Kodiak Launch Complex, Alaska
Environmental Monitoring Studies
February 2005
STARS IFT 14 Launch

by

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Introduction

This document provides the results of environmental monitoring studies done in support of the 13 February 2005 launch of the U.S. Missile Defense Agency's Strategic Target System (STARS) Integrated Flight Test (IFT) 14 from the Kodiak Launch Complex (KLC), Kodiak Island, Alaska. The three-stage rocket was the same as the one used for the IFT 13C launch in December 2004 and consisted of the first two stages of a decommissioned A-3 missile and an Orbis third stage. The University of Alaska Anchorage's Environment and Natural Resources Institute (ENRI) conducted these studies under contract to the Alaska Aerospace Development Corporation (AADC), the state-owned corporation that owns and operates KLC. ENRI also conducted the environmental monitoring studies for the first seven KLC missions.

ENRI designed the IFT 14 environmental studies in accordance with the KLC Environmental Monitoring Plan (EMP), the findings and recommendations of the previous KLC environmental monitoring reports (ENRI 1999, 2000, 2001, 2002a,b,c,d, 2005), and resource agency input. The EMP had a design life of five missions provided that at least one of those missions included the largest booster that could be flown from KLC. That requirement was met in September 2001 with the launch of a Lockheed/Martin Athena, which was followed by the fifth launch from KLC later in the year. Following completion of the EMP studies, AADC requested that ENRI convene the agencies to review the summary findings (ENRI 2002d) and determine future courses of action. That meeting was held in March 2002. Attendees included the U.S. National Marine Fisheries Service (NMFS), Alaska Department of Environmental Conservation (ADEC), and Alaska Division of Governmental Coordination. All participants expressed an interest in continuing with the overarching intent of the EMP.

Subsequent to this, the U.S. Fish and Wildlife Service (USFWS) issued a letter addressing the effects of activities at KLC as they relate to the endangered short-tailed albatross *(Diomedea albatrus)* and the threatened population of Steller's eider *(Polysticta stelleri).* USFWS (Rappoport 2004) concurred with the finding that noise associated with rockets of the sizes being launched at KLC are not likely to adversely affect Steller's eiders or short-tailed albatross. After the December 2004 IFT 13C mission, USFWS requires no further monitoring of launches at KLC for effects to Steller's eiders. In the same letter (Rappoport 2004), USFWS informed AADC that threatened status is being proposed for the southwestern population of the northern sea otter *(Enhydra lutris).*

The primary KLC environmental monitoring study area was set in a September 1996 meeting of AADC with representatives of the USFWS; NMFS; U.S. Department of Transportation, Federal Aviation Administration, Office of the Associate Administrator for Commercial Space Transportation; and ENRI. It focuses on the lands and waters within a circular area having a six-mile radius extending out from the KLC launch pad (Figure 1). The IFT 14 environmental monitoring studies focused on the same study area and included an environmental quality task and a new sea otter survey task.

