RED DOG MINE EXTENSION

AQQALUK PROJECT

FINAL SUPPLEMENTAL

ENVIRONMENTAL IMPACT STATEMENT

VOLUME 2

OCTOBER 2009

Cooperating Agencies:

Maniilaq Association represents the cooperating agency interests and responsibilities of the Native communities of Buckland, Kiana, Kivalina, Kobuk, Kotzebue, Noatak, Noorvik, Selawik, and Shungnak

PREPARED BY:

TETRA TECH

310 K Street, Suite 200

Anchorage, AK 99501

Red Dog Mine Extension – Aqqaluk Project

Supplemental Environmental Impact Statement

Volume 2

APPENDICES

List of Appendices

Appendix A

Corps of Engineers Section 404 Permit Application Review Process and Public Notice

Corps of Engineers Section 404 Permit Application Review Process

The Corps of Engineers (Corps), as a cooperating agency for the Red Dog Mine Extension - Aqqaluk Project Supplemental Environmental Impact Statement (SEIS), will conduct a review of the proposed project as outlined below.

Teck Cominco Alaska Incorporated (TCAK) has indicated they will submit, prior to issuance of the Final SEIS, a Department of the Army permit application to conduct work within jurisdictional waters of the United States in order to begin development of the Aqqaluk Deposit, including the pit and buffer area. A Corps' public notice will be released concurrently with the Final SEIS for the project. Additional public notices may be issued later as the full project evaluated by the SEIS is developed and TCAK applies for permits. Each public notice will detail the scope of the Corps' jurisdiction as it applies to the project.

Scope of Jurisdiction: The Corps review is limited to the proposed jurisdictional permit area. The term "permit area" as used in Corps regulations (33 CFR, Part 325, Appendix C) means those areas comprising the waters of the United States that will be directly affected by the proposed work (discharge of dredged or fill material) and uplands directly affected as a result of authorizing the work. The following three tests must all be satisfied for an activity undertaken outside the waters of the United States to be included within the "permit area":

Such activity would not occur but for the authorization of the work (discharge of dredged or fill material) within the waters of the United States;

Such activity must be integrally related to the work to be authorized within waters of the United States. Or, conversely, the work to be authorized must be essential to the completeness of the overall project or program; and

Such activity must be directly associated (first order impact) with the work to be authorized.

Mitigation: In accordance with 33 CFR Part 325.1(d)(7), TCAK's permit application will not be complete without a statement describing how impacts to waters of the United States are to be avoided and minimized. Also required will be a statement describing how impacts to waters of the United States are to be compensated for or a statement explaining why compensatory mitigation should not be required for the proposed impacts. This information will be included in the public notice. TCAK's proposed mitigation will be evaluated in accordance with 33 CFR Part 332, Compensatory Mitigation for Losses of Aquatic Resources.

Evaluation Process: The decision whether to issue a permit will be based on an evaluation of the probable impacts, including cumulative impacts of the proposed activity, and its intended use on the public interest. Evaluation of the probable impacts, which the proposed activity may have on the public interest, requires a careful weighing of all those factors, which become relevant in each particular case. The benefits, which reasonably may be expected to accrue from the proposal, must be balanced against its reasonably foreseeable detriments. The decision whether to authorize a proposal, and if so, the conditions under which it will be allowed to occur, are therefore determined by the outcome of the general balancing process. That decision should reflect the national concern for both protection and utilization of important resources. All factors which may be relevant to the proposal must be considered, including the cumulative effects thereof. Among those are conservation, economics, aesthetics, general environmental concerns, wetlands, cultural values, fish and wildlife values, flood hazards, floodplain values, land use, navigation, shore erosion and accretion, recreation, water supply and conservation, water quality, energy needs, safety, food and fiber production, mineral needs, considerations of property ownership, and, in general, the needs and welfare of the people. For activities involving 404 discharges, a permit will be denied if the discharge that would be authorized by such permit would not comply with the Environmental Protection

Agency's 404(b)(l) guidelines. Subject to the preceding sentence and any other applicable guidelines or criteria (see Sections 320.2 and 320.3), a permit will be granted unless the District Engineer determines that it would be contrary to the public interest.

The Corps of Engineers will be reviewing comments from the public; Federal, State, and local agencies and officials; Indian Tribes; and other interested parties in order to consider the impacts of this proposed activity. Any comments received during the DEIS and FEIS will be considered by the Corps of Engineers to determine whether to issue, modify, condition, or deny a permit for this proposal. To make this decision, comments are used to assess impacts on endangered species, historic properties, water quality, general environmental effects, and the other public interest factors listed above. Comments are used in the preparation of a Record of Decision pursuant to the National Environmental Policy Act.

Authorities: Discharge dredged or fill material into waters of the United States - Section 404 Clean Water Act (33 U.S.C. 1344). Therefore, our public interest review will consider the guidelines set forth under Section 404(b) of the Clean Water Act (40 CFR 230).

Perform work in or affecting navigable waters of the United States – Section 10 Rivers and Harbors Act 1899 (33 U.S.C. 403).

US Army Corps
of Engineers
Alaska District

Public Notice of Application for Permit

Regulatory Division (1145)
CEPOA-RD
Post Office Box 6898
Elmendorf AFB, Alaska 99506-0898

PUBLIC NOTICE DATE: 10/09/2009

EXPIRATION DATE: 11/09/2009

REFERENCE NUMBER: POA-1984-12-M45

WATERWAY: Chukchi Sea

Interested parties are hereby notified that a Department of the Army permit application has been received for work in waters of the United States as described below and shown on the enclosed project drawings.

Comments on the described work, with the reference number, should reach this office no later than the expiration date of this Public Notice to become part of the record and be considered in the decision. Please contact Don Kuhle at (907) 753-2780, toll free from within Alaska at (800) 478-2712, by fax at (907) 753-5567, or by email at don.p.kuhle@usace.army.mil if further information is desired concerning this notice.

APPLICANT: Teck Alaska Incorporated, 3105 Lakeshore Drive, Building A, Suite 101, Anchorage, Alaska 99517. Point of contact is Mr. Devin Harbke at (907) 426-9141 or Mr. Chris Eckert at (907) 426-9139.

LOCATION: The project site is located within Sections 16, 17, 20, and 21, T. 31 N., R. 18 W., Kateel River Meridian; USGS Quad Map De Long Mountains A-2; Latitude 68.075° N., Longitude 162.831° W.; 82 miles north of Kotzebue, Alaska.

PURPOSE: The applicant’s stated purpose is to develop the Aqqaluk Deposit at Red Dog Mine using traditional open pit mining methods to extract zinc and lead resources.

PROPOSED WORK: Develop a 600-foot-deep, 0.5 to 0.75-mile-diameter, circular open pit mine. The project would affect 245 acres, of which 119 acres are wetlands, and would require discharges of fill material for construction of auxiliary structures such as temporary stockpiles, access roads, and diversion channels. Access roads and diversion structures would be located within the pit boundary. The majority of the excavated waste rock would be deposited in the existing Red Dog Main Pit, with the remainder deposited on the existing Main Waste Rock Pile. No temporary stockpiles or double handling of material would occur in wetlands outside the project area.

A permanent diversion structure, or similarly functioning temporary structures, would be constructed for Sulfur Creek prior to pit development within the Sulfur

Creek drainage basin. The purpose of the structure would be to divert clean water around the pit, thereby minimizing the volume of water that contacts mineralized materials and limiting the volume of water requiring treatment.

All work would be performed in accordance with the enclosed plan (sheets 1-3), dated July 10, 2009.

ADDITIONAL INFORMATION: The U.S. Environmental Protection Agency has prepared the "Red Dog Mine Extension, Aqqaluk Project, Supplemental Environmental Impact Statement" (SEIS) to evaluate the environmental effects associated with development of the Aqqaluk Deposit. The Corps of Engineers participated as a Cooperating Agency for preparation of the SEIS and will use it as part of their decision-making process. The SEIS is available at www.reddogseis.com, or a copy may be obtained by contacting Don Kuhle at (907) 753-2780, toll free from within Alaska at (800) 478-2712, by fax at (907) 753-5567, or by email at don.p.kuhle@usace.army.mil.

APPLICANT PROPOSED MITIGATION: The applicant proposes the following mitigation measures to avoid, minimize, and compensate for impacts to waters of the United States from activities involving discharges of dredged or fill material.

a. Avoidance: Placement of the waste rock from the Aqqaluk deposit on the existing Main waste rock pile and in the Main pit will avoid additional new ground disturbance. Impacts to Sulfur Creek and the wetlands immediately adjacent the Aqqaluk pit are unavoidable because of the physical location of the economic ore body.

b. Minimization: Unavoidable impacts to wetlands adjacent the Aqqaluk pit are minimized by limiting the pit to only the size necessary to recover the economic ore. Wetlands are primarily on the periphery of the Aqqaluk deposit so impacts will be minimized by maintaining pit walls at the steepest angle possible that ensures the longterm stability of the pit.

Impacts will be minimized by placing the temporary ore stockpiles required to provide a consistent grade of ore feed to the milling facilities on disturbed ground within the active pit boundary.

Minimization will occur wherever possible by maintaining the natural vegetated surface in contiguous sections in such a way as to not fragment the wetland habitats or bisect the natural direction of subsurface or surface water flow.

c. Compensatory Mitigation: If a viable agent can be identified to offset the unavoidable impacts to waters of the United States, in the form of tundra wetlands, Teck proposes an In Lieu Fee program for compensatory mitigation. Recognizing that an In Lieu Fee program would require an agent such as The Conservation Fund for the service area with a suitable number and type of available credits to offset the impacts, Teck proposes a 1.5 to 1 or a 2 to 1 ratio of compensation based on an inferred moderate function of the 119 acres of impacted wetlands.

