PATHOGENS EXPOSURES FOR COOK INLET BELUGA WHALES

A SUPPLEMENT TO CHEMICAL EXPOSURES FOR COOK INLET BELUGA WHALES: A LITERATURE REVIEW AND EVALUATION, URS CORP 2010

Prepared by URS Corp. for
NMFS Contract No. AB133F-06-BU-0058
NOAA Fisheries, National Marine Fisheries Service,
Anchorage, Alaska
May 2011

URS

This report is intended to help inform scientists and administrators with the National Marine Fisheries Service (NMFS) in their efforts to conserve and promote the recovery of Cook Inlet beluga whales. It has been produced by toxicologists and environmental scientists in the Anchorage, Alaska and Oakland, California offices of URS Corp. The presentation of information and recommendations for additional toxicological investigations represent the professional judgments of the URS authors alone. This report is advisory in nature and does not require NMFS to take any action based on its recommendations.

Recommended citation:
URS Corp., 2011. Pathogens exposures for Cook Inlet beluga whales: a supplement to Chemical exposures for Cook Inlet beluga whales: a literature review and evaluation, URS Corp., 2010. Report prepared for NOAA Fisheries, National Marine Fisheries Service, Anchorage, Alaska. NMFS contract no. AB133F-06-BU-0058

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Acronyms

AFSC	Alaska Fisheries Science Center
AIDS	Acquired immune deficiency syndrome
AWWTF	John M. Asplund Waste Water Treatment Facility
CHA	Critical Habitat Area
CIB	Cook Inlet beluga whale
DNA	Deoxyribonucleic acid
E. coli	*Escherichia coli*
FC	Fecal coliforms
mgd	million gallons per day
MOA	Municipality of Anchorage
MSD	Marine Sanitation Devices
NIH	National Institute of Health
NMFS	National Marine Fisheries Service
NPDES	National Pollutant Discharge Elimination System
PCBs	Polychlorinated biphenyl
RNA	Ribonucleic Acid
TRC	Total Residual Chlorine
USEPA	United States Environmental Protection Agency
WEF	Water Environment Federation
WWTF	Wastewater Treatment Facility

SECTION 1 INTRODUCTION

1.1 BACKGROUND

The National Marine Fisheries Service (NMFS) is currently implementing management strategies geared toward promoting the recovery of the Cook Inlet beluga whale (*Delphinapterus leucas*) population. The Conservation Plan for this beluga population includes a number of elements related to ensuring the survival and reproductive success of the whales (NMFS 2008).

NMFS has implemented conservation efforts for decades, the most significant of which, was the management of the subsistence harvest in 1999. Despite this and other measures, the population continued to decline and NMFS listed the Cook Inlet beluga whale (CIB) as endangered under the Endangered Species Act in 2008 (73 FR 62919), designated critical habitat in 2011 (76 FR 20180), and is currently developing a Recovery Plan for this endangered species. The critical habitat area (CHA) encompasses 3,013 square miles (7800 square km) of marine and estuarine environments considered to be essential for the survival of CIBs (Figure 1). CHA 1 includes the upper portions of Cook Inlet, Turnagain Arm, and Knik Arm and is bounded by the Municipality of Anchorage, the Matanuska-Susitna Borough, and the Kenai Peninsula Borough. CHA 1 was designated as such because CIBs concentrate in this important calving and foraging habitat from spring through fall. The Port of Anchorage and the Eagle River Flats Range on Joint Base Elmendorf-Richardson are excluded from CHA 1, due to national security reasons. CHA 2 includes a larger area within Cook Inlet from 3-Mile Creek on the west to Point Possession on the east extending south into Cook Inlet and along the western side of Cook Inlet and Kachemak Bay on the east side of the lower inlet. The areas included in CHA 2 experience less concentrated use in the spring and summer, but are known to be used by CIBs in the fall and winter as feeding and transit areas (76 FR 20180).

As the population continues to decline, NMFS is attempting to identify other causative factors or agents that may play a role in impeding the recovery of the CIB population. CIBs are seasonally clustered near-shore where they may be exposed to point and non-point source discharges and because of this, NMFS is evaluating the possible consequences of such exposures to CIBs.

1.2 PURPOSE AND NEED

The threat of pathogens introduced into the marine environment is an emerging issue that is receiving global interest, but few baseline data are available (Burek et al. 2008). Consequently, it is not clear how grave the threat of pathogens are to marine mammals, and to CIBs in particular. The purpose of this report is to provide a preliminary overview of the potential for pathogen exposures to affect the health and reproductive success of CIBs, not to identify which pathogens may or may not be currently affecting CIBs. The objective of this report is to prioritize pathogens and sources that may warrant additional data collection and evaluation. This report also serves as an addendum to a previous URS report that evaluated chemical exposures to CIBs (URS 2010).

1.3 REPORT OBJECTIVES

This report reviews available information to evaluate pathogen exposure to CIBs, such as:

- Microbial pathogens and diseases reported in CIBs and other populations of belugas
- Potential sources of pathogens in Cook Inlet
- Potential for transmission and infection of pathogens to CIBs

1.4 SCOPE AND METHODOLOGY OF REPORT

The following sections describe the search criteria used, identified data gaps, interpretation of data, and the development of recommendations provided.

1.4.1 Boundaries of Search

This report is based on a review of available literature regarding potential pathogen sources to Cook Inlet and pathogenic infections in CIBs. Where specific information regarding Cook Inlet or CIBs was not available, comparable studies from other locations that may be relevant to Cook Inlet were reviewed as was literature regarding pathogenic diseases in other beluga populations and marine mammals. The search was limited to peer-reviewed literature and "grey" literature in the form of technical reports from the last 20 years (1990 to November 2010).

1.4.2 Identification of Data Gaps

Data gaps are identified and described within the report and are identified as significant and substantial or relatively minor with regard to evaluating the potential impact of pathogens on CIBs.

1.4.3 Interpretation of Data

All information interpreted in this report was done so in accordance with the report objectives.

Inferences regarding the occurrence of pathogenic diseases, sources of pathogens, and adverse effects in CIBs were made by using specific data for CIBs, similar regions and source data, or literature regarding disease pathology in other beluga or marine mammal populations.

The pathogens discussed herein were classified as having probable, possible, unlikely, or unknown potential to warrant further evaluation of their significance in affecting CIB recovery. It is emphasized that the purpose of the classification is to provide NMFS with a prioritization scheme for pathogens and sources that may warrant additional data collection and evaluation. The level of confidence and uncertainty associated with these potential linkages and the associated data gaps are also discussed.

1.4.4 Development of Recommendations

Using the information, inferences, and the classification scheme described above in Section 1.4.3, a series of recommendations were developed. The recommendations provide NMFS with areas for further study and evaluation, in order to better understand pathogen exposures and their effects on CIB recovery.

1.5 TERMINOLOGY FOR PATHOGEN EVALUATION

The evaluation of pathogens and disease potential requires an understanding of the terms used to describe these issues. This section defines the terms used in this report.

1.5.1 Types of Pathogens

A pathogen is as an agent that causes disease (National Institute of Health [NIH] undated) and it most commonly refers to infectious microorganisms such as bacteria and viruses. Pathogens that infect marine mammals may belong to any of several taxonomic groups including viruses, bacteria, fungi, protozoans, and other invertebrate parasites, such as flukes and tapeworms. Not all members of these groups are pathogens and many are beneficial to health of the host and the environment. Pathogens may be naturally occurring or introduced into the marine environment. Whether pathogens are major threats or benignly present depend on a number of factors such as, receptor location (CIBs, in this case) and the spatial and temporal conditions affecting the viability of the pathogens. A brief description of each group is presented below.