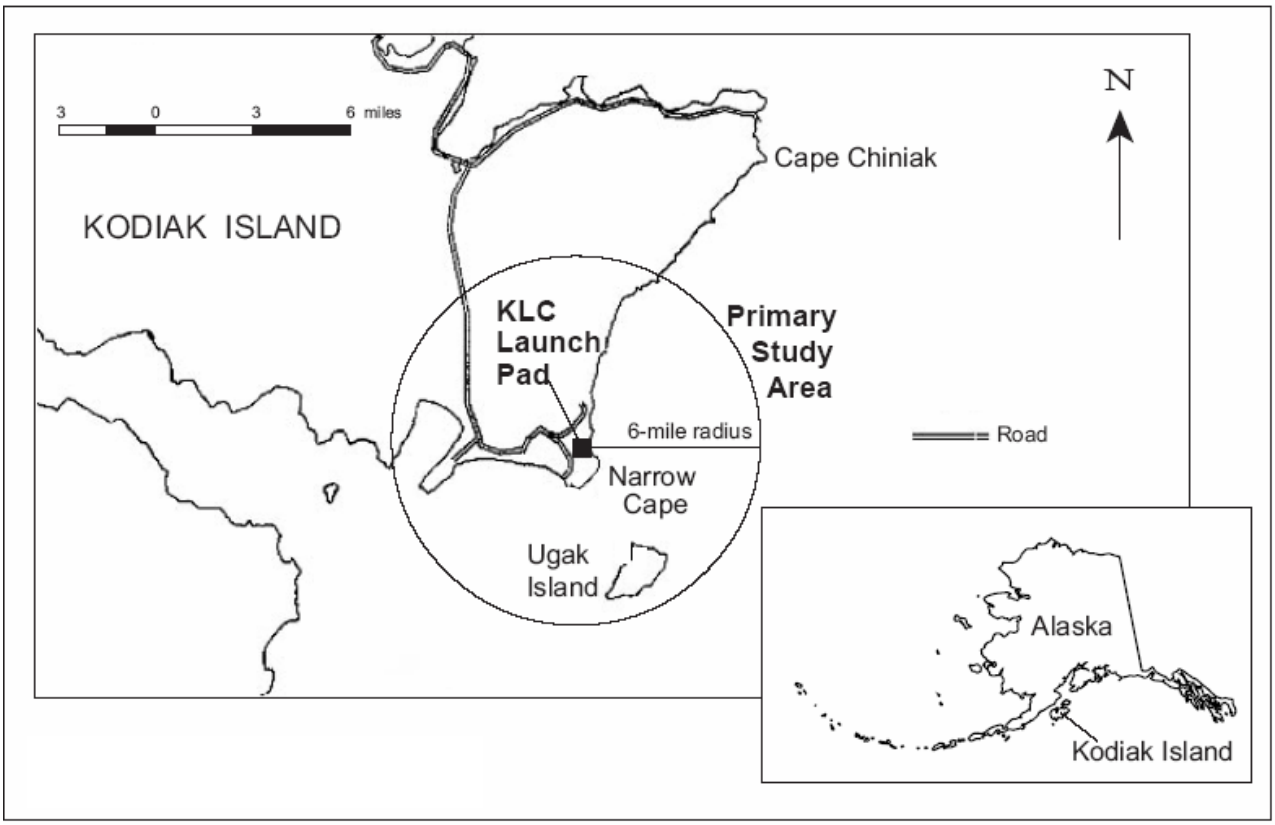

Figure 1. Primary study area.

Sea Otter Survey

Objectives

In 2004 USFWS (Rappoport 2004) notified AADC of a current proposal to list the southwest Alaska population segment of the northern sea otter—one that includes Kodiak Island—as threatened. In order to better prepare for such an eventuality, AADC asked ENRI to conduct a review of extant documentation for sea otters around Kodiak Island, as well as to conduct an aerial survey of the KLC area for otters using methods acceptable to USFWS. The principal objective of the IFT 14 sea otter survey was to test sampling methods for counting otters in the vicinity of KLC; a secondary objective was to identify any marine mammals or birds observed.

Background

The Kodiak Archipelago supported an abundant sea otter population prior to their commercial exploitation during the eighteenth and nineteenth centuries. The population survived extirpation, and in 1911 the International Fur Seal Treaty halted commercial hunting of sea otters. A remnant population remained at the northern tip of Shuyak Island (Kenyon 1969). From the late 1950s through the mid-1980s episodic range expansion occurred throughout the northern Kodiak Archipelago (Kenyon 1969; Schneider 1976; and Simon-Jackson et al. 1986). The population experienced slower growth rates than in other parts of Alaska, possibly due to illegal harvest (Bodkin et al. 1999).

Schneider (1976) identified the primary range of the Kodiak Archipelago sea otter population as extending from Shuyak Island south to Raspberry Island on the west side and Marmot Island on the east side. During the mid-1980s, Simon-Jackson, Vivion, and Zwiefelhofer (1985) reported a southern range expansion on both sides of the Kodiak Archipelago and a shift in distribution from the 1975–76 surveys. Since these surveys, sea otter distribution in the area has not changed. The leading edges of the population are Chiniak Bay and Uyak Bay on Kodiak Island (Doroff, pers. comm. 2005). Scattered individuals or small groups of sea otters have been observed along the entire coast of Kodiak Island, but biologists believe they do not represent established groups (Doroff, pers. comm. 2005; Schneider 1976). A March 1976 aerial survey of the east side of Kodiak Island found only one otter, which was between Narrow Cape and Pasagshak Point.