Based on the Magee method of hydro geomorphic rapid assessment of wetland function and data collected in conjunction with the Wetland Jurisdictional Determinations, the impacted wetlands are slope class wetlands that perform a moderate function in the Red Dog Creek watershed. The high-level functions performed by the impacted wetlands relate to water quality, export of detritus, diversification of vegetation and fauna habitat. The impacted wetlands perform a moderate function for storm and flood water storage with low value function in modification of stream flow, ground water discharge, and recharge. The 119 acres of impacted wetlands, comprised of mixed shrub and ericaceous shrub-sedge tundra habitats, amount to approximately 1.3% of the most common wetland habitats in the Red Dog Creek watershed, assuming approximately 57.1% of the 15,789 acres of Red Dog Creek watershed are wetlands. The 119 acres of impacted wetland habitats in the Aqqaluk disturbance area are not unique to the project area and do not perform a critical function to the surrounding watershed or Alaskan tundra habitats.

If a suitable In Lieu Fee program cannot be identified, Teck proposes unavoidable impacts to waters of the United States be offset through permittee-responsible mitigation that enhances the function of stream, riverine, and wetland habitats downstream of the mine. Enhancement would be accomplished through the construction of the Sulfur Creek Diversion.

The water quality of Sulfur Creek is naturally high in metals similar to the pre-mining condition of Red Dog Creek. Prior to mining, the metal-laden waters of Red Dog Creek produced naturally degraded stream and riverine habitats downstream of the mine. Isolation of Sulfur Creek from the sub-surface water and surface water that originates in the mineralized and naturally denuded areas of the Aqqaluk deposit will improve the water quality in the Middle Fork and Main Stem of Red Dog Creek, thereby enhancing stream water quality and habitats in the adjacent floodplains. An estimated 68 acres of Middle Fork Red Dog Creek floodplain and an additional 86.4 acres of floodplain in the Main Stem Red Dog Creek would be enhanced by improved water quality.

Sulfur Creek is an intermittent stream that drains a 166-acre drainage basin contributing approximately 95 million gallons of water per year (based on annual average precipitation of 20.6 inches) to the Red Dog Creek watershed. These waters naturally carry a significant load of metals, particularly lead, zinc, cadmium, and iron. Although Sulfur Creek accounts for only about 7% of the 1.3 billion gallons of water that drains through the Red Dog Creek Diversion it contributes the majority of the annual lead load to the Red Dog Creek watershed. Sulfur Creek also produces the highest maximum concentrations of zinc, lead, cadmium, iron, sulfate, total dissolved solids, and total suspended solids of the tributaries that drain areas adjacent and upstream of Red Dog Mine.

Capture and treatment of Sulfur Creek sub-surface and surface water runoff from the mineralized areas of the Aqqaluk deposit in conjunction with the diversion and segregation of cleaner surface water draining from the vegetated areas will be the purpose of the Sulfur Creek Diversion. The diversion of Sulfur Creek is analogous to the Red Dog Creek diversion in the Main pit and by improving water quality will result in further enhancement of downstream high value riverine and aquatic habitats. Although the steeper gradient of the Sulfur Creek drainage adds significant engineering challenges above those encountered in the design of the Red Dog Creek Diversion, the Sulfur Creek Diversion is a viable method of mitigating impacts to downstream water quality.

If Permittee-responsible mitigation is identified as the preferred mitigation program, Teck in cooperation with the Corps of Engineers will develop a Final Mitigation Work Plan that ensures the Sulfur Creek diversion functions in an efficient and sustainable manner to offset the functional loss of the impacted wetlands. The final work plan would include a maintenance plan; establish performance standards, monitoring requirements, long-term and adaptive management plans, along with a mechanism of financial assurance.

Various studies, including the annual bio-monitoring studies conducted by the Alaska Department of Fish and Game, have demonstrated increased function of downstream aquatic and riverine habitats since mining and the associated water management practices began. The proposed mitigation is a proven technique that has been successfully used in the specific watershed at issue. The Sulfur Creek diversion will contribute significantly to an already successful mitigation technique by further improving water quality downstream of the mine.

WATER QUALITY CERTIFICATION: A permit for the described work will not be issued until a certification or waiver of certification, as required under Section 401 of the Clean Water Act (Public Law 95-217), has been received from the Alaska Department of Environmental Conservation.

COASTAL ZONE MANAGEMENT ACT CERTIFICATION: Section 307(c)(3) of the Coastal Zone, Management Act of 1972, as amended by 16 U.S.C. 1456(c)(3), requires the applicant to certify the described activity affecting land or water uses in the Coastal Zone complies with the Alaska Coastal Management Program. A permit will not be issued until the Division of Coastal and Ocean Management, Department of Natural Resources has concurred with the applicant's certification.

CULTURAL RESOURCES: The latest published version of the Alaska Heritage Resources Survey (AHRS) has been consulted for the presence or absence of historic properties, including those listed in or eligible for inclusion in the National Register of Historic Places. There are two properties in the vicinity of the worksite. They have been designated DEL-163 and DEL-337. Because the properties have been determined to be outside of the project area, no further action is required. This application is being coordinated with the State Historic Preservation Officer (SHPO). Any comments SHPO may have concerning presently unknown archeological or historic data that may be lost or destroyed by work under the requested permit will be considered in our final assessment of the described work.

ENDANGERED SPECIES: No threatened or endangered species are known to use the project area. Preliminarily, the described activity will not affect threatened or endangered species, or modify their designated critical habitat, under the Endangered Species Act of 1973 (87 Stat. 844). This application is being coordinated with the U.S. Fish and Wildlife Service and the National Marine Fisheries Service (NMFS). Any comments they may have concerning endangered or threatened wildlife or plants or their critical habitat will be considered in our final assessment of the described work.

ESSENTIAL FISH HABITAT: The Magnuson-Stevens Fishery Conservation and Management Act, as amended by the Sustainable Fisheries Act of 1996, requires all Federal agencies to consult with the NMFS on all actions, or proposed actions, permitted, funded, or undertaken by the agency, that may adversely affect Essential Fish Habitat (EFH). Preliminarily, the described activity will not affect EFH in the project area. This Public Notice initiates EFH consultation with the NMFS. Any comments or recommendations they may have concerning EFH will be considered in our final assessment of the described work.

TRIBAL CONSULTATION: The Alaska District fully supports tribal self-governance and government-to-government relations between Federally recognized Tribes and the Federal government. Tribes with protected rights or resources that could be significantly affected by a proposed Federal action (e.g., a permit decision) have the right to consult with the Alaska District on a government-to-government basis. Views of each Tribe regarding protected rights and resources will be accorded due consideration in this process. This Public Notice serves as notification to the Tribes within the area potentially affected by the proposed work and invites their participation in the Federal decision-making process regarding the protected Tribal right or resource. Consultation may be initiated by the affected Tribe upon written request to the District Commander during the public comment period.

PUBLIC HEARING: Any person may request, in writing, within the comment period specified in this notice, that a public hearing be held to consider this application. Requests for public hearings shall state, with particularity, reasons for holding a public hearing.

EVALUATION: The decision whether to issue a permit will be based on an evaluation of the probable impacts including cumulative impacts of the proposed activity and its intended use on the public interest. Evaluation of the probable impacts, which the proposed activity may have on the public interest, requires a careful weighing of all the factors that become relevant in each particular case. The benefits, which reasonably may be expected to accrue from the proposal, must be balanced against its reasonably foreseeable detriments. The outcome of the general balancing process would determine whether to authorize a proposal, and if so, the conditions under which it will be allowed to occur. The decision should reflect the national concern for both protection and utilization of important resources. All factors, which may be relevant to the proposal, must be considered including the cumulative effects thereof. Among those are conservation, economics, aesthetics, general environmental concerns, wetlands, cultural values, fish and wildlife values, flood hazards, floodplain values, land use, navigation, shore erosion and accretion, recreation, water supply and conservation, water quality, energy needs, safety, food and fiber production, mineral needs, considerations of property ownership, and, in general, the needs and welfare of the people. For activities involving 404 discharges, a permit will be denied if the discharge that would be authorized by such permit would not comply with the Environmental Protection Agency's 404(b)(l) guidelines. Subject to the preceding sentence and any other applicable guidelines or criteria (see Sections 320.2 and 320.3), a permit will be granted unless the District Commander determines that it would be contrary to the public interest.

The Corps of Engineers is soliciting comments from the public; Federal, State, and local agencies and officials; Indian Tribes; and other interested parties in order to consider and evaluate the impacts of this proposed activity. Any comments received will be considered by the Corps of Engineers to determine whether to issue, modify, condition or deny a permit for this proposal. To make this decision, comments are used to assess impacts on endangered species, historic properties, water quality, general environmental effects, and the other public interest factors listed above. Comments are used in the preparation of an Environmental Assessment and/or an Environmental Impact Statement pursuant to the National Environmental Policy Act. Comments are also used to determine the need for a public hearing and to determine the overall public interest of the proposed activity.

AUTHORITY: This permit will be issued or denied under the following authority:

(X) Discharge dredged or fill material into waters of the United States – Section 404 Clean Water Act (33 U.S.C. 1344). Therefore, our public interest review will consider the guidelines set forth under Section 404(b) of the Clean Water Act (40 CFR 230).

Project drawings, Notice of Application for Certification of Consistency with the Alaska Coastal Management Program, and Notice of Application for State Water Quality Certification are enclosed with this Public Notice.

