pronounced shoulder hump and smaller ears. They also have longer straighter claws used for digging up roots or to expose burrowing animals. An average brown bear weighs between 500 and 900 pounds, though they can weigh up to 1,500 pounds. They feed on sedges, grasses, horsetails, herbs, moose calves, waterfowl eggs and young, spawning eulachon, salmon, cow parsnip, ground squirrels, carrion, roots and berries. (ADF&G 2018d).

Most brown bears reach sexual maturity at five years of age, but females do not usually produce a litter until later. Brown bears mate from May to July. In the fall, pregnant females usually enter dens first, and leave them, with their newborn cubs, last in the spring. Cubs are born in the den during January and February and litters of two cubs are common. Adult males do the opposite, entering dens later in the fall and emerging sooner in the spring. Most denning sites are found on hillsides or mountain slopes, usually below 1,800-foot elevation. In areas with mild winters, some male bears may stay active all winter. Bear populations in Alaska are healthy and productive, however, population densities vary with the quality of the environment and availability of food (ADF&G 2018d).

b. Moose

Moose are present throughout the License Area. They are the largest member of the deer family. Adult moose can grow up to 1,600 pounds and up to six feet tall at the shoulder. They range in color from brown to almost black. In the 1950s, Cordova residents raised 24 captive moose calves and released them on the western Copper River Delta. By the 1960s, the population expanded into the Bering River Valley within the License Area. The population has since expanded due to the habitat changes following the uplift of tidal lands during the 1964 earthquake (referenced in Chapter Three), which transitioned the landscape to one dominated by willows and alders (C. 2014). Female moose typically breed at 28 months and gestation lasts about 230 days. Calves are born in the spring and weaned by fall in time for mating season in late September and early October. Moose move around seasonally to calving, rutting, and wintering areas. Moose travel a few miles to as many as 60 miles during the transitions (ADF&G 2017).

Vegetation type, quality, and production are important to moose habitat. High quality forage near wetlands of forbs, the leaves of birch, willow, aspen, and vegetation in shallow ponds, are a primary food source. Riverbanks, gravel bars, and areas adjacent to rivers also provide good moose habitat because of the scouring effect of floods, which produce regenerating willows and other plants accessible to moose (Woodford 2006). Moose in Prince William Sound and the Gulf of Alaska coast are estimated at 1,200 animals and considered stable. Numbers declined below management objectives in all subunits of GMU 6 except in GMU 6C, an area bounded by the Copper and Rude rivers and the Copper River Highway. The estimate for the area east of the Copper River Delta and including the License Area was 227 moose (C. 2014).

c. Furbearers

The License Area supports healthy populations of several furbearer species. Most furbearer species are challenging to study because of their secretive behaviors. Beavers and lynx are two of the more commonly trapped species of furbearer in the region and are described in more detail below. Population trends and estimates usually come from harvest data, trapper questionnaires, and research conducted over the last 35 years in Alaska (Parr 2018).

Beavers are considered common and abundant throughout their range in Alaska. They are found in forested areas and live near and within freshwater. Beavers construct dams to secure dens used for food storage, rearing, and shelter. Litters are born from late April to June, and young stay with their family for about two years. Beavers feed on aquatic plants, roots, grasses, and bark (ADF&G 2018a).

The lynx population is dependent on prey availability and tends to follow a 10-year population cycle. In the Gulf of Alaska area, they inhabit GMU 6 in low numbers (Parr 2018). Snowshoe hare, the primary food source of lynx, undergo an eight- to eleven-year cycle of abundance that precedes the cycle of lynx abundance. Breeding season takes place during March and early April. Two to four kittens are born after a 63-day gestation period in shelters such as a spruce felled by wind, a rock ledge, or a log jam. Kitten survival is highly dependent on prey. Kittens remain with their mother until late winter, usually around the time the next breeding season begins. When snowshoe hares are scarce, lynx will regularly prey on grouse, ptarmigan, squirrels, and small rodents (ADF&G 2018m).

Other furbearers present throughout the area are wolf, wolverine, marten, red fox, muskrat, and mink. All furbearer populations are subject to population fluctuations. Trapper questionnaires issued by ADF&G may indicate a particular animal is scarce some years and common the next (Parr 2018).

Based on GMU 6 data from 2013-2014, red foxes were considered scarce. Marten density was highly variable, with the highest density of marten between Cape Suckling and Cape Yakataga. Mink were abundant in most of GMU 6. Muskrats are common east of Prince William Sound, and in low densities in the Copper River Delta. Wolf and wolverine are present on the mainland of GMU 6 but considered scarce in the most recent reporting period (Parr 2018).

4. Marine Mammals

The Gulf of Alaska area in and around the License Area provides habitat and transitioning routes for Steller sea lions, seals, otters, and several migrating whale species. The humpback, North Pacific right whale, gray whale, and orcas either migrate through or are resident to the Gulf of Alaska.

a. Steller Sea Lions

Steller sea lions, which are present in the vicinity of the License Area, are divided into western and eastern stocks. The eastern stock's range includes Southeast Alaska to California, and the western stock's range is Cape Suckling west to the Russian Far East. Only the western stock is present in the License Area. (ADF&G 2008). They are the largest member of the eared seal family. They are brown to reddish brown, but the color lightens towards the end of the summer. They have external ear flaps, long front flippers, and rotatable hind flippers that allow for locomotion on land. They have prominent broad foreheads and heavy muscular necks (NOAA 2018e)

There are six Steller sea lion haul outs west of Cape Suckling in the region of the License Area where they base their foraging activities: Cape St. Elias on Kayak Island; Hook Point and Cape Hinchinbrook on Hinchinbrook Island; Seal Rocks, south of Hinchinbrook Entrance; Wooded Island, south of Montague Island; and Pt. Elrington on Elrington Island (NOAA 2018e). Sea lions will change haul outs as seasonal concentrations of prey materialize. They also use haul outs as nurseries and to rest (ADF&G 2008).

Male Steller sea lions can live up to 20 years and females to 30 years. The males reach sexual maturity at age three to seven, but do not command territory or breeding rookeries until they are 9

to 13 years old. Females start breeding between ages three and seven and are fertile for the next two decades. Mating occurs in June, but fertilized eggs do not implant until October; pups are born the following June. Most pups wean after one winter but may nurse for up to three years. The western stock feeds mostly on mackerel and pollock (ADF&G 2008).

The western stock's population declined 15 percent annually in the late 1980s. The decline continued through the 1990s at 5.4 percent annually. In the early 2000s, the population appeared to be stable and possibly increasing slightly. The latest population figures, from 2008 to 2011, estimate a minimum abundance of 53,303 Steller sea lions for the entire western stock population. The western stock of Steller sea lions is listed as endangered under the Endangered Species Act and as depleted under the Marine Mammal Protection Act. However, recent population trends for Steller sea lions in the eastern Gulf of Alaska and Prince William Sound show an increase of 5.36 percent (Muto et al. 2018)

b. Harbor Seals

There are 12 stocks of harbor seals in Alaska, but only the Prince William Sound stock is present near the License Area. They are considered true seals because they have no external ear flap. They weigh up to 180 pounds and can reach up to 6 feet in length. They have short stiff hair and typically are gray with darker gray blotches or light rings (ADF&G 2008).

Harbor seals use the northeastern Gulf of Alaska coastline for breeding and feeding. Icebergs are important pupping habitat from May to July and molting habitat from June to October. Common prey includes walleye pollock, Pacific cod, capelin, eulachon, Pacific herring, sand lance, Pacific salmon, sculpin, flatfish, octopus, and squid. The average life span for a male is 26 years and for a female is 35 years. They weigh about 24 pounds at birth and gain weight rapidly during a one-month nursing period that typically occurs between mid-May and July. Pups are weaned about one month after birth and the female mates shortly after. The embryo's development is suspended for about 11 weeks and the gestation lasts eight to nine months (ADF&G 2008).

Harbor seals haul out in groups of several animals to thousands of animals. Tagging studies indicate the extent of a harbor seal's range depends on sex and age. Pups may range up to 232 miles from their birth site but more typically they stay within 62 miles. The range of an adult is less than 37 miles (ADF&G 2008).

The most recent minimum population estimate for Prince William Sound harbor seals is 29,889 animals in 2011, which was the most recent year that a survey was conducted. Between 1984 and 1997, their numbers declined 63 percent. More recent analysis of this stock's population abundance and trends suggests the population stabilized in 2002 and the population trend over period between 2006 and 2011 shows an increase of 26 seals per year (Muto et al. 2018).

c. Sea Otters

Sea otters found in in the vicinity of the License Area comprise part of the Southcentral Alaska sea otter stock, a subset of the northern sea otter Southcentral Alaska stock. They are the largest member of the weasel family and they have very dense brown to black fur. They can grow up to 5 feet in length and weigh up to 70 pounds. Female sea otters are sexually mature between ages two and five, males between ages four and six. They breed year-round, but in Alaska most pups are

born in late spring. Sea otters forage in shallow coastal waters, diving to the bottom for one to two minutes to depths from five to 250 feet. They primarily prey upon sea urchins, crabs, clams, mussels, octopus, fish, and other marine invertebrates. Their home range generally is limited to about 15 square miles (ADF&G 2008).

Sea otter populations east of Cape Yakataga do not appear to have increased generally, but in Yakutat Bay abundance increased between 1998 and 2008. Biologists estimate that population trends are stable for these populations (USFWS 2014).

The 1989 Exxon-Valdez oil spill contributed to an estimated decline of 40 percent of the western Prince William Sound sea otter population. By 1993 numbers began to increase four percent annually (EVOSTC 2014). The National Oceanic and Atmospheric Association's 2014 Marine Mammal Stock Assessment Report estimated a population of 11,989 in Prince William Sound, a population of 428 in the northern Gulf of Alaska, and a 2.6 percent increase in Prince William Sound between 1993 and 2009. Prince William Sound sea otter population trends are considered to be increasing (USFWS 2014).

d. Orcas

Orcas are found in the Gulf of Alaska region in and around the License Area. A resident group known as AT1 remains in Prince William Sound, and the Aleutian and western stocks of transient orcas may be present at times in the vicinity of the License Area. Orcas live long and reproduce slowly, and both sexes have multiple breeding partners throughout their lifetimes. Orcas are mostly black with white patches under their jaw and under each eye and along their bottom sides. They have a tall dorsal fin reaching up to six feet tall on males and up to three feet on females (ADF&G 2008).

The life expectancy for a male is about 30 years and as long as 60 years; females live about 50 years and up to 100 years. Females reach sexual maturity when they grow to 15-18 feet long. Young are born every three to eight years and gestate from 15 to 18 months (NOAA 2018c). In the North Pacific, most births appear to occur between fall and spring. Transient orcas prey on virtually any large marine animal available and do not typically feed on fish. Resident whales will feed on a variety of fish such as salmon, herring, halibut, and cod (ADF&G 2008). A minimum population estimate for the Gulf of Alaska/Aleutian Islands and Bering Sea transient stock is 521 animals, based on a direct count of individually identifiable animals (Muto et al. 2018).

e. Pacific White-Sided Dolphin

The Pacific white-sided dolphin is present throughout the North Pacific Ocean and in and around the License Area. The animals that are present in the License Area are part of the North Pacific Stock (Muto et al. 2018). Pacific white-sided dolphins are robust with a large dorsal fin and a relatively short snout. They are known for the distinct white coloring on their sides earning them their name. They are considered playful and are often seen swimming in the wave near the front of a ship and jumping and spinning in the air (NOAA 2018d).

An average sized Pacific white-sided dolphin is between 5.5 and eight feet long and can weigh up to 400 pounds. They work together in groups to corral schools of fish and adults eat up to 20 pounds of fish each day. Males reach sexual maturity at approximately 10 years of age and females

reach sexual maturity between eight and 11 years. They generally mate and give birth in the summer months with gestation periods lasting up to 12 months. They feed on squid and small schooling fish including capelin, sardines, and herring (NOAA 2018d). They are relatively abundant and the most recent population estimate for the dolphins in the Gulf of Alaska was 15,200 (Muto et al. 2018).

f. Harbor Porpoises

Harbor porpoises are widely distributed and may be locally abundant (NOAA Fisheries 2014). Those occurring in the License Area belong to the Gulf of Alaska stock, one of three stocks found in Alaska. They are found in fjords, bays, harbors, estuaries, and large rivers. They have a dark grey or brown body that fades to a lighter grey on the sides and have small flippers and a smaller beak. They can weigh up to 130 pounds and grow as long as six feet (ADF&G 2008). Harbor porpoises make inshore-offshore seasonal movements that may be related to prey or ice conditions (NOAA Fisheries 2014).

Harbor porpoises are usually found singly, in pairs, or in groups of up to 10. Little is known of their reproductive behavior, although mating occurs in summer and births occur between May and July (NOAA Fisheries 2014). Sexual maturity is reached after three to four years of age and females can give birth every two years after a gestation period of approximately 11 months. The life span of a harbor porpoise is generally eight to 10 years but can be up to 20 years. They feed on a wide variety of fish and cephalopods, including cod, herring, pollock, sardines, whiting, squid, and octopus (ADF&G 2008). The most recent abundance estimate for the Gulf of Alaska harbor porpoise stock is 31,046 animals (Muto et al. 2018).

g. Gray Whales

There are two isolated geographic distributions of gray whales in the North Pacific Ocean. The western North Pacific stock is found along the coast of eastern Asia. The eastern North Pacific stock migrates through the Gulf of Alaska near the License Area on its way to summer feeding grounds off the coast of northwest Alaska. Gray whales are slate gray in color with white patches. They are typically covered with abrasions and scars and clusters of barnacles. The adult gray whale averages 45 feet in length and weighs 30 to 40 tons. They reach sexual maturity between ages five and 11, or when they reach 36 to 39 feet in length and live an estimated 50 to 60 years. Females give birth to one calf every two or more years and gestate for 12 to 13 months. Calves nurse for seven to eight months (ADF&G 2008).

The gray whale is a baleen whale and bottom-feeder that feeds primarily on amphipod crustaceans, though they rarely feed while migrating. They are generally slow swimmers, averaging 3 to 5 miles per hour during migration. The eastern North Pacific stock typically begins its migration north from late February to May. They begin the southern migration in mid-October (ADF&G 2008). The most recent minimum population estimate for this stock is 18,017. The eastern North Pacific stock is not on the endangered species list (Allen and Angliss 2012).

h. Humpback Whales

The humpback is a baleen whale that are found throughout the world's oceans (Muto et al. 2018). They occur in subtropical and tropical waters during the winter. The Central North Pacific stock

migrates between wintering areas in Hawaii or Mexico where they calve, and a summer feeding area in the North Pacific that includes the Gulf of Alaska and the License Area (ADF&G 2008).

Female humpback whales average 52 feet in length and weigh approximately 35 tons. They have a robust body shape that becomes slender towards its tail. They are primarily black in color and have a broad rounded head with knobs on the lower jaw. Males average 49 feet and weigh slightly less than the females. Humpback whales live an estimated 40 to 50 years. Females are sexually mature at age five and males at age seven. Females reproduce every two or three years. They gestate for 12 months and bear a single calf (NOAA 2018b).

Humpback whales migrate in the spring and the majority of central Pacific humpbacks are found along the Alaskan coast with high densities found in certain areas of their range. Humpback whales feed on euphausiids or krill, and small schooling fish (ADF&G 2008). Humpback whales are listed as endangered species under the Endangered Species Act, and the Western and Central North Pacific stocks, both with ranges overlapping with the Gulf of Alaska, are listed as strategic stocks. The estimated population for the central North Pacific humpback whales was 10,103 animals (Muto et al. 2018).

C. References

- ADF&G (Alaska Department of Fish and Game). 2006. Our wealth maintained: A strategy for conserving Alaska's diverse wildlife and fish resources, Juneau, Alaska.
<http://library.state.ak.us/asp/edocs/2006/07/ocm70702164.pdf> (Accessed May 30, 2014).
- ADF&G (Alaska Department of Fish and Game). 2008. Alaska wildlife notebook series (with 1999 and 2003 updates for some species). ADF&G Wildlife Notebook Series.
- ADF&G (Alaska Department of Fish and Game). 2014. Unit 6 black bear management report of survey and inventory activities 1 July 2010 - 30 June 2013. Pages 8-1 through 8-16. Alaska Department of Fish and Game, Species Management Report ADF&G/DWC/SMR-2014-5. Juneau, AK.
http://www.adfg.alaska.gov/static/research/wildlife/speciesmanagementreports/pdfs/blackbear_2014_chapter_8_unit_6.pdf (Accessed November 29, 2018).
- ADF&G (Alaska Department of Fish and Game). 2016. Dungeness crab fishery catch, effort & value. Registration Area D (Yakutat).
http://www.adfg.alaska.gov/index.cfm?adfg=commercialbyareasoutheast.shellfish_harvest_dungenessd (Accessed July 28, 2016).
- ADF&G (Alaska Department of Fish and Game). 2017. Moose (*Alces alces*) species profile.
<http://www.adfg.alaska.gov/index.cfm?adfg=moose.printerfriendly> (Accessed 3/1/2017).
- ADF&G (Alaska Department of Fish and Game). 2018a. Beaver Species Profile.
<http://www.adfg.alaska.gov/index.cfm?adfg=beaver.main> (Accessed 5/21/2018).
- ADF&G (Alaska Department of Fish and Game). 2018b. Birds.
<http://www.adfg.alaska.gov/index.cfm?adfg=animals.listbirds> (Accessed November 29, 2018).
- ADF&G (Alaska Department of Fish and Game). 2018c. Black Bear Species Profile, Alaska Department of Fish and Game.
<http://www.adfg.alaska.gov/index.cfm?adfg=blackbear.main> (Accessed May 17, 2018).
- ADF&G (Alaska Department of Fish and Game). 2018d. Brown Bear Species Profile.
<http://www.adfg.alaska.gov/index.cfm?adfg=brownbear.main> (Accessed February 9, 2017).
- ADF&G (Alaska Department of Fish and Game). 2018e. Chum Salmon Species Profile.
<http://www.adfg.alaska.gov/index.cfm?adfg=chumsalmon.main> (Accessed 5/15/2018).
- ADF&G (Alaska Department of Fish and Game). 2018f. Copper River Delta – Critical Habitat Area Fish and Wildlife.
<http://www.adfg.alaska.gov/index.cfm?adfg=copperriverdelta.species> (Accessed November 19, 2018).
- ADF&G (Alaska Department of Fish and Game). 2018g. Cutthroat trout species profile.
<http://www.adfg.alaska.gov/index.cfm?adfg=cutthroat.main> (Accessed December 18, 2018).
- ADF&G (Alaska Department of Fish and Game). 2018h. Dolly Varden Species Profile.
<http://www.adfg.alaska.gov/index.cfm?adfg=dollyvarden.main> (Accessed November 27, 2018).

- ADF&G (Alaska Department of Fish and Game). 2018i. Eulachon species profile. <http://www.adfg.alaska.gov/index.cfm?adfg=eulachon.main> (Accessed November 28, 2018).
- ADF&G (Alaska Department of Fish and Game). 2018j. Fish. State of Alaska. Species. <http://www.adfg.alaska.gov/index.cfm?adfg=animals.listfish> (Accessed November 28, 2018).
- ADF&G (Alaska Department of Fish and Game). 2018k. Halibut species profile. <http://www.adfg.alaska.gov/index.cfm?adfg=halibut.main> (Accessed November 28, 2018).
- ADF&G (Alaska Department of Fish and Game). 2018l. Invertebrates. <http://www.adfg.alaska.gov/index.cfm?adfg=animals.listinvertebrates> (Accessed November 28, 2018).
- ADF&G (Alaska Department of Fish and Game). 2018m. Lynx species profile. <http://www.adfg.alaska.gov/index.cfm?adfg=lynx.main> (Accessed 5/21/2018).
- ADF&G (Alaska Department of Fish and Game). 2018n. Prince William Sound Management Area Fishing Research. <http://www.adfg.alaska.gov/index.cfm?adfg=ByAreaSouthcentralPrinceWilliamSound.research> (Accessed November 19, 2018).
- ADF&G (Alaska Department of Fish and Game). 2018o. Short-tailed albatross special status species page. Federal Listed, Special Status Home, Endangered. Species. <http://www.adfg.alaska.gov/index.cfm?adfg=specialstatus.fedsummary&species=shorttailedalbatross> (Accessed November 29, 2018).
- ADF&G (Alaska Department of Fish and Game). 2018p. Steelhead/Rainbow Trout Species Profile. <http://www.adfg.alaska.gov/index.cfm?adfg=steelhead.main> (Accessed December 18, 2018).
- ADF&G (Alaska Department of Fish and Game). 2018q. Trumpeter Swan Species Profile. <http://www.adfg.alaska.gov/index.cfm?adfg=trumpeterswan.main> (Accessed 5/17/2018).
- ADF&G (Alaska Department of Fish and Game). 2018r. Waterfowl Habitat Enhancement Projects. <http://www.adfg.alaska.gov/index.cfm?adfg=habitatrestoration.waterfowlenhancement> (Accessed December 19, 2018).
- Allen, B. M. and R. P. Angliss. 2012. Alaska marine mammal stock assessments, 2011. Page 288. US Department of Commerce, NOAA Technical Memorandum NMFS-AFSC-234. <https://repository.library.noaa.gov/view/noaa/4144> (Accessed July 28, 2016).
- Audubon Alaska 2015. Important bird areas of Alaska, v3 - North Slope. Audubon Alaska. Last Modified April 2015. Anchorage, Alaska. <https://databasin.org/datasets/f9e442345fb54ae28cf72f249d2c23a9> (Accessed October 16, 2018).
- Boggs, K. 2000. Classification of community types, successional sequences, and landscapes of the Copper River delta, Alaska. PNW-GTR-469. United States Department of Agriculture, General Technical Report. <http://www.fs.fed.us/pnw/pubs/gtr469a.pdf> (Accessed July 28, 2015).
- Bowman, T. 1999. Bald eagle. ExxonValdez Oil Spill Trustee Council. http://www.evostc.state.ak.us/static/PDFs/RN_baldeagle.pdf (Accessed July 28, 2015).

- C., Westing. 2014. Unit 6 moose management report. Chapter 7, Pages 7-1 through 7-21 [In] P. Harper and L. A. McCarthy, editors. Moose management report of survey and inventory activities 1 July 2011 - 30 June 2013. Alaska Department of Fish and Game, Species Management Report ADF&G/DWC/SMR-2014-6, Juneau, Alaska.
http://www.adfg.alaska.gov/static/research/wildlife/speciesmanagementreports/pdfs/moose_2014_chapter_7_unit_6.pdf (Accessed November 29, 2018).
- CLO (Cornell Lab of Ornithology). 2014. Western sandpiper overview, All about birds.
https://www.allaboutbirds.org/guide/Western_Sandpiper/id (Accessed December 19, 2018).
- Cornell. 2018. Dunlin. Cornell Lab of Ornithology All About Birds. Ithaca, NY.
<https://www.allaboutbirds.org/guide/Dunlin/id> (Accessed December 19, 2018).
- Day, R. H., A. K. Prichard, and D. A. Nigro. 2002. Exxon Valdez Oil Spill Restoration Project Final Report At-sea Ecological Segregation and Overlap of *Brachyramphus murrelets* in Prince William Sound, Alaska. ABR, Inc., Environmental Research and Services, Restoration Project 00516. Fairbanks, AK. <http://www.arlis.org/docs/vol1/51605895.pdf> (Accessed November 29, 2018).
- EPA (US Environmental Protection Agency). 2018. Level III ecological regions of North America. Corvallis, OR.
ftp://newftp.epa.gov/EPADDataCommons/ORD/Ecoregions/cec_na/NA_LEVEL_III.pdf (Accessed May 14, 2018).
- EVOSTC (*Exxon Valdez* Oil Spill Trustee Council). 2014. 2014 update injured resources and services. <http://www.evostc.state.ak.us/static/PDFs/2014IRSUpdate.pdf> (Accessed April 3, 2018).
- Gallant, A. L., E. F. Binnian, J. M. Omernik, and M. B. Shasby. 1995. Ecoregions of Alaska. US Geological Survey, US Geological Survey Professional Paper 1567. Washington, DC (Accessed September 17, 2015).
- Gustafson, R. L. and K. J. Goldman. 2012. Assessment of Weathervane Scallops in Kamishak Bay and at Kayak Island 2004 through 2010. Alaska Department of Fish and Game, Fishery Data Series No. 12-62. Anchorage, AK. <http://www.adfg.alaska.gov/FedAidPDFs/FDS12-62.pdf> (Accessed December 18, 2018).
- Harding, R. D. and C. L. Coyle. 2011. Southeast Alaska steelhead, trout, and Dolly Varden management. Alaska Department of Fish and Game, Special Publication No. 11-17. Anchorage, AK. <http://www.adfg.alaska.gov/fedaidpdfs/SP11-17.pdf> (Accessed November 27, 2018).
- Hochhalter, Samuel J., Brittany J. Blain, and Barbi J. Failor. 2011. Recreational Fisheries in the Prince William Sound Management Area 208-2010. Alaska Department of Fish and Game, Fishery Management Report No. 11-54. Anchorage, AK.
<http://www.adfg.alaska.gov/FedAidpdfs/FMR11-54.pdf> (Accessed November 27, 2018).
- Johnson, J. and B. Blossom. 2018. Catalog of waters important for spawning, rearing or migration of anadromous fishes - Southcentral Region, effective June 1, 2018. Alaska Department of Fish and Game, Special Publication No. 18-04. Anchorage, Alaska.
https://www.adfg.alaska.gov/static-sf/AWC/PDFs/2018scn_CATALOG.pdf (Accessed October 22, 2018).
- Johnson, S. W., A. D. Neff, J. F. Thedinga, M. R. Lindberg, and J. M. Maselko. 2012. Atlas of nearshore fishes of Alaska a synthesis of marine surveys from 1998 to 2011. US

- Department of Commerce, National Oceanic and Atmospheric Administration, Technical Memorandum NMFS-AFSC-239. <https://www.afsc.noaa.gov/Publications/AFSC-TM/NOAA-TM-AFSC-239.pdf> (Accessed November 19, 2018).
- Kesti, S., M. Burcham, B. Campbell, R. DeVelice, C. Huber, T. Joyce, D. Lang, B. MacFarlane, D. Sherman, R. Velarde, and L. Yarborough. 2004. East Copper River delta landscape assessment. Edited by S. Kesti. US Forest Service, Cordova Ranger District. https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/fsbdev2_038247.pdf (Accessed November 20, 2018).
- Kline, Thomas. 2007. Rockfish Trophic Relationships in Prince William Sound, Alaska, Based on Natural Abundance of Stable Isotopes. Pages 21-37. Biology, Assessment and Management of North Pacific Rockfishes, Fairbanks, AK.
- Ladd, C., P. Stabeno, and E. D. Cokelet. 2004. A note on cross-shelf exchange in the northern Gulf of Alaska. *Deep-Sea Research Part II* 52: 667-679.
- Marston, Brian H., Matt G. Miller, and Steven J. Fleischman. 2011. Spawning Movements of Cutthroat Trout on a Copper River Delta Tributary. Alaska Department of Fish and Game, Fishery Data Series No 11-69. Anchorage, AK. <http://www.sf.adfg.state.ak.us/FedAidPDFs/FDS11-69.pdf> (Accessed November 27, 2018).
- Miller, Arthur J., Emanuele Di Lorenzo, Douglas J. Neilson, Hey-Jin Kim, Antonietta Capotondi, Michael A. Alexander, Steven J. Bograd, Franklin B. Schwing, Roy Mendelsohn, Kate Hedstrom, and David L. Musgrave. 2005. Interdecadal changes in mesoscale eddy variance in the Gulf of Alaska circulation: Implications for the Steller sea lion decline. *Atmosphere-Ocean* 43(3): 231-240.
- Muto, M. M., V. T. Helker, R. P. Angliss, B. A. Allen, P. L. Boveng, J. M. Breiwick, M. F. Cameron, P. J. Clapham, S. P. Dahle, M. E. Dahlheim, B. S. Fadely, M. C. Ferguson, L. W. Fritz, R. C. Hobbs, Y. V. Ivashchenko, A. S. Kennedy, J. M. London, S. A. Mizroch, R. R. Ream, E. L. Richmond, K. E. W. Shelden, R. G. Towell, P. R. Wade, J. M. Waite, and A. N. Zerbini. 2018. Alaska marine mammal stock assessments, 2017. June 2018. US Department of Commerce, NOAA Technical Memorandum NMFS-AFSC-378. <https://repository.library.noaa.gov/view/noaa/18114> (Accessed November 14, 2018).
- NOAA (National Oceanic and Atmospheric Administration Fisheries). 2018a. Flathead sole *Hippoglossoides elassodon*. <https://www.fisheries.noaa.gov/species/flathead-sole> (Accessed December 18, 2018).
- NOAA (National Oceanic and Atmospheric Administration Fisheries). 2018b. Humpback whale *Megaptera novaeangliae*. https://www.afsc.noaa.gov/nmml/species/species_humpback.php (Accessed December 7, 2018).
- NOAA (National Oceanic and Atmospheric Administration Fisheries). 2018c. Killer whale *Orcinus orca*. <https://www.fisheries.noaa.gov/species/killer-whale> (Accessed December 7, 2018).
- NOAA (National Oceanic and Atmospheric Administration Fisheries). 2018d. Pacific white-sided dolphin *Lagenorhynchus obliquidens*. <https://www.fisheries.noaa.gov/species/pacific-white-sided-dolphin> (Accessed December 5, 2018).
- NOAA (National Oceanic and Atmospheric Administration Fisheries). 2018e. Steller sea lion *Eumetopias jubatus*. <https://www.fisheries.noaa.gov/species/steller-sea-lion> (Accessed December 5, 2018).

- NOAA Fisheries (National Oceanic and Atmospheric Administration Fisheries). 2014. Harbor porpoise (*Phocoena phocoena*). National Marine Mammal Laboratory. Marine mammal species. http://www.afsc.noaa.gov/nmml/species/species_harporp.php (Accessed January 31, 2014).
- NOAA Fisheries (National Oceanic and Atmospheric Administration, National Marine Fisheries Service). 2018. Essential fish habitat. Alaska Regional Office. <https://alaskafisheries.noaa.gov/habitat/efh> (Accessed May 30, 2018).
- Nowacki, G. J., P. Spencer, M. Fleming, T. Brock, and T. Jorgenson. 2001. Unified ecoregions of Alaska: 2001. US Geological Survey, Open-File Report 02-297. <https://agdc.usgs.gov/data/usgs/erosafo/ecoreg/index.html> (Accessed February 25, 2015).
- NWF (National Wildlife Federation). 2005. Special Ecological Sites in Alaska's Eastern Prince William Sound & Copper River Delta. Page 36. Alaska Natural Resources Center. Anchorage, AK. https://www.nwf.org/~media/PDFs/Regional/Alaska/PRCA_NWF_EPWS_CR_EcoSites.pdf (Accessed 1/4/2019).
- Parr, B. L. 2018. 2013 Alaska trapper report: 1 July 2013 - 30 June 2014. Alaska Department of Fish and Game, Division of Wildlife Conservation, Juneau. <http://www.adfg.alaska.gov/static/hunting/trapping/pdfs/trap2014.pdf> (Accessed May 21, 2018).
- Pearson, W. H., R. A. Elston, K. Humphrey, and R. B. Deriso. 2013. Oil in the Environment. LEGacies and Lessons of the Exxon Valdez Oil Spill. Edited by J. A. Wiens. Cambridge University Press.
- Powers, Sean P., Mary Anne Bishop, and Erika Clesceri. 2006. Characterization of energy and potential contaminant pathways in subarctic estuarine habitats: Ecology of tidal flat communities of the Copper River delta, Alaska. Final report to the Prince William Sound Regional Citizens Advisory Council. Cordova, Alaska. <http://www.arlis.org/docs/vol1/191103178.pdf> (Accessed November 19, 2018).
- PWSAC (Prince William Sound Aquaculture Corporation). 2018. Hatcheries in Prince William Sound. <http://pwsac.com/about/hatcheries/> (Accessed November 20, 2018).
- Rumble, J. , M. Wessel, E. Russ, K.J. Goldman, P. Shields, and C. Russ. 2016. Cook Inlet Area and Prince William Sound commercial fisheries for Dungeness crab, shrip, and miscellaneous shellfish through 2014. Alaska Department of Fish and Game, Fishery Management Report No. 16-24. Anchorage. <http://www.adfg.alaska.gov/FedAidPDFs/FMR16-24.pdf> (Accessed October 17, 2017).
- Savereide, James W. 2008. Relative abundance, migratory timing, and overwintering and spawning distribution of steelhead in the Copper River drainage. Page 27. Alaska Dept. of Fish and Game Division of Sport Fish Research and Technical Services, Fishery data series No. 08-56. Anchorage. <http://library.state.ak.us/asp/edocs/2009/01/ocn298897764.pdf>.
- Schoch, G. Carl and Molly McCammon. 2012. Demonstrating the Alaska Ocean Observing System in Prince William Sound. Continental Shelf Research.
- Stewart, I. and A. Hicks. 2018. Assessment of the Pacific halibut (*Hippoglossus stenolepis*) stock at the end of 2017. International Pacific Halibut Commission. <https://iphc.int/uploads/pdf/am/2018am/iphc-2018-am094-10.pdf> (Accessed November 27, 2018).

- Turnock, Benjamin J., Carey R. McGilliard, and Wayne Palsson. 2017. Assessment of the Flathead Sole Stock in the Gulf of Alaska. Edited by National Oceanic and Atmospheric Administration Fisheries. National Oceanic and Atmospheric Administration, Resource Ecology and Fisheries Management Division, Seattle, WA.
<https://www.afsc.noaa.gov/REFM/Docs/2017/GOAflathead.pdf> (Accessed December 18, 2018).
- USFWS (United States Fish and Wildlife Service). 2006. Alaska Seabird Information Series. Anchorage, AK. https://www.fws.gov/alaska/mbsp/mbm/seabirds/pdf/asis_complete.pdf (Accessed November 29, 2018).
- USFWS (United States Fish and Wildlife Service). 2008a. Exxon Valdez oil spill restoration project final report: Prince William Sound bird surveys, synthesis and restoration. Restoration Project 080751. <http://www.evostc.state.ak.us/Store/FinalReports/2008-080751-Final.pdf> (Accessed 1/18/2017).
- USFWS (United States Fish and Wildlife Service). 2008b. Short-Tailed Albatross Recovery Plan. Anchorage, AK.
https://www.st.nmfs.noaa.gov/Assets/nationalseabirdprogram/stal_recovery_plan.pdf (Accessed November 29, 2018).
- USFWS (United States Fish and Wildlife Service). 2012. 2010 North American Trumpeter Swan Survey. Juneau, AK.
<http://www.trumpeterswansociety.org/docs/North%20American%20TRUS%20Survey%202010%20Rept.pdf> (Accessed 2/7/2017).
- USFWS (United States Fish and Wildlife Service). 2014. Northern Sea Otter (*Enhydra lutris kenyoni*) Southcentral Alaska Stock.
https://www.fws.gov/alaska/fisheries/mmm/stock/Revised_April_2014_Southcentral_Alaska_Sea_Otter_SAR.pdf (Accessed December 6, 2018).
- USFWS (United States Fish and Wildlife Service). 2017. The 2015 North American Trumpeter Swan Survey A Cooperative North American Study. Division of Migratory Bird Management. Juneau, AK. https://www.fws.gov/migratorybirds/pdf/surveys-and-data/NATrumpeterSwanSurvey_2015.pdf (Accessed May 17, 2018).
- USFWS (United States Fish and Wildlife Service). 2018a. Alaska Seabird Information Series Aleutian Tern. Last Modified 2006.
<https://www.fws.gov/alaska/mbsp/mbm/seabirds/pdf/alte.pdf> (Accessed November 29, 2018).
- USFWS (United States Fish and Wildlife Service). 2018b. Dusky Canada Geese *Branta canadensis occidentalis*.
https://www.fws.gov/refuge/William_L_Finley/Wildlife_And_Habitat/Birds/Dusky_Canada_Goose.html (Accessed December 18, 2018).
- USFWS (United States Fish and Wildlife Service). 2018c. Marbled Murrelet. Last Modified October 11, 2011. Arcata, CA. https://www.fws.gov/arcata/es/birds/mm/m_murrelet.html (Accessed November 29, 2018).
- USFWS (United States Fish and Wildlife Service). 2018d. Threatened and Endangered Species Short-Tailed Albatross. Last Modified September 2011.
https://www.fws.gov/alaska/fisheries/fieldoffice/anchorage/endangered/pdf/factsheet_stal.pdf (Accessed November 29, 2018).

- Warren, Kelly. 2006. Identification Field Guide to the Geese of the Willamette Valley and Lower Columbia River. Wild Spirit Resources LLC.
https://www.dfw.state.or.us/resources/hunting/waterfowl/goose-permits/docs/Goosefieldguide_front_and_ch1-2.pdf (Accessed December 18, 2018).
- Woodford, Riley. 2006. Assessing Moose Habitat in Alaska. Alaska Fish and Wildlife News (December 2006). Alaska Department of Fish and Game.
http://www.adfg.alaska.gov/index.cfm?adfg=wildlifeneews.view_article&articles_id=256. (Accessed 3/1/2017).
- Woodford, Riley. 2008. Pigeon Guillemots. Alaska Fish and Wildlife News (August 2008). Alaska Department of Fish and Game.
http://www.adfg.alaska.gov/index.cfm?adfg=wildlifeneews.view_article&articles_id=390. (Accessed November 29, 2018).
- Woods, G. F. and N. L. Zeiser. 2013. Annual Management Report of the 2012 Yakutat Area commercial salmon fisheries. Alaska Department of Fish and Game, Fishery Management Report No. 13-22. Anchorage, AK. <http://www.adfg.alaska.gov/FedAidPDFs/FMR13-22.pdf> (Accessed November 26, 2018).

Chapter Five: Current and Projected Uses

Contents

	Page
A. State Game Refuges, Critical Habitat Areas, and Other Designated Areas.....	5-1
B. Current and Projected Uses in the License Area.....	5-2
1. Subsistence and Personal Use.....	5-3
2. Commercial Fishing	5-4
a. Yakutat	5-5
b. Prince William Sound	5-6
3. Sport Fishing	5-9
4. Personal Use Fishing	5-11
5. Hunting and Trapping.....	5-11
6. Other Uses	5-13
a. Recreation and Tourism	5-13
b. Forestry	5-13
c. Mining	5-13
d. Oil and Gas.....	5-13
C. References.....	5-14

Figures

	Page
Figure 5.1. Critical Habitat Area and Anadromous Rivers in and adjacent to the License Area.....	5-2
Figure 5.2. Gulf of Alaska Game Management Units	5-12

Tables

	Page
Table 5.1. Nominal Prince William Sound permit values, 2000–2016.....	5-7
Table 5.2. Nominal total Prince William Sound permit earnings, 2000–2016.....	5-8
Table 5.3. Economic impact of sport fishing in Alaska in 2001, 2003, 2006, 2011.	5-10

Chapter Five: Current and Projected Uses

This chapter considers and discusses the current and projected uses in the License Area, including uses and value of fish and wildlife as required by AS 38.05.035(g)(iv). The land and waters included in and near the License Area provide habitat for many species of fish and wildlife as described in Chapter Four. The License Area also provides a variety of uses such as subsistence use, fishing, and hunting activities. In addition, the area has been used for forestry and mineral and oil and gas exploration. These and other current and projected uses are considered and discussed below. The following information is not intended to be all inclusive, but to provide an overview of the current and projected uses. Due to the compact size and remote nature of the exploration license, DNR has compiled the current and projected use information from the region surrounding the License Area including Prince William Sound, and southeast towards Yakutat.

A. State Game Refuges, Critical Habitat Areas, and Other Designated Areas

The State of Alaska manages 14 marine parks, one state game refuge, and one critical habitat area in the Gulf of Alaska area. Alaska marine parks were established to complete an international system of marine parks and recreation areas that begin in Washington State, include sites in British Columbia and Southeast Alaska, and end at Resurrection Bay. In 1983 and again in 1990, the state legislature designated marine parks in Prince William Sound (DNR 2012).

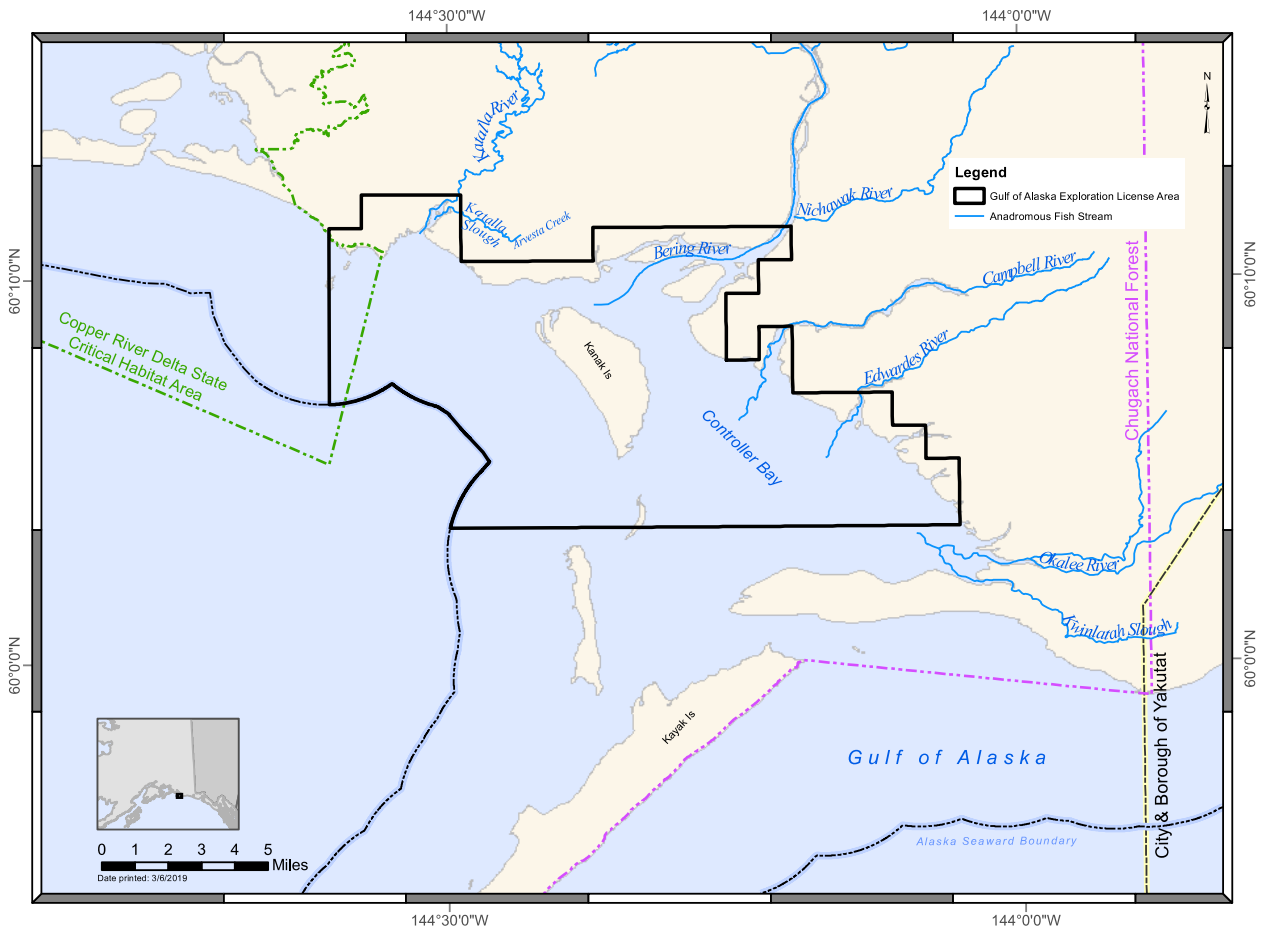
The marine parks closest to the License Area include Canoe Passage, Boswell Bay, and Kayak Island. Kayak Island is located just south of the License Area and is known as the site where the first Europeans visited Alaska. The park is seldom visited because of its remote location and inhospitable weather with exposed shoreline (DNR 2018).

The Copper River Delta Critical Habitat Area (CHA) is the only CHA in this region, and a portion of it is located within the License Area and to the west. The legislature established CHAs to protect and preserve areas crucial to the perpetuation of fish and wildlife and to restrict all other uses not compatible with that primary purpose (AS 16.20.500). They are managed by the Alaska Department of Fish and Game (ADF&G) to provide a higher level of protection to those habitats. CHAs do not prohibit oil and gas exploration or development but do require an ADF&G Special Area Permit (ADF&G 2018b).

The Copper River Delta CHA is composed of land and water stretching from Hook Point on Hinchinbrook Island to Palm Point near Katalla and approximately 35 miles inland on the braided delta system. In the spring, approximately 12 million shorebirds use the shores of the Copper River Delta as a stopover on their way to more northern nesting grounds. Up to 250,000 shorebirds per square mile have been observed feeding on the Copper River Delta tide flats from late April through May. Despite the six-foot uplift of the delta's wetlands during the 1964 earthquake and the resulting drying of some lands, the delta remains a productive summer nesting habitat for thousands of water birds (ADF&G 2018b).

The Yakataga State Game Refuge is approximately 70 miles southeast of the License Area boundary and is managed by ADF&G. The refuge’s current management plan policy, from 1999, is to protect fish and wildlife, conserve their populations, and maintain public use opportunities. Non-renewable resource extraction would need to be compatible with these goals and policies and would require a Special Area Permit described in 5 AAC 95.420. Likewise, hazardous substances cannot be stored in the refuge, though amounts more than 20 gallons may be allowed by Special Area Permit. Roads, docks, pipelines and utility lines are allowed for consideration in the refuge but only under specific conditions. They may be allowed by the ADF&G commissioner if they show a need for which there is no feasible alternative. Impacts associated with development would have to be fully mitigated, up to rehabilitation and restoration (ADF&G 1999). Figure 5.1 displays the anadromous rivers within and adjacent to the License Area.

Figure 5.1. Critical Habitat Area and Anadromous Rivers in and adjacent to the License Area



B. Current and Projected Uses in the License Area

ADF&G manages wildlife resources through game management units (GMUs). ADF&G compiles and analyzes harvest and biological information, enabling the establishment of ecologically sound population-based fishing, hunting, and trapping regulations. This information may also be used to promote conservation strategies and recovery actions. The License Area is located within the boundaries of GMU 6A.

1. Subsistence and Personal Use

Cordova, Tatitlek, and Chenega Bay are the communities in this region nearest to the License Area most dependent on fish and wildlife for subsistence. These communities are not within the License Area and it is unknown how much of the harvest activities occur within the boundaries of the License Area. In terms of big game hunting, residents of Cordova, Chenega Bay, and Tatitlek have historically hunted black bear in GMU 6. Black bear once was a staple of subsistence hunting, however, between 1986 and 2006, almost 90% of all black bear harvests were by nonresidents. Since then, Sitka black-tailed deer has replaced black bears in importance to Prince William Sound residents. Mountain goats continue to be a subsistence food for residents of Chenega Bay and Tatitlek, however, these species are not present in the License Area (Simeone 2008).

Data on the use of migratory birds and eggs for subsistence is sparse. However, in 2004 and 2010, data were collected for the Gulf of Alaska region. Researchers estimated 2,756 birds and 2,173 eggs were harvested in 2004, and 1,049 birds and 1,366 eggs were harvested in 2010. Those numbers include data from the villages of Port Graham and Nanwalek, which are closer to Homer and west of the Gulf of Alaska region (Naves and Braem 2014). More recently, the Cordova region harvested 42 birds in 2014 and reported no birds in 2015. They reported harvesting 131 eggs in 2014, and an estimated 263 eggs in 2015 from the Cordova region. Harvest estimates were based on 15 completed mail-out surveys from 20 registered households (Naves 2016).

Between 1985 and 2003, Cordova residents annually harvested from 128 to 234 pounds per capita of non-commercial resources. In 2003, salmon was the primary subsistence resource and accounted for 44 percent of subsistence harvests among Cordova residents. Large land mammals were 30 percent of the harvests, followed by non-salmon fish at 16 percent, and a mix of marine invertebrates, birds, eggs, marine mammals, small land mammals, and vegetation making up the rest. There is typically a small harvest of razor clams east of the Copper River delta. In 2011, ADF&G issued 11 non-commercial clam harvest permits for a total harvest of 2.5 pounds. Subsistence users in this region use trout, char, whitefish, grayling, suckers, and burbot from freshwaters. Saltwater subsistence foods are salmon, shrimp, lingcod, rockfish, halibut, razor clams, golden king and Tanner crabs (Holen et al. 2011). In 2014, the estimated halibut subsistence harvest for Prince William Sound was 32,690 pounds and in 2016, approximately 26,000 pounds of halibut were harvested for subsistence (Fall, J. A. and Koster 2018).

In the Copper River District Subsistence Salmon Fishery, which is primarily reported from residents of Cordova, 243 permits were issued in 2015 and approximately 96 percent of the permits were returned. While participation in 2015 was lower than the 10-year average, it was greater than the historical average, with 181 permits on average between 1965 and 2014. The estimated salmon harvest for 2015 was 1,709 salmon, a decrease from 1,939 in 2014. The vast majority of the harvest comprised sockeye salmon at 90 percent. Chinook salmon comprised 10 percent with no pink salmon or chum harvested (Fall, J. A. et al. 2018).

Based on the most current available data provided on ADF&G's Community Subsistence Information System, important resources, other than salmon, harvested by Cordova subsistence users include deer, moose, halibut, and vegetation including salmon berries and blueberries. In Cordova, the average household harvested an estimated 82 pounds of moose meat, 22 pounds of deer meat, and 40 pounds of halibut. Edible vegetation made up approximately nine percent of the

community harvest. Cordova households reported harvesting approximately 11 pounds of vegetation (Fall, J. A. and Zimpelman 2016). In the 2013-2014 season, 155 permits were issued for tanner crab subsistence fishing. However, king crab subsistence fishing has remained low since the fishery opened in 2008, with no reported effort of harvest during 2012-2013 (Rumble, J. et al. 2014).

Yakutat residents use about 200 miles of coastline for subsistence. Areas especially highly used include coastal areas east of the Situk River west to Ocean Cape, all of the lands and waters of the Ankaun lagoon system, all areas of the shore and offshore in Yakutat Bay, and virtually all of the Situk River drainage. These areas are all outside of the License Area boundaries (City and Borough of Yakutat 2010). Between 2007 and 2016, Yakutat residents harvested annually just over 5,400 salmon of all species on average (Conrad and Gray 2018). A mid-1980s survey showed that Yakutat residents hunted seals throughout Yakutat Bay, at the entrances to major salmon streams along the Yakutat Forelands, and in Icy Bay (Hood et al. 2006). Black and brown bears are both prevalent large mammals in the Yakutat subsistence harvest. Most black bears were taken in May and all brown bears were taken in October based on 2015 data. Bears were hunted both along the road system and on the coastlines of Russell Fjord. Additional bear hunting areas include the Situk and Italio Rivers approximately 165 miles east of the License Area (Sill et al. 2017).

Subsistence harvests in Yakutat follow a yearly cycle based on seasonal availability, conditions, and regulatory restrictions. In general, eulachon appear in the Situk, Italio, and Alsek rivers in February. In February and March, clams, scallops, shrimp, and crab can be harvested from islands immediately northwest of Yakutat. Halibut and cod may also be available in the same area and are harvested all year. Herring arrive in late February or March. Winter chinook are harvested throughout the winter, with the most fish caught in March and April. Chinook are also harvested May through July. Seals are also harvested in the protected waters of these islands, with 345 harbor seals harvested in 2015 (Sill et al. 2017). In 2015, residents of Yakutat harvested about 16,000 pounds of halibut for subsistence, and in 2016, about 23,000 pounds (Fall, J. A. and Koster 2018; ADF&G 2018a).

Salmon dominate summer harvest activities. The Situk River is the site of most fishing (both commercial and subsistence) in Yakutat. Most salmon fishing in 2015 occurred in the Situk River and Yakutat Bay. Sockeye and coho salmon made up the bulk of the harvest with roughly 27,000 pounds of sockeye and about 15,000 pounds of coho harvested (Sill et al. 2017).

Later in the season people harvest berries, and other plants, such as wild celery, ferns and beach greens. In the autumn months of September to October, late run coho salmon are harvested, mountain goats may be hunted near Icy Bay, black bears are sought, and moose season begins. This is also the time of year for harvesting waterfowl. Trapping activities take over during the winter months, November through January (Sill et al. 2017). Trapping of furbearers occurs along the Malaspina Forelands south of Sitkagi Bluffs and the shoreline southeast of Icy Bay (Hood et al. 2006).

2. Commercial Fishing

ADF&G manages two distinct commercial fishing areas in and around the License Area. The Prince William Sound area includes the Copper River Delta and the Bering River. The Gulf of

Alaska coast includes areas to the south and east of the License Area around Yakutat. The Yakutat set gillnet fisheries take place in the Yakutat and Yakataga districts (Zeiser and Hoffman 2017).

a. Yakutat

The Yakutat commercial fishing district extends from Cape Fairweather to Icy Cape. The Yakataga district extends from Icy Cape to Cape Suckling. There are 16 rivers that are fished in these districts. The Yakataga fishery targets coho salmon only; the Yakutat fishery targets sockeye and coho salmon primarily, though the other three species of Pacific salmon are harvested as well. Since the 1930s, a Yakutat-based fishery has taken place in the Tsiu and Kaliakh rivers in the Yakataga district. In the 1970s, the fishery shifted to the Tsiu River for coho, with lesser effort at the Kiklukh, Tashalich, and Seal Rivers. The Tsiu River fishery is smaller today than in the past and only three permits were fished in 2016. The fishing effort in the Tsiu River was the lowest since 1977, due to changing river conditions which created inefficient fishing (Zeiser and Hoffman 2017).

In 2016, the Yakutat set gillnet fishery harvested 260,000 salmon of all five Pacific salmon species, which was 25 percent below the 10-year average. There were 174 set gillnets in the Yakutat fishery, but in 2016, only 112 were fished, which was also below the 10-year average. In 2016, the average earnings were \$22,000, which was 27 percent higher than the 10-year average and nearly double the income earned in 2015 (Zeiser and Hoffman 2017).

In 2016, the Situk-Ahrnklin Inlet was the top sockeye salmon producer in the district and accounted for approximately one-third of the region's harvest of approximately 93,000 fish. This was however, below the 10-year average of 130,000 fish. The Alsek River fisheries produced below average harvests with only 7,000 sockeye salmon which was the lowest harvest in the past five years. Yakutat Bay accounted for 22 percent of the area's sockeye salmon harvest totaling 21,000 salmon. The coho salmon harvest for the area was 144,000 fish, just above the 10-year average of 129,000 fish. There are two major coho producers in Yakutat in 2016, the Tsiu River and Situk-Ahrnklin Inlet. The Tsiu River fishery harvested about 11,000 coho which is well below the 5-year average and was caused by decreased fishing effort in 2016. However, the Situk-Ahrnklin Inlet harvest was above the 5-year average, at 130,000 coho salmon (Zeiser and Hoffman 2017).

The Yakutat weathervane scallop fishery began in the late 1960s with early scallop harvests of 900,000 pounds in 1968 and 800,000 pounds in 1969. In the early 1990s, the weathervane scallop fishery expanded rapidly with an influx of new participants. ADF&G has reduced the general harvest levels several times since then as catch rates have decreased. Since 1993, catches, as measured in pounds of meat, have been as high as about 244,000 pounds in 1997 and 1998, and as low as 86,950 pounds in 2004 and 2005 (Burt et al. 2013). In 2016, ADF&G initiated a statewide dredge survey for managing weathervane scallops in Alaska (NPFMC 2018).

Lingcod is commercially harvested near Yakutat in the Icy Cape area, which is the northernmost of the Southeast Alaska groundfish management areas. Between 2014 to 2017, the lingcod harvest ranged from 208,715 pounds to 237,793 pounds, which is a decrease from the previous 5-year average (Olson et al. 2017).

Sidestripe and northern shrimp are harvested with otter trawls in the Icy Bay section of the Yakutat fishery management area. Before 1997, the fishery took place in Yakutat Bay and the entire area between Cape Suckling and Cape Fairweather. There have been no trawl gear harvests since the

2004–2005 season. A pot shrimp fishery takes place in Yakutat Bay from October through February. However, from 2010 to 2017, there was only one season where more than three permits were fished. The most recent recorded harvest for this fishery was 3,638 pounds by four permits in the 2012–2013 season (Smith and Gray 2017).

b. Prince William Sound

In March 1989 the *Exxon Valdez* ran aground on Bligh Reef in Prince William Sound and spilled over 11 million gallons of crude oil into the water. Approximately 40% of the spilled oil impacted beaches and shorelines in Prince William Sound. Following the spill many studies indicated that fish and wildlife were exposed to the spilled oil. The exact number of fish and wildlife killed as a result of the spill is unknown. Additional discussion on the effects of the *Exxon Valdez* Oil Spill is included in Chapter Eight.

The Prince William Sound salmon management area has 11 management districts in seven large management areas and includes the Bering and Copper rivers. Six hatcheries contribute to the area’s salmon fisheries, and the Gulkana Hatchery in Paxson, produces sockeye salmon for the Copper River. The other hatcheries are Armin Koernig Hatchery on Evans Island, near Chenega Bay; Main Bay Hatchery, east of Port Nellie Juan; Wally Noerenberg Hatchery, at the south end of Esther Island; and Cannery Creek Hatchery, on the east side of Unakwik Inlet. The Solomon Gulch Hatchery in Port Valdez produces pink and coho salmon (Wiese et al. 2015).

Purse seine, drift, and set gillnet gear are all used in the area fisheries, and drift gillnets are the most common gear type. There are 29 set gillnet permits, which are used only in the Eshamy District, in western Prince William Sound. Drift gillnet permits are the most numerous, at 517, and operate in the Bering River, Copper River, Coghill, Unakwik, and Eshamy districts. There are 210 purse seine permits, which are allowed to fish in the Eastern, Northern, Unakwik, Coghill, Northwestern, Southwestern, Montague, and Southeastern districts (Russell et al. 2017).

Between 2012 and 2014, total harvest average for Prince William Sound salmon fisheries was 61.4 million fish and exceeded the 10-year average from 2002 through 2011 of 46.8 million fish. The 2013 harvest of 99.7 million fish included a record harvest of 92.6 million pink salmon. The rest of the harvest included 2.3 million sockeye, 4.1 million chum, 619,000 coho, and 10,800 Chinook. The estimated value of the 2013 harvest was \$168.3 million (Wiese et al. 2015).

The 2016 Prince William Sound commercial salmon harvest totaled 18.54 million fish. About 12.88 million were pink salmon, followed by 3.17 million chum, 1.99 million sockeye, 483,930 coho, and 13,467 Chinook. About 28 percent of the harvest was hatchery fish. The preliminary estimated value of the 2016 fishery including the value of the commercial common property fishery and the hatchery fishery was about \$62.6 million (Russell et al. 2017). The value of permits and overall earnings increased significantly since 2000, and in the case of the purse seine permit value, peaked in 2014 before decreasing in 2015 and 2016 (Tables 5.1 and 5.2) (CFEC 2017).

About 33 percent of Prince William Sound purse seine salmon permits are owned by residents of the Valdez-Cordova Census Area. About 43 percent of the drift gillnet permits are locally owned, and about 14 percent of set gillnet permits are locally owned. Permit values adjusted for inflation were at an all-time high in 1990 before declining to their lowest values in the early 2000s. Between 2005 and 2012, as illustrated in Table 5.1, salmon permit values steadily increased (CFEC 2017).

Table 5.1. Nominal Prince William Sound permit values, 2000–2016

Year	Purse Seine	Drift Gillnet	Set Gillnet
2000	\$22,000	\$59,300	\$60,500
2001	\$21,400	\$57,500	\$60,300
2002	\$20,000	\$41,000	\$59,200
2003	\$13,500	\$35,900	\$59,900
2004	\$14,000	\$40,400	\$62,800
2005	\$19,200	\$48,300	\$62,700
2006	\$26,100	\$51,600	\$61,500
2007	\$30,900	\$52,000	\$61,500
2008	\$70,200	\$90,300	\$59,500
2009	\$75,300	\$110,900	\$59,500
2010	\$100,500	\$128,100	\$59,800
2001	\$140,000	\$162,100	\$59,800
2012	\$168,700	\$180,200	\$61,000
2013	\$168,000	\$195,200	\$119,300
2014	\$213,000	\$237,500	\$190,800
2015	\$186,700	\$224,200	\$190,800
2016	\$147,900	\$155,400	\$190,800

Source: CFEC 2017

In 1993, the spawning biomass of herring in Prince William Sound was 20 percent of what was expected, and herring numbers have not recovered since. The decline has been attributed to a massive adult die off between spring of 1992 and 1993 caused by poor nutrition, possibly in combination with disease (Pearson et al. 2011). Based on stock assessment information, all Pacific herring fisheries were closed in the 2016 season (Russell et al. 2017).