1.5.2 Bacteria

Bacteria are microscopic, unicellular organisms that lack organized cellular organelles or nuclei. They may occur freely in water, soil, organic matter, and in living tissues. Bacteria are divided into two broad classes based on their cell wall structure and further divided into groups based on their shapes (e.g., rods, spheres, spirals, chains). *Staphylococcus aureus* is an example of a pathogenic bacterium that can cause skin, respiratory, and wound infections in mammals (NIH undated).

Two groups of bacteria, coliforms and fecal streptococci, are used as indicators of possible sewage contamination because they are commonly found in human and animal feces (United States Environmental Protection Agency [USEPA] undated [a]). Fecal coliforms (a sub-set of coliform bacteria) are bacteria that reside in the intestinal tract of warm-blooded animals and are excreted in their feces. Although they are generally not harmful, they are useful indicators of the possible presence of pathogenic bacteria, viruses, and protozoans, since they also live in human and animal digestive systems. Since it is difficult, time-consuming, and expensive to directly test for the presence of a large variety of pathogens, water is usually tested for coliforms and fecal streptococci instead. Sources of fecal contamination to surface waters include wastewater treatment plants, on-site septic systems, domestic and wild animal manure, and runoff. The most commonly tested fecal bacteria indicators that belong to the coliform or streptococcal groups described above are total coliforms, fecal coliforms, *Escherichia coli* (*E. coli*), fecal streptococci, and enterococci. Some strains of *E.coli* are pathogenic to marine mammals (Wong 2008).

Testing for the presence of fecal coliform bacteria is not always a reliable indicator of the destruction of individual species or groups of pathogens during wastewater treatment processes; this is because during anaerobic digestion (a form of secondary or tertiary wastewater treatment), viral pathogens appear to have a greater survivability than fecal coliforms. According to the USEPA (undated [a]), fecal coliform enumeration is most reliable as an indicator of the presence of bacterial pathogens, especially *Salmonella*. Fecal coliforms are a reliable indicator of the survival of most bacterial pathogens, but are less reliable as an indicator for the presence of viruses and parasites.

1.5.3 Viruses

Viruses are microorganisms that are typically smaller than bacteria. Viruses may contain either deoxyribonucleic acid (DNA) or ribonucleic acid (RNA) as their genetic material and are surrounded by a protein coat. Unlike bacteria, a virus cannot grow or reproduce by itself but has to invade a living host cell and then use the chemical machinery of the host cell to replicate itself. Viruses are classified by shape, size, and type of genetic material. The herpes virus is a DNA virus that can cause cold sores, chicken pox, and genital lesions in mammals. The morbillivirus is a type of RNA virus whose variants may cause measles in humans and distemper and other diseases in marine mammals (NIH undated).

1.5.4 Fungi

Fungi are unicellular or multicellular, spore-producing organisms with true nuclei that feed on living or dead organic matter. Fungi include molds, yeasts, and mushrooms (NIH undated). *Candida* genus yeasts are pathogenic fungi that cause “thrush”, a throat infection, in humans.

1.5.5 Protozoa

Protozoa are unicellular organisms with true nuclei and cell membranes but no cell walls. Two common protozoan parasites, *Giardia lamblia* and *Cryptosporidium parvum* cause diarrheal illness in humans (NIH undated).

1.5.6 Parasites

Parasites may include a number of taxonomic groups such as tapeworms, nematodes, and flukes. Helminths are simple, multicellular, invertebrate animals, some of which are infectious parasites (NIH undated). *Schistosoma* is a flatworm helminth that causes “swimmer’s itch” in humans. The trematode worm, *Nasitrema*, may lodge in the brains of marine mammals and cause strandings (Dierauf 2001).

1.5.7 Prions

Prions are infectious particles comprised only of proteins, most commonly associated with Scrapie disease in sheep and bovine spongiform encephalopathy (i.e. “mad cow disease”) in cows (NIH undated).

1.5.8 Infection and Disease

As noted by the NIH (undated), the terms "infection" and "disease" are not synonymous. An infection results when a pathogen invades and begins growing within a host. Disease results only if and when, as a consequence of the invasion and growth of a pathogen, tissue function is impaired. Our bodies have defense mechanisms to prevent infection and, should those mechanisms fail to prevent the infection, they will work to prevent the disease after infection occurs. Some infectious agents are easily transmitted (i.e. very contagious), but they are not very likely to cause disease (i.e. not very virulent). The polio virus is an example; it infects most people who come in contact with it, but only about five to ten percent of those infected develop the disease. Other infectious agents are very virulent, but not terribly contagious. The most worrisome infectious agents are those that are both very contagious and very virulent (NIH undated).

The reservoir for a disease is the site where the infectious agent survives. For example, humans are the reservoir for the measles virus because it does not infect other organisms. Animals often serve as reservoirs for diseases that infect humans. The major reservoir for *Yersinia pestis*, the bacteria that causes plague, is wild rodents. There are also non-living reservoirs. Soil is the reservoir for many pathogenic fungi as well as some pathogenic bacteria such as *Clostridium tetani*, which causes tetanus (NIH undated).

Infectious agents may be transmitted through either direct or indirect contact. Direct contact occurs when an individual is infected by contact with the reservoir (e.g., touching an infected animal, ingesting infected meat, or being bitten by an infected animal or insect). Transmission by direct contact also includes inhaling the infectious agent in droplets emitted by sneezing or coughing and contracting the infectious agent through intimate contact. Diseases transmitted primarily by direct contact with the reservoir include ringworm, Acquired Immune Deficiency Syndrome (AIDS), trichinosis, influenza, rabies, and malaria (NIH undated).

Indirect contact occurs when a pathogen can survive outside its host for a long period of time before infecting another individual. Ingesting food and water contaminated by contact with a disease reservoir are examples of transmission by indirect contact. The fecal-oral route of transmission, in which waste-contaminated water is ingested, is a significant form of indirect transmission, especially for gastrointestinal diseases such as cholera, rotavirus infection, cryptosporidiosis, and giardiasis (NIH undated).

These are all examples of transmission of the infectious agent from individual to individual. Some diseases also are transmitted inter-generationally from parent to offspring during the processes of reproduction (through sperm or egg cells), fetal development, or birth. Diseases transmitted inter-generationally include AIDS and herpes encephalitis (which occurs when the calf/pup contracts the herpes simplex type II virus during birth) (NIH undated).

SECTION 2 PATHOGENS AND DISEASES REPORTED IN COOK INLET BELUGAS AND OTHER MARINE MAMMALS

This section discusses the occurrence of pathogenic diseases in CIBs and other marine mammals. Later sections discuss the sources from which pathogens may enter Cook Inlet. The most comprehensive overview of pathogenic diseases in CIBs is provided in the 2008 status review report for CIBs (Hobbs et al. 2008) and further updates (Burek and Goertz 2010). General information from the status review and recent scientific literature about other populations of marine mammals is summarized below as circumstantial evidence for the potential adverse effects of introduced pathogens in the marine environment.