District Commander
U.S. Army, Corps of Engineers

Enclosures

SEAN PARNELL, GOVERNOR

STATE OF ALASKA

DEPARTMENT OF NATURAL RESOURCES
DIVISION OF COASTAL AND OCEAN MANAGEMENT

DIVISION OF COASTAL AND OCEAN MANAGEMENT
550 WEST 7TH AVENUE, SUITE 705
ANCHORAGE, ALASKA 99501-3559
PHONE: (907) 269-7470/FAX: (907) 269-3981

**NOTICE OF APPLICATION
FOR
CERTIFICATION OF CONSISTENCY WITH THE
ALASKA COASTAL MANAGEMENT PROGRAM**

Notice is hereby given that a request is being filed with the Division of Coastal and Ocean Management for a consistency determination, as provided in Section 307(c)(3) of the Coastal Zone Management Act of 1972, as amended [16 U.S.C. 1456(c)(3)], that the project described in the Corps of Engineers Public Notice No. **POA-1984-12-M45, Chukchi Sea**, will comply with the Alaska Coastal Management Program and that the project will be conducted in a manner consistent with that program.

This project is being reviewed for consistency with the Alaska Coastal Management Program. Written comments about the consistency of the project with the applicable ACMP statewide standards and district policies must be submitted to the Division of Coastal and Ocean Management (DCOM). For information about this consistency review, contact DCOM at the address or phone number above, or visit the ACMP web site at http://www.alaskacoast.state.ak.us//Projects/projects.html.

SEAN PARNELL, GOVERNOR

STATE OF ALASKA

DEPT. OF ENVIRONMENTAL CONSERVATION
DIVISION OF WATER
401 Certification Program
Non-Point Source Water Pollution Control Program

DEPARTMENT OF ENVIRONMENTAL CONSERVATION
WQM/401 CERTIFICATION
555 CORDOVA STREET
ANCHORAGE, ALASKA 99501-2617
PHONE: (907) 269-7564/FAX: (907) 334-2415

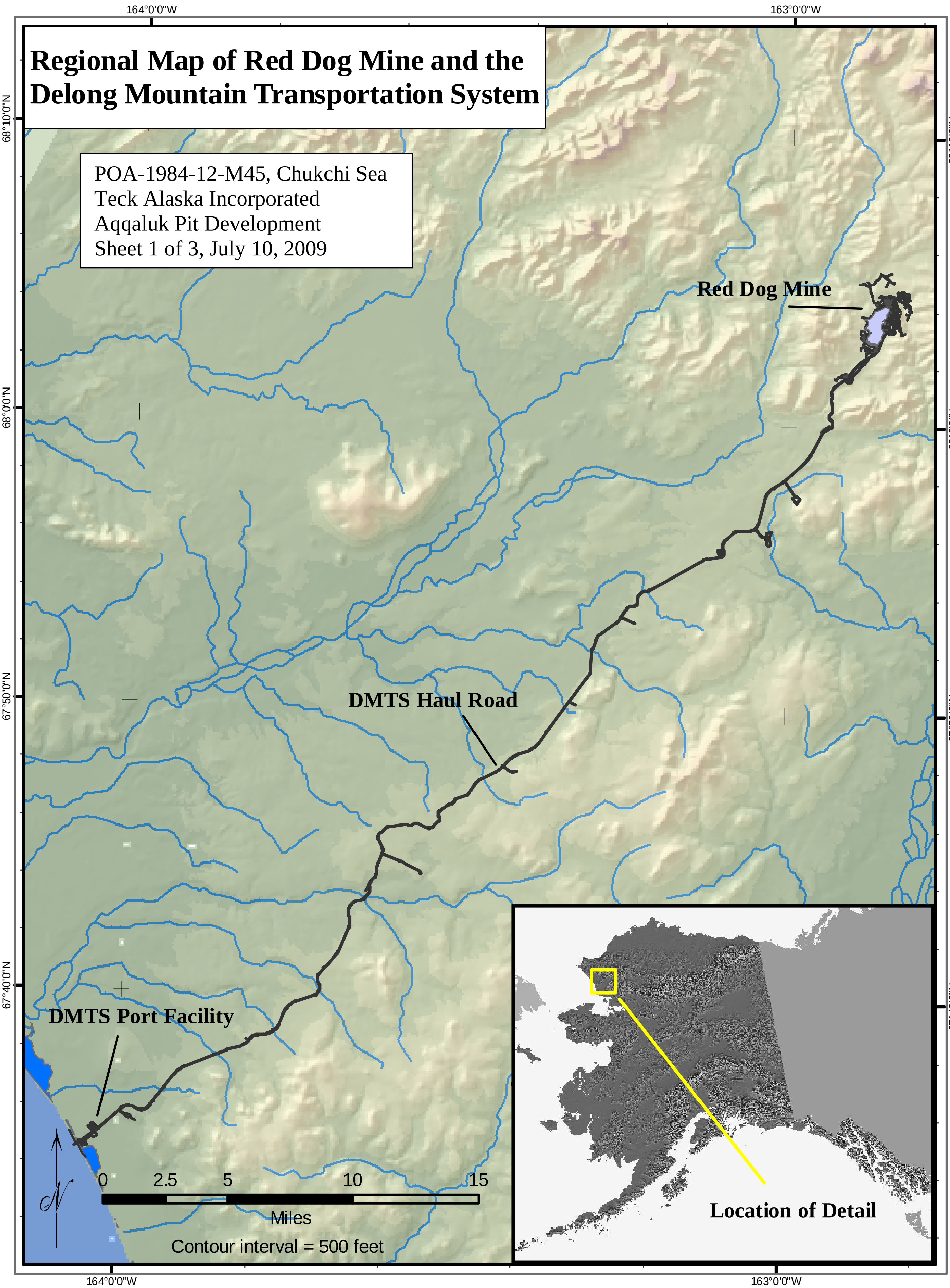
NOTICE OF APPLICATION FOR STATE WATER QUALITY CERTIFICATION

Any applicant for a federal license or permit to conduct an activity that might result in a discharge into navigable waters, in accordance with Section 401 of the Clean Water Act of 1977 (PL95-217), also must apply for and obtain certification from the Alaska Department of Environmental Conservation that the discharge will comply with the Clean Water Act, the Alaska Water Quality Standards, and other applicable State laws. By agreement between the U.S. Army Corps of Engineers and the Department of Environmental Conservation, application for a Department of the Army permit to discharge dredged or fill material into navigable waters under Section 404 of the Clean Water Act also may serve as application for State Water Quality Certification.

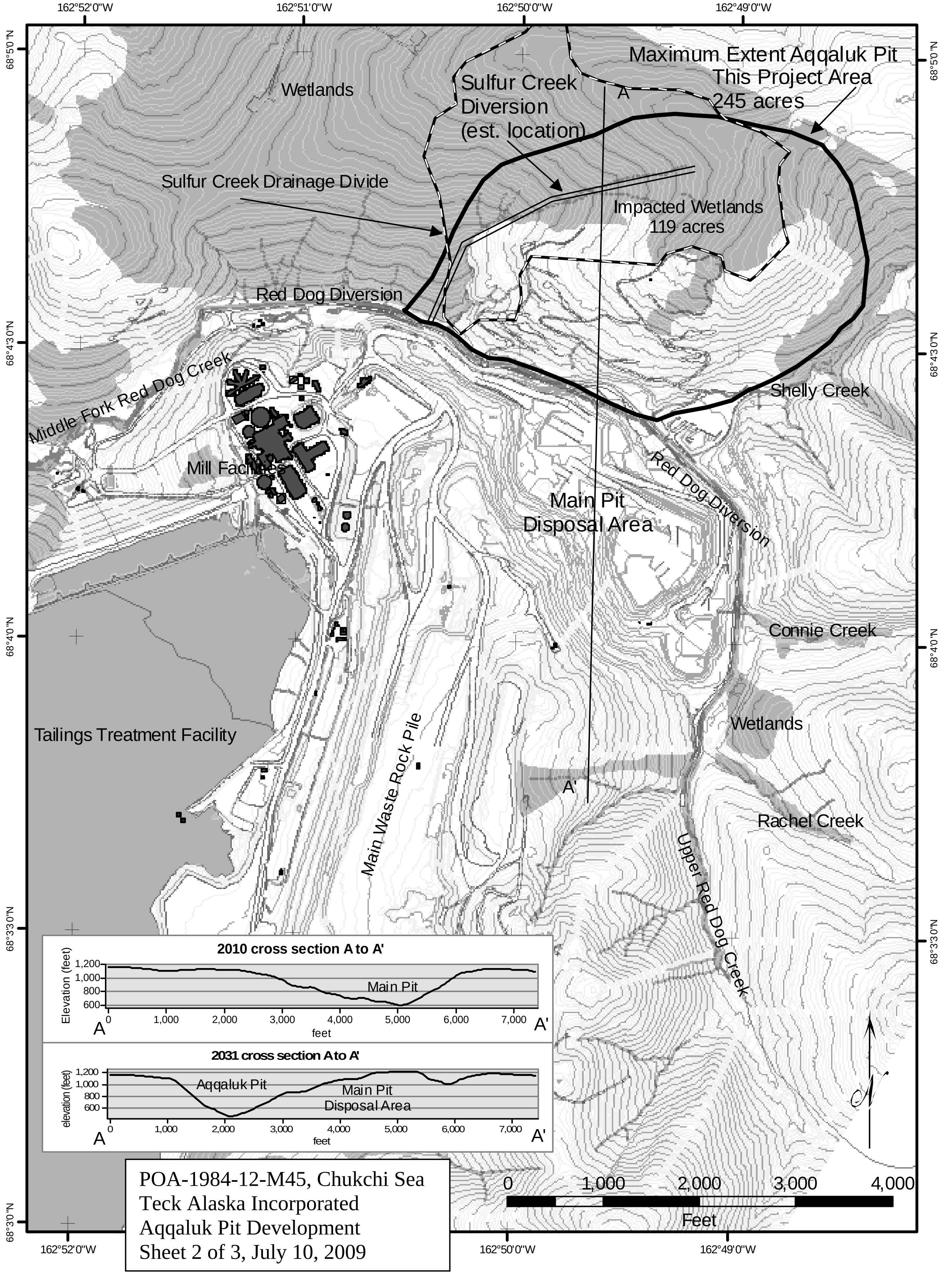
Notice is hereby given that the application for a Department of the Army Permit described in the Corps of Engineers' Public Notice No. **POA-1984-12-M45, Chukchi Sea**, serves as application for State Water Quality Certification from the Department of Environmental Conservation.