During the mid-1980s, Simon-Jackson et al. (1986) noted that only a few observations of sea otters had been reported in the southern end of Kodiak Island, while the population size was increasing. In 1989, USFWS (DeGange et al. 1995) conducted a helicopter survey of the Kodiak Archipelago—north of Rocky Point and the Buskin River on Kodiak Island—and estimated the otter population to be 13,526. More recently, USFWS surveys in 1994, 2001, and 2004 suggest a recent decline in the sea otter population of the Kodiak Archipelago. The 2001 population

estimate for Kodiak Archipelago was 5,893 (coefficient of variation 0.228) (USFWS 2002). The 2004 population estimate for the area was 6,284, with a 95% confidence interval of +/- 1,807 (Doroff, pers. comm. 2005).

Sea otters have also been observed during marine mammal and bird surveys associated with earlier KLC environmental monitoring studies (ENRI 2002c,d, 2005). The number of individuals observed varied between surveys but was generally low. The largest number was observed in March 2001, with 95 seen in four replicate aerial surveys (Table 1). These surveys also identified that sea otters could potentially inhabit the waters around KLC during any season of the year. Although no otters were observed near KLC during the December 2004 surveys, a group of 30 were seen during helicopter transit between the Kodiak airport and KLC in Chiniak Bay just north of the study area. Overall, individual or small groups of sea otters are irregularly observed south of Chiniak Bay (Doroff, pers. comm. 2005).

Methods

Several characteristics of sea otters facilitate their detection, as compared to most marine mammals. First, they are relatively shallow divers, which results in well-defined spatial boundaries to their distribution. Typically, foraging depths are between 25 and 40 meters with maximum depth to 100 meters (Bodkin and Udevitz 1999). Schneider (1976) found that more than 90% of sea otters observed in Bristol Bay were between the shoreline and the 40 meters depth contour. Another factor easing sea otter detection is their relatively short dive duration (25–173 seconds), which results in frequent periods at the surface. Foraging generally occurs alone and is distinctly crepuscular, with resting peaks near midday. Sea otters often rest in groups that may be more visible than single individuals.

Table 1. Sea otter observations near KLC.

Date	Location	Survey Method	No. of Surveys	No. of Otters
Jan 97	Pasagshak Bay	Aerial	1	1
Jul 97	Cape Chiniak	Aerial	1	3
Aug 97	Cape Chiniak	Aerial	1	2
Nov 98	Narrow Cape	Aerial and Point Count	9	3
Sep 99	Narrow Cape	Point Count	8	0
Mar 01	Narrow Cape	Aerial	4	95
Sep 01	Narrow Cape	Point Count	14	12
Nov 01	Narrow Cape & Pasagshak Bay	Aerial	8	2
Apr 02	Narrow Cape & Pasagshak Bay	Aerial	7	1
Dec 04	Narrow Cape & Pasagshak Bay	Aerial	6	0
Feb 05	Narrow Cape & Pasagshak Bay	Aerial and Point Count	3	0

Some environmental factors—such as sea state, glare, wind speed, and precipitation—may make sea otters difficult to see. Also, sea otters prefer to rest in areas where canopy-forming kelp beds occur, such as are common in waters off KLC. Detecting sea otters in kelp beds is difficult. Detection can also vary with distance to survey platform, number of observers, observer skill, disturbance, and search intensity (Bodkin and Udevitz 1999).

Sea otter populations have been surveyed from shore, small and large vessels, and fixed or rotary wing aircraft. Shore-based surveys have provided the most accurate estimates (94.5% probability of sightings) of nearshore sea otter abundance (Bodkin and Udevitz 1999). However, because otters can occur far offshore, this type of survey is limited to only a portion of the otter's habitat. A skiff-based survey does not cover as much habitat as an aerial survey, but the data indicate that skiff-based observers miss fewer otters than aerial observers (Burns, pers. comm. 2005). Aerial surveys are applicable over a broad range of areas and can cover a considerable amount of area in a short period of time.