Limited information is available regarding the incidence of pathogenic diseases in live CIBs. In a study of 34 CIB carcasses, Burek and Goertz (2010) identified disease as the primary cause of death in two cases (systemic infections and systemic herpes virus), while diseases were identified as contributors to mortality in 25 of the 34 carcasses examined. The identified contributory diseases included cardiomyopathy (heart muscle disease, 3 cases), lungworm pneumonia (infection and inflammation of the lung tissue, 11 cases), *Crassicauda pyelonephritis* (kidney infection, 14 cases), and miscellaneous diseases (3 cases). Diseases that were considered incidental included herpes virus dermatitis (skin infection, 2 cases), panniculitis (infection and inflammation of sub-cutaneous fatty tissue, 2 cases), lungworm pneumonia (2 cases), *Crassicauda pyelonephritis* (2 cases), and miscellaneous diseases (1 case). Whether these diseases were contributors to reduced longevity or reproductive success was difficult to determine.

Bacteria

Bacterial infection, particularly of the respiratory tract, is one of the most common types of diseases encountered in marine mammals (Hobbs et al. 2008) and may occur in both wild and captive beluga populations. Bacterial pneumonia, either alone or in combination with a parasitic infection, is reported to be a common cause of stranding and death in marine mammals (Hobbs et al. 2008). Antibodies to *Brucella* (a bacterial pathogen) were detected in 23 percent of Black Sea bottlenose dolphins (*Tursiops truncatus ponticus*) and seven percent of Sea of Okhotsk beluga whales sampled (Alekseev et al. 2009). In various beluga whale populations, bacterial infections causing septicemia (blood infection), mastitis (breast or udder infection), nocardiosis (lung or whole-body infection), dermatitis (skin infection), and reproductive and brain lesions have been reported (Martineau et al. 1988, De Guise 1995a, b). The bacterial pathogens found in these studies include *Nocardia* (septicemia, nocardiosis), *Vibrio cholera* (mastitis), *Vibrio parahaemolyticus* (sepsis), and *Edwardsiella* (sepsis), *Erysipelothrix* (systemic disease and dermatitis), and *Brucella* antibodies. *Mycobacterium* has been associated with dermatitis and panniculitis in a captive animal. Bacterial agents that were detected in CIB carcasses as aerobic cultures or as fecal pathogens by Burek and Goertz (2010) included *Vibrio parahaemolyticus*, *Edwardsiella*, *Aeromonas*, *Enterococcus*, and *Pleisomonas*. As noted by the authors, whether the CIBs actually had the diseases associated with these pathogens was not clear.

Studies of belugas in Canada identified the bacterial pathogen, *Brucella*, as having the potential to reduce fertility, as it may cause reproductive lesions, abortions, and may also cause brain lesions. However, of the 17 tissue samples collected from five CIBs, *Brucella* was not detected (Burek and Goertz 2010).

Viruses

The prevalence of antibodies to morbilliviruses and measles-like viral pathogens was studied in the Black Sea bottlenose dolphin and the beluga whale from the Sea of Okhotsk in 2002 to 2007 (Alekseev et al. 2009). Antibodies to morbilliviruses were detected in 15 of 74 bottlenose dolphins (20.3%) and 20 of 147 beluga whales (13.6%). Of the pathogens (bacterial, viral, protozoan) found in the marine mammals, a high frequency of incidence was found in the densely populated coastal areas with heavy urban and economic development (Alekseev et al. 2009).

Several diseases attributable to viruses (skin lesions, genital and cutaneous warts, herpes, influenza) have been reported in various populations of marine mammals, including in St. Lawrence belugas, Bristol Bay belugas and in CIBs based on carcass observations (Hobbs et al. 2008, Burek and Goertz 2010). Viruses reported in sub-arctic and St. Lawrence Estuary beluga populations included strains of bovine herpes virus, dolphin and porpoise morbillivirus, phocine herpes virus and dolphin rhabdovirus (Hobbs et al. 2008; Martineau et al. 1988; De Guise 1995a,b). Burek and Goertz (2010) reported herpes virus in CIB carcasses but did not report morbillivirus or fecal viral agents.

The influenza A virus may cause respiratory illness followed by secondary bacterial infections that may weaken the animal (Hobbs et al. 2008). These viruses are virulent, and may be transmitted through cetacean respiration (i.e., discharged from the blowholes during expiration) and by contact with other marine mammals.

The influenza A virus, herpes virus and morbillivirus were identified as warranting additional evaluation in CIBs (Hobbs et al. 2008).

Fungi

Fungal diseases in marine mammals are a relatively small but significant proportion of infectious diseases. Samples collected from seventeen of 83 (20.5%) live bottlenose dolphins (*Tursiops truncatus*) captured, tested, and released off the eastern U.S. coast were positive (from fecal samples or rectal swab) for Microsporidia, a collective name for a group of single-celled fungal pathogens (Fayer et al. 2008). Of the 17 positive samples, 14 had gene sequences similar (not identical) to Microsporidian species reported from fish. The three remaining specimens had an approximately 87% similarity to a species known primarily to infect humans and a variety of terrestrial mammals, including livestock, pets, and wildlife. It was not clear whether these three specimens represented species from a terrestrial source or were a closely related species unique to dolphins (Fayer et al. 2008).

Among the diseases caused by fungi, pulmonary aspergillosis is the most common infection in marine mammals. Fungal infections such as *Aspergillus fumigatus* are most commonly reported in captive beluga populations and have not been reported in CIBs, to date (Hobbs et al. 2008). Fungal agents are thought to be of terrestrial origin and the potential for exposure to CIBs exists due to runoff and discharges from terrestrial sources entering Cook Inlet.

Protozoans

One of the most studied pathogens is *Toxoplasma gondii*, a protozoan parasite in cats. Toxoplasmosis, a protozoan-caused disease, has been reported in marine mammals including St. Lawrence Estuary belugas and *Toxoplasma* specific antibodies were detected in Black Sea bottlenose dolphins and Sea of Okhotsk beluga whales (Alekseev et al. 2009). In the 1990s, evidence arose that California sea otters (*Enhydra lutris*) were being infected by *T. gondii* oocytes (a dormant life stage that remains infective) which were believed to have been washed into seawater (Conrad et al. 2005). Infection with *T. gondii* remains an important potential source of mortality to California sea otters and can constitute a relatively long-lived threat. Oocytes in the laboratory were kept in cold seawater and still retained oral infectivity to lab mice for a minimum of 24 months, while oocytes kept at room temperature lost infectivity after six months (Lindsay and Dubey 2009). In other species monitored for the presence of *T. gondii*, there was 100% detection of serological antibodies to *T. gondii* in wild Florida dolphins, although active infection or adverse responses were not observed (Dubey et al. 2005). Confirmation of Type X *T. gondii* in coastal-dwelling felids (e.g., domestic cats), canids (e.g., domestic dogs, foxes, wolves, coyotes), marine bivalves such as oysters and mussels, and near-shore-dwelling sea otters, supports the hypotheses that feline fecal contamination is flowing from land to sea through surface runoff, and that otters can be infected with *T. gondii* via consumption of filter-feeding marine invertebrates (Miller et al. 2008). A recent study indicates that anthropogenic changes in the coastal environment can enhance the potential threat of *T. gondii* in runoff. Degradation of vegetated estuarine wetlands to mudflats increased the waterborne transport of particulate surrogates of *T. gondii* oocysts (Shapiro et al. 2010).