After reviewing the application, the Department may certify there is reasonable assurance the activity, and any discharge that might result, will comply with the Clean Water Act, the Alaska Water Quality Standards, and other applicable State laws. The Department also may deny or waive certification.

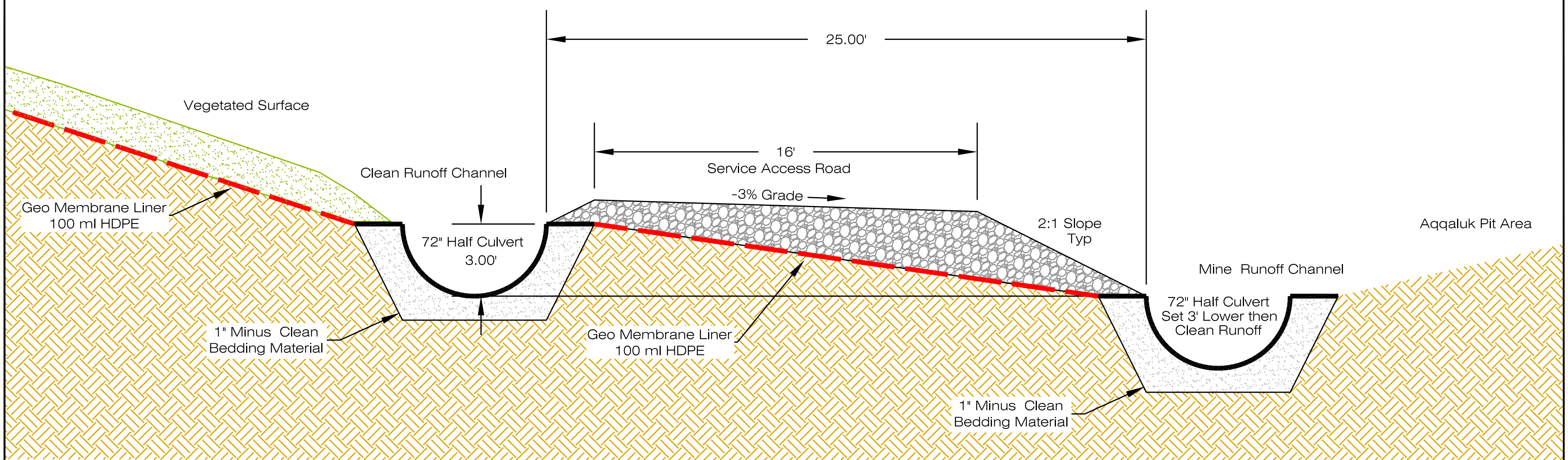
Any person desiring to comment on the project, with respect to Water Quality Certification, may submit written comments to the address above by the expiration date of the Corps of Engineer's Public Notice.


Regional Map of Red Dog Mine and the
Delong Mountain Transportation System
POA-1984-12-M45, Chukchi Sea
Teck Alaska Incorporated
Aqqaluk Pit Development
Sheet 1 of 3, July 10, 2009
Red Dog Mine
DMTS Haul Road
DMTS Port Facility
Location of Detail
0
2.5
5
10
15
Miles
Contour interval = 500 feet
164°0'0"W
163°0'0"W
68°10'0"N
68°0'0"N
67°50'0"N
67°40'0"N
N

Aqqaluk Pit Disturbance Area and Vicinity Map



POA-1984-12-M45, Chukchi Sea
Teck Alaska Incorporated
Aqqaluk Pit Development
Sheet 2 of 3, July 10, 2009



POA-1984-12-M45, Chukchi Sea
Teck Alaska Incorporated
Aqqaluk Pit Development
Sheet 3 of 3, July 10, 2009

Red Dog Mine Aqqaluk Deposit Proposed Sulfur Creek Diversion	Drawn By: SOH	Date: 5/26/09
	Checked By:	Check date:
Rev: 0	Scale: Horiz 1"=5' Vert 1"=5'	Teck

Computer File: Y:\Enviro Intra\Projects\Aqqaluk Drawings\Aqq-Prop-Sulfer-Crk-Diversion.dwg

Appendix B

Stochastic Modeling to Evaluate Allowable Volumes of Discharge to Red Dog Creek at Outfall 001

Stochastic Modeling to Evaluate Allowable Volumes of Discharge to Red Dog Creek at Outfall 001

Technical Memorandum

Red Dog Mine Extension: Aqqaluk Project
Supplemental Environmental Impact Statement

Prepared By

Tetra Tech
310 K Street, Suite 200
Anchorage, Alaska

November 10, 2008

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List of Figures

1.0 Introduction

1.1 Background

Teck Cominco Alaska Incorporated (Teck), in partnership with the NANA Regional Corporation, operates the Red Dog zinc/lead mine in the Northwest Arctic Borough (NWAB) of Alaska, 90 miles north of Kotzebue and 47 miles inland from the coast of the Chukchi Sea. The mine site is located on a ridge between the Middle and South Forks of Red Dog Creek, in the DeLong Mountains of the Western Brooks Range. Red Dog is the world's largest zinc mine. NANA Management Services, Inc. provides camp management, housekeeping, catering and other services; and NANA/Lynden LLC, operates trucks carrying mineral concentrates from the mine to the Alaska Industrial Development and Export Authority's (AIDEA's) Delong Mountain Transportation System port facility.

The Red Dog deposit consists of metal sulfides in Mississippian shale. The ore body lies within the drainage basin of the Middle Fork of Red Dog Creek. Facilities at the mine site include an open pit zinc/lead mine, concentrator, tailings impoundment, concentrate storage building, maintenance facilities, power generation plant and an accommodations complex. The open pit mine is established on both sides of the valley of the Middle Fork of Red Dog Creek.

Mine production at the Red Dog Mine involves the stripping and stockpiling of ore, waste (i.e., rock with sub-economic value), and overburden/topsoil. Mill production involves crushing, grinding and processing to produce mineral concentrates. Mining is done by open-pit methods and averaged 8,900 ore tonnes per day in 2002. The ore is processed in a mill located on a graded pad adjacent to, and northeast of, the tailings dam. The operation includes two crushing plants and grinding, flotation, reagent and dewatering facilities. Froth flotation processes separate materials into floating (particles attached to bubbles) and sinking components, which produce concentrate and tailings, respectively.

Final lead and zinc concentrates are thickened and dewatered to a final cake. Filtered concentrates are stored in the mill site concentrate storage building until transfer by truck to the port site for shipment. The concentrator tailings are pumped from the mill to the tailings facility and deposited either sub-aqueously or sub-aerially in the tailings pond.

Teck uses the tailings impoundment to manage any contaminated or potentially contaminated water from the mine. To minimize the volume of water requiring treatment, clean runoff is directed around all mine site facilities into natural water courses. Teck uses three water treatment plants to treat water collected in the tailings pond. Water Treatment Plant #1 (WTP1) treats water that is reclaimed from the tailings impoundment for use in processing the ore. Most of this treated water comes back to the impoundment with the tailings. Water Treatment Plant #2 (WTP2) currently treats water from the tailings impoundment to be discharged to Red Dog Creek during the summer months. Water Treatment Plant #3 (WTP3) began operating in 2006 and was designed to pre-treat seepage and runoff from the Main Waste Stockpile and Mine Sump before it enters the tailings impoundment. The primary purpose of WTP3 is to provide additional reduction of total dissolved solids (TDS) and sulfate levels influent to the tailings pond.

All three plants use a lime treatment process. Lime is added to the water to raise the pH and precipitate metal hydroxides and gypsum (calcium sulfate). Both the tailings pond water and the discharges at Red Dog Creek are close to saturation with respect to gypsum. Teck is testing the use of barium hydroxide in place of lime in WTP2 in order to reduce the levels of TDS in the discharge.

1.2 NPDES Permit

A permit must be granted under the National Pollutant Discharge Elimination System (NPDES) in order for Teck to discharge the treated tailings pond water to Red Dog Creek. In the early 1980s, Teck submitted several applications for federal authorizations for the project. The surface water discharge was a new source which required EPA to prepare an Environmental Impact Statement (EIS) under the National Environmental Policy Act (NEPA). The EIS was issued in 1984 and the first NPDES permit was issued in 1985 and expired in 1990. The permit was reissued in 1998, modified in 2003, and expired in 2003. The 2003 permit modification was appealed to the EAB which remanded the permit back to EPA. EPA reissued the permit in 2007. The 2007 permit was appealed and EPA withdrew the permit to revise the NEPA analysis associated with the permit. Teck re-applied for the reissuance of their NPDES permit in a timely manner so the permit has been administratively extended until it is reissued. EPA developed a draft NPDES permit that will be public noticed with the draft Supplemental EIS.