Strip-and-line transects methods are widely used in aerial surveys to estimate population densities. This method requires estimating detection to reduce bias from animals not observed due to diving. Aerial surveys are typically flown at 91 meters (300 feet) altitude at a relatively slow speed (less than 185 kilometers/hour). The strip transect follows the coastline at a distance of 400 meters (1/8 of a mile) from shore. This is similar to the aerial bird surveys that have been conducted at KLC.

Another type of aerial survey used for sea otters is the line-transect. This method is used to estimate offshore sea otter abundance beyond 400 meters from shore. Transect locations are established systematically prior to the survey. Transects typically run perpendicular from the shoreline to the 91 meter (50 fathom) isobath and are paired (usually 3.7 kilometers apart). This pattern allows flying one transect offshore and another on the return, minimizing deadhead time on transects. Two observers count otters, one on each side of the aircraft.

On 11 February 2005, ENRI flew a strip-and-line aerial transect survey around Narrow Cape, Ugak Island, and Pasagshak Bay. The strip-and-line transect was similar to the aerial bird surveys conducted during previous KLC launches; they followed the shoreline around Narrow Cape, Pasagshak Bay, and Ugak Island (ENRI 2002d). ENRI also conducted nine line-transect surveys that were evenly spaced and perpendicular to shore. Four transects were flown between Lone Point and Narrow Cape, one from Narrow Cape to Ugak Island, and four between Narrow Cape to the west shore of Pasagshak Bay (Figure 2). The first line transect started at Lone Point and went east for approximately 4.0 kilometers offshore (Ugak Island was used as a visual cue of distance). Transects 2–4 were spaced 1.6 kilometers apart and were also 4.0 kilometers long. Transect 5 was between Narrow Cape and Ugak Island and, again, was roughly 4.0 kilometers long. It was flown during the strip transect to minimize deadhead time. Transects 6–9 ran in a north to south direction and were between 6.4 and 8.1 kilometers long.

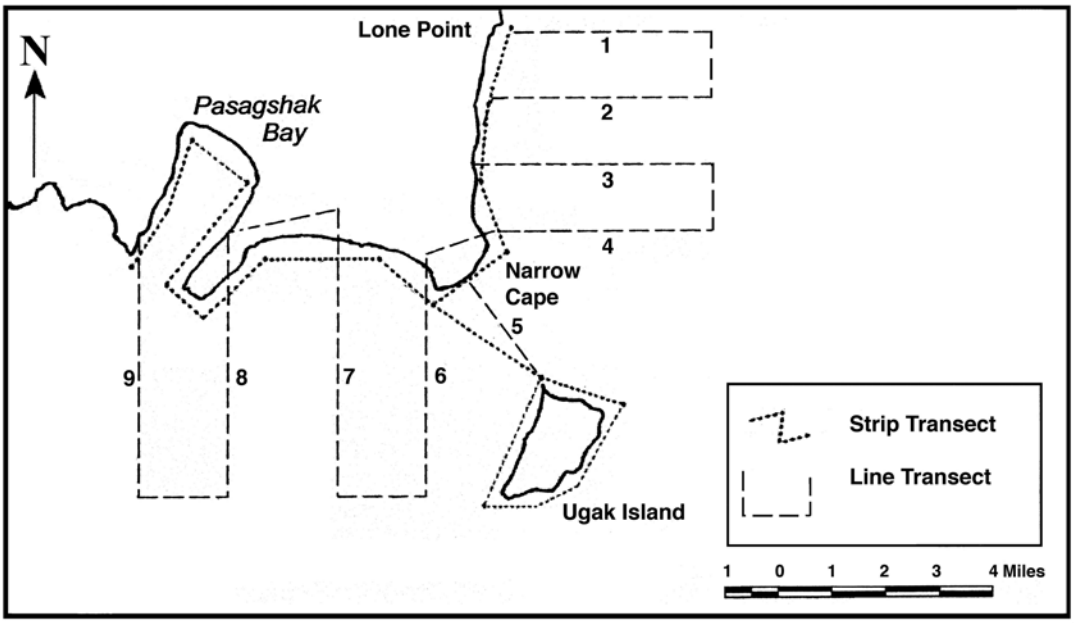

Figure 2. Sea otter survey aerial transects.