The protozoans *Giardia* and *Cryptosporidium* have also been reported in marine mammals. Fecal samples from several species of marine mammals, including beluga whales, were evaluated for the presence of *Cryptosporidium* and *Giardia* (Hughes-Hanks et al. 2005); samples were positive in bowhead whales (*Balaena mysticetus*), North Atlantic right whales (*Eubalaena glacialis*), and ringed seals (*Phoca hispida*), and negative in bearded seals (*Erignathus barbatus*) and beluga whales. *Giardia* and *Cryptosporidium* have the potential to occur in Cook Inlet due to contributions from wildlife; however, they have not been reported in CIBs, to date (Hobbs et al. 2008).

Encysted protozoans are reported to be commonly found in the muscle tissue of CIB and are thought to *Sarcocystis,* an incidental, non-pathogenic protozoan. Therefore, health concerns related to this finding appear to be low (Hobbs et al. 2008).

Parasites

Parasites, including nematodes, helminthes, and trematodes have been implicated in strandings of marine mammals and may cause damage to various tissues such as bones, lungs, kidneys, and circulatory systems (Hobbs et al. 2008). However, the extent of the infestations as the cause of mortality or reduced reproductive success is not clear.

Gastric parasites reported in beluga populations include *Contracaecum, Anisakis simplex, Hadwenius seymouri* and *Leucastella arctica*; lungworm nematodes described in belugas included *Phararurus pallasii, Stenurus artomarinus, Halocercus monoceris* and *Stenurus minor* and the infestations may extend far beyond the lungs and occur in other parts of the body (Hobbs et al. 2008; Burek and Goertz 2010). However, the documentation of adverse health effects related to parasite occurrence is not always clear. Infection is thought to occur when young beluga feed on infected prey items. Bacterial and parasitic infections were reported in almost 40% of belugas studied and pneumonia was common and considered to be of parasitic origin (De Guise et al. 1995a, Hamill et al. 2004).

A parasitic nematode, *Crassicauda giliakiana* has been reported in the kidneys of CIBs and may damage bones, renal blood vessels, and mammary tissue. It was reported in 18 of 25 samples in CIBs (Burek and Goertz 2010) but its effect on population health is unknown. Stomach parasites of *Contracaecum* and *Anisakis* have also been reported. Although *Anisakis* has been reported to cause ulcers in other belugas, it is unknown if such effects occur in CIBs. Lungworms were commonly reported in CIBs (38% of 34 carcasses) and inflammation of tissue was noted in some cases, although little is documented about the associated health effects on CIBs. Other parasites occasionally noted in CIBs include *Trichinella* which results from consumption of infected prey (Burek and Goertz 2010).

SECTION 3 SOURCES OF PATHOGENS AND PATHWAYS OF EXPOSURE IN COOK INLET

CIBs may be exposed to pathogens from many different sources; descriptions of these sources are provided in this section.

3.1 DEFINITION OF POINT AND NON-POINT SOURCES

There are two categories of aquatic pollution, point source pollution and non-point source pollution. Point source pollution is from an easily identifiable source, such as a pipe from a wastewater treatment plant and non-point source pollution is from diffuse sources and not a single identifiable point (USEPA undated [b]). An example of non-point source pollution is runoff. Runoff is generated when rain and snowmelt flow over the land and, rather than percolating into the ground, the water is released as overland flow or is carried downstream accumulating nutrients, synthetic chemicals, heavy metals, organic compounds, organic matter (including animal waste), and pathogens that could adversely affect the aquatic environment.

3.2 POINT SOURCES

The introduction of pathogens from treated and untreated sanitary wastewater is one of the most direct means of introducing pathogens into the aquatic environment, although the actual threat level is highly dependent on the level of treatment, volume of discharge, environmental conditions in the receiving waters, and the physiology of the receptor populations (CIBs). The types of point sources of pathogens that are most relevant to Cook Inlet include discharge from municipal wastewater treatment facilities (WWTF), discharge of wastewater from offshore oil and gas platforms, and offshore barge, ship, and boat traffic.

Municipal Wastewater Treatment Plants

Influent is the untreated wastewater going into the wastewater treatment plant, effluent is the treated wastewater that comes out of the plant (the discharge). Receiving water is the water body into which the effluent is discharged; in this case the receiving water is Cook Inlet, near Point Woronzof.

Current permitted wastewater dischargers to Cook Inlet are listed in Table 1. Approximately seven large communities and an unknown number of small communities discharge municipal wastewater that is directly or indirectly released into Cook Inlet. Of these, three discharge directly into CHA 1 in upper Cook Inlet. The John M. Asplund Wastewater Treatment Facility (AWWTF), (Permit AK-002255-1) at Point Worzonof in Anchorage discharges the largest volume of effluent (32 million gallons per day [mgd]) into Cook Inlet, while the Eagle River (Permit AK-002254-3) and Girdwood (Permit AK-0047856) treatment plants discharge smaller volumes of 2.5 mgd and 0.6 mgd, respectively. The level of treatment and disinfection for these facilities is also noted in Table 1. AWWTF is a primary treatment facility that provides screening, grit removal, sedimentation, skimming, and chlorination. Eagle River and Girdwood plants provide secondary treatment and chlorine disinfection. Earlier publications in support of the NPDES permit for AWWTF indicate low levels of fecal coliforms (FC) occurring in shoreline intertidal stations and offshore stations in the vicinity of the discharge (USEPA undated [c]). Levels ranged from 2 to 80 FC/100ml in the shoreline stations and 2-300 FC/100ml in the offshore stations. The FC levels were in compliance with permit limits; no other pathogens or indicator species appear to have been monitored (USEPA undated [c]).

The remaining four WWTPs discharge into CHA 2 and are characterized by discharges of 0.95 to 1.3 mgd, and include secondary treatment with chlorine or ultraviolet radiation disinfection. There may also be numerous smaller treatment plants that are regulated under general permits and for which information is not readily available.

Chlorination is an established treatment method for the purposes of disinfection and its effectiveness is generally measured by monitoring for microbial indicators of fecal contamination in the discharge (USEPA 1999). The microbial monitoring parameters included in National Pollutant Discharge Elimination System (NPDES) permits for wastewater treatment facilities typically include fecal and total coliform measurements for effluent.

Temperature has a significant effect on the decay of bacterial indicators in the environment, with slower decay observed at lower temperatures (WEF 2010). This implies that pathogens may remain viable for longer periods in cold conditions.

Some studies show that microorganisms are able to resist complete removal during wastewater treatment and may remain in treated wastewater effluent. Bacterial pathogens such as *Salmonella*, *Shigella*, and *Vibrio* were detected at all stages of sewage treatment and even in chlorinated effluent (WEF 2008; Stewart et al. 2008; Dungeni et al. 2010). Some strains of Salmonella have been associated with pup mortality, gastric infections, and other gastric concerns in various marine mammals (Dierauf 2001).