A Supplemental EIS is currently being prepared to evaluate the establishment of a new permit renewal for the discharge of treated pond water. Under NPDES permits, the discharge of treated water is managed using effluent limits that define the maximum rate, volume, mass, and/or concentration of metals, solids and/or other constituents that can be discharged. Effluent limits are established so that water quality within the receiving stream is protected for designated uses that have been determined by the State of Alaska. For Red Dog, effluent limits have previously been developed for various metals (including cadmium, lead and zinc), ammonia, solids, pH and TDS. In the draft permit these limits must be met at the end of the discharge pipe (except for TDS). The lime treatment process used at the Red Dog mine efficiently removes a majority of metals from the impoundment water allowing the effluent to be discharged within the required limits. However, the treatment process currently employed does not significantly reduce TDS in the effluent. The TDS limits are proposed to be based on meeting the TDS water quality standard downstream of the outfall at the edge of a mixing zone. Therefore, the volume of water that can be discharged at any given time is dependent on the amount of stream flow in Red Dog Creek and the ambient TDS levels in the creek.

In 1999, the State of Alaska through the Alaska Department of Environmental Conservation (ADEC) changed the water quality criterion under Alaska Administrative Code 18 AAC 70.020(b) for inorganic dissolved solids (TDS) to 1000 milligrams per liter (mg/L) from the confluence of Ikalukrok Creek with Main Stem Red Dog Creek down to the Wulik River, **except** during chum salmon and/or Dolly Varden spawning in Ikalukrok Creek, when the aquatic life criterion of 500 mg/L applies at Station 160 on Ikalukrok Creek. In 2007, the State of Alaska adopted, and EPA approved, a site specific criterion (SSC) for TDS under provisions outlined by 18 AAC 70.235(c). This criterion allows TDS concentrations up to 1,500 mg/L in the Main Stem Red Dog Creek without timing restrictions. At these levels, ADEC has determined that designated uses for the growth and propagation of fish, shellfish, other aquatic life, and wildlife will remain protective. In its certification of the 2007 NPDES permit (which was withdrawn) ADEC authorized mixing zones for TDS. These mixing zones were from the confluence of North Fork Red Dog Creek and Middle Fork Red Dog Creek to Station 151 and from the confluence of Middle Fork Red Dog Creek and Ikalukrok Creek to Station 150 on Ikalukrok Creek. It is anticipated that ADEC will authorize these same TDS mixing zones for the reissued permit. These mixing zones result in the following TDS limits in the draft NPDES permit:

> *After the commencement of discharge, the permittee shall limit the TDS load discharged from Outfall 001 so as to maintain in-stream TDS concentrations at or below all of the following:*
>
> 1. *1,500 mg/L at the edge of the mixing zone at Station 151 in Main Stem Red Dog Creek,*
> 2. *1,000 mg/L at the edge of the mixing zone in Ikalukrok Creek at Station 150 throughout the discharge season, and*

3. *500 mg/L from July 25th through the end of the discharge season at Station 160.*

1.3 Current Water Balance

Teck has developed a water and chemical load balance model to evaluate mine water management, particularly management of the water and chemistry of the tailings impoundment and requirements for the treatment of waters for discharge to Red Dog Creek. The model is used by Teck to assess and manage potential impacts to site hydrology and water quality associated with current and proposed future operations.

The model uses actual metered water flows and measured water quality from mine sumps, pump back systems, runoff conveyance systems, area creeks, water treatment plants and the mine site meteorological station. These data are used for model input as well as model calibration and evaluation. The basic model has currently been used by Teck to evaluate and plan mine operations based on two potential closure scenarios: (1) mine closure in 2012 after completion of mining of the Main Pit; and (2) mine closure in 2031 after mining the Aqqaluk Pit. It also is used to evaluate water treatment needs that will be required after either closure scenario.

The Teck model can be used to reasonably predict the water balance of the mine and estimate the pond water chemistry that would result by implementing various closure scenarios. Currently, the Teck model estimates that an average of 1,527 million gallons (Mgal) needs to be discharged annually until the year 2026 in order to maintain the water balance in the tailings pond. After that period, an average of 1,350 Mgal needs to be discharged annually. In the long term, a lower average rate of discharge may create increased storage requirements for the tailings pond or result in a long term water balance that is constantly gaining. Additional collection of water could eventually become unmanageable under the currently employed site management scenarios.

In the Arctic environment, stream flows vary significantly across the seasons and from year to year. Virtually all flow occurs in the five-month period beginning with spring thaw in May and ending with winter freeze in October. Storm water runoff is also significantly variable depending on topography, degree of soil saturation, and depth to permafrost. Small tributary streams typically freeze to the bottom in the winter months, whereas larger rivers can sometimes continue to flow beneath an ice covering. In the spring, discharge in creeks and rivers are highly dependent on the timing of break-up and the amount of snow pack which melts and runs off. Breakup normally occurs in May but the exact timing varies significantly year to year. Stream flows generally decrease throughout July until a rainy season, which is also highly variable, occurs in August. Flows generally continue until freezing conditions again return in late September to October.

Based on the State criteria and mixing zones for TDS, the volume of water that can be discharged from WTP2 at any given time is dependent on the levels of TDS in the discharge, the amount of stream flow in Red Dog Creek and the ambient (natural) TDS levels in the creek. Since 1999, the water levels in the tailings pond have been increasing. The water balance between 1999 and 2005 shows that the total inflow to the tailings impoundment for the period was 9.05 billion gallons, while the total outflow (including evaporation) from the facility was 8.6 billion gallons. Teck has indicated that in certain years, the discharge was discontinued in order to allow pond levels to rise and cover beach tailings. However, given the large annual variability in stream flows in this region, it is unclear if the overall gaining water balance in the tailings pond is due to some relatively dry years occurring in a row, or if a gaining water balance and increasing pond volume would be expected in the long-term.

2.0 Description of Study

A study was designed to estimate the expected long-term annual volume of treated effluent that can be discharged, given the large annual variations in stream flow conditions. In effect, the study was designed to determine if Teck can expect to be able to discharge at least 1,527 Mgal of treated water as a long-term average, or whether operations will need to be modified to accommodate for a different expected average discharge volume.

A stochastic Monte Carlo model was developed to predict average long-term flows that can be expected in Red Dog Creek and thus, the expected annual volume of water that could be discharged. A stochastic model is a tool for estimating probability distributions of potential outcomes (in this case the volume of effluent discharge) by allowing for random variation in one or more inputs over time (stream flow). The random variation is usually based on fluctuations observed in historical data for a selected period using standard time-series techniques. Distributions of expected outcomes are derived from a large number of simulations (stochastic projections) which reflect the random variation in the input(s). Stochastic modeling uses repeated statistical sampling of input variables with a known distribution (mean and standard deviation) until an average outcome can be determined that can be considered the long-term expected value. Repeated sampling of conditions is conducted until the long-term average outcome is statistically unchanging.

2.1 Model Description

The Monte Carlo stochastic model was developed using @Risk Monte Carlo simulation software. @Risk is “add-in” software for Microsoft Excel that allows one to define input variables within a spreadsheet with appropriate probability distribution functions and perform repeated sampling to predict statistical outcomes.

In general, the spreadsheet model was designed to predict monthly average stream flows in Wulik River, Red Dog Creek and Ikalukrok Creek, estimate appropriate ambient TDS levels for those flow levels, and calculate the allowable discharge at Outfall 001 from WTP2. Average monthly values are then summed up to determine the total volume of water discharged at Outfall 001 for the year.

2.1.1 Prediction of Monthly Stream Flow

Daily discharge of the Wulik River has been monitored since 1984 by the United States Geological Survey (USGS) at Station 2, immediately below the confluence with Ikalukrok Creek. These data represent the longest record of discharge in the watershed (Table 2-1). Evaluations of these data show the significant seasonal variation in surface water flow in the vicinity of the mine site. May has the largest coefficient of variation (1.72) with recorded flows ranging from a low of 9 cubic feet per second (cfs) to a high of 19,000 cfs. The May variation can be attributed to the timing of the spring thaw. The highest flow recorded on the Wulik River, between 1984 and 2007, was 26,700 cubic feet per second (cfs) in August 1989, while the lowest recorded flow in August was 203 cfs. These data demonstrate the extreme variation in the rainy season, which sometimes does not occur at all.

Because it has a good long-term record, the discharge from Station 2 was used to stochastically model the variation in stream flow that could occur monthly in Red Dog Creek and Ikalukrok Creek. Predictions of creek discharge were based on an evaluation of simultaneous daily flows on the Wulik River and at a number of stream stations in the vicinity of the mine and on Ikalukrok Creek (Figure 2-1). Table 2-2 shows the average monthly discharge based on available record for select stream monitoring stations on Red Dog Creek and Ikalukrok Creek.

Table 2-1. River Discharge from Station 2 on the Wulik River (1984-2007)

Month	Discharge			
	Average cfs	Coefficient of Variation [2]	Min cfs	Max cfs
May	1,693	1.72	9	19,000
June	3,175	0.80	180	15,000
July	1,574	1.50	277	19,700
August	2,433	1.24	203	26,700
September	1,661	1.03	255	13,400
October	558	1.14	100	8,250
November	136	0.51	44	470
Annual[1]	1,603	1.19	--	--

[1] Average discharge from May 1st through November 30th.

[2] Coefficient of Variation (CV) is calculated as the standard deviation divided by the mean of the data. The CV shows the relative variation in monthly discharge; values > 1 indicate a high monthly variation in average river discharge.

Table 2-2. Average Monthly Stream Discharge for Select Stations

Month	Average Discharge (cfs)					
	Station 2	Station 160	Station 9	Station 140	Station 12	Station 150
June	3,017	585	309	22	52	379
July	1,363	274	172	9	20	205
August	2,817	417	292	19	47	282
September	1,868	338	166	13	40	298

Station 2 – Wulik River immediately below confluence with Ikalukrok Creek

Station 160 – Ikalukrok Creek downstream of the mine site.