Results

One sea otter survey was successfully flown during the IFT 14 launch-monitoring period. Date, time, and weather conditions for the aerial survey are provided in Table 2. Overall, the weather conditions were optimal for locating and counting marine mammals and birds, although kelp and numerous fishing buoys added complexity to the survey. The total flight time was 1.5 hours and roughly 48 kilometers of both shoreline and offshore habitats were covered. During the return flight, a strip survey was also flown north of the study area to Cape Chiniak. No sea otters were observed during this survey

ENRI also conducted two shore-based surveys at Pasagshak Bay and Fossil Beach during the environmental quality task sampling. Viewing conditions were ideal for both locations during the prelaunch survey and were fair for the postlaunch survey due to increased wave height. Fossil Beach was more affected by the state of the sea. No sea otters were observed during these surveys.

During the sea otter aerial surveys, ENRI opportunistically observed other marine mammals and birds in the study area. Approximately 200 harbor seals *(Phoca vitulina)* were observed on the east side of Ugak Island, which is a preferred haulout in the study area. One unidentified porpoise was seen in Pasagshak Bay; no Steller sea lions *(Eumetopias jubatus)* or gray whales *(Eschrichtius robustus)* were observed. Bird species observed included Steller's eider (*Polysticta stelleri),* harlequin duck *(Histrionicus histrionicus),* long-tailed duck *(Clangula hyemalis),* black scoter *(Melanitta nigra),* surf scoter (*Melanitta perspicillata),* horned grebe

Table 2. Sea otter aerial survey conditions.

Date	Start Time	End Time	Temp	Wind	Barometer	Visibility	Wave Height	Cloud Cover	Glare	Tide
11 Feb 05	1345	1530	34°F	WNW 5–10	29.74	20 miles	< 1 foot	5%	Slight	High 1532

(*Podiceps auritus)*, loon spp. *(Gavia spp.)*, common merganser (*Mergus merganser)*, black-legged kittiwake *(Rissa tridactyla)*, glaucous-winged gull *(Larus glaucescens)*, bald eagle *(Haliaeetus leucocephalus)*, raven *(Corvus corax)*, northwestern crow *(Corvus caurinus)*, and pelagic cormorant *(Phalacrocorax pelagicus)*. Results were similar to the aerial bird survey conducted in December 2004 (ENRI 2005), although long-tailed ducks were most common and there were generally fewer individuals of all taxa. Just north of the study area, on Lake Rose Tead, tundra swan (*Cygnus columbianus)*, gadwall (*Anas strepera)*, mallard *(Anas platyrhynchos)*, American wigeon (*Anas americana)*, Barrow's goldeneye *(Bucephala islandica)*, greater scaup (*Aythya marila)*, bufflehead *(Bucephala albeola)*, green-winged teal *(Anas crecca)*, and a northern pintail *(Anas acuta)* were observed.

Discussion

Aerial surveys may be useful for monitoring sea otters during launch periods at KLC. They provide a fast, cost-effective survey of the entire study area. Although no sea otters were observed during the study period, fixed-winged aircraft provided a good viewing platform. The flight was conducted under ideal weather conditions and future flights could take more time if weather conditions were less suitable and if sea otters were encountered. Shore-based surveys were conducted during the water quality sampling done for the IFT 14 launch; they provided an opportunity to quickly scan the shoreline for the presence of sea otters. Shore-based surveys are considered less biased than aerial surveys but are limited in terms of the amount of habitat that can be covered. A more thorough shore-based survey would take considerably more time.

In this report, both the historic and current low abundance and distribution of sea otters in the KLC study area have been documented. Because sea otters are infrequently found in the study area, this could add complexity to any monitoring effort to evaluate the effects of a rocket launch. Also, sea otters were observed on particular days but not every day during some previous launch periods. This suggests that several surveys may be required during the sampling period to accurately estimate otter abundance during launch periods. Another consideration for future monitoring would be to establish a control site that is unaffected by the launch. One possible control site would be the shoreline south of Ugak Bay, from Gull Point south to Dangerous Cape, and around Boulder Bay and Santa Flavia Bay. This area has very similar shoreline topography to Narrow Cape and would be subjected to the same environmental conditions.

Environmental Quality

Objective

The objective of the KLC environmental quality task is to detect any adverse effects to soil, water, and vegetation attributable to rocket flight operations. Solid rocket motors on firing release large quantities of exhaust products that consist chiefly of hydrogen chloride, carbon monoxide, nitrogen oxides, and aluminum oxide.