Sanitary Discharge from Offshore Oil and Gas Platforms

Sanitary wastewater (as opposed to industrial wastewater from oil production) released from manned offshore oil and gas platforms may also represent a source of pathogens into Cook Inlet. The results of a search of NPDES permit information regarding such sources is summarized in Table 2. All the oil and gas platforms, for which information is readily available, are located within CHA 2. Of the 21 platforms with discharge permits, on-board workers may be present on an intermittent or continual basis on at least eight of them, during which time wastewater is generated. Three of the platforms provide biological treatment of waste; the remaining five use Marine Sanitation Devices (MSDs). No information is readily available regarding the nature of the biological treatment provided or MSDs used. MSDs may involve maceration of sewage to fine particles prior to discharge or may simply be holding tanks that eventually convey the collected waste to an advanced treatment unit located onshore USDOT/USCG undated). However, the NPDES permits for some of these rigs list total residual chlorine (TRC) as a monitoring parameter for their discharges. This implies that some level of treatment or at least disinfection of the wastewater is required and performed at these platforms and that it is then discharged into Cook Inlet. Occupancy and TRC information was not readily available for the remaining 13 platforms.

Offshore Ship, Barge and Recreational Boat Traffic

A large number of commercial and recreational vessels ply the navigable waters of Cook Inlet (Cape International 2006). Small recreational vessels and boats frequent the shallower areas of Cook Inlet as well as the streams that flow into Cook Inlet. The vessels would generally be expected to unload sanitary wastewater at the docking facilities for conveyance and eventual treatment at a wastewater treatment facility.

Under “upset” conditions, when on-board wastewater containment systems are overloaded or non-functional, the potential may exist for sanitary wastewater from vessel traffic to discharge directly into receiving waters (USEPA undated [b]). Small boats without collection facilities may also discharge small quantities of sanitary wastewater directly into Cook Inlet. There was no readily information to characterize the nature and magnitude of potential sanitary waste discharge from vessel traffic into Cook Inlet.

There is no readily available information regarding coliform or pathogen inputs from offshore sources in Cook Inlet, with the exception of very limited, preliminary evaluations reported for Alaska waters (ADEC 2002). Offshore sources of human waste are likely to be similar in composition to the onshore sources; although offshore sources would likely be much smaller in magnitude, they may represent a more direct and undiluted release of pathogens into the environment of the CIBs.

3.3 NON-POINT SOURCES

Storm water Runoff

Anchorage receives approximately 16 water-equivalent inches (water-equivalent because Anchorage receives more snowfall than rain) of precipitation per year, the majority of which is deposited as snow (USEPA 2009). Storm water from the Municipality of Anchorage (MOA) is managed under NPDES Storm Water Permit AKS05258 (USEPA 2010, 2009). Surface runoff within the MOA is directed to a wide network of subsurface conveyances, ditches, and surface streets. In these “municipal separate storm sewers”, storm water is collected and handled separately from municipal wastewater. This system provides drainage for an area of approximately 1,955 square miles and includes all areas under the direct jurisdiction of the MOA and Alaska Department of Transportation and Public Facilities as well as the smaller communities of Eagle River, Girdwood, Chugiak, and Eklutna. The collected storm water is released into Cook Inlet or various freshwater streams that drain into Cook Inlet through an unknown number of storm water outfalls.

While discharges from the wastewater treatment plants constitute a year-round input of effluent into Cook Inlet, runoff is more seasonal. Storm water permits include conditions and requirements for the monitoring of fecal coliform levels in storm water. Although the permit calls for 100% control of all precipitation events of less than 0.52 inches (90% of all storm events), it is not known whether such control is actually being implemented. Therefore, the potential volume of storm water discharged to Cook Inlet and its tributaries per year is unknown. Storm water permits also call for monitoring and recordkeeping regarding the effectiveness of best management practices for reducing the amount of animal waste (and other pollutants) entering the system. However, the efficiency of the storm water system in preventing or reducing the amount of animal waste (along with the associated pathogens) that eventually discharges into Cook Inlet is not known. The highest loads of coliforms and potential pathogens in storm water runoff are typically noted in the spring during snowmelt and during rainstorms (WEF 2010; MOA 2003).

The importance of storm water as a potential pathogen source is further reinforced by a study conducted in 2003 regarding pathogen inputs at the watershed level for Anchorage (MOA 2003) that identified significant contributors to creeks and streams. Since the creeks and streams noted in this study discharge into Cook Inlet, this study appears to provide a fairly comprehensive review of non-point source contributors in the vicinity of Cook Inlet. Domestic animals in urbanized residential areas (i.e., pets) were identified as the primary source of fecal coliforms in this study. For example, it is estimated that the approximately 60,000 pet dogs in the MOA area may generate up to 45,000 pounds per day of solid waste (USEPA 2010). Other contributors included domestic animals in rural residential areas and domestic animals in animal husbandry operations, such as kennels and animal care centers, exposed garbage, and landscaped areas in densely urbanized areas. In riparian areas and wetlands, wastes from wildlife (e.g., beavers, otters, voles) and waterfowl (e.g., ducks, geese) contributed to microbial loads that eventually entered streams and creeks. This report also discusses potential contributions from terrestrial wildlife such as bear, moose, beaver, and other wildlife whose wastes may enter Cook Inlet from streams and creeks along the estuary (MOA 2003). Fecal indicator bacteria, coliphages, adenoviruses and enteroviruses were also detected in storm water runoff (WEF 2008). Unlike municipal wastewater, runoff is generally not treated or disinfected and may represent a more "raw" source of pathogens to enter into Cook Inlet. Although microbial water quality data is available for the streams and creeks that discharge into Cook Inlet, little readily available information was found for Cook Inlet waters, with the exception of the few stations that are monitored as part of the Anchorage Wastewater Utility (AWWU) monitoring program (AWWU 2011).

Coastal and Marine Wildlife

CIBs may also be exposed to pathogens from other infected marine mammal species, birds, fish, and invertebrate prey items which may form a potent network for the exchange and transmission of pathogens and diseases. When microbial agents are released into the environment, a large proportion (40-65% depending on the microbial genera) may adhere to particulate matter that drops out of the water column and deposit in the sediments (Krometis et al. 2007, 2009; WEF 2008, 2010). Microorganisms were also observed to have increased survival in sediments around coastal environments. Thus, sediments in near-shore areas may function as a reservoir for pathogen populations that may infect either the food sources (e.g., invertebrates, shellfish, and finfish) consumed by marine mammals, or may directly infect the marine mammals if they come in contact with the sediments.

The most comprehensive discussion for CIBs on potential sources of infection from prey species (e.g., salmon, shellfish) and from other marine mammals (e.g., harbor seals, harbor porpoises, northern sea otters and various species of whales) is provided in the 2008 status review report for CIBs (Hobbs et al. 2008) and follow up presentations (Burek and Goertz 2010).

Burek and Goertz (2010) also note that some strains of influenza virus may have the potential to be transferred from harbor seals to belugas and morbillivirus strains may be transferred from porpoises and harbor seals to belugas. Such cross-species infections may occur due to the migratory patterns and social habits of the different marine mammal species. It appears likely that cross-species infections between marine mammals are viable modes of transmission of infection. The occurrence of such infections, however, appears to be governed largely by the degree of co-occurrence and interaction between the populations. In CIBs, this depends on the extent to which harbor seals and other marine mammals frequent the areas of Cook Inlet where CIBs are present and appears to be most likely for viral transmissions. However, this does not mean that such transmissions are not occurring for other pathogenic groups, only that more evidence is needed.

Gulls in coastal areas are also identified as potential sources for pathogens to reach beaches and coastal waters, especially when the gulls are frequenting areas with wastewater and trash, such as landfills (Nelson et al. 2008 cited in WEF 2010). Gull feces were shown to contain many bacteria that are pathogenic to mammals including *Salmonella*, *Campylobacter*, and *Aeromonas* (WEF 2010).