Station 9 – Ikalukrok Creek above confluence with the main stem of Red Dog Creek

Station 9 – Ikalukrok Creek above confluence with the main stem of Red Dog Creek

Station 12 – North Fork Red Dog Creek

Station 150 – Ikalukrok Creek below confluence with main stem of Red Dog Creek

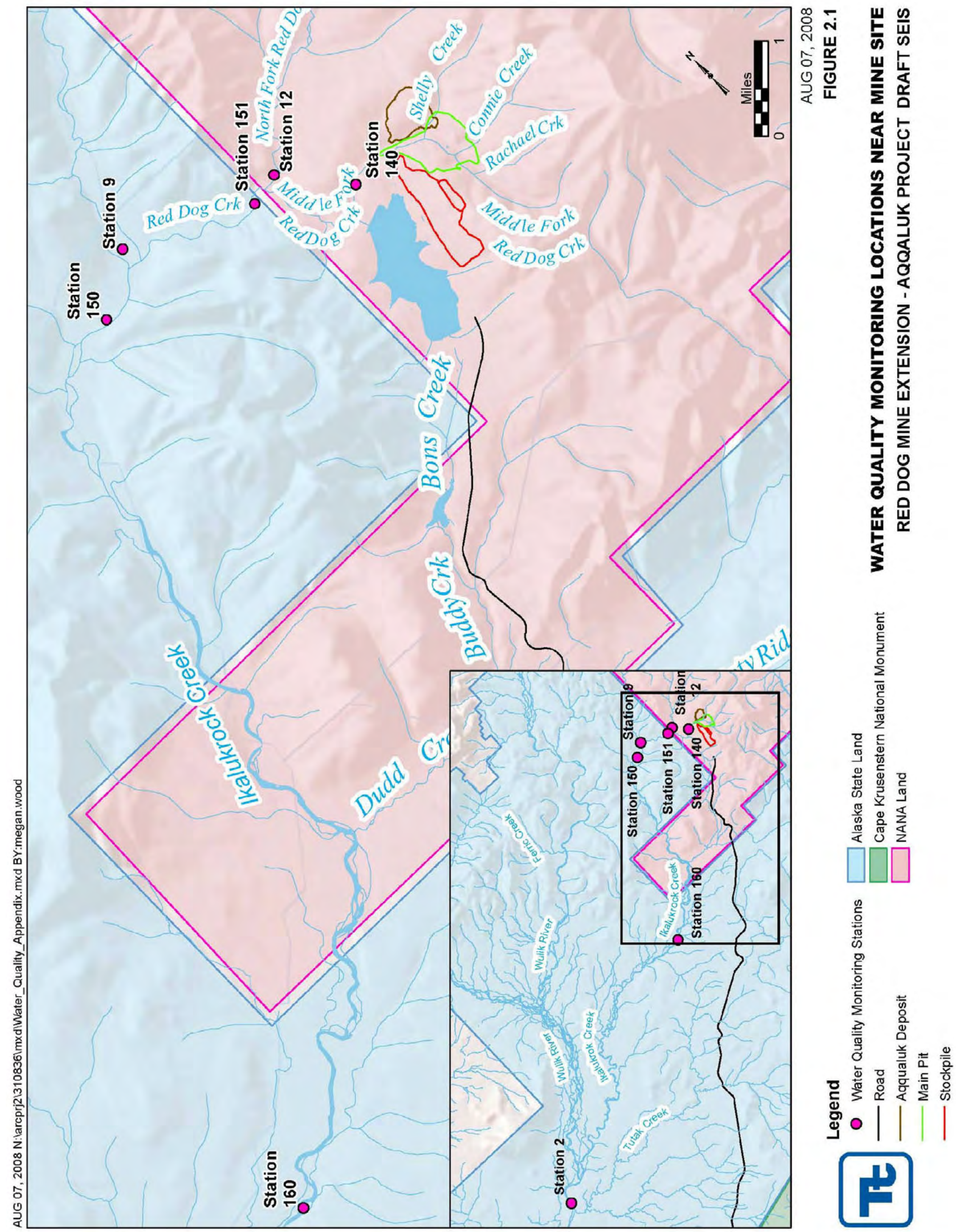

FIGURE 2.1

WATER QUALITY MONITORING LOCATIONS NEAR MINE SITE

RED DOG MINE EXTENSION - AQQALUK PROJECT DRAFT SEIS

Table 2-3 shows the average monthly ratio of daily stream discharge for the stream monitoring stations compared to Station 2 on the Wulik River. As can be seen the proportion of discharge for each station is similar for most months but does vary slightly.

Within the model, these ratios were used to estimate average monthly flows at the select stations based on the varying monthly flow in the Wulik River.

Table 2-3. Average Ratio of Discharge between Select Monitoring Stations and Station 2 on the Wulik River

Month	Average Ratio to Station 2					
	Station 2	Station 160	Station 9	Station 140	Station 12	Station 150
June	1.00	0.213	0.111	0.007	0.017	0.131
July	1.00	0.234	0.128	0.007	0.016	0.165
August	1.00	0.231	0.110	0.007	0.019	0.160
September	1.00	0.189	0.102	0.006	0.024	0.144

Station 2 – Wulik River immediately below confluence with Ikalukrok Creek

Station 160 – Ikalukrok Creek downstream of the mine site

Station 9 – Ikalukrok Creek above confluence with the main stem of Red Dog Creek

Station 140 – Middle Fork Red Dog Creek above immediately above mine site

Station 12 – North Fork Red Dog Creek

Station 150 – Ikalukrok Creek below confluence with Red Dog Creek

2.1.2 Prediction of Ambient TDS Concentration

As discussed in Section 1.1, the State of Alaska adopted site specific criteria (SSC) and authorized mixing zones that allow TDS concentrations up to 1500 mg/L in the Main Stem Red Dog Creek throughout the year, 1000 mg/L at the edge of the mixing zone (Station 150) in Ikalukrok Creek throughout the discharge season, and 500 mg/L from July 25th through the end of the discharge season at Station 160 in Ikalukrok Creek. In order to calculate the allowable discharge at Outfall 001, both the stream flow and ambient (background) TDS concentration in Red Dog and Ikalukrok Creek need to be determined.

The natural concentration of TDS in the stream is dependent on the season of year, the amount of flow, and the mineralogy of the area where the stream flow occurs. During spring break-up, stream flow is primarily made up of runoff melt water that has a tendency to be more dilute with lower concentrations of TDS. Lower creek flows during the summer are primarily supported by a base of shallow alluvial ground water flowing from a thin thaw zone in the permafrost. These flows have a tendency to have naturally higher concentrations of TDS. High runoff events caused by late summer rain storms also have a tendency to be more dilute than base flows. The local mineralogy that the stream transverses, such as in mineralized zones, can also affect TDS concentration.

For predictive modeling, relationships between naturally occurring stream flow, time of the year, and TDS concentration needed to be developed. These relationships were determined by comparing simultaneous stream flow and measured TDS concentrations at select monitoring stations on Red Dog Creek and Ikalukrok Creek.

First, TDS and flow data simultaneously sampled from select stations on 12 sampling dates between 2005 and 2007 were used to determine the following general relationships:

1. The flow-weighted TDS concentration from Station 12, Station 140 and Outfall 001 can be used to reasonably predict the measured TDS concentration at Station 151.
2. Based on 1 above, the flow-weighted TDS concentration from Station 12 and Station 140 can be used to predict the expected ambient TDS concentration at Station 151 if Outfall 001 were not flowing.
3. The flow-weighted TDS concentration from Station 12, Station 140, Station 9 and Outfall 001 can be used to reasonably predict the measured TDS concentration at Station 150 on Ikalukrok Creek.
4. The flow-weighted TDS concentration from Station 9, Station 12, and Station 140 is approximately equal to the flow-weighted concentration of Station 9 and Station 12 alone. In effect, for predictive purposes, the use of flow-weighted data from Station 140 data is not significant.
5. Based on 4 above, the flow-weighted concentration from Station 9, Station 12, and Outfall 001 can be also be used to reasonably predict the measured TDS concentration at Station 150 on Ikalukrok Creek.
6. Based on 5 above, the flow weighted TDS concentration from Station 9 and Station 12 can be used to predict the expected ambient TDS concentration at Station 150 if Outfall 001 were not flowing.
7. The measured TDS concentration at Station 160 is 16% lower than the measured TDS concentration at Station 150 due to diluting tributaries.

Second, all available flow and sampled TDS data were used to develop empirical relationships between the volume of stream flow and the measured TDS concentration at Station 9 and Station 12. Predictive empirical equations were developed using linear regression of log-transformed data. Figures 2-2 through 2-5 depict the predictive relationships that were developed for June through July and August through September for Stations 9 and 12.

Sufficient simultaneously measured flow and TDS data were not available during the month of May to develop relationships such as those shown in Figures 2-2 through 2-5. This is because of the highly variable flow conditions in all area streams during spring break up. For this reason, estimates of allowable discharge from Outfall 001 in the predictive Monte Carlo stochastic model were based on actual discharges that have historically occurred. This is discussed in more detail in Section 2.1.3 below.