Methods

For the IFT 14 launch, ENRI monitored environmental quality at KLC by taking basic surface water chemistry data to detect any changes in aquatic chemistry. Samples were taken at streams 2, 7, and 8 within the primary study area and at a reference (R) stream near Lake Rose Tead in the Pasagashak Drainage (Figure 3).

Water pH, temperature, and conductivity were measured in situ following the launch using a Hanna HI 98129 pH, EC/TDS, and temperature meter. Temperature is reported as degrees Celsius (ºC), and conductivity as microSiemens per centimeter (µS/cm).

Water samples were collected for alkalinity analyses in clean 300 milliliter (ml) nalgene bottles and kept in a cooler until analysis. Alkalinity is typically expressed as milligrams calcium carbonate per liter (mg $CaCO_3$/L). The minimum reporting limit (MRL) was 4.0 mg $CaCO_3$/L. The alkalinity water samples were taken to Analytica Alaska in Anchorage for analyses.

ENRI also collected water samples for total aluminum and perchlorate analyses. Samples for the aluminum analyses were collected in clean 300 ml nalgene bottles, each containing 5 ml nitric acid (2 molar concentration). Samples for the perchlorate analyses were collected in clean 300 ml nalgene bottles and refrigerated until analysis at Columbia Analytical in Kelso, Washington. U.S. Environmental Protection Agency (USEPA) method 6020 with a MRL of 2.0 micrograms per liter (µg/L) (parts per billion [ppb]) was used for the aluminum analysis; USEPA method 314.0 with a MRL of 5.0 µg/L (ppb) was used for the perchlorate analysis.