Historically vibrant fisheries for Dungeness crab and other shellfish once existed in Prince William Sound and the Copper River delta. Between 1981 and 1991, harvests for Dungeness crabs ranged from 70,000 to 1.5 million pounds. The average harvest from 1983 to 1992 was 590,000 pounds among twelve vessels. The Board of Fisheries closed the crab fishery in 2000, and the likelihood of these fisheries reopening in Prince William Sound remains low. The decline of Copper River Dungeness crab stocks coincided with the collapse of other shellfish in Prince William Sound. Possible explanations for the decline and failure to recover are overfishing, bycatch, predation, and environmental changes that affect disease, growth, and larval survival (Rumble, J. et al. 2016).

The Prince William Sound shrimp pot season opened in 2010, after an 18-year closure. In 2017, just over 67,000 pounds of shrimp were commercially harvested in Prince William Sound by 61 permit holders on 54 vessels (Rumble, J. et al. 2018).

Table 5.2. Nominal total Prince William Sound permit earnings, 2000–2016

Year	Purse Seine	Drift Gillnet	Set Gillnet
2000	\$18,003,064	\$20,325,656	\$1,008,002
2001	\$12,862,182	\$21,236,239	\$1,341,957
2002	\$5,166,570	\$21,026,589	\$1,726,484
2003	\$16,719,325	\$20,269,755	\$1,305,689
2004	\$5,898,622	\$22,408,577	\$499,698
2005	\$19,390,127	\$24,066,702	\$540,779
2006	\$11,413,062	\$27,497,718	\$849,458
2007	\$35,955,115	\$34,903,708	\$1,365,898
2008	\$52,047,970	\$33,038,463	\$1,498,602
2009	\$10,451,033	\$32,395,561	\$1,704,971
2010	\$82,212,884	\$47,761,081	\$4,085,598
2011	\$37,692,355	\$50,157,831	\$3,215,004
2012	\$48,550,233	\$60,292,130	\$3,541,396
2013	\$100,114,897	\$52,020,760	\$2,751,731
2014	\$39,955,927	\$54,568,021	\$3,094,241
2015	\$67,368,461	\$37,828,620	\$2,038,043
2016	\$14,547,133	\$36,830,335	\$1,921,950

Source: CFEC 2017

During the first part of the 1900s there was a strong razor clam industry near Cordova, with the community once touting itself as “the razor clam capital of the world”. However, markets declined between the 1950s and the 1980s because of concerns for paralytic shellfish poisoning. The 1964 earthquake significantly affected the habitat of razor bed clams during that period of decline. Annual commercial harvests from 1980 to 1988 averaged 51,611 pounds by 20 diggers. The only commercial harvest to occur since 1988 took place in 1993. The results of the 1993 commercial harvest remain confidential due to only two diggers participating (Rumble, J. et al. 2016).

Beginning in 1992, a weathervane scallop fishery opened near Kayak Island and its vicinity, including in federal waters beyond three miles from shore. Kayak Island was divided into two separate fishing areas in 1998: West Kayak Subsection, and the East Kayak Subsection. In both areas, harvests have declined since the 2004 season; from 26,000 pounds in 2005 to 8,400 pounds in 2011 on the East Kayak Subsection, and from 24,000 pounds harvested in 2005 season to 5,000 pounds in the 2011 season on the West Kayak Subsection. ADF&G expects fishing effort to remain low because of the continued small harvests (Rumble, J. et al. 2016).

Groundfish fisheries managed by ADF&G in Prince William Sound take place in state waters from Cape Fairfield to Cape Suckling, in both state and federal waters. Species managed include rockfish, Pacific cod, pollock, sablefish, and lingcod. In 2016, the state-managed groundfish harvest totaled 8.43 million pounds with a value of \$1.5 million. Pollock is the highest-volume fishery in Prince William Sound with nearly 7.9 million pounds harvested in 2016, with a value of \$629,341. This is a drop from 2015 when 9.7 million pounds of pollock were harvested and valued at just over \$1 million. In both 2015 and 2016, Pacific cod was the second highest-volume groundfish fishery. The 2015 harvest was 3.2 million pounds from state waters and the 2016 harvest was 2.2 million

pounds. However, in both 2015 and 2016, Pacific cod was more valuable than pollock, being valued at \$1.1 million in 2015 and about \$720,000 in 2016 (Rumble, J. et al. 2017).

In 2015 and 2016, the sablefish harvest of 16,910 and 40,457 pounds respectively were the lowest recorded in Prince William Sound. Between 2007 and 2016, sablefish harvests have averaged about 157,000 pounds. Most of the lingcod harvest is in federal waters; between 2014 and 2016, the federal waters harvest averaged 74 percent of the total harvest for lingcod. The outside district harvest was 5,132 pounds in a directed fishery and another 8,558 pounds as bycatch. Harvest in the inside district was 404 pounds, all of which was bycatch (Rumble, J. et al. 2017).

3. Sport Fishing

Whittier, Valdez, and Cordova are three ports that provide access to Prince William Sound sport fishing opportunities. There are some streams accessible by road from Cordova and Valdez, but for the most part sport fisheries in Prince William Sound and the Gulf of Alaska are remote and difficult to access. Hundreds of lakes and streams, combined with hatchery-raised fish, provide opportunity for recreational fishers to catch four species of Pacific salmon from May to October. Wild and hatchery Chinook salmon are fished all year in the saltwater of Prince William Sound. Shrimp, hard-shell clams, salmon sharks, trout, halibut, rockfish, and lingcod all attract recreational fishers (Thalhauser 2014).

In Prince William Sound, angler effort increased from 132,794 angler days to 210,188 angler days between 2001 and 2007. In 2013, effort was 177,434 angler days, an uptick from the 2012 season of 135,852 days. Between 2001 and 2013, boat anglers most commonly launched from the ports of Valdez and Whittier. In 2013, 33 percent of the effort was based out of Valdez, 45 percent out of Whittier, and 4 percent out of Cordova. Between 2001 and 2013, the Valdez Arm averaged the highest number of angler days with 51,173 days. Whittier held the second highest average with 46,254 days. Between 2004 and 2013, regionally, Eastern Prince William Sound averaged the most angler days annually with 74,977, followed by Western Prince William Sound's average of 74,079 angler days (Thalhauser 2014).

Cordova has a relatively small road system that provides access to freshwater fishing opportunities to residents and tourists for sockeye and coho salmon, grayling, Dolly Varden, and trout. Anglers can access Clear and Ibeck Creeks and the Eyak River from the road system. Additionally, there are fishing opportunities in Alaganik Slough for sockeye and coho salmon. Clear Creek and Sheridan Dike Pond are the only water bodies near Cordova where Arctic grayling are reliably found as they are no longer stocked along the Copper River Highway (ADF&G 2015a)

Halibut are caught throughout the marine waters of Prince William Sound. Harvests in western Prince William Sound increased after 2001 from 13,412 harvested that year to an average of 32,545 between 2011 and 2013. Harvests are higher in western Prince William Sound than in the eastern portion. The average yearly sport harvest for the Cordova area was 2,400 fish (Thalhauser 2014; ADF&G 2015a).

Six species of pelagic and nonpelagic rockfish are harvested in the Prince William Sound sport fishery. There are 10 species of rockfish that are regularly harvested in the Cordova area sport fishery. After the Whittier tunnel opened in 2000, catch and harvest of rockfish in western Prince

William Sound tripled between 2001 and 2009 and continue to be close to 2009 levels. In 2001, total catch in the Prince William Sound management area was 28,935 fish and harvest was 19,412 fish. In 2010, catch was 60,296 fish and harvest was 39,953 fish (Thalhauser 2014; ADF&G 2015a).

Lingcod are common along the ocean entrances from Cape Fairfield at the southern tip of the eastern Kenai Peninsula to Hinchinbrook Entrance and are also caught around rocky reefs and underwater pinnacles throughout Prince William Sound. From 2001 to 2007, total lingcod harvest increased from 4,586 fish to 11,961 fish and was split evenly between western and eastern Prince William Sound. The lingcod harvest remained stable until a decline began in 2010 (Thalhauser 2014).

Shrimp are harvested mostly out of the ports of Whittier and Valdez. Whittier shrimp are primarily harvested in the areas of Passage Canal, Culross Island, and Port Wells. Shrimping effort out of Valdez focuses near Port Valdez and Valdez Arm. Shrimp harvest in 2002 was 15,054 pounds and was 85,988 pounds in 2013. Effort and harvest peaked in 2010 at 142,146 pounds (Thalhauser 2014).

Fishing for steelhead and salmon near Yakutat is focused on the Alsek, East, Akwe, Italio, Dangerous, Antlen, Arhrnklin, Situk, Tsiu, Tsivat, Kaliakh and Kiklukh drainages. The runs begin in May and last into the autumn (City and Borough of Yakutat 2010).

Current economic estimates for sport fishing specific to the License Area are unavailable. From 1999 to 2006, sport fishing peaked in 2000 at 1.46 million angler-days, but otherwise ranged from about 1.11 to 1.30 million angler-days. In 2016, about 66 percent of the total statewide sport fishing effort occurred in the Southcentral area (ADF&G 2018c).

Table 5.3. Economic impact of sport fishing in Alaska in 2001, 2003, 2006, 2011.

Year	Retail Sales	Output	Wages and Salaries	Jobs
2001	\$587,028,597	\$959,821,921	\$238,011,311	11,064
2003	\$640,167,515	\$1,046,706,782	\$259,556,537	12,065
2006	\$530,165,682	\$800,921,744	\$252,957,398	8,465
2011	\$718,452,401	\$1,073,716,980	\$358,679,292	9,992

Sources: (ASA 2002; Southwick Associates, Inc. et al. 2008; Southwick Associates 2013).

Notes: Estimates use data from the U.S. Fish and Wildlife Service’s National Survey of Fishing, Hunting and Wildlife-Associated Recreation, and probably underestimate the total economic impact of sport fishing in Alaska because they do not include expenditures made outside Alaska.

Many sport anglers, particularly non-residents, use the services of sport fishing guides and charters. The guided fishing industry provides significant economic benefits to Alaska and the Cook Inlet area by providing jobs and supporting tourism. Sport fishing guides are required to be licensed and must meet minimum professional standards such as first aid training, a U.S. Coast Guard operator’s license, a business license, and proof of insurance. In December 2014, over 1,800 guides were licensed in Alaska (DOLWD 2015).

In 2011, through the multiplier or ripple effect, statewide fishing in Alaska generated approximately \$359 million in salaries and wages, 9,992 jobs, and over \$1 billion into the statewide economy as a

result of sport fishing in Alaska (Southwick Associates 2013; USFWS 2016). It should be noted that these estimates, which use data from the USFWS's National Survey of Fishing, Hunting and Wildlife-Associated Recreation, may underestimate the total economic impact of sport fishing in Alaska. (Southwick Associates, Inc. et al. 2008).

4. Personal Use Fishing

There is a personal use shrimp pot fishery in Prince William Sound that takes place by emergency order from April 15 to September 15. The fishery is primarily accessed from Whittier and Valdez (ADF&G 2019). Permit data shows that most of the shrimp harvest out of Whittier comes from Port Nellie Juan, Culross Passage, Squaw Bay, Blue Fjord, King's Bay, Port Wells, Bay of Isles, McClure Bay, Derecksen Bay, Deep Water Bay, and Cochrane Bay. Near Valdez, most of the harvest comes from Knowles Bay, Bligh Reef, Columbia Bay, Unakwik Inlet, Glacier Island, and Port Gravina (ADF&G 2013).

5. Hunting and Trapping

Hunting and trapping of brown and black bear, moose, deer, goat, and various furbearers occur in and around the License Area. The License Area is located primarily within ADF&G's GMU 6A (Figure 5.1). Due to the limited use in GMU 6A, data for this finding is compiled for areas adjacent to the License Area to reflect the use of the nearby communities.

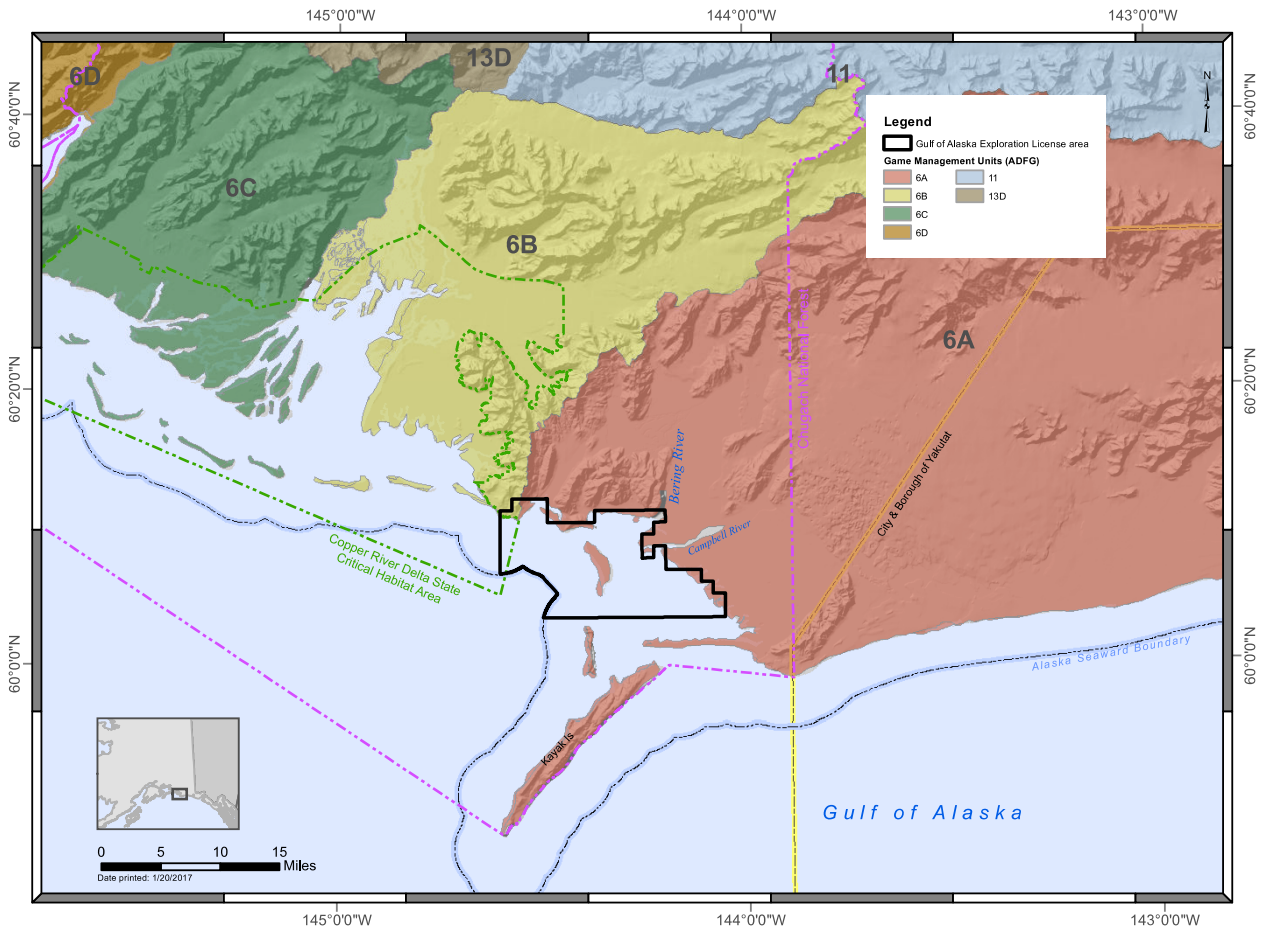
Black bear harvest data and observations indicated that general abundance of black bears increased in the 1990s. Monitoring of the harvests was initiated in 1973. Stakeholders have expressed concern for the population of black bears in the area due to a severe winter in 2011, and late spring of 2012. Harvest of black bear has grown at a rate of approximately 12 percent annually from 1998 to 2007, peaking at 674 bears. However, the harvest rate has declined by 10 percent annually since 2007 with 396 bears taken in 2012. The majority of black bears were harvested by nonresident hunters in GMU 6A during the most recent regulatory periods (ADF&G 2014).

Moose were introduced to the western Copper River delta in GMU 6C and the first hunt took place in 1960. The first hunt in GMU 6A took place in 1971. During 2013, 29 moose were harvested from GMU 6A, and 30 moose were harvested in 2014. Both harvests were below the 10-year average of 33 moose. Local residents participated in 79 percent of the successful moose hunts in GMU 6 in 2014 (Westing, C. 2018a).

Brown bears inhabit most of GMU 6 and are common on the mainland east of Columbia Glacier to Icy Bay. Typically, GMU 6D has the highest number of bears harvested; however, more bears were harvested in GMU 6A during 2012 and 2013. The harvest from GMU 6A may be more stable due to the high percentage of hunts led by a guide. Harvest in the entirety of GMU 6 was considerably lower in 2012 and 2013 with 43 and 48 bears taken respectively, than the 10-year average of 64 bears. Nonresidents took 76 percent of the harvest of brown bears during 2013 (ADF&G 2015b).

Between 1916 and 1923, Sitka black-tailed deer were introduced to GMU 6 when 24 were released on Hawkins and Hinchinbrook Islands. This was the first and one of the most successful big game translocations in the state, in part because of the lack of wolves and coyotes on the islands of the region and the abundant food sources for the deer (Westing, C. L. 2018b).

Figure 5.2. Gulf of Alaska Game Management Units



In 2011, an extreme weather event occurred causing earlier and more persistent snow which in turn forced the deer to stay nearer the beaches where they were more easily harvested. This resulted in a total estimated harvest for deer of 3,168 deer in 2011, which was a large increase from 2010 with 1,882 deer harvested. This weather event had a ripple effect, with 2012 and 2013 having two of the lowest deer harvests on record, with 630 and 674 deer harvested respectively. More recently, harvest numbers have begun to rise again with 1,495 deer harvested in 2014 and nearly 2,000 harvest in 2015. Cordova residents primarily hunt on Hawkins and Hinchinbrook Islands where there was a 95 percent and 81 percent decline in harvests, respectively. This is thought to be due to the severe winter of 2011 and 2012, and more hunters have not participated in the hunt in the subsequent years. Non-local residents represented up to 60 percent of successful hunters during the 2015 season (Westing, C. L. 2018b).

Beaver, river otter, marten, and wolverine are trapped throughout GMU 6. Since 1927, ADF&G has tagged and recorded beaver hides to monitor beaver harvest in GMU 6. Beaver is the most commonly trapped furbearer in GMU 6C and 87 to 96 percent of the harvest comes from this unit. Between 2009 and 2012, beaver harvests ranged from 22 to 25 animals which is below the 10-year average of 65 beavers. About 80 percent of the river otters are trapped in GMU 6D. In 2011, the overall harvest in GMU 6, totaled 22 beavers, 91 river otters, 147 martens, and 17 wolverines were caught (Westing, C. L. 2013).

6. Other Uses

a. Recreation and Tourism

The License Area is remote and much of it is inaccessible by major modes of transport. The region is not connected by roads, and recreational visitors either arrive by air, or use trails and rivers. Recreational activities for visitors to the region include wildlife viewing, camping, rafting, fishing, and hunting. In 2006, Prince William Sound and Resurrection Bay state parks had 81,948 visitor days and an estimated tourist expenditure of \$12.2 million. Landscape viewing was the most popular activity, followed by hiking, wildlife and plant viewing, and photography. Other uses were camping, kayaking, boating, skiing, berry picking, prospecting, and collecting (Elder and Gorman 2008).

Since the 1970s, cruise ship visits to Alaska have been increasing. In 2012, Alaska received about 22 percent of all U.S. cruise ship port visits. In 2018, the Gulf of Alaska had about 20 percent more cruise ship crossings than in previous years. In Alaska, cruise ship visitor volume increased from 470,000 passengers in 1995 to 1.2 million in 2017 (CLIA 2019). Besides cruise ships, Icy Bay, Disenchantment Bay, and Yakutat Bay are seeing increased recreation tourism with camping, hiking, kayaking, and flightseeing. Due to the continued increase in tourism in the area, residents are advocating for a shift to more non-consumptive ecotourism to counteract the ever-increasing competition for resources like fish and game (Sill et al. 2017).

b. Forestry

There are no designated state forests in or around the License Area, however it is surrounded by lands managed by the U.S. Forest Service as part of the Chugach National Forest. According to the Land Management Plan for Chugach National Forest for 2002, there are currently 102,550 acres available for wood product production in the Copper River Delta area, and 185,310 acres available for wood product production in the Prince William Sound area (USDA 2002). Timber was harvested commercially on Chugach Alaska Corporation land in east Icy Bay, and on Alaska Mental Health Trust lands between Cape Yakataga and west Icy Bay, approximately 85 miles east of the License Area (City and Borough of Yakutat 2010).

c. Mining

There is no active mining in the License Area or in the vicinity, though in the early 1900s copper was mined at Ellamar, in Prince William Sound (Tatitlek Corporation 2014). Additionally, coal was discovered in the Katalla area in 1903 and mined briefly in the early 1900s (Katalla 2018). The Alaska Mental Health Trust Authority has property that could be made available for mining opportunities on its lands 72 miles northwest of Yakutat at Cape Yakataga (AMHTA 2013).

d. Oil and Gas

In the early 1900s, oil and gas exploration and development began in the Katalla district, southeast of Cordova. Several periods of delineation and development drilling began in 1904 ending in 1939. During this period, six exploration wells were completed in the Gulf of Alaska basin. Katalla was the location of Alaska's first oil refinery which provided fuel to the Kennecott mine approximately 150 miles to the north of the License Area (Katalla 2018). More details of the history of oil and gas exploration in the region are in Chapter 3 and Chapter 6.

C. References

- ADF&G (Alaska Department of Fish and Game). 1999. Yakataga State Game Refuge Management Plan. Douglas, AK.
http://www.adfg.alaska.gov/static/lands/protectedareas/_management_plans/yakataga.pdf
(Accessed December 20, 2018).
- ADF&G. 2013. Prince William Sound Shrimp. Alaska Department of Fish and Game Division of Sport Fish, Cordova, Alaska.
- ADF&G (Alaska Department of Fish and Game). 2014. Unit 6 black bear management report of survey and inventory activities 1 July 2010 - 30 June 2013. Pages 8-1 through 8-16. Alaska Department of Fish and Game, Species Management Report ADF&G/DWC/SMR-2014-5. Juneau, AK.
http://www.adfg.alaska.gov/static/research/wildlife/speciesmanagementreports/pdfs/blackbear_2014_chapter_8_unit_6.pdf (Accessed November 29, 2018).
- ADF&G (Alaska Department of Fish and Game). 2015a. Fishing in the Cordova area. Southcentral Region, Anchorage, AK.
<http://www.adfg.alaska.gov/static/fishing/pdfs/sport/byarea/southcentral/cordova.pdf>
(Accessed January 24, 2019).
- ADF&G (Alaska Department of Fish and Game). 2015b. Unit 6 brown bear management report of survey and inventory activities 1 July 2012-30 June 2014. Pages 5-1 through 5-15. Species Management Report. ADF&G/DWC/SMR-2015-1. Juneau, AK.
http://www.adfg.alaska.gov/static/research/wildlife/speciesmanagementreports/pdfs/brownbear_2015_chapter_5_unit_6.pdf (Accessed January 18, 2019).
- ADF&G (Alaska Department of Fish and Game). 2018a. Community Subsistence Information System Harvest Information by Community, Yakutat, AK.
<http://www.adfg.alaska.gov/sb/CSIS/index.cfm?ADFG=harvInfo.harvest> (Accessed December 21, 2018).
- ADF&G (Alaska Department of Fish and Game). 2018b. Copper River Delta – Critical Habitat Area Fish and Wildlife.
<http://www.adfg.alaska.gov/index.cfm?adfg=copperriverdelta.species> (Accessed November 19, 2018).
- ADF&G (Alaska Department of Fish and Game). 2018c. Sport Fishing Survey - Southcentral effort. <http://www.adfg.alaska.gov/sf/sportfishingsurvey/> (Accessed March 12, 2018).
- ADF&G (Alaska Department of Fish and Game). 2019. PWS Shrimp Fishery. Alaska Department of Fish and Game. Prince William Sound Management Area. Anchorage, Alaska.
<http://www.adfg.alaska.gov/index.cfm?adfg=ByAreaSouthcentralPrinceWilliamSound.shrimp> (Accessed January 17, 2019).
- AMHTA (The Alaska Mental Health Trust Authority). 2013. Resource Management Strategy. Page 106. AMHTA. <https://alaskamentalhealthtrust.org/wp-content/uploads/2018/07/Resource-Management-Strategy.pdf> (Accessed January 22, 2019).
- ASA (American Sportfishing Association). 2002. Sportfishing in America: Values of our traditional pastime. American Sportfishing Association under a US Fish and Wildlife Service Sport Fish Restoration grant (F12AP00137, VA M-26-R) awarded by the Association of Fish and Wildlife Agencies. Alexandria, VA. https://asafishing.org/wp-content/uploads/Sportfishing_in_America_2002.pdf (Accessed May 29, 2018).

- Burt, R., K. J. Goldman, R. L. Gustafson, J. Zheng, S. Miller, P. Murphy, G. Rosenkranz, E. Russ, Q. Smith, M. Stichert, D. L. Stram, and C. E. Trowbridge. 2013. Stock assessment and fishery evaluation report for the weathervane scallop fishery off Alaska. 95 p. North Pacific Fishery Management Council, Anchorage, Alaska.
- CFEC (Commercial Fisheries Entry Commission). 2017. CFEC Permit Holdings and Estimates of Gross Earnings in the Prince William Sound Commercial Salmon Fisheries, 1975-2016. CFEC Report. Commercial Fisheries Entry Commission, Number 17-4N. Juneau, Alaska. http://www.adfg.alaska.gov/static/regulations/regprocess/fisheriesboard/pdfs/2017-2018/pws/CFEC_17-04N.pdf (Accessed January 17, 2019).
- City and Borough of Yakutat. 2010. City and Borough of Yakutat Comprehensive Plan. YakutatAlaska. <https://yakutatak.govoffice2.com/vertical/sites/%7B6349CA29-2633-4DA2-A860-125A317CCB51%7D/uploads/%7B426BE8EA-3A9F-4576-BC57-1533E8A87139%7D.PDF> (Accessed January 14, 2019).
- CLIA. 2019. Cruise Lines International Association Alaska. History of the Alaska cruise industry. Economic Impact. CLIA Alaska. <http://www.cliaalaska.org/economy/alaska-cruise-history/> (Accessed January 22, 2019).
- Conrad, S. and D. Gray. 2018. Overview of the 2017 Southeast Alaska and Yakutat commercial, personal use, and subsistence salmon fisheries. Alaska Department of Fish and Game, Fishery Management Report No. 18-01. Anchorage, Alaska. <http://www.adfg.alaska.gov/FedAidPDFs/FMR18-01.pdf> (Accessed January 16, 2019).
- DNR (Division of Parks and Outdoor Recreation Alaska Department of Natural Resources). 2012. Prince William Sound Marine Trail - Phase I. <http://dnr.alaska.gov/parks/units/pwssmp/pwsmarinetrlph1.pdf> (Accessed December 11, 2018).
- DNR (Division of Parks and Outdoor Recreation Alaska Department of Natural Resources). 2018. State Marine Parks Near Cordova. <http://dnr.alaska.gov/parks/units/pwssmp/smpcord.htm> (Accessed December 20, 2018).
- DOLWD (Department of Labor and Workforce Development). 2015. Sport Fishing Guide. Last Modified April 2015. <http://live.laborstats.alaska.gov/dlo/dlo.cfm?c=1&o=1110> (Accessed May 24, 2018).
- Elder, L. and B. Gorman. 2008. An economic impact report: How state park visitors impact Prince William Sound/Resurrection Bay communities. University of Alaska-Fairbanks Cooperative Extension Service, Fairbanks, AK.
- EVOSTC (Exxon Valdez Oil Spill Trustee Council). 2017. Research, monitoring and restoration. <http://www.evostc.state.ak.us/> (Accessed 1/18/2017).
- Fall, J. A. , A. Godduhn, G. Halas, L. Hutchinson-Scarborough, B. Jones, E. Mikow, L. A. Sill, A. Trainor, A. Wiita, and T. Lemons. 2018. Alaska subsistence and personal use salmon fisheries 2015 annual report. Alaska Department of Fish and Game Division of Subsistence, Technical Paper No. 440. Anchorage, Alaska. <http://www.adfg.alaska.gov/techpap/TP440.pdf> (Accessed December 21, 2018).
- Fall, J. A. and D. Koster. 2018. Subsistence harvests of Pacific halibut in Alaska, 2016. Alaska Department of Fish and Game, Division of Subsistence, Technical Paper No. 436. Anchorage, Alaska. <http://www.adfg.alaska.gov/techpap/TP436.pdf> (Accessed December 21, 2018).

- Fall, J. A. and G. Zimpelman, editors. 2016. Update on the status of subsistence uses in Exxon Valdez oil spill area communities, 2014. 426. Alaska Department of Fish and Game, Division of Subsistence. Anchorage, Alaska.
<http://www.adfg.alaska.gov/techpap/TP412.pdf> (Accessed January 8, 2019).
- Holen, D., J. A. Fall, and R. La Vine. 2011. Customary and Traditional Use Worksheet: Salmon, Copper River District, Prince William Sound Management Area. Alaska Department of Fish and Game Division of Subsistence, Special Publication No. BOF 2011-06. Anchorage, AK. http://www.adfg.alaska.gov/specialpubs/SP2_SP2011-006.pdf (Accessed December 21, 2018).
- Hood, E., G. Eckert, S. Nagorski, and C. Talus. 2006. Assessment of coastal water resources and watershed conditions at Wrangell - St. Elias National Park and Preserve, Alaska. National Park Service, Technical Report NPS/NRWRD/NRTR-2006-346. Juneau, Alaska.
- Katalla. 2018. The Katalla and Controller Bay Alaska Project. <http://katallaproject.tripod.com/> (Accessed October 15, 2018).
- Naves, Liliana C. 2016. Alaska Subsistence Harvest of Birds and Eggs, 2015, Alaska Migratory Bird Co-Management Council. Alaska Department of Fish and Game, Technical Paper No. 422. Anchorage, AK.
https://www.researchgate.net/publication/312155747_Alaska_Subsistence_Harvest_of_Birds_and_Eggs_2015_Alaska_Migratory_Bird_Co-Management_Council (Accessed December 21, 2018).
- Naves, Liliana C. and Nicole M. Braem. 2014. Alaska Subsistence Harvest of Birds and Eggs, 2012, Alaska Migratory Bird Co-Management Council. Alaska Department of Fish and Game Division of Subsistence, Technical Paper No. 397. Anchorage, AK.
<https://www.fws.gov/alaska/ambcc/ambcc/Harvest/TP397.pdf> (Accessed December 21, 2018).
- NPFMC (North Pacific Fishery Management Council). 2018. Stock Assessment and Fishery Evaluation Report for the Scallop Fishery off Alaska in 2017. Prepared by the Scallop Plan Team. C2 Scallop SAFE 2018. Anchorage, AK. <https://www.npfmc.org/safe-stock-assessment-and-fishery-evaluation-reports/> (Accessed September 20, 2018).
- Olson, A., J. Stahl, M. Vaughn, K. Carroll, and A. Baldwin. 2017. Annual management report for the Southeast and Yakutat commercial groundfish fisheries, 2017. Alaska Department of Fish and Game, Fishery Management Report No. 17-54. Anchorage, Alaska.
<http://www.adfg.alaska.gov/FedAidPDFs/FMR17-54.pdf> (Accessed January 16, 2019).
- Pearson, W. H., R. B. Deriso, R. A. Elston, S. E. Hook, K. R. Parker, and J. W. Andersen. 2011. Hypotheses concerning the decline and poor recovery of Pacific herring in Prince William Sound, Alaska.
- Rumble, J., M. Wessel, E. Russ, K.J. Goldman, P. Shields, and C. Russ. 2016. Cook Inlet Area and Prince William Sound commercial fisheries for Dungeness crab, shrip, and miscellaneous shellfish through 2014. Alaska Department of Fish and Game, Fishery Management Report No. 16-24. Anchorage. <http://www.adfg.alaska.gov/FedAidPDFs/FMR16-24.pdf> (Accessed October 17, 2017).
- Rumble, J., J. Baumer, K. J. Goldman, J. Mumm, X. Zhang, P. Hansen, E. Russ, and C. Russ. 2018. Prince William Sound shrimp pot fisheries, 2010-2017. Alaska Department of Fish and Game, Special Publication No. 18-01. Anchorage, Alaska.
<http://www.adfg.alaska.gov/FedAidPDFs/SP18-01.pdf> (Accessed January 16, 2019).

- Rumble, J., E. Russ, C. Russ, and M. Byerly. 2017. Prince William Sound Registration Area E groundfish fisheries management report, 2014-2017. Alaska Department of Fish and Game, Fishery Management Report No. 17-40. Anchorage, Alaska. <http://www.adfg.alaska.gov/FedAidPDFs/FMR17-40.pdf> (Accessed January 16, 2019).
- Rumble, J., M. Wessel, E. Russ, K. J. Goldman, R. L. Gustafson, and C. Russ. 2014. Cook Inlet and Prince William Sound Area Management Report for Tanner and king crab fisheries through 2013. Alaska Department of Fish and Game, Fishery Management Report No. 14-08. Anchorage, AK. <http://www.adfg.alaska.gov/FedAidPDFs/FMR14-08.pdf> (Accessed September 20, 2018).
- Russell, C. W., J. Botz, S. Haught, and S. Moffitt. 2017. 2016 Prince William Sound area finfish management report. Alaska Department of Fish and Game, Fishery Management Report No. 17-37. Anchorage, Alaska. <http://www.adfg.alaska.gov/FedAidPDFs/FMR17-37.pdf> (Accessed January 17, 2019).
- Sill, Lauren A., Joshua T. Ream, and Margaret Cunningham. 2017. Harvest and Use of Wild Resources in Yakutat, Alaska, 2015. Alaska Department of Fish and Game Division of Subsistence, Technical Paper No. 432. Anchorage, Alaska. <http://www.adfg.alaska.gov/techpap/TP432.pdf> (Accessed January 15, 2019).
- Simeone, William E. 2008. Subsistence Harvests and Uses of Black Bears and Mountain Goats in Prince William Sound. Alaska Department of Fish and Game Division of Subsistence, Technical Paper No. 334. Juneau, AK. <http://www.subsistence.adfg.state.ak.us/techpap/tp334.pdf> (Accessed December 20, 2018).
- Smith, Q. and D. Gray. 2017. 2018 Report to the Board of Fisheries on Region 1 Shrimp Fisheries. Alaska Department of Fish and Game, Fishery Management Report No. 17-61. Anchorage, Alaska. <http://www.adfg.alaska.gov/FedAidPDFs/FMR17-61.pdf> (Accessed January 16, 2019).
- Southwick Associates. 2013. Sportfishing in America: An economic force for conservation. Edited by Southwick Associates. Produced for the American Sportfishing Association (ASA) under a US Fish and Wildlife Service (USFWS) Sport Fish Restoration grant (F12AP00137, VA M-26-R) awarded by the Association of Fish and Wildlife Agencies (AFWA), Alexandria, Virginia. http://asafishing.org/uploads/2011_ASASportfishing_in_America_Report_January_2013.pdf (Accessed April 5, 2017).
- Southwick Associates, Inc., W. J. Romberg, A. E. Bingham, G. B. Jennings, and R. A. Clark. 2008. Economic impacts and contributions of sportfishing in Alaska, 2007. Alaska Department of Fish and Game, Professional Publication No. 08-01. <http://www.adfg.alaska.gov/FedAidpdfs/PP08-01.pdf> (Accessed April 5, 2017).
- Tatitlek Corporation. 2014. The Tatitlek Corporation. Our History. <http://www.tatitlek.com/our-history/> (Accessed January 22, 2019).
- Thalhauser, M. 2014. Recreational fisheries in the Prince William Sound management area, 2011-2013. Alaska Department of Fish and Game, No. 14-44. Anchorage, Alaska. <http://www.adfg.alaska.gov/FedAidPDFs/FMR14-44.pdf> (Accessed January 17, 2019).
- USDA (United States Department of Agriculture). 2002. Revised land and resource management plan Chugach National Forest. USDA. Anchorage, Alaska.

- USFWS (US Fish and Wildlife Service). 2016. 2016 National survey of fishing, hunting, and wildlife-associated recreation. US Department of Interior, Fish and Wildlife Service, US Department of Commerce, and US Census Bureau. <https://www2.census.gov/programs-surveys/fhwar/publications/2016/fhw16-nat.pdf> (Accessed 5/25/2018).
- Westing, C. 2018a. Moose management report and plan, Game Management Unit 6: Report period 1 July 2010-30 June 2015, and plan period 1 July 2015-30 June 2020. Alaska Department of Fish and Game, Species Management Report and Plan ADF&G/DWC/SMR&P-2018-15, Juneau, Alaska. http://www.adfg.alaska.gov/static/research/wildlife/speciesmanagementreports/pdfs/moose_2015_2020_smr_gmu_6.pdf (Accessed January 18, 2019).
- Westing, C. L. 2013. Unit 6 furbearer management report. Pages 95-110 [In] P. Harper and Laura A. McCarthy, editors. Furbearer management report of survey and inventory activities 1 July 2009-30 June 2012. Alaska Department of Fish and Game, Species Management Report ADF&G/DWC/SMR-2013-5, Juneau, AK. http://www.adfg.alaska.gov/static/home/library/pdfs/wildlife/mgt_rpts/13_furbearers.pdf (Accessed January 18, 2019).
- Westing, C. L. 2018b. Deer Management Report and Plan, Game Management Unit 6. Report Period 1 July 2011-30 June 2016, and Plan Period 1 July 2016-30 June 2021. Alaska Department of Fish and Game, Species Management Report and Plan ADF&G/DWC/SMR&P-2018-41, Juneau, AK. http://www.adfg.alaska.gov/static/research/wildlife/speciesmanagementreports/pdfs/deer_2011_2021_smr_gmu_6.pdf (Accessed December 5, 2018).
- Wiese, Amanda, Tommy Sheridan, Jeremy Botz, Steve Moffitt, and Rich Brenner. 2015. 2014 Prince William Sound area finfish management report. Page 195. Alaska. Division of Sport Fish. Research and Technical Services, Alaska. Division of Commercial Fisheries. <http://library.state.ak.us/asp/edocs/2015/11/ocn930804273.pdf> (Accessed September 27, 2016).
- Zeiser, N. L. and R. A. Hoffman. 2017. Annual Management Report of the 2016 Yakutat Area commercial salmon fisheries. Alaska Department of Fish and Game, Fishery Management Report No. 17-36. Anchorage, Alaska. <http://www.adfg.alaska.gov/FedAidPDFs/FMR17-36.pdf> (Accessed January 16, 2019).

Chapter Six: Petroleum Potential and the Likely Methods of Oil and Gas Transportation in the License Area

Contents

	Page
A. Geology.....	6-1
1. Geologic background and regional setting	6-1
2. Petroleum Systems and Resource Potential.....	6-2
B. Phases of Oil and Gas Development.....	6-4
1. Disposal Phase.....	6-4
2. Exploration Phase.....	6-5
3. Development and Production Phase.....	6-5
C. Oil and Gas Exploration, Development, and Production Activities.....	6-6
1. Oil and Gas Activities.....	6-6
a. Seismic	6-6
b. Drilling.....	6-7
i. Exploration Drilling.....	6-7
ii. Delineation or Development Drilling	6-8
iii. Drilling and Production Discharges.....	6-9
c. Roads, Pads, and Facility Construction.....	6-10
D. Likely Methods of Oil and Gas Transportation in the License Area.....	6-11
1. Pipelines	6-11
2. Tankers	6-12
3. Advantages and Disadvantages of Transportation Methods.....	6-12
a. Pipelines	6-12
b. Tankers or Marine Vessels.....	6-13
4. Mitigation Measures and Other Regulatory Protections	6-13
E. Spill Risk, Prevention, and Response.....	6-14
1. Regulation of Oil Spill Prevention and Response	6-14
a. Federal Statutes and Regulations	6-14
b. Alaska Statutes and Regulations	6-15
c. Industry Contingency Plans.....	6-15
d. Financial Responsibility.....	6-15
e. Government Contingency Plans.....	6-16
2. Spill History and Risk.....	6-16
a. Drilling	6-17
b. Offshore Transportation.....	6-17
c. Pipelines	6-18
3. Spill and Leak Prevention.....	6-18
a. Blowout Prevention.....	6-19
b. Leak Detection	6-19
4. Oil Spill Response	6-20
a. Incident-Command System	6-20
b. Response Teams.....	6-20
c. Training.....	6-21

d. Response Organizations6-21
e. Geographic Response Strategies6-23
5. Cleanup and Remediation.....6-23
6. Hazardous Substances6-24
F. References6-26

Chapter Six: Petroleum Potential and the Likely Methods of Oil and Gas Transportation in the License Area

A. Geology

1. Geologic background and regional setting

The geologic origins and history of the Yakutat-Gulf of Alaska area are fundamentally different than other southcentral Alaska sedimentary basins. The Yakutat-Gulf of Alaska basin occupies southeast Alaska's marine shelf and onshore coastal plain, where it is exposed in a 30 by 115-mile outcrop belt along the Robinson Mountains. Onshore areas of petroleum potential include the historic oil-producing Katalla district in the west and the Yakataga district to the east, which has been explored, though relatively lightly and without commercial success.

The primary tectonic process in the region is the Oligocene to recent subduction and underplating of the buoyant Yakutat terrane, resulting in significant compressional deformation and uplift. As a region of relatively young and ongoing crustal accretion, the sedimentary strata are entirely Tertiary in age, comprising three stratigraphic sequences. The underlying basement consists of Late Paleocene to Early Eocene basaltic oceanic crust in the area west of the Dangerous River zone, and Cretaceous metamorphic rocks to the east.

The oldest sedimentary units make up the Lower Tertiary sequence, predominantly Eocene in age, consisting of interstratified formations deposited west of the Dangerous River zone, where they reach an overall thickness of up to 1.8 miles (Trop and Ridgway 2007; Risley et al. 1992). This sequence includes two formations. The Kulthieth Formation consists of shallow marine to nonmarine strata with significant sandstone, carbonaceous siltstone, coal, and related coastal plain deposits. The laterally equivalent Stillwater and Tokun Formations are dominated by shale and siltstone deposited mainly in shelfal to deepwater submarine slope environments (Trop and Ridgway 2007; Risley et al. 1992). Some Kulthieth Formation coals have been identified as oil and gas source rocks (Risley et al. 1992; Larson and Martin 1998; Van Kooten et al. 2002), and were interpreted as the source of prolific oil seeps in the Kulthieth Formation at the Samovar Hills near the Malaspina Glacier. Magoon hypothesized that the Stillwater Formation rather than the Kulthieth was the primary source for the oils in the Lower Tertiary sequence (Magoon 1994).

The Middle Tertiary sequence is of Oligocene and Miocene age and is dominated by the Poul Creek Formation deposited across a wide area west of the Dangerous River zone; partially equivalent formations further east are more restricted in depositional extent. Consisting of deepwater shale, siltstone, and lesser sandstone, the Poul Creek attains a thickness of approximately 1.2 miles (Trop and Ridgway 2007; Risley et al. 1992). The upper one-third includes organic-rich brown to black shale and mudstone that occur in one or more beds totaling 50 to 790 feet in thickness. Total organic carbon contents range from 1.5 percent to 8 percent, consisting of oil prone marine-algal kerogen (Risley et al. 1992). This interval is of significant exploration importance as a potential oil

source rock in the region and is the presumed origin of dozens of oil seeps in the Poul Creek Formation stretching across distances of nine miles in the Katalla District and more than six miles along the Sullivan anticline in the Yakataga District (Magoon 1994; Risley et al. 1992; Martin 1921; Miller 1951b, 1957, 1975, 1951a).

The Upper Tertiary and Quaternary sequence constitutes mainly the Yakataga Formation, glacially influenced clastic deposits of Miocene to Holocene age that locally exceed three miles in thickness (Hamilton 1994; Risley et al. 1992). Represented by interbedded marine, glaciomarine, and glaciofluvial deposits, the Yakataga Formation is dominated by an essentially unsorted rock fabric known as diamictite. This rock type reflects deposition of sediments with a wide range of grain sizes (clay, silt, sand, pebbles, cobbles, and boulders) typically either directly from the melting of sediment-bearing glacial ice, or as debris flows, but in either case, without the size sorting and winnowing that occurs during deposition from moving currents. Other important Yakataga Formation rock types include conglomerate and conglomeratic sandstone, and rhythmites, thinly-bedded, repetitive cycles of alternating slightly coarser versus finer grained sediments, reflecting seasonal shutoff of sediment input during the frozen winter months into lakes, fjords, bays, and similar low-energy environments.

Surficial deposits in the Yakutat-Gulf of Alaska basin are glacial, glaciomarine, and glaciofluvial, essentially the most recent phase of Yakataga Formation deposition. Late Pleistocene to Holocene glacial valleys incised into the underlying Tertiary and Pleistocene strata extend offshore as far as the edge of the continental shelf, and are partially filled by till, outwash, and glaciomarine deposits locally exceeding 160 feet in thickness. The most recent episode of deglaciation began 12,000 to 15,000 years ago, and the current extent of glaciers in the region has been relatively stable for more than 9,000 years (Hamilton 1994).

2. Petroleum Systems and Resource Potential

To accumulate thermally generated hydrocarbons a petroleum system must be present. A conventional petroleum system consists of three major components in conjunction with a critically timed burial history. Those components are:

- 1) a source rock rich in algal and lipid compounds to generate oil, and cellulose or humic compounds to generate gas; for a source to be effective, it must undergo sufficient burial heating to convert these organic precursors to oil and thermogenic gas, generating fluid pressures that expel them out of the source rock unit; biogenic gas may occur independently of oil or thermogenic gas, formed by bacterial action on organic material in the shallow subsurface;
- 2) a reservoir rock with porosity to contain the hydrocarbon and permeability to allow it to flow to wells; and
- 3) a sealed trapping configuration, either structural, stratigraphic, or a combination of both, to promote the accumulation of hydrocarbons in the reservoir after migration from the source, and to prevent their escape.

Unconventional petroleum systems such as shale and tight sand plays are similar but commonly have such miniscule pores and such low permeability that they do not require a mappable trap; the hydrocarbon is trapped by pore-throats that are of similar size to the hydrocarbon molecules.

As noted above, both the Lower Tertiary and Middle Tertiary sequences contain effective oil- and gas-prone source rocks recognized as the source of numerous active petroleum seepages in the Yakutat-Gulf of Alaska basin. Unlike most regions of southern Alaska, the basin offers potential for both conventional and unconventional oil and gas resources.

In the onshore part of the basin, potential conventional reservoir targets include the sandy and conglomeratic portions of most of the Tertiary formations in the Yakutat Terrane. Because the source of Tertiary sediments was onshore to the north and northeast, strata become finer grained with increasing shale content toward the south and southwest. Offshore, adequate porosity, permeability, and thickness to form conventional sandstone reservoirs is likely available only in the Kulthieth and Yakataga Formations (Risley et al. 1992). Unconventional reservoir potential is locally exemplified by the oil seeps and oil wells that formerly produced from folded and fractured black shales in a fault zone mapped by (Miller 1975) in Oligocene strata equivalent to the Poul Creek Formation at the Katalla oil field.

Because the Gulf of Alaska region has experienced faulting and folding associated with compressional and strike-slip tectonics throughout the Tertiary, numerous structures were formed prior to the timing of petroleum generation and migration, and thus have the potential to form effective traps for conventional hydrocarbon accumulations. Stratigraphic traps are also likely to be present, given the lateral variations in depositional thickness, reservoir, and seal facies, and erosional truncations that are commonplace in structurally complex areas. For conventional plays, exploration challenges include locating undrilled traps of sufficient size to justify economic development; as noted by (Miller 1975), anticlines in the Katalla area are “either inaccessible or too small and complex to justify exploratory drilling to date.”

The Bering River coal field just northeast of Katalla hosts 110 million short tons of identified mineable coal resources in the Oligocene Kushtaka and Kulthieth Formations. Varying from bituminous to anthracite rank, seams locally reach thicknesses of up to 30 feet. where thickened by strong deformation (Merritt and Hawley 1986). The intensive folding and faulting that have contributed to the elevated rank of this coal field have also proven detrimental to attempts to mine these resources, and the same factors make the Bering River coal unfavorable to exploitation of coalbed gas resources. Some 50 miles east of the Bering River coal field, the Duktoth River coal district is a smaller occurrence of bituminous coals. Data are insufficient to quantify the mineable coal resources or coalbed gas potential in the Duktoth River area, but it is likely significantly less than the Bering River coal field, due to similar structural complexity and much reduced area.

The onshore Katalla area alone hosts at least 75 oil seeps, 11 gas seeps, and dozens of historical wells that produced approximately 154,000 barrels of oil along with significant but undocumented quantities of natural gas between 1902 and 1933 (Miller 1951a). All available information indicates this is an unconventional shale oil play, as the oil produced there flowed from fault and fracture systems in structurally complex, very low porosity and permeability shales and mudstones rather than from conventional reservoir rocks. Although there is no evidence of a viable conventional petroleum system, it is likely that the unconventional shale play still holds technically recoverable

oil and gas resources. Current drilling and completion technologies would likely yield better flow rates and ultimate recovery than were achievable in the early 1900s. Considerable new exploration drilling and testing using these unconventional methods could incur significant costs. However, this may be necessary to determine whether production rates and ultimately recoverable volumes would be sufficient to overcome the area's geologic and logistic complexities, making development commercially viable.

B. Phases of Oil and Gas Development

There are several different phases of oil and gas activities: disposal or licensing and leasing, exploration, development, and production. While not all post-disposal oil and gas activities are routine, there are some oil and gas activities that are reasonably foreseeable because they are commonly undertaken regardless of the project. Routine oil and gas activities include seismic surveys, drilling, construction of facilities, and pipelines and production.

Oil and gas activities include those direct and indirect activities that have occurred in the past, are presently occurring, or are likely to occur in the future. Petroleum-related activities include such major undertakings as conducting seismic operations, constructing roads and trails for transporting equipment and supplies, drilling exploration and delineation wells, constructing gravel pads and roads, drilling production and service wells, installing pipelines, and constructing oil and gas processing facilities. The activities likely to have the greatest effects vary by resource.

Common industrial facilities potentially associated with the oil and gas industry in the License Area include: drill sites, well pads, production pads and injection pads, platforms, wells (such as exploratory, development, production and waste disposal), processing facilities, facility oil piping, crude oil and natural gas transmission pipelines, flow lines and pipelines, maintenance complex, emergency response center, gravel roads, airports, bridges, docks, power plants, refineries, and camp facilities.

1. Disposal Phase

An exploration license serves as the disposal of state lands, and as the license can be converted to leases, is the first required step in developing the state's oil and gas resources. The exploration license program supplements the state's oil and gas leasing program by targeting areas outside of known oil and gas provinces. The intent of exploration licensing is to encourage exploration in areas far from existing oil and gas infrastructure, with unknown hydrocarbon potential, and where there is a higher investment risk to the operator. Through exploration licensing, the state receives the license fee and valuable subsurface geologic information on these undeveloped regions and, if the license is converted to leases and development occurs, additional revenue through royalties and taxes could be realized.

Exploration licensing allows interested parties to explore frontier basins without the initial expense of bonus bids or the other costs and restrictions of a competitive oil and gas lease sale. An exploration license gives the licensee the exclusive right to use the licensed area for exploration activities. If the license is converted to leases, then the now lessee will have the right to use the leased area for development and production activities. However, neither a license or a lease authorizes operations or any specific activities to be conducted on the area.

2. Exploration Phase

The purpose of the exploration phase is to search for reservoirs of oil and gas. Oil and gas resource exploration begins with gathering information about the petroleum potential of an area by examining the surface and subsurface geology, researching data from existing wells, performing environmental assessments, conducting geophysical surveys, and drilling exploratory wells. The surface analysis includes the study of surface topography or the natural surface features, and near-surface structures revealed by examining and mapping nearby exposed rock layers. Geophysical surveys, primarily seismic, help reveal the characteristics of the subsurface geology, and normally precede exploratory drilling. Although geophysical exploration and exploration drilling are activities that could result in potential effects to the License Area, exploration predominately occurs in the winter to mitigate effects on the landscape and wildlife.

Common activities undertaken during the exploration phase include aerial and geophysical surveys used to define prospects, geological studies, core testing, and exploratory drilling. Exploration wells may be used to drill in unproven areas, for field extension step outs, or delineation wells used in unproven areas to increased proven limits of a field, or to conduct deep tests within a producing area to unproven deeper zones.

3. Development and Production Phase

The development and production phases are interrelated and overlap in time; therefore, this section discusses them together. During development, operators evaluate the results of exploratory activities and develop plans to bring the discovery into production. Production operations bring well fluids to the surface and prepare them for transport to the processing plant or refinery. These phases can begin only after some exploration has been completed and tests show that a discovery is economically viable. However, exploration in new formations for additional reserves can continue in concert with development and production activities.

The purpose of development is to gather, examine, and analyze geologic and other data pertaining to newly discovered reservoirs drilled in exploration to plan how to produce the maximize recovery of hydrocarbons from a reservoir. Common activities include drilling development and disposal wells, construction of roads and pads, and installation of pipelines and production facilities. Development wells are drilled in proven areas of a field to prepare for production operations. Some production operations overlap with development operations. Delineation and development drilling occur after initial discovery of hydrocarbons in a reservoir and several wells may be required.

Production is the process of bringing well fluids to the surface and preparing them for transport to the processing plant or refinery. The fluids undergo operations to be purified, measured, tested, and transported. Pumping, storage, handling, and processing are typical production processes. The final project parameters will depend on the surface location, size, depth, and geology of a specific commercial discovery. Production also refers to the amount of oil or gas produced in a given period. Pipeline systems are built, and transportation of oil and natural gas begins.

C. Oil and Gas Exploration, Development, and Production Activities

1. Oil and Gas Activities

a. Seismic

Seismic survey work is an integral part of exploration for oil and gas fields. Seismic data is collected from surface-induced seismic pulses to image subsurface formations with sensors collecting the data as seismic shock waves bounce off formations. The shock waves are generally created by vibrator trucks along predetermined lines or deploying these techniques behind a marine vessel. Seismic surveys are typically conducted in two-dimension (2D) or three-dimension (3D) surveys. Both survey types are useful for evaluating a prospect.

Seismic survey work may be used during all phases of oil and gas development, including before disposal, to locate and produce oil and gas from new and existing developments. Companies may elect to license existing data and reprocess the data without conducting a seismic survey. Other companies may acquire data through commissioning their own program. It is also common for seismic contractors to conduct seismic surveys on behalf of, or with the potential to market to, a licensee. Geophysical exploration by means of seismic surveys informs the analysis of a play, where a company will conduct exploratory drilling, further mapping of a producing field, and evaluating new intervals throughout the development process.

To conduct a seismic survey, source and receiver locations are surveyed using Global Positioning Systems and traditional land survey methods. Source and receiver locations are laid out in predesigned patterns. For 2D data, the receivers and sources lie in as straight a line as possible given the terrain and can extend for many tens of miles. For 3D data, data is collected over a much wider swath, and can cover tens to hundreds of square miles. 2D seismic programs usually have fewer crewmembers and employ much less equipment than 3D programs. A 3D seismic survey is similar to 2D acquisition with more sensors collecting more data (Rigzone 2018b).

Multiple seismic sources can be used on land surveys, based on the terrain and conditions, including explosives, weight drop, and hydraulic devices (vibrator trucks). Explosives may be placed into drill holes and detonated, or, much less commonly, they may be suspended on stakes above the ground (Poulter method). When buried, drill holes are typically 20 to 35 feet deep with 2.5 to 5 pounds of explosives set at the bottom of the hole. Holes are either drilled with track-mounted drills or, if in remote or sensitive areas, drills are slung into position by helicopters. Soil is disturbed in the immediate vicinity of the explosive charges placed into the ground. At locations with existing developments, allowable maximum peak particle velocity is mapped and if explosives are contra-indicated, vibrators or a weight drop are used to produce the seismic wave energy (Shellenbaum 2013).

In intertidal (transition) zones, either shallow hole explosive sources at low tide or very shallow towed airguns at high tide can be used. The receivers are typically connected by cables laid directly on the mud. Seismic surveys may also be conducted in marine waters. Marine seismic programs typically use a vessel between 100 and 175 feet long. Marine seismic equipment consists of an

airgun array for the energy source, hydrophones to detect sound, an amplifier and recording system, and a navigation system. For some seismic surveys, the detectors and cables are placed directly on the bottom (ocean bottom cable, or OBC) where they remain stationary as the shooting boat traverses across them.

Recently, “nodal” acquisition technology has been used. “Nodal” acquisition uses receivers placed in battery-powered nodes that store data internally or transmit data to recording instruments. Nodal receivers are preferred in rough terrain, urban areas and applications near roads, and river crossings (Shellenbaum 2013). Additional seismic techniques can be used to gather information specifically about the ocean bottom and very near surface geology, usually to identify drilling hazards.

In addition to seismic data, gravity and magnetic data surveys are collected. In these surveys, airborne instruments measure the intensity of the earth’s gravity or magnetic field. Resulting measurements are processed and interpreted to yield information about the subsurface mineralogy and structure. Since the field measurements are passive, as opposed to the use of an active seismic source, these surveys are often referred to as “potential field data.” There is little to no impacts to the environment from this type of passive survey methodology.

When a contractor seeks a permit to perform a seismic survey of any variety in the License Area, a miscellaneous land use permit (MLUP) is required through DNR. Seismic surveys can be performed at any phase of oil and gas development and whether a party holds interest in the subject license or not. Through the MLUP review, DNR will evaluate the project plan and consider other agencies’ input and authorities to assess potential impacts of the project. Potential project impacts are mitigated through mitigation measures or stipulations.

b. Drilling

Before initiating any drilling, a plan of operation application must be submitted to DNR for review. The application is reviewed for legal compliance by DNR and other state, federal, and local government entities. DNR evaluates foreseeable effects of the proposed application operations, assesses compliance with mitigation measures, and determines the need for stipulations to protect resources and the best interest of the state. An application may require conditions for approval before final approval of a plan of operations. All well drilling is subject to plan of operation approval. Other agencies also issue authorizations for drilling of wells.

i. Exploration Drilling

Exploratory drilling often occurs after seismic surveys are conducted, and when the interpretation of the seismic data incorporated with all available geologic data reveals oil and gas prospects. Exploration drilling, which proceeds only after obtaining the appropriate permits, is the only way to determine whether a prospect contains commercial quantities of oil or gas. Drilling operations collect well logs, core samples, cuttings, and a variety of other data. A well log is a record of one or more physical measurements as a function of depth in a borehole and is achieved by lowering measuring instruments into the well bore. Well logs can also be recorded while drilling. Cores may be cut at various intervals so that geologists and engineers can examine the sequences of rock that are being drilled (Chaudhuri 2011).

Drilling technology continues to improve to minimize environmental footprint and maximize oil or gas recovery. Multilateral, horizontal, and extended reach wells can access a greater reservoir extent than a conventional straight-hole well while improving pressure maintenance and enhanced recovery methods (Joshi 2008). Very generally, the drilling process begins with special steel pipe (conductor casing) bored into the soil. Then, a drill bit, connected to the end of the drill pipe, rotates and drills a hole through the rock formations below the surface. Upon reaching a targeted depth, the hole is cleaned up and surface casing, a smaller diameter steel pipe, is lowered into the hole and cemented in place to keep the hole from caving in, seal off rock formations, seal the well bore from groundwater, and provide a conduit from the bottom of the hole to the drilling rig. After surface casing is set, drilling continues until the objective formation is reached. Once the drilling is complete, the well is tested, and decisions are made on well completion techniques or plugging and abandoning the well (Rigzone 2018c).

Offshore exploratory drilling rigs include bottom-supported rigs such as submersibles and jackup rigs, barges, floating rigs such as drill ships, and semi-submersibles. Water depth and bottom conditions determine which equipment will be used. When a prospect cannot be reached from directional drilling from shore, jackup rigs are the most likely to be used in the License Area for exploratory wells, as they are best suited to withstanding the very large currents and tidal variations experienced there. These rigs have watertight barge hulls that can float on the surface of the water while the unit is being moved between drill sites. Before the location is finalized, the operator performs a geological hazards survey to make sure that the sea floor can support the rig. High resolution shallow seismic surveys look for shallow gas (methane) deposits and faults. When the jackup is positioned at the drill site, the legs are jacked down until they rest on the seabed. Before drilling, the hull is then jacked up above the water's surface until a sufficient gap exists to accommodate tides and waves (Rigzone 2018a).

ii. Delineation or Development Drilling

After designing the facilities and obtaining the necessary permits, the operator constructs permanent structures and drills production wells. The operator must build production structures that will last the life of the field and may have to design and add new facilities for enhanced recovery operations as production proceeds. The development “footprint” has decreased in recent years as advances in drilling technology have led to smaller, more consolidated pad sizes.