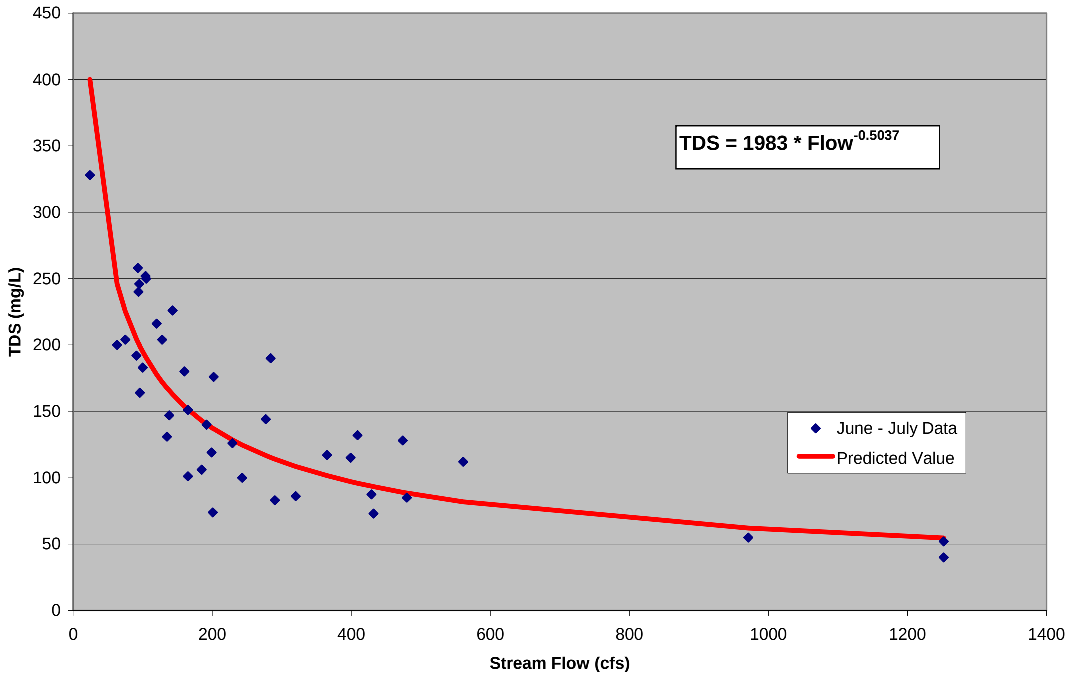

Figure 2-2. Predictive Relationship between Stream Flow and TDS Concentration at Station 9 for June and July

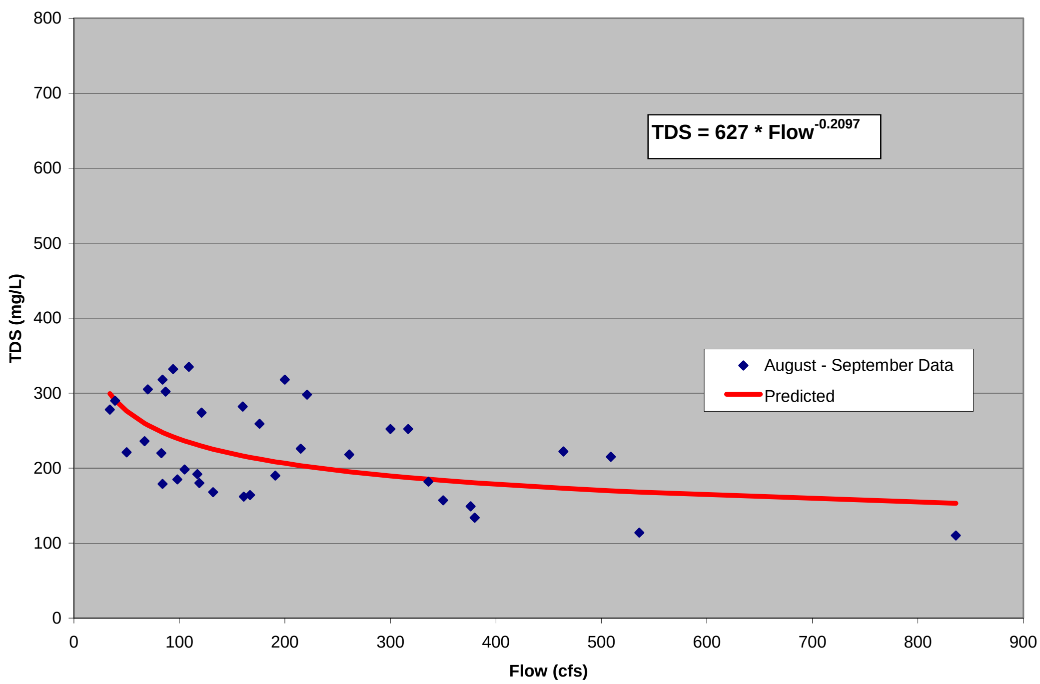

Figure 2-3. Predictive Relationship between Stream Flow and TDS Concentration at Station 9 for August and September

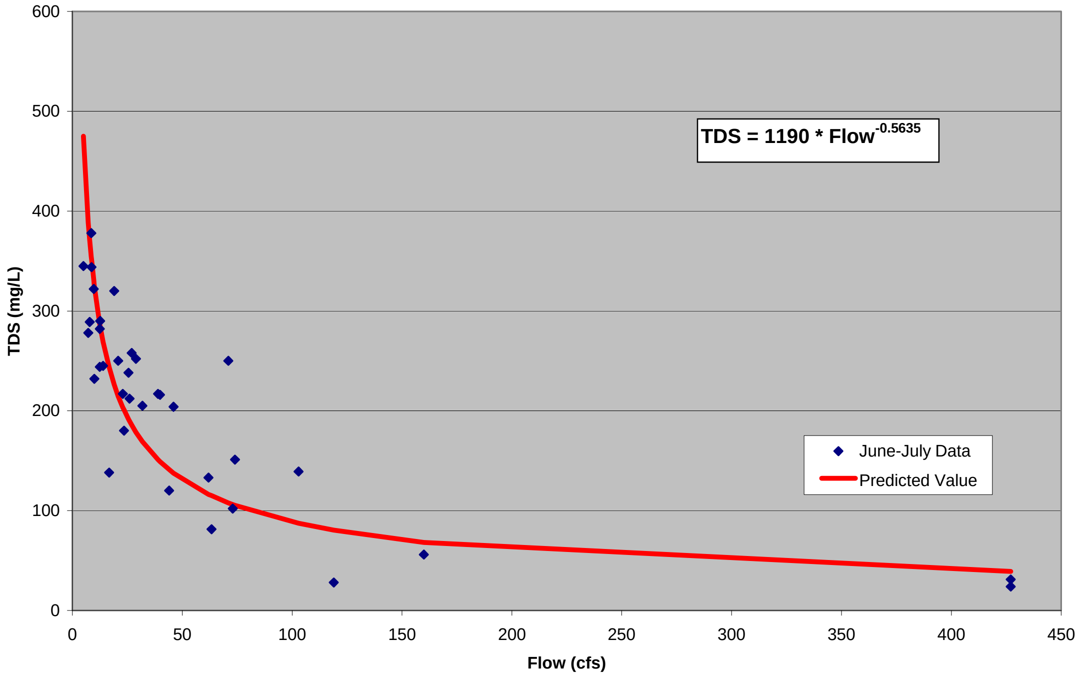

Figure 2-4. Predictive Relationship between Stream Flow and TDS Concentration at Station 12 for June and July

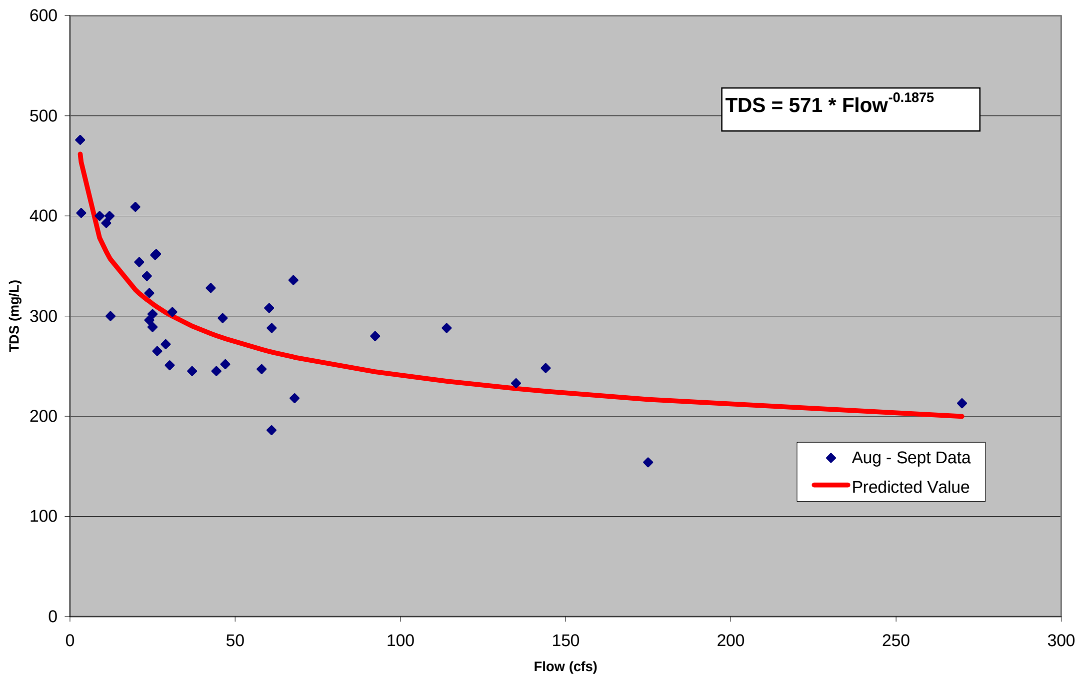

Figure 2-5. Predictive Relationship between Stream Flow and TDS Concentration at Station 12 for August and September

2.1.3 Monte Carlo Stochastic Model

The Monte Carlo simulation model was developed using the relationships for stream flow that were described in Section 2.1.1 and the relationships for predicting TDS and stream flow versus TDS concentration that were discussed in Section 2.1.2. It has long been recognized that annual variations in both climatic and stream flow variables often occur along a log-normal distribution (Chow, 1964). For this reason, the year-to-year and month-to-month variation in stream flow was modeled using a log-normal distribution. This distribution was developed from the historic discharge data base for Station 2 on the Wulik River. Figure 2-6 depicts the log-normal distribution from the @Risk model for June on the Wulik River.