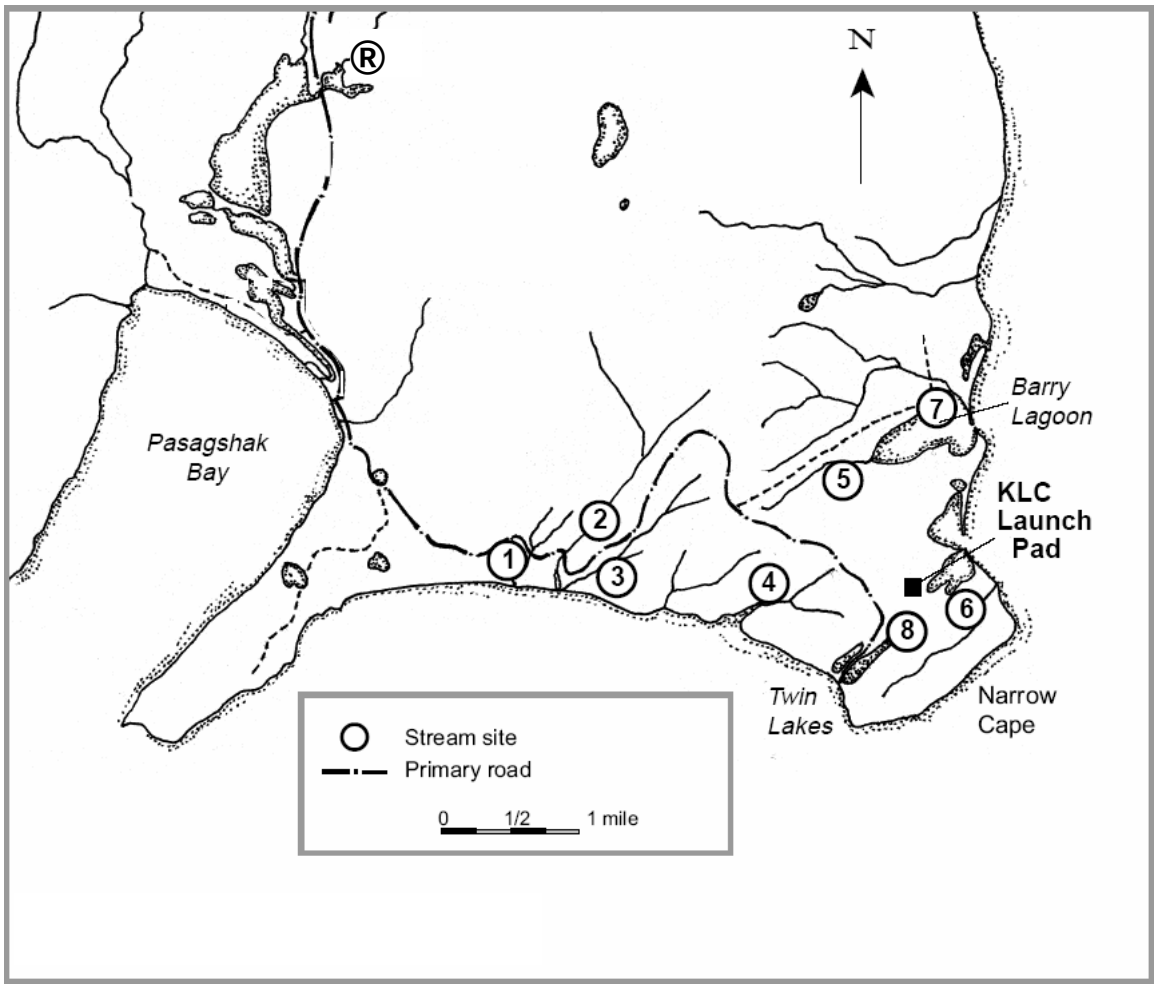

Figure 3. Water quality study sites.

Results

In situ water chemistry (pH, temperature, and conductivity) values were all normal for the time of year and show no effects from KLC launches (Table 3). Alkalinity measures were below 25 mg $CaCO_3$/L for all water bodies tested and were consistent with previous results in the area. This indicates a low buffering capacity in these waters. All water chemistry measurements were consistent with recorded values for the area, as well as those from previous analyses (ENRI 1999, 2000, 2001, 2002a,b,c,d, 2005).

Total recoverable aluminum was detected at low levels for the four water bodies sampled and ranged from 25.0 µg/L to 299.0 µg/L at stream 7 (Table 4). Perchlorate was not detected at any site (Table 4).

Table 3. Water chemistry results, February 2005.

Stream	Date	Temperature (°C)	pH	Conductivity (µS)	Alkalinity (mg $CaCO_3$/L)
2	12 Feb 14 Feb	1.0 2.2	7.1 7.2	52 44	10.4 7.6
7	12 Feb 14 Feb	0.7 2.1	6.8 7.2	51 39	9.5 4.8
8	12 Feb 14 Feb	1.0 2.8	6.8 7.1	127 105	11.4 8.6
R	12 Feb 14 Feb	1.5 2.5	7.1 7.3	21 19	25.0 < 4.0

Table 4. Total aluminum and perchlorate concentration (ND = not detected), February 2005.

Stream	Total Aluminum (µg/L)		Perchlorate (µg/L)	
	12 Feb	14 Feb	12 Feb	14 Feb
2	158.0	281.0	ND	ND
7	25.0	299.0	ND	ND
8	103.0	230.0	ND	ND
R	98.4	130.0	ND	ND

Discussion

All measured water chemistry parameters (pH, temperature, and conductivity) as well as alkalinity remained normal for the area, which continues to indicate no effects to environmental quality from KLC launches.

Total recoverable aluminum was detected in low concentrations in the four water bodies sampled but was somewhat higher than previously reported for both pre- and postlaunch values (ENRI 2002c,d, 2005). Postlaunch values were higher than prelaunch for all streams including the reference stream outside the study area. Stream 7 showed the largest increase from 25 µg/L prelaunch to 299 µg/L postlaunch. Aluminum levels are generally low in Alaska streams, but are highly variable among seasons; they have been recorded up to nearly 5000 µg/L (U.S. Geological Survey 2000). Importantly, there was no associated decrease in pH to warrant

concern from aluminum toxicity as powdered aluminum is rapidly oxidized to aluminum oxide, which is non-toxic at the pH that prevails in the surface waters surrounding KLC. Aluminum oxide, being highly stabile, is not considered an environmental risk factor to water quality (U.S. Air Force 2000).

Perchlorate was not detected in any water body tested near KLC. This was expected, as perchlorate would only be present at KLC if a rocket launch were to fail over land.

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