SECTION 4 POTENTIAL FOR PATHOGENIC EXPOSURES FOR COOK INLET BELUGAS

Once pathogens are released into the marine environment, their potential to infect CIBs depends on a number of factors, including their abundance and distribution, persistence and viability in the environment, and the presence of exposure routes such as dermal contact or infected prey ingestion by CIBs.

Based on this literature review, the potential exists for bacterial pathogens (and perhaps other pathogen groups as well) to survive and remain viable in coastal sediments and seawater. Although the study of storm water runoff (MOA 2003) reported the occurrence of fecal coliforms in runoff that would enter upper Cook Inlet, they did not provide information regarding occurrence of coliforms or other pathogen indicators in the shallow waters or sediments of upper Cook Inlet. Therefore, the actual occurrence and persistence of pathogens in shallow sediments and water in upper Cook Inlet is unknown. If pathogens are present in the shallow sediments of CHAs 1 and 2, this may render exposure pathways to CIBs complete since they spend considerable time in shallow bays and estuaries (Goetz et al. 2007, Moore et al. 2000), and may come into contact with or ingest infected prey from sediments harboring pathogen populations.

Research on the St. Lawrence Estuary population of belugas indicate that exposure to high concentrations of chemicals (such as PCBs and dioxins) may result in immunosuppression effects, lowering the resistance of the belugas to infectious diseases and make them more susceptible to cancers and microbial agents (De Guise et al. 1995a, b). The levels of chemicals reported in CIB tissues are generally far lower than those reported in St. Lawrence belugas and the potential for chemical-induced immunosuppression cannot be adequately evaluated at this time (URS 2010).

4.1 CLASSIFICATION FRAMEWORK

Following the literature review, the evaluated pathogens and sources were classified as of probable, possible, unlikely, or unknown concern with respect to whether there was sufficient reason to evaluate them further for potential adverse effects on CIBs.

Pathogen groups and sources were designated pathogens of probable concern if they were reported in environmental media in Cook Inlet and/or in CIB tissues and if they are known to be associated with adverse effects on reproduction or growth in marine mammals. Pathogen groups and sources were designated as possible concern if they are known to be or are suggested to be associated with adverse effects on growth or reproduction in marine mammals or if they are known to be pathogenic to beluga whale dietary items (fish and invertebrates), but if there was insufficient data as to the presence of these chemicals in Cook Inlet media and in beluga whales.

Pathogen groups and sources of unlikely concern are those that are associated with low pathogenic potential to marine mammals and aquatic biota, pathogens whose adverse effects are unknown but whose environmental occurrence appear to be at extremely low levels.

Pathogen groups and sources of unknown concern are those for which the current state of the literature does not appear to allow evaluation of their potential for infection and disease production in beluga whales (e.g., prions).

Note that the terms probable, possible, and unlikely do not refer to the likelihood of adverse effects on the Cook Inlet beluga whale population but to whether there is sufficient reason to evaluate them further. A pathogen or source of probable concern does not automatically mean that it is causing adverse effects to belugas in Cook Inlet; it simply means that there is probable cause to evaluate it further.

4.2 FINDINGS

On the basis of the literature review described above, some preliminary findings and conclusions were developed regarding the role of pathogenic diseases in CIB population recovery.

4.2.1 Pathogen Groups and Sources of Probable Concern

Bacteria, viruses, protozoans and parasites are identified as pathogenic groups of probable concern for the health and reproductive success of CIBs. They are selected because representatives of these pathogen groups have been observed in CIBs (live or in necropsies), the associated health effects may themselves be severe or may lead to severe secondary health effects, and sources for these pathogenic groups exist in the geographic area.

Several pathogenic species of bacteria have been observed in CIB carcasses and may have the potential to cause sepsis, mastitis, and other health effects. Influenza viruses are recommended for further evaluation because of their virulence and the shallow habitats preferred by CIBs, although whether they are present in CIBs appears to be unknown. Herpes viruses are recommended for further study since they are known to occur in CIBs and they may cause dermatitis, ulcers, encephalitis, neoplasia, and mortality. Although their occurrence in CIBs is unknown, morbilliviruses appear to be transmitted primarily through contact with other mammals and are recommended for further evaluation because of the potential to infect CIBs and cause mortality. Study of protozoan infections in CIBs is recommended since there appears to be a high likelihood that *T. gondii*, *Cryptosporidium* and *Giardia* may be released into CHA 1. Continued study of CIBs for parasitic infestations is recommended since CIBs have been observed to have lungworms, nematodes of the genus *Crassicauda* in the kidneys, and *Anisakis* and *Contracaecum* in the gastro-intestinal tract.

Some sources of pathogens are also identified as of probable concern. It is likely that there are multiple sources of viruses, protozoans, and parasites in upper Cook Inlet, with the sources of greatest discharge volume consisting of storm water and WWTF effluent. Storm water runoff may release large loads of pathogens on a seasonal basis and effluent from wastewater treatment plants, particularly those which release into the vicinity of CHA 1, may also function as a pathogen source since the efficiency of chlorination in removal of viruses, protozoans and parasites, particularly from primary treated wastewater, does not appear to have been investigated. Additionally, contributions of pathogens from biological sources such as birds, terrestrial mammals, and marine mammals are also considered to be sources of probable concern.

4.2.2 Pathogen Groups and Sources of Possible Concern

Although *Brucella* has not been observed in CIBs, it was designated as a possible concern due to the originating source and transmission methods, because antibodies have been observed in other beluga populations, and because of the potential for *Brucella* to affect CIB fertility.

Mycotic fungi have been recommended for further study in the 2008 status review (Hobbs et al. 2008). Continued study of CIBs for parasite infestations has also been recommended.

Sources of possible concern include sanitary wastewater that may be discharged from offshore oil and gas platforms. All the oil and gas platforms, for which information is readily available, are located in CHA 2 and may consist of small discharges that are readily diluted by the volume of the receiving water and tidal action. However, the potential for localized areas of pathogen concentrations may exist. Due to the lack of available information regarding level of treatment and volume of discharge, these sources are recommended for further study to confirm or eliminate their potential to contribute pathogens to CHA 2.

4.2.3 Pathogen Groups and Sources of Unlikely Concern

No pathogen groups could be classified as unlikely due to the lack of adequate information.

No sources were classified as unlikely due to the lack of adequate information in eliminating any particular category of sources.

4.2.4 Pathogen Groups and Sources of Unknown Concern

No pathogen groups could be classified as of unknown concern due to the lack of information.

Potential releases of untreated wastewater from small craft vessels which ply the shallow waters and creeks near upper Cook Inlet are classified as sources of unknown potential concern since no information was found regarding the handling of sanitary waste from small vessels. Although the contribution from an individual boat may be small, the potential for a more substantial contribution from the numerous small recreational and other shallow-water vessels may not be negligible, if it exists.