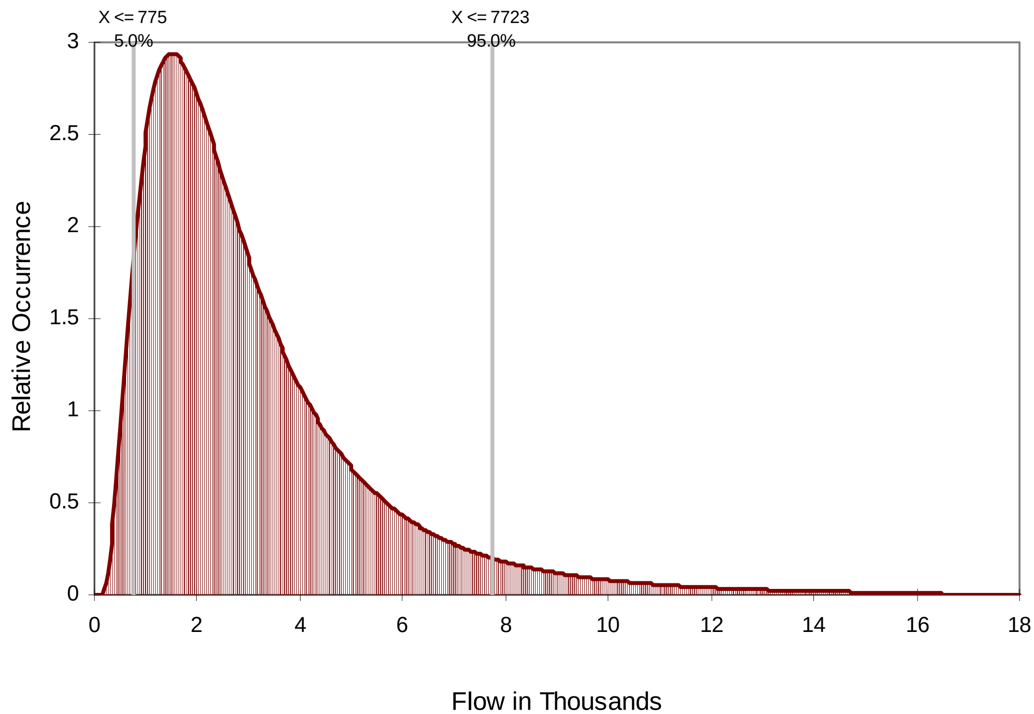

Figure 2-6. Log-normal Distribution of Discharge (Flow) for Station 2 on the Wulik River

The Monte Carlo simulation consists of repetitive calculations of stream flows, ambient TDS concentrations, and allowable discharge rates for Outfall 001. Each repetitive calculation is called an iteration of the model. For each iteration, a value for the monthly average discharge for the Wulik River is chosen based on its probability of occurrence. The probability of occurrence and the value chosen is based on the log-normal distribution. Values for stream discharge and ambient TDS concentration at the select stations are then calculated based on the chosen discharge value for the Wulik River. These values are calculated using the relationships developed and described in Sections 2.1.1 and 2.1.2 above. The baseline model assumes that the TDS concentration of the effluent is 4,078 mg/L. This value is the average TDS concentration of the Outfall 001 discharge for the 2007 discharge season. Other modeled values for the TDS concentration in the effluent based on safety factors and enhanced treatment scenarios are explained in Section 2.2 below.

The modeling consisted of 5,000 iterations, where each iteration represented an estimate for the allowable discharge volume that could occur from Outfall 001 in a given year (i.e., the sum of the calculated monthly averages). It was found that after 5,000 iterations of the model, the mean value for the expected annual volume of allowable discharge was statistically unchanging (i.e., the model reached closure). Once closure was achieved, additional iterations of the model (for example 10,000) would not be expected to have significantly different results.

The final mean value of the model represents the long-term average annual estimated discharge that would be allowable into Red Dog Creek, based on the long-term measured variability of annual flows in the Wulik River.

Table 2-4 shows the spreadsheet input values for the model. The values in this table are based on the long-term average values for the Wulik River. For each iteration of the model, the values in this table are recalculated based on the specific value chosen for the Wulik River for each month based on the log normal distribution. Table 2-5 depicts the input values that were calculated for one internal iteration of the model.

Table 2-6 shows the spreadsheet output values calculated by the model. The values in this table are based on the input values depicted in Table 2-5.

2.2 Model Calibration and Variations

The base model described in Section 2.1 above was calibrated and modified by comparing model predictions for allowable discharge volumes at Outfall 001 with actual discharge data for Outfall 001 for 2004 through 2007. The predicted discharge volumes were generated using actual data for those years. The model was calibrated in several steps with each step representing a different model version.

Results from running the baseline model showed a wide discrepancy between the predicted volume of water that could be discharged and the volume of water that was actually discharged by Teck. The base model showed that the volume of water that could be discharged was far greater than what had actually been discharged for the years 2004 through 2007. One of the primary discrepancies between these levels is factors associated with clogging of the sand filters (the last treatment step prior to discharge to assist in removal of solids). Down times caused by clogging and maintenance of these filters are believed to account for many of the large differences in the actual discharge volumes and the calculated allowable discharge volumes prior to 2006 when Teck made improvements to this system.

Another source of the discrepancy between these levels could be caused by several safety factors that are employed by Teck to ensure that discharges do not exceed the maximum allowable in-stream TDS concentrations specified by State standards (see Section 1.1). These safety factors account for potential inaccuracies in conducting in-stream monitoring at the stations, the travel time between the Outfall and the monitoring stations, as well as an assumption that the ambient stream TDS is actually 6.7 percent higher than actually measured. Additionally, the 2007 draft NPDES permit specified an additional safety factor requiring Teck to assume that the TDS concentration of the effluent was 10 percent higher than indicated by actual measurement. This safety factor was included by the Environmental Protection Agency (EPA) to further insure that the Alaska in-stream standards for TDS are not exceeded. The base model did not incorporate these safety factors, but rather shows the base-line capacity of the system.

Table 2-4. Input Values Table for the Model Based on Long-term Average Monthly Discharge for the Wulik River

Station	Description	June		July		Aug		Sep	
		Flow (cfs)	TDS (mg/L)	Flow (cfs)	TDS (mg/L)	Flow (cfs)	TDS (mg/L)	Flow (cfs)	TDS (mg/L)
Station 2	Wulik River d/s Ikalukrok Cr	**3,108**	--	**1,714**	--	**2,411**	--	**1,674**	--
Station 140	Middle Fork Red Dog Cr	23	124	11	180	16	278	11	286
Station 12	North Fork Red Dog Cr	53	124	28	180	47	278	40	286
Station 9	Ikalukrok Cr u/s Red Dog Cr	344	105	220	131	266	194	246	198
Station 151	Red Dog Cr u/s Ikalukrok Cr	76	124	39	180	62	278	51	286
Station 150	Ikalukrok Cr d/s Red Dog Cr	408	107	283	136	385	207	348	210
Station 160	Ikalukrok Cr u/s Wulik River	663	90	401	115	556	174	457	176

Shaded values are re-sampled for each model iteration based on a log-normal distribution. The remainder of the table is generated from those values.

Table 2-5. Input Values for a Randomly Chosen Iteration of the Model

Station	Description	June		July		Aug		Sep	
		Flow (cfs)	TDS (mg/L)	Flow (cfs)	TDS (mg/L)	Flow (cfs)	TDS (mg/L)	Flow (cfs)	TDS (mg/L)
Station 2	Wulik River d/s Ikalukrok Cr	2,824	--	934	--	2,268	--	1,197	--
Station 140	Middle Fork Red Dog Cr	21	131	6	254	15	281	8	304
Station 12	North Fork Red Dog Cr	48	131	15	254	44	281	29	304
Station 9	Ikalukrok Cr u/s Red Dog Cr	313	110	120	178	250	197	231	200
Station 151	Red Dog Cr u/s Ikalukrok Cr	69	131	21	254	59	281	37	304
Station 150	Ikalukrok Cr d/s Red Dog Cr	371	113	154	186	362	210	328	212
Station 160	Ikalukrok Cr u/s Wulik River	603	95	218	157	523	176	430	178

Table 2-6. Output Data Table for the Randomly Chosen Iteration Shown in Table 2-5

Month	Qe 151	Calc TDS 150	Calc TDS 160	$Q_{allowable}$	Q_a Max	Total Discharge	
	(cfs)	mg/L	mg/L	(cfs)	(cfs)	ft^3	Mgal
May	--	--	--	--	--	--	110
June	36.7	470	--	36.7	32.3	8.37E+07	626
Jul 1 - Jul 24	10.3	429	--	10.3	10.3	2.13E+07	160
Jul 25-Aug 1	10.3	429	333	10.3	10.3	6.22E+06	47
August	27.8	485	373	27.8	27.8	7.44E+07	556
September	16.9	402	326	16.9	16.9	4.39E+07	328
Total						2.30E+08	1,827

Qe 151 is the maximum effluent discharge rate at Outfall 001 without exceeding 1,500 mg/l TDS at Station 151.

Calc TDS 