Directional drilling is used to extend the length of the reservoir that is penetrated by the well (US Senate 2011). The drilling technique used is controlled to direct the bore hole to reach a particular part of the reservoir. Directional drilling technology enables the driller to steer the drill stem and bit to a desired bottom-hole location, sometimes miles away from the surface location of the rig. Directional wells initially are drilled straight down to a predetermined depth and then gradually curved at one or more different points to penetrate one or more given target reservoirs (Duplantis 2016). Directional drilling allows multiple production and injection wells to be drilled from a single surface location such as a gravel pad or offshore production platform, thus minimizing cost and the surface impact of oil and gas drilling, production, and transportation facilities. A single production pad and several directionally drilled wells can develop more than one and possibly several 640-acre sections. It can also be used to reach a target located beneath an environmentally-sensitive area and may offer the most economical way to develop offshore oil fields from onshore facilities. Extended reach drilling is used to access reservoirs that are remote, up to six miles, from the drilling location.

These techniques allow for drilling into reservoirs where it is not possible to place the drilling rig over the reservoir (U.S. Senate 2011).

In addition to production wells, other wells are drilled to inject water or gas into the field to maximize oil recovery. These wells generally are referred to as service, or injection, wells. Numerous injection wells are required for waterflood programs, which are used routinely throughout the production cycle to maintain reservoir pressure. Application of horizontal well technology can reduce the number of production wells required to drain a pool and reduce the number of drilling pads and their sizes (U.S. Senate 2011).

The AOGCC, through its statutory and regulatory mandate, oversees drilling and production practices for safety measures, to maximize oil and gas recovery, prevent waste, and ensure protection of correlative rights within the state. It is a quasi-judicial agency that conducts hearings to review drilling and development to ensure regulatory compliance.

iii. Drilling and Production Discharges

The bulk of the waste materials produced by oil and gas activities, onshore and offshore, are produced water and drilling muds and cuttings. Small quantities of treated waste, produced sand, chemical products, excess cement, and trash and debris can also be produced (Joshi 2008). The fluids pumped down the well are called “mud” and are naturally occurring clays with small amounts of biologically inert products. Different formulations of mud are used to meet the various conditions encountered in the well. The mud cools and lubricates the drill bit, prevents the drill pipe from sticking to the sides of the hole, seals off cracks in down-hole formations to prevent the flow of drilling fluids into those formations, and carries cuttings to the surface (Joshi 2008).

Disposal of mud, cuttings, and other effluent is regulated by the National Pollutant Discharge Elimination System (NPDES) and the U.S. Environmental Protection Agency’s (EPA) Underground Injection Control program administered by the AOGCC under regulations in 20 AAC Chapter 25. The state discourages the use of reserve pits, and most operators store drilling solids and fluids in tanks or in temporary on-pad storage areas until they can be disposed of, generally down the annulus of the well or in a disposal well that is completed and equipped to take mud and cuttings; and permitted in accordance with 20 AAC 25.080 and 20 AAC 25.252. If a reserve pit is necessary, it is constructed off the drill pad and could be as large as 5 feet deep and 40 feet wide by 60 feet long. It is lined with a 0.3 inch (8.0 millimeter) thick geotextile liner to prevent contamination of surrounding soils. Drilling muds, fluids, and cuttings produced from the well are separated and disposed of, often by reinjection into an approved disposal well annulus or disposal well, or they may be shipped to a disposal facility out-of-state.

In the case of offshore platforms, the waste is treated and released or transported onshore for appropriate disposal. Section 402(a) of the Clean Water Act prohibits the discharge of produced water and drilling wastes into the marine environment from oil and gas production facilities that are either onshore or in coastal waters.

Produced water is water that comes from an oil and gas reservoir to the surface through a production well with hydrocarbons. It is the largest waste stream of conventional oil and gas wells. The produced water volume increases over the economic lifetime of a producing field and may be up to 95 percent of the total volume produced by the end of the field’s production history. Produced

water contains formation water, injection water, and other chemical additives such as hydrate inhibitors, emulsion breakers, flocculants, coagulants, defoaming agents, scale and corrosion inhibitors bactericides and other substances (AMAP 2010). Often, seawater is treated and injected into the reservoir in addition to produced water to maintain pressure, improve recovery, and replace produced fluids. When produced water can no longer be treated and reinjected, the alternative is disposal. The Alaska Department of Environmental Conservation (ADEC) and AOGCC authorize disposal of produced water. More information can be found in Chapter Seven outlining government authorities to regulate waste water disposal and produced water injection.

c. Roads, Pads, and Facility Construction

After a discovery of oil or gas is sanctioned for development upon positive results from delineation wells and seismic surveys, several construction activities are required to develop a permanent production operation. A production operation complex would, at a minimum, contain a production pad that could potentially support from one well to dozens of wells and contain a central processing facility for an oil field or a combined central processing and gas compressor facility. In addition, a production complex may typically include an airstrip, roads, camp facilities, and storage yard. The production operation also may include feeder lines, regional pipelines, a booster pump for oil or additional compression stations for gas, a gas conditioning facility, and a gas or oil sale pipeline to transport the resource to market (NRC 2003). Similar to drilling operations, all construction activities on a license or lease are subject to a plan of operations approval by the DNR. The construction or maintenance of major production facilities also requires plans of exploration or development.

When drilling onshore, the drill site is selected to provide access to the prospect and, if possible, is located to minimize the surface area that may have to be cleared. Sometimes temporary roads must be built to the area. Roads are constructed of sand and gravel placed on a liner above undisturbed ground. Construction of support facilities such as production pads, roads, and pipelines may be required. A typical drill pad is made of sand and gravel placed over a liner and is about 300 feet by 400 feet. The pad supports the drill rig, which is brought in and assembled at the site, and, if necessary, a fuel storage area and a camp for workers. If possible, an operator will use nearby existing facilities for housing its crew. If the facilities are not available, a temporary camp of trailers on skids may be placed on the pad.

When the development area is offshore and not within reach of existing infrastructure, a new platform may be proposed. Drilling platforms are normally constructed onshore, floated to the desired location, sunk, and driven in place. A platform consists of a steel jacket with legs fastened to the seabed and the topside which houses the staff and equipment necessary for producing oil and gas. Each leg is fastened to the seafloor with piles that penetrate below the surface. The piles serve as drilling slots and conductor pipe (Talberth and Branosky 2013).

Production facilities generally include several production wells, water injectors, gas injection wells, and a waste disposal well. Wellhead spacing may be as little as 10 feet. A separation facility removes water and gas from the produced crude, and pipelines carry the crude to the onshore storage and terminal facilities. The oil is then piped to a refinery or loaded onto tankers for shipment to outside refineries. Some of the natural gas produced is used to power equipment on the

platform, well pad, or processing facility but most is re-injected to maintain reservoir pressure in those reservoirs that have a surplus of produced gas.

Oil and gas production facilities found on the topside of a platform include gas and oil processing facilities to remove some of the water produced with the petroleum, water and sewage treatment equipment; power generators; a drilling rig that can move between legs; housing for about 75 workers; and a helipad. Onshore support facilities include a production facility to receive and treat the oil and gas for transportation to a refinery or other processing facilities, a supply base and vessel to provide the platform with cement, mud, water, food, and other necessary items, a supply vessel to bring the items to the platform, and a helicopter base. Helicopters carry crews to and from the platforms.

Onshore and offshore oil and gas production operations generally follow similar paths to market. Once produced from downhole, oil and gas move through production facilities for separation and processing, the sales product through a metering station, and on to market.

At the time of writing the finding, it is nearly impossible to predict what a full development scenario will entail. The final project parameters will depend on the surface location, size, depth, and geology of a specific commercial discovery.

D. Likely Methods of Oil and Gas Transportation in the License Area

AS 38.05.035(g)(1)(B)(viii) directs that best interest findings shall consider and discuss the method or methods most likely to be used to transport oil or gas from the License Area and the advantages, disadvantages, and relative risks of each.

A discussion of specific transportation alternatives for oil from the License Area is not possible at this time because strategies used to transport potential petroleum resources depend on many factors, most of which are unique to an individual discovery. The location and nature of oil or gas deposits determine the type and extent of facilities necessary to develop and transport the resource. DNR and other state, federal, and local agencies will review the specific transportation system when it is proposed. Modern oil and gas transportation systems usually include the following major components: pipelines, and tankers from marine terminals. Oil and gas produced in the License Area would most likely be transported by a combination of these depending on the type, size, and location of the discovery.

The possible modes of transport from a discovery will be an important factor in determining whether future discoveries can be economically produced – the more expensive a given transportation option is, the larger a discovery will have to be in order to be economically viable. For this exploration license, the only viable transportation methods would be through pipelines or tankers.

1. Pipelines

The most common method of transporting oil in the Alaska is by pipeline. Pipelines may be onshore or offshore. A pipeline or pipeline facility means all the facilities of a total system of pipe,

whether owned or operated under a contract, agreement, license or lease, used by a carrier for transportation of crude oil, natural gas, or products for delivery, for storage, or for further transportation. A pipeline is a general term that includes all the components of a total system of pipe to transport crude oil or natural gas or hydrocarbon products for delivery, storage, or further transportation (AS 38.35.230).

Subsea pipelines may be the most likely system for transporting oil or gas from new offshore development areas to loading or processing facilities. Offshore pipelines that are properly designed and maintained do not hinder water circulation and minimally affect fish and wildlife habitat. If offshore pipelines are not buried or pinned, they can hinder or disrupt normal water circulation. Pipelines may be buried in trenches in shallower waters to avoid creating a navigational hazard, being damaged by a ship's anchor or sea ice, or being caught in fishing nets or exposed by erosion and tidal action. Platforms and subsea pipelines are possible, but not anticipated to be utilized in this exploration license because the applicant has proposed to directionally drill from on-shore to targets under the sea floor.

2. Tankers

Tankers, or marine vessels, and barges can transport petroleum all around the world. Because these marine vessels can carry a lot of fuel, the amount it costs per barrel to move this oil is cost-effective. Barges are similar to tankers, but smaller and do not have any method of propulsion to move them. They are often pushed or towed by tugs. This makes barges very ineffective for transporting oil long distances or for traveling across rough seas. Barges are most often used for transporting fuel shorter distances in calmer waters. It is unlikely, but possible, for tankers to enter Controller Bay to transport oil or gas from the License Area.

3. Advantages and Disadvantages of Transportation Methods

Transporting and distributing petroleum products and natural gas from oilfields to refining and processing plants requires a comprehensive transportation system. Any oil or gas ultimately produced from leases converted from the License Area will have to be transported to market. The director is required under AS 38.05.035(g)(1)(B)(viii) to consider and discuss the method or methods most likely to be used to transport oil or gas from the License Area, and the advantages, disadvantages, and relative risks of each. The disadvantages and advantages of each transportation method are described with discussions of the relative risks of each transportation method addressed under the Spill History and Risk section below.

a. Pipelines

Safety and reduced environmental effects are important advantages of pipeline transportation for oil and gas resources. Data from several U.S. and Canadian studies strongly suggest that pipelines are the safer way to move oil compared to railways or roadways (Green and Jackson 2015). From 1992 to 2011, Pipeline and Hazardous Materials Safety Administration (PHMSA) data shows far fewer incidents from gathering lines than transmission and distribution lines. The data further reflects the incidents of rail and trucking far exceed the incident rates of natural gas pipelines (Furchtgott-Roth 2013).

Additional advantages of transporting natural gas through pipelines are the reduced operational cost; and a faster, more dependable delivery to markets. Elevated pipelines onshore are relatively easy to maintain and visually inspect for leaks, but they can restrict wildlife movements unless provisions are made to allow for their unimpeded passage. Buried pipelines are more common on shore, but leaks can be more difficult to detect.

The most distinct disadvantage of pipelines is their high up-front investment for construction costs. However, once the cost is borne, the cost to move petroleum products is significantly less expensive than other transportation methods. Pipeline transportation in the United States has approximately 280 significant spills each year where there is either a fatality, injury requiring hospitalization, or the spill causes over \$50,000 in damages. Although pipeline spills do occur, they are rare in relation to the massive quantity of product they move per year. Transportation by pipeline is 4.5 times less likely to result in a spill than transport by rail when the amount transported is considered (Strata 2017).

Technical design of pipelines and other facilities reduces the chance of oil spills. National industry standards, and federal, state, and local codes and standards ensure the safe design, construction, operation, maintenance, and repair of pipelines and other facilities. The potential problems and risks associated with transportation of natural gas through pipelines are typically addressed in mitigation measures and lease stipulations. A major risk of transporting gas through a pipeline is a leak or explosion. The measures and methods employed to prevent leaks or explosion, including line integrity protection, pipeline monitoring, and in-line inspections, are detailed in the Spill and Leak Prevention section below.

b. Tankers or Marine Vessels

Oil tankers and marine vessels move large amounts of oil to a variety of locations throughout the world and are very cost-effective. Over 13 billion barrels of oil were transported by marine vessel in 2016 (CRS 2018). The U.S. Coast Guard (USCG) maintains a vessel traffic system in Prince William Sound in combination with industry-supplied escort tugs for tanker traffic.

Use of oil tankers brings the risk of potentially large spills into marine waters. The occurrence of large (greater than 4,800 barrels), medium (48 to 4,800 barrels), and small (less than 48 barrels) spills has decreased significantly over the past 50 years. Most spills from tanker operations are small and occur during loading or unloading. Most medium to large spills occur while vessels are underway and result from allisions, collisions, and groundings. The volume of oil lost in accidents during 2010 to 2017 represented 1 percent of the volume delivered safely (ITOPF 2018).

4. Mitigation Measures and Other Regulatory Protections

The decision to license or lease oil and gas resources in the state does not authorize the transportation of any product. If oil or gas is found in commercial quantities and production is proposed, final decisions on transportation will be made through the local, state, and federal permitting processes. Those processes will consider any required changes in oil spill contingency planning and other environmental safeguards and will involve public participation. The state has broad authority to withhold, restrict, and condition its approval of transportation facilities. In addition, boroughs, municipalities, and the federal government have jurisdiction over various

aspects of any transportation alternative. Measures are included in this best interest finding to avoid, minimize, and mitigate potential negative effects of transporting oil and gas (see Chapter Nine). Additional site-specific and project-specific mitigation measures may be imposed as necessary if exploration and development take place.

E. Spill Risk, Prevention, and Response

AS 38.05.035(g)(1)(B)(vii) requires the director to consider and discuss mitigation measures to prevent and mitigate releases of oil and hazardous substances and a discussion of the protections offered by these measures.

Oil spills and natural gas releases could occur on pads within the License Area during exploration activities, development and production drilling, and in transportation.

Chapter Seven provides information on regulatory authorities for prevention and response, process for spill or release containment, cleanup, and response training. Chapter Nine includes mitigation measures related to the release of oil and hazardous substances developed after the director considered the risk of oil spills, methods for preventing spills, and techniques for responding to spills.

1. Regulation of Oil Spill Prevention and Response

a. Federal Statutes and Regulations

Section 105 of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) (42 U.S.C. §9605), and §311(c)(2) of the Clean Water Act, as amended (33 U.S.C. §1321(c)(2)) require environmental protection from oil spills. CERCLA regulations contain the National Oil and Hazardous Substances Pollution Contingency Plan (40 CFR. §300). Under these regulations, the responsible party must plan to prevent and immediately respond to oil and hazardous substance spills and be financially liable for any spill cleanup. If the pre-designated Federal On-Scene Coordinator (FOSC) determines that neither timely nor adequate response actions are being implemented, the federal government may respond to the spill and seek to recover cleanup costs from the responsible party.

The Oil Pollution Act of 1990 (OPA 90) requires the development of facility and tank vessel response plans and an area-level planning and coordination structure to coordinate federal, regional, and local government planning efforts with the industry. OPA 90 amended the Clean Water Act (§311(j)(4)), to establish area committees and area contingency plans as the primary components of the national response planning structure. In addition to human health and safety, these area committees have three primary responsibilities:

- Prepare an area contingency plan;
- Work with state and local officials on contingency planning and preplanning of joint response efforts, including procedures for mechanical recovery, dispersal, shoreline cleanup, protection of sensitive areas, and protection and rehabilitation of fisheries and wildlife; and,
- Work with state and local officials to expedite decisions for the use of dispersants and other mitigating substances and devices.

In Alaska, the area committee structure has incorporated state and local agency representatives, and the jointly prepared plans coordinate the response activities of the various governmental entities that have responsibilities regarding oil spill response. The area contingency plan for Alaska is the Unified Plan. Because Alaska is large and geographically diverse, federal agencies have found it necessary to prepare sub-area contingency plans, also discussed in the Government Contingency Plans section below. OPA 90 also created two citizen advisory groups: the Prince William Sound and the Cook Inlet regional citizens advisory councils to promote environmentally safe marine oil transportation and oil facility operations.

b. Alaska Statutes and Regulations

As discussed in Chapter Seven, ADEC is the agency responsible for implementing state oil spill response and planning regulations under AS 46.04.030. In 2006, ADEC adopted new regulations (18 AAC 75) for oilfield flowlines and new construction and maintenance standards for oil tanks and pipeline facilities. Additionally, ADEC is placing increased emphasis on oil spill prevention training.

Alaska Department of Fish and Game (ADF&G) and DNR support ADEC in these efforts by providing expertise and information. The industry must file an oil discharge prevention and contingency plans with ADEC before operations commence. DNR reviews and provides comments to ADEC regarding the adequacy of industry contingency plans.

c. Industry Contingency Plans

Contingency plans for exploration facilities must include: a description of methods for responding to and controlling blowouts; the location and identification of oil spill cleanup equipment; the location and availability of suitable drilling equipment; and an operations plan to mobilize and drill a relief well. If development and production should occur, additional contingency plans must be filed for each facility before beginning an activity as part of the permitting process. Any vessels transporting crude oil from the potential development area must also have an approved contingency plan.

d. Financial Responsibility

Holders of approved contingency plans must provide proof of financial ability to respond (AS 46.04.040). Financial responsibility may be demonstrated by one or a combination of self-insurance, insurance, surety, guarantee, approved letter of credit, or other ADEC-approved proof of financial responsibility (AS 46.04.040(e)). Operators must provide proof of financial responsibility acceptable to ADEC as follows:

- Crude oil terminals: \$50,000,000 in damages per incident
- Non-crude oil terminals: \$25 per incident for each barrel of total non-crude oil storage capacity at the terminal or \$1,000,000, whichever is greater, with a maximum of \$50,000,000
- Pipelines and offshore exploration or production facilities: \$50,000,000 per incident.
- Onshore production facilities:

\$20,000,000 per incident if the facility produces over 10,000 barrels per day of oil;

\$10,000,000 per incident if the facility produces over 5,000 barrels per day of oil;

\$5,000,000 per incident if the facility produces over 2,500 barrels per day but not more than 5,000 barrels per day of oil; and,

\$1,000,000 per incident if the facility produces 2,500 barrels per day or less of oil.

- Onshore exploration facilities: \$1,000,000 per incident.
- Crude oil vessels and barges: \$300 per incident, for each barrel of storage capacity or \$100,000,000, whichever is greater
- Non-crude oil vessels and barges: \$100 per barrel per incident or \$1,000,000, whichever is greater, with a ceiling of \$35,000,000
- The coverage amounts are adjusted every third year based on the Consumer Price Index (AS 46.04.045).

e. Government Contingency Plans

In accordance with AS 46.04.200, ADEC must prepare, annually review, and revise the statewide master oil and hazardous substance discharge prevention and contingency plan. The plan must identify and specify the responsibilities of state and federal agencies, municipalities, facility operators, and private parties whose property may be affected by an oil or hazardous substance discharge. The plan must incorporate the incident command system, identify actions to be taken to reduce the likelihood of occurrence of catastrophic oil discharges and significant discharges of hazardous substances (not oil), and designate the locations of storage depots for spill response material, equipment, and personnel.

ADEC must also prepare and annually review and revise a regional master oil and hazardous substance discharge prevention and contingency plan (AS 46.04.210). The regional master plans must contain the same elements and conditions as the state master plan but are applicable to a specific geographic area.

2. Spill History and Risk

Any time crude oil or petroleum products are handled there is a risk that a spill might occur. Oil spills associated with the exploration, development, production, storage, and transportation of crude oil may occur from well blowouts, or pipeline or tanker accidents. Petroleum activities may generate chronic low volume spills involving fuels and other petroleum products associated with normal operation of drilling rigs, vessels, and other facilities for gathering, processing, loading, and storing of crude oil. Spills may also be associated with the transportation of refined products to provide fuel for generators, marine vessels, and other vehicles used in exploration and development activities. Generally, the highest frequency of spills come from facility oil piping, process piping, and tanks. A worst-case oil discharge from an exploration facility, production facility, pipeline, or storage facility is restricted by the maximum tank or vessel storage capacity, or by a well's ability to produce oil.

Since 2009, there have been no crude oil spills of 100 gallons or more in the License Area. There is only one contaminated site listed on ADEC's contaminated sites database, which is located at the Federal Aviation Administration site in the old townsite of Katalla (ADEC 2018b, a).

The ADEC commonly cites the primary causes of spills of crude oil by volume as line failure, equipment failure, human error, containment overflow, and tank failure (ADEC 2018b). Although

there are risks associated with spills resulting from exploration, production, storage, and transportation of oil and gas, these risks can be mitigated through prevention and response plans such as the Unified Plan and Subarea Contingency Plans (ARRT 2018).

a. Drilling

One form of spill from drilling operations can occur during a well blowout. A well blowout can take place when high pressure is encountered in the well and sufficient precautions, such as increasing the weight of the drilling mud, are not effective. The result is that oil, gas, or mud is suddenly and violently expelled from the wellbore, followed by uncontrolled flow from the well. Blowout preventers, which immediately close off the open well to prevent or minimize any discharges, are required for all drilling and work-over rigs and are routinely inspected by the AOGCC to prevent such occurrences.

Major offshore oil and gas accidents are rare events, but when they occur effects can be substantial. The *Deepwater Horizon* rig was finishing work after drilling the Macondo exploration well in the Gulf of Mexico in 2010, when a kick escalated to a blowout, followed by a series of explosions and fire. Eleven men died and nearly 5 million barrels of oil were discharged into the gulf (BOEMRE 2011). The central cause of the Macondo blowout was identified as the failure of the cement barrier in the production casing string that allowed hydrocarbons to flow up the wellbore coupled with failure of the crew to detect the kick and failure of the blowout preventer to contain the well (BOEMRE 2011).

The AOGCC held hearings on drilling safety to determine whether changes to regulations were necessary in the aftermath of the *Deepwater Horizon* incident. The primary findings were that regulators should demand a safety culture; eliminate regulatory complexity; conduct inspections, enforce regulations, and monitor performance; keep the focus on regulating; and require a blowout contingency plan. AOGCC concluded that many of these recommendations were already in place in Alaska (PAME 2014).

Blowouts are extremely rare in Alaska and their numbers decline worldwide as technology, experience, and regulations influence drilling practices. The AOGCC regulations set forth a comprehensive well permitting process and rigorous well operations inspection program. It also has a program to ensure well failures or blowouts do not occur. Drilling plans and procedures are scrutinized to assess potential problems within rock formations and the drilling fluids used to control downhole pressure. Well construction is evaluated, and rigs are inspected before permission to drill is granted.

b. Offshore Transportation

Alaska's largest oil spill was the March 1989 *Exxon Valdez* tanker spill in Prince William Sound, the second largest spill recorded in U.S. waters. It spilled nearly 10.8 million gallons of crude oil, contaminated fishing gear, fish and shellfish, killed marine birds and mammals, and led to the closure or disruption of many Prince William Sound, Cook Inlet, Kodiak, and Chignik fisheries (Alaska Office of the Governor 1989; Graham 2003; University of North Carolina At Chapel Hill 2003; City of Valdez 2017). Effects of oils spills on fish and other wildlife are discussed in Chapter Eight.

Other large tanker spills include the 1987 tanker Glacier Bay spill of 2,350 to 3,800 barrels of North Slope crude oil being transported to Cook Inlet for processing at the Nikiski Refinery. Less than 10 percent of the oil was recovered, and the spill interrupted commercial fishing activities near Kalgin Island during the peak of the sockeye salmon run (ADEC 1988).

Both incidents demonstrated that preventing large tanker spills is easier than cleaning them up, and that focused legislative attention on the prevention and cleanup of oil spills on both the federal and state levels. At the state level, statutes created the oil and hazardous substance spill response fund (AS 46.08.010), established the Spill Preparedness and Response (SPAR) Division of ADEC (AS 46.08.100), and increased financial responsibility requirements for tankers or barges carrying crude oil up to a maximum of \$100 million (AS 46.04.040(c)(1)).

c. Pipelines

Both state and federal agencies have oversight of pipelines in Alaska. State agencies include the ADEC and DO&G, which includes the State Pipeline Coordinator's Section. Federal agencies include the PHMSA within the U.S. Department of Transportation and the Bureau of Safety and Environmental Enforcement within the U.S. Department of the Interior. Additionally, there is the Joint Pipeline Office which consists of a variety of state and federal agencies that oversee Trans-Alaska Pipeline System (TAPS).

The pipeline system that transports North Slope crude includes flowlines that carry oil, gas, and produced water to processing facilities; transmission pipelines carry oil to Pump Station 1, where it is delivered to TAPS for transport to the marine terminal at the Port of Valdez. These pipelines vary in size, length, and content. As an example, a 14-inch pipeline can store about 1,000 barrels (bbl) per mile of pipeline length. Under static conditions, if oil were lost from a 5-mile stretch of this pipeline (a hypothetical distance between emergency block valves), a maximum of 5,000 bbl of oil could be discharged if the entire volume of oil in the segment drained from the pipeline.

3. Spill and Leak Prevention

A number of measures contribute to the prevention of oil spills during the exploration, development, production, and transportation of crude oil. Some of these prevention measures are presented as mitigation measures in Chapter Nine. Prevention measures are also described in the oil discharge and contingency plans that the industry must prepare before beginning operations. Thorough training, well-maintained equipment, and routine surveillance are important components of oil spill prevention.

The oil industry employs, and is required to employ, many techniques and operating procedures to help reduce the possibility of spilling oil, including use of existing facilities and roads; water body protection, including proper location of onshore oil storage and fuel transfer areas; use of proper fuel transfer procedures and secondary containment, such as impermeable liners and dikes; and appropriate siting of facilities and pipelines. Additionally, there are some newer technologies and tools that help prevent and mitigate large spills such as employing pipeline leak detection and well blowout prevention.

a. Blowout Prevention

Blowout preventers greatly reduce the risk of a gas release. If a release occurs, the released gas will dissipate unless it is ignited by a spark (Florence et al. 2011). Each well has a blowout prevention program that is developed before the well is drilled. Operators review bottom-hole pressure data from existing wells in the area and seismic data to learn what pressures might be expected in the well. Engineers use this information to design a drilling mud program with enough hydrostatic head to overbalance the formation pressures from the surface to the total depth of the well. Engineers also design the casing strings to prevent various formation conditions from affecting well control performance. Blowout preventer (BOP) equipment is installed on the wellhead after the surface casing is set and before actual drilling begins. BOP stacks are routinely tested in accordance with government requirements. Under 20 AAC 25.035, AOGCC regulates compliance with blowout prevention requirements.

If well control is lost and there is an uncontrolled flow of fluids at the surface, a well control plan is devised. The plan may include instituting additional surface control measures, igniting the blowout, or drilling a relief well. Regaining control at the surface is faster than drilling a relief well and has a high success rate. Operators may pump mud or cement down the well to kill it, replace failed equipment, remove part of the BOP stack and install a master valve, or divert the flow and install remotely-operated well control equipment (BPXA 1996).

b. Leak Detection

Leak detection systems and effective emergency shut-down equipment and procedures are essential in preventing discharges of oil from any pipeline that might be constructed in the License Area. These systems protect the public and the environment from consequences of a pipeline failure. Pipeline operators are alerted when a leak occurs, so that appropriate actions can be taken to minimize spill volume and duration. Leak detection methods vary from simply compare “metered out” product volumes with “metered in” volumes or more complex computational monitoring systems that simultaneously monitor numerous operating conditions. In most cases, pipeline operators will employ two or more different types of leak detection systems to improve the effectiveness of their leak detection program (USDOT 2018).

The technology for monitoring pipelines is continually improving. Leak detection methods may be categorized as hardware-based (optical fibers or acoustic, chemical, or electric sensors) or software-based (to detect discrepancies in flow rate, mass, and pressure). Leak detection methods include acoustic monitoring, pressure point analysis, ultrasound, radiographic testing, magnetic flux leakage, the use of coupons, regular ground and aerial inspections, and combinations of some or all of the different methods. The approximate location of a leak can be determined from the sensors along the pipeline. A computer network is used to monitor the sensors and signal any abnormal responses. In recent years, computer-based leak detection through a Real-Time Transient Model has come into use, to mathematically model the fluid flow within a pipe (Scott and Barrufet 2003). Modern pipeline systems are operated from control centers with computer connectivity and satellite and telecommunication links to strive for rapid response and constant monitoring of pipeline conditions (NRC 2003).

Design and use of “smart pigs,” data collection devices that are run through the pipeline while it is in operation, have greatly enhanced the ability of a pipeline operator to detect internal and external corrosion and differential pipe settlement in pipelines. Pigs can be sent through the pipeline on a regular schedule to detect changes over time and give warning of any potential problems. Three types of pigs are used. A caliper pig is used to measure internal deformation such as dents or buckling. A geometry pig records configuration of the pipeline system and determines displacement. A wall thickness pig measures the thickness of the pipeline wall. All can provide early warnings of weaknesses where leaks may occur (NRC 2003).

4. Oil Spill Response

Spill preparedness and response practices for the License Area are driven by the Alaska Federal/State Preparedness Plan for Response to Oil and Hazardous Substance Discharges/Releases (Unified Plan) and the Prince William Sound Subarea Contingency Plan. The Unified and Subarea Contingency Plans represent a coordinated and cooperative effort by government agencies and were written jointly by the USCG, EPA, and ADEC (ADEC 2018c; ARRT 2018).

a. Incident-Command System

An Incident Command System (ICS) response is activated in the event of an actual or potential oil or hazardous material spill. The ICS system is designed to organize and manage responses to incidents involving several interested parties in a variety of activities. Since oil spills usually involve multiple jurisdictions, the joint federal and state response contingency plan incorporates a unified command structure in the oil and hazardous substance discharge ICS. The unified command consists of the FOSC, the State On-Scene Coordinator (SOSC), the Local On-Scene Coordinator, and the responsible party On-Scene Coordinator. The ICS is organized around five major functions: command, planning, operations, logistics, and finance/administration (ARRT 2018).

The Unified Command jointly makes decisions on objectives and response strategies; however, only one Incident Commander oversees the spill response. The Incident Commander is responsible for implementing these objectives and response strategies. If the responsible party is known, the responsible party Incident Commander may remain in charge until or unless the FOSC and SOSC decide that the responsible party is not doing an adequate job of response (ARRT 2018).

b. Response Teams

The Alaska Regional Response Team (ARRT) monitors the actions of the responsible party. The ARRT is composed of representatives from 15 federal agencies and one representative agency from the State of Alaska. The ARRT is co-chaired by the USCG and EPA, while the ADEC represents the state. The team provides coordinated federal and state response policies to guide the FOSC in responding effectively to spill incidents. The Statewide Oil and Hazardous Substance Incident Management System Workgroup, which consists of the ADEC, industry groups, spill cooperatives, and federal agencies, published the *Alaska Incident Management System* (AIMS) for oil and hazardous substance response (ARRT 2018).

Each operator identifies a spill response team for their facility, and each facility must have an approved spill contingency plan. Company teams provide on-site, immediate response to a spill

event. First, responders attempt to stop the flow of oil and may deploy booms to confine oil that has entered the water. Responders may deploy booms to protect major inlets, wash-over channels, and small inlets. Deflection booming may be placed to enclose smaller bays and channels to protect sensitive environmental areas. If the nature of the event exceeds the facility's resources, the responsible party calls in its response organization. The spill response team:

- identifies the threatened area;
- assesses the natural resources, i.e., environmentally sensitive areas such as major fishing areas, spawning or breeding grounds;
- identifies other high-risk areas such as offshore exploration and development sites and tank-vessel operations in the area;
- obtains information on local tides, currents, prevailing winds, and ice conditions; and
- identifies the type, amount, and location of available equipment, supplies, and personnel.

It is especially important to prevent oil spills from spreading rapidly over a large area. Cleanup activities continue as long as necessary, without any time frame or deadline.

c. Training

Individual members of the spill response team train in basic spill response; skimmer use; detection and tracking of oil; oil recovery on open water; river booming; radio communications; all-terrain vehicle, snowmobile, and four-wheeler operations; oil discharge, prevention, and contingency plan review; communication equipment operations; open water survival; oil spill burning operations; pipeline leak plugging; and spill volume estimations.

d. Response Organizations

Primary Response Action Contractors (RAC) and Oil Spill Response Organizations (OSRO) may play an important role in a spill response. Primary RACs and OSROs are organizations that may enter into a contractual agreement with a responsible party, assisting the responsible party in spill cleanup operations. RACs and OSROs can provide equipment, trained personnel, and additional resources. The Operations/Technical Manuals maintained by the RACs and OSROs may be referenced in vessel or facility contingency plans and serve as supplementary reference documents during a response. OSROs generally have access to large inventories of spill equipment and personnel resources. The FOSC or SOSC may contract these assets for use (ARRT 2018).

Alaska Chadux Corporation (Chadux) is the main spill response organization operating in Prince William Sound and to the east in the License Area and was formed in 1993 in accordance with the federal Oil Pollution Act of 1990. Chadux ensures companies distributing and transporting petroleum product comply with required oil spill prevention measures. From its headquarters in Anchorage, Chadux is also able to deploy rapid response teams to contain, control, and clean-up petroleum spills. There are 17 equipment hubs throughout Alaska used for quick mobilization in the case of a spill, providing equipment and personnel for all response services. Chadux also offers various spill response and restoration training along with preparation exercises (ACC 2018).

Operators of various facilities contract with Chadux for response activities. The USCG designates Chadux as a Tier 3 OSRO, which is the highest level of designation and is based on spill containment and removal requirements for an offshore and ocean response. Chadux is registered

with the State of Alaska as a Primary Response Action Contractor and as a Non-Tank Vessel Cleanup Contractor.

Chadux maintains response centers in Prince William Sound. In the event of a spill, the response center serves as the emergency operations center for all federal, state, and industry personnel.

Response actions would include:

- **Notification and Initiation of Response:** The OSRO manager receives notification from the responsible party or the USCG and in turn notifies the Operations Manager. The Operations Manager initiates a group call-out for technicians to respond within one hour. In the event of a non-member or mystery spill, the USSCG calls the OSRO manager and initiates a response.
- **Organization and Call-out:** OSRO personnel assemble at the designated staging area and begin response actions appropriate to the problem. Personnel are dispatched to the location of the spill for site assessment. In an offshore spill, response personnel would activate the OSRO's spill response vessel.
- **Documentation:** All OSRO personnel are required to document their activities during an oil spill. The documentation covers actions taken, when and by whom directions were given, and where and by whom the action was performed. The Operations Section staff log who directed the action, what personnel and/or equipment was deployed, when it was deployed, and how long the action is expected to last.

In mid-2018 Edison-Chouest Offshore (ECO) of Louisiana replaced Crowley Marine Services as Alyeska's Ship Escort/Response Vessel System contractor in Alaska. Services provided by this contract include operation of escort tugs, general purpose tugs, oil recovery storage barges, and associated personnel to escort tankers on their transits of Prince William Sound. ECO has built or is currently building 13 new vessels for the contract: five escort tugs, four general purpose tugs, and four open water barges. New technology onboard the tugs will include: render-recover winches, a sophisticated technology that automatically maintains constant tension on a line improving safety and performance during towing. The tugs will also have forward-looking infrared and digital radar signal processing systems to improve floating ice detection as well as enhancing the ability to detect spilled oil on water should prevention measures fail. New open ocean response barges will have Crucial and OceanBuster skimmers, the latest in skimming technology and equipment. ECO will have one offshore anchor handling utility vessel, the Ross Chouest, which is proposed as the Hinchinbrook sentinel 17-mile standby tug.

Other OSROs may operate in Prince William Sound if they meet USCG and ADEC standards. Each organization may operate a little differently, but the objective is the same – to minimize the impact of an oil spill. Some OSROs maintain mutual aid agreements with other operators so that if the spill exceeds their individual capabilities, they may access other resources.

Response actions vary greatly with the nature, location and size of the spill. General response activities may include:

- Locate and stop the spill if possible;
- Estimate the spill amount, determine the substance's chemistry, and estimate the trajectory;
- Determine what equipment would most effectively recover spilled oil;

- Mobilize appropriate equipment to confine spilled oil or to protect especially sensitive areas from oiling; and
- Assess the damage to oiled areas, develop a plan for cleanup, and implement it.

e. Geographic Response Strategies

Geographic Response Strategies (GRS) are oil spill response plans that protect specific sensitive areas from the effects of oil following a spill. The purpose of these map-based strategies is to save time during the critical first few hours after an oil spill. They provide the location of sensitive areas and where to deploy oil spill protection equipment (ADEC 2019).

A workgroup composed of local spill response experts and the state and federal agencies developed the GRS with public input. Sites were selected based on environmental sensitivity, risk of being impacted from a water borne spill, and feasibility of successfully protecting the site with existing technology. Strategies focus on minimizing environmental damage, using as small a footprint as possible to support the response operations, and selecting sites for equipment deployment. Within the Prince William Sound area, there are five geographic response zones. The License Area is on the southeastern side of the Copper River Delta zone that stretches from the eastern portion of Hinchinbrook Island to the Okalee Spit on the eastern edge of the License Area (ADEC 2019).

5. Cleanup and Remediation

Cleanup plans for crude oil spills on terrestrial and wetland ecosystems must balance the objectives of maximizing recovery and minimizing ecological damage. Many past cleanup operations have caused as much or more damage than the oil itself. All oils are not the same, and knowledge of the chemistry, fate, and toxicity of the spilled oil can help identify cleanup techniques that can reduce the ecological impacts of an oil spill. Hundreds of laboratory and field experiments have investigated the fate, uptake, toxicity, behavioral responses, and population and community responses to crude oil (Jorgenson and Cater 1996).

Oil spills can affect freshwater and marine environments as well. The effects of an oil spill into a marine or other surface water environment are dependent on factors including the flow rate, wave action, and temperature of the water. Cleaning spilled oil from shorelines can be a difficult task with many variables that determine the techniques that are most effective and environmentally responsible. Some physical methods that are employed include deploying booms and sorbent material to contain the spill; wiping the shore with adsorbent materials; pressure washing to mobilize the contaminant; or raking and bulldozing to remove the impacted material (EPA 1999).

The best techniques are those that quickly remove volatile aromatic hydrocarbons. This is the portion of oil that causes the most concern regarding the physical fouling of birds and mammals. To limit the most serious effects, it is desirable to remove the maximum amount of oil as soon as possible after a spill. The objective is to promote ecological recovery and not allow the ecological effects of cleanup to exceed those caused by the spill itself.

After a spill, the physical and chemical properties of the individual constituents in the oil begin to be altered by the physical, chemical, and biological characteristics of the environment; this is called weathering. The factors that are most important during the initial stages of cleanup are the evaporation, solubility, and movement of the spilled oil. As much as 40 percent of most crude oils

may evaporate within a week after a spill. Over the long term, microscopic organisms (bacteria and fungi) break down oil (Jorgenson and Cater 1996).

Following an oil spill in a marine or surface water environment, a Shoreline Cleanup and Assessment Technique (SCAT) team may be deployed by the Unified Command to evaluate shoreline types, impacted shorelines, and the degree and type of oiling. The SCAT method provides guidelines for decision making and prioritization of cleanup of coastlines during the response to an oil spill. The SCAT process includes eight basic steps:

- Conduct reconnaissance surveys,
- Segment the shoreline,
- Assign teams and conduct SCAT surveys,
- Develop cleanup guidelines and endpoints,
- Submit survey reports and oiling sketches to the Incident Command planning section,
- Monitor effectiveness of cleanup,
- Conduct post-cleanup inspections, and
- Conduct final evaluation of cleanup activities.

The SCAT teams consider the resources that are present along the shore and try to maximize the value of the recovery effort while balancing that with the safety of the oil spill responders. SCAT surveys are a preliminary step in the spill response process to assess initial shoreline conditions and continue in advance of operational cleanup. Surveys continue throughout the response to verify the effectiveness of the cleanup efforts and to ensure they meet cleanup endpoints. They evaluate the potential for human exposure as well as the nature and extent of the environmental impacts of the oil in place. In some instances, attempts to remediate a shoreline can be more harmful than allowing the spilled product to naturally attenuate (NOAA 2018).

Cleanup stages include initial response, remediation, and restoration. During initial response, the responsible party gains control of the source of the spilling oil; contains the spilled oil; protects the natural and cultural resource; removes, stores and disposes of collected oil; and assesses the condition of the impacted areas. During remediation, the responsible party performs site and risk assessments; develops a remediation plan; and removes, stores, and disposes of more collected oil. Restoration attempts to re-establish the ecological conditions that preceded the spill and usually includes a monitoring program to assess the results of the restoration activities (Jorgenson and Cater 1996).

6. Hazardous Substances

Hazardous substances are identified as a large range of elements, compounds, and substances regulated by the EPA, USCG, ADEC, and other government agencies. In addition to petroleum products, waste products, toxic water pollutants, hazardous air pollutants, hazardous chemical substances, and other products presenting an imminent danger to public health or welfare are identified for prevention from release and response in cases of spills. AS 46.03.826(5). ADEC, USCG, and EPA monitor and inspect operations and facilities to enforce compliance with preventative measures to ensure safe use and storage of hazardous substances (ADEC 2018c). Mitigation measures have been developed to minimize releases or spills during oil and gas operations and can be found in Chapter Nine.

Spill response protocols are well established for the Prince William Sound Subarea. ADEC, USCG and EPA – Region 10 have established guidelines for operations in the event of a major response effort to an oil spill or hazardous material release in the Prince William Sound Subarea Contingency Plan. Any release of a hazardous substance must be reported by a responsible party as soon as the person has knowledge of the discharge. The release must be reported to the National Response Center and the ADEC, and response protocols must be initiated. There are several safeguards in place to react quickly to hazardous releases. Coordination, trained personnel, and technological advances can be employed quickly to address the occasions when releases occur (ADEC 2018c).

It is essential for those in command control to recognize and identify the substance release for safe containment. An initial characterization of the hazard during the evaluation phase of containment requires an assessment of potential threat to public health and environment, need for protective actions, and protection of response personnel. A more comprehensive characterization will follow if necessary. In certain cases, local or state entities have the authority to order evacuations beginning with those living or working in downwind or in low-lying areas. Response personnel will secure sites, establish control points, and establish work zones. The Local On-Scene Coordinator is in command and control until he or she determines an imminent threat to public safety no longer exists. While the largest volume of transport hazard substances are natural gas and crude oil, agency coordination between federal, state, and local entities are equipped to contain and manage releases of all hazardous substances present in the License Area (ADEC 2018c).

F. References

- ACC (Alaska Chadux Corporation). 2018. Services. <https://www.chadux.com/> (Accessed June 13, 2018).
- ADEC (Alaska Department of Environmental Conservation). 1988. A report on the tanker *Glacier Bay* spill in Cook Inlet, Alaska - July 2, 1987. Anchorage, Alaska.
- ADEC (Alaska Department of Environmental Conservation). 2018a. Contaminated Sites Database. Division of Spill Prevention and Response. <http://dec.alaska.gov/spar/csp.aspx> (Accessed April 10, 2018).
- ADEC (Alaska Department of Environmental Conservation). 2018b. Prevention, preparedness and response spills database search. Alaska Department of Environmental Conservation. <http://dec.alaska.gov/Applications/SPAR/PublicMVC/PERP/SpillSearch> (Accessed February 13, 2018).
- ADEC (Alaska Department of Environmental Conservation). 2018c. Prince William Sound Subarea Plan. Anchorage, AK. <http://dec.alaska.gov/spar/ppr/contingency-plans/response-plans/> (Accessed February 5, 2019).
- ADEC (Alaska Department of Environmental Conservation). 2019. Prince William Sound Geographic Response Strategies. Division of Spill Prevention and Response; Prevention, Preparedness, and Response. <https://dec.alaska.gov/spar/ppr/response-resources/grs/pws/> (Accessed February 5, 2019).
- Alaska Office of the Governor. 1989. *Exxon Valdez* oil spill information packet. Juneau, Alaska.
- AMAP (Arctic Monitoring and Assessment Programme). 2010. Assessment 2007: Oil and gas activities in the arctic - effects and potential effects. Volumes 1 and 2. Oslo, Norway. <http://www.amap.no/documents/doc/assessment-2007-oil-and-gas-activities-in-the-arctic-effects-and-potential-effects.-volume-1/776> and <https://www.amap.no/documents/doc/assessment-2007-oil-and-gas-activities-in-the-arctic-effects-and-potential-effects.-volume-2/100> (Accessed June 11, 2018).
- ARRT (Alaska Regional Response Team). 2018. Alaska regional contingency plan, version 1. Final, August 2018. <https://dec.alaska.gov/spar/ppr/contingency-plans/response-plans/> (Accessed January 24, 2019).
- BOEMRE (Bureau of Ocean Energy Management, Regulation and Enforcement). 2011. Report regarding the causes of the April 20, 2010 Macondo well blowout. <https://repository.library.noaa.gov/view/noaa/279> (Accessed May 31, 2018).
- BPXA (British Petroleum Exploration, Alaska, Inc.). 1996. Northstar Project, BP Exploration (Alaska) proposal for modified lease terms.
- Chaudhuri, U. R. 2011. Fundamentals of petroleum and petrochemical engineering. [In] J. G. Speight, editor. Chemical Industries. Vol. 130. CRC Press, Boca Raton, Florida.
- City of Valdez. 2017. Exxon Valdez oil spill. <http://www.valdezalaska.org/discover-valdez-history/valdez-history-exxon-valdez-oil-spill> (Accessed June 5, 2017).
- CRS (Clarkson Research Services). 2018. Transport volume of crude oil in global seaborne trade from 2010 to 2016 (in million metric tons). Statista. <https://www.statista.com/statistics/264013/transport-volume-of-crude-oil-in-seaborne-trade/> (Accessed June 12, 2018).

- Duplantis, S. 2016. Slide drilling - farther and faster. *Oilfield Review* 28(2): 50-56.
- EPA (US Environmental Protection Agency). 1999. Understanding oil spills and oil spill response. Office of Emergency and Remedial Response, EPA 540-K-99-007. Washington, DC. <https://www.epa.gov/sites/production/files/2018-01/documents/ospguide99.pdf> (Accessed April 23, 2018).
- Florence, F., J. Hadjioannou, J. Rasmus, A. Cook, J. L. Vieira, J. Haston, B. Rehm, D. Arceneaux, S. Vorenkamp, and J. Johnstone. 2011. Part 2: Drilling. Pages 103-278 [In] D. Denehy, editor. *Fundamentals of petroleum*. The University of Texas at Austin - PETEX.
- Furchtgott-Roth, D. 2013. Pipelines are safest for transportation of oil and gas. Issue Brief No. 23. Manhattan Institute for Policy Research. https://www.manhattan-institute.org/pdf/ib_23.pdf. (Accessed January 8, 2018).
- Graham, S. 2003. Environmental effects of *Exxon Valdez* spill still being felt. *Scientific American*. <https://www.scientificamerican.com/article/environmental-effects-of/>. (Accessed June 5, 2017).
- Green, K. and T. Jackson. 2015. Safety in the Transportation of Oil and Gas: Pipelines or Rail. Fraser Institute. <http://www.ourenergypolicy.org/wp-content/uploads/2015/08/safety-in-the-transportation-of-oil-and-gas-pipelines-or-rail.pdf> (Accessed 5/29/2018).
- Hamilton, T. D. 1994. Late Cenozoic glaciation of Alaska. *The Geology of Alaska V G-1*, p 813-844. Geological Society of America, the Geology of North America, Boulder, CO.
- ITOPF (International Tanker Owners Pollution Federation Limited). 2018. Oil Tanker Spill Statistics 2017. http://www.itopf.com/fileadmin/data/Photos/Statistics/Oil_Spill_Stats_2017_web.pdf (Accessed June 12, 2018).
- Jorgenson, M. T. and T. C. Cater. 1996. Minimizing ecological damage during cleanup of terrestrial and wetland oil spills. *Storage tanks 10*(Advances in environmental control technology series): 257-293.
- Joshi, S. 2008. Horizontal and multilateral well technology. Edited by E. Mesini and P. Macini. Vol. *Petroleum Engineering - Upstream*. UNESCO-EOLSS, University of Bologna.
- Larson, J. and G. Martin. 1998. Gulf of Alaska shelf assessment province. Pages 301-305. Undiscovered oil and gas resources, Alaska federal offshore. OCS Monograph MMS 98-0054. US Minerals Management Service.
- Magoon, L. B. 1994. Petroleum resources in Alaska. Pages 905-936 [In] G. Plafker and H. C. Berg, editors. *The geology of Alaska*. Geological Society of America, Boulder, Colorado.
- Martin, G. C. 1921. Preliminary report on petroleum in Alaska,. 83 p, 5 sheets scale 1:125,000 p US Geological Survey Bulletin 719.
- Merritt, R. D. and C. C. Hawley. 1986. Map of Alaska's coal resources, 1 sheet, 1:2,500,000. Alaska Division of Geological and Geophysical Surveys, Special Report 37
- Miller, D. J. 1951a. Preliminary report on the geology and oil possibilities of the Katalla District, Alaska. 66 p, 4 sheets, scale 1:96,000 p. United States Geological Survey, Open File Report 51-20.
- Miller, D. J. 1951b. Report on the Geology and Oil Possibilities of the Katalla District, Alaska. 47 p. 2 sheets, scale 1:96,000 p. United States Geological Survey, Open File Report 51-39.

- Miller, D. J. 1957. Geology of the southeastern part of the Robinson Mountains, Yakataga District, Alaska. United States Geological Survey Oil and Gas Investigations Map
- Miller, D. J. 1975. Geologic Map and Sections of Central Part of Katalla District, Alaska. United States Geological Survey Miscellaneous Field Studies 722
- NOAA (National Oceanic and Atmospheric Administration). 2018. Shoreline cleanup and assessment technique (SCAT). Office of Response and Restoration.
<https://response.restoration.noaa.gov/oil-and-chemical-spills/oil-spills/resources/shoreline-cleanup-and-assessment-technique-scat.html> (Accessed September 21, 2018).
- NRC (National Research Council). 2003. Cumulative environmental effects of oil and gas activities on Alaska's North Slope. The National Academies Press. Washington, DC.
- PAME (Protection of the Arctic Marine Environment Working Group). 2014. Arctic offshore oil and gas guidelines. Systems safety management and safety culture. Avoiding major disasters in Arctic offshore oil and gas operations. Arctic Council. Tromsø, Norway.
<https://oaarchive.arctic-council.org/handle/11374/418> (Accessed May 31, 2018).
- Rigzone. 2018a. How Do Jackups Work?
https://www.rigzone.com/training/insight.asp?insight_id=339&c_id= (Accessed May 30, 2018).
- Rigzone. 2018b. How Does Land Seismic Work. Training.
https://www.rigzone.com/training/insight.asp?insight_id=301&c_id=18 (Accessed January 24, 2018).
- Rigzone. 2018c. How Does Well Completion Work?
https://www.rigzone.com/training/insight.asp?insight_id=326&c_id= (Accessed May 29, 2018).
- Risley, D. E., G. C. Martin, J. A. Larson, M. B. Lynch, T. F. Flett, and Q. L. Horowitz. 1992. Geologic report for the Gulf of Alaska planning area. Edited by R. F. Turner. 302, 9 appendices, 6 plates p. US Department of the Interior, Minerals Management Services, Alaska OCS Region, OCS Report MMS 92-0065,.
- Scott, S. L. and M. A. Barrufet. 2003. Worldwide assessment of industry leak detection capabilities for single and multiphase pipelines. Minerals Management Service, and Offshore Technology Research Center, Texas A&M University, Cooperative Research Agreement 1435-01-99-CA-31003 Task Order 18133. College Station, Texas.
<http://www.celou.com/res/icelou/medicalres/201011/20101116203055479.pdf> (Accessed June 26, 2017).
- Shellenbaum, D. P. 2013. Seismic data acquisition, processing, and interpretation in the Cook Inlet Basin - local geologic and logistical impacts. Pages 117-132. Oil and Gas Fields of the Cook Inlet Basin, Anchorage, Alaska.
- Strata. 2017. Pipelines, rail and trucks: economic, environmental, and safety impacts of transporting oil and gas in the US. <https://www.strata.org/pdf/2017/pipelines.pdf> (Accessed February 26, 2018).
- Talberth, John and Evan Branosky. 2013. Oil and Gas Infrastructure in Cook Inlet, Alaska A Potential Public Liability? Center for Sustainable Economy, West Linn, OR.
<http://sustainable-economy.org/wp-content/uploads/Cook-Inlet-DRR-Costs-Report-Final.pdf> (Accessed 5/29/2018).

Trop, J. M. and K. D. Ridgway. 2007. Mesozoic and Cenozoic tectonic growth of southern Alaska: A sedimentary basin perspective. Pages 55-94 [In] K. D. Ridgway, J. M. Trop, J. M. G. Glen and J. M. O'neil, editors. Tectonic Growth of a Collisional Continental Margin: Crustal Evolution of Southern Alaska: Geological Society of America Special Paper 431. The Geological Society of America.

University of North Carolina At Chapel Hill. 2003. *Exxon Valdez* oil spill impacts lasting far longer than expected, scientists say. ScienceDaily.
<https://www.sciencedaily.com/releases/2003/12/031219073313.htm>. (Accessed February 16, 2010).

US Senate. (Committee on Energy and Natural Resources). 2011. New developments in upstream oil and gas technologies (112th Congress, 1st session, May 10).

USDOT (US Department of Transportation Pipeline and Hazardous Materials Safety Administration). 2018. Fact sheet: Leak detection systems.
<https://primis.phmsa.dot.gov/comm/FactSheets/FSLeakDetectionsystems.htm> (Accessed 5/29/2018).

Van Kooten, Gerald K., Jeffrey W. Short, and Jonathan J. Kolak. 2002. Low-maturity Kulthieth Formation coal: a possible source of polycyclic aromatic hydrocarbons in benthic sediment of the northern Gulf of Alaska. *Environmental Forensics* 3: 227-241.

Chapter Seven: Governmental Powers to Regulate Oil and Gas

Contents

	Page
A. State of Alaska	7-1
1. Department of Natural Resources (DNR).....	7-2
a. Plan of Operations Approval.....	7-2
b. Pipeline Rights-of-way.....	7-2
c. Temporary Water Use Authorization	7-2
d. Permit and Certificate to Appropriate Water	7-2
e. Land Use Permits	7-3
f. Material Sale Contract	7-3
g. Office of History and Archaeology (OHA).....	7-3
2. Alaska Department of Environmental Conservation (ADEC)	7-4
a. Interference with Salmon Spawning Permits	7-4
b. Air Quality Permits	7-4
i. Title I (NSR) Construction Permits.....	7-5
ii. Title V Operations Permits	7-5
iii. Other Requirements	7-6
c. Solid Waste Disposal Permit.....	7-6
d. Wastewater Disposal Permit	7-7
e. APDES Discharge Permits and Certification	7-7
f. Industry Oil Discharge Prevention and Contingency Plans.....	7-7
3. Alaska Department of Fish and Game (ADF&G)	7-8
a. Fish Habitat Permit.....	7-8
b. Special Area Permit.....	7-8
4. Alaska Oil and Gas Conservation Commission (AOGCC).....	7-8
a. Permit to Drill.....	7-9
b. Underground Injection Control Program (UIC).....	7-9
c. Annular Disposal of Drilling Waste.....	7-9
d. Disposal Injection Orders.....	7-10
e. Area Injection Orders	7-10
f. Flaring Oversight	7-10
5. Department of Labor and Workforce Development (DOLWD)	7-10
B. Federal.....	7-11
1. Environmental Protection Agency (EPA)	7-11
a. Air Quality Permits	7-11
b. Hazardous Waste (RCRA) Permits.....	7-11
c. National Pollutant Discharge Elimination System Discharge Permit	7-11
d. Underground Injection Control (UIC) Class I and II Injection Well Permits	7-11
2. U.S. Army Corps of Engineers	7-12
3. Pipeline and Hazardous Materials Safety Administration (PHMSA)	7-12
4. U.S. Fish and Wildlife Service	7-13
5. National Marine Fisheries Service	7-13
6. U.S. Coast Guard	7-13
C. Other Federal and State Regulatory Considerations	7-14

Chapter Seven: Governmental Powers to Regulate Oil and Gas

1. Regulations of Oil Spill Prevention and Response.....7-14
2. Alaska National Interest Lands Conservation Act (ANILCA).....7-14
3. Native Allotments.....7-15
D. References.....7-16

Chapter Seven: Governmental Powers to Regulate Oil and Gas

AS 38.05.035(g)(1)(B)(v) requires the director to consider and discuss the governmental powers to regulate the exploration, development, production, and transportation of oil and gas or gas only. Oil and gas activities are subject to numerous federal, state and local laws, regulations, policies, and ordinances. Each licensee is obligated to comply with all federal, state, and local laws. Regulatory agencies may have different roles in the oversight and regulation of oil and gas activities, and some agencies may have overlapping authorities with other agencies.

Most oil and gas activities require individual authorizations regardless of the phase (disposal, exploration, and development and production) with which they are associated. Common oil and gas activities associated with exploration requiring prior authorization include seismic surveys, development of drill pads, and drilling exploration wells. In the development and production phase, common activities requiring prior authorization include construction of pads, roads, support facilities, and drilling development wells. In the production phase, common oil and gas activities requiring prior authorization include constructing and operating processing facilities, construction of transmission pipelines, flowlines, and above-ground storage tanks. The likely methods of transportation in the production and development phase are focused on moving oil and gas, and regulatory authorities tend to shift toward monitoring activities and facilities in the field to ensure post-disposal oil and gas activities are conducted as approved. These phases are not always sequential and associated oil and gas activities may occur at any point throughout the project. The completion of one phase does not automatically trigger the beginning of a new phase.

This chapter is not intended to provide a comprehensive description of the multitude of laws and regulations that may be applicable to oil and gas activities. However, its intent is to display the broad spectrum of government agencies authorized to prohibit, regulate, and condition oil and gas activities which may ultimately occur as a result of the issuance of the Gulf of Alaska exploration license. Actual processes, terms, conditions, and required authorizations will vary with time and certain, site-specific operations, and the activities discussed in the previous paragraph are not all inclusive. Licensees are responsible for knowing and complying with all applicable federal, state, and local laws, regulations, policies, ordinances, and the provisions of the license. Some, but not all, of the major permits and approvals required by each agency are discussed below.

A. State of Alaska

The State of Alaska has several agencies that approve, oversee, or coordinate activities related to oil and gas exploration, development, production, and transportation. The licensee is required to keep the area open for inspection by authorized state officials. Several state agencies including the Alaska Department of Natural Resources (DNR), Alaska Department of Environmental Conservation (ADEC), Alaska Department of Fish and Game (ADF&G), and Alaska Oil and Gas Conservation Commission (AOGCC) may monitor field operations for compliance with each agency's terms. The agencies and their authorities are set forth below.

1. Department of Natural Resources (DNR)

The Alaska Department of Natural Resources (DNR) reviews, coordinates, conditions, and approves plans of exploration, or operations and other permits as required before on-site activities can take place. The DNR monitors activities through field inspections once they have begun. Each plan of operations is site-specific and must be tailored to the activity requiring the permit. Applicable fees for DNR permits and applications are outlined in 11 AAC 05.010.

a. Plan of Operations Approval

Oil and gas operations undertaken on or in the License Area are regulated by 11 AAC 83.158 and 11 AAC 83.346. An application for approval of a plan of operations must contain sufficient information for DO&G to determine the surface use requirements and impacts directly associated with the proposed operations. Amendments may be required as necessary, but DO&G will not require an amendment that is inconsistent with the terms of the exploration license. The terms and conditions of the license, including amendments to the plan of operations, are attached to the plan of operations approval and are binding on the licensee. In addition to an approved plan of operations, a bond must be furnished to DNR in accordance with 11 AAC 83.160, before starting operations (11 AAC 83.160).

b. Pipeline Rights-of-way

The DO&G State Pipeline Coordinator's section is the lead state agency for processing pipeline right-of-way leases under AS 38.35, the Right-of-Way Leasing Act. This responsibility includes coordination of the state's efforts related to the federal right-of-way process. The State Pipeline Coordinator also coordinates the state's oversight of preconstruction, construction, operation and termination of jurisdictional pipelines.

c. Temporary Water Use Authorization

Temporary water use authorizations may be required for oil and gas activities. The Division of Mining, Land, and Water (DMLW) administers temporary water use authorizations as required under 11 AAC 93.035 before (1) the temporary use of a significant amount of water, (2) if the use continues for less than five consecutive years, and (3) the water applied for is not otherwise appropriated. The volume of water to be used and permitted depends upon whether it is for consumptive uses, and the duration of use. The authorization may be extended one time for good cause for a period of time not to exceed five years.

The authorization is subject to conditions and may be suspended or terminated if necessary to protect the water rights of other persons or the public interest. Information on lake bathymetry, fish presence, and fish species may be required when winter water withdrawal is proposed to calculate the appropriate withdrawal limits.

d. Permit and Certificate to Appropriate Water

Industrial or commercial water use requires a Permit to Appropriate Water under 11 AAC 93.120. The permit is issued for a period consistent with the public interest and adequate to finish construction and establish full use of water. The maximum duration for this permit is five years,

unless the applicant proves, or the commissioner independently determines, a longer time is required. The commissioner may issue a permit subject to terms, conditions, restrictions, and limitations necessary to protect the rights of others, and the public interest. Under 11 AAC 93.120(e), permits are subject to conditions to protect fish and wildlife habitat, recreation, navigation, sanitation or water quality, prior appropriators, or any other purpose DNR determines is in the public interest.

e. Land Use Permits

DO&G issues land use permits, such as a geophysical permit or a miscellaneous land use permit, under 11 AAC 96.010. Geophysical exploration permits are required for all geophysical and exploration activity in the License Area.

Seismic surveys are the most common activity authorized by this permit. The purpose of the permit is to minimize adverse effects on the land and its resources while making important geological information available to the state (11 AAC 96.210).

A \$100,000 bond is required to conduct seismic work. The bond amount for other geophysical surveys is determined when the activity is proposed. A geophysical exploration permit contains measures to protect the land and resources of the area.

The DMLW issues land use permits to manage surface uses and activities on state public domain land and to minimize adverse effects on the land and its resources under 11 AAC 96. Land use permits may be issued for a period of up to five years depending on the activity and may be revoked at will or for cause in accordance with 11 AAC 96.040. Generally allowed uses on state land are subject to the conditions set out in 11 AAC 96.025.

f. Material Sale Contract

If the licensee or operator proposes to use state-owned gravel or other materials for construction of pads and roads, DMLW requires a material sale contract (11 AAC 71). The contract must include, at a minimum, a description of the License Area, the materials to be extracted, the volume of material to be extracted, the method of removal of the material, the bonds and deposits required of the purchaser, and the purchaser's liability under the contract. The material sale contract must also include the purchaser's site-specific operating requirements (11 AAC 71.200).

A contract may be extended if the DMLW director determines the delay in completing the contract is due to unforeseen events beyond the purchaser's control, or the extension is in the state's best interests (11 AAC 71.20).

The DMLW director may require the purchaser to provide a performance bond guaranteeing performance of the terms of the contract. If required, the bond amount is based on the total value of the sale and must remain in effect for the duration of the contract unless released in writing by the DMLW director (11 AAC 71.095).

g. Office of History and Archaeology (OHA)

The Office of History and Archaeology (OHA) performs the work of the State Historic Preservation Office pursuant to the National Historic Preservation Act of 1966 (OHA 2018a). OHA follows the state's historic preservation plan in maintaining the Alaska Heritage Resources Survey (AHRs). The

historic preservation plan guides preservation activities in the state from 2018 through 2023 (OHA 2018b).

AHRS is an inventory of all reported historic and prehistoric sites within the state. This inventory includes objects, structures, buildings, sites, districts, and travel ways, with a general guideline that the sites are over 50 years old. The fundamental use of the AHRS is to protect cultural resource sites from unwanted destruction (AHRS 2017). Before beginning a multi-phase development project, information regarding important cultural and historic sites should be obtained by contacting OHA. The AHRS data sets are “restricted access documents” and site-specific location data should not appear in final reports or be distributed to others.

AS 41.35.010 enables the state to preserve and protect the historic, prehistoric, and archaeological resources of Alaska from loss, desecration, and destruction so the scientific, historic, and cultural heritage embodied in these resources may pass undiminished to future generations. Further, the historic, prehistoric, and archaeological resources of the state are properly the subject of concerted and coordinated efforts exercised on behalf of the general welfare of the public, so these resources may be located, preserved, studied, exhibited, and evaluated.

2. Alaska Department of Environmental Conservation (ADEC)

ADEC has the statutory responsibility to conserve, improve, and protect Alaska’s natural resources and environment, by regulating air, land, and water pollution, and oil spill prevention and response. ADEC implements and coordinates several federal regulatory programs in addition to state laws (ADEC 2018b).

a. Interference with Salmon Spawning Permits

ADEC is responsible for issuing permits for activities that interfere with salmon spawning streams and waters. Activities that may potentially obstruct, divert, or pollute waters of the state used by salmon in the propagation of the species, or that may interfere with the free passage of salmon must first apply for and obtain a permit before beginning any work (AS 16.10.010).

Permits may be granted if ADEC finds the purpose of the permit is to develop power, obtain water for civic, domestic, irrigation, manufacturing, mining, or other purposes with the intent to develop the state’s natural resources. The applicant may also be required to construct and maintain adequate fish ladders, fishways, or other means by which fish may pass over, around, or through the dam, obstruction, or diversion in the pursuit of spawning.

b. Air Quality Permits

ADEC administers the federal Clean Air Act (42 U.S.C. §§7401-7671 et seq.) and the state’s air quality program under the federally approved State Implementation Plan (AS 46.14; 18 AAC 50). Through this plan, federal requirements of the Clean Air Act are met, including National Ambient Air Quality Standards (NAAQS), Non-Attainment New Source Review (N-NSR), New Source Performance Standards (NSPS), National Emission Standards for Hazardous Air Pollutants (NESHAP), and Prevention of Significant Deterioration (PSD). Additionally, ADEC monitors air quality and compliance.

NAAQS set limits on certain pollutants (called criteria pollutants) considered harmful to public health and the environment. NAAQS have been established for: carbon monoxide, lead, nitrogen dioxide, particulate matter (PM10), small particulate matter (PM2.5), ozone, ammonia, and sulfur dioxide. NSR and PSD, a permitting program required for the review of new sources, new construction projects, or modifications to an existing facility, ensures that air quality is not degraded by the new project, and that large, new, or modified industrial sources are as clean as possible (EPA 2018c). NSPS are intended to promote the use of the best air pollution control technologies available, and account for the cost of technology and any other non-air quality, health and environmental impact, and energy requirements (EPA 2018a). NESHAPs are set for air pollutants (air toxics) that are not covered by NAAQS, but that may be harmful (EPA 2018b). The standards are categorized by type of source and require the maximum degree of reduction in emissions that is achievable, as determined by the U.S. Environmental Protection Agency (EPA).

Title I Construction Permits, and Title V Operations Permits are the two primary types of permits issued to meet air quality requirements. These permits specify what activities are allowed, what emission limits must be met, and may specify how the facility must be operated. The permits contain monitoring, recordkeeping, and reporting requirements to ensure that the applicant meets the permit requirements (ADEC 2018c).

i. Title I (NSR) Construction Permits

Title I permits refer specifically to air construction permits and minor source specific permits for certain activities such as the PSD program as well as other requirements of the Clean Air Act. This permit must be obtained before onsite construction may begin. Operators of existing and new facilities who propose to construct or modify a stationary source may need to apply for either a construction or minor source specific permit. Title I permits are required for projects that are new major sources for pollutants, or major modifications at existing sources. PSD requires installation of the “Best Available Control Technology,” an air quality analysis, and additional impacts analysis and public involvement (EPA 2018d).

The process for a Title I permit can take up to three years, depending on the amount of pre-construction meteorological or pollutant monitoring data that must be collected. Once a complete Title I permit application is submitted, ADEC strives to issue Title I minor permits within 130 days. Title I PSD permits can take up to 18 months to issue once a complete permit application is received. Article 5 of 18 AAC 50 contains the regulations covering Title I minor permits. Article 3 of 18 AAC 50 contains the regulations covering the Title I PSD permits. With a few exceptions, ADEC has adopted the federal PSD permit program under 40 CFR 52.21 by reference.

ii. Title V Operations Permits

The federal Clean Air Act gives EPA authority to limit emissions from air pollution sources after the source has begun to operate. EPA regulations require facilities that emit certain pollutants or hazardous substances to obtain a permit to operate the facility, known as a Title V permit. In Alaska, ADEC is responsible for issuing Title V permits and making compliance inspections (AS 46.14; 18 AAC 50). The permit establishes limits on the type and amount of emissions, requirements for pollution control devices and prevention activities, and requirements for monitoring and record keeping (ADEC 2018c).

If a Title V permit is required, a permittee has up to one year after becoming a major source to submit a complete Title V permit application. Operations can continue while ADEC processes the application (the application shield) if the application is both timely and complete. However, significant revisions to an existing permitted facility cannot be made until ADEC approves the permit revision. Processing time for permit revisions can generally take up to six months. Title V permits and revisions can be processed concurrently with Title I permits. Article 3 of 18 AAC 15 contains the regulations covering Title V permits. With a few exceptions, ADEC has adopted the federal operating permit program under 40 CFR Part 71 by reference.

iii. Other Requirements

ADEC also operates ambient air quality monitoring networks under the Clean Air Act to assess compliance with NAAQS for carbon monoxide, particulates, nitrogen dioxide, sulfur oxide, and lead; assesses ambient air quality for ambient air toxics levels; provides technical assistance in developing monitoring plans for air monitoring projects; and issues air advisories to inform the public of hazardous air conditions (ADEC 2018a). ADEC provides oversight for operators that must collect air and meteorological monitoring data to meet air permit requirements.

Operators in Alaska are required to minimize the volume of gas released, burned, or permitted to escape into the air (20 AAC 25.235(c)). Operators must report monthly to AOGCC any flaring event lasting over an hour. The AOGCC investigates these incidents to determine if there was unnecessary waste (AOGCC 2006). More information is provided in Section 4 below.

c. Solid Waste Disposal Permit

ADEC regulates solid waste storage, treatment, and disposal under 18 AAC 60. The EPA administers the Resource Conservation and Recovery Act (RCRA) relating to hazardous wastes and Underground Injection Control (UIC) Class I injection wells. AOGCC regulates UIC Class II oil and gas waste management wells.

ADEC requires a comprehensive plan for all solid waste disposal facilities that it regulates. Solid waste permit applications are reviewed for compliance with air and water quality standards, wastewater disposal, drinking water standards, and consistency with the Alaska Historic Preservation Act before approval. A comprehensive facility plan is required and includes specific engineering design criteria and a discussion demonstrating how the various design features (liners, berms, dikes) will ensure compliance with regulations.

Disposal of waste in Municipal Solid Waste Landfills (MSWLFs) is regulated under 18 AAC 60.300-398. Other solid waste disposal facilities that accept primarily one type of solid waste are regulated as monofill under 18 AAC 60.400-495. An inactive reserve pit is a historic, generally unlined drilling waste disposal area that operated prior to 1996 and is required to be closed under 18 AAC 60.440. Currently 95 percent of the identified inactive reserve pits have met closure requirements.

Waste storage, treatment, and land applications facilities also require permits under 18 AAC 60. Permit applications include detailed reviews of design and operations to ensure that the facilities will perform their planned function, comply with other ADEC regulations, and be protective of health, safety and the environment. Typical permitted treatment facilities include municipal solid waste

incinerators and treatment facilities for medical waste, sewage solids, and drilling waste (prior to underground injection).

Hazardous waste storage, treatment, and disposal facilities are permitted and regulated by EPA. Currently, no hazardous waste disposal facilities are permitted in Alaska. If a hazardous waste management facility is proposed for Alaska, ADEC is responsible for a review of the facility siting under 18 AAC 63, although no specific program is designated to perform the review.

d. Wastewater Disposal Permit

Domestic graywater must be disposed of properly at the surface and requires a wastewater disposal permit (18 AAC 72). Monitoring records must be available for inspection, and a written report may be required upon completion of operations.

e. APDES Discharge Permits and Certification

ADEC administers the Alaska Pollution Discharge Elimination System (APDES) program (ADEC 2018e, 2015). This program regulates discharges of pollutants into U.S. waters by “point sources,” such as industrial and municipal facilities. Permits are designed to maximize treatment and minimize harmful effects of discharges. The APDES covers a broad range of pollutants, which include any type of industrial, municipal, and agricultural waste discharged into water.

APDES permits may be general or individual. General permits cover multiple facilities that have similar wastewater characteristics in a defined area. Individual permits are issued to a single facility and the terms, limits, and conditions are specifically tailored for that facility and circumstances. An APDES permit is effective for a period not exceeding five years and must be renewed before it expires.

f. Industry Oil Discharge Prevention and Contingency Plans

ADEC regulates spill prevention and response under AS 46.04.030. ADF&G and DNR support the ADEC in these efforts by providing expertise and information. Oil discharge prevention and contingency plans (contingency plans) must be filed with ADEC before beginning operations. DNR reviews and provides comments to ADEC regarding the adequacy of these contingency plans.

Contingency plans for exploration facilities must include a description of methods for responding to and controlling blowouts, the location and identification of oil spill cleanup equipment, the location and availability of suitable drilling equipment, and an operations plan to mobilize and drill a relief well. Holders of approved plans are required to have sufficient oil discharge containment, storage, transfer, cleanup equipment, personnel, and resources to meet the response planning standards for the particular type of facility, pipeline, tank vessel, or oil barge (AS 46.04.030(k)). If development and production follow, additional contingency plans must be approved for each facility before activity commences.

Discharges of oil or hazardous substances must be reported to ADEC. The report must record the volume released, whether the release is to land or to water, and whether the release has been contained by secondary containment or a structure. The discharge must be cleaned up to ADEC’s satisfaction. ADEC will modify proposed cleanup techniques or require additional cleanup

techniques for the site as it determines to be necessary to protect human health, safety, welfare, and the environment (18 AAC 75.335(d)).

Contingency plans must describe existing and proposed means of oil discharge detection, including surveillance schedules, leak detection, observation wells, monitoring systems, and spill-detection instrumentation (AS 46.04.030; 18 AAC 75.425(e)(2)(E)). Contingency plans must include: a Response Action Plan, a Prevention Plan, and Supplemental Information to support the response plan, including a Best Available Technology Section (18 AAC 75.425). Operators must also provide proof of financial ability to respond to damages (AS 46.04.040).

3. Alaska Department of Fish and Game (ADF&G)

ADF&G, Division of Habitat, evaluates the potential effect of any activity on fish and wildlife, their habitat, and the users of those resources. ADF&G manages approximately 750 active fisheries, 26 game management units, and 32 special areas. The Division of Habitat's mission is to protect Alaska's valuable fish and wildlife resources and their habitats as Alaska's population and economy continue to expand. For activities in the License Area, fish habitat and hazing permits may be required.

a. Fish Habitat Permit

Under AS 16.05.841–871, ADF&G has the statutory responsibility for protecting freshwater anadromous fish habitat and providing free passage for anadromous and resident fish in freshwater bodies and any activity or project that is conducted below the ordinary high-water mark of an anadromous stream. These activities include, but are not limited to, construction and maintenance for bridges and culverts, stream diversion, stream crossing, and using explosives in the bed of a specified river, lake, or stream. ADF&G may attach additional stipulations to any permit authorization to mitigate potentially negative impacts of the proposed activity.

b. Special Area Permit

Under AS 16.20, authorization for land and water use activities that may impact fish, wildlife, habitats, or existing public use in any of the refuges, sanctuaries, or critical habitat areas designated by the Alaska State Legislature, may require a special area permit. Examples of activities requiring a special area permit include, but are not limited to, construction or placement of structures, damaging or clearing vegetation, detonation of explosives, natural resource development, or energy exploration, and any activity that is likely to have a significant effect on vegetation, drainage, water quality, soil stability, fish, wildlife, or their habitat, or which disturbs fish or wildlife (5 AAC 95.420). The ADF&G may require a mitigation plan pursuant to 5 AAC 95 when deemed necessary.

4. Alaska Oil and Gas Conservation Commission (AOGCC)

AOGCC is an independent, quasi-judicial agency of the State of Alaska established under the Alaska Oil and Gas Conservation Act, AS 31.05.005. The AOGCC's regulatory authority is outlined in 20 AAC 25.

AOGCC acts to prevent waste, protect correlative rights, improve ultimate recovery, and protect underground freshwater. It issues permits, orders, and administers the UIC program for enhanced oil recovery and underground disposal of oil field waste. AOGCC serves as an adjudicatory forum for resolving certain oil and gas disputes between owners, including the state (AOGCC 2018).

a. Permit to Drill

Under AS 31.05.090, AOGCC is authorized to issue permits to drill. Any licensee wishing to drill a well for oil, gas, or geothermal resources must first obtain a permit to drill from AOGCC. This requirement applies to exploratory, stratigraphic test and development wells, and injection and other service wells related to oil, gas, and geothermal activities. Typically, operating companies have obtained approval from all other concerned agencies by the time an operator, as defined by 20 AAC 25.990(46), applies to the AOGCC for a permit to drill. The application must be accompanied by the items set out in 20 AAC 25.005(c).

Under 20 AAC 25.015, once a permit to drill has been approved, the operations detailed in the permit to drill application must not be changed without additional approval from the AOGCC. After issuance of a permit to drill, information on the surface and proposed bottom-hole locations and the identity of the license, pool, and field for each well is published as part of the AOGCC's weekly drilling report (AOGCC 2018).

b. Underground Injection Control Program (UIC)

The goal of the UIC program under the federal Safe Drinking Water Act is to protect underground sources of drinking water from contamination by oil and gas (Class II) injection activities. The UIC program requires the AOGCC to verify the mechanical integrity of injection wells, determine if appropriate injection zones and overlying confining strata are present, determine the presence or absence of freshwater aquifers and ensure their protection, and prepare quarterly reports of both in-house and field monitoring for EPA. Through a Memorandum of Understanding with EPA, AOGCC has primacy for Class II wells in Alaska, including oilfield waste disposal wells, enhanced oil recovery wells, and hydrocarbon storage wells.

AOGCC reviews and takes appropriate action on proposals for the underground disposal of Class II oil field wastes (20 AAC 25.252). Before receiving approval, an operator must demonstrate that injected fluids will not move into freshwater sources. Disposal or storage wells must be cased, and the casing cemented in a manner that will isolate the disposal or storage zone and protect oil, gas, and freshwater sources. Once approved, liquid waste from drilling operations may be injected through a dedicated tubing string into the approved subsurface zone. The pumping of drilling wastes through the annular space of a well is an operation incidental to drilling of the well and is not a disposal operation subject to regulation as a Class II well (AOGCC 2018).

c. Annular Disposal of Drilling Waste

An AOGCC permit is required if waste fluid is to be injected into a well annulus. The material must be muds and cuttings incidental to the drilling of a well. AOGCC considers the volume, depth, and other physical and chemical characteristics of the formation designated to receive the waste. Annular disposal is not permitted into water bearing zones where dissolved solids or salinity concentrations

fall below predetermined threshold limits. Waste not generated from a hydrocarbon reservoir cannot be injected into a reservoir (AOGCC 2018).

d. Disposal Injection Orders

Under 20 AAC 25.252, operators may apply for disposal injection orders to dispose of waste in individual wells. After the public review process and AOGCC's analysis, an order may be issued that approves the proposed disposal project (AOGCC 2018).

e. Area Injection Orders

Injection orders may be issued on an area basis rather than for individual wells in areas where greater activity is anticipated (20 AAC 25.402). The area injection orders describe, evaluate, and approve subsurface injection on an area wide basis for enhanced oil recovery and disposal purposes (AOGCC 2018).

f. Flaring Oversight

The goal of the flaring oversight program is the elimination of unnecessary flaring whenever possible in accordance with 20 AAC 25.235. Operators are required to report all flaring events lasting longer than one hour to AOGCC. Flaring events over one hour are analyzed and investigated if necessary. The operator may be penalized if it is determined that waste has occurred (AOGCC 2018).

5. Department of Labor and Workforce Development (DOLWD)

Recent studies of the state's workforce by the Alaska Department of Labor and Workforce Development (DOLWD) identified the need to increase the supply of skilled construction workers available in the state. In response, Governor Walker signed Administrative Order No. 278 (AO 278) to increase opportunities for on-the-job training through monitoring the use of apprentice workers on state-financed construction projects and improve the available pool of skilled construction workers. AO 278 directed DNR to consider ways to encourage licensees and lessees developing minerals, including oil and gas, on state-owned land to employ apprentices for work performed on the licensed or leased area. In February 2019, Alaska Governor Michael J. Dunleavy rescinded AO 278 by AO 309.

DOLWD also administers some delegated authorities of the Occupational Safety and Health Administration (OSHA) Section 18 of the OSHA Act of 1970 allows states to obtain approval to assume responsibility for development and enforcement of federal occupational safety and health standards. The DOLWD has obtained approval from OSHA for administration of some of the federal OSHA standards (DOLWD 2016; OSHA 2018).

B. Federal

1. Environmental Protection Agency (EPA)

EPA implements, administers, or oversees programs required by federal environmental laws and regulations. The implementation of some programs has been delegated to the states to safeguard the air, land, and water.

a. Air Quality Permits

ADEC administers the federal Clean Air Act and the air quality program for the State of Alaska under a federally-approved state implementation plan (EPA 2017a). For more information, see section 2(b) above.

b. Hazardous Waste (RCRA) Permits

The federal RCRA regulates the management of solid waste, hazardous waste, and underground storage tanks holding petroleum products or certain chemicals (40 CFR 264.175(b)-(c)). Regulations set the parameters for transporting, storing, and disposing of hazardous wastes and for designing and operating treatment, storage, and disposal facilities safely (40 CFR 264.193(b)). Regulations are enforced through inspections, monitoring of waste handlers, taking legal action for noncompliance, and providing compliance incentives and assistance (EPA 2017b).

Some states may receive authorization to administer parts of the program, which requires that state standards be at least as strict as federal standards. EPA administers the RCRA program in Alaska.

c. National Pollutant Discharge Elimination System Discharge Permit

The National Pollutant Discharge Elimination System (NPDES) discharge permit is required under the federal Clean Water Act, although its administration may be delegated to a state agency. ADEC administers this EPA program within state waters, under the APDES (see Section 2(e) above). However, EPA retains responsibility for issuing NPDES permits in Alaska for facilities within Denali National Park, outside of state waters, on tribal lands, and facilities subject to Clean Water Act Section 301(h) waivers. Both ADPES and NPDES permits specify the type and amount of pollutant, and include monitoring and reporting requirements, so that discharges do not harm water quality or human health.

d. Underground Injection Control (UIC) Class I and II Injection Well Permits

The EPA regulates injection wells used to dispose of fluid pumped into the well. Authorized as part of the federal Safe Drinking Water Act of 1974, the EPA's UIC program protects underground sources of drinking water from being contaminated by the waste injected in the wells. Injection wells are categorized into five classes; Classes I and II are most common in the oil and gas industry. The EPA administers the program for Class I wells in Alaska, and authority for Class II oil and gas wells has been delegated to AOGCC (see Section D).

All injections falling into Class I must be authorized through the EPA's UIC Class I program. Class I wells must operate under a permit that is valid for up to 10 years. Permits stipulate requirements such

as siting, construction, operation, monitoring and testing, reporting and record keeping, and closure. Requirements differ for wells depending on whether they accept hazardous or non-hazardous wastes.

2. U.S. Army Corps of Engineers

The U.S. Army Corps of Engineers (USACE) has regulatory authority over construction, excavation, or deposition of materials in, over, or under navigable waters of the United States, or any work which would affect the course, location, condition, or capacity of those waters (Rivers and Harbors Acts of 1890 (superseded) and 1899 (33 U.S.C. 401, et seq.; 33 U.S.C. 403). Section 10 permits cover oil and gas activities, including exploration drilling from jack-up drill rigs and installation of production platforms (USACE 2018a).

Section 404 of the Clean Water Act regulates discharge of dredged and fill material into United States waters and wetlands. This program is administered by USACE, which is authorized to issue Section 404 permits for discharging dredge and fill materials.

Permits issued for specific projects are the basic type of permit issued. General permits (including programmatic, nationwide, and regional general permits) authorize activities that are minor and will result in minimal individual and cumulative adverse effects. General permits carry a standard set of stipulations and mitigation measures. Letters of permission, another type of project authorization, are used when the proposed project will not have significant individual or cumulative environmental impacts, and appreciable opposition is not expected (USACE 2018b).

In making a final decision on whether to issue a permit, USACE considers conservation, economics, aesthetics, wetlands, cultural values, navigation, fish and wildlife values, water supply, water quality, and other factors judged important to the needs and welfare of the people (USACE 2018a).

ADEC reviews Section 404 and 10 permit applications for compliance with Alaska water quality standards. If the applications comply, ADEC approves the permit.

Permits may also be reviewed by other agencies, such as EPA, U.S. Fish and Wildlife Service (USFWS), and National Marine Fisheries Service (NMFS), to ensure compliance with the Endangered Species Act (ESA), the National Environmental Policy Act, and Essential Fish Habitat Provisions of the Magnuson-Stevens Act (USACE 2018a).

3. Pipeline and Hazardous Materials Safety Administration (PHMSA)

The federal Office of Pipeline Safety (OPS) in the Pipeline and Hazardous Materials Safety Administration (PHMSA), an agency of the U.S. Department of Transportation, regulates movement of hazardous materials by pipeline (PHMSA 2018). PHMSA inspectors review technical issues on hazardous liquid pipelines in Alaska. The 2016 PIPES Act requires hazardous liquid pipeline operators to develop integrity management programs for transmission pipelines (Transportation and Infrastructure Committee 2016).

Jurisdictional authority over pipelines depends on many factors such as design, pipe diameter, product transported, or whether it meets state or federal designation, e.g., transmission line, gathering

line, or distribution line, and other attributes as specified in regulations. Generally, the design, maintenance, and preservation of transmission pipelines transporting hydrocarbon products are under the authority and jurisdiction of PHMSA with specific federal regulations for natural gas (49 CFR 192) and hazardous liquids (49 CFR 195). Both regulations prescribe the minimum requirements that all operators must follow to ensure the safety of their pipelines and piping systems. The regulations not only set requirements, but also provide guidance on preventive and mitigation measures, establish time frames for upgrades and repairs, development of integrity management programs, and incorporate other relevant information such as standards, incorporated by reference, developed by various industry consensus organizations.

4. U.S. Fish and Wildlife Service

The U. S. Fish and Wildlife Service (USFWS) is a federal agency within the Department of the Interior dedicated to conservation, protection, and management of fish, wildlife, and natural habitats. USFWS has management authority for migratory birds, threatened and endangered species, the national wildlife refuge system, aquatic resources, and landscape conservation (USFWS 2015). USFWS issues incidental take permits under the ESA for a limited set of marine mammals such as polar bears, walrus, and sea otters, as well as freshwater and terrestrial endangered species. Incidental take permits with respective habitat conservation plans are required when non-federal activities will result in take of threatened or endangered species (USFWS 2013).

5. National Marine Fisheries Service

The National Marine Fisheries Service (NMFS) is an office of the National Oceanic and Atmospheric Administration within the U.S. Department of Commerce. NMFS has jurisdiction over dolphins, porpoises, whales, sea lions, and seals protected under the Marine Mammal Protection Act (MMPA) and the ESA (NOAA Fisheries 2018c). NMFS issues permits and authorizations under the MMPA and ESA for activities that may result in the take or harassment of marine mammals (NOAA Fisheries 2018b). NMFS is also tasked with conservation and enhancement of Essential Fish Habitat (EFH) under the Magnuson-Stevens Act (NOAA Fisheries 2018a).

6. U.S. Coast Guard

The U.S. Coast Guard (USCG) has authority to regulate oil pollution under 33 CFR §§ 153–157 in waters of the United States, and to make determinations on hazards to navigation under 33 CFR § 64.31. USCG may respond to discharges or threats of discharges of oil and hazardous substances into the navigable waters of the United States and promulgate certain pollution prevention regulations under 33 U.S.C. § 1321. USCG also has regulatory authority over offshore activities pursuant to the Outer Continental Shelf Lands Act. They are responsible for the regulation, inspection, and oversight of systems and subsystems on mobile offshore drilling units like jack-up rigs and drilling platforms. The USCG also evaluates hazards to navigation including artificial islands and pipelines. USCG regulates hazardous materials in commerce under U.S.C. Title 49. USCG safeguards fisheries and marine protected resources by enforcing living natural resource authorities like the Magnuson-Stevens Fisheries Conservation and Management Act (16 U.S.C.

§ 1801), the Lacey Act (16 U.S.C. §§ 3371–3378), the Endangered Species Act (16 U.S.C. §§ 1531–1544), and the National Marine Sanctuaries Act (16 U.S.C. §§ 1431–1445).

C. Other Federal and State Regulatory Considerations

1. Regulations of Oil Spill Prevention and Response

Section 105 of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) (42 U.S.C. § 9605), and § 311(c)(2) of the Clean Water Act, as amended (33 U.S.C. § 1321(c)(2)) require environmental protection from oil spills. CERCLA and the Clean Water Act require a National Oil and Hazardous Substances Pollution Contingency Plan (40 CFR § 300; 33 U.S.C. § 1321(d)). Under the implementing regulations, a violator must plan to prevent and immediately respond to oil and hazardous substance spills and be financially liable for any spill cleanup. If the pre-designated Federal On-Scene Coordinator (FOSC) determines the response is neither timely nor adequate, the federal government may elect to respond to the spill absent adequate actions by the responsible party and if it so chooses, may seek to recover the costs of such response from the responsible party.

The Oil Pollution Act of 1990 (OPA 90) requires the development of facility and tank vessel response plans and an area-level planning and coordination structure to coordinate federal, regional, and local government planning efforts with the industry. OPA 90 amended the Clean Water Act (§ 311(j)(4); 33 U.S.C. § 1231(j)) and established regional citizen advisory councils (RCACs) and area contingency plans as the main parts of the national response planning structure.

The Alaska Regional Response Team is an advisory board to the FOSC. It provides processes for participation by federal, state and local governmental agencies to participate in response to pollution incidents (ARRT 2014). The Alaska Regional Contingency Plan is the area contingency plan for Alaska (ARRT 2018). Since Alaska is large and geographically diverse, federal agencies also prepare geographic-specific contingency plans. The License Area is located within the Prince William Sound area contingency plan (ADEC 2018d).

2. Alaska National Interest Lands Conservation Act (ANILCA)

The Alaska National Interest Lands Conservation Act (ANILCA) designated over 100 million acres of conservation system units across Alaska, which are each separately managed by one of four federal land management agencies, the National Park Service, the U.S. Fish and Wildlife Service, the Bureau of Land Management and the USDA Forest Service. ANILCA includes numerous special provisions intended by Congress to balance the national interest in Alaska’s vast scenic and wildlife resources with recognition of Alaska’s developing economy and infrastructure, and distinctive rural way of life. The State, through its interagency ANILCA program, continues to closely monitor the implementation of ANILCA. State interests include the need for continued public access for traditional activities; guaranteed access to State and private inholdings within CSUs for economic and other uses; consideration of transportation and utility systems within or across CSUs; access for subsistence activities; and recognition of state authorities concerning fish, wildlife, navigable waterways, tidelands and submerged lands.

Title XI of ANILCA provides that Alaska's transportation and utility network is largely undeveloped and future needs for those systems should be identified through a cooperative effort involving the state and federal government, with public participation. The development of any transportation or utility corridors should be established to minimize any adverse impacts to the environment. Additionally, ANILCA requires drafting a timely environmental impact statement for a proposed utility or transportation corridor, prepared by all federal agencies with which the application was filed under.

3. Native Allotments

Licensees must comply with applicable federal law concerning Native allotments. Activities proposed in a plan of operations must not unreasonably diminish the use and enjoyment of lands within a Native allotment. Before entering lands subject to a pending or approved Native allotment, licensees must contact the Bureau of Indian Affairs (BIA) and the Bureau of Land Management (BLM) and obtain approval to enter.

D. References

- ADEC (Alaska Department of Environmental Conservation). 2015. Alaska pollutant discharge elimination system program. Last Modified August 15, 2015. <http://dec.alaska.gov/WATER/npdes/index.htm> (Accessed May 30, 2018).
- ADEC (Alaska Department of Environmental Conservation). 2018a. Air monitoring and quality assurance. Division of Air Quality. <http://dec.alaska.gov/air/am/index.htm> (Accessed May 30, 2018).
- ADEC (Alaska Department of Environmental Conservation). 2018b. Office of the commissioner, department policy. <http://dec.alaska.gov/commish/index.htm> (Accessed May 30, 2018).
- ADEC (Alaska Department of Environmental Conservation). 2018c. Permit information page. Air Permits Program. <http://www.dec.state.ak.us/air/ap/permit.htm> (Accessed May 30, 2018).
- ADEC (Alaska Department of Environmental Conservation). 2018d. Prince William Sound Subarea Plan. Anchorage, AK. <http://dec.alaska.gov/spar/ppr/contingency-plans/response-plans/> (Accessed February 5, 2019).
- ADEC (Alaska Department of Environmental Conservation). 2018e. Wastewater discharge authorization and APDES program. Division of Water. <http://dec.alaska.gov/water/wastewater.aspx> (Accessed May 30, 2018).
- AHRS (Alaska Heritage Resources Survey). 2017. Alaska heritage resources survey - general overview. Office of History and Archaeology. <http://www.dnr.state.ak.us/parks/oha/ahrs/ahrs.htm> (Accessed April 20, 2017).
- AOGCC (Alaska Oil and Gas Conservation Commission). 2006. 2004 annual report. Gas disposition. February 17, 2006 update. http://doa.alaska.gov/ogc/annual/2004/2004_Gas_Disposition_Final.pdf (Accessed May 30, 2018).
- AOGCC (Alaska Oil and Gas Conservation Commission). 2018. Oversight activities. Forms and processes. <http://doa.alaska.gov/ogc/forms/apply.html> (Accessed May 30, 2018).
- ARRT (Alaska Regional Response Team). 2014. Alaska regional response team charter. <http://alaskarrt.org/files/New%20Charter%20Signed%205%20June%202014.pdf> (Accessed May 30, 2018).
- ARRT (Alaska Regional Response Team). 2018. Alaska regional contingency plan, version 1. Final, August 2018. <https://dec.alaska.gov/spar/ppr/contingency-plans/response-plans/> (Accessed January 24, 2019).
- DOLWD (Alaska Department of Labor and Workforce Development). 2016. 18(b) occupational safety and health plan for the State of Alaska. http://labor.alaska.gov/lss/forms/AK_State_Plan.pdf (Accessed August 3, 2016).
- EPA (US Environmental Protection Agency). 2017a. Clean Air Act permitting authorities in Alaska. Last Modified May 15, 2017. <https://www.epa.gov/caa-permitting/clean-air-act-permitting-authorities-alaska> (Accessed May 30, 2018).
- EPA (US Environmental Protection Agency). 2017b. Summary of the Resource Conservation and Recovery Act. Last Modified August 24, 2017. <http://www2.epa.gov/laws-regulations/summary-resource-conservation-and-recovery-act> (Accessed May 30, 2018).

- EPA (US Environmental Protection Agency). 2018a. Demonstrating compliance with new source performance standards and state implementation plans. <https://www.epa.gov/compliance/demonstrating-compliance-new-source-performance-standards-and-state-implementation-plans> (Accessed May 30, 2018).
- EPA (US Environmental Protection Agency). 2018b. National emission standards for hazardous air pollutants. <https://www.epa.gov/stationary-sources-air-pollution/national-emission-standards-hazardous-air-pollutants-neshap-9> (Accessed May 30, 2018).
- EPA (US Environmental Protection Agency). 2018c. New source review permitting. <https://www.epa.gov/nsr> (Accessed May 30, 2018).
- EPA (US Environmental Protection Agency). 2018d. Prevention of significant deterioration basic information. <http://www2.epa.gov/nsr/prevention-significant-deterioration-basic-information> (Accessed May 30, 2018).
- NOAA Fisheries (National Oceanic and Atmospheric Administration, National Marine Fisheries Service). 2018a. Essential fish habitat. Alaska Regional Office. <https://alaskafisheries.noaa.gov/habitat/efh> (Accessed May 30, 2018).
- NOAA Fisheries (National Oceanic and Atmospheric Administration, National Marine Fisheries Service). 2018b. Permits or authorizations for marine mammal takes. Alaska Regional Office. <https://alaskafisheries.noaa.gov/pr/permits> (Accessed May 30, 2018).
- NOAA Fisheries (National Oceanic and Atmospheric Administration, National Marine Fisheries Service). 2018c. Protected resources. Alaska Regional Office. <https://alaskafisheries.noaa.gov/pr> (Accessed May 30, 2018).
- OHA (Office of History and Archaeology). 2018a. Office of History and Archaeology. Alaska Department of Natural Resources. <http://dnr.alaska.gov/parks/oha/> (Accessed April 26, 2018).
- OHA (Division of Parks and Outdoor Recreation Office of History and Archaeology, Interpretation and Education). 2018b. Saving our past: Planning for our future. Alaska's state historic preservation plan 2018-2023. Alaska Department of Natural Resources. <http://dnr.alaska.gov/parks/oha/ASHPP%20Document.pdf> (Accessed February 15, 2019).
- OSHA (Occupational Safety and Health Administration). 2018. OSH Act of 1970. https://www.osha.gov/pls/oshaweb/owasrch.search_form?p_doc_type=oshact (Accessed May 30, 2018).
- PHMSA (Pipeline and Hazardous Materials Safety Administration). 2018. Office of Pipeline Safety. Last Modified March 15, 2018. <https://www.phmsa.dot.gov/about-phmsa/offices/office-pipeline-safety> (Accessed May 30, 2018).
- Transportation and Infrastructure Committee. 2016. Protecting Our Infrastructure of Pipelines and Enhancing Safety (PIPES) Act Of 2016. US House of Representatives. https://transportation.house.gov/uploadedfiles/pipes_2016.pdf (Accessed May 30, 2018).
- USACE (US Army Corps of Engineers). 2018a. Alaska District regulatory program - program overview 2017. http://www.poa.usace.army.mil/Portals/34/docs/regulatory/2017/Alaska_District_Regulatory_Program_Overview.pdf (Accessed May 30, 2018).
- USACE (US Army Corps of Engineers). 2018b. Permits - overview. Alaska District. <http://www.poa.usace.army.mil/Missions/Regulatory/Permits/> (Accessed May 30, 2018).

USFWS (US Fish and Wildlife Service). 2013. Permits for native species under the Endangered Species Act. Last Modified March 2013. <http://www.fws.gov/endangered/esa-library/pdf/permits.pdf> (Accessed May 30, 2018).

USFWS (US Fish and Wildlife Service). 2015. Management in action. Alaska Region. Last Modified December 2015. <http://alaska.fws.gov/mission.htm> (Accessed May 30, 2018).

Chapter Eight: Reasonably Foreseeable Effects of Licensing and Subsequent Activity

Contents

	Page
A. Introduction.....	8-1
B. Reasonably Foreseeable Cumulative Effects on Air.....	8-2
1. Potential Cumulative Effects on Air Quality.....	8-2
2. Mitigation Measures and Other Regulatory Protections	8-3
C. Reasonably Foreseeable Cumulative Effect on Water Resources and Water Quality	8-3
1. Potential Cumulative Effects on Water Quality	8-4
a. Surface Water	8-4
i. Fresh Waters	8-4
ii. Marine and Estuarine Waters	8-4
b. Groundwater.....	8-5
2. Mitigation Measures and Other Regulatory Protections	8-6
D. Reasonably Foreseeable Cumulative Effects on Terrestrial and Freshwater Habitats and Fish and Wildlife Populations	8-7
1. Potential Cumulative Effects on Terrestrial Habitats and Wildlife Populations	8-8
a. Seismic Surveys	8-8
b. Exploration, Development, and Production	8-9
c. Discharges, Leaks, and Spills.....	8-10
2. Potential Cumulative Effects on Freshwater Habitats and Fish Populations.....	8-11
a. Seismic Surveys	8-11
b. Exploration, Development, and Production	8-12
c. Discharges, Leaks, and Spills.....	8-13
3. Mitigation Measures and Other Regulatory Protections	8-13
E. Reasonably Foreseeable Cumulative Effects on Coastal and Marine Habitats and Fish and Wildlife Populations	8-14
1. Potential Cumulative Effects on Coastal and Marine Habitats	8-15
a. Seismic Surveys	8-15
b. Development and Production.....	8-15
c. Discharges, Leaks, and Spills.....	8-16
2. Potential Cumulative Effects on Marine and Anadromous Fish Populations	8-18
a. Seismic Surveys	8-18
b. Development and Production.....	8-19
c. Discharges, Leaks, and Spills.....	8-20
3. Potential Cumulative Effects on Coastal and Marine Wildlife Populations.....	8-20
a. Seismic Surveys	8-21
b. Development and Production.....	8-22
c. Discharges, Leaks, and Spills.....	8-23
4. Mitigation Measures and Other Regulatory Protections	8-24
F. Reasonably Foreseeable Cumulative Effects on Fish and Wildlife Uses.....	8-25
1. Potential Cumulative Effects on Subsistence	8-25

Chapter Eight: Reasonably Foreseeable Effects of Licensing and Subsequent Activity

2. Potential Cumulative Effects on Hunting and Sport, Commercial, Personal Use, and Educational Fishing	8-26
3. Mitigation Measures and Other Regulatory Protections	8-27
G. Reasonably Foreseeable Cumulative Effects on Historic and Cultural Resources.....	8-28
1. Potential Cumulative Effects on Historic and Cultural Resources	8-28
2. Mitigation Measures and Other Regulatory Protections	8-29
H. Reasonably Foreseeable Fiscal Effects of the Disposal and Subsequent Activity on the State and Affected Municipalities and Communities	8-29
1. Fiscal Effects on the State	8-29
a. Royalties.....	8-30
b. Rents	8-30
c. State Corporate Income Tax.....	8-31
d. Oil and Gas Property Tax.....	8-31
e. Production Tax	8-31
f. Alaska Permanent Fund.....	8-32
g. Public School Trust Fund.....	8-32
2. Fiscal Effects on Municipalities and Communities	8-32
a. Property Tax.....	8-32
b. Community Assistance Program.....	8-33
c. Employment	8-33
I. Other Reasonably Foreseeable Effects on Municipalities and Communities Near the License Area.....	8-33
1. Access.....	8-33
2. Recreation and Tourism	8-34
3. Mitigation Measures and Other Regulatory Protections	8-34
J. References.....	8-35

Chapter Eight: Reasonably Foreseeable Effects of Licensing and Subsequent Activity

In accordance with AS 38.05.035(g), the reasonably foreseeable effects of post-disposal oil and gas activities and brief summaries of measures to mitigate those impacts are presented in this chapter. Alaska statutes specify that speculation about possible future effects is not required (AS 38.05.035(h)). The Division of Oil and Gas (DO&G) has cooperatively developed general mitigation measures that the licensee must follow to minimize pollution and habitat degradation, and disturbances to fish and wildlife, subsistence users, commercial and sport fisheries, and communities within or adjacent to the License Area. Further, post-disposal authorizations may be subject to additional project-specific and site-specific mitigation measures that the director deems necessary to protect the state's interest. Despite these protective measures, however, effects may occur. See Chapter Nine for a complete listing of the mitigation measures for the License Area.

A. Introduction

Under AS 38.05.035(g)(1)(B)(vi), the director is required to consider and discuss the reasonably foreseeable cumulative effects of post-disposal oil and gas activities on the License Area including: effects on fish and wildlife habitat and populations; subsistence and other uses; and historic and cultural resources. Under AS 38.05.035(g)(1)(B)(ix), the director is required to consider and discuss facts material to the reasonably foreseeable fiscal effects of the exploration license on the state and affected municipalities and communities. The director must also consider and discuss facts material to the reasonably foreseeable effects of exploration, development, production and transportation of oil and gas on municipalities and communities within or adjacent to the License Area under AS 38.05.035(g)(1)(B)(x).

An exploration license includes a specified work commitment expressed in dollars. This exploration license has a work commitment of \$1,000,000. The licensee's strategy and methods for expending this work commitment are variable and the director cannot predict whether the full commitment will be met in post-disposal activities. If a commercially viable deposit is found, development will require construction of one or more drill sites or production platforms. If commercial quantities of oil, gas, or both are located, construction of pipelines or offshore terminals may be likely, and additional production and transportation facilities may also be necessary.

Issuing the exploration license is not expected to have any effects other than to provide initial revenue to the state in the form of the \$1 per acre license fee. DO&G evaluates the reasonably foreseeable effects of oil and gas development by describing the license area and the communities in Chapter Three; the Fish, wildlife, and habitat in Chapter Four; and the uses of the resources in Chapter Five. This chapter is dedicated to analyzing the effects on those potential receptors based on the established oil and gas operations discussed in Chapter Six.

In addition to the mitigation measures in Chapter Nine, all post-disposal activities are subject to local, state, and federal statutes, regulations, and ordinances, some of which are listed as other regulatory requirements in this chapter and some of which are discussed in Chapter Seven. Additional project-specific and site-specific measures may be required by other regulatory agencies, in response to public comments received during review of the proposed activity in the form of a plan of operations, or as deemed necessary.

B. Reasonably Foreseeable Cumulative Effects on Air

Oil and gas exploration, development, and production include a wide range of activities and equipment that produce emissions and have the potential to affect air quality. The potential for cumulative effects on air quality arises primarily from engine emissions, generation of fugitive dust, methane emissions, and emissions of volatile organic compounds and nitrogen oxides. Combustion emissions are generated by construction equipment, vehicles and vessels, drilling rigs, and compressor engines. Fugitive dust and particulate matter can be generated by traffic as well as combustion. Methane and other volatile organic compounds can be released during flaring, venting, or loading operations and may also escape through leaks in piping and equipment (Alvarez and Paranhos 2012; NPC 2011).

Emissions from oil and gas activities typically include carbon monoxide; nitrogen oxides; sulfur dioxide; coarse and fine particulate matter; volatile organic compounds; ozone; and greenhouse gases including carbon dioxide, methane, and nitrous oxide (ADEC 2018a). In addition to these air pollutants, small quantities of hazardous pollutants including hydrogen sulfide, and compounds released during volatilization of oil and gas such as benzene, toluene, ethylbenzene, and xylenes may also be released (Alvarez and Paranhos 2012; NPC 2011). The U.S. Environmental Protection Agency (EPA) and the Alaska Department of Environmental Conservation (ADEC), Division of Air Quality require industries with emissions that may affect air quality to control and reduce their air emissions such that Alaska and national ambient air quality standards are maintained. The oil and gas industry has developed best management practices and implemented control technologies where appropriate to meet regulatory requirements (NPC 2011).

1. Potential Cumulative Effects on Air Quality

The main air pollutants of concern in Alaska are fine and coarse particulate matter, followed by carbon monoxide, lead, ozone, sulfur dioxide, and nitrogen oxides (ADEC 2017a). Emissions from combustion are the primary source of fine particulates. ADEC and EPA require an annual emissions inventory report for sources with potential emissions at or above 2,500 tons per year of sulfur oxide, nitrogen oxide, or carbon monoxide, and for annual emission of 250 tons for volatile organic compounds, ammonium, and for coarse and fine particulate matter (ADEC 2017b). Fuel-burning equipment, vehicles, and vessels; oil and gas storage, handling and transport; venting, flaring, and spills; and construction and traffic generated fugitive dust from oil and gas activities could cumulatively effect air quality within the License Area.

A 2005 ADEC survey of the 37 communities in the Valdez-Cordova Census Area showed carbon monoxide emissions of 7,404 tons, 690 tons of nitrogen oxide, 6,265 tons of large particulate matter, 1,973 tons of small particulate matter, and 26 tons of sulfur oxide. These do not include

point sources, commercial marine, or aviation sources. These levels are considered relatively low compared to other parts of the state that were evaluated in the study, however emissions from wood burning and fugitive dust in these rural communities lead the statewide inventory and the smaller ports and harbors like the communities that are present near the License Area contribute significantly to the overall statewide marine emission inventory (Delaney and Dulla 2007).

The air quality throughout the Gulf of Alaska coast is considered good (not exceeding national and Alaska ambient air quality standards). All major industrial air pollutant sources in the region are in compliance with the national and Alaska ambient air quality standards (ADEC 2016).

Local weather conditions influence the dispersal and distribution of air pollutants. Community-based monitoring focused on locations identified as experiencing air impacts from oil and gas operations identified benzene, formaldehyde, and hydrogen sulfide levels exceeding acute and health-based risk levels. In some instances, high concentrations of formaldehyde (up to 2,591 feet) and benzene (up to 885 feet) were found at distances greater than regulated setbacks from homes and other occupied structures (Macey et al. 2014).

2. Mitigation Measures and Other Regulatory Protections

Oil and gas facilities and activities are required to control and limit emissions. Combustion and fugitive emissions are minimized and mitigated by using best management practices and control technologies. Construction and traffic induced fugitive dust is minimized and mitigated by using best management practices such as construction area and road watering.

Emissions associated with oil and gas activities would increase with exploration and subsequent development. Maximum concentrations of air pollutants occur close to facilities and disperse with air movements. Any future oil and gas activities would be required to control emissions and maintain national and Alaska ambient air quality standards. Air quality standards are enforced by ADEC.

Industry compliance with federal and state air quality regulations, particularly the Clean Air Act (42 U.S.C. §§ 7401-7671), AS 46.03, AS 46.14, and 18 AAC 50 are expected to prevent potential cumulative negative effects on air quality. Additional information regarding air quality permits and regulations can be found in Chapter Seven.

C. Reasonably Foreseeable Cumulative Effect on Water Resources and Water Quality

It is reasonable to expect oil and gas exploration, development and production may require the construction and continued use of support facilities such as roads, offshore platforms, production pads, pipelines, tank farms, and distribution terminals. In addition to the clearing of trees and vegetation cover, facility construction may require site preparation, placement of gravel fill, and impoundment and diversion of surface water that may alter water quality and distribution through increased erosion, storm water runoff and altered hydrology.

Oil and gas activities that may affect water resources and water quality within the License Area include seismic exploration, overland transport, gravel mining, gravel road and pad construction,

and water withdrawals to support drilling, construction, and operation activities. Effects include physical disturbances that could alter drainage patterns resulting in upslope impoundments and downslope drying, increases in turbidity and sedimentation from erosion and fugitive dust from gravel road traffic, drawdowns and contamination of groundwater, and contamination of freshwater and marine waters from discharges from well drilling and production, gas blowouts, or oil spills.

1. Potential Cumulative Effects on Water Quality

Potential cumulative effects from oil and gas activities on water quality include contamination from discharges of drilling muds, cuttings, and produced water; increased turbidity from construction of roads, pads, and pipelines; and contamination from inadvertent release of fuel, oil, or gas. Potential cumulative effects on water quantity include water use from lakes, ponds or groundwater wells for construction and maintenance of roads and pads; for dust suppression; for mixing drilling muds; for potable, domestic, and fire suppression water supplies; and for industrial process and cooling water.

a. Surface Water

i. Fresh Waters

Turbidity is the measure of particulate matter suspended in water. Turbidity of surface waters increases when sediment-laden runoff from pipeline construction or repair or facility construction flows into surface waters. Erosion from ground disturbing activities can result in elevated turbidity and increased sedimentation of nearby streams and lakes. This could lead to decreased fish productivity and habitat loss. Other activities that may affect surface water quality include accidental spills of fuel, oil, lubricants, or other hazardous chemicals.

Discharges, spills, and leaks from oil and gas activities could affect freshwaters in the License Area, including surface waters and groundwater. Spill and leak prevention and response are addressed in Chapter Six. Discharges and freshwater use may result in cumulative effects to surface waters such as increased turbidity and sedimentation from activities associated with exploration, development, and production of oil and gas. Section C2 of this chapter discusses mitigation measures and other regulatory protections that are expected to avoid, minimize, and mitigate potential cumulative effects to fresh water quality and availability.

ii. Marine and Estuarine Waters

Potential oil and gas activities that could have cumulative effects on marine and estuarine water quality in the License Area include seismic surveys, discharges from well drilling and production platforms, pipelines, construction of support facilities, and ongoing vessel traffic. In addition, well blowouts and oil and gas spills and leaks could potentially occur during exploration, development, production, and transportation. Seismic surveys can disrupt benthic sediments and increase turbidity. Survey and crew vessel deck drainage and discharges can include contaminants that could potentially reduce water quality in the immediate area of the discharge. Typical oil and gas discharges regulated under permits issued by ADEC and EPA include: drill cuttings, drilling fluids, deck drainage, sanitary and domestic waste, desalination unit waste, blowout preventer fluid, boiler blowdown, fire control system test water, non-contact cooling water, ballast water, bilge water, excess cement, and chemically treated seawater discharges (EPA 2013).

Components of a Cook Inlet Regional Citizens Advisory Council monitoring and assessment program related to the cumulative effects of oil industry activities on water quality included monitoring to assess ecosystem health, produced water discharge, and background river source sampling (Saupe et al. 2012).

This Cook Inlet study found no evidence that water column hydrocarbons were associated with produced water discharges, other oil and gas activity, or recent product releases in the area near the observed drilling operations. Volatile organic compound (benzene, ethylbenzene, toluene, and xylene) concentrations above water quality standards were identified at three locations in adjacent marine waters (Saupe et al. 2012).

Studies from 2011 on the North Slope determined oil and gas activities have impacted an estimated 18,400 acres of water indirectly by oil and gas activities. These effects on water resources are likely to continue and additional impacts may occur. Water withdrawals are necessary for oil field operations. Permit regulations help mitigate potential effects by maintaining water quality and quantity in studied lakes as natural recharge processes have been sufficient to recharge the lakes each year (BLM 2012).

Typical oil and gas discharges regulated under permits issues by ADEC and EPA include: drill cuttings, drilling fluids, deck drainage, storm water, dewatering water, hydrostatic test water, domestic waste water, graywater, desalination unit waste, boiler blowdown, fire control system test water, non-contact cooling water, uncontaminated ballast water, bilge water, excess cement, and chemically treated seawater discharges. Discharging drilling fluids and cuttings to the ocean has the potential to affect two ecosystems: the water column, or pelagic region, and the sea floor, or benthic region. Two broad categories of drilling fluids are in use: water based, and non-water based. The non-aqueous fluids have oil-based and synthetic-based fluids as subsets (Neff et al. 2000)

Water-based drilling fluids, typically used in the early stages of a well, contain bentonite and clay, which are chemically inert and non-toxic. Water-based drilling fluids tend to mix with and disperse in the water column and the individual cuttings particles sink to the bottom (Neff et al. 2000). Heavy metals associated with drilling are barium, cadmium, zinc and lead; their effects are minimal because the metals are bound in minerals and consequently are not easily bioavailable (IE 2007). The discharge plume may contain clay-sized particles that flocculate as the mud dilutes. Some of the larger flocculates may settle near the well site, but most of the mud particles settle over a wide area and accumulate in low concentrations (IPIECA 2009).

b. Groundwater

Groundwater provides drinking water for about 50 percent of Alaska's population, and 90 percent of the Alaska's rural residents. Aquifers used for water sources are typically unconfined (i.e., not protected by a layer of clay or silt), and are at risk of contamination from spills of fuel and oil, and wastewater disposal from onsite septic systems (ADEC 2008). Petroleum products spilled on the ground may infiltrate through soils until they reach the water table, where the spill plume disperses and dilutes. Diesel and gasoline penetrate soils more readily than crude oil and once spills reach the water table they are very difficult to cleanup.

Groundwater contamination has been documented at over 2,800 sites statewide; the most common issues are related to petroleum hydrocarbons and wastewater. Sources and causes of petroleum

contamination include leaking pipes and storage tanks, fuel spills, and improper handling and disposal (ADEC 2008).

Typical industrial use of groundwater could lower the water table elevation within a conic area surrounding industrial wells that can affect water depths in nearby domestic wells. These effects are usually insignificant and temporary as hydraulically connected groundwater sources infiltrate and replace the pumped volume. Groundwater withdrawal from aquifers confined at their lower boundaries induces leakage from streams while decreasing groundwater upwelling that maintains stream flows (Callegary et al. 2013). Reduction of in-stream flow may be of greater consequence during winter months when stream flows are maintained primarily by groundwater (Zenone and Anderson 1978).

Disposal wells, natural gas storage wells, and hydraulic fracturing of oil and gas wells can potentially effect groundwater quality through the introduction of contaminants into groundwater or aquifers (EPA 2016b; Shwartz 2016). Disposal wells are classified by use and waste type: Class I wells may be used for disposal of hazardous, non-hazardous industrial, municipal wastewater, and radioactive waste disposal (EPA 2016a). Class II underground injection wells are used for disposal of produced water which is usually a brine, for enhanced recovery through water flood, or for storage of liquid hydrocarbons associated with oil and natural gas production (EPA 2017).

Wells used for production, storage, or injection must demonstrate that barriers prevent any flow from the well to the surrounding rocks or the surface. Barriers include casing, pipeline strings, cement, and mechanical packers. Cemented surface casing must be installed below the base of the deepest formation that could be used as a source of drinking water. Wells are monitored, and mechanical integrity tests are completed to ensure there is no loss of integrity. Wells that are proposed for hydraulic fracturing must be identified and the volume and chemical composition of the fluids used must be disclosed. Stringent construction requirements, pressure monitoring, and periodic integrity testing are required to ensure that underground sources of drinking water are protected (AOGCC 2015, 2016).

2. Mitigation Measures and Other Regulatory Protections

Oil and gas activities such as exploration, development, production, and transportation could result in adverse effects to the water resources of the License Area. Many adverse effects could be lessened by mitigation but would not be eliminated completely. Most of the effects to water resources and water quality would result from oil and gas development and production activities, with construction of roads, stream-crossing structures, pads, offshore platforms with discharges, runoff, and water use being the major contributors. Potential effects include changes in surface drainage due to construction of roads and pads, loss of wetlands and associated chemical and hydrologic functions, gravel mine development, and increased risk of spills and leaks.

DNR considers local demand and may require permit applicants to conduct aquifer yield studies. Generally, water table declines associated with the upper unconfined aquifer can be best mitigated by industrial users tapping confined (lower) layers or searching for alternate water sources. Permits may contain stipulations on water use and withdrawal quantity to meet standards related to protection of recreation activities, navigation, water rights, or any other substantial public interest. Water use permits may also be subject to conditions, including suspension and termination of

exploration activities, to protect fish and wildlife habitat, public health, or the water rights of other persons. Before a permit to appropriate water is issued,

New facilities are required to control and manage stormwater and snow melt runoff during construction and operation to avoid and minimize potential contamination. Groundwater protection is accomplished through regulation of contaminated sites, storage tanks, underground injection wells, spill response, and specific waste disposal activities under state and federal programs (ADEC 2008).

Water quality is not expected to be impacted by drilling muds, cuttings, produced waters, and other effluents associated with oil and gas exploration, development, and production because of permitting requirements for proper disposal. Permanent roads, large-scale fill of wetlands, and coastal and offshore facilities will require a Clean Water Act Section 404 permit and/or a Rivers and Harbors Act Section 10 permit. Effluents discharged by the oil and gas industry are regulated through ADEC's Alaska Pollution Discharge Elimination System (APDES) program (ADEC 2018b).

Measures in this best interest finding, along with regulations imposed by state, federal and local agencies are expected to avoid, minimize, and mitigate potential effects. Risk of oil spills, spill avoidance, and spill response planning are discussed in Chapter Six. A complete listing of mitigation measures can be found in Chapter Nine.

D. Reasonably Foreseeable Cumulative Effects on Terrestrial and Freshwater Habitats and Fish and Wildlife Populations

Potential oil and gas activities that could have cumulative effects on terrestrial and freshwater habitats and fish and wildlife within the License Area include seismic surveys, construction of onshore support facilities, drilling activities, discharges from well drilling, transportation, and gas blowouts or oil spills. Some potential effects of these activities include physical changes and disturbance that could alter the landscape, water bodies, and wetlands; habitat availability and suitability; and behavior and abundance of fish and wildlife.

Cumulative effects include loss of habitat and disturbance from water withdrawals; construction and operation of drill pads, roads, and personnel housing; and ongoing air, water, and sound emissions. Effects from transportation include habitat loss from pipeline and terminal construction, and potential fuel and oil leaks and spills. Existing and future oil and gas extraction carry the risk of spills, both small and large, within and outside the boundaries of the License Area.

Localized effects from small spills are generally limited to the direct damage to habitat and wildlife in the immediate vicinity representing a very small effect in relation to habitat and wildlife in the state. Effects from spills become dispersed and potentially more significant when they occur within or near water because oil is more difficult to contain and recover from water than from land. A spill that contaminates groundwater could also result in impacts to freshwater streams and possibly intertidal areas. Indirect cumulative effects of oil and gas production can include artificial increases in numbers of predators such as gulls, ravens, raptors, bears, or foxes from access to garbage, cover,

and perching habitats associated with camps and infrastructure, which can depress nesting success of ground-nesting birds in the surrounding area (Liebezeit et al. 2009; Wallace et al. 2016; Meixell and Flint 2017).

1. Potential Cumulative Effects on Terrestrial Habitats and Wildlife Populations

Oil and gas activities may have cumulative effects on terrestrial habitats and wildlife, primarily related to habitat loss from construction of roads, pads, and facilities and habitat alteration from indirect effects resulting from construction and use of these facilities. Attributing potential cumulative effects from normal oil and gas activities to population level changes is often problematic as it is not usually possible to distinguish oil and gas activity effects alone from other potential sources of population variation. Some of the other factors include weather events, precipitation, and snow depth; flood, fire, vegetation succession, pest, and disease induced changes in habitat quality; disease outbreaks; immigration and emigration; predation, hunting, and highway traffic mortality; and habitat loss or alteration from other concurrent or adjacent land uses (Wasser et al. 2011; Brockman et al. 2017).

a. Seismic Surveys

Past practices of clearing trees for seismic surveys created long linear corridors through forested habitats that can affect habitat quality and behavior of wildlife. Traditional seismic lines can leave a long-lasting footprint in boreal forests (MacFarlane 2003). Traditional seismic surveys cleared 20 to 30-foot-wide corridors; modern seismic surveys clear either limited 6-foot-wide corridors or require no vegetation clearing which minimizes potential effects. Developments in wireless technology have resulted in further changes. In 2013, 25 percent of new seismic receiver equipment sold was wireless, and that percentage is expected to increase because of the associated cost savings and reduced environmental impacts associated with the technology (Rassenfoss 2013).

The evolution of seismic technology in the field is in the intensity of data acquisition, the sensitivity of the instrumentation, and precision that the equipment can be located using global positioning satellite system. Advancements in the digital processing of the acquired data and the resultant resolution of the subsurface stratigraphy has led to better seismic interpretation resulting in higher success rates for exploration wells. It is anticipated these advancements will create greater efficiency in exploration with fewer effects on the environment (US Senate 2011).

The slow recovery rate of disturbed land from seismic lines may be due to factors such as damage to root systems and competition from grass species. The use of heavy equipment may result in erosion, and cratering may occur from improperly filled shot holes. Increased access for all-terrain vehicles, snow machines, and off-road trucks, and continued use of the lines by these vehicles may also contribute to extended recovery times (Schneider 2002). However, other studies have shown that low impact lines do not recover any faster, and the length of time for natural plant communities to be restored on low impact lines is unknown (MacFarlane 2003). Bog habitats that have been disturbed may take many years to return naturally to their pre-disturbance state (ADF&G 2006).

Besides potential habitat damage, clearing operations to prepare seismic lines and explosions that occur during seismic surveys may disturb wildlife. Wildlife can be particularly sensitive to

disturbance during nesting and calving periods, but disturbances during winter when food resources are limited can be more problematic. Onshore seismic surveys may be conducted during winter or summer. Bears would be denning during winter, explosions near den sites could disturb bears during hibernation such that they prematurely emerge from the den (Linnell et al. 2000).

A study conducted in boreal forests in Alberta, determined that traditional 20- to 30-foot-wide seismic line corridors may alter predator-prey interactions. The results indicated that radio-collared wolves were found significantly closer to linear corridors, and they traveled faster along linear seismic corridors than through forests (James and Stuart-Smith 2000). Black bears and brown bears are both attracted to edge habitats such as those created by traditional seismic line corridors. A 2014 study of black bears in northwest Canada found that they preferred to travel along seismic lines rather than going through deep forest. They used most types of seismic lines more frequently than undisturbed forest, but more seismic lines in the lowlands did not encourage more use of that habitat. Nor did the bears appear to prefer using lines that were greater than two yards wide to using the forest interior (Tigner et al. 2014; Stewart et al. 2013).

A study evaluating songbird response to 20-foot-wide seismic line corridors concluded that seismic lines did not affect abundance of songbirds one year after clearing in boreal forests of the Northwest Territories. The corridors also had little to no effect on the location and size of their territories, (Machtans 2006).

b. Exploration, Development, and Production

Cumulative effects of oil and gas activities on terrestrial habitats and wildlife are primarily related to habitat loss from construction of roads, pads, and facilities and habitat alteration from indirect effects resulting from construction and use of these facilities such as altered drainage patterns, fugitive dust, and changes in vegetation cover. Activities including vehicle traffic, aircraft traffic, sounds from equipment and machinery, and changes in vegetation types resulted in reduced use or avoidance of the area surrounding oil and gas facilities. Cumulative effects are primarily related to habitat impacts that include direct loss through cover by facilities and functional losses through habitat alteration and behavioral displacement away from facilities (Van Dyke et al. 2012; Sawyer et al. 2009).

Oil and gas development may also directly affect wildlife through collision mortality. Development and production generally require construction and continued use of support facilities including roads, production pads, airstrips, gathering and transport pipelines, processing facilities, and living quarters for field personnel. In addition to clearing trees for construction, facilities may also require placement of gravel fill, and impoundment and diversion of water (Child 2007; Northrup and Wittemyer 2013).

Disturbance from vehicles and human activity at facilities can affect waterfowl nesting success (Meixell and Flint 2017). Active bird nests could be lost when trees are cut, and vegetation is cleared. Bald or golden eagles could be affected by destruction of their nesting trees or cliffs, disturbance to their nest sites, or disturbance to bald eagle communal roost sites (ADF&G 2018a, g). Infrastructure, however, may also be used as nesting platforms by raptors, ravens, and other nest predators that can lead to reduced nesting success near infrastructure, especially for ground-nesting birds like trumpeter swans (Wallace et al. 2016; Thomas et al. 2014; Liebezeit et al. 2009).

Cumulative effects of noise generated during oil and gas activities on wildlife are likely to lead to localized short-term disturbance and displacement effects during exploration and development, and localized long-term displacement effects during production of sensitive animals during sensitive periods such as nesting, denning, and near parturition.

c. Discharges, Leaks, and Spills

Cumulative effects of discharges, leaks, and spills on terrestrial wildlife are largely related to loss of habitat owing to contamination though some individual animals may be injured or die from acute toxic exposure. Oil spills may result in habitat degradation, changes in prey or forage availability, and contamination of prey or forage resources. Changes in preferred prey or forage may lead to displacement into lower quality habitats with reduced prey or forage, which can reduce survival or reproductive fitness. Sub-lethal physiological and ecological effects of oil may persist after cleanup activities have concluded and may have consequences on the fitness of individuals and populations (Henkel et al. 2012; Burns et al. 2014).

From 2000 through 2005, a six-year study of national oil spill data and of data from four oil producing states, (Arkansas, Colorado, Kansas, and Oklahoma) showed that spills were composed of produced water, crude oil, and mixtures of production fluids. Crude oil made up 73 percent of total volumes spilled in that period and 5 percent of the incidents involved inactive, orphaned, or improperly abandoned wellheads, flowlines, and abandoned tanks. The most common sources of discharge were flowlines, gathering lines, and piping associated with disposal, followed by wellheads and storage tanks. Half of the total reported spill volume came from oil storage tanks and from water disposal system components (Howard et al. 2008).

Petroleum hydrocarbons are grouped into four fractions: saturates, aromatics, resins, and asphaltenes. The aromatic fractions contain the BTEX molecules: benzene, toluene, ethylbenzene, xylene(s). Included among the aromatics are the polyaromatic hydrocarbons (PAHs), which contain suspected and known carcinogens. Microorganisms degrade petroleum hydrocarbons on land as well as on water and are widely distributed in freshwater and soil habitats. A variety of these microorganisms degrade a range of aromatic compounds. The biodegradation of PAHs depends on the characteristics of the spilled oil. One concern is that, as they degrade, PAHs can produce an intermediate substance more toxic than the parent compound. Studies on PAH degradation in sediments have suggested that these more toxic compounds do not necessarily accumulate in nature because of the rapidity with which they are further transformed. More resistant to biodegradation are the tars, bitumens, and asphalt-type materials. Asphaltenes in particular are resistant to biodegradation, but they are also inert, insoluble, and not likely to be hazardous to the environment (Balba et al. 1998).

Many factors contribute to the effects of oil spills on terrestrial habitats including the size of the spill, type of oil spilled, time of year, type of vegetation, and terrain. Spilled oil spreads both horizontally and vertically depending on the volume spilled, type of ground cover (plant or snow), slope, presence of cracks or troughs in the ground, moisture content of the soil, temperature, thickness of the oil, discharge point, and ability of the ground to absorb the oil (Linkins et al. 1984). If oil penetrates the soil layers and remains in the plant root zone, longer-term effects, such as mortality or reduced regeneration could occur in following summers. Under the right conditions involving oxygen, temperature, moisture in the soil, and the composition of the spilled oil, bacteria

may assist in the breakdown of hydrocarbons in soils. Oil spreads less when it is thicker, cooler, or is exposed to chemical weathering. If the ground temperature is less than the pour point of the oil, it pools and is easier to contain. Because dry soils are more porous, the potential for spilled oil to seep downward into the soil is greater (Everett 1978).

The amount of time that contaminants remain in the soil depends on several factors, including: the type and quality of clay particles; type and concentration of solutes; organic content and composition; pH; and temperature. Hydrocarbon spills in boreal forests can have a range of potential effects, including killing plants directly, slowing growth of plants, inhibiting seed germination, and creating conditions in which plants cannot receive adequate nutrition. Although a single addition of petroleum hydrocarbons does not appear to limit microbial communities in the long term, species richness often decreases. Oil spills and leaks can create changes in the physical and chemical properties of soil that disturb supplies of water, nutrients, and oxygen (Robertson et al. 2007).

Spill response and cleanup activities could also affect wildlife although effects are not likely to be cumulative. In situ burning to remove spilled oil could injure some animals. Cleanup operations decrease the likelihood that wildlife will contact oil or oiled forage or prey, but these activities could temporarily disturb and displace some wildlife.

2. Potential Cumulative Effects on Freshwater Habitats and Fish Populations

Oil and gas exploration infrastructure including roads and seismic lines could affect freshwater habitats in the License Area. Oil and gas activities may affect freshwater habitats and fish through increased sediment transport, pressure impacts from the use of explosives, water withdrawal, blockage of stream flow and fish passage, removal of riparian vegetation, changes in water temperature, increased access and fisheries exploitation, and contaminant spills. Impacts can be direct through physical or chemical damage to fish or eggs, and indirect through habitat loss and degradation (Cott et al. 2015).

Most freshwaters in the License Area support anadromous and resident fishes and are important for spawning, rearing, overwintering, and migration habitat. Many waters within and adjacent to the License Area provide salmon and trout that support subsistence, commercial, and sport fisheries as discussed in Chapter Four and Chapter Five.

a. Seismic Surveys

The effects of seismic noise have been studied on wild and caged freshwater fish, with differing results. A 2009 study in the Mackenzie River delta found that fish did not change swimming direction or show a startle response to air gun blasts (Jorgenson and Gyselman 2009). One experiment showed that northern pike and chubb showed no difference between the ear tissues of fish exposed to an air gun blast and those from ear tissues of a control group not exposed to an air gun blast (Song et al. 2008). Conversely, another study showed that air gun blasts caused substantial damage to red snapper ears, which are similar to a salmon's ear structure (McCauley 1998).

The two studies differed in the sizes and numbers of air guns used, the pressures, sound exposures, and recovery times of the fish (24 hours in the Song study vs. 58 days in the McCauley study). In the McCauley study, the subjects were caged in shallow water, and bathymetry is one variable that can affect how sound behaves in the ocean. Seismic pulses in shallow water will be higher-frequency than those in deep water (Song et al. 2008).

On the Kenai Peninsula, portions of the dense network of traditional seismic survey corridors dating to the 1950s and 1960s have become established as more than 1,795 miles of roads and trails used by off-road vehicles especially during the fall moose hunting season. Bank alteration and exposed soil are the most common physical impacts from off-road vehicles at stream crossings with about half of the crossings on the Kenai Peninsula on trails originating with seismic lines (Wiedmer 2002).

Cumulative effects from seismic surveys are primarily indirect through habitat degradation at stream crossings, especially where seismic corridors are used by off-road vehicles long after the surveys have been completed. Bank and riparian vegetation damage increase input of fine sediment to streams that can smother salmon and trout eggs in redds and reduce primary and secondary productivity that contribute to overall reduced growth and survival of fish (Wiedmer 2002). Modern seismic survey techniques reduce the potential for this type of environmental impact in the License Area.

b. Exploration, Development, and Production

Potential cumulative effects on water availability for fish and wildlife include water use from lakes, ponds or groundwater wells for construction and maintenance of roads and pads and for dust suppression; for mixing drilling muds; for potable, domestic, and fire suppression water supplies; and for industrial process and cooling water. Cumulative effects from oil and gas activities on freshwater habitats may include increased turbidity from construction of roads, pads, and pipelines; increased stream temperatures from removal of riparian vegetation; blockage of fish passage; contamination from discharges of drilling muds, cuttings, and storm water runoff.

Development and production activities may require the construction and continued use of support facilities such as roads, production pads, pipelines, tank farms, and distribution terminals. Facility construction may require road construction, site preparation, placement of gravel fill, and impoundment and diversion of surface water. These activities may alter aquatic habitats through increased erosion, storm water runoff, and altered hydrology.

Erosion can increase turbidity and deposit fine sediments in aquatic habitats, that result in decreased primary productivity and reduced food for aquatic insects, freshwater mollusks, and fish. Secondary effects of road construction and use could include dust deposition, which may reduce photosynthesis and plant growth for adjacent riparian vegetation (Cott et al. 2015). This can lead to direct mortality, reduced physiological function, and depressed growth rates and reproduction in aquatic organisms (Henley et al. 2000).

Some activities associated with oil and gas exploration and development, such as gravel removal, heavy equipment operations, and siting of support facilities could increase stream sedimentation and erosion, impede fish passage, alter drainage patterns, and have other negative effects on freshwater habitats and fish (Cott et al. 2015; Schneider 2002).

Winter water withdrawals from lakes and rivers can reduce water quality by lowering dissolved oxygen levels, trap or entrain overwintering fish, and reduce connectivity to adjacent water bodies. Construction of new roads can also facilitate fishing access and the dispersal of invasive aquatic organisms. Surface water use is regulated to prevent damage to fish and their overwintering habitats (Cott et al. 2015; Trammell et al. 2015).

c. Discharges, Leaks, and Spills

Some discharges from well drilling and production are intentional, such as permitted discharges regulated by the APDES or NPDES, others are unintentional, such as gas blowouts, leakages, and spills. Discharges, spills, and leaks from oil and gas activities could affect freshwater habitats and fish populations. ADEC records on active contaminated sites attributable to oil and gas exploration, production, and transportation that could affect freshwater habitats indicate that most contamination is from leaking fuel and oil tanks and pipelines and that in some cases hydrocarbon contamination has reached the groundwater surface where it has leached from the spill site (ADEC 2019).

Gravity will cause oil spilled on land to migrate down through the soil and, as it descends, to also spread. If the spill substance is less dense than water then, once it reaches a water aquifer, it will form a lens on top and spread laterally. As it encounters flowing water, soluble components may dissolve and form a plume. If the spill substance is heavier than water, it will displace water and continue migrating until it encounters an impermeable stratum (Abriola 1989).

Spilled oil, fuel, and associated polycyclic aromatic hydrocarbons are toxic to fish and a spill that affects spawning habitats could kill eggs and impair recruitment. Sublethal effects and contamination from spills and leaks can reduce productivity and impact subsistence use of fisheries resources. Failure of sumps used to store drilling mud or camp greywater can also be harmful if wastes reach fish bearing waters (Cott et al. 2015).

The location and timing of a spill can affect fish and freshwater habitats differently. Spills into lakes and wetlands may have longer lasting effects than a spill into a large stream or river that is quickly diluted and dispersed. Spills occurring farther upstream in a watershed also place more freshwater habitat at risk than those that occur in lower reaches or along the coast where the contaminants are more readily diluted with the higher volumes of water. Oil spills along or near the coast would likely disperse and degrade faster due to stronger currents and wind.

3. Mitigation Measures and Other Regulatory Protections

Oil and gas activities could potentially have cumulative effects on terrestrial and freshwater habitats and fish and wildlife populations. Mitigation measures included in this best interest finding address avoidance of habitat loss; protection of wetland, riparian, and aquatic habitats; prohibitions and restrictions on surface entry into critical habitat areas, as well as restrictions on other important habitat areas; disturbance avoidance; and free passage and movement of fish and wildlife. Other measures and regulatory protections address seismic activities, siting of facilities, pipelines, drilling waste, oil spill prevention and control, and rehabilitation.

Mitigation measures in this written finding, along with regulations imposed by state, federal and local agencies, are expected to avoid, minimize, and mitigate potential effects to freshwater habitats

and fish populations. Oil and gas development and production are most likely to contribute to cumulative effects on freshwater habitats and fish through construction and use of permanent roads and the gravel mining necessary to build this infrastructure. Gravel roads and associated gravel mine sites have resulted in effects by impeding fish movements and altering physical and chemical conditions of fish habitat. Mitigation measures in this best interest finding, along with regulations imposed by state, federal, and local agencies are expected to avoid, minimize, and mitigate potential effects to freshwater habitats and fish populations. AS 16.05 requires protection of documented anadromous streams from disturbances associated with development. New facilities are required to be located away from lakes and rivers and stream crossing must be designed and maintained to allow fish passage. Any water intake structures in fish bearing waters will be designed, operated, and maintained to prevent fish entrapment, entrainment, or injury. All water withdrawal equipment must be equipped and must use fish screening devices approved by the ADF&G and withdrawal volumes are regulated to prevent damage to fish wintering habitats. Discharge of drilling muds and cuttings to freshwaters or wetlands is prohibited. Disposal of wastewater into water bodies is prohibited unless authorized by an APDES permit. Best management practices and mitigation including: perpendicular crossing of waterways by roads and pipelines, appropriately sized culverts and bridges, and siting permanent infrastructure at least ½ mile from fish-bearing waterways minimizes the potential for cumulative effects of oil and gas activities in the License Area.

A complete listing of mitigation measures can be found in Chapter Nine. Chapter Seven also provides information on requirements for solid waste and wastewater disposal in the License Area.

E. Reasonably Foreseeable Cumulative Effects on Coastal and Marine Habitats and Fish and Wildlife Populations

Post-disposal activities that could potentially have cumulative effects on coastal and marine habitats and fish and wildlife within the License Area include seismic surveys, discharges from well drilling and production, construction and operation of coastal support facilities and offshore platforms, and ongoing disturbance from vessel and aircraft traffic. Loud sounds generated by seismic surveys, construction activities such as pile driving, and vessels are a concern for fish and other marine life. Discharge of drilling fluids, cuttings, and wastewater; and transport of nuisance aquatic organisms from vessel bilge, hull, and cooling water systems from other geographic regions can also degrade coastal and marine habitats. Minimizing and mitigating harmful impacts from oil spills requires that spill response equipment and trained personnel are available and can be deployed rapidly (Limpinsel et al. 2017; NPC 2011).

Gas blowouts and oil spills could potentially occur during development and production. An oil spill affecting coastal migration staging and molting areas could expose millions of birds to harm, and reproductive success in coastal seabirds can be reduced for up to 10 years after a spill event. Effects on fish and wildlife from oil spills in the marine environment include the deaths of seabirds, waterfowl, marine mammals, fish, and marine invertebrates, with potential for widespread and population level effects depending on the size and location of the spill (Barros et al. 2014).

1. Potential Cumulative Effects on Coastal and Marine Habitats

Habitats on the ocean floor and along the shoreline may be disturbed by oil and gas activities. Some of these activities may include seismic surveys; construction of docks and loading facilities with associated dredging; placement and operation of jack-up drilling rigs, pipelines, and platforms; ship and barge anchoring; and sediments and drilling fluids from discharges. These activities have the potential to result in destruction of the organisms living there.

Coastal and marine habitats within the License Area are essential habitat for numerous wildlife species, valuable fish, and marine invertebrates. Among the most valuable are juvenile, marine immature, and maturing adult life stages for chum, pink, coho, sockeye, and Chinook salmon (NOAA Fisheries 2018; ADF&G 2018h). The License Area also includes a portion of the Copper River Delta Critical Habitat Area.

a. Seismic Surveys

Activities associated with seismic surveys can directly affect tide flats, benthic habitats, and invertebrates through disturbance when cables are placed directly on sediments and shot holes are dug in tidal flats. Immobile invertebrates and seaweeds at these locations could be damaged or destroyed, but generally effects would be temporary and localized. Invertebrates living in or on tidal flats and benthos may also be affected by the particle motion produced by seismic pulses (Carroll et al. 2017).

Disturbances to sediment such as trenches and shot holes would be quickly filled through tidal mixing and wave action on substrates. There is a possibility that some larval and adult invertebrates such as scallops, clams, and crabs could be destroyed, damaged, or show behavioral responses to the particle motion produced by seismic pulses, however, none of the reviewed studies have identified cumulative population level effects on catch rates or abundance (Carroll et al. 2017).

Seismic vibrations from hydrophone array and air bladder explosions may liquefy sediments and have the effect of dislodging clams from the substrate. Seismic activity could also compact beach sand and reduce available habitat for clams and other invertebrates (Kerkvliet et al. 2018; Kerkvliet and Booz 2016). Blasting criteria have been developed by ADF&G and are available upon request. The location of known fish bearing waters and information on blasting criteria can be obtained from ADF&G's Division of Habitat.

b. Development and Production

Activities associated with development and production include the construction and eventual decommissioning and removal of facilities such as platforms, storage and production facilities, and pipelines to onshore facilities. These activities can potentially alter offshore and coastal habitats. Vessel anchoring, platform construction, pipeline laying, dredging, and pipeline burial can temporarily or permanently change bottom habitat by altering substrates used by invertebrates and fish for feeding or shelter (Limpinsel et al. 2017).

Dredging, trenching, and pipe laying generate spoils that when disposed of in the marine environment may smother benthic organisms. Benthic organisms may avoid recolonizing disturbed areas where the substrate composition has changed or where facilities remain. Vessel wakes can

increase shoreline erosion, affect wetland habitat, and increase water turbidity. Propeller wash can damage aquatic vegetation and disturb sediments, which can increase turbidity and resuspend contaminants. The associated epifaunal communities, which may provide feeding or predator escape habitats, may also be removed (Limpinsel et al. 2017).

Pile-driving effects on marine invertebrates would be similar to seismic pulse effects and would be minor due to the low potential for cumulative population level effects. Platform legs may provide habitat for intertidal communities by providing a solid surface for settlement and attachment of larval algae, barnacles, and mussels (Carroll et al. 2017; Fukuyama et al. 2012).

c. Discharges, Leaks, and Spills

A large spill within the License Area could negatively affect marine habitats in Controller Bay, and while the high-energy environment would quickly disperse the spill, it also makes containment difficult. Spill risk, prevention, and response is discussed in Chapter Six. The state issues permits for the discharge of drilling muds, cuttings, produced water, and stormwater within state waters to ensure the activities meet Alaska's water quality standards. Discharges, leaks, and spills, as discussed above, could affect marine mammals and birds within and outside of the License Area. Discharges of drilling muds, cuttings, and produced water are non-toxic and regulated by ADEC and EPA. Potential discharges from oil and gas activities include: well drilling fluids, produced water, surface runoff and deck drainage, domestic waste water generated from offshore facilities, solid waste from wells (drilling muds and cuttings), and other trash and debris associated with oil and gas facilities (Limpinsel et al. 2017).

Oil is typically less dense than water, so it floats on the surface of the water when spilled and disperses across the surface. There is a risk of oil spills with offshore development. The location and fate of oil on a shoreline depend on whether it is a subsurface or surface spill, the spill trajectory, the porosity and physical nature of the shoreline, and the characteristics of the oil spilled (Wiens 2013). The effect of a spill also depends on the toxicity, viscosity and amount of oil, the sensitivity of contacted organisms, and the length of contact time (IPIECA 2008).

Weather and wave conditions, and the amount of suspended sediment in the water will determine the fate of the oil in the water. As soon as oil hits water, it begins to transform, or weather, as it is moved by wind, waves, and currents (Wiens 2013). A spill in the eastern Gulf of Alaska would likely be carried west by the Alaska Coastal Current, towards Hinchinbrook and Montague islands and Prince William Sound. The islands present about 100 miles of high-energy coastline exposed to the southeast. The National Oceanic and Atmospheric Administration's Alaska ShoreZone project has mapped the Alaskan coast and cataloged geomorphic and biological resources (Harper and Morris 2014).

ShoreZone's Oil Residency Index (ORI) ranks the sensitivity of beaches to oil spills on a scale of one to five. The ORI shows that spilled oil would last anywhere from days to months on most of the License Area's shoreline, which is ranked 1 to 2 on its scale, where the higher the rating numbers, the more vulnerable the area is to spilled oil. Likewise, the barrier islands of the Copper River delta rate 1 to 2 on the ORI scale. Sections of the Egg Islands, which are barrier islands west of the Copper River delta and east of Hinchinbrook Island, have a 5 rating, which is the most sensitive and where oil would persist for months to years. Other sections of these islands have a 1 rating. Oil

could move into Orca Inlet and to Hawkins Island, with its more sheltered beaches and higher sensitivities to the persistence of oil further up the inlet (Harper and Morris 2014).

Oil may also move through the Hinchinbrook Entrance into Prince William Sound. Coastal ocean currents enter Prince William Sound from the east and flow out through the west, causing an exchange of water every three to four weeks (Gilfillan et al. 2001). Much of the mainland on Orca Inlet across from Hawkins Island has a 5 rating. The islands within Prince William Sound have shorelines that range from least sensitive to most sensitive (Harper and Morris 2014).

Crude oils are classed from light crude to heavy oils, based on specific gravity and viscosity, and each one behaves differently in water. With low viscosity oils (thin oils) breaking waves tend to disperse and break down the contaminant quickly. The dispersed oil mixes in increasing volumes of sea water, which reduces its concentration. The increased surface area promotes biodegradation, dissolution, and sedimentation, and the speed at which the oil spreads depends on its viscosity. Heavier crudes or oils with high viscosity, persist longer in the environment than lighter crudes (Wiens 2013).

Immediately following the Exxon Valdez oil spill, the consensus in the scientific and spill response community was that the spilled oil would degrade rapidly and stabilize as an asphalt-like material. Over 20 years following the spill, the lightest components of the oil like benzene and toluene had degraded, but the other PAHs were still present at similar levels as they were immediately following the spill and still toxic to the environment. The remaining oil that was buried in the sediment on impacted beaches were not exposed to significant amounts of oxygen to degrade. However, recent studies show that the remaining oil is no longer bioavailable and the species of concern that were studied including sea otters, harlequin ducks, and mussels were no longer being affected by the lingering oil (Michel et al. 2016).

Discharge of drilling muds and rock cuttings may change the seafloor and suspend fine-grained particles in the water column (IOGP 2016). These changes can affect bottom-dwelling organisms by covering immobile forms or by displacing mobile forms. Fine-grained suspended particulates can reduce light penetration and reduce primary productivity by lowering the rate of photosynthesis (Limpinsel et al. 2017). In addition, these discharges may contain contaminants that can be toxic in high concentrations to aquatic organisms, although toxic ingredients in modern water-based drilling fluids have been removed and replaced with non-toxic additives (IOGP 2016).

The effects of water-based mud and cuttings that accumulate on the sea floor include smothering benthic organisms within about 80 feet of the discharge and affecting species diversity up to about 300 feet, though these effects were temporary. The accumulated cuttings can also diminish the diversity of fauna, which in turn can then be dominated by opportunistic species. Faunal diversity may be similar to the surrounding area further from the platform, but the species composition can change. These changes have been detected up to about 20,000 feet from a drilling platform (Grant and Briggs 2002)

Marine vessel and pipeline operations pose a risk of accidental spills which would affect water quality and, in turn, organisms and habitats. Diesel, the most commonly used vessel fuel, is acutely toxic to fish, invertebrates, and plants that come in direct contact with a spill. Crabs and bivalves

can be impacted by small diesel spills in shallow, nearshore areas. These organisms bioaccumulate the oil but will also remove the oil over a period of several weeks (Michel et al. 2013).

Mitigation measures identified in Chapter Nine clarifies that discharge of drilling muds and cuttings to lakes, streams, rivers, or wetlands is prohibited and that the preferred method for disposal of muds and cuttings is by underground injection.

2. Potential Cumulative Effects on Marine and Anadromous Fish Populations

Oil and gas activities including the construction of new infrastructure, seismic activities, and discharges into coastal and nearshore waters could have cumulative effects on fish populations. Potential negative effects could include: damage or disturbance from seismic or other loud sounds; uptake or entrainment at water intakes; blockage of coastal movements from support facilities such as marine terminals, docks and piers; and reduced water quality from point and non-point source pollution, increased turbidity, and increased sedimentation. Collectively, these effects could contribute to reduced egg, larval, juvenile, or adult survival of marine and anadromous fishes through behavioral changes, diminished condition, reduced spawning site fidelity, increased susceptibility to pollutants or disease, shifts in fish distribution, and direct mortality.

a. Seismic Surveys

Many species of fish are more sensitive to seismic noise and pressures than are marine mammals. Studies have shown a variety of effects caused by seismic pulses, among them fish moving out of the area and becoming more difficult to catch (Wardle et al. 2001).

A 1999 study found that fish density among herring and other pelagic and mesopelagic fish was clearly lower within the seismic shooting area and that fish abundance increased further from the shooting area. Fish density appeared highest about 20 nautical miles (17.4 miles) from the center of the shooting area. Fish migrations appeared to return to normal after the seismic work ended (Slotte et al. 2004). As noted above, another study showed that air gun blasts caused substantial damage to red snapper ears, which are similar to a salmon's ear structure (McCauley 1998).

Fish response to open water seismic in and around shallow waters showed evidence of habitat displacement through changes in catch per unit effort. Measured sound pressure levels from air gun pulses at nets were low, reflecting loss of low frequencies in shallow water although fish responses may have been related to changes in particle motion from air gun sounds. Changes in catch rates at one or more nets were significant for seven of eight fish species, and included both increased and decreased catch rates, potentially reflecting displacement of fish in response to air gun sounds (Streever et al. 2016).

Fish hear through the effects of particle motion in water. Generally, fishes with swim bladders that also allow for sound pressure detection, such as salmon and herring, have lower sound pressure thresholds (55 to 83 decibels [dB] reference level in water [re] 1 micro pascal [μ Pa]) and respond at higher frequencies (200 hertz [Hz] to 3 kilohertz [kHz]) than fishes such as sharks and rays that have thresholds between 78 and 150 dB re 1 μ Pa and detect frequencies below 100 Hz to 1 kHz. Where particle acceleration thresholds have been measured, fish showed threshold values between

30 and 70 dB re 1 micrometer per square second ($\mu\text{m}/\text{s}^2$). Prolonged or extreme exposure to high-intensity, low-frequency sound can lead to physical damage including temporal threshold shifts in hearing or barotrauma rupture, which in extreme cases may cause mortality (Carroll et al. 2017).

Most energy from seismic airguns range from 10 to 120 Hz with sound pressures as high as 255 dB or well above the levels known to cause injury to fish (Limpinsel et al. 2017; Halvorsen et al. 2012). Received sound pressure levels depend on the distance of the fish from the source. Loud sounds may cause fish to change behavior moving away from the source, display alarm response, change schooling pattern, change swimming speed and location in the water column, and interrupt feeding and reproduction (Limpinsel et al. 2017). A review of studies on the effects of low-frequency sound on fishes identified evidence for physical trauma and other negative effects, but conflicting evidence for changes in catch rates and abundance (Carroll et al. 2017).

Standard ramp up procedures for seismic surveys allow for mobile fish to escape the area before any detrimental physical effects occur (NOAA 2016). Blasting criteria have been developed by ADF&G and are available upon request. The location of known fish bearing waters and information on blasting criteria can be obtained from ADF&G's Division of Habitat.

b. Development and Production

Oil and gas activities that generate noise that could affect marine and anadromous fishes include drilling, construction (pile driving), production facility operations, seismic surveys, and vessel operations. Oil and gas pipeline installation can affect marine and anadromous fish primarily through habitat loss or alteration that affect shallow-water environments such as estuaries and wetlands. Pipeline burial can alter benthic habitats by changing substrates, creating barriers or escarpments that prevent invertebrates from migration and movement; and cause vegetation loss, soil erosion, submergence, or drainage of saltmarshes that decrease feeding and shelter habitat for commercially important invertebrates and fish. Buried pipeline installation can also resuspend and release contaminants from sediments (Limpinsel et al. 2017).

Pile-driving sound pressure levels have been shown to cause serious injury to fish that remain in close proximity to the source (Popper and Hastings 2009; Halvorsen et al. 2012). Pile driving, dredging, and vessel sounds may block or delay the migration of anadromous fishes, interrupt or impair communication, or impact foraging behavior (Limpinsel et al. 2017). Fish may habituate to consistent stationary noises associated with drilling and facility operations which would reduce potential effects from displacement (NOAA 2016). Cumulative population level effects of industrial sounds on fish abundance and catch rates are equivocal (Carroll et al. 2017). While pile-driving has been shown to affect the distribution and behavior of juvenile pink and chum salmon, the question of whether these responses affect the fitness of juvenile salmon could not be answered (Feist et al. 1996).

Docks, piers, and marine oil and gas terminals can block sunlight penetration, alter wave and current energy, introduce chemicals, and restrict access and navigation. The size and composition of docks and piers, and orientation in relation to the sun's angle, can influence the shade footprint from an overwater structure and the extent of the localized shading effect. Shading caused by overwater structures may affect primary production and the distribution of fish and zooplankton.

While the impacts of individual overwater structures would be localized and minor, where multiple structures are aggregated within the same area effects would be cumulative (Limpinsel et al. 2017).

c. Discharges, Leaks, and Spills

Accidental discharges and spills from oil and gas activities may contaminate aquatic habitats within the License Area. Spilled petroleum products may result from activities such as drilling and transportation of personnel and materials. Petroleum products may persist in aquatic environments for years after a spill or leak. Petroleum products in the water column can affect the ability of fish to take up oxygen or through ingestion. Oil contaminations can also severely impact egg, larvae, and juvenile survival because they may not have the ability to escape from the contaminated waterbody (Trammell et al. 2015). Discharge of drilling muds, cuttings, and produced water may affect feeding, nursery, and shelter habitat for fish and invertebrates (Limpinsel et al. 2017).

Spills in open water are quickly dispersed to non-toxic levels, although fish kills can result from small spills in confined, shallow waters. Vessel operations pose a risk of accidental spills that can affect water quality, coastal and marine habitats, and marine and anadromous fish populations. Diesel, the most commonly used fuel, is acutely toxic on contact to fish, invertebrates, and plants (Michel et al. 2013). While most adult fish in coastal and marine habitats can usually avoid fuel and oil spills; egg, larvae, and juvenile fish survival may be affected because their limited mobility may not allow them to escape the spill area (Trammell et al. 2015).

Oil spills along or near the coast would likely disperse and degrade faster due to stronger currents and wind. However, if oil from a spill along the coast remains in the water when the water begins to freeze, it could migrate upstream into rivers during the winter due to saltwater intrusion (EPPR 1998). A large spill within the License Area could negatively affect coastal and marine habitats used by marine and anadromous fishes. Oil deposited in river deltas and estuary mouths could have the greatest potential for direct and indirect effects, primarily to pink salmon that spawn in these habitats. A key finding from the decades of work funded by the Exxon Valdez Oil Spill Trustee Council (EVOSTC) is that there are multiple mechanisms for effects on marine life, including direct toxic effects and subtle indirect effects (Michel et al. 2016).

Acute effects on growth and survival of pink salmon fry were detected 1989, but by 1990, fry grew comparably in oiled and unoiled reference portions of Prince William Sound, suggesting there were no residual effects from lingering oil. Continued sampling, however, found that lingering oil adjacent to streams increased the mortality rate for pink salmon embryos (Michel et al. 2016).

3. Potential Cumulative Effects on Coastal and Marine Wildlife Populations

Most oil and gas development projects would result in some cumulative effects to marine wildlife populations. Oil and gas activities which introduce infrastructure could have a greater cumulative effect on fish and fish habitat. Most potentially negative effects would be limited to the localized area of development.

A primary concern about oil and gas development in marine waters is the potential effects that noise from construction activities, drilling, seismic surveys, vessel, and aircraft activities could have on marine mammals and other coastal and marine animals (Hofman 2003). Current mitigation

efforts are directed at reducing the risk of injury that can result in permanent threshold shifts and temporary threshold shifts in marine mammal hearing from exposure to high sound pressure levels (Simmonds et al. 2014; NMFS 2016; Fisheries 2017). Long-term chronic impacts including masking of marine mammal sounds critical for feeding and reproduction and cumulative effects from multiple stressors that are more difficult to determine and have received less management attention (Simmonds et al. 2014; NAS 2017). Below is a discussion of reasonably foreseeable potential cumulative effects from oil and gas activities on coastal and marine wildlife populations in the License Area.

a. Seismic Surveys

The way sound travels through water depends on the depth of the sound source, the bathymetry, and the sea-bed properties. The perceived loudness of a sound depends on the hearing ability and sensitivity of the animal, the level of background noise, and the physical environment through which the noise travels before reaching the animal. Marine seismic shots produce noise in the ocean, sometimes over extensive areas and for extended periods of time. Large ships can tow an array of 12 to 48 air guns that release a specified volume of air under high pressure, creating a sound-pressure wave form. The multiple air guns fire with precise timing about every 10 seconds to produce a coherent pulse of sound (Hildebrand 2004). Nevertheless, the slow rise times of the pressure pulses from seismic air guns are less likely to cause damage than would pressure waves from high explosives (Gordon et al. 2004).

Whales that travel through the Gulf of Alaska communicate at frequencies that overlap with seismic frequencies (Compton et al. 2007). Because of this, researchers have investigated whether seismic surveys interfere with or mask a whale's ability to monitor their acoustic environment and possible negative effects that could follow such as reduced foraging efficiency, reproductive potential, social cohesion, and ability to detect predators. However, the marine mammal behavior response to noise is complex and remains poorly understood. There are examples of animals moving away from mid-frequency noise and reducing or ceasing vocalizations (Hildebrand 2004).

Air gun blasts may affect whale behavior, but different studies of different whale species at different times and places have yielded a variety of observations. A study of bowhead whales found that the use of air guns resulted in shorter surfacing times, fewer exhalations (blows) per surfacing, longer blow intervals, and subtle to overt changes in surface behaviors. The whales appeared to tolerate continuous and full-scale seismic sounds at distances greater than six miles. Responses varied within that range depending on the distance from the source. At about 5 miles, whales began to show avoidance behavior with air guns firing at 158 db. At about 2 miles, all whales in the pod showed signs of avoidance (Ljungblad et al. 1988).

A 2009 study of how air guns affect foraging behavior of sperm whales found no signs of avoidance reactions but did find possible effects on foraging behavior. The number of air guns being fired were gradually increased and fired within 4 to 8 miles of the whales and were fully operating from a half mile to 8 miles. Maximum received noise levels were 152 db. The most closely approached whale rested longer than was typical, but it resumed foraging immediately after the air guns ceased firing. This led the researchers to surmise it may have been waiting for the air guns to stop firing before foraging. Researchers also noticed a difference in how the foraging

whales positioned themselves in the water, which may have been because of a behavioral change in the prey (Miller et al. 2009).

In one experiment, air guns were fired from moored vessels as Eastern gray whales migrated past them. The whales were observed avoiding the sound of the air guns and having greater reactions as sound levels increased (Gordon et al. 2004). Western gray whales have been studied in relation to offshore oil development. A 2001 study took place at their feeding grounds and investigated relative abundance, behavior, and movement patterns of gray whales in relation to the occurrence and proximity of a seismic survey. Researchers found no correlation in this study between seismic survey variables and whale movements, changes in whale swimming speed, mean direction of whale movement, mean number of whale exhalations per minute at the surface, mean time at the surface, and mean number of exhalations per minute during a surface-to-dive cycle. But at higher sound exposure levels, the animals traveled faster, changed directions of movement less, were recorded further from shore, and stayed under water longer between respirations. In general, however, whales remained in the area and continued to feed during the seismic survey (Gailey et al. 2007).

In 2004, the International Whaling Commission Scientific Committee reported that avoiding seismic sounds during migration is not considered critical to the overall length of migration and is a matter of tens of miles in relation to a migration of several thousand miles (IWC 2004).

Coastal birds may be displaced by noise and disturbance from seismic surveys. The disturbances may impact migration staging, molting, and foraging habitats. Molting waterfowl are particularly vulnerable to disturbance as they cannot fly, and during migration waterfowl and shorebirds have limited amounts of time to gain resources at staging areas to fuel migration (Lacroix et al. 2003; Gill and Tibbitts 1999; Powell et al. 2010; Taylor et al. 2010; Colwell 2010). Disturbance and displacement during these periods can reduce survival and productivity. Seismic surveys, while introducing intense sound, are a transient disturbance lasting usually only hours to days at specific locations. A study of nearshore seismic surveys evaluated potential effects on molting long-tailed ducks and concluded that seismic surveys did not alter distribution or diving behavior (Lacroix et al. 2003). Reduced productivity of intertidal invertebrates, an important food for migratory waterfowl and shorebirds, from seismic surveys could reduce prey availability, leading to impacts on migratory waterfowl and shorebirds (ADF&G 1988, 1994).

b. Development and Production

Oil and gas development and production activities can affect coastal and marine wildlife through habitat loss, disturbance that results in displacement, collision mortality with vessels or infrastructure, and reduced survival and productivity from cumulative disturbances. Of these potential effects, the cumulative effects of stress from exposure to anthropogenic sounds has been identified as a primary concern for determining the welfare of marine mammal populations (NAS 2017). Potential effects from exposure to sound pressure levels generated during pile driving have similar effects as seismic exploration discussed above. While individual projects would be localized, they have the potential for cumulative effects in combination with other oil and gas and non-oil and gas-related projects. Construction noise is generally more intense than production noise since more vessels and equipment would generally be in use. Continuous sounds during drilling from the Spartan 151 jack-up rig, in Cook Inlet, did not exceed levels considered to harass marine

mammals; impulse sounds exceeding 120 dB re 1 μ Pa, considered to result in non-injurious harassment, were measured within 1.2 to 1.4 km from the rig (Marine Acoustics 2011).

Propulsion noise from shipping has increased ocean sound levels within the 25 to 50 Hz band by 8 to 10 dB between the mid-1960s to the mid-1990s and has remained constant or decreased slightly from the mid-1990s to the mid-2000s. The cumulative effects of stress from exposure to anthropogenic sounds has been identified as a primary concern for determining the welfare of marine mammal populations (NAS 2017). The use of vessels and aircraft for crew exchange, delivery of equipment and supplies, and shipping of products would add to the sound levels from all shipping and air traffic in the License Area. Long-term chronic impacts from anthropogenic noise, such as masking of marine mammal sounds critical for feeding and reproduction and cumulative effects from multiple stressors, are difficult to determine (Simmonds et al. 2014; NAS 2017).

Seabirds and waterfowl can collide with vessels, coastal buildings and towers, and offshore platforms, especially during poor weather conditions (Kuletz and Labunski 2017; Ronconi et al. 2015). Exploration, transportation and support vessel traffic, and production noise could potentially disturb seabirds and waterfowl from important habitat areas, potentially displacing them into lower quality habitats leading to reduced survival or reproduction potential (Larned 2006). Awareness and avoidance of seasonal concentrations areas for waterfowl and seabirds would minimize potential impacts (Kuletz and Labunski 2017). Molting waterfowl are particularly vulnerable to disturbance because they cannot fly (Lacroix et al. 2003), and during migration staging waterfowl and shorebirds have limited amounts of time to gain resources at staging areas to fuel migration. Disturbance and displacement during these periods can reduce survival and productivity (Gill and Tibbitts 1999; Powell et al. 2010; Taylor et al. 2010).

c. Discharges, Leaks, and Spills

Discharges, leaks, and spills could affect marine mammals and birds in and outside of the License Area. A large spill within the License Area could negatively affect coastal and marine wildlife. Oil spills can affect marine mammals and birds through inhalation, ingestion, direct contact, and absorption. Coastal or marine spills that coincide with use of the spill area by large numbers of marine mammals or coastal birds could have significant population-level impacts, such as within the Bering, Campbell, or Edwardes river deltas in Controller Bay on salmon runs; in coastal molting areas during late-summer and fall; or on mudflats and coastal areas used by migrating waterfowl or shorebirds in spring and fall. Smaller discharges of drilling muds, cuttings, and produced water are non-toxic and regulated and are not likely to contribute to cumulative effects on marine mammals or other coastal wildlife.

In March 1989, the Exxon Valdez ran aground on Bligh Reef at the mouth of Valdez Arm in Prince William Sound and spilled over 11 million gallons of crude oil into the water. Approximately 40 percent of the spilled oil impacted beaches and shorelines in Prince William Sound. Following the spill many studies indicated that significant fish and wildlife populations were exposed to the spilled oil. The exact number of fish and wildlife killed as a result of the spill is not known (EVOSTC 2017).

Cormorant populations in Prince William Sound have recovered from lows caused by environmental regime shifts and by the Exxon-Valdez oil spill (EVOSTC 2017). Overall density for cormorants in oiled areas of Prince William Sound increased significantly between 1989 and 2007 (USFWS 2008).

Sea lions and other animals that haul out or spend time on shore are more likely to encounter and suffer from the effects of oil. Whales, dolphins and other cetaceans may be at risk from floating oil when surfacing to breathe or breach, but where there have been mortalities near oil spills, necropsies have shown the cause of death was not related to oil (ITOPF 2014).

After the Deepwater Horizon blowout and spill in the Gulf of Mexico there were no documented fish kills in offshore waters. This is likely due to adult fish being able to avoid the most heavily contaminated waters. Many fisheries were closed due to the potential for contaminated fish and chemical screening was implemented. PAHs were detected in samples of fish taken in May-August 2010, however, within one year of the spill PAH levels were below the public health limits established by the National Oceanic and Atmospheric Administration, the federal Food and Drug Administration, and the Gulf Coast states. The chemical monitoring found little evidence for seafood being significantly contaminated, and fishermen-led sampling of fish fillets demonstrated no elevated concentrations of PAH's, select metals, or components of the dispersants used (Beyer et al. 2016).

Direct contamination of shorebirds is also a concern, as is direct or indirect contamination and elimination of benthic food supplies. Oil deposited in mud flats, river deltas, and estuaries would have the greatest potential for direct and indirect effects on migrant shorebirds as these areas are used extensively for foraging during migration staging (Gill and Tibbitts 1999). Oil spills as well as low-level exposure to toxins could have deleterious effects on resident and overwintering populations of rock sandpipers (Warnock 2017; Stenhouse and Senner 2005). A key finding from the decades of work funded by the *Exxon Valdez* Oil Spill Trustee Council is that there are multiple mechanisms for effects on marine life, including direct toxic effects and subtle indirect effects (Michel et al. 2016).

4. Mitigation Measures and Other Regulatory Protections

Oil and gas activities could potentially have cumulative effects on coastal and marine habitats and fish and wildlife populations. Cumulative effects are most likely to include some direct habitat loss and degradation from facilities and disturbance from vessel and air traffic, construction, drilling, and production sounds.

AS 16.05 requires protection of documented anadromous streams from disturbances associated with development. Any water intake structures in fish bearing water bodies will be designed, operated, and maintained to prevent fish entrapment, entrainment, or injury. All water withdrawal equipment must be equipped with and use fish screening devices approved by the ADF&G. Discharge of drilling mud, cuttings, produced water, and wastewater is prohibited unless authorized by an APDES permit. Marine invertebrates, fish, mammals, and birds are not expected to be impacted by discharge of non-toxic drilling muds, cuttings, produced waters, and other effluents associated with oil and gas exploration, development, and production.

Mitigation measures also address disturbance avoidance, particularly in critical habitat areas; seismic activities; siting of facilities; pipelines; oil spill prevention and control; and discharges and waste from drilling and production. Measures in this best interest finding, along with regulations imposed by state, federal and local agencies, are expected to avoid, minimize, and mitigate potential effects. Risk of oil spills, spill avoidance, and spill response planning are discussed in Chapter Six. A complete listing of mitigation measures and other regulatory protections is found in Chapter Nine.

F. Reasonably Foreseeable Cumulative Effects on Fish and Wildlife Uses

As described in Chapter Five, fish and wildlife resources in the License Area support subsistence, educational, commercial, and sport fishing and hunting, as well as non-consumptive recreation and tourism use. Consumptive and non-consumptive uses both depend on healthy habitats and wildlife populations, which can experience cumulative effects from oil and gas activities as described above. Additional potential effects on consumptive uses are discussed in the following sections.

Potential oil and gas activities that could have cumulative effects on fish and wildlife uses within the License Area include seismic surveys, construction of support facilities, discharges from well drilling and production, and ongoing disturbances from production activities such as vehicle, vessel, and aircraft traffic. In addition, oil spills could potentially occur during exploration, development, and production.

1. Potential Cumulative Effects on Subsistence

The communities near the License Area and in Prince William Sound use a wide variety of wild resources, including salmon and other fish, large terrestrial mammals, small terrestrial mammals, migratory waterfowl and upland game birds, marine mammals, marine invertebrates and wild plants and berries (ADF&G 2018c, f, d, b, e). The primary cumulative impact from construction of support facilities for onshore oil and gas development, besides impacts to habitats and distribution and abundance of fish and wildlife populations, is related to changes in access for subsistence uses. During oil and gas exploration, seismic surveys could displace game animals from hunting and trapping areas, limiting their availability for harvest. During oil and gas development and production, oil field roads may be unavailable for access for subsistence uses with potentially cumulative effects on hunting, fishing and gathering access (USFWS 2016). Alternatively, when access is allowed for subsistence, users' perceptions of possible contamination or unwillingness to hunt, fish, or gather near developments may result in long-term changes to subsistence-use areas.

A major oil spill could decrease resource availability and accessibility and create or increase concerns about food safety which could result in significant effects on subsistence users, which could linger for decades or longer (Jones and Kostick 2016). Subsistence harvests of fish and wildlife by residents of 15 predominately Alaska Native communities, as well as by residents in larger rural communities, declined by as much as 77 percent after the 1989 *Exxon Valdez* oil spill (EVOSTC 2014). Subsistence use in Tatitlek and Chenega Bay, two villages in Prince William Sound, decreased 56% following the *Exxon-Valdez* oil spill in 1989-1990. Most affected resources

were marine invertebrates, marine mammals and birds. Traditional patterns of sharing were consequently disrupted (Fall 1999).

The main reason that subsistence harvest declined so dramatically was fear that oil had contaminated the resources and made them unfit to eat. By 2006, most users considered seals, finfish and chitons safe for consumption, but expressed concerns over the safety of clams. Additional complex factors may confound effects of an oil spill, including demographic changes in communities, ocean warming, increased competition for fish and wildlife resources by other user groups, predators, and increased awareness about paralytic shellfish poisoning and other contaminants (EVOSTC 2014). Fears about food safety have diminished since the spill although some respondents expressed concerns about the safety of herring and clams, and harvest levels from villages in the spill area are comparable to other Alaskan communities (Jones and Kostick 2016; EVOSTC 2014; Michel et al. 2016). Spill and leak prevention and response are addressed in Chapter Six, and Chapter Nine includes mitigation measures that will prevent spills and minimize the impacts from any releases that may occur.

2. Potential Cumulative Effects on Hunting and Sport, Commercial, Personal Use, and Educational Fishing

Cumulative effects from construction of support facilities for onshore oil and gas development includes changes in public access and impacts to habitats and abundance and distribution of fish and wildlife populations. Seismic surveys could displace game animals from hunting and trapping areas, limiting their availability for harvest. During oil and gas development and production, the public use of oil field roads may be prohibited, excluding public access to public lands with potentially cumulative effects on hunting and fishing access. Increased public access to hunting, trapping and fishing areas through construction of new roads and trails could reduce costs for subsistence activities, increase harvest efficiency, and increase competition between user groups for fish and wildlife resources (USFWS 2016)

Oil and gas terminals and docks and associated vessel traffic associated with development and production, can interfere with setnet fisheries through reducing the area available for fishing and potentially displacing migrating salmon further offshore beyond the reach of the setnets. A 2004 study found that oil and gas infrastructure did not create a subsurface obstruction hazard for fishing gear because most infrastructure is too deep to be within the range of that gear. Platforms were considered a navigational safety issue, although reports of actual interactions with gillnet operations were rare. Temporary structures such as jack-up rigs were found to pose more of a hazard for fishers than permanent platforms because their locations were less predictable. Areas with infrastructure in shallower water were generally avoided by gillnet fishers to prevent grounding (Pettersen and Glazier 2004).

Fishing areas may be closed due to the presence of oil, and fisheries products may be considered tainted and unacceptable to the consumer. Oil pollution could result in harmful effects to fisheries through direct lethal or sub-lethal effects to fish stocks. In the case of large spills and blowouts, fishers could be forced to change fishing locations (Davis et al. 1984). A large oil spill to nearshore beach and intertidal fish habitats could persist for long periods of time; and fisheries could be closed due to actual or perceived contamination of fish or shellfish (BOEM 2016). Closures,

contaminated salmon losses, and gear fouling during peak salmon fishing could result in income loss for commercial fishers (Burden et al. 1990). Moreover, periods of commercial fishing restriction or closure can result in over-escapement of anadromous salmon, which in turn can produce smaller returns of fish in the future (Schmidt et al. 1995).

Noise and activities associated with seismic surveys and construction could result in localized temporary displacement of fishery resources and fishers. Seismic surveys conducted during the commercial drift gillnetting season could have incremental cumulative effects on the commercial fishing industry because survey vessels and equipment would interfere with fishing. Platforms or rigs located near riptide locations could impact the drift gillnet fishery by reducing the area of riptide available for fishing (BOEM 2016). Bottom trawl fisheries within the License Area could encounter problems with subsea pipelines that may create a gear entanglement hazard. Long-line and drift gillnet fisheries do not interact with subsea pipelines (Gómez and Green 2013).

The 1989 *Exxon Valdez* oil spill had direct impacts to commercial fish stocks, including over-escapement, and because emergency closures of fisheries for salmon, herring, crab, shrimp, rockfish and sablefish led to dramatic declines in income of commercial fishers (EVOSTC 2014; Schmidt et al. 1995). In the year following the spill, sport anglers likely avoided areas contacted by the oil with participation decreasing in numbers by 13 percent and harvest by 10 percent, following five years of steady increases before the spill (Mills 1992). Disruptions to the commercial fishing industry in the oil spill area continued many years after the spill in the form of changes in average earnings, ex-vessel prices, and values of fishing permits. Although pink salmon and sockeye salmon were considered recovered from the spill by 2002, Pacific herring, in decline before the spill, were still listed as “not recovering” in 2014 and therefore the fisheries that depend on herring were also considered in the process of recovery but not fully recovered. Direct cause-effect relationships between oil spills and changes in fisheries are difficult to demonstrate because of the many confounding factors that also affect fisheries such as the world supply of fishery products, regulatory and allocation changes, closures for management of sea lions, and increased competition among user groups (EVOSTC 2014).

3. Mitigation Measures and Other Regulatory Protections

Oil and gas activities could potentially have cumulative effects on subsistence uses; hunting; and sport, commercial, personal use, and educational fishing, primarily through cumulative effects on habitat, fish and wildlife populations, access, or competition among user groups. Measures in this finding, along with regulations imposed by state, federal and local agencies, are expected to avoid, minimize, and mitigate potential cumulative effects. In addition to mitigation measures addressing fish, wildlife, and habitat, other mitigation measures specifically address harvest interference avoidance, public access, road construction, and oil spill prevention.

Specific harvest interference mitigation requires:

- Restriction on unreasonable conflicts with subsistence or sport fish and wildlife harvest activities;
- Maintenance of traditional and customary access to subsistence areas;
- Requirements for consultation with nearby communities and Native organizations for assistance in identifying and contacting local subsistence users;

- Through consultation require the licensee to adjust exploration activities to avoid interference with subsistence harvests.

Measures in this best interest finding, along with regulations imposed by state, federal and local agencies, are expected to avoid, minimize, and mitigate potential cumulative effects on fish and wildlife uses. A complete listing of mitigation measures is found in Chapter Nine.

G. Reasonably Foreseeable Cumulative Effects on Historic and Cultural Resources

1. Potential Cumulative Effects on Historic and Cultural Resources

The Alaska Heritage Resources Survey database indicates that there are 126 reported cultural resource sites within the solicitation area for this license and 21 reported cultural resource sites within the License Area. The resource types include paleontological sites, prehistoric sites, Russian-era occupation sites, and early 20th century era sites (AHRs 2017). Historic buildings, cultural sites, and prehistoric archeological sites may be encountered during field-based activities, and these resources could be damaged or destroyed by ground disturbance during exploration, development, and production.

If development occurs, impacts and disturbances to the historic and cultural resources could be associated with installation and operation of oil and gas facilities, including drill pads, roads, airstrips, pipelines, processing facilities, and any other ground disturbing activities. Damage to archaeological sites may include: direct breakage of cultural objects; damage to vegetation and the thermal regime, leading to erosion and deterioration of organic sites; shifting or mixing of components in sites resulting in loss of association between objects and damage or destruction of archeological or historic sites by oil spill cleanup crews collecting artifacts (DOI 1987).

Spills can have an indirect effect on archaeological sites by contaminating organic material, which would eliminate the possibility of using carbon C-14 dating methods (DOI 1987). The effects of cleanup activity on these resources are minor because the work plan for cleanup is constantly reviewed, and cleanup techniques are changed as needed to protect archaeological and cultural resources (Bittner 1996).

For example, historic and cultural resources may be encountered during field-based activities, and these resources could be affected by accidents such as an oil spill. Following the *Exxon-Valdez* oil spill, 24 archaeological sites experienced adverse effects including oiling of the sites, disturbance by clean-up activities, and looting and vandalism. Monitoring of the sites over a seven-year period indicated that vandalism continued to be a minor problem, and that although some sites were initially badly damaged by oiling, residual oil does not appear to be contaminating known sites, and sites are now considered to be recovered (Reger et al. 2000; EVOSTC 2014).

2. Mitigation Measures and Other Regulatory Protections

Because historic and cultural resources are irreplaceable, caution is necessary to not disturb or impact them. AS 41.35.200 addresses unlawful acts concerning cultural and historical resources. It prohibits the appropriation, excavation, removal, injury or destruction of any state-owned cultural site. In addition, all field-based construction and spill response workers are required to adhere to historic properties protection policies that reinforce these statutory requirements and to immediately report any historic property that they see or encounter (AHRS 2017).

Because of the varying circumstances of occurrence surrounding the location and vulnerability of cultural resources, the significance of future impacts to these resources is difficult to assess in terms of the cumulative case. However, if the protections that are currently in place carry forward, then the cumulative impact would be expected to be minor within the License Area. As in the past, assessments to identify and protect cultural resources before initiation of surface disturbing activities is a major factor in reducing future cumulative adverse impacts to cultural resources. A complete listing of mitigation measures is found in Chapter Nine.

H. Reasonably Foreseeable Fiscal Effects of the Disposal and Subsequent Activity on the State and Affected Municipalities and Communities

This section considers and discusses the fiscal effects of licensing activities. Licensing and subsequent activity may generate income for state government, with additional benefits that include increased revenue sharing, creation of new jobs, and indirect income multiplier effects. Fiscal effects may be statewide and local.

1. Fiscal Effects on the State

Alaska's economy is heavily reliant on revenues from oil and gas production, with petroleum revenues accounting for 80 percent of unrestricted general fund revenues, which is the money available to pay for government operations, basic services and capital improvements, in fiscal year 2018. The Alaska Department of Revenue reported unrestricted general fund revenues from petroleum of \$1.94 billion in FY2018, forecasted to climb to \$2.21 billion in FY2019 (ADOR 2018)⁶.

Should an exploration license be awarded in the Gulf of Alaska, there will be positive initial revenue. To receive an exploration license, the licensee must provide the state with a licensing fee of \$1 per acre of exploration area (AS 38.05.132(c)(6)). Given that exploration acreage must range between 10,000 and 500,000 acres (AS 38.05.132(c)(2)), the licensing fee associated with the proposed exploration license will vary between \$10,000 and \$500,000. In the case of this exploration license, the license fee is \$65,773. This licensing fee would provide a one-time increase in State revenues. Beyond the licensing fee, the licensee is also required to provide the state with a

⁶ While still heavily dependent on revenues from oil and gas, this represents a material decline from the decade between 2004 and 2013 when between 87% and 93% of unrestricted general fund revenues were derived from petroleum (ADOR, 2018).

performance bond in an amount equal to the unfulfilled portion of the work commitment made during the award of the license. Should the work commitments be unfulfilled, the state may call against this bond and receive a cash consideration in an amount up to the penal sum of the bond. The license fee and any draw against the performance bond would represent one-time, incremental revenue to the state stemming from the license.

While a short-term revenue increase is expected if an exploration license is issued, the ultimate revenue impact associated with exploration in the Gulf of Alaska is presently indeterminate. The ultimate revenue impact of issuing an exploration license depends critically on whether commercial quantities of hydrocarbons are ultimately found and placed into production.

The License Area lies south of 68 degrees North latitude and outside of the Cook Inlet sedimentary basin, a region commonly referred to as “Middle Earth.” While most exploration tax credits have expired for the North Slope and Cook Inlet basins, many remain in effect for Middle Earth. For example, qualified capital exploration expenditures in Middle Earth may qualify for a 10 percent Qualified Capital Expenditure Credit for Exploration (AS 43.55.023(a)(2)). Certain expenditures for exploration wells in Middle Earth are eligible for a 20% Well Lease Expenditure Credit for Exploration (AS 43.55.023(l)(2)). Middle Earth explorers may also qualify for up to a 40 percent credit for certain exploration well expenses through the end of 2021 (AS 43.55.025). Should these credits be claimed for an exploration program that ultimately fails to identify commercial quantities of hydrocarbons, the net revenue impact of the proposed exploration license could be negative.

However, should exploration activity find commercial quantities of oil and gas, the net revenue impact may be positive, perhaps significantly so. By statute, if the licensee completes the work commitments required under the exploration license, the licensee may request that some portion of the exploration acreage granted under the license be converted to oil and gas leases (AS 38.05.134). Under the assumption that at least some part of the License Area is converted to oil and gas leases, and these leases are placed into production, the fiscal benefits to the state will include royalties, rents, state corporate income tax, oil and gas property tax, and production tax.

a. Royalties

By statute, should any of the exploration acreage be converted into oil and gas leases, these leases must reserve for the state a royalty interest of at least 12.5 percent (AS 38.05.134(3)). While currently lacking an empirical basis to determine the expected magnitude of the royalty payments from the exploration acreage, the royalty revenue would be positive and potentially significant. Royalties received from oil and gas leases are a material source of revenue for the state. In FY2018, oil and gas royalties provided \$977.8 million in unrestricted general fund revenue, representing over forty percent of total unrestricted general funds revenues in FY18. Beyond contributing to the general fund, at least twenty five percent of the cash flows generated by royalties must be deposited into the Alaska Permanent Fund (\$356.1 million in FY2018) and one-half of one percent of royalty revenue must be placed in the Public-School Trust (\$7 million in FY18) (ADOR 2018).

b. Rents

Should exploration acreage granted under the proposed license be converted into oil and gas leases, the state would also collect rental revenue from these leases. Oil and gas leases attributable to exploration licensing would yield yearly rents of \$3 per acre until sustained commercial production

was initiated (AS 38.05.134(4)). Due to the uncertainty surrounding the number of exploration acres that will ultimately be converted to oil and gas leases and the uncertainty around the time to production, it is not possible to provide a definitive estimate of revenues from rentals payments. However, with reasonable certainty the yearly revenue impact would be non-negative, but likely small.

c. State Corporate Income Tax

The state may also receive benefits from exploration licensing through increased corporate income tax receipts. The State of Alaska levies an income tax on Alaska apportioned income for all oil and gas C-corporations. The corporate income tax is a progressive tax levied on Alaska apportioned income with a highest marginal tax rate of 9.4 percent (ADOR 2019a). In fiscal year 2018, \$67.9 million in oil and gas corporate income tax revenues were received by the state (ADOR 2018). Should the proposed exploration activity result in hydrocarbon production, the organization(s) that place that resource into production may generate sufficient income to owe a state corporate income tax liability, thereby creating a positive revenue benefit to the state.

Beyond the potential direct revenue benefits provided by the corporate income tax received from the entities that develops the resource, there may be a positive revenue impact from the economic activity associated with exploration and development activities facilitated by an exploration license. When a dollar is spent, or a worker hired, the economic impact of that action is not siloed solely to the business receiving the dollar or the worker earning the wage. Rather, a cascading economic effect is set in motion in which the business spends the dollar to buy goods and services, the worker builds a home, and so on. The change in the total volume of goods and services produced as a consequence of the initial economic injection is commonly referred to as the economic multiplier. To the extent that exploration has a positive multiplier, and the additional economic activity is retained in Alaska, then some of the multiplier may be captured by state corporate income taxes.

d. Oil and Gas Property Tax

Oil and gas property taxes are levied each year on the full and true value of exploration, production, and pipeline transportation properties at a rate of 2 percent of the assessed value (AS 43.56). Municipalities may levy a tax on oil and gas property, and the tax paid to a municipality is credited against the property tax paid to the state. However, there is presently no local municipal- or borough-level property tax in the License Area, as such any property tax benefits from the exploration or development in the License Area will be captured by the state. In state fiscal year 2018, total state oil and gas property tax revenues were \$121.6 million (ADOR 2018).

e. Production Tax

If the License Area is converted to leases, oil and gas produced in the License Area is subject to the state production tax (AS 43.55). The production tax is based on the net value of production, but there are tax ceilings for oil and gas in License Area (AS 43.55.011(p)). The tax ceiling for the License Area is 4 percent of the gross value at the point of production.⁷ This four percent tax ceiling applies to production for the first seven years of a development and production must begin before 2027. Thus, should a commercial discovery be made in the License Area, and should that

⁷ Gross Value at the Point of Productions is the well-head value of taxable, produced oil and gas.

discovery be placed into production, the state would receive direct revenue benefits through the production tax.

f. Alaska Permanent Fund

At least one-quarter of rental, royalty, and bonus revenue received by the state is deposited into Alaska's sovereign wealth fund, the Alaska Permanent Fund. In fiscal year 2018, oil and gas revenues contributed \$356.1 million to the Alaska Permanent Fund (ADOR 2018). As of January 31, 2019, the Alaska Permanent Fund had a balance in excess of \$63 billion (APFC 2019).

g. Public School Trust Fund

The Public-School Trust Fund is an endowment trust fund created by the legislature to provide funding to the state public school system (AS 37.14.110). Each year, 0.5 percent of the receipts from the state's management of its public lands, including royalties and rent, must be deposited into the School Trust Fund (AS 37.14.150). The legislature may then appropriate up to five percent of the market value of the fund for the purpose of funding public education. The principal balance of the fund in FY 2018 was just under \$650 million dollars (ADOR 2019b).

2. Fiscal Effects on Municipalities and Communities

As discussed above, the economic benefit of exploration activity does not necessarily accrue only to the organizations involved in the exploration activity. Rather, the benefits will circulate throughout the economy and multiply the effect of the spending associated with the exploration license. The distribution of the local-level economic benefits associated with the exploration activity are difficult to forecast and depend on several factors including aggregate spending on exploration, the size and commerciality of any identified resource, how spending is distributed between goods and services, where those goods and services are sourced, the behavior of municipalities and communities in response to increased oil and gas activity in the localities, etc. As was the case when considering the fiscal effect of the proposed exploration activity on the state, the empirical basis for making quantitative forecast of local impacts is lacking. However, it is possible to discuss the avenues through which benefits may accrue should the exploration license lead to production.

a. Property Tax

Local municipalities and communities may directly benefit from oil and gas activity by levying a tax on the oil and gas property (AS 43.56.010(b)). The local fiscal impact of taxing oil and gas property is significant in many communities. For example, in fiscal year 2018, the North Slope Borough generated \$397.4 million in property tax revenues, accounting for 83.6 percent of borough general revenue (NSB 2018). As a state, in fiscal year 2018, oil and gas property taxes resulted in over half a billion dollars (\$562.6 million) in revenue with \$439.9 million of that shared with local communities (ADOR 2018).

The License Area is contained in the unorganized Valdez-Cordova Borough. As such, the License Area would not currently levy a petroleum property tax. However, under current law, a share of the

revenue benefit that would flow to the state could be captured by the locality should it choose to institute an oil and gas property tax.

b. Community Assistance Program

Local municipalities and communities may also indirectly benefit from the exploration license through the Community Assistance Program (CAP). The CAP takes revenues received by the state in the form of corporate income taxes and distributes non-locally generated, unrestricted revenue to communities and municipalities throughout the state (AS 29.60.855). In fiscal year 2016, \$57 million in assistance was distributed to 229 communities in Alaska, with nearly 90 percent of this revenue coming from oil and gas (McDowell Group 2017).

c. Employment

The oil and gas sector also plays a prominent role in the Alaska labor market. In 2017, a study prepared for the Alaska Oil and Gas Association estimated the employment and wage impact of 14 of the largest oil and gas organizations in Alaska.⁸ It found that 45,575 direct, indirect, and induced jobs were related to the spending of the 14 companies, with roughly \$3.1 billion in wages tied to their spending. Across the state, an estimated 103,875 (32 percent) Alaskan wage and salary jobs were related to the oil and gas industry, with oil and gas responsible for \$6 billion (35 percent) of the wages in the state (McDowell Group 2017).

The level, and geographical distribution, of the employment effect driven by the exploration license will depend on the size of any commercial resource that is identified. If the exploration program does not find material quantities of hydrocarbons, the labor market effect of the exploration license would likely be negligible. However, should the exploration program find commercial quantities of hydrocarbons and should these hydrocarbons be placed into production, the labor market effect of the exploration license could be significant and could impact communities throughout Alaska.

I. Other Reasonably Foreseeable Effects on Municipalities and Communities Near the License Area

1. Access

The State of Alaska is the predominant landowner in the License Area, although much of the area is offshore. Existing transportation systems are very limited but include unmaintained roads and winter trails. Movement and placement of offshore jack-up rigs and platforms and increased vessel traffic may cause navigation hazards and traffic congestion, especially during the fishing season. Temporary barge landing sites could also be developed because there is no road access to the License Area. Access to the License Area would be primarily by vessels and aircraft. Vessel and air traffic would incrementally increase with exploration and development of oil and gas projects and traffic increases would be cumulative with existing traffic levels. Temporary roads may be

⁸ The 14 organizations were: BP Exploration (Alaska) Inc., Chevron, Petro Star Inc., Shell Exploration & Production Company, Alyeska Pipeline Service Company, BlueCrest Energy Inc, Caelus Energy, LLC, ConocoPhillips Alaska, Inc, ExxonMobil Production Company, Furie Operating Alaska, Glacier Oil & Gas, Great Bear Petroleum, Hilcorp Energy Company, and Tesoro Alaska Company.

constructed for onshore exploration drilling, and roads, pads, and airstrips may be constructed for onshore projects or to support offshore projects. New roads may also facilitate access to remote locations, if they are open to the public. New or improved access could create community development, land use planning, or fish and wildlife management issues. Use of existing roads and trails for transportation of heavy equipment and supplies, especially during construction, could degrade the condition of existing roads or trails.

Cumulative increases in vessel, road, and air traffic would likely be greatest during construction when more equipment and personnel are generally required. Expected increases in permanent road infrastructure would also be cumulative, although impacts from increased traffic would be reduced during operation compared to construction activities.

2. Recreation and Tourism

Despite the remote nature and difficulty of access to the License Area, recreation and tourism are important to the culture of the Gulf of Alaska and Prince William Sound communities and are a major economic resource. Sightseeing, fishing, camping, hunting, boating, hiking, cross-country and backcountry skiing, snow machining, and all-terrain vehicle use are popular activities. Existing public recreation use of the area is limited because of its remoteness and inaccessibility and primarily consists of fly-in hunting and fishing (DNR 1988). Outdoor recreational activities are often closely tied to fish and wildlife habitats and populations. Habitat loss, alteration, and disturbance effects from oil and gas activities on fish and wildlife populations discussed in the preceding sections could result in cumulative effects on recreation and tourism. Potential effects on recreation and tourism are discussed below.

Where oil and gas activities coincide with or restrict access to fishing or hunting areas, and/or campgrounds or other recreation areas, a visitor's use or enjoyment of the area could be adversely affected. If visitors avoid or reduce travel and spending within the area, decreased use and associated revenues to businesses and the local economy could result. Reduced use of the area for recreation or by tourists due to conflicts with oil and gas activities could potentially be cumulative across the License Area and surrounding Gulf of Alaska Region.

3. Mitigation Measures and Other Regulatory Protections

Although oil and gas activities after leasing could potentially have effects on municipalities and communities in the Gulf of Alaska and Prince William Sound areas, measures in this best interest finding, along with regulations imposed by state, federal and local agencies, are expected to avoid, minimize, or mitigate potentially negative effects. Positive effects are expected on local governments and economies, employment, personal income, reasonable energy costs, and opportunities for industrial development.

Mitigation measures address critical habitat areas and state game refuges, protection of streams, siting of facilities, public access, navigable waters, and public water supplies. A complete listing of mitigation measures is found in Chapter Nine.

J. References

- Abriola, Linda M. 1989. Modeling multiphase migration of organic chemicals in groundwater systems - A review and assessment. *Environmental Health Perspectives* 83: 117-143.
- ADEC (Alaska Department of Environmental Conservation). 2008. Groundwater in Alaska. dec.alaska.gov/eh/pdf/dw/dwp-groundwater-fact-sheet-2008.pdf - 19k - 2017-07-14 (Accessed April 11, 2018).
- ADEC (Alaska Department of Environmental Conservation). 2016. State of Alaska 2015 ambient air quality network assessment, November 2016. Air monitoring and quality assurance program. <http://dec.alaska.gov/air/air-monitoring/network-assessments> (Accessed March 28, 2018).
- ADEC (Alaska Department of Environmental Conservation). 2017a. Annual air quality monitoring network plan. Division of Air Quality. <http://dec.alaska.gov/air/air-monitoring/monitoring-plans> (Accessed March 28, 2018).
- ADEC (Alaska Department of Environmental Conservation). 2017b. Instruction: Emission inventory development and submission. Division of Air Quality. <http://dec.alaska.gov/Applications/Air/airtoolsweb/PointSourceEmissionInventory> (Accessed March 28, 2018).
- ADEC (Alaska Department of Environmental Conservation). 2018a. Alaska greenhouse gas emissions inventory 1990 – 2015. Division of Air Quality. <https://dec.alaska.gov/media/7623/ghg-inventory-report-overview-013018.pdf> (Accessed March 27, 2018).
- ADEC (Alaska Department of Environmental Conservation). 2018b. Wastewater discharge authorization and APDES program. Division of Water. <http://dec.alaska.gov/water/wastewater.aspx> (Accessed May 30, 2018).
- ADEC (Alaska Department of Environmental Conservation). 2019. Contaminated sites database. Division of Spill Prevention and Response. <http://dec.alaska.gov/spar/csp.aspx> (Accessed February 5, 2019).
- ADF&G (Alaska Department of Fish and Game). 1988. Susitna Flats State Game Refuge management plan. Division of Habitat. http://www.adfg.alaska.gov/static/lands/protectedareas/_management_plans/susitna.pdf (Accessed September 29, 2017).
- ADF&G (Alaska Department of fish and Game). 1994. Trading Bay State Game Refuge and Redoubt Bay Critical Habitat Area management plan. Division of Habitat and Wildlife Conservation. http://www.adfg.alaska.gov/static-f/lands/protectedareas/_management_plans/tradingbay.pdf (Accessed September 29, 2017).
- ADF&G (Alaska Department of Fish and Game). 2006. Our wealth maintained: A strategy for conserving Alaska's diverse wildlife and fish resources, Juneau, Alaska. <http://library.state.ak.us/asp/edocs/2006/07/ocm70702164.pdf> (Accessed May 30, 2014).
- ADF&G (Alaska Department of Fish and Game). 2018a. Bald Eagle Species Profile. <http://www.adfg.alaska.gov/index.cfm?adfg=baldeagle.main> (Accessed 5/17/2018).
- ADF&G (Alaska Department of Fish and Game). 2018b. Community Subsistence Information System Harvest Information by Community, Chenega, AK.

- <http://www.adfg.alaska.gov/sb/CSIS/index.cfm?ADFG=harvInfo.harvest> (Accessed December 21, 2018).
- ADF&G (Alaska Department of Fish and Game). 2018c. Community Subsistence Information System Harvest Information by Community, Cordova, AK. <http://www.adfg.alaska.gov/sb/CSIS/index.cfm?ADFG=harvInfo.harvest> (Accessed December 21, 2018).
- ADF&G (Alaska Department of Fish and Game). 2018d. Community Subsistence Information System Harvest Information by Community, Tatitlek, AK. <http://www.adfg.alaska.gov/sb/CSIS/index.cfm?ADFG=harvInfo.harvest> (Accessed December 21, 2018).
- ADF&G (Alaska Department of Fish and Game). 2018e. Community Subsistence Information System Harvest Information by Community, Valdez, AK. <http://www.adfg.alaska.gov/sb/CSIS/index.cfm?ADFG=harvInfo.harvest> (Accessed December 21, 2018).
- ADF&G (Alaska Department of Fish and Game). 2018f. Community Subsistence Information System Harvest Information by Community, Yakutat, AK. <http://www.adfg.alaska.gov/sb/CSIS/index.cfm?ADFG=harvInfo.harvest> (Accessed December 21, 2018).
- ADF&G (Alaska Department of Fish and Game). 2018g. Golden Eagle Species Profile. <http://www.adfg.alaska.gov/index.cfm?adfg=goldeneagle.main> (Accessed 5/17/2018).
- ADF&G (Alaska Department of Fish and Game). 2018h. State of Alaska anadromous waters catalog. <https://www.adfg.alaska.gov/sf/SARR/AWC/index.cfm?ADFG=main.home> (Accessed May 14, 2018).
- ADOR (Alaska Department of Revenue). 2018. Revenue sources book fall 2018. Tax Division. <http://www.tax.alaska.gov/programs/documentviewer/viewer.aspx?1496r> (Accessed January 14, 2019).
- ADOR (Tax Division Alaska Department of Revenue). 2019a. Corporate Income Tax 2018 Annual Report. <http://tax.alaska.gov/programs/programs/reports/Annual.aspx?60380&Year=2018> (Accessed April 9, 2019).
- ADOR (Alaska Department of Revenue). 2019b. Public school trust funds. Treasury Division. <http://treasury.dor.alaska.gov/Investments/Public-School-Trust-Funds.aspx> (Accessed January 30, 2019).
- AHRS (Alaska Heritage Resources Survey). 2017. Data Repository of the Alaska Heritage Resources Survey. Alaska Department of Natural Resources, Division of Parks and Recreation, Office of History and Archaeology. <https://dnr.alaska.gov/ohasecurity/portal> (Accessed September 28, 2017).
- Alvarez, R. A. and E. Paranhos. 2012. Air pollution issues associated with natural gas and oil operations. EM Magazine 2012(June): 22-25. Air and Waste Management Association. www.edf.org/content/air-pollution-issues-associated-natural-gas. (Accessed March 29, 2018).
- AOGCC (Alaska Oil and Gas Conservation Commission). 2015. Hydraulic Fracturing in Alaska. White Paper. <http://doa.alaska.gov/ogc/reports/reports.html> (Accessed April 9, 2018).

- AOGCC (Alaska Oil and Gas Conservation Commission). 2016. Gas Storage Wells in Alaska. White Paper. <http://doa.alaska.gov/ogc/reports/reports.html> (Accessed April 9, 2018).
- APFC (Alaska Permanent Fund Corporation). 2019. Alaska Permanent Fund Corporation Monthly Performance Report for January 31, 2019. <https://apfc.org/report-archive/#68-fy-2019-1535401004> (Accessed April 9, 2019).
- Balba, M. T., N. Al-Awadhi, and R. Al-Daher. 1998. Bioremediation of oil-contaminated soil: microbial methods for feasibility assessment and field evaluation. *Journal of Microbiological Methods* 32: 155-164.
- Barros, A., D. Alvarez, and A. Velando. 2014. Long-term reproductive impairment in a seabird after the *Prestige* oil spill. *Biology Letters* 10: 20131041. <http://rsbl.royalsocietypublishing.org/>. (Accessed April 17, 2018).
- Beyer, Jonny, Hilde C. Trannum, Torgeir Bakke, Peter V. Hodson, and Tracy K. Collier. 2016. Environmental effects of the Deepwater Horizon oil spill: A review. *Marine Pollution Bulletin* 110(1): 28-51.
- Bittner, J. E. 1996. Cultural resources and the *Exxon Valdez* oil spill: An overview. Pages 814-818 [In] S. D. Rice, R. B Spies, D. A. Wolfe and B. A. Wright, editors. *Exxon Valdez Oil Spill Symposium American Fisheries Society Symposium* 18 February 2-5, 1993, Anchorage, Alaska.
- BLM (Bureau of Land Management). 2012. National Petroleum Reserve-Alaska final integrated activity plan/environmental impact statement. https://eplanning.blm.gov/epl-front-office/projects/nepa/5251/41003/43153/Vol1_NPR-A_Final_IAP_FEIS.pdf (Accessed December 11, 2017).
- BOEM (Bureau of Ocean Energy Management). 2016. Cook Inlet Planning Area Oil and Gas Lease Sale 244 In the Cook Inlet, Alaska. Final Environmental Impact Statement. Alaska OCS Region, OCS EIS/EA BOEM 2016-069. <https://www.boem.gov/Sale-244/> (Accessed March 29, 2018).
- Brockman, C. J., W. B. Collins, J. M. Welker, D. E. Spalinger, and B. W. Dale. 2017. Determining kill rates of ungulate calves by brown bears using neck-mounted cameras. *Wildlife Society Bulletin* 41(1): 88-97.
- Burden, P., J. Isaacs, J. Richardson, S. Braund, E. Witten, and L. Moorehead. 1990. Economic impacts of the S.S. Glacier Bay oil spill. 150 p. US Department of the Interior, Minerals Management Service, Alaska OCS Region, OCS Study MMS 90-0081. Anchorage, Alaska. https://www.boem.gov/BOEM-Newsroom/Library/Publications/1990/90_0081.aspx (Accessed May 8, 2018).
- Burns, C. M. B., J. A. Olin, S. Woltmann, P. C. Stouffer, and S. S. Taylor. 2014. Effects of oil on terrestrial vertebrates: Predicting impacts of the Macondo blowout. *BioScience* 64(9): 820-828.
- Callegary, J. B., C. P. Kikuchi, J. C. Koch, M. R. Lilly, and S. A. Leake. 2013. Review: Groundwater in Alaska (USA). *Hydrogeology Journal* (2013) 21(25-39).
- Carroll, A. G., R. Przeslawski, A. Duncanb, M. Gunning, and B. Bruce. 2017. A critical review of the potential impacts of marine seismic surveys on fish and invertebrates. *Marine Pollution Bulletin* 114(2017): 9-24.

- Child, K. N. 2007. Chapter 8. Incidental mortality. Pages 276-335. Ecology and management of the North American moose, second edition. University Press of Colorado, Boulder, Colorado.
- Colwell, M. A. 2010. Shorebird ecology, conservation, and management. University of California Press, Berkeley and Los Angeles, California.
- Compton, R., L. Goodwin, R. Handy, and V. Abbott. 2007. A critical examination of worldwide guidelines for minimising the disturbance to marine mammals during seismic surveys. *Marine Policy* 32: 255-262.
- Cott, P. A., A. Schein, B. W. Hanna, T. A. Johnston, D. D. MacDonald, and J. M. Gunn. 2015. Implications of linear developments on northern fishes. *Environmental Review* 23: 177-190.
- Davis, W. P., D. E. Hoss, G. I. Scott, and P. F. Sheridan. 1984. Fisheries resource impacts from spills of oil or hazardous substances. Pages 157-172 [In] J. Cairns, Jr. and A. L. Buikema, Jr., editors. Restoration of habitats impacted by oil spills. Butterworth Publishers, Boston, Massachusetts.
- Delaney, Siona S. and Robert G. Dulla. 2007. Alaska Rural Communities Emission Inventory. Sierra Research Inc., SR2007-02-01. Sacramento, CA. <https://dec.alaska.gov/media/7627/alaska-2005-rural-emission-inventory.pdf> (Accessed December 28, 2018).
- DNR (Alaska Department of Natural Resources). 1988. Prince William Sound Area Plan for State Lands. http://dnr.alaska.gov/mlw/planning/areaplans/prince/pdf/prince_william_sound_area_plan_for_state_lands.pdf (Accessed August 29, 2018).
- DOI (Department of the Interior). 1987. Arctic National Wildlife Refuge, Alaska, coastal plain resource assessment; Report and recommendations to the Congress of the United States and final legislative environmental impact statement. Prepared by the US Fish and Wildlife Service in cooperation with the US Geological Survey and the Bureau of Land Management. Washington, D. C. <https://pubs.usgs.gov/fedgov/70039559/report.pdf> (Accessed 1/18/2017).
- EPA (US Environmental Protection Agency). 2013. Final ocean discharge criteria evaluation for the Cook Inlet Exploration NPDES General Permit. Region 10. Seattle, Washington. <https://www.epa.gov/sites/production/files/2017-10/documents/r10-npdes-cook-inlet-oil-gas-akg285100-odce-2013.pdf> (Accessed April 9, 2018).
- EPA (US Environmental Protection Agency). 2016a. Class I Industrial and Municipal Waste Disposal Wells. Last Modified September 6, 2016. <https://www.epa.gov/uic/class-i-industrial-and-municipal-waste-disposal-wells> (Accessed April 9, 2018).
- EPA (US Environmental Protection Agency). 2016b. Hydraulic fracturing for oil and gas: Impacts from the hydraulic fracturing water cycle on drinking water resources in the United States. Office of Research and Development, EPA/600/R-16/236Fa. Washington, DC. <https://cfpub.epa.gov/ncea/hfstudy/recordisplay.cfm?deid=332990> (Accessed May 18, 2018).
- EPA (US Environmental Protection Agency). 2017. Class II Oil and Gas Related Injection Wells. Last Modified December 18, 2017. <https://www.epa.gov/uic/class-ii-oil-and-gas-related-injection-wells> (Accessed April 9, 2018).

- EPPR (Preparedness and Response Emergency Prevention). 1998. Field guide for oil spill response in arctic waters 1998. Environment Canada. Yellowknife, NT Canada.
<http://environmentalunit.com/Documentation/05%20Response%20Techniques/EPPR%20Field%20Guide%20for%20Oil%20Arctic.pdf> (Accessed December 18, 2017).
- Everett, K. R. 1978. Some effects of oil on the physical and chemical characteristics of wet tundra soils. *Arctic* 31(3): 260-276.
- EVOSTC (*Exxon Valdez* Oil Spill Trustee Council). 2014. 2014 update injured resources and services. <http://www.evostc.state.ak.us/static/PDFs/2014IRSUpdate.pdf> (Accessed April 3, 2018).
- EVOSTC (*Exxon Valdez* Oil Spill Trustee Council). 2017. Research, monitoring and restoration. <http://www.evostc.state.ak.us/> (Accessed 1/18/2017).
- Fall, J. A. 1999. Subsistence. September. Exxon Valdez Oil Spill Trustee Council, Restoration Notebook. Anchorage.
http://www.evostc.state.ak.us/Universal/Documents/Publications/RestorationNotebook/RN_subst.pdf.
- Feist, B. E., J. J. Anderson, and R. Miyamoto. 1996. Potential impacts of pile driving on juvenile pink (*Onchorhynchus gorbuscha*) and chum (*O. keta*) salmon behavior and distribution. Fisheries Research Institute, School of Fisheries, University of Washington, FRI-UW-9603. Seattle, Washington.
<https://digital.lib.washington.edu/researchworks/bitstream/handle/1773/.../9603.pdf> (Accessed May 3, 2018).
- Fisheries, NOAA (National Oceanic and Atmospheric Administration, National Marine Fisheries Service). 2017. Marine mammal acoustic technical guidance.
<http://www.nmfs.noaa.gov/pr/acoustics/guidelines.htm> (Accessed May 3, 2018).
- Fukuyama, Allan, Gary Gillingham, and Ian Hartwell. 2012. Integrated Cook Inlet Environmental Monitoring and Assessment Program (ICIEMAP): Benthic infaunal communities. Alaska Marine Science Symposium January 16-20, 2012, Anchorage, Alaska.
- Gailey, G., B. Wursig, and T. L. McDonald. 2007. Abundance, behavior, and movement patterns of western gray whales in relation to a 3-D seismic survey, Northeast Sakhalin Island, Russia. *Environmental Monitoring and Assessment* 134(1-3): 75-91.
- Gilfillan, E. S., D. S. Page, J. M. Neff, K. R. Parker, and P. D. Boehm. 2001. A 10-year study of shoreline conditions in the Exxon Valdez spill zone, Prince William Sound, Alaska. 1 Pages 559-567. IIOSC International Oil Spill Conference. March 2001.
- Gill, Jr., R. E. and T. L. Tibbitts. 1999. Seasonal shorebird use of intertidal habitats in Cook Inlet, Alaska. US Geological Survey, Biological Resources Division, OCS Study MMS 99-0012.
- Gómez, Cristina and David R. Green. 2013. The impact of oil and gas drilling accidents on EU fisheries. 56 p. Directorate General for Internal Policies, Policy Department B: Structural and Cohesion Policies, Fisheries, IP/B/PECH/IC/2013-073. Brussels, Belgium.
<http://www.europarl.europa.eu/studies> (Accessed May 7, 2018).
- Gordon, J., D. Gillespie, J. Potter, A. Frantzis, M. P. Simmonds, R. Swift, and D. Thompson. 2004. A review of the effects of seismic surveys on marine mammals. *Marine Technology Society Journal* 37(4): 16-34.

- Grant, A. and A. D. Briggs. 2002. Toxicity of sediments from around a North Sea oil platform: are metals or hydrocarbons responsible for ecological impacts? *Marine Environmental Research* 53: 95-116.
- Halvorsen, M. B., B. M. Casper, C. M. Woodley, T. J. Carlson, and A. N. Popper. 2012. Threshold for onset of injury in Chinook salmon from exposure to impulsive pile driving sounds. *PLoS ONE* 7(6): e38968. <https://doi.org/10.1371/journal.pone.0038968> (Accessed April 25, 2018).
- Harper, J. R. and M. C. Morris. 2014. Alaska ShoreZone coastal habitat mapping protocol. Bureau of Ocean Energy Management. <https://alaskafisheries.noaa.gov/sites/default/files/chmprotocol0114.pdf> (Accessed September 7, 2018).
- Henkel, J. R., B. J. Sigel, and C. M. Taylor. 2012. Large-scale impacts of the Deepwater Horizon oil spill: Can local disturbance affect distant ecosystems through migratory shorebirds? *BioScience* 62(7): 676-685.
- Henley, W. F., M. A. Patterson, R. J. Neves, and A. D. Lemly. 2000. Effects of sedimentation and turbidity on lotic food webs: A concise review for natural resource managers. *Reviews in Fisheries Science* 8(2): 125-139.
- Hildebrand, J. A. 2004. Impacts of anthropogenic sound on cataceans. Scripps Institution of Oceanography University of California, San Diego, IWC/SC/56/E13. La Jolla, CA. <ftp://cetus.ucsd.edu/Publications/Reports/HildebrandIWCSC-56-E13-2004.pdf> (Accessed January 11, 2017).
- Hofman, R. J. 2003. Marine sound pollution: Does it merit concern? *Marine Technology Society Journal* 37(4): 66-77.
- Howard, M., I. Morin, and K. Watts. 2008. Review of oil spill incidents reported to the National Response Center from onshore oil production facilities. Pages 561-570. *International Oil Spill Conference: IOSC 2008 Vol. 2008 (1) May 4-8, Savannah, Georgia*.
- IE, UNEP (United Nations Environment Programme Industry and Environment). 2007. Environmental management in oil and gas exploration and production. An overview of issues and management approaches. Technical Report 37 (Accessed January 17, 2017).
- IOGP (International Association of Oil and Gas Producers). 2016. Environmental fates and effects of ocean discharge of drill cuttings and associated drilling fluids from offshore oil and gas operations. Technical Report 543, March 2016. <https://www.iogp.org/bookstore/product/environmental-fate-and-effects-of-ocean-discharge-of-drill-cuttings-and-associated-drilling-fluids-from-offshore-oil-and-gas-operations/> (Accessed April 25, 2018).
- IPIECA (International Petroleum Industry Environmental Conservation Association). 2008. Oil spill preparedness and response. <http://www.world-petroleum.org/docs/docs/socialres/oil%20spill%20preparedness%20and%20response%20report.pdf> (Accessed 1/18/2017).
- IPIECA (International Petroleum Industry Environmental Conservation Association). 2009. Drilling fluids and health risk management. A guide for drilling personnel, managers and health professionals in the oil and gas industry. OGP Report Number 396. <http://www.ipieca.org/resources/good-practice/drilling-fluids-and-health-risk-management/> (Accessed January 8, 2019).

- ITOPF (International Tanker Owners Pollution Federation). 2014. Effects of oil pollution on the marine environment. Technical information paper 13.
<http://www.itopf.com/fileadmin/data/Documents/TIPS%20TAPS/TIP13EffectsofOilPollutionontheMarineEnvironment.pdf> (Accessed 1/18/2017).
- IWC (International Whaling Commission). 2004. Annex K: Report of the Standing Working Group on environmental concerns (May 2004). (IWC56 meeting). International Whaling Commission, Scientific Committee (IWC-SC) Report. Section 6. Mini-symposium on acoustics.
http://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=3&ved=0CCsQFjACahUKEwiN-9nEpJDIAhWXXIqKHVsEck4&url=http%3A%2F%2Fwww.acousticecology.org%2Fdocs%2FIWC56-noisesymposium.doc&usg=AFQjCNEpAxDWGnc_Mus09RMs0OoSDeuRA (Accessed 1/11/2017).
- James, A. R. C. and A. K. Stuart-Smith. 2000. Distribution of caribou and wolves in relation to linear corridors. *Journal of Wildlife Management* 64(1): 154-159.
- Jones, B. and M. L. Kostick. 2016. The harvest and use of wild resources in Nikiski, Seldovia, Nanwalek, and Port Gram, Alaska 2014. 517 p. Alaska Department of Fish and Game Division of Subsistence, Technical Paper No. 420. Anchorage, Alaska.
<http://www.adfg.alaska.gov/sf/publications/> (Accessed April 26, 2018).
- Jorgenson, J. K. and E. C. Gyselman. 2009. Hydroacoustic measurements of behavioral response of arctic riverine fishes to seismic air guns. *Journal of the Acoustical Society of America* 126(3).
- Kerkvliet, C. and M. Booz. 2016. Digging into a dilemma - Cook Inlet razor clams. *Oncorhynchus* 36(2).
- Kerkvliet, C., M. Booz, T. Blackmon, and P. Hansen. 2018. Digging into common razor clam questions. *Alaska Fish and Wildlife News* (May 2018). Alaska Department of Fish and Game.
http://www.adfg.alaska.gov/index.cfm?adfg=wildlifeneews.view_article&articles_id=865. (Accessed October 23, 2018).
- Kuletz, K. J. and E. A. Labunski. 2017. Seabird distribution and abundance in the offshore environment final report. 59 p. US Department of the Interior, Bureau of Ocean Energy Management, Alaska OCS Region, OCS Study BOEM 2017-004. Anchorage, Alaska.
<http://www.boem.gov/Environmental-Stewardship/Environmental-Studies-Program-Information-System.aspx> (Accessed April 25, 2018).
- Lacroix, D. L., R. B. Lanchtot, J. A. Reed, and T. L. McDonald. 2003. Effect of underwater seismic surveys on molting male long-tailed ducks in the Beaufort Sea, Alaska. *Canadian Journal of Zoology* 81(11): 1862-1975.
- Larned, William W. 2006. Winter distribution and abundance of Steller's eiders (*Polysticta stelleri*) in Cook Inlet, Alaska 2004-2005. Minerals Management Service, OCS Study MMS 2006-066. https://www.fws.gov/alaska/mbsp/mbm/waterfowl/surveys/pdf/cistei_report.pdf (Accessed May 4, 2018).
- Liebezeit, J. R., S. J. Kendall, S. Brown, C.B. Johnson, P. Martin, T. L. McDonald, D. C. Payer, C. L. Rea, B. Streever, and A. M. Wildman. 2009. Influence of human development and

- predators on nest survival of tundra birds, Arctic Coastal Plain, Alaska. *Ecological Applications* 19(6): 1628-1644.
- Limpinsel, D. E., M. P. Eagleton, and J. L. Hanson. 2017. Impacts to essential fish habitat from non-fishing activities in Alaska. EFH 5 year review: 2010 through 2015. US Department of Commerce, National Oceanic and Atmospheric Administration National Marine Fisheries Service, NOAA Technical Memorandum NMFS-F/AKR-14.
<https://alaskafisheries.noaa.gov/habitat/efh> (Accessed April 30, 2018).
- Linkins, A. E., L. A. Johnson, K. R. Everett, and R. M. Atlas. 1984. Oil spills: Damage and recovery in tundra and taiga. Pages 135-155 [In] J. Cairns Jr. and A. L. Buikema Jr., editors. *Restoration of habitats impacted by oil spills*. Butterworth Publishers, Boston, Massachusetts.
- Linnell, J. D. C., J. E. Swenson, R. Andersen, and B. Barnes. 2000. How vulnerable are denning bears to disturbance? *Wildlife Society Bulletin* 28(2): 400-413.
- Ljungblad, Donald K., Bernd Wursig, Steven L. Swartz, and James M. Keene. 1988. Observations on the behavioral responses of bowhead whales (*Balaena mysticetus*) to active geophysical vessels in the Alaska Beaufort Sea. *Arctic* 41(3): 183-194.
- Macey, G. P., R. Breech, M. Chernaik, C. Cox, D. Larson, D. Thomas, and D. O. Carpenter. 2014. Air concentrations of volatile compounds near oil and gas production: A community-based exploratory study. *Environmental Health* 13: 82.
<https://ehjournal.biomedcentral.com/articles/10.1186/1476-069X-13-82>. (Accessed April 5, 2018).
- MacFarlane, A. K. 2003. Vegetation response to seismic lines: edge effects and on-line succession. Master's thesis, University of Alberta.
- Machtans, C. T. 2006. Songbird response to seismic lines in the western boreal forest: a manipulative experiment. *Canadian Journal of Zoology* 84: 1421-1430.
- Marine Acoustics, Inc. 2011. Underwater acoustic measurement of the Spartan 151 jack-up drilling rig in the Cook Inlet beluga whale critical habitat. 40 p. Furie Operating Alaska, LLC, Anchorage, Alaska.
<https://alaskafisheries.noaa.gov/sites/default/files/acousticmeasurejackuprig1211.pdf> (Accessed May 4, 2018).
- McCauley, Rob. 1998. Radiated underwater noise measured from the drilling rig Ocean General, rig tenders Pacific Ariki and Pacific Frontier, fishing vessel Reef Venture and Natural Sources in the Timor Sea, Northern Australia. Curtin University of Technology; Prepared for: Shell Australia Shell House Melbourne, Project CMST Report C98-20.
<http://cmst.curtin.edu.au/local/docs/pubs/1998-19.pdf> (Accessed April 23, 2018).
- McDowell Group. 2017. The role of the oil and gas industry in Alaska's economy. Alaska Oil and Gas Association. Anchorage, Alaska.
http://www.aoga.org/sites/default/files/news/final_mcdowell_group_aoga_report_7.5.17.pdf (Accessed July 26, 2017).
- Meixell, B. W. and P. L. Flint. 2017. Effects of industrial and investigator disturbance on arctic-nesting geese. *Journal of Wildlife Management* 81(8): 1372-1385.
- Michel, J., A. C. Bejarano, C. H. Peterson, and C. Voss. 2013. Review of biological and biophysical impacts from dredging and handling of offshore sand. US Department of the

- Interior, Bureau of Ocean Energy Management, OCS Study BOEM 2013-0119. Herndon, Virginia. <https://www.boem.gov/ESPIS/5/5268.pdf> (Accessed May 2, 2018).
- Michel, J., D. Esler, and Z. Nixon. 2016. Studies on *Exxon Valdez* lingering oil: Review and update on recent findings – February 2016. Alaska Department of Fish and Game and US Geological Survey, Anchorage, Alaska. http://www.evostc.state.ak.us/Universal/Documents/Publications/04-05-16_March_2016_LO_Update.pdf (Accessed April 3, 2018).
- Miller, P. J. O., M. P. Johnson, P. T. Madsen, N. Biassoni, M. Quero, and P. L. Tyack. 2009. Using at-sea experiments to study the effects of airguns on the foraging behavior of sperm whales in the Gulf of Mexico. *Deep Sea Research I*.
- Mills, Michael J. 1992. Alaska sport fishing in the aftermath of the *Exxon Valdez* oil spill. Alaska Department of Fish and Game, No. 92-5. Anchorage. <http://www.sf.adfg.state.ak.us/FedAidPDFs/sp92-05.pdf> (Accessed May 29, 2008).
- NAS (National Academies of Sciences, Engineering, and Medicine). 2017. Approaches to understanding the cumulative effects of stressors on marine mammals. The National Academies Press. Washington, DC. <https://doi.org/10.17226/23479> (Accessed April 25, 2018).
- Neff, J. M., S. McKelvie, and Jr. R. C. Ayers. 2000. Environmental impacts of synthetic based drilling fluids. Report prepared for MMS by Robert Ayers & Associates, Inc. August 2000. US Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, OCS Study MMS 2000-064. New Orleans, Louisiana. http://www.ibrarian.net/navon/paper/Environmental_Impacts_Of_Synthetic_Based_Drilling.pdf?paperid=6456919 (Accessed April 25, 2018).
- NMFS (National Marine Fisheries Service). 2016. Technical guidance for assessing the effects of anthropogenic sound on marine mammal hearing: Underwater acoustic thresholds for onset of permanent and temporary threshold shifts. US Department of Commerce, National Oceanic and Atmospheric Administration, NOAA Technical Memorandum NMFS-OPR-55. <http://www.nmfs.noaa.gov/pr/publications/techmemos.htm> (Accessed May 3, 2018).
- NOAA (National Oceanic and Atmospheric Administration). 2016. Effects of oil and gas activities in the Arctic Ocean final environmental impact statement. National Marine Fisheries Service, Office of Protected Resources. <http://www.nmfs.noaa.gov/pr/permits/eis/arctic.htm> (Accessed April 30, 2018).
- NOAA Fisheries (National Oceanic and Atmospheric Administration, National Marine Fisheries Service). 2018. Alaska ShoreZone coastal mapping and imagery. Alaska Regional Office. <https://alaskafisheries.noaa.gov/habitat/shorezone> (Accessed May 1, 2018).
- Northrup, J. M. and G. Wittemyer. 2013. Review and synthesis: Characterising the impacts of emerging energy development on wildlife, with an eye towards mitigation. *Ecology Letters* 16: 112-125.
- NPC (National Petroleum Council). 2011. Prudent development: Realizing the potential of North America's abundant natural gas and oil resources. <http://www.npc.org/> (Accessed March 29, 2018).
- NSB (North Slope Borough). 2018. North Slope Borough, Alaska Comprehensive Annual Financial Report. http://www.north-slope.org/assets/images/uploads/Final_FY2018_CAFR.PDF (Accessed April 9, 2019).

- Petterson, John S. and Edward W. Glazier. 2004. A study of the drift gillnet fishery and oil/gas industry interactions and mitigation possibilities in Cook Inlet. Prepared for Minerals Management Service, Alaska OCS Region by Impact Assessment, Inc., OCS Study MMS 2004-038. La Jolla, CA. <https://www.boem.gov/BOEM-Newsroom/Library/Publications/2004/2004-038.aspx> (Accessed October 10, 2017).
- Popper, A. N. and M. C. Hastings. 2009. The effects of human-generated sound on fish. *Integrative Zoology* 4: 43-52.
- Powell, A. N., A. R. Taylor, and R. B. Lanctot. 2010. Pre-migratory ecology and physiology of shorebirds staging on Alaska's North Slope. September 2010. Coastal Marine Institute, University of Alaska Fairbanks, OCS Study Final Report MMS 2009-034. <http://www.arlis.org/docs/vol1/C/693592014.pdf>.
- Rassenfoss, Stephen. 2013. Seismic unwired: cutting the cable can help in difficult spots. *Journal of Petroleum Technology*.
- Reger, D. R., D. Corbett, A. Steffian, P. Saltonstall, T. Birkedal, and L. F. Yarborough. 2000. Archaeological index site monitoring: Final report. *Exxon Valdez Oil Spill Restoration Project 99007A Final Report*. <http://www.evostc.state.ak.us/Store/FinalReports/1999-99007A-Final.pdf> (Accessed April 4, 2018).
- Robertson, S. J., W. B. McGill, H. B. Massicotte, and P. M. Rutherford. 2007. Petroleum hydrocarbon contamination in boreal forest soils: a mycorrhizal ecosystems perspective. *Biological Reviews* 82: 213-240.
- Ronconi, R. A., K. A. Allard, and P. D. Taylor. 2015. Bird interactions with offshore oil and gas platforms: Review of impacts and monitoring techniques. *Journal of Environmental Management* 147(2015): 34-45.
- Saupe, S. M., A. K. Fukuyama, G. Gillingham, S. I. Hartwell, T. L. Robertson, M. A. Savoie, and J. J. Trefrey. 2012. Integrated Cook Inlet Environmental Monitoring and Assessment Program (ICIEMAP): A collaboration of four Inlet contaminant studies. Alaska Marine Science Symposium January 16-20, 2012, Anchorage, Alaska.
- Sawyer, H., M. J. Kauffman, and R. M. Nielson. 2009. Influence of well pad activity on winter habitat selection patterns of mule deer. *Journal of Wildlife Management* 73(7): 052–1061.
- Schmidt, D. C., K. E. Tarbox, G. B. Kyle, and S. R. Carlson. 1995. Sockeye salmon overescapement: 1993 annual report on Kenai River and Kodiak investigations: *Exxon Valdez Oil Spill Restoration Project 930002*. Alaska Department of Fish and Game, Division of Commercial Fisheries Management and Development, Regional Information Report No. 5J95-15. Juneau, Alaska. <http://www.sf.adfg.state.ak.us/FedAidPDFs/RIR.5J.1995.15.pdf>.
- Schneider, R. R. 2002. Alternative futures: Alberta's boreal forest at the crossroads. The Federation of Alberta Naturalists and The Alberta Centre for Boreal Research, Edmonton, Alberta.
- Shwartz, Mark. 2016. Stanford scientist weighs the risk of groundwater contamination from oil and gas wells. Stanford News. Last Modified February 18, 2016. <https://news.stanford.edu/2016/02/18/aaas-jackson-water-021816/> (Accessed May 18, 2018).
- Simmonds, M. P., S. J. Dolman, M. Jasny, E. C. M. Parsons, L. Weilgart, A. J. Wright, and R. Leaper. 2014. Marine noise pollution – increasing recognition but need for more practical action. *Journal of Ocean Technology* 9(1): 71-90.

- Slotte, Aril, Kaare Hansen, John Dalen, and Egil Ona. 2004. Acoustic mapping of pelagic fish distribution and abundance in relation to a seismic shooting area off the Norwegian west coast. *Fisheries Research* 67: 143-150.
- Song, J., D. A. Mann, P. A. Cott, B. W. Hanna, and A. N. Popper. 2008. The inner ears of northern Canadian freshwater fishes following exposure to seismic air gun sounds. *Journal of the Acoustical Society of America* 124(2): 1360-1366.
- Stenhouse, I.J. and S.E. Senner. 2005. Alaska WatchList - 2005. Audubon Alaska, Anchorage, Alaska.
http://www.briloon.org/uploads/Library/item/359/file/Audubon_Alaska%20WatchList%202005.pdf (Accessed April 25, 2018).
- Stewart, B. P., T. A. Nelson, K. Laberee, S. E. Nielsen, M. A. Wulder, and G. Stenhouse. 2013. Quantifying grizzly bear selection of natural and anthropogenic edges. *Journal of Wildlife Management* 77(5): 957–964.
- Streever, B., S. W. Raborn, K. H. Kim, A. D. Hawkins, and A. N. Popper. 2016. Changes in fish catch rates in the presence of air gun sounds in Prudhoe Bay, Alaska. *Arctic* 69(4): 346 – 358.
- Taylor, A. R., R. B. Lanctot, A. N. Powell, F. Huettmann, D. A. Nigro, and S. J. Kendall. 2010. Distribution and community characteristics of staging shorebirds on the northern coast of Alaska. *Arctic* 63(4): 451–467.
- Thomas, E. H., M. C. Brittingham, and S. H. Stoleson. 2014. Conventional oil and gas development alters forest songbird communities. *Journal of Wildlife Management* 78(2): 239-306.
- Tigner, Jesse, Erin M. Bayne, and Stan Boutin. 2014. Black bear use of seismic lines in Northern Canada. *Journal of Wildlife Management* 78(2): 282–292.
- Trammell, E. J., M. L. Carlson, N. Fresco, T. Gotthardt, M. L. McTeague, and D. Vadapalli. 2015. North Slope rapid ecoregional assessment manager’s summary. Prepared for the US Department of the Interior, Bureau of Land Management, Anchorage, Alaska.
http://www.blm.gov/wo/st/en/prog/more/Landscape_Approach/reas.html (Accessed April 26, 2016).
- US Senate. (Committee on Energy and Natural Resources). 2011. New developments in upstream oil and gas technologies (112th Congress, 1st session, May 10).
- USFWS (United States Fish and Wildlife Service). 2008. Exxon Valdez oil spill restoration project final report: Prince William Sound bird surveys, synthesis and restoration. Restoration Project 080751. <http://www.evostc.state.ak.us/Store/FinalReports/2008-080751-Final.pdf> (Accessed 1/18/2017).
- USFWS (US Fish and Wildlife Service). 2016. Effects on resources. National Wildlife Refuge System. Last Modified November 10, 2016. <https://www.fws.gov/refuges/oil-and-gas/effects.html> (Accessed May 8, 2018).
- Van Dyke, F., A. Fox, S. M. Harju, M. R. Dzialak, L. D. Hayden-Wing, and J. B. Winstead. 2012. Response of mule deer to habitat modification near natural gas development. *Wildlife Biology in Practice* 8(1).
- Wallace, Z. P., P. L. Kennedy, J. R. Squires, L. E. Olson, and R. J. Oakleaf. 2016. Human-made structures, vegetation, and weather influence ferruginous hawk breeding performance. *Journal of Wildlife Management* 80(1): 78–90.

- Wardle, C. S., T. J. Carter, G. G. Urquhart, A. D. F. Johnstone, A. M. Ziolkowski, G. Hampson, and D. Mackie. 2001. Effects of seismic air guns on marine fish. *Continental Shelf Research* 21: 1005-1027.
- Warnock, N. 2017. The Alaska WatchList 2017. Audubon Alaska, Anchorage, Alaska. http://ak.audubon.org/sites/g/files/amh551/f/static_pages/attachments/2017_watchlist_final_panels_highres.pdf (Accessed March 21, 2018).
- Wasser, S. K., J. L. Keim, M. L. Taper, and S. R. Lele. 2011. The influences of wolf predation, habitat loss, and human activity on caribou and moose in the Alberta oil sands. *Frontiers in Ecology and the Environment* 9(10): 546–551.
- Wiedmer, Michael. 2002. Draft report Lower Kenai Peninsula summer off-road vehicle trail stream crossings. Habitat and Restoration Division, Alaska Department of Fish and Game, Anchorage, Alaska. https://www.adfg.alaska.gov/static/home/library/pdfs/habitat/02_02_draft.pdf (Accessed April 17, 2018).
- Wiens, J. A. 2013. *Oil in the environment: Legacies and lessons of the Exxon Valdez oil spill*. Cambridge University Press.
- Zenone, C. and G. S. Anderson. 1978. Summary appraisals of the nation's ground-water resources - Alaska. US Government Printing Office, 813-P. Washington, DC. <https://pubs.usgs.gov/pp/0813p/report.pdf> (Accessed March 19, 2018).

Chapter Nine: Mitigation Measures

Contents

A. Mitigation Measures	9-1
1. Facilities and Operations	9-1
2. Fish Wildlife and Habitat	9-4
3. Subsistence, Commercial, and Sport Harvest Activities	9-5
4. Fuel and Hazardous Substances	9-5
5. Access.....	9-7
6. Prehistoric, Historic, and Archaeological Sites	9-7
7. Hiring Practices	9-7
B. Definitions.....	9-8

Chapter Nine: Mitigation

Measures Mitigation Measures

Under AS 38.05.035(e), the director of the Division of Oil and Gas (DO&G) is authorized to impose conditions or limitations, in addition to those imposed by statute, to ensure that a resource disposal is in the state’s best interest. AS 38.05.133(f)(1) also requires that this written finding describe the limitations, stipulations, conditions, or changes from the initiating proposal that are required to make the issuance of the exploration license conform to the best interests of the state. Finally, AS 38.05.035(g)(1)(B)(vii) requires that this written finding consider and discuss lease stipulations and mitigation measures, and the protections offered by these measures, including any measures to prevent and mitigate oil spills. To mitigate the potential adverse social and environmental effects of specific post-disposal related activities, DO&G has developed mitigation measures which are conditions and limitations to the exploration license and any subsequent leases, are binding on the licensee, and will condition plans of operation, plans of development, and other permits.

The mitigation measures presented in this Gulf of Alaska Exploration License best interest finding were developed to mitigate potential effects of license and lease-related activities, after considering all information made known to the director at this time. Additional project-specific mitigation measures may be imposed when the licensee submits plans of operation or development.

The mitigation measures discussed in this chapter will apply to oil and gas activities in, on, or accessing all licensed land and waterbodies as a condition of issuing the license, regardless of the ownership status of the land. The director may consult with local government organizations and other agencies in implementing the mitigation measures below. The licensee is subject to applicable local, state, and federal laws and regulations, as amended.

The director may grant exceptions to these mitigation measures. Exceptions will only be granted upon a showing by the licensee that compliance with the mitigation measure is not practicable and that the licensee will undertake an equal or better alternative to satisfy the intent of the mitigation measure. Requests and justifications for exceptions must be included in the plan of operations application as specified by the application instructions, and decisions of whether to grant exceptions will be made during the plan of operations review.

A. Mitigation Measures

1. Facilities and Operations

- a. Oil and gas facilities, including pipelines, shall be designed using industry-accepted engineering codes and standards. Technical submittals to the DO&G that reflect the “practice of engineering,” as defined by AS 08.48.341, must be sealed by a professional engineer registered in the State of Alaska.
- b. A plan of operations shall be submitted to and approved by DO&G before conducting exploration, development, or production activities in accordance with 11 AAC 83.

- c. Facilities shall be designed and operated to minimize sight and sound impacts in areas of high residential, recreational, and subsistence use and important wildlife habitat.
- d. The siting of facilities, including roads, airstrips, and pipelines, is prohibited within one-half mile from the mean high-water mark and 500 feet of all fish-bearing waterbodies.
- e. Notwithstanding (d) above, the siting of facilities, is prohibited within one-half mile of the banks of the Katalla, Bering, Nichawak, Campbell, Edwardes, and Okalee rivers, and Arvesta Creek as measured from the ordinary high-water mark. Facilities may be sited, on a case-by-case basis, within the ½ mile buffer if the lessee demonstrates that siting of such facilities outside this buffer zone is not feasible or prudent, or that a location within the buffer is environmentally preferable.
- f. Impacts to important wetlands shall be minimized to the satisfaction of the director, in consultation with ADF&G and Alaska Department of Environmental Conservation (ADEC). The director will consider whether facilities are sited in the least sensitive areas.
- g. Road and pipeline crossings shall be aligned perpendicular or near perpendicular to watercourses.
- h. Pipelines
 - i. In areas with above ground placement, pipelines shall be designed, sited, and constructed to allow for the free movement of wildlife and to avoid significant alteration of large ungulate movement and migration patterns.
 - ii. At a minimum, above ground pipelines shall be elevated seven feet, as measured from the ground to the bottom of the pipeline, except where the pipeline intersects a road, pad, or a ramp installed to facilitate wildlife passage. A licensee shall consider snow depth in relation to pipe elevation to ensure adequate clearance for wildlife.
 - iii. Pipelines that must cross marine waters will be constructed beneath the marine waters using directional drilling techniques. Offshore pipelines must be located and constructed to prevent obstruction to marine navigation and fishing operations.
 - iv. Pipelines and gravel pads shall facilitate the containment and cleanup of spilled fluids.
 - v. Pipelines must be located and constructed in consultation with ADF&G and the local borough
- i. Exploration roads, pads, and airstrips must be temporary. Use of gravel roads, pads, and airstrips may be permitted on a case-by-case basis by the director, in consultation with the Division of Mining, Land, and Water (DMLW) and ADF&G. Approval for use of existing facilities will depend on the extent and method of restoration needed to return these structures to a usable condition.
- j. Artificial gravel islands and bottom founded structures shall not be in active stream channels, except as provided for in (k).
- k. Each proposed structure will be reviewed on a case-by-case basis. Causeways, docks, artificial gravel islands, and bottom-founded structures may be permitted if the director, in consultation with ADF&G and ADEC, determines that the structures are necessary for field development and that no practicable alternatives exist. A monitoring program may be

required to address the objectives of water quality and free passage of fish, and mitigation shall be required where significant deviation from objectives occurs.

- l. Upon abandonment of material sites, drilling sites, roads, buildings or other facilities, such facilities must be removed, and the site rehabilitated to the satisfaction of the director, unless the director, in consultation with DMLW, ADF&G, ADEC, and any non-state surface owner, determines that such removal and rehabilitation is not in the state's interest.
- m. Material sites required for oil and gas activities shall be:
 - i. restricted to the minimum necessary to develop the field efficiently and with minimal environmental damage;
 - ii. where practicable, material sites must be designed and constructed to function as water reservoirs for future use; and
 - iii. located outside active floodplains of a watercourse unless the director, after consultation with DMLW and ADF&G, determines that there is no practicable alternative, or that a floodplain site would enhance fish and wildlife habitat after mining operations are completed and the site is closed.
- n. The director may include plan stipulations if necessary to reduce or eliminate adverse impacts to fish and wildlife or to protect the environment.
- o. The siting of permanent facilities is prohibited within one-quarter mile of important habitat including breeding and nesting areas, as well as migratory bird staging areas, and seabird colonies to reduce impacts on avian species.
- p. Powerlines must be buried in the proposed license area to avoid and reduce collisions of migratory birds with overhead powerlines.
- q. Lights must be down-shielded to reduce potential bird collisions with buildings and other vertical structures in the License Area.
- r. Motion detection type lighting must be installed on permanent facilities in the License Area to reduce the attraction of birds to steady burning lights and potential collision with structures.
- s. A disturbance buffer of 660 feet must be implemented to reduce impacts to bald eagles and to avoid blasting and other activities that produce extremely loud noises within 0.5 mile of bald eagle nests (or within one mile in open areas), unless greater tolerance to the activity (or similar activity) has been demonstrated by the eagles in the nesting area.
- t. Gravel fill is prohibited in tidelands, except for docks. Construction of temporary or permanent airstrips or roads in intertidal areas is prohibited. Outside of tidelands, drill pads, airstrips, and roads may be allowed, or use of gravel roads, pads, and airstrips during the development phase may be permitted on a case-by-case basis by the director, in consultation with DMLW and ADF&G.
- u. Drilling in offshore tracts will only be conducted directionally from onshore locations unless the licensee proposes an alternative offshore location that is environmentally preferable to DO&G, after consultation with ADF&G, DMLW, and ADEC.

2. Fish Wildlife and Habitat

- a. Surface entry will be prohibited within the Copper River Delta Critical Habitat Area.
- b. Any water intake structures in fish bearing or non-fish bearing waters shall be designed, operated, and maintained to prevent fish entrapment, entrainment, or injury. All water withdrawal equipment must be equipped and must use fish screening devices approved by ADF&G.
- c. Removal of snow from fish-bearing rivers, streams, and natural lakes shall be subject to prior written approval by ADF&G. Compaction of snow cover overlying fish-bearing waterbodies is prohibited except for approved crossings.
- d. The director, in consultation with ADF&G, may impose seasonal restrictions on activities located in, or requiring travel through or overflight of large ungulate calving and wintering areas during the plan of operations approval stage.
- e. Bears
 - i. A licensee must consult with ADF&G before commencing any activities to identify the locations of known bear den sites that are occupied in the season of proposed activities.
 - ii. Exploration and production activities shall not be conducted within one-half mile of occupied bear dens unless alternative mitigation measures are approved by ADF&G.
 - iii. A licensee who encounters an occupied bear den not previously identified by ADF&G shall report it to the Division of Wildlife Conservation, ADF&G, within 24 hours. The licensee will avoid conducting mobile activities one-half mile from discovered occupied dens unless alternative mitigation measures are approved by the director, with concurrence from ADF&G. Non-mobile facilities will not be required to relocate.
- f. The licensee must avoid disturbance around estuaries, bird rookeries, sea lion haul outs, and essential waterfowl areas (within $\frac{1}{4}$ mile) from April 1 to September 31.
- g. Seasonal Restrictions may be applied on exploration, development, and major maintenance activities located within the Copper River Delta Fish and Wildlife Management Area (CRDFWMA) to minimize impacts to migrating birds and to important waterfowl and shorebird habitats. These restrictions will be developed by the director, in consultation with the CRDFWMA Memorandum of Understanding (MOU) agency signatories. Routine maintenance and emergency repairs will be permitted on a year-round basis during the production phase. A detailed plan describing routine maintenance activity between April 1 and October 31 in these areas must be included in the plan of operations.
- h. Trumpeter Swans
 - i. The director, in consultation with ADF&G, will impose seasonal restrictions on activities located in, or requiring travel through or overflight of, important trumpeter swan nesting and brooding sites or important spring and fall migratory bird staging areas, during approval of a plan of operations. Trumpeter swan nesting

and brooding sites and migratory bird staging areas can be provided by ADF&G upon request

- ii. Seasonal Restrictions may be applied, and surface entry prohibited within one-half mile of trumpeter swan nesting sites and within one-quarter mile of seabird breeding colonies. The siting of permanent facilities, including roads, material sites, storage areas, power lines, and above ground pipelines will be prohibited within one-quarter mile of known nesting sites and breeding colonies. Trumpeter swan nesting sites and seabird colonies can be provided by ADF&G upon request.
- iii. Permanent, staffed facilities must be sited outside of identified trumpeter swan nesting and brood rearing areas, seabird colonies, and migratory bird spring and fall staging areas, unless the director, in concurrence with ADF&G, approves a proposed alternative. Trumpeter swan nesting sites, seabird colonies, and spring and fall staging areas can be provided by ADF&G upon request.
- i. The director, in consultation with ADF&G, will impose seasonal restrictions and sound pressure levels on seismic activities in fresh water, estuarine, and marine waters to minimize impacts to bony fishes, such as salmon, and marine mammals. The director, in consultation with ADF&G, will impose sound pressure levels for the use of explosives in or near fish bearing streams and lakes. Blasting criteria have been developed by ADF&G and are available upon request.

3. Subsistence, Commercial, and Sport Harvest Activities

- a. License-related use will be restricted if necessary to prevent unreasonable conflicts with subsistence or sport fish and wildlife harvest activities. Traditional and customary access to subsistence areas will be maintained unless reasonable alternative access is provided to subsistence users. “Reasonable access” is access using means generally available to subsistence users. Licensees will consult nearby communities, and Native organizations for assistance in identifying and contacting local subsistence users.
- b. Before submitting a plan of operations that has the potential to disrupt subsistence activities, the licensee will consult with the potentially affected subsistence communities (collectively “parties”) to discuss the siting, timing, and methods of proposed operations and safeguards or mitigating measures that could be implemented by the operator to prevent unreasonable conflicts. The parties will also discuss the reasonably foreseeable effect on subsistence activities of any other operations in the area that they know will occur during the licensee’s proposed operations. Through this consultation, the licensee will make reasonable efforts to ensure that activities are compatible with subsistence hunting and fishing activities and will not result in unreasonable interference with subsistence harvests.

4. Fuel and Hazardous Substances

- a. The licensee will ensure that secondary containment is provided for the storage of fuel or hazardous substances and sized as appropriate to container type and according to governing regulatory requirements in 18 AAC 75 and 40 CFR 112. Containers with an aggregate

storage capacity of greater than 55 gallons that contain fuel or hazardous substances will not be stored within 100 feet of a waterbody, or within 1,500 feet of a current surface drinking water source.

- b. During equipment storage or maintenance, the site must be protected from leaking or dripping fuel and hazardous substances by the placement of drip pans or other surface liners designed to catch and hold fluids under the equipment, or by creating an area for storage or maintenance using an impermeable liner or other suitable containment mechanism.
- c. During fuel or hazardous substance transfer, secondary containment or a surface liner must be placed under all container or vehicle fuel tank inlet and outlet points, hose connections, and hose ends. Appropriate spill response equipment, sufficient to respond to a spill of up to five gallons, must be on hand during any transfer or handling of fuel or hazardous substances.
- d. The licensee will ensure that vehicle refueling will not occur within the annual floodplain, except as addressed and approved in the plan of operations. This measure does not apply to water-borne vessels.
- e. All independent fuel and hazardous substance containers must be marked with the contents and the licensee's or contractor's name using paint or a permanent label.
- f. A freshwater aquifer monitoring well, and quarterly water quality monitoring are required down gradient of a permanent storage facility, unless alternative acceptable technology is approved by ADEC.
- g. Waste from operations must be reduced, reused, or recycled to the maximum extent practicable. Garbage and domestic combustibles must be incinerated whenever possible or disposed of at an approved site in accordance with 18 AAC 60.
- h. Proper disposal of garbage and putrescible waste is essential to minimize attraction of wildlife. The licensee must use the most appropriate and efficient method to achieve this goal. The primary method of garbage and putrescible waste is prompt, on-site incineration in compliance with State of Alaska air quality regulations. The secondary method of disposal is on-site storage in animal-proof containers with backhaul to an approved waste disposal facility.
- i. New solid waste disposal sites, other than for drilling waste, will not be approved or located on state property for exploration.
- j. The preferred method for disposal of muds and cuttings from oil and gas activities is by underground injection. Drilling mud and cuttings will not be discharged into lakes, streams, rivers, or wetlands. On-pad temporary cuttings storage may be allowed as necessary to facilitate annular injection and backhaul operations. Injection of non-hazardous oilfield wastes is regulated by Alaska Oil and Gas Conservation Commission through its Underground Injection Control Program for oil and gas wells.

5. Access

- a. Except for approved off-road travel, exploration activities must be supported only by temporary roads, winter trails, existing road systems, or air service. Wintertime off-road travel across wetlands may be approved in areas where snow and frost depths are sufficient to protect the ground surface. Summertime off-road travel across wetlands may be authorized subject to time periods and vehicle types approved by DMLW. Exceptions may be granted by the director if it is determined that travel can be accomplished without damaging vegetation or the ground surface. Exceptions, including the use of gravel, may also be granted on a site-specific basis if it is determined that no practicable alternatives exist for constructing an exploration road or pad.
- b. Public access to, or use of, the License Area may not be restricted except within the immediate vicinity of drill sites, buildings, and other related structures. Areas of restricted access must be identified in the plan of operations.

6. Prehistoric, Historic, and Archaeological Sites

- a. Before the construction or placement of any structure, road, or facility supporting exploration, development, or production activities, the licensee must conduct an inventory of prehistoric, historic, and archaeological sites within the area, including a detailed analysis of the effects that might result from that construction or placement.
- b. The inventory of prehistoric, historic, and archaeological sites must be submitted to the director and the Office of History and Archaeology (OHA), who will review and provide comments. If a prehistoric, historic, or archeological site or area could be adversely affected by a license activity, then the director, after consultation with OHA, will direct the licensee as to the course of action to take to avoid or minimize adverse effects.
- c. If a site, structure, or object of prehistoric, historic, or archaeological significance is discovered during license operations, the licensee shall report the discovery to the director as soon as possible. The licensee shall make all reasonable efforts to preserve and protect the discovered site, structure, or object from damage until the director, after consultation with the State Historic Preservation Office, has directed the licensee on the course of action to take for its preservation.

7. Hiring Practices

- a. The licensee is encouraged to employ local and Alaska residents and contractors, to the extent they are available and qualified, for work performed in the License Area. Licensees shall submit, as part of the plan of operations, a hiring plan that shall include a description of the operator's plans for partnering with local communities to recruit, hire, and train local and Alaska residents and contractors. As a part of this plan, the licensee is encouraged to coordinate with employment and training services offered by the State of Alaska and local communities to train and recruit employees from local communities.
- b. A plan of operations application must describe the licensee's past and prospective efforts to communicate with local communities and interested local community groups.

- c. A plan of operations application must include a training program
 - i. for all personnel including contractors and subcontractors;
 - ii. designed to inform each person working on the project of environmental, social, and cultural concerns that relate to that person's job;
 - iii. using methods to ensure personnel understand and use techniques necessary to preserve geological, archaeological, and biological resources; and
 - iv. designed to help personnel increase their sensitivity and understanding of community values, customs, and lifestyles in areas where they will be operating.

B. Definitions

Facilities - Any structure, equipment, or improvement to the surface, whether temporary or permanent, including, but not limited to, roads, pads, pits, pipelines, power lines, generators, utilities, airstrips, wells, compressors, drill rigs, camps, and buildings.

Hazardous substance - As defined under 42 USC 9601 – 9675 (Comprehensive Environmental Response, Compensation, and Liability Act of 1980).

Important wetlands - Those wetlands that are of high value to fish, waterfowl, and shorebirds because of their unique characteristics or scarcity in the region or that have been determined to function at a high level using the hydrogeomorphic approach.

Minimize - To reduce adverse impacts to the smallest amount, extent, duration, size, or degree reasonable considering the environmental, social, or economic costs of further reduction.

Plan of operation - A plan of operations under 11 AAC 83.158 and a unit plan of operations under 11 AAC 83.346.

Practicable - Feasible in light of overall project purposes after considering cost, existing technology, and logistics of compliance with the mitigation measure.

Secondary containment - An impermeable diked area, portable impermeable containment structure, or integral containment space capable of containing the volume of the largest independent container. The container shall, in the case of external containment, have enough additional capacity to allow for local precipitation. Minimum secondary requirements are identified in 18 AAC 75.075.

Temporary - No more than 12 months.

Appendix A: Summary of Comments and Responses

Contents

	Page
1. State of Alaska Division of Parks and Outdoor Recreation, Office of History and Archaeology	1
2. Trust Land Office	1
3. David Janka	2
4. Cascadia Wildlands	2
5. Barbara RadyKazdan.....	3
6. U.S. Division of Agriculture, Forest Service.....	4
7. David Lynn Grimes	4
8. Cordova District Fishermen United.....	5
9. Copper River Watershed Project	6
10. ADF&G Division of Habitat	7
11. Alaska Scallop Association	9
12. Lauren Padawer	9
13. Melissa Fraser.....	10
14. Ryan Schuetze	10
15. Erica Clark.....	11
16. U.S. Division of Agriculture, Forest Service.....	11
17. Ellen Americus	12
18. Prince William Sound Audubon Society.....	12
19. Dune Lankard	13
20. Department of Interior, National Park Service.....	14
21. Eyak Preservation Council	15
22. Sarah Keller.....	16
23. U.S. Department of Interior, Fish and Wildlife Service	17
24. Belle Mickelson.....	18
25. Julie Reynolds	19
26. Pete Lowney	20

Appendix A. Summary of Comments and Responses

AS 38.05.035(e)(7)(A) requires that preliminary written findings include a summary of agency and public comments, if any, and the department's preliminary responses to those comments. This appendix summarizes comments received in response to the May 21, 2015 Notice of Intent to Evaluate the Oil and Gas Exploration License Proposal, Request for Additional Proposals, and Request for Comments on Exploration in the solicitation area, and the department's responses.

1. State of Alaska Division of Parks and Outdoor Recreation, Office of History and Archaeology

Anchorage, AK, May 29, 2015, Judith Bitner, State Historic Preservation Officer

The Office of History and Archaeology (OHA) commented that state law requires licensing or permitting from the State of Alaska to comply with the Alaska Historic Preservation Act. The Alaska Historic Preservation Act requires reporting of historic and archaeological sites on lands licensed by the state. According to the Alaska Heritage Resources Survey database, there are 126 reported cultural resource sites within the solicitation area. The resource types identified include paleontological, prehistoric, Russian-era, and early 20th century era sites.

OHA stated because there are no specific plans included in the solicitation, they are unable to comment definitively on the potential for conflicts. Depending on project specifics, it may be necessary for DO&G to consider hiring a qualified cultural professional to review and survey the project areas to assess the potential effects of the project on cultural resources. If there is Federal involvement with the project that it is the statutory obligation of the lead Federal agency to comply with Section 106 of the National Historic Preservation Act.

DNR response: DNR recognizes the importance of preservation of cultural resources and reporting of newly discovered historic and archaeological sites during the course of any activities on the ground that could impact those cultural resources. As described in Chapter Seven of this best interest finding, AS 41.35.010 declares it is the policy of the state to preserve and protect the historic, prehistoric, and archeological resources of Alaska from loss, desecration, and destruction so that the scientific, historic, and cultural heritage embodied in these resources may pass undiminished to future generations. The licensee will be required to coordinate and permit the on-the-ground work with OHA before any ground disturbing work can move forward.

2. Trust Land Office

Anchorage, AK, June 15, 2015, Dr. Karsten Eden, Minerals and Energy Section Chief

The Trust Land Office represents the Alaska Mental Health Trust Authority which is a significant land owner in the Icy Bay area. The Trust Land Office stated that they are a strong advocate for oil and gas development in the Gulf of Alaska. They stated that the solicitation map incorrectly

identifies Trust land as state land and clarified that any parties interested in oil and gas exploration on their land would need to negotiate a lease agreement with the Trust Land Office.

DNR response: DNR recognizes that the map provided in the solicitation does not identify all of the land ownership or status included in the region. However, the map provided in this best interest finding is more focused on the actual License Area and land ownership and management. Following the issuance of this exploration license, the licensee will be required to seek additional permissions from any land owner other than the state to gain access and proceed with any exploration activities.

3. David Janka

Cordova, AK, June 19, 2015, Owner/Operator Auklet Charter Services,

Mr. Janka stated concern that an oil spill or other pollution resulting from oil and gas activity would impact the Copper River Delta and Prince William Sound. Mr. Janka requested cancelling the solicitation.

DNR response: DNR has considered the comments and the identified concerns. In the written finding, Chapter Seven, Governmental Powers to Regulate Oil and Gas, of this best interest finding identifies the agencies responsible for regulating and responding to any release of fuels or hazardous substances. The review and permitting of exploration activities will be coordinated through DEC's Spill Prevention and Response program as well as the U.S. Coast Guard. DNR also recognizes the potential effects from oil and gas exploration and development and we have included an evaluation of these reasonably foreseeable effects in Chapter Eight, of this best interest finding. Additionally, DNR has included mitigation measures in Chapter Nine of this best interest finding to reduce and minimize those potential effects.

4. Cascadia Wildlands

Cordova, AK, June 20, 2015, Gabriel Scott, Alaska Legal Director

Cascadia Wildlands (CW) stated that their staff and members would be adversely impacted by the approval of an exploration license for oil and gas. CW requested that DNR produce a preliminary best interest finding for the potential disposal of lands in an exploration license. They stated that the solicitation document was vague and the area too large to allow for meaningful comment. A preliminary finding would allow for the state, applicant and public to engage in a meaningful exchange of information to enable a decision under Article VIII of the Alaska Land Act.

CW suggested that the DNR not overly phase our analysis of oil development. CW recommended DNR should take into account the reasonably foreseeable cumulative effects of the proposal. They are concerned that there is no existing infrastructure in the solicitation area to support oil and gas development. They are concerned that there is not a suitable location for oil and gas development because of the logistical constraints of the lack of roads and lack of deep-water port locations. Extreme weather is common in the area and could limit the siting of facilities in the solicitation area. CW stated that the solicitation materials do not provide adequate information regarding competing allowable uses and references the planning documents that address the other competing uses.

CW listed species of specific concern including bears, mountain goats, salmon, marine mammals, and migratory birds. The potential benefits to the state are low as the area has been previously explored with limited success, because of the logistical problems due to the remoteness of the solicitation area. They are concerned that DNR consider the threat of global climate change.

CW stated that due to this remoteness, spill response would be problematic and DNR should consider the problems associated with the most recent contingency plan associated with exploratory drilling near Katalla. Legal and illegal hunting has decreased the populations of some species and recommended a mitigation measure to not allow company employees to hunt or trap.

DNR response: Comments were solicited from the public on May 21, 2015 and the comment period was extended on June 8, 2015 to allow for public participation in the process until August 3, 2015. DO&G is issuing a preliminary best interest finding for this exploration license, and additional comments will be solicited following its issuance.

DO&G evaluates the cumulative effects of oil and gas development at several phases of the development because we learn more about the prospective project, initially through the proposal, and then again at later phases including a subsequent plan of exploration, plan of operation or a plan of development. If this project advances to those phases, DO&G will take the opportunity to take another hard look at the potential cumulative effects of the specific project plans. At this phase of approving the exploration license, DO&G evaluates the reasonably foreseeable effects of oil and gas development that extends beyond this initial phase and this is discussed in Chapter Eight, Reasonably Foreseeable Effects of Licensing and Subsequent Activities, of this best interest finding. The commenter expressed concerns regarding the exploration license area's propensity for dangerous weather conditions, and this is discussed in Chapter Three, Description of the License Area, in the discussion of the natural hazards. Logistics and facility siting may be a challenge for this project and the various agencies that are responsible for permitting, inspection and compliance are discussed in Chapter Seven, Governmental Powers to Regulate Oil and Gas, of this best interest finding. DO&G, in coordination, with these other agencies will remain responsible for reviewing applications for permits associated with this project and will continue to protect the state's interest when making decisions about specific plans for siting of facilities and logistics of future activities. Additionally, mitigation measures included in Chapter Nine address specific restrictions and protective measures for siting of facilities.

Protection and management of the species of concern listed in CW's comment is the responsibility of the Alaska Department of Fish and Game (ADF&G). As stated in Chapter Seven of this best interest finding, ADF&G has statutory responsibility to protect, maintain, and improve the fish, game, and aquatic plant resources of the state, and manage their use and development in the interest of the economy and general well-being of the people of the state (AS 16.05.020(2)), consistent with the sustained yield principle. Additionally, mitigation measures included in Chapter Nine address specific restrictions and protective measures for fish, wildlife and their habitat.

5. Barbara RadyKazdan

Silver Spring, MD, June 27, 2015

Ms. RadyKazdan is opposed to DNR using public funds for resource extraction in the Copper River region because of the importance of the commercial and subsistence fishing grounds in the region.

DNR response: DNR is not proposing to spend any public funds for resource extraction as a part of this exploration license associated with this best interest finding. All expenditures will be the responsibility of the licensee, and those expenditures will be reported to DO&G on an annual basis along with any seismic or exploration data gathered during that time.

As stated in Chapter Seven, *Governmental Powers to Regulate Oil and Gas*, of this best interest finding, ADF&G has statutory responsibility to protect, maintain, and improve the fish, game, and aquatic plant resources of the state, and manage their use and development in the interest of the economy and general well-being of the people of the state (AS 16.05.020(2)), consistent with the sustained yield principle.

6. U.S. Division of Agriculture, Forest Service

Anchorage, AK, July 9, 2015, Robert Skorkowsky, District Ranger

Mr. Skorkowsky commented on behalf of the United States Forest Service. Mr. Skorkowsky requested additional information on the proposal. It is unclear if the proposal is limited to parcels of surface estate owned by the state of Alaska or if it includes tidally influenced coastal lands and areas off shore.

Mr. Skorkowsky requested a more detailed map identifying the areas which are being considered for leasing. There is a 1992 Memorandum of Agreement (MOA) regarding the management of coastal lands in Alaska. That there is a multi-agency Copper River Delta Fish and Wildlife Management Area Memorandum of Understanding (MOU) from 1986 regarding cooperative management of the Copper River Delta Fish and Wildlife Management Area. Both the MOU and MOA contain agreements for interagency consultation prior to a disposal.

DNR response: The proposal and exploration license include areas offshore out to the 3-mile state boundary. The proposal was not limited and included lands owned by the United States Forest Service, however the exploration license is limited to state owned unencumbered lands. A more detailed map of the exploration license and surrounding land ownership is included in Chapter Three, Description of the License Area, of this best interest finding.

In accordance with the 1986 MOU, DO&G held a meeting with the participating agencies to review the proposal and solicited comments and suggestions for mitigation measures as required by the MOU. Many of the suggested mitigation measures have been included in Chapter Nine to address citing of facilities, seasonal restrictions and other protective measures for fish, wildlife and habitat.

In accordance with the MOA, DO&G and the Forest Service conducted separate meetings to discuss the land ownership and management concepts outlined in the MOA. In Controller Bay, state-owned tidal and submerged lands were uplifted as a result of the 1964 earthquake. Acreage that was previously below the mean high tide line are now state-owned uplands. DNR is seeking quiet title to the coastal lands defined in the MOA and is including those coastal lands within the boundary of the License Area.

7. David Lynn Grimes

Cordova, AK, July 14, 2015

Mr. Grimes stated that he is interested in the conservation of fish and wildlife habitat in the state's best interest. Oil and gas development leads to industrial spills and accidents. The Alaska Coastal

Current would carry any spills into the ocean towards the Copper River Delta and Prince William Sound which is still recovering from the 1989 *Exxon Valdez* Oil Spill. A spill could result in negative effects on the salmon industry in Alaska. The Copper River Delta Critical Habitat Area is managed for the conservation of fish, wildlife, and their habitat.

Mr. Grimes stated the region is considered the jewel in the crown of the Western Hemisphere flyway because of its crucial role in the survival of coastal migratory water birds. The Copper River Delta has been designated a Western Hemisphere Shorebird Reserve Hemisphere Site.

DNR response: DNR recognizes the importance of conservation of fish, wildlife and their habitat in concert with the state's constitutional mandate to maximize the state's natural resources. As stated in Chapter Seven, Governmental Powers to Regulate Oil and Gas, of this best interest finding, ADF&G has statutory responsibility to protect, maintain, and improve the fish, game, and aquatic plant resources of the state, and manage their use and development in the interest of the economy and general well-being of the people of the state (AS 16.05.020(2)), consistent with the sustained yield principle. Additionally, Chapter Seven identifies the agencies responsible for regulating and responding to any release of fuels or hazardous substances and the review and permitting of exploration activities will be coordinated through DEC's Spill Prevention and Response program as well as the U.S. Coast Guard.

DNR has considered the comments and the identified concerns. In the written finding, mitigation measures described in Chapter Nine are established to reduce the potential for oil spills and minimize the impacts of all spills through contingency plans and spill response plans.

DNR included additional mitigation measures in this written finding to prohibit surface activities in the Copper River Delta State Critical Habitat Area for this exploration license, as well as impose seasonal restrictions and other protective measures for fish, wildlife and their habitat.

8. Cordova District Fishermen United

Cordova, AK, July 28, 2015, Alexis Cooper, Executive Director

Ms. Cooper stated that the Cordova District Fishermen United (CDFU) currently represents over 800 fishing families in the Prince William Sound and Copper River Delta Region. Their mission is to preserve, promote, and perpetuate that commercial fishing industry for future generations. The Copper River is home to a world-class salmon fishery that has supported the livelihoods of commercial fishermen, the community of Cordova, the State Alaska and native Alaskans for generations.

CDFU cited a June 2015 McDowell Group report on the economic impact of the commercial fishing industry in Southcentral Alaska communities, which notes Cordova as the most seafood dependent community in the region and 14th among US fishing ports in terms of value and volume. Portions of the solicitation area are within the ADF&G commercial fishing district boundaries where up to 300 vessels can be fishing.

The coastal area in the Gulf of Alaska provides habitat for Pacific herring and Weathervane scallop that hold subsistence and commercial value. CDFU stated that following the *Exxon Valdez* Oil Spill the face of the community and the abundance of fishing opportunities was forever changed. Their organization does not believe that exploration or lease sales in the area are in the best interests of

the state of Alaska until technologies become available that do not pose a substantial risk to the renewable resources and industry of the region.

DNR response: DNR understands the importance of the commercial fishing industry in the Gulf of Alaska and specifically the Copper River delta region. For these reasons, DNR has included additional mitigation measures in this best interest finding to prohibit surface activities in the Copper River Delta State Critical Habitat Area associated with the exploration license. DNR also recognizes the potential effects from oil and gas exploration and development and we have included an evaluation of these reasonably foreseeable effects in Chapter Eight, Reasonably Foreseeable Effects of Licensing and Subsequent Activity, of this best interest finding. Additionally, DNR has included mitigation measures in Chapter Nine of this best interest finding to reduce and minimize those potential impacts.

Spill response techniques and technology have improved since the time of the Exxon Valdez oil spill and other agencies including ADEC are responsible for review of spill prevention and response plans for any proposed activity associated with this exploration license. Those responsibilities are discussed in Chapter Seven, Governmental Powers to Regulate Oil and Gas, of this best interest finding.

9. Copper River Watershed Project

Cordova, AK, July 29, 2015, Kristin Carpenter, Executive Director

The Copper River Watershed Project (CRWP) stated they support sustainable economic development for the watershed but concluded that oil development presents a conflict with fisheries resources that support the southcentral Alaskan economy. The Copper River Delta State Critical Habitat Area was created to protect fisheries, waterfowl, and shorebird resources in the coastal area. The State of Alaska entered into a Memorandum of Understanding with the U.S. Department of Agriculture, Western Hemisphere Shorebird Reserve Network, the Chugach Alaska Corporation, the Eyak Corporation, the City of Cordova, and the USFWS to administer lands within the Critical Habitat Area and the Copper River Delta Shorebird Unit consistent with the legislature's intent for those lands and with the Prince William Sound Area Plan.

In their letter, they describe that salmon and scallop fisheries are managed by the state of Alaska near Kayak Island and along the entire coast north of Yakutat. These fisheries occur less than three miles off shore and could be greatly affected by an oil spill in that area. CRWP contends that allowing oil and gas development will create a “public risk for private gain” situation where the fisheries resource users with the most to lose have the least amount of control over how the oil and gas resources are developed.

The region has first-hand experience with an oil transport disaster with the *Exxon Valdez* which affected pink salmon prices for 15 years, and losses were felt throughout the fishing industry. Polycyclic aromatic hydrocarbons (PAH's), which are the residual part of oil particles are now known to be 1,000 times more toxic than previously accounted for. CRWP stated that the sandy beaches in the Copper River Delta area would be more difficult to clean up from an oil spill than the rocky shores in Prince William Sound. CRWP also stated that the Division of Geological and Geophysical Surveys already analyzed this area for Lease Sale 79 and concluded that "natural processes in this area will impose severe constraints to exploration, production, and transportation

activities associated with possible petroleum development". CRWP stated that the same concerns still exist today.

DNR response: DNR understands the importance of the commercial fishing industry in the Gulf of Alaska and specifically the Copper River delta region. For these reasons, DNR has included additional mitigation measures to prohibit surface activities in the Copper River Delta State Critical Habitat Area in this exploration license. DNR also recognizes the potential effects from oil and gas exploration and development and we have included an evaluation of these reasonably foreseeable effects in Chapter Eight, Reasonably Foreseeable Effects of Licensing and Subsequent Activities, of this best interest finding. Additionally, DNR has included mitigation measures in Chapter Nine of this best interest finding to reduce and minimize those potential impacts.

Spill response techniques and technology have improved since the time of the Exxon Valdez oil spill and other agencies including ADEC are responsible for review of spill prevention and response plans for any proposed activity associated with this exploration license. Those responsibilities are discussed in Chapter Seven, Governmental Powers to Regulate Oil and Gas, of this best interest finding.

DNR recognizes the limitations and constraints that the weather and exposed coastline will have on any future infrastructure and oil and gas activities in the region. The natural hazards of this region are discussed in Chapter Three, Description of the License Area. It is the responsibility of the licensee to prepare for adverse conditions, and the responsibility of ADEC and other governmental agencies to ensure that plans are in place and approved to prevent any release of hazardous substances as a result of dangerous conditions.

10. ADF&G Division of Habitat

July 30, 2015, Greg Albrecht, Habitat Biologist

Mr. Albrecht represents the ADF&G Division of Habitat and has coordinated this request for comments and agency information with Region I and Region II staff from the Divisions of Habitat, Subsistence, Sport Fish, Commercial Fisheries, and Wildlife Conservation. He stated the Yakataga State Game Refuge (YSGR) is in the solicitation area and was established to protect fish and wildlife habitat and populations, public use of fish, wildlife, and their habitat, and the use and disposition of other resources when the activities are not inconsistent with those protections.

The YSGR Management Plan requires nonrenewable resource exploration and extraction to be conducted in a manner compatible with the goals and policies of the YSGR Management Plan. The Copper River Delta Critical Habitat Area which lies west of Point Martin was established by the Alaska Legislature in 1978 to protect and preserve habitat areas especially crucial for the perpetuation of fish and wildlife. Each spring, approximately 12 million shorebirds (the largest gathering in the western hemisphere) stop along the shores of the Copper River Delta on their way to nesting grounds further north. Several special area permits are required for activities conducted in the YSGR and CRDCHA.

Mr. Albrecht stated that activities below the ordinary high-water mark of waters identified in the Catalog of Waters Important for the Spawning, Rearing, or Migration of Anadromous Fishes require fish habitat permits pursuant to the Anadromous Fish Act (AS 16.05.871(b)). Activities in waterbodies containing resident fish require fish passage permits pursuant to the Fishway Act (AS

Appendix A: Summary of Comments and Responses

16.05.841). Mr. Albrecht attached a copy of the Copper River Delta Fish and Wildlife Interagency Memorandum of Understanding (MOU). Parties to the MOU agree to consult with each other before issuing authorizations for oil or mineral explorations. Cordova residents use the Copper River, its delta, and Kayak Island for subsistence fishing and hunting, and subsistence information for these areas will be available in fall 2015.

Mr. Albrecht stated that the rivers and streams in the solicitation area contain five species of Pacific salmon, cutthroat trout, Dolly Varden, char, steelhead, and eulachon. He listed several rivers in the area that are important systems for sockeye and Coho salmon harvest. Wildlife in the area includes moose, wolves, brown and black bear, goats, wolverine, small mammals, trumpeter swans, migratory birds. Mr. Albrecht stated that the Copper River Delta is listed on the Western Hemisphere Shorebird Reserve Network as a Site of Hemispheric Importance.

Mr. Albrecht stated the range of harvests for various species of game animals. Avoiding disturbance in areas where trumpeter swan nests, bear or wolf dens occur will minimize negative effects to these animals. Marine mammals in the area include harbor seals, Steller sea lions, killer whales, and pacific white-sided minke whales. The area is in the historical distribution of the North Pacific right whale which is endangered under the ESA and listed as depleted under the Marine Mammal Protection Act.

Mr. Albrecht stated that the endangered population of Steller sea lions west of Cape Suckling has an active haul out at Cape St. Elias, and up to 1,490 animals from the endangered western Distinct Population and the delisted eastern Distinct Population Segment have been observed at this location during ADF&G surveys. The highest densities of hauled out harbor seals occur on the shores of Vitus Lake, the Seal River, and along the shoreline west to Kayak Island. The National Oceanic and Atmospheric Administration National Marine Fisheries Service is responsible for managing cetaceans and pinnipeds, except walrus, in U.S. waters.

DNR response: DNR understands the value and importance of the resources in the Yakataga State Game Refuge and the Copper River Delta State Critical Habitat Area and have included mitigation measures into this written finding to prohibit surface activities in the Copper River Delta State Critical Habitat Area from this exploration license. The License Area is approximately 60 miles west of the Cape Yakataga State Game Refuge.

Chapter Four, Fish Wildlife and Habitat considers and discusses the various species that reside and migrate through the License Area. Chapter Five considers the current and projected uses of the License Area. Chapter Seven, Governmental Powers to Regulate Oil and Gas, discusses how the licensee is responsible for knowing and complying with all applicable state, federal, and local laws, regulations, policies, and ordinances. Reasonably foreseeable effects from oil and gas exploration and development are considered and discussed in Chapter Eight of this best interest finding. Mitigation measures to prevent and reduce adverse effects are included in Chapter Nine of this best interest finding to reduce the potential for adverse effects to the fish wildlife and habitat in and around the License Area.

11. Alaska Scallop Association

Cordova, AK, July 31, 2015, Bruce Weyhrauch, Legal Counsel

Mr. Weyhrauch stated concern over interactions between oil and gas exploration and scallop fishing activities. Commercial scallop fishermen should be compensated from a fund financed by exploration companies if gear or vessels are damaged or lost. Scallop fishermen should be compensated for any lost habitat due to exploration activities in the Solicitation Area. The Solicitation Area contains some of the highest known densities of weathervane scallops in Alaska.

Mr. Weyhrauch stated that fishing season for weathervane scallops is generally from July 1 - February 15. There is a scallop Fisheries Management Plan and the scallop fishery is managed by ADF&G and National Marine Fisheries Service (NMFS). The Fisheries Management Plan outlines concerns about oil and gas exploration as well as a list of recommendations. Oil and gas exploration should be prohibited or limited in the solicitation area.

Mr. Weyhrauch also included a petition to adopt regulations so that DNR would establish a compensation fund financed by the exploration companies to reimburse fishermen for any claimed damages resulting from interactions with oil and gas activities.

DNR response: DNR received, responded to, and denied Mr. Weyhrauch's petition to adopt regulations regarding a compensation fund to reimburse fishermen for claimed damages from interactions with oil and gas activities. Any damage to fishing vessels or equipment from oil and gas infrastructure would be negotiated with the operator on a case by case basis.

DNR appreciates the importance of the scallop fishing industry and has excluded the areas that are identified as scallop fishing grounds in this proposed exploration license. DNR has considered the comments and the identified concerns. In the written finding, Chapter Seven, Governmental Powers to Regulate Oil and Gas, of this written finding identifies ADF&G and NMFS's role in regulating the fishery.

12. Lauren Padawer

Cordova, AK, August 2, 2015

Ms. Padawer stated that she is concerned about the current application for oil and gas exploration in the Copper River Delta and the Gulf of Alaska. The area consists of prime commercial and subsistence fishing grounds for Copper River salmon. She believes there would be significant adverse impacts to fish and wildlife species and their habitats and the uses of those resources.

DNR response: DNR has considered the comments and the identified concerns. In the written finding, reasonably foreseeable effects from oil and gas exploration and development are considered and discussed in Chapter Eight of this best interest finding. Upon identifying reasonably foreseeable effects to fish and wildlife and their habitats, mitigation measures are developed to mitigate or eliminate those identified effects. Mitigation measures to prevent and reduce adverse effects are included in Chapter Nine of this best interest.

13. Melissa Fraser

Cordova, AK, August 2, 2015

Ms. Fraser stated she is against the exploration and extraction of any oil in the Gulf of Alaska.

DNR response: The Alaska Constitution provides that the state’s policy is “to encourage...the development of its resources by making them available for maximum use consistent with the public interest” and that the “legislature shall provide for the utilization, development, and conservation of all natural resources belonging to the State...for the maximum benefit of its people” (Alaska Constitution, article VIII, §1 and 2). Exploring for oil and gas resources is a vital part of that mandate, and the exploration licensing is an important program to discover and maximize those resources.

Reasonably foreseeable effects from oil and gas exploration and development are considered and discussed in Chapter Eight of this best interest finding. Mitigation measures to prevent and reduce adverse effects are included in Chapter Nine of this best interest finding to reduce the potential for adverse effects to the environment.

14. Ryan Schuetze

Cordova, AK, August 2, 2015

Mr. Schuetze stated that he is strongly opposed to any oil and gas exploration in the Gulf of Alaska or Copper River Delta. He is a commercial fisherman and resident of Cordova and does not trust any assurances that there would be no risk, and that Cordova would likely not benefit financially from any development taking place in the area because of the lack of infrastructure and borough to collect taxes. Because the comment period was open during fishing season that the comment period should be extended until the middle of September to allow community members to become better educated on the topic.

DNR response: The Alaska Constitution provides that the state’s policy is “to encourage...the development of its resources by making them available for maximum use consistent with the public interest” and that the “legislature shall provide for the utilization, development, and conservation of all natural resources belonging to the State...for the maximum benefit of its people” (Alaska Constitution, article VIII, §1 and 2). Exploring for oil and gas resources is a vital part of that mandate, and the exploration licensing is an important program to discover and maximize those resources.

Comments were solicited from the public on May 21, 2015 and the comment period was extended on June 8, 2015 to allow for public participation in the process until August 3, 2015.

Reasonably foreseeable effects from oil and gas exploration and development are considered and discussed in Chapter Eight of this best interest finding. Mitigation measures to prevent and reduce adverse effects are included in Chapter Nine of this best interest finding to reduce the potential for adverse effects to the environment.

15. Erica Clark

August 2, 2015

Ms. Clark stated that she is strongly opposed to any oil and gas exploration or lease in the Gulf of Alaska and the Copper River Delta. Hundreds of Alaskan families depend on these waters as a source of income from commercial fishing. The potential negative impacts of exploration could have catastrophic financial impacts.

DNR response: The Alaska Constitution provides that the state’s policy is “to encourage...the development of its resources by making them available for maximum use consistent with the public interest” and that the “legislature shall provide for the utilization, development, and conservation of all natural resources belonging to the State...for the maximum benefit of its people” (Alaska Constitution, article VIII, §1 and 2). Exploring for oil and gas resources is a vital part of that mandate, and the exploration licensing is an important program to discover and maximize those resources.

DNR has considered the comments and the identified concerns. In the written finding, reasonably foreseeable effects from oil and gas exploration and development are considered and discussed in Chapter Eight of this best interest finding. Mitigation measures to prevent and reduce adverse effects are included in Chapter Nine of this best interest finding to reduce the potential for adverse effects to the environment.

16. U.S. Division of Agriculture, Forest Service

Anchorage, AK, August 3, 2015, Robert Skorkowsky, District Ranger

Mr. Skorkowsky stated National Forest Service Lands within the solicitation area are managed with the primary objective for the conservation of fish and wildlife and their habitat. Mr. Skorkowsky stated that this stems from ANILCA Section 501. United States Department of Agriculture, United States Forest Service (USFS) with the Bureau of Land Management, ADF&G, United States Fish and Wildlife Service are parties to a Memorandum of Understanding (MOU). If proposals are received that could affect the Management Area or coastal lands within the Chugach National Forest Boundary, interagency consultation is required prior to the issuance of leases for oil, minerals or other resource development activities.

Mr. Skorkowsky requested the opportunity to consult and concur with the proposals prior to issuance of any license, permit or other authorization. Mr. Skorkowsky also provided a Memorandum of Agreement (MOA) regarding the management of coastal lands in which the DNR and USFS have agreed to obtain written concurrence when a permitted or leased use of coastal lands is anticipated to exceed 10 years. The coastal lands in the area are considered to have a high probability for the presence of archaeological sites according to Forest Service heritage specialist. Several of the sites are pending adjudication and possible conveyance to the Chugach Alaska Corporation.

Mr. Skorkowsky stated a potential for oil and gas development increases the potential for an oil spill. Gulf of Alaska currents move from east to west, so any release would likely be carried to the Bering and Copper River Deltas with drastic effects on prime salmon habitat and economic impacts as well.

DNR response: The exploration license boundary is limited to state owned unencumbered lands. A more detailed map of the exploration license and surrounding land ownership is included in Chapter Three, Description of the License Area, of this best interest finding.

In accordance with the 1986 MOU, DO&G held a meeting with the participating agencies to review the proposal and solicited comments and suggestions for mitigation measures as required by the MOU. Many of the suggested mitigation measures have been included in Chapter Nine to address citing of facilities, seasonal restrictions and other protective measures for fish, wildlife, and habitat.

In accordance with the MOA, DO&G and the Forest Service conducted separate meetings to discuss the land ownership and management concepts outlined in the MOA. In Controller Bay, state-owned tidal and submerged lands were uplifted as a result of the 1964 earthquake. Acreage that was previously below the mean high tide line are now state-owned uplands. DNR is seeking quiet title to the coastal lands defined in the MOA and is including those coastal lands within the boundary of the License Area.

17. Ellen Americus

Cordova, AK, August 3, 2015

Ms. Americus requested that no oil and gas exploration occur in the Gulf of Alaska because the area is one of the richest areas for wildlife on the planet, and it should be protected as a national park.

DNR response: It is outside DNR's authority to recommend or administer lands to create a national park. Additionally, it is beyond the scope of this best interest finding to discuss changes of land ownership. DNR recognizes the importance of fish and wildlife to the region and have made a decision to include additional mitigation measures prohibiting surface activities within the Copper River Delta State Critical Habitat Area in an effort to support the conservation of the region's fish, wildlife, and habitat as well as many other mitigation measures designed to protect the fish, wildlife and habitats of the License Area.

18. Prince William Sound Audubon Society

Cordova, AK, August 3, 2015, Mary Anne Bishop, President

The Prince William Sound Audubon Society (PWSAS) is based in Cordova and represents members from Cordova and throughout the Prince William Sound region. PWSAS stated that there are several geographic areas within the proposed drilling area that provide critical habitat for fish and wildlife. Icy Bay is critical foraging habitat for marbled murrelet and Kittlitz's murrelet.

PWSAS stated that the Tsiu River has a world class salmon run and several fishing lodges are located on the river. Kayak Island has a Stellar Sea Lion rookery, a black-legged kittiwake colony, and are spawning grounds for Pacific herring. Wingham Island and the Martin Islands all have seabird colonies. The Martin Islands are also an important haul out area for sea lions. The mudflats at Controller Bay provide waterfowl and shorebird habitat and large flocks of snow geese, scoters, and other waterfowl are regularly observed in Controller Bay.

PWSAS stated that studies show the importance of the region as a stopover for many migratory bird species. Salmon runs in the region are the fishing grounds for local subsistence use and a commercial gillnet fleet with over 500 permits. They are concerned about the cumulative impacts oil and gas drilling could have on the fish and wildlife resources in the proposed area. They are also concerned that the area has been identified as a likely site for a future earthquake and that future oil and gas exploration should be banned in the area.

DNR response: DNR understands the value of the state critical habitats in the region and has included additional mitigation measures that prohibit surface activities within the Copper River Delta State Critical Habitat Area, and have excluded Icy Bay, or the Tsiu River drainage in this exploration license. As explained in Chapter Seven, Governmental Powers to Regulate Oil and Gas, it is the role of ADF&G to review each permit application for activities associated with this exploration license or any other activity before it may commence and determine if those activities will adversely affect the natural habitat and the resident and migratory species of concern.

The natural hazards of this region are considered and discussed in Chapter Three, Description of the License Area, of this best interest finding including earthquakes, glacial outburst flooding, and the climate and weather. It is the responsibility of the licensee to plan and prepare for these hazards, however, spill prevention and contingency plans will be required and reviewed by ADEC as discussed in Chapter Seven, Governmental Powers to Regulate Oil and Gas, of this best interest finding to mitigate these potential hazards during activities on the license.

DNR also recognizes the potential effects from oil and gas exploration and development and we have included an evaluation of these reasonably foreseeable effects in Chapter Eight, Reasonably Foreseeable Effects of Licensing and Subsequent Activity, of this best interest finding. Additionally, DNR has included mitigation measures in Chapter Nine of this best interest finding to reduce and minimize those potential impacts.

19. Dune Lankard

Cordova, AK, August 3, 2015

Mr. Lankard stated that he is opposed to any oil and gas drilling in the Copper River Delta or Gulf of Alaska region. The applicants for the exploration license should be identified to the public. Only a small amount of oil was ever recovered in the region. There are still effects from the *Exxon Valdez* Oil Spill that have not been cleaned up and the wildlife has not recovered.

Mr. Lankard stated that the region is critical habitat for fish and wildlife and that the communities rely on subsistence and commercial fishing. The region is an earthquake zone. The area's glaciers are melting rapidly and icebergs from the Bering Glacier are a hazard for boat traffic. Glacial outburst flooding can occur in the Bering, Yagataga, and White Rivers.

Mr. Lankard is an Eyak Athabaskan Native, subsistence and commercial fisherman, and the Eyak people have survived and thrived in this region for 3,500 years and that the region is sacred to them. Alaska is experiencing climate change and if development is allowed to occur then the companies and government should establish a restoration fund to compensate people for a lost economy and clean up the environment.

DNR response: DNR understands the value of the habitats in the region and has included additional mitigation measures that prohibit surface activities within the Copper River Delta State Critical Habitat Area in this exploration license, among many other mitigation measures designed to protect the fish, wildlife and habitats of the License Area.

The natural hazards of this region are considered and discussed in Chapter Three, Description of the License Area, of this best interest finding including earthquakes, glacial outburst flooding, and the climate and weather. It is the responsibility of the licensee to plan and prepare for these hazards, however, spill prevention and contingency plans will be required and reviewed by ADEC as discussed in Chapter Seven, Governmental Powers to Regulate Oil and Gas, of this written finding to mitigate these potential hazards during activities on the license.

DNR has considered the comments and the identified concerns. In the written finding, the current and projected uses of the area including subsistence, commercial and sport fishing are discussed in Chapter Five, Current and Projected Uses, and a description of the salmon resources, as well as other species that inhabit and migrate through the License Area are discussed in Chapter Four, Habitats, Fish, and Wildlife. Under AS 38.05.035(g)(vi) DNR must discuss the “reasonably foreseeable cumulative effects of oil and gas exploration, development, production, and transportation on the License Area, including effects on subsistence uses, fish and wildlife habitat and populations and their uses, and historic and cultural resources.” This is done in Chapter Eight, Reasonably Foreseeable Effects of Licensing and Subsequent Activities. Mitigation measures in Chapter Nine provide that the commissioner will restrict lease-related use when he or she determines it is necessary to prevent unreasonable conflicts with subsistence harvests and commercial fishing.

20. Department of Interior, National Park Service

Anchorage, AK, August 3, 2015, Debora Cooper, Associate Regional Director for Resources

Ms. Cooper represents the National Park Service (NPS) and stated that portions of the Wrangell-Saint Elias National Park (WSNP) are within the exploration solicitation area. There are state lands within the park boundary and the solicitation area and NPS stated that oil or gas operations on state lands within the boundary of the National Park would be subject to NPS regulations.

NPS stated that the Wrangell Saint. Elias National Park was established by ANILCA to maintain unimpaired scenic beauty and wildlife and for recreational opportunities. The state's planning process should recognize the resources and values for which the WSNP was established and fully evaluate effects on the NPS values. NPS resources and values should be evaluated on lands adjacent to the park as well. No authority to lease federally owned minerals in NPS units in Alaska has been provided by Congress.

NPS stated that if drilling and production occur on state lands that could result in drainage of federally owned minerals, the NPS would notify the BLM. If damage is caused to park resources in the park boundary from operations outside the boundary, the NPS has authority to recover up to treble damages under the System Unit Resource Protection Act 54 USC 100722. They are concerned about short-term and long-term impacts to park resources. NPS requested continuing dialog with the Division and other stakeholders for the continued development of exploration project stipulations, and that the solicitation boundary be altered to exclude NPS administered areas.

NPS stated that it would be prudent to exclude areas interior and in front of Icy Bay from the solicitation boundary because of the presence of marine mammal pupping areas. They suggested a 1-3-mile distance for any oil and gas activity from a park boundary. NPS requested the opportunity to review exploration license or lease sale information when it is available, especially on lands which may occur near the boundaries of the park.

DNR response: DNR has excluded any national park lands in this exploration license. The solicitation area boundary was drawn to be inclusive of surrounding areas and lands that are not owned by the State of Alaska in order to solicit comments from stakeholders outside the boundaries of this exploration license.

DNR will not be adding a new mitigation measure as suggested by NPS. Other mitigation measures along with state and federal requirements are sufficient to protect park resources. Regarding concerns about drainage, Alaska Oil and Gas Conservation Commission statutes were established to, among other things, protect correlative rights.

Chapter Four, Habitats, Fish, and Wildlife, discussion includes state and federally managed refuges, critical habitat area, parks and preserves, and other designated areas. Chapter Four also states that specific legislation provides additional protection of habitat that is important to fish and wildlife populations and recreational opportunities.

21. Eyak Preservation Council

Cordova, AK, August 3, 2015, Carol Hoover, Executive Director

The Eyak Preservation Council (EPC) stated that the proposed area is known as one of the richest wildlife and wild salmon ecological baseline regions of coastlands and waters in North America. The area is designated critical habitat for many plant and wildlife species. The area supports one of the most valued commercial fisheries in Alaska famous for returns of salmon. These fisheries are successful because there is no oil and gas operations in the region. The area supports commercial tourism, hunting, and sport fishing. The subsistence users of the region are very significant, which support the Indigenous population and their cultural history.

EPC stated that the area contains archaeological sites that must be respected and preserved. Previous attempts for oil and gas exploration have been shut down because of lack of resource findings, severe weather, opposition from the regional communities, fishing and science-based groups, and state and federal policy makers. There is no evidence that oil and gas activities are safe for the environment. Increased pollution and the risk of an oil spill would threaten the salmon in the area.

EPC stated that the region is still suffering environmentally, economically, and socially from the 1989 *Exxon Valdez* Oil Spill. EPC stated that the 1993 Hazards section from Oil and Gas Lease Sale 79 states known hazards include earthquakes, seafloor hazards, tsunamis, volcanic eruptions, icebergs, glacial outburst flooding, landslides, avalanches, and severe storms as some of the regional concerns. The Lease Sale 79 overlaps some of the same areas in this solicitation. Climate change may heighten the geologic hazards.

EPC stated that research shows that ocean currents and winds in the region could bring an oil spill towards Cordova. They are adamantly opposed to this proposed exploration license application and requested that the DNR deny the request.

DNR response: DNR recognizes the importance of fish and wildlife to the region and have made a decision to include additional mitigation measures prohibiting surface activities within the Copper River Delta State Critical Habitat Area in an effort to support the conservation of the region’s fish, wildlife, and habitat as well as many other mitigation measures designed to protect the fish, wildlife and habitats of the License Area.

The cultural resources and history of the region are discussed in Chapter Three, Description of the License Area. The management of cultural resources for the state are enforced by the Office of History and Archaeology, and their role in protecting the cultural resources are discussed in Chapter Three, and in additional detail in Chapter Seven, Governmental Powers to Regulate Oil and Gas. Additionally, mitigation measures are included in this best interest finding to protect and preserve the cultural resources within the License Area.

The natural hazards of this region are considered and discussed in Chapter Three, Description of the License Area, of this best interest finding including earthquakes, glacial outburst flooding, and the climate and weather. It is the responsibility of the licensee to plan and prepare for these hazards, however, spill prevention and contingency plans will be required and reviewed by ADEC as discussed in Chapter Seven, Governmental Powers to Regulate Oil and Gas, of this written finding to mitigate these potential hazards during activities on the License Area.

DNR has considered the comments and the identified concerns. In the written finding, the current and projected uses of the area including subsistence, commercial and sport fishing are discussed in Chapter Five, Current and Projected Uses, and a description of the salmon resources, as well as other species that inhabit and migrate through the License Area are discussed in Chapter Four, Habitats, Fish, and Wildlife. Under AS 38.05.035(g)(vi) DNR must discuss the “reasonably foreseeable cumulative effects of oil and gas exploration, development, production, and transportation on the License Area, including effects on subsistence uses, fish and wildlife habitat and populations and their uses, and historic and cultural resources.” This is done in Chapter Eight, Reasonably Foreseeable Effects of Licensing and Subsequent Activities. Mitigation measures in Chapter Nine provide that the commissioner will restrict lease-related use when he or she determines it is necessary to prevent unreasonable conflicts with subsistence harvests and commercial fishing.

A discussion of the spill response techniques and technology and how they have improved since the time of the Exxon Valdez oil spill is included in Chapter Six. Other agencies including ADEC and United States Coast Guard are responsible for review of spill prevention and response plans for any proposed activity associated with this exploration license. Those responsibilities are discussed in Chapter Seven of this best interest finding.

22. Sarah Keller

Fairbanks, AK, August 3, 2015

Ms. Keller stated that she is concerned that oil and gas exploration is incompatible with irreplaceable habitat for avian species that use the area for breeding, resting, and feeding during spring and fall migrations. She is concerned about the salmon industry in the event of an oil spill. The weather and ocean conditions in this region are harsh and unpredictable. The area is a very

active seismic zone and it would seem unwise to risk additional lives, habitat, and state equipment on exploration in this area. This is a risky and expensive area to look for oil and gas.

DNR response: DNR recognizes the importance of fish and wildlife to the region and have made a decision to include additional mitigation measures prohibiting surface activities within the Copper River Delta State Critical Habitat Area in an effort to support the conservation of the region's fish, wildlife, and habitat as well as many other mitigation measures designed to protect the fish, wildlife, and habitats of the License Area.

DNR recognizes the limitations and constraints that the weather and exposed coastline, and seismic activity will have on any future infrastructure and oil and gas activities in the region. The natural hazards of this region are discussed in Chapter Three, Description of the License Area. It is the responsibility of the licensee to prepare for adverse conditions, and the responsibility of ADEC and other governmental agencies to ensure that plans are in place and approved to prevent any release of hazardous substances as a result of dangerous conditions. DNR also recognizes the potential effects from oil and gas exploration and development and we have included an evaluation of these reasonably foreseeable effects in Chapter Eight, of this best interest finding. Additionally, DNR has included mitigation measures in Chapter Nine of this best interest finding to reduce and minimize those potential effects.

23. U.S. Department of Interior, Fish and Wildlife Service

Anchorage, AK, August 3, 2015, Catherine Yeargan, Fish and Wildlife Biologist

U.S. Department of Interior, Fish and Wildlife Service (USFWS) stated that the project description and accompanying map do not provide enough information for the USFWS to adequately review the project for impacts. USFWS stated that these comments are general in nature and subject to revision as additional project information becomes available.

USFWS stated that the short-tailed albatross is an endangered species listed under the Endangered Species Act. USFWS stated the short-tailed albatross forage along the continental shelf of the Gulf of Alaska. USFWS stated that the potential effects of oil spills include oiling of feathers that can lead to decreased insulation and hypothermia, and ingestion of contaminated food items.

USFWS stated Northern sea otters can be found in the solicitation area and are protected under the Marine Mammal Protection Act. USFWS stated that oil and gas activities may result in take of sea otters, seismic operations can produce sound levels that have potential to cause hearing damage, and they are susceptible to the acute and chronic effects of spills in the marine environment. USFWS stated that the operator should contact USFWS Marine Mammals Management Office prior to conducting oil and gas activities that may result in take of otters.

USFWS stated that migratory birds are protected under the Migratory Bird Treaty Act. Migratory birds including bald eagles, can be sensitive to habitat alterations. USFWS suggested that the National Bald Eagle Management Guidelines should be consulted to avoid the risk of impacting eagles. USFWS stated that Controller Bay and the Bering River Delta are heavily used by shorebirds during spring migration.

USFWS stated the nearby Copper River Delta is one of the most important shorebird concentration sites in the world. USFWS listed several shorebirds that utilize this area during migration. USFWS stated that 12 seabird species are known to breed at colonies within the solicitation area. Four of those shorebirds are priority bird species for the USFWS in Alaska. Those priority species include the Aleutian tern, red-faced cormorant, Kittlitz's murrelet, and marbled murrelet. USFWS stated that because of the importance of the area to migratory birds, USFWS recommends careful evaluation of proposed activities' impacts on the resources.

USFWS stated they are concerned about the effects that a large oil spill could have during spring migration. USFWS stated that spilled oil could be swept into the mudflats of the Copper River and Bering River Deltas and impact important food sources that the shorebirds rely on.

DNR response: DNR recognizes the importance of fish and wildlife to the region and have made a decision to include additional mitigation measures prohibiting surface activities within the Copper River Delta State Critical Habitat Area in an effort to support the conservation of the region's fish, wildlife, and habitat as well as many other mitigation measures designed to protect the fish, wildlife and habitats of the License Area.

DNR also recognizes the potential effects from oil and gas exploration and development and we have included an evaluation of these reasonably foreseeable effects in Chapter Eight of this written finding. Chapter Seven, Governmental Powers to Regulate Oil and Gas identifies USFWS's authority to issue incidental take permits under the ESA. DNR also recognizes the potential effects from oil and gas exploration and development and we have included an evaluation of these reasonably foreseeable effects in Chapter Eight, of this best interest finding. Additionally, DNR has included mitigation measures in Chapter Nine of this best interest finding to reduce and minimize those potential effects.

The northern sea otters, bald eagle, short tailed albatross, Aleutian tern, red-faced cormorant, Kittlitz's murrelet, and marbled murrelet are discussed in Chapter Four, Habitats, Fish, and Wildlife, as well as effects on those species are discussed in Chapter Eight of this best interest finding. Sources provided from USFWS in their comments were utilized for the drafting of portions of this written finding.

A discussion of the spill response techniques and technology is included in Chapter Six including how technology has improved since the time of the Exxon Valdez oil spill. Other agencies including ADEC are responsible for review of spill prevention and response plans for any proposed activity associated with this exploration license. Those responsibilities are discussed in Chapter Seven, Governmental Powers to Regulate Oil and Gas, of this written finding.

24. Belle Mickelson

Cordova, AK August 3, 2015

Ms. Mickelson stated that she is a resident of Cordova, and against the proposed oil and gas exploration on the East Copper River Delta and Controller Bay to Icy Bay in the Gulf of Alaska. She stated that the wetlands produce some of the world's finest salmon, crab, halibut, and other fisheries, and contain critical habitat for shorebird migration.

Ms. Mickelson stated that the Copper River Delta and Controller Bay fisheries supported the economy of Cordova while the Prince William Sound fishery recovered from the *Exxon Valdez* Oil Spill. The spring shorebird migration is one of the wonders of the world and has the largest concentration of birds in the western hemisphere. Ms. Mickelson requested that DNR say no to the proposed oil and gas development in this area.

DNR response: DNR recognizes the importance of fish and wildlife to the region and have made a decision to include additional mitigation measures prohibiting surface activities within the Copper River Delta State Critical Habitat Area in an effort to support the conservation of the region's fish, wildlife, and habitat as well as many other mitigation measures designed to protect the fish, wildlife and habitats of the License Area. Chapter Seven, Governmental Powers to Regulate Oil and Gas, discusses how the licensee is responsible for knowing and complying with all applicable state, federal, and local laws, regulations, policies, and ordinances. DNR also recognizes the potential effects from oil and gas exploration and development and we have included an evaluation of these reasonably foreseeable effects in Chapter Eight, of this best interest finding. Additionally, DNR has included mitigation measures in Chapter Nine of this best interest finding to reduce and minimize those potential effects.

25. Julie Reynolds

Cordova, AK, August 3, 2015

Ms. Reynolds stated that she is living and raising her family in Cordova, and her husband makes a living fishing for salmon. Ms. Reynolds requested that the state not explore for oil or natural gas in the Copper River Delta or area west of Controller Bay to Icy Bay. Ms. Reynolds stated that the fishing fleet of Cordova already extract a precious, renewable natural resource from the area in salmon. Ms. Reynolds stated that exploring or extracting oil and gas from the area would negatively impact the salmon and her way of life.

DNR response: DNR recognizes the importance of fish and wildlife to the region and have made a decision to include additional mitigation measures prohibiting surface activities within the Copper River Delta State Critical Habitat Area in an effort to support the conservation of the region's fish, wildlife, and habitat as well as many other mitigation measures designed to protect the fish, wildlife and habitats of the License Area. DNR has considered the comments and the identified concerns. In the written finding, Chapter Seven, Governmental Powers to Regulate Oil and Gas, discusses how the licensee is responsible for knowing and complying with all applicable state, federal, and local laws, regulations, policies, and ordinances. DNR also recognizes the potential effects from oil and gas exploration and development and we have included an evaluation of these reasonably foreseeable effects in Chapter Eight, of this best interest finding. Additionally, DNR has included mitigation measures in Chapter Nine of this best interest finding to reduce and minimize those potential effects.

26. Pete Lowney

Valdez, AK, August 3, 2015

Mr. Lowney stated that he is completely opposed to the state opening the solicitation area for onshore and off shore oil and gas drilling. Mr. Lowney requested that the state extend the comment period by at least 30 days and that public meetings be held in the affected communities. Pristine areas of Alaska's coastline should be preserved for their wild, scenic, recreational, and habitat values. Mr. Lowney requested the state to reverse decisions allowing drilling in Bristol Bay and near ANWR.

DNR response: Reversal of the decisions regarding drilling in Bristol Bay and near the ANWR boundary are outside the scope of this best interest finding

DNR recognizes the importance of fish and wildlife to the region and have made a decision to include additional mitigation measures prohibiting surface activities within the Copper River Delta State Critical Habitat Area in an effort to support the conservation of the region's fish, wildlife, and habitat as well as many other mitigation measures designed to protect the fish, wildlife and habitats of the License Area.

DNR also recognizes the potential effects from oil and gas exploration and development and we have included an evaluation of these reasonably foreseeable effects in Chapter Eight, of this best interest finding. Additionally, DNR has included mitigation measures in Chapter Nine of this best interest finding to reduce and minimize those potential effects.

Comments were solicited from the public on May 21, 2015 and the comment period was extended on June 8, 2015 to allow for public participation in the process until August 3, 2015. The commissioner has the discretion to hold a public hearing under AS 38.05.946(a). No hearing is scheduled to be conducted at this time. Additionally, the director must make a written finding available before a public hearing can be conducted in accordance with AS 38.05.035(e)(6).

Appendix B: Gulf of Alaska Sample Exploration License

Oil and Gas Exploration License
Form #DOG 2013-09 EL

**STATE OF ALASKA
DEPARTMENT OF NATURAL RESOURCES**

**Gulf of Alaska Exploration License
ADL 393173**

THIS OIL AND GAS EXPLORATION LICENSE is issued by the State of Alaska, Department of Natural Resources ("the state" or "the department") to

Cassandra Energy Corporation

("the licensee") whether one or more, whose address for purposes of notification is set out in Paragraph 18.

In consideration of the nonrefundable Oil and Gas exploration license fee, work commitment, and performance bond, and subject to the provisions of this exploration license ("license"), including the attached schedules, and by reference, incorporated into this license, the state and the licensee agree as follows.

1. GRANT. (a) Subject to the provisions contained in this license, the state grants to the licensee the exclusive right to explore for Oil and Gas on the state lands described in Schedule 1 ("licensed land"), unless this license is terminated in whole or part under the provisions of this license or applicable statutes and regulations.

(b) This license may be converted to one or more Oil and Gas Leases under the provisions of AS 38.05.134 and 11 AAC 82.978.