SECTION 5 DATA GAPS

This literature-based evaluation of pathogen exposures to CIBs attempted to identify potential sources of pathogens, exposure and transmission pathways, and infectious potential to CIBs. Data gaps were identified along the source to receptor pathway for exposure of CIBs to microbial agents. The data gaps are summarized as follows:

1. Sources of pathogens – The nature, volume, and seasonality of pathogens in runoff have not been defined with respect to the presence of belugas in the "mixing zones", creeks and rivers, and outfalls, in the spring where the highest concentrations of pathogens may occur. This data gap is of environmental and management significance. It is difficult to develop pathogen management plans without an understanding of all the sources from which pathogens may enter Cook Inlet and the composition and magnitude of their pathogen loads.
2. Media of exposure – The searches did not identify any readily available information regarding potential pathogen occurrence in the shallow sediments of upper Cook Inlet. Since CIBs spend a large portion of their time in the shallow bays and estuaries of upper Cook Inlet and the water contains very heavy loads of suspended sediments, they are directly and almost continually exposed to sediments suspended in the water column. If pathogen populations persist in the sediments, CIBs would be directly exposed by dermal contact and by incidental ingestion. There is also little information on the occurrence of pathogens in the tissues of prey items that form the diet of CIBs, primarily fish and shellfish, or from other marine mammals in Cook Inlet that might come in contact with CIBs. This is a data gap of ecological significance since it is difficult to characterize the relative risk of CIB exposures to pathogens in one medium versus another. It is also difficult to develop management plans for limiting pathogen exposure without an understanding of the magnitude of pathogen loads in the various exposure media for CIBs.
3. Environmental monitoring data – The majority of the environmental data for upper Cook Inlet and in the general literature is focused on fecal indicator pathogens as a surrogate for biogenic pollution. The available data also examines the potential occurrence of pathogens in general terms, primarily in relation to measuring the effectiveness of wastewater treatment and best management practices for managing runoff. In reality, pathogens are a large and diverse group, including bacteria, viruses, fungi, protozoans, and parasites. These groups have different and often widely varying levels of persistence, viability, and infection potential in the environment. Therefore, the use of indicator organisms is considered an incomplete measure for evaluating the prevalence and potency of infectious agents in CIBs. This is a data gap of toxicological significance. As noted by many authors cited in this report, incomplete measures of pathogen characterization lead to incomplete evaluations of disease-causing potential.
4. CIB pathology data – As noted in the Hobbs et al. (2008) CIB status review, an important data gap is that little is known about the causes of death in CIBs. The occurrence of mild or even severe infections does not necessarily mean that diseases were prevalent in the individual and also does not mean that the infection was the cause of death or somehow limited the reproductive success of the individual. Since most of the available data is gathered from necropsies, identifying the cause of mortality is partly a forensic exercise

and may not provide definitive evidence of pathogenic agents as a factor in the survival or reproductive success of CIBs. This data gap is of significance with regard to "cause and effect" evaluation. The weaknesses inherent in carcass data lead to lower levels of confidence in establishing the links between pathogen sources, exposure routes and disease in CIBs.

SECTION 6 CONCLUSIONS

Collectively, these studies confirm that exposure of marine mammals to terrestrially originating pathogens does occur. Point and non-point sources, including wastewater treatment plant effluent and storm water runoff, are probable conduits for the transport of pathogens to the marine environment. The presence of pathogens introduced from terrestrial sources into the marine environment pose potential threats to marine ecosystem health. By virtue of their habitat and dietary preferences, CIBs may be exposed to pathogens from multiple point and non-point sources.

However, other than necropsy work on CIB beached carcasses, there are no specific data on pathogenic infections in CIBs or how they may affect reproduction and survival. There have also been no studies conducted that have attempted to track potential sources of terrestrial pathogens to actual infections in CIBs, let alone adverse effects in CIBs. There are so many fundamental unknowns (as described in Data Gaps, Section 5.0) that useful distinctions cannot be drawn at this time regarding various groups of pathogens. Not enough is known at this time to eliminate any potential types of pathogens as potential conservation or health issues.

SECTION 7 RECOMMENDATIONS

On the basis of the inferences and data gaps identified thus far, recommendations for additional evaluation were developed, and include the following:

- Sampling and microbial analysis of sediments, water and prey items in upper Cook Inlet, particularly in CHA 1, is recommended to identify whether viable reservoirs of pathogenic populations exist in these media and areas.

- Microbial analysis that includes a wider range of microorganisms than the limited range of fecal coliforms and total coliforms is recommended in order to evaluate whether bacterial and non-bacterial pathogens are present.

- Evaluation of the fate and viability of pathogens released into upper Cook Inlet from storm water runoff representing a variety of land uses is recommended.

- Evaluation of pathogenic infections and diseases in live and necropsied CIBs is recommended to establish a more direct connection between sources, reservoirs, transmission, infection, and disease in CIBs.

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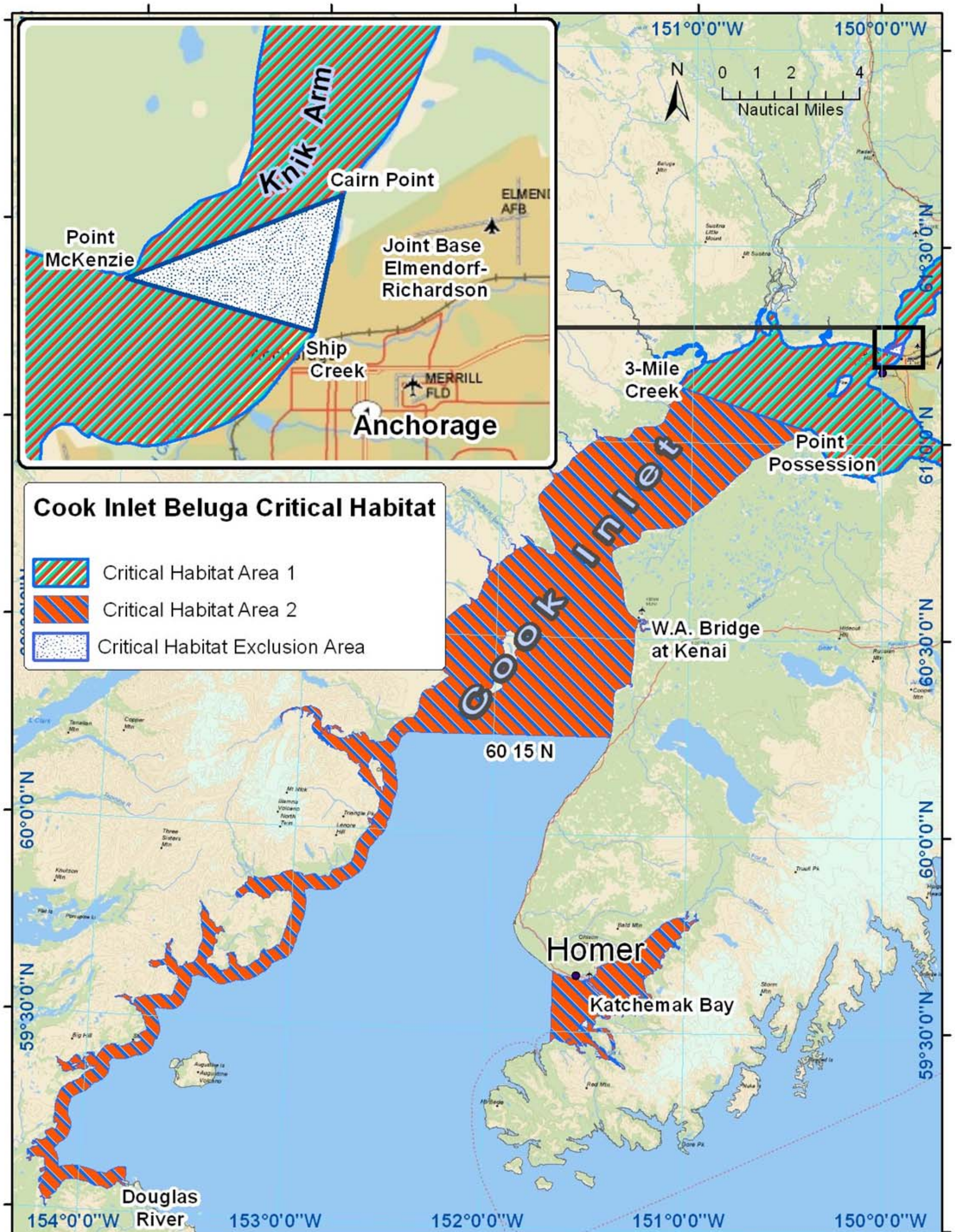
Figure 1 - Cook Inlet Beluga Critical Habitat Designation



Source: NMFS 2011.