(c) If the state's ownership interest in the Oil and Gas in the licensed land is less than an entire and undivided interest, the grant under this license is effective only as to the state's interest in that Oil and Gas.

(d) The state makes no representations or warranties, express or implied, as to title, or access to, or quiet enjoyment of, the licensed land. The state is not liable to the licensee for any deficiency in title to the licensed land, nor is the licensee or any successor in interest to the licensee entitled to any refund due to deficiency in title for work commitments or other expenditures made under this license.

2. RESERVED RIGHTS. (a) The state, for itself and others, reserves all rights not expressly granted to the licensee. These reserved rights include, but are not limited to:

(1) the right to dispose of to others the surface of the licensed land subject to the license, and the right to authorize others by grant, lease, or permit, subject to the license;

(2) the right to explore for Oil or Gas by geological or geophysical means including the drilling of shallow core holes or stratigraphic tests to a depth of not more than 1,000 feet;

(3) the right to explore for, develop, and remove natural resources other than Oil or Gas on or from the licensed land;

(4) the right to non-exclusive easements and rights-of-way for any lawful purpose, including shafts and tunnels necessary or appropriate for working of the licensed land or other land for natural resources other than Oil or Gas;

(5) the right to well sites and well bores of wells drilled from or through the licensed land to explore for or produce Oil, Gas, and Associated Substances in and from other land; and

(6) the right to undertake any other purpose authorized by law and not inconsistent with the rights under the license.

(b) Reserved rights may be exercised by the state, or by any person or entity acting under authority of the state, in any manner that does not unreasonably interfere with or endanger the licensee's operations under this license.

3. TERM. This license is issued for a term of **10** years from the Effective Date.

4. WORK COMMITMENT. This license is conditioned upon the performance of a work commitment, as required under AS 38.05.132, of **\$1,000,000.00**. Failure of the licensee to timely meet this work commitment

Appendix B: Gulf of Alaska Sample Exploration License

will result in the relinquishment, removal, or deletion of the licensed land, termination of this license, and forfeiture of the bond under the provisions of AS 38.05.132 and 11 AAC 82.903—11AAC82.990.

5. GEOLOGIC AND GEOPHYSICAL DATA. (a) On or before each Anniversary Date of the Effective Date of this license, the licensee shall submit to the department all geologic and geophysical data, as defined in 11 AAC 82.990, in accordance with 11 AAC 82.981 and 11 AAC 82.984.

6. DATA SUBMITTAL. (a) The licensee shall submit to the state, at the Department of Natural Resources, Division of Oil & Gas (Division), all geological, geophysical, and engineering data obtained from the license within 30 days following completion, abandonment, or suspension of each well, pilot hole, and plugged back well bore. The licensee shall also submit to the Division, on behalf of the state, data acquired subsequent to completion, abandonment, or suspension of each well, pilot hole, and plugged back well bore within 30 days following acquisition of those data. The Division, on behalf of the state, may waive receipt of operational data from some development, service, or injection wells, and will inform the operator of the waiver in writing prior to data submittal. Data shall be submitted according to the instructions set out in Attachment 1. Submission of data under this paragraph does not affect any statutory or regulatory obligation to submit data or other information to the state or any of its agencies.

(b) Any data submitted to the state, at the Department of Natural Resources, Division of Oil & Gas will be available at all times for use by the state and its agents, and will be held confidential as provided in AS 38.05.035(a)(8) and its applicable regulations. In accordance with AS 38.05.035(a)(8)(C), in order for geological, geophysical, and engineering data to be held confidential, the licensee must request confidentiality at the time of submission and mark the data "CONFIDENTIAL" in compliance with applicable regulations.

7. BONDING. (a) On or before the Effective Date of this license the licensee shall post, and during the term of this license the licensee shall maintain, a performance bond or other security in accordance with AS 38.05.132 and 11 AAC 82.945. The form to be used for bond calculations is incorporated as Schedule 2 to this license.

8. FORCE MAJEURE. (a) If by the fourth anniversary of this license the state determines that the licensee has been prevented by Force Majeure from performing an act that would maintain this license, the Effective Date of this license will be extended by adding the time lost as result of the Force Majeure.

(b) If Force Majeure occurs after the fourth anniversary and before the expiration of the term of this license, the term of this license will be extended by adding the period of time lost as a result of the Force Majeure.

9. AUDIT. The commissioner will, in the commissioner's discretion, audit expenditures as set out in 11 AAC 82.960. The licensee shall keep and have in its possession books and records showing all expenditures regarding the licensee's direct exploration expenditures, reports, data, or other information relevant to the drilling of an Oil and Gas exploration well or the gathering of geologic or geophysical data, whether or not that information is confidential. The licensee shall permit the state or its agents to examine these books and records at all reasonable times. Upon request by the state, the licensee's books and records must be made available to the state at the state office designated by the state. These books and records must employ methods and techniques that will ensure the most accurate figures reasonably available. The licensee shall use generally accepted accounting procedures consistently applied.

10. PLAN OF OPERATIONS. Before operations may be undertaken on the licensed land, the licensee shall comply with the applicable statutes and regulations in effect on the date the proposed activity is scheduled to commence, including the provisions of AS 38.05.130 and 11 AAC 82.951. Upon submission of a plan of operations, the licensee shall furnish a bond in accordance with 11 AAC 83.160.

11. INSPECTION. The licensee shall keep open at all reasonable times, for inspection by any duly authorized representative of the State of Alaska, the licensed land, all wells, improvements, machinery, and fixtures on the licensed land, and all reports and records relative to operations and surveys or investigations on or with regard to the licensed land or under this license. Upon request, the licensee shall furnish the State of Alaska with copies of and extracts from any such reports and records.

12. ASSIGNMENT. This license, or an interest in this license, may be assigned or otherwise transferred in accordance with 11 AAC 82.966, 11 AAC 82.969, and 11 AAC 82.972.

Appendix B: Gulf of Alaska Sample Exploration License

13. SURRENDER. The licensee may, at any time, file with the state a written surrender of rights under the provisions of 11 AAC 82.957.

14. TERMINATION. The commissioner will, in the commissioner's discretion, terminate this license under the provisions of 11 AAC 82.975 for the licensee's failure to comply with any of its provisions, applicable statutes, regulations, or stipulations.

15. RIGHTS UPON SURRENDER OR TERMINATION. (a) Upon the surrender or termination as to all or any portion of the licensed land, the state will direct the licensee in writing and the licensee will have the right at any time within a period of one year after the surrender or termination, or any extension of that period as the state may grant, to remove from the licensed land or portion of the licensed land all machinery, equipment, tools, and materials. Upon the expiration of that period or extension of that period and at the option of the state, any machinery, equipment, tools, and materials that the licensee has not removed from the licensed land or portion of the licensed land become the property of the state or may be removed by the state at the licensee's expense. At the option of the state, all improvements such as roads, pads, and wells must either be abandoned and the sites rehabilitated by the licensee to the satisfaction of the state, or be left intact and the licensee absolved of all further responsibility as to their maintenance, repair, and eventual abandonment and rehabilitation. Subject to the above conditions, the licensee shall deliver the licensed land or those portions of the licensed land in good condition.

(b) The state may require such financial assurances as the commissioner determines necessary to ensure the licensee's ability to meet its obligation under this paragraph. If at any time the commissioner determines that existing financial assurances are insufficient to satisfactorily guarantee the performance of all the licensee's obligations under this paragraph, the commissioner may require the delivery of such substitute or supplemental financial assurances as the commissioner determines necessary.

16. DAMAGES AND INDEMNIFICATION. (a) The licensee shall indemnify the state for, and hold it harmless from, any claim, including claims for loss or damage to property or injury to any person caused by or resulting from any act or omission committed under this license by or on behalf of the licensee. The licensee is not responsible to the state under this subparagraph for any loss, damage, or injury caused by or resulting from the sole negligence of the state.

(b) The licensee expressly waives any defense to an action for breach of a provision of this license or for damages resulting from an oil spill, well blow-out, or other harm to the environment that is based on an act or omission committed by an independent contractor in the licensee's employ. The licensee expressly agrees to assume responsibility for all actions of its independent contractors.

17. AUTHORIZED REPRESENTATIVES. The Director of the Division of Oil and Gas, Department of Natural Resources, State of Alaska, and the person executing this license on behalf of the licensee will be authorized representatives for their respective principals for the purposes of administering this license. The state or the licensee may change the designation of its authorized representative or the address to which notices to that representative are to be sent by a notice given in accordance with Paragraph 18 below. When activities under a plan of operations are underway, the licensee shall also designate, by notice under Paragraph 18 below, by name, job title, and address, an agent who will be present in the state during all license activities.

18. NOTICES; PROTEST. (a) Any notices required or permitted under this license must be by electronic media producing a permanent record or in writing and must be given personally or by registered or certified mail, return receipt requested, addressed as follows:

TO THE STATE:

DIRECTOR, DIVISION OF OIL AND GAS
DEPARTMENT OF NATURAL RESOURCES
550 WEST 7TH AVENUE, SUITE 1100
ANCHORAGE, ALASKA 99501-3563

TO THE LICENSEE:

Cassandra Energy Corporation
William H. Stevens

Appendix B: Gulf of Alaska Sample Exploration License

P.O. Box 8596
Nikiski, AK 99635

(b) Any notice given under this paragraph will be effective when delivered to the above authorized representative.

19. APPEALS. The licensee shall appeal decisions of the commissioner related to this license in accordance with 11 AAC 82.963.

20. STATUTES AND REGULATIONS. This license is subject to all applicable state and federal statutes and regulations in effect on the Effective Date of this license, and to all statutes and regulations placed in effect after the Effective Date of this license. A reference to a statute or regulation in this license includes any future change in that statute or regulation whether by amendment, repeal and replacement, or other means. This license does not limit the power of the State of Alaska or the United States of America to enact and enforce legislation or to promulgate and enforce regulations affecting, directly or indirectly, the activities of the licensee or its agents in connection with this license or the value of the interest held under this license. In case of conflicting provisions, statutes and regulations take precedence over this license.

21. INTERPRETATION. This license is to be interpreted in accordance with the rules applicable to the interpretation of contracts made in the State of Alaska. The paragraph headings are not part of this license and are inserted only for convenience. The state and the licensee expressly agree that the law of the State of Alaska will apply in any judicial proceeding affecting this license.

22. WAIVER OF CONDITIONS. The state reserves the right to waive any breach of a provision of this license, but any waiver extends only to the particular breach waived and does not limit the rights of the state with respect to any future breach; nor will the waiver of a particular breach prevent cancellation of this license for any other cause or for the same cause occurring at another time. Notwithstanding the foregoing, the state will not be deemed to have waived a provision of this license unless it does so in writing.

23. SEVERABILITY. If it is finally determined in any judicial proceeding that any provision of this license is invalid, the state and the licensee may jointly agree by a written amendment to this license that, in consideration of the provisions in that written amendment, the invalid portion will be treated as severed from this license and that the remainder of this license, as amended, will remain in effect.

24. LOCAL HIRE. The licensee is encouraged to hire and employ local and Alaska residents and companies, to the extent they are available and qualified, for work performed on the license area. Licensees shall submit, with the plans of operations, a proposal detailing the means by which the licensee will comply with this measure. The licensee is encouraged, in formulating this proposal, to coordinate with employment services offered by the State of Alaska and local communities and to recruit employees from local communities.

25. NONDISCRIMINATION. The licensee and the licensee's contractors and subcontractors may not discriminate against any employee or applicant because of race, religion, marital status, change in marital status, pregnancy, parenthood, physical handicap, color, sex, age, or national origin as set out in AS 18.80.220. The licensee and its contractors and subcontractors shall, on beginning any operations under this license, post in a conspicuous place notices setting out this nondiscrimination provision.

26. DEFINITIONS. To the extent that the words and phrases used in this license are defined in 11 AAC 82.990, those definitions will apply to this license. With respect to all other words and phrases used in this license, they will be interpreted in accordance with AS. 01.10.040. However, the following words have the following meanings unless the context unavoidably requires otherwise.

(1) "Anniversary Date" means the date in each successive calendar year following the Effective Date that is the same as the Effective Date.

(2) "Associated Substances" means all substances except helium produced as an incident of production of Oil or Gas by ordinary production methods and not defined in this license as Oil or Gas;

(3) "Effective Date" means the first day of the month following the date on which the exploration license or, if an extension is granted, the extension was signed on behalf of the state or, upon written request, on the first day of the month in which it was signed on behalf of the state.

Appendix B: Gulf of Alaska Sample Exploration License

(4) "Force Majeure" means war, riots, acts of God, unusually severe weather, or any other cause beyond the licensee's reasonable ability to foresee or control and includes operational failure of existing transportation facilities and delays caused by judicial decisions or lack of them.

(5) "Gas" means all natural gas (except helium gas) and all other hydrocarbons produced that are not defined in this license as Oil;

(6) "Oil" means crude petroleum oil and other hydrocarbons, regardless of gravity, that are produced in liquid form by ordinary production methods, including liquid hydrocarbons known as distillate or condensate recovered by separation from Gas other than at a Gas processing plant.

27. EFFECTIVE DATE. This license takes effect on

BY SIGNING THIS LICENSE, the state and the licensee agree to be bound by its provisions.

STATE OF ALASKA

By: _____

Director, Division of Oil and Gas

STATE OF ALASKA)
) ss.
Third Judicial District)

On _____, before me appeared Chantal Walsh, Director of the Division of Oil and Gas of the State of Alaska, Department of Natural Resources, and who executed this license and acknowledged voluntarily signing it on behalf of the State of Alaska as lessor.

Notary public in and for the State of Alaska
My commission expires _____

LICENSEE: _____

Signature: _____

Printed Name/Title: _____

INSERT NOTARY ACKNOWLEDGMENT OF LICENSEE'S SIGNATURE HERE

Annual Bonding Calculation

(This schedule must be updated and submitted annually to the Division of Oil & Gas)

1.	Enter	Beginning Work Commitment	\$ _____
2.	Enter	Cumulative Direct Exploration Expenditures	\$ _____
	Line 1 Minus		
3.	Line 2	Balance of Remaining Work Commitment	\$ _____
4.	Enter	# of Years Remaining in Term of License	_____
	Line 3 Divided by		
5.	Line 4	Annual Bond Due	\$ _____

Attachment 1
Alaska Department of Natural Resources, Division of Oil & Gas
Submittal of Well Data Required by DNR License

Data shall be submitted to the Division in a digital format, generally in PDF. For spreadsheets, include the original Excel document. For images such as maps or charts, include a high-resolution TIFF or JPEG. For logs, see formats specified below, but include a graphical image file of the logs as a PDF or TIFF in addition to the final merged data file of the log curves. Data may be submitted on CD, DVD or USB mass storage device (include any necessary cables). Required data shall include any and all of the following:

1. A copy of the well completion report (AOGCC Form 10-407) for each well bore.
2. Daily drilling reports or a summary report of daily drilling.
3. Latitudinal and longitudinal coordinates for each well, pilot hole, and plugged back well bore with completed surface and bottom hole locations. Coordinates can be based upon either the NAD 83 or NAD 27 geodetic datum as long as the datum used is clearly specified.
4. Directional survey for each well, pilot hole, and plugged back well bore.
5. A list of all logs run and the depth interval covered for each well, pilot hole, and plugged back well bore.
6. A list of formations and other geologic markers encountered and the measured depths (MD) and true vertical depths (TVD) of each, for each well, pilot hole, and plugged back well bore.
7. Summary of cored intervals (conventional and sidewall), including depth, formation name, lithology, presence of oil, gas, gas hydrates, and water, porosity, fractures and apparent dips; indicate “**none**” on completion report or in an attachment if no cores were taken.
8. Core reports including lab analyses of lithology, porosity, permeability (vertical and horizontal, air and liquid), density, capillary pressure, and fluid saturation, if available.
9. Conventional and sidewall core photos (plain light and ultraviolet), if applicable.
10. Identified formation names and corresponding depths for oil, gas, and gas hydrate shows. Indicate “**none**” on the completion report or in an attachment if no shows were observed.
11. Identified depth zones of abnormal pressure. Indicate “**none**” on the completion report or in an attachment if none were observed.
12. A synopsis or summary of testing and all fluid recovery efforts, including production tests (IP), drill stem tests (DST), wireline formation tests (i.e. repeat formation tests (RFT) and modular dynamics tests (MDT)), and any other production and formation testing data; the summary should include test date, time, depth, formation name, method of operation, recovered fluid type(s) and amount(s), fluid rate, gas-oil ratio (GOR), oil gravity, pressure, and choke size, when available. If no tests were undertaken, indicate “**none**” where appropriate on the completion report or in an attachment, if tests were undertaken but failed to recover fluids indicate “**no recovery**”.
13. Pressure build-up and fluid PVT analyses, if applicable.
14. Open flow potential test reports and report attachments to AOGCC Forms 10-421.
15. Well test procedures, field chronologies, and field data; including details necessary for evaluation (intervals open to test; volumes of oil, gas, water, mud, and other borehole substances; API gravity; gas density; wellhead and down hole pressure; and formation and wellhead temperature).
16. Geochemical and formation fluid analyses and reports, if applicable.
17. Down hole and surface fluid sampling procedures, field chronologies, raw data, and laboratory test results for all water and hydrocarbon-bearing zones (oil, gas, gas hydrates) sampled; including details sufficient to fully evaluate quality of sample data.
18. Permit to drill (AOGCC form 10-401) and the survey as-built of the well location.
19. LAS Version 2, TAP, TIF, LIS and DLIS (if available) files of final merged open-and cased-hole log data, including specialty logs (such as Schlumberger’s cyberlook, formation microscanners and dipmeter logs), measured-while-drilling (MWD) and logged-while-drilling (LWD) logs. Include a graphical image file of the 2-inch MD & TVD logs as a PDF or TIFF in addition to the log data file.
20. LAS Version 2 of final composite mudlog or lithology log curves. Include a graphical image file of the final 2-inch MD & TVD logs, with lithology display, oil, gas, and gas hydrate show indicators, mud properties, and cuttings descriptions and report as a PDF or TIFF in addition to the log data file.
21. Clear, legible files of all well data and reports including, but not limited to, paleontology, palynology, petrography (including point-count analyses), X-ray diffraction analyses, SEM micrographs, thermal maturity, vitrinite reflectance, total organic carbon, RockEval pyrolysis, geochronology, fission track analyses, fluid inclusion analyses, Mercury injection capillary pressure analyses, chemical analyses

Appendix B: Gulf of Alaska Sample Exploration License

- (EPMA, XRF, ICP, etc.), isotope analyses, water chemistry, burial and temperature history analyses, strain analyses, acoustic analyses, gas hydrate analyses and well pressure and temperature survey analyses.
22. Final reports of velocity, checkshot or VSP surveys (an ASCII format digital version of the above data shall also be submitted), including seismic profile data in SEG-Y format. Indicate "none" in your response to this request if no velocity, checkshot or VSP surveys were undertaken. Submission of velocity, checkshot, and VSP surveys is always required by DNR under the operator surface-use permit obligations.
 23. All coalbed core, gas, and water quality reports including lab analyses of core lithology, coal rank, vitrinite reflectance, maceral composition, total organic carbon, ash, sulfur and BTU content, moisture content, cleating, adsorption/desorption data, residual gas measurements, porosity and permeability analyses, core photos, if available.
 24. Any other geoscience- and engineering-related data sets from the well(s).

Please note: Physical samples of well cuttings or cores specified in 20 AAC 25.071(b)(2) and 20 AAC 25.071(b)(4) should be sent to AOGCC, not to the Division.

All material should be either hand-carried by bonded courier or mailed by registered mail to:

Resource Evaluation Section
Alaska Department of Natural Resources, Division of Oil & Gas
550 West 7th Avenue, Suite 1100
Anchorage, AK 99501-3510
Email: DOG.REdata@alaska.gov

Appendix C: Gulf of Alaska Sample Lease

Oil and Gas Conversion Lease
Form #DOG 201804 CL

STATE OF ALASKA
DEPARTMENT OF NATURAL RESOURCES

Oil and Gas Exploration License Conversion Lease
ADL No.

THIS LEASE is entered into _____, between the State of Alaska, "the state," and _____

"the lessee," whether one or more, whose sole address for purposes of notification is under Paragraph 25.

In consideration of the cash payment made by the lessee to the state, which payment includes the first year's rental and any required cash bonus, and subject to the provisions of this lease, including applicable stipulation(s) and mitigating measures attached to this lease and by this reference incorporated in this lease, the state and the lessee agree as follows:

1. GRANT. (a) Subject to the provisions in this lease, the state grants and leases to the lessee, without warranty, the exclusive right to drill for, extract, remove, clean, process, and dispose of oil, gas, and associated substances in or under the following described tract of land:

containing approximately _____ acres, more or less (referred to in this lease as the "leased area"); the nonexclusive right to conduct within the leased area geological and geophysical exploration for oil, gas, and associated substances; and the nonexclusive right to install pipelines and build structures on the leased area to find, produce, save, store, treat, process, transport, take care of, and market all oil, gas, and associated substances and to house and board employees in its operations on the leased area. The rights granted by this lease are to be exercised in a manner which will not unreasonably interfere with the rights of any permittee, lessee or grantee of the state consistent with the principle of reasonable concurrent uses as set out in Article VIII, Section 8 of the Alaska Constitution.

(b) For the purposes of this lease, the leased area contains the legal subdivisions as shown on the attached plat marked Exhibit A.

(c) If the leased area is described by protracted legal subdivisions and, after the effective date of this lease, the leased area is surveyed under the public land rectangular system, the boundaries of the leased area are those established by that survey, when approved, subject, however, to the provisions of applicable

Appendix C: Gulf of Alaska Sample Lease

regulations relating to those surveys. If for any reason the leased area includes more acreage than the maximum permitted under applicable law (including the "rule of approximation" authorized in AS 38.05.145 and defined in AS 38.05.965(18)), this lease is not void and the acreage included in the leased area must be reduced to the permitted maximum. If the state determines that the leased area exceeds the permitted acreage and notifies the lessee in writing of the amount of acreage that must be eliminated, the lessee has 60 days after that notice to surrender one or more legal subdivisions included in the leased area comprising at least the amount of acreage that must be eliminated. Any subdivision surrendered must be located on the perimeter of the leased area as originally described. If a surrender is not filed within 60 days, the state may terminate this lease as to the acreage that must be eliminated by mailing notice of the termination to the lessee describing the subdivision eliminated.

(d) If the State of Alaska's ownership interest in the oil, gas, and associated substances in the leased area is less than an entire and undivided interest, the grant under this lease is effective only as to the state's interest in that oil, gas, and associated substances, and the royalties and rentals provided in this lease must be paid to the state in the proportion that the state's interest bears to the entire undivided fee.

(e) The state makes no representations or warranties, express or implied, as to title, or access to, or quiet enjoyment of, the leased area. The state is not liable to the lessee for any deficiency in title to the leased area, nor is the lessee or any successor in interest to the lessee entitled to any refund due to deficiency in title for any rentals, bonuses, or royalties paid under this lease.

2. RESERVED RIGHTS. (a) The state, for itself and others, reserves all rights not expressly granted to the lessee by this lease. These reserved rights include, but are not limited to:

(1) the right to explore for oil, gas, and associated substances by geological and geophysical means;

(2) the right to explore for, develop, and remove natural resources other than oil, gas, and associated substances on or from the leased area;

(3) the right to establish or grant easements and rights-of-way for any lawful purpose, including without limitation for shafts and tunnels necessary or appropriate for the working of the leased area or other lands for natural resources other than oil, gas, and associated substances;

(4) the right to dispose of land within the leased area for well sites and well bores of wells drilled from or through the leased area to explore for or produce oil, gas, and associated substances in and from lands not within the leased area; and

(5) the right otherwise to manage and dispose of the surface of the leased area or interests in that land by grant, lease, permit, or otherwise to third parties.

(b) The rights reserved may be exercised by the state, or by any other person or entity acting under authority of the state, in any manner that does not unreasonably interfere with or endanger the lessee's operations under this lease.

3. TERM. This lease is issued for an initial primary term of _____ years from the effective date of this lease. The term may be extended as provided in Paragraph 4 below.

4. EXTENSION. (a) This lease will be extended automatically if and for so long as oil or gas is produced in paying quantities from the leased area.

(b) This lease will be extended automatically if it is committed to a unit agreement approved or prescribed by the state, and will remain in effect for so long as it remains committed to that unit agreement.

(c) (1) If the drilling of a well whose bottom hole location is in the leased area has commenced as of the date on which the lease otherwise would expire and is continued with reasonable diligence, this lease will continue in effect until 90 days after cessation of that drilling and for so long as oil or gas is produced in paying quantities from the leased area.

(2) If oil or gas in paying quantities is produced from the leased area, and if that production ceases at any time, this lease will not terminate if drilling or reworking operations are commenced on the leased area within sixty days after cessation of production and are prosecuted with reasonable diligence; if those drilling or reworking operations result in the production of oil or gas, this lease will remain in effect for so long as oil or gas is produced in paying quantities from the leased area.

(d) If the lease is not automatically extended under subsections (a) – (c) above, the state may approve a one-time extension of the primary term of the lease upon written application by the lessee if the state finds that the extension is in the best interest of the state. A lessee requesting a one-time extension must send the request to the state at least 180 days before the expiration date of the primary term of the lease. The length of the primary term of the lease combined with the term of the one-time extension may not exceed a total of 10

Appendix C: Gulf of Alaska Sample Lease

years. The state shall consider the funds expended by the lessee to explore and develop the lease, the types of work completed by or on behalf of the lessee, and any other relevant information in deciding whether to extend the lease. The state may condition a lease extension on posting of a performance bond by the lessee, meeting a minimum work commitment, or both. The work commitment, if required, must be expressed in terms of money to be spent or type and amount of work to be performed.

(e) If there is a well capable of producing oil or gas in paying quantities on the leased area, this lease will not expire because the lessee fails to produce that oil or gas unless the state gives notice to the lessee, allowing a reasonable time, which will not be less than six months after notice, to place the well into production, and the lessee fails to do so. If production is established within the time allowed, this lease is extended only for so long as oil or gas is produced in paying quantities from the leased area.

(f) If the state directs or approves in writing a suspension of all operations on or production from the leased area (except for a suspension necessitated by the lessee's negligence), or if a suspension of all operations on or production from the leased area has been ordered under federal, state, or local law, the lessee's obligation to comply with any express or implied provision of this lease requiring operations or production will be suspended, but not voided, and the lessee shall not be liable for damages for failure to comply with that provision. If the suspension occurs before the expiration of the primary term, the primary term will be extended at the end of the period of the suspension by adding the period of time lost under the primary term because of the suspension. If the suspension occurs during an extension of the primary term under this paragraph, upon removal of that suspension, the lessee will have a reasonable time, which will not be less than six months after notice that the suspension has been removed, to resume operations or production. For the purposes of this subparagraph, any suspension of operations or production specifically required or imposed as a term of sale or by any stipulation made a part of this lease will not be considered a suspension ordered by law.

(g) If the state determines that the lessee has been prevented by force majeure, after efforts made in good faith, from performing any act that would extend the lease beyond the primary term, this lease will not expire during the period of force majeure. If the force majeure occurs before the expiration of the primary term, the primary term will be extended at the end of the period of force majeure by adding the period of time lost under the primary term because of the force majeure. If the force majeure occurs during an extension of the primary term under this paragraph, this lease will not expire during the period of force majeure plus a reasonable time after that period, which will not be less than 60 days, for the lessee to resume operations or production.

(h) Nothing in subparagraphs (f) or (g) suspends the obligation to pay royalties or other production or profit-based payments to the state from operations on the leased area that are not affected by any suspension or force majeure, or suspends the obligation to pay rentals.

5. RENTALS. (a) The lessee shall pay annual rental to the state of \$3.00 per acre or fraction of an acre, provided that the state may increase the annual rental rate as provided by law upon extension of this lease beyond the primary term.

(b) Annual rental paid in advance is a credit on the royalty or net profit share due under this lease for that year.

(c) The lessee shall pay the annual rental to the State of Alaska (or any depository designated by the state with at least 60 days' notice to the lessee) in advance, on or before the annual anniversary date of this lease. The state is not required to give notice that rentals are due by billing the lessee. If the state's (or depository's) office is not open for business on the annual anniversary date of this lease, the time for payment is extended to include the next day on which that office is open for business. If the annual rental is not paid timely, this lease automatically terminates as to both parties at 11:59 p.m., Alaska Standard Time, on the date by which the rental payment was to have been made.

6. RECORDS. The lessee shall keep and have in its possession books and records showing the development and production (including records of development and production expenses) and disposition (including records of sale prices, volumes, and purchasers) of all oil, gas, and associated substances produced from the leased area. The lessee shall permit the State of Alaska or its agents to examine these books and records at all reasonable times. Upon request by the state, the lessee's books and records shall be made available to the state at the state office designated by the state. These books and records of development, production, and disposition must employ methods and techniques that will ensure the most accurate figures reasonably available without requiring the lessee to provide separate tankage or meters for each well. The lessee shall use generally accepted accounting procedures consistently applied.

7. APPORTIONMENT OF ROYALTY FROM APPROVED UNIT. The landowners' royalty share of the unit production allocated to each separately owned tract shall be regarded as royalty to be distributed to and

Appendix C: Gulf of Alaska Sample Lease

among, or the proceeds of it paid to, the landowners, free and clear of all unit expense and free of any lien for it. Under this provision, the state's royalty share of any unit production allocated to the leased area will be regarded as royalty to be distributed to, or the proceeds of it paid to, the state, free and clear of all unit expenses (and any portion of those expenses incurred away from the unit area), including, but not limited to, expenses for separating, cleaning, dehydration, gathering, saltwater disposal, and preparing oil, gas, or associated substances for transportation off the unit area, and free of any lien for them.

8. **PAYMENTS.** All payments to the State of Alaska under this lease must be made payable to the state in the manner directed by the state, and unless otherwise specified, must be tendered to the state at:

DEPARTMENT OF NATURAL RESOURCES
550 WEST 7TH AVENUE, SUITE 1410
ANCHORAGE, ALASKA 99501-3561
ATTENTION: FINANCIAL SERVICES SECTION

or in person at either of the Department's Public Information Centers located at

550 W. 7th Ave., Suite 1260
Anchorage, Alaska

3700 Airport Way
Fairbanks, Alaska

or to any depository designated by the state with at least 60 days' notice to the lessee.

9. **PLAN OF OPERATIONS.** (a) Except as provided in (b) of this section, a plan of operations for all or part of the leased area must be approved by the commissioner before any operations may be undertaken on or in the leased area.

A plan of operations is not required for:

- (1) activities that would not require a land use permit; or
- (2) operations undertaken under an approved unit plan of operations.

(c) Before undertaking operations on or in the leased area, the lessee shall provide for full payment of all damages sustained by the owner of the surface estate as well as by the surface owner's lessees and permittees, by reason of entering the land.

(d) An application for approval of a plan of operations must contain sufficient information, based on data reasonably available at the time the plan is submitted for approval, for the commissioner to determine the surface use requirements and impacts directly associated with the proposed operations. An application must include statements and maps or drawings setting out the following:

- (1) the sequence and schedule of the operations to be conducted on or in the leased area, including the date operations are proposed to begin and their proposed duration;
- (2) projected use requirements directly associated with the proposed operations, including the location and design of well sites, material sites, water supplies, solid waste sites, buildings, roads, utilities, airstrips, and all other facilities and equipment necessary to conduct the proposed operations;
- (3) plans for rehabilitation of the affected leased area after completion of operations or phases of those operations; and
- (4) a description of operating procedures designed to prevent or minimize adverse effects on other natural resources and other uses of the leased area and adjacent areas, including fish and wildlife habitats, historic and archeological sites, and public use areas.

(e) In approving a lease plan of operations or an amendment of a plan, the commissioner will require amendments that the commissioner determines necessary to protect the state's interest. The commissioner will not require an amendment that would be inconsistent with the terms of sale under which the lease was obtained, or with the terms of the lease itself, or which would deprive the lessee of reasonable use of the leasehold interest.

(f) The lessee may, with the approval of the commissioner, amend an approved plan of operations.

(g) Upon completion of operations, the lessee shall inspect the area of operations and submit a report indicating the completion date of operations and stating any noncompliance of which the lessee knows, or should reasonably know, with requirements imposed as a condition of approval of the plan.

10. **PLAN OF DEVELOPMENT.** (a) Except as provided in subparagraph (d) below, within 12 months after completion of a well capable of producing oil, gas, or associated substances in paying quantities, the lessee shall file two copies of an application for approval by the state of an initial plan of development that must describe

Appendix C: Gulf of Alaska Sample Lease

the lessee's plans for developing the leased area. No development of the leased area may occur until a plan of development has been approved by the state.

(b) The plan of development must be revised, updated, and submitted to the state for approval annually before or on the anniversary date of the previously approved plan. If no changes from an approved plan are contemplated for the following year, a statement to that effect must be filed for approval in lieu of the required revision and update.

(c) The lessee may, with the approval of the state, subsequently modify an approved plan of development.

(d) If the leased area is included in an approved unit, the lessee will not be required to submit a separate lease plan of development for unit activities.

11. DATA SUBMITTAL. (a) The lessee shall submit to the state, at the Department of Natural Resources, Division of Oil & Gas (Division), all geological, geophysical, and engineering data obtained from the lease within 30 days following completion, abandonment, or suspension of each well, pilot hole, and plugged back well bore. The lessee shall also submit to the Division, on behalf of the state, data acquired subsequent to completion, abandonment, or suspension of each well, pilot hole, and plugged back well bore within 30 days following acquisition of those data. The Division, on behalf of the state, may waive receipt of operational data from some development, service, or injection wells, and will inform the operator of the waiver in writing prior to data submittal. Data shall be submitted according to the instructions set out in Attachment 1. Submission of data under this paragraph does not affect any statutory or regulatory obligation to submit data or other information to the state or any of its agencies.

(b) Any data submitted to the state, at the Department of Natural Resources, Division of Oil & Gas will be available at all times for use by the state and its agents, and will be held confidential as provided in AS 38.05.035(a)(8) and its applicable regulations. In accordance with AS 38.05.035(a)(8)(C), in order for geological, geophysical, and engineering data to be held confidential, the lessee must request confidentiality at the time of submission and mark the data "CONFIDENTIAL" in compliance with applicable regulations.

12. DIRECTIONAL DRILLING. This lease may be maintained in effect by directional wells whose bottom hole location is on the leased area but that are drilled from locations on other lands not covered by this lease. In those circumstances, drilling will be considered to have commenced on the leased area when actual drilling is commenced on those other lands for the purpose of directionally drilling into the leased area. Production of oil or gas from the leased area through any directional well surfaced on those other lands, or drilling or reworking of that directional well, will be considered production or drilling or reworking operations on the leased area for all purposes of this lease. Nothing contained in this paragraph is intended or will be construed as granting to the lessee any interest, license, easement, or other right in or with respect to those lands in addition to any interest, license, easement, or other right that the lessee may have lawfully acquired from the state or from others.

13. DILIGENCE AND PREVENTION OF WASTE. (a) The lessee shall exercise reasonable diligence in drilling, producing, and operating wells on the leased area unless consent to suspend operations temporarily is granted by the state.

(b) Upon discovery of oil or gas on the leased area in quantities that would appear to a reasonable and prudent operator to be sufficient to recover ordinary costs of drilling, completing, and producing an additional well in the same geologic structure at another location with a reasonable profit to the operator, the lessee must drill those wells as a reasonable and prudent operator would drill, having due regard for the interest of the state as well as the interest of the lessee.

(c) The lessee shall perform all operations under this lease in a good and workmanlike manner in accordance with the methods and practices set out in the approved plan of operations and plan of development, with due regard for the prevention of waste of oil, gas, and associated substances and the entrance of water to the oil and gas-bearing sands or strata to the destruction or injury of those sands or strata, and to the preservation and conservation of the property for future productive operations. The lessee shall carry out at the lessee's expense all orders and requirements of the State of Alaska relative to the prevention of waste and to the preservation of the leased area. If the lessee fails to carry out these orders, the state will have the right, together with any other available legal recourse, to enter the leased area to repair damage or prevent waste at the lessee's expense.

The lessee shall securely plug in an approved manner any well before abandoning it.

Appendix C: Gulf of Alaska Sample Lease

14. **OFFSET WELLS.** The lessee shall drill such wells as a reasonable and prudent operator would drill to protect the state from loss by reason of drainage resulting from production on other land. Without limiting the generality of the foregoing sentence, if oil or gas is produced in a well on other land not owned by the State of Alaska or on which the State of Alaska receives a lower rate of royalty than under this lease, and that well is within 500 feet in the case of an oil well or 1,500 feet in the case of a gas well of lands then subject to this lease, and that well produces oil or gas for a period of 30 consecutive days in quantities that would appear to a reasonable and prudent operator to be sufficient to recover ordinary costs of drilling, completing, and producing an additional well in the same geological structure at an offset location with a reasonable profit to the operator, and if, after notice to the lessee and an opportunity to be heard, the state finds that production from that well is draining lands then subject to this lease, the lessee shall within 30 days after written demand by the state begin in good faith and diligently prosecute drilling operations for an offset well on the leased area. In lieu of drilling any well required by this paragraph, the lessee may, with the state's consent, compensate the state in full each month for the estimated loss of royalty through drainage in the amount determined by the state.

15. **UNITIZATION.** (a) The lessee may unite with others, jointly or separately, in collectively adopting and operating under a cooperative or unit agreement for the exploration, development, or operation of the pool, field, or like area or part of the pool, field, or like area that includes or underlies the leased area or any part of the leased area whenever the state determines and certifies that the cooperative or unit agreement is in the public interest.

(b) The lessee agrees, within six months after demand by the state, to subscribe to a reasonable cooperative or unit agreement that will adequately protect all parties in interest, including the state. The state reserves the right to prescribe such an agreement.

(c) With the consent of the lessee, and if the leased area is committed to a unit agreement approved by the state, the state may establish, alter, change, or revoke drilling, producing, and royalty requirements of this lease as the state determines necessary or proper to secure the proper protection of the public interest.

(d) Except as otherwise provided in this subparagraph, where only a portion of the leased area is committed to a unit agreement approved or prescribed by the state, that commitment constitutes a severance of this lease as to the unitized and nonunitized portions of the leased area. The portion of the leased area not committed to the unit will be treated as a separate and distinct lease having the same effective date and term as this lease and may be maintained only in accordance with the terms and conditions of this lease, statutes, and regulations. Any portion of the leased area not committed to the unit agreement will not be affected by the unitization or pooling of any other portion of the leased area, by operations in the unit, or by suspension approved or ordered for the unit. If the leased area has a well certified, under 11 AAC 83.361, as capable of production in paying quantities as defined in 11 AAC 83.395(4) on it before commitment to a unit agreement, this lease will not be severed. If any portion of this lease is included in a participating area formed under a unit agreement, the entire leased area will remain committed to the unit and this lease will not be severed.

16. **INSPECTION.** The lessee shall keep open at all reasonable times, for inspection by any duly authorized representative of the State of Alaska, the leased area, all wells, improvements, machinery, and fixtures on the leased area, and all reports and records relative to operations and surveys or investigations on or with regard to the leased area or under this lease. Upon request, the lessee shall furnish the State of Alaska with copies of and extracts from any such reports and records.

17. **SUSPENSION.** The state may from time to time direct or approve in writing suspension of production or other operations under this lease.

18. **ASSIGNMENT, PARTITION, AND CONVERSION.** This lease, or an interest in this lease, may, with the approval of the state, be assigned, subleased, or otherwise transferred to any person or persons qualified to hold a lease. No assignment, sublease, or other transfer of an interest in this lease, including assignments of working or royalty interests and operating agreements and subleases, will be binding upon the state unless approved by the state. The lessee shall remain liable for all obligations under this lease accruing prior to the approval by the state of any assignment, sublease, or other transfer of an interest in this lease. All provisions of this lease will extend to and be binding upon the heirs, administrators, successors, and assigns of the state and the lessee. Applications for approval of an assignment, sublease, or other transfer must comply with all applicable regulations and must be filed within 90 days after the date of final execution of the instrument of transfer. The state will approve a transfer of an undivided interest in this lease unless the transfer would adversely affect the interests of Alaska or the application does not comply with applicable regulations. The state

Appendix C: Gulf of Alaska Sample Lease

will disapprove a transfer of a divided interest in this lease if the transfer covers only a portion of the lease or a separate and distinct zone or geological horizon unless the lessee demonstrates that the proposed transfer of a divided interest is reasonably necessary to accomplish exploration or development of the lease, the lease is committed to an approved unit agreement, the lease is allocated production within an approved participating area, or the lease has a well capable of production in paying quantities. The state will make a written finding stating the reasons for disapproval of a transfer of a divided interest. Where an assignment, sublease, or other transfer is made of all or a part of the lessee's interest in a portion of the leased area, this lease may, at the option of the state or upon request of the transferee and with the approval of the state, be severed, and a separate and distinct lease will be issued to the transferee having the same effective date and terms as this lease.

19. SURRENDER. The lessee at any time may file with the state a written surrender of all rights under this lease or any portion of the leased area comprising one or more legal subdivisions or, with the consent of the state, any separate and distinct zone or geological horizon underlying the leased area or one or more legal subdivisions of the leased area. That surrender will be effective as of the date of filing, subject to the continued obligations of the lessee and its surety to make payment of all accrued royalties and to place all wells and surface facilities on the surrendered land or in the surrendered zones or horizons in condition satisfactory to the state for suspension or abandonment. After that, the lessee will be released from all obligations under this lease with respect to the surrendered lands, zones, or horizons.

20. DEFAULT AND TERMINATION; CANCELLATION. (a) The failure of the lessee to perform timely its obligations under this lease, or the failure of the lessee otherwise to abide by all express and implied provisions of this lease, is a default of the lessee's obligations under this lease. Whenever the lessee fails to comply with any of the provisions of this lease (other than a provision which, by its terms, provides for automatic termination), and fails within 60 days after written notice of that default to begin and diligently prosecute operations to remedy that default, the state may terminate this lease if at the time of termination there is no well on the leased area capable of producing oil or gas in paying quantities. If there is a well on the leased area capable of producing oil or gas in paying quantities, this lease may be terminated by an appropriate judicial proceeding. In the event of any termination under this subparagraph, the lessee shall have the right to retain under this lease any and all drilling or producing wells for which no default exists, together with a parcel of land surrounding each well or wells and rights-of-way through the leased area that are reasonably necessary to enable the lessee to drill, operate, and transport oil or gas from the retained well or wells.

(b) The state may cancel this lease at any time if the state determines, after the lessee has been given notice and a reasonable opportunity to be heard, that:

(1) continued operations pursuant to this lease probably will cause serious harm or damage to biological resources, to property, to mineral resources, or to the environment (including the human environment);

(2) the threat of harm or damage will not disappear or decrease to an acceptable extent within a reasonable period of time; and

(3) the advantages of cancellation outweigh the advantages of continuing this lease in effect. Any cancellation under this subparagraph will not occur unless and until operations under this lease have been under suspension or temporary prohibition by the state, with due extension of the term of this lease, continuously for a period of five years or for a lesser period upon request of the lessee.

(c) Any cancellation under subparagraph (b) will entitle the lessee to receive compensation as the lessee demonstrates to the state is equal to the lesser of:

(1) the value of the cancelled rights as of the date of cancellation, with due consideration being given to both anticipated revenues from this lease and anticipated costs, including costs of compliance with all applicable regulations and stipulations, liability for clean-up costs or damages, or both, in the case of an oil spill, and all other costs reasonably anticipated under this lease; or

(2) the excess, if any, over the lessee's revenues from this lease (plus interest on the excess from the date of receipt to date of reimbursement) of all consideration paid for this lease and all direct expenditures made by the lessee after the effective date of this lease and in connection with exploration or development, or both, under this lease, plus interest on that consideration and those expenditures from the date of payment to the date of reimbursement.

21. RIGHTS UPON TERMINATION. (a) Upon the expiration or earlier termination of this lease as to all or any portion of the leased area, the lessee will be directed in writing by the state and will have the right at any time within a period of one year after the termination, or any extension of that period as may be granted by the state, to remove from the leased area or portion of the leased area all machinery, equipment, tools, and

Appendix C: Gulf of Alaska Sample Lease

materials. Upon the expiration of that period or extension of that period and at the option of the state, any machinery, equipment, tools, and materials that the lessee has not removed from the leased area or portion of the leased area become the property of the state or may be removed by the state at the lessee's expense. At the option of the state, all improvements such as roads, pads, and wells must either be abandoned and the sites rehabilitated by the lessee to the satisfaction of the state, or be left intact and the lessee absolved of all further responsibility as to their maintenance, repair, and eventual abandonment and rehabilitation. Subject to the above conditions, the lessee shall deliver up the leased area or those portions of the leased area in good condition.

(b) The state may require such financial assurances as the commissioner determines necessary to ensure the lessee's ability to meet its obligation under this paragraph. If at any time the commissioner determines that existing financial assurances are insufficient to satisfactorily guarantee the performance of all the lessee's obligations under this paragraph, the commissioner may require the delivery of such substitute or supplemental financial assurances as the commissioner determines necessary.

22. DAMAGES AND INDEMNIFICATION. (a) No rights under the AS 38.05.125 reservation may be exercised by the lessee until the lessee has provided to pay the owner of the land, his lessees and permittees, upon which the AS 38.05.125 reserved rights are sought to be exercised, full payment for all damage sustained by the owner by reason of entering the land. If the owner for any reason does not settle the damages, the lessee may enter the land after posting a surety bond determined by the state, after notice and an opportunity to be heard, to be sufficient as to form, amount, and security to secure to the owner, his lessees and permittees, payment for damages, and may institute legal proceedings in a court of competent jurisdiction where the land is located to determine the damages which the owner of the land may suffer. The lessee agrees to pay for any damages that may become payable under AS 38.05.130 and to indemnify the state and hold it harmless from and against any claims, demands, liabilities, and expenses arising from or in connection with such damages. The furnishing of a bond in compliance with this paragraph will be regarded by the state as sufficient provision for the payment of all damages that may become payable under AS 38.05.130 by virtue of this lease.

(b) The lessee shall indemnify the state for, and hold it harmless from, any claim, including claims for loss or damage to property or injury to any person caused by or resulting from any act or omission committed under this lease by or on behalf of the lessee. The lessee is not responsible to the state under this subparagraph for any loss, damage, or injury caused by or resulting from the sole negligence of the state.

(c) The lessee expressly waives any defense to an action for breach of a provision of this lease or for damages resulting from an oil spill or other harm to the environment that is based on an act or omission committed by an independent contractor in the lessee's employ. The lessee expressly agrees to assume responsibility for all actions of its independent contractors.

23. BONDS. (a) If required by the state, the lessee shall furnish a bond prior to the issuance of this lease in an amount equal to at least \$5 per acre or fraction of an acre contained in the leased area, but no less than \$10,000, and must maintain that bond as long as required by the state.

(b) The lessee may, in lieu of the bond required under (a) above, furnish and maintain a statewide bond in accordance with applicable regulations.

(c) The state may, after notice to the lessee and a reasonable opportunity to be heard, require a bond in a reasonable amount greater than the amount specified in (a) above where a greater amount is justified by the nature of the surface and its uses and the degree of risk involved in the types of operations being or to be carried out under this lease. A statewide bond will not satisfy any requirement of a bond imposed under this subparagraph, but will be considered by the state in determining the need for and the amount of any additional bond under this subparagraph.

(d) If the leased area is committed in whole or in part to a cooperative or unit agreement approved or prescribed by the state, and the unit operator furnishes a statewide bond, the lessee need not maintain any bond with respect to the portion of the leased area committed to the cooperative or unit agreement.

24. AUTHORIZED REPRESENTATIVES. The Director of the Division of Oil and Gas, Department of Natural Resources, State of Alaska, and the person executing this lease on behalf of the lessee shall be authorized representatives for their respective principals for the purposes of administering this lease. The state or the lessee may change the designation of its authorized representative or the address to which notices to that representative are to be sent by a notice given in accordance with Paragraph 25 below. Where activities pursuant to a plan of operations are underway, the lessee shall also designate, pursuant to a notice under Paragraph 25 below, by name, job title, and address, an agent who will be present in the state during all lease activities.

Appendix C: Gulf of Alaska Sample Lease

25. NOTICES; PROTEST. (a) Any notices required or permitted under this lease must be by electronic media producing a permanent record or in writing and must be given personally or by registered or certified mail, return receipt requested, addressed as follows:

TO THE STATE:

DIRECTOR, DIVISION OF OIL AND GAS
DEPARTMENT OF NATURAL RESOURCES
550 WEST 7TH AVENUE, SUITE 1100
ANCHORAGE, ALASKA 99501-3563

TO THE LESSEE:

(b) Any notice given under this paragraph will be effective when delivered to the above authorized representative.

(c) A lessee who wishes to protest the amount of money due the state under the lease or any action of the state regarding a provision of this lease must file a written protest with the Division of Oil and Gas within 30 days after the mailing date of the state's notice or bill. A lessee who fails to file a protest within the required time waives any further right to protest. The state will establish the administrative appeal procedure to be followed and will inform the lessee of the procedure no later than 30 days after the filing of the written protest.

26. STATUTES AND REGULATIONS. This lease is subject to all applicable state and federal statutes and regulations in effect on the effective date of this lease, and insofar as is constitutionally permissible, to all statutes and regulations placed in effect after the effective date of this lease. A reference to a statute or regulation in this lease includes any change in that statute or regulation whether by amendment, repeal and replacement, or other means. This lease does not limit the power of the State of Alaska or the United States of America to enact and enforce legislation or to promulgate and enforce regulations affecting, directly or indirectly, the activities of the lessee or its agents in connection with this lease or the value of the interest held under this lease. In case of conflicting provisions, statutes and regulations take precedence over this lease.

27. INTERPRETATION. This lease is to be interpreted in accordance with the rules applicable to the interpretation of contracts made in the State of Alaska. The paragraph headings are not part of this lease and are inserted only for convenience. The state and the lessee expressly agree that the law of the State of Alaska will apply in any judicial proceeding affecting this lease.

28. INTEREST IN REAL PROPERTY. It is the intention of the parties that the rights granted to the lessee by this lease constitute an interest in real property in the leased area.

29. WAIVER OF CONDITIONS. The state reserves the right to waive any breach of a provision of this lease, but any such waiver extends only to the particular breach so waived and does not limit the rights of the state with respect to any future breach; nor will the waiver of a particular breach prevent cancellation of this lease for any other cause or for the same cause occurring at another time. Notwithstanding the foregoing, the state will not be deemed to have waived a provision of this lease unless it does so in writing.

30. SEVERABILITY. If it is finally determined in any judicial proceeding that any provision of this lease is invalid, the state and the lessee may jointly agree by a written amendment to this lease that, in consideration of the provisions in that written amendment, the invalid portion will be treated as severed from this lease and that the remainder of this lease, as amended, will remain in effect.

31. LOCAL HIRE. The lessee is encouraged to hire and employ local and Alaska residents and companies, to the extent they are available and qualified, for work performed on the leased area. Lessees shall submit, with the plans of operations, a proposal detailing the means by which the lessee will comply with this measure. The lessee is encouraged, in formulating this proposal, to coordinate with employment services offered by the State of Alaska and local communities and to recruit employees from local communities.

32. CONDITIONAL LEASE. If all or a part of the leased area is land that has been selected by the state under laws of the United States granting lands to the state, but the land has not been patented to the state by the United States, then this lease is a conditional lease as provided by law until the patent becomes effective.

Appendix C: Gulf of Alaska Sample Lease

If for any reason the selection is not finally approved, or the patent does not become effective, any rental, royalty, or other production or profit-based payments made to the state under this lease will not be refunded.

33. **NONDISCRIMINATION.** The lessee and the lessee's contractors and subcontractors may not discriminate against any employee or applicant because of race, religion, marital status, change in marital status, pregnancy, parenthood, physical handicap, color, sex, age, or national origin as set out in AS 18.80.220. The lessee and its contractors and subcontractors must, on beginning any operations under this lease, post in a conspicuous place notices setting out this nondiscrimination provision.

34. **DEFINITIONS.** All words and phrases used in this lease are to be interpreted where possible in the manner required in respect to the interpretation of statutes by AS 01.10.040. However, the following words have the following meanings unless the context unavoidably requires otherwise:

(1) "oil" means crude petroleum oil and other hydrocarbons, regardless of gravity, that are produced in liquid form by ordinary production methods, including liquid hydrocarbons known as distillate or condensate recovered by separation from gas other than at a gas processing plant;

(2) "gas" means all natural gas (except helium gas) and all other hydrocarbons produced that are not defined in this lease as oil;

(3) "associated substances" means all substances except helium produced as an incident of production of oil or gas by ordinary production methods and not defined in this lease as oil or gas;

(4) "drilling" means the act of boring a hole to reach a proposed bottom hole location through which oil or gas may be produced if encountered in paying quantities, and includes redrilling, sidetracking, deepening, or other means necessary to reach the proposed bottom hole location, testing, logging, plugging, and other operations necessary and incidental to the actual boring of the hole;

(5) "reworking operations" means all operations designed to secure, restore, or improve production through some use of a hole previously drilled, including, but not limited to, mechanical or chemical treatment of any horizon, plugging back to test higher strata, etc.;

(6) "paying quantities" means production in quantities sufficient to yield a return in excess of operating costs, even though drilling and equipment costs may never be repaid and the undertaking considered as a whole may ultimately result in a loss; and

(7) "force majeure" means war, riots, acts of God, unusually severe weather, or any other cause beyond the lessee's reasonable ability to foresee or control and includes operational failure of existing transportation facilities and delays caused by judicial decisions or lack of them.

35. **ROYALTY ON PRODUCTION.** Except for oil, gas, and associated substances used on the leased area for development and production or unavoidably lost, the lessee shall pay to the state as a royalty 12.5 percent in amount or value of the oil, gas, and associated substances saved, removed, or sold from the leased area and of the gas from the leased area used on the leased area for extraction of natural gasoline or other products.

36. **VALUE.** (a) For the purposes of computing royalties due under this lease, the value of royalty oil, gas, or associated substances shall not be less than the highest of:

(1) the field price received by the lessee for the oil, gas, or associated substances;

(2) the volume-weighted average of the three highest field prices received by other producers in the same field or area for oil of like grade and gravity, gas of like kind and quality, or associated substances of like kind and quality at the time the oil, gas, or associated substances are sold or removed from the leased or unit area or the gas is delivered to an extraction plant if that plant is located on the leased or unit area; if there are less than three prices reported by other producers, the volume-weighted average will be calculated using the lesser number of prices received by other producers in the field or area;

(3) the lessee's posted price in the field or area for the oil, gas, or associated substances; or

(4) the volume-weighted average of the three highest posted prices in the same field or area of the other producers in the same field or area for oil of like grade and gravity, gas of like kind and quality, or associated substances of like kind and quality at the time the oil, gas, or associated substances are sold or removed from the leased or unit area or the gas is delivered to an extraction plant if that plant is located on the leased or unit area; if there are less than three prices posted by other producers, the volume-weighted average will be calculated using the lesser number of prices posted by other producers in the field or area.

(b) If oil, gas, or associated substances are sold away from the leased or unit area, the term "field price" in subparagraph (a) above will be the cash value of all consideration received by the lessee or other producer from the purchaser of the oil, gas, or associated substances, less the lessee's actual and reasonable costs of transportation away from the leased or unit area to the point of sale. The "actual and reasonable costs of transportation" for marine transportation are as defined in 11 AAC 83.229(a), (b)(2), and (c) – (l).

Appendix C: Gulf of Alaska Sample Lease

(c) In the event the lessee does not sell in an arm's-length transaction the oil, gas, or associated substances, the term "field price" in subparagraphs (a) and (b) above will mean the price the lessee would expect to receive for the oil, gas, or associated substances if the lessee did sell the oil, gas, or associated substances in an arm's-length transaction, minus reasonable costs of transportation away from the leased or unit area to the point of sale or other disposition. The lessee must determine this price in a consistent and logical manner using information available to the lessee and report that price to the state.

(d) The state may establish minimum values for the purposes of computing royalties on oil, gas, or associated substances obtained from this lease, with consideration being given to the price actually received by the lessee, to the price or prices paid in the same field or area for production of like quality, to posted prices, to prices received by the lessee and/or other producers from sales occurring away from the leased area, and/or to other relevant matters. In establishing minimum values, the state may use, but is not limited to, the methodology for determining "prevailing value" as defined in 11 AAC 83.227. Each minimum value determination will be made only after the lessee has been given notice and a reasonable opportunity to be heard. Under this provision, it is expressly agreed that the minimum value of royalty oil, gas, or associated substances under this lease may not necessarily equal, and may exceed, the price of the oil, gas, or associated substances.

37. ROYALTY IN VALUE. Except to the extent that the state elects to receive all or a portion of its royalty in kind as provided in Paragraph 38 below, the lessee shall pay to the state that value of all royalty oil, gas, and associated substances as determined under Paragraph 36 above. Royalty paid in value will be free and clear of all lease expenses (and any portion of those expenses that is incurred away from the leased area), including, but not limited to, expenses for separating, cleaning, dehydration, gathering, saltwater disposal, and preparing the oil, gas, or associated substances for transportation off the leased area. All royalty that may become payable in money to the State of Alaska must be paid on or before the last federal banking day of the calendar month following the month in which the oil, gas, or associated substances are produced. The amount of all royalty in value payments which are not paid when due under this lease or the amount which is subsequently determined to be due to the state or the lessee as the result of a redetermination will bear interest from the last federal banking day of the calendar month following the month in which the oil, gas, or associated substances were produced, until the obligation is paid in full. Interest shall accrue at the rate provided in AS 38.05.135(d) or as may later be amended. Royalty payments must be accompanied by such information relating to valuation of royalty as the state may require which may include, but is not limited to, run tickets, evidence of sales, shipments, and amounts of gross oil, gas, and associated substances produced.

38. ROYALTY IN KIND. (a) At the state's option, which may be exercised from time to time upon not less than 50 days' notice to the lessee, the lessee shall deliver all or a portion of the state's royalty oil, gas, or associated substances produced from the leased area in kind. Delivery will be on the leased area, unit area, or at a place mutually agreed to by the state and the lessee, and must be delivered to the State of Alaska or to any individual, firm, or corporation designated by the state.

(b) Royalty oil, gas, or associated substances delivered in kind must be delivered in good and merchantable condition, of pipeline quality, and free and clear of all lease expenses (and any portion of those expenses incurred away from the leased area), including, but not limited to, expenses for separating, cleaning, dehydration, gathering, saltwater disposal, and preparing the oil, gas, or associated substances for transportation off the leased area.

(c) After having given notice of its intention to take, or after having taken its royalty oil, gas, or associated substances in kind, the state, at its option, may elect to receive a different portion or none of its royalty in kind. If, under federal regulations, the taking of royalty oil, gas, or associated substances in value by the state creates a supplier-purchaser relationship, the lessee hereby waives its right to continue to receive royalty oil, gas, or associated substances under that relationship, and further agrees that it will require any purchasers of the royalty oil, gas, or associated substances likewise to waive any supplier-purchaser rights.

(d) The lessee shall furnish storage for royalty oil, gas, and associated substances produced from the leased or unit area to the same extent that the lessee provides storage for the lessee's share of oil, gas, and associated substances. The lessee shall not be liable for the loss or destruction of stored royalty oil, gas and associated substances from causes beyond the lessee's ability to control.

(e) If a state royalty purchaser refuses or for any reason fails to take delivery of oil, gas, or associated substances, or in an emergency, and with as much notice to the lessee as is practical or reasonable under the circumstances, the state may elect without penalty to underlift for up to six months all or a portion of the state's royalty on oil, gas, or associated substances produced from the leased or unit area and taken in kind. The state's right to underlift is limited to the portion of royalty oil, gas, or associated substances that the royalty purchaser refused or failed to take delivery of, or the portion necessary to meet the emergency condition. Underlifted oil, gas, or associated substances may be recovered by the state at a daily rate not to exceed 100 percent of its royalty interest share of daily production at the time of the underlift recovery.

Appendix C: Gulf of Alaska Sample Lease

39. REDUCTION OF ROYALTY. Lessee may request a reduction of royalty in accordance with the applicable statutes and regulations in effect on the date of application for the reduction.

40. EFFECTIVE DATE. This lease takes effect on _____ .

BY SIGNING THIS LEASE, the state as lessor and the lessee agree to be bound by its provisions.

STATE OF ALASKA

By: _____
Director, Division of Oil and Gas

STATE OF ALASKA)
) ss.
Third Judicial District)

On _____, before me appeared _____ of the Division of Oil and Gas of the State of Alaska, Department of Natural Resources, and who executed this lease and acknowledged voluntarily signing it on behalf of the State of Alaska as lessor.

Notary public in and for the State of Alaska
My commission expires _____

LESSEE: _____
Signature: _____
Printed Name/Title: _____

INSERT NOTARY ACKNOWLEDGMENT OF LESSEE'S SIGNATURE HERE.

LESSEE: _____
Signature: _____
Printed Name/Title: _____

INSERT NOTARY ACKNOWLEDGMENT OF LESSEE'S SIGNATURE HERE.