Table 1 – Summary of Wastewater Treatment Plant Discharge into Cook Inlet

Facility	Facility Receives	Effluent Receiving Water**	Treatment	Disinfection	Max Daily Flow Rate (mgd)
Anchorage- Eagle River Wastewater Treatment Facility (WWTF)	Domestic and commercial waste water	Eagle River (Knik Arm of Cook Inlet)	Secondary	Chlorine	2.5
Anchorage- Girdwood WWTF	Domestic and commercial waste water	Glacier Creek (Turnagain Arm of Cook Inlet)	Secondary	Chlorine	0.6
Anchorage, Municipality of, and Alaska Department of Transportation & Public Facilities	Urban storm water	Cook Inlet, Eklutna River, Edmonds Creek, Mink Creek, Mirror Creek, Peters Creek, Fire Creek, Eagle River, Meadow Creek, South Fork Eagle River, Ship Creek, Chester Creek, North Fork Chester Creek, Middle Fork Chester Creek, South Fork Chester Creek, Fish Creek, Campbell Creek, North Fork Campbell Creek, South Fork Campbell Creek, Little Campbell Creek, Craig Creek, Hood Creek, Furrow Creek, Little Survival Creek, Rabbit Creek, Little Rabbit Creek, Potter Creek, Bird Creek, Indian Creek, and Glacier Creek, their tributaries, associated lake systems, and wetlands.	UNK	UNK	UNK
Anchorage Publicly Owned Treatment Plant (POTW)	Domestic and commercial waste water, some industrial	Knik arm of Cook Inlet	Primary	Chlorine	33
Cook Inlet Oil & Gas Exploration, Development & Production Facilities	Domestic and industrial waste water	Cook Inlet	See Table 2		
Kenai, City of, Wastewater Treatment Plant (WWTP)	Domestic and commercial waste water	Cook Inlet	Secondary	Chlorine	1.3
Palmer, AK, City of	Domestic and commercial waste water, one industrial facility	Matanuska River (Knik arm of Cook Inlet)	Secondary	UV	0.95
Soldotna, WWTF	Domestic and commercial waste water	Kenai River (Cook Inlet)	Secondary	Chlorine*	1.02

Source: USEPA 2009; NPDES 2008.

* Will switch to Ultraviolet (UV) soon. mgd = million gallons per day UNK = No readily available information

Nanwalek, Port Graham, Seldovia, Tyonek, and Homer were identified by the NMFS Cook Inlet Beluga Conservation Plan as wastewater treatment facilities that discharge into Cook Inlet, but National Pollutant Discharge Elimination System (NPDES) information was not readily available from USEPA, 2009.

** Effluent is the treated wastewater that flows out of the plant (their discharge); effluent receiving water is the water body into which the effluent is discharged.

Table 2 – Oil and Gas Platform and Facilities in Cook Inlet

Major?	Number	Name 1	Name 2	Expiration Date	Location	Treatment	Pollutant	Limit
Yes	AK0000396	UNK	Drift River Terminal	UNK	UCI	UNK	UNK	UNK
Yes	AKG285001	Unocal	Granite Point Production Facility	7/2/2012	UCI	UNK	UNK	UNK
Yes	AKG285002	Unocal	Trading Bay Production Facility	7/2/2012	UCI	UNK	UNK	UNK
Yes	AKG285003	XTO Energy Inc	East Foreland Treatment Facility	7/2/2012	UCI	UNK	UNK	UNK
No	AKG285004	Unocal	Anna Platform	7/2/2012	UCI	UNK	UNK	UNK
No	AKG285005	Unocal	Baker Platform	7/2/2012	UCI	M9IM/biological	TRC	2.25 mg/L
No	AKG285006	Unocal	Bruce Platform	7/2/2012	UCI	M9IM/biological	TRC	2.25 mg/L
No	AKG285007	Unocal	Dillon Platform	7/2/2012	UCI	M9IM/biological	TRC	0.66 mg/L
No	AKG285008	Unocal	King Salmon Platform	7/2/2012	UCI	UNK	UNK	UNK
No	AKG285009	Unocal	Dolly Varden Platform	7/2/2012	UCI	M9IM/MSD	TRC	13.35 mg/L
No	AKG285010	UNK	Marathon Spark Platform	UNK	UCI	UNK	UNK	UNK
No	AKG285011	ConocoPhillips Alaska, Inc.	Tyonek Platform A	7/2/2012	UCI	M10/MSD	TRC	13.35 mg/L
No	AKG285012	XTO Energy Inc	Platform "A"	7/2/2012	UCI	M9IM/MSD	TRC	13.35 mg/L
No	AKG285013	XTO Energy Inc	Platform "C"	7/2/2012	UCI	M9IM/MSD	TRC	13.35 mg/L
No	AKG285014	UNK	Marathon Spurr Platform	UNK	UCI	UNK	UNK	UNK
No	AKG285015	Unocal	Granite Point Platform	7/2/2012	UCI	M9IM/MSD	TRC	7.68 mg/L
No	AKG285016	Unocal	Grayling Platform	7/2/2012	UCI	UNK	UNK	UNK
No	AKG285017	Unocal	Monopod Platform	7/2/2012	UCI	UNK	UNK	UNK
No	AKG285019	Unocal	Steelhead Platform	7/2/2012	UCI	UNK	UNK	UNK
No	AKG285024	Forest Oil Corp	Forest Oil Corp	7/2/2012	UCI	UNK	UNK	UNK
UNK	AK-0055330-9	Pacific Energy Res. Ltd.	Osprey Platform	9/30/2014	LCI	M9IM	TRC	UNK

Source: USEPA 2009; NPDES 2008.

UNK = No readily available information
MSD = Marine Sanitation Devices
UCI = Upper Cook Inlet
M10 => 10 workers and continually occupied
LCI = Lower Cook Inlet
TRC = Total Residual Chlorine
M9IM = <10 workers and intermittently occupied

MAJOR = A domestic "major" discharger is mutually defined by the State of Alaska's (SOA) Department of Environmental Conservation (DEC) and the United States Environmental Protection Agency (USEPA) based on a design treatment plant flow ≥ 1.0 mgd, an approved pretreatment program, a high potential for violation of water quality standards, or poses a potential or actual threat to human health or the environment. A nondomestic major discharger is a facility mutually defined by the DEC and EPA as a major discharger based on the APDES Permit Rating Work Sheet that is based on EPA's NPDES Permit Rating Work Sheet, plus any additional dischargers that, in the opinion of the DEC or EPA, have a high potential for violation of water quality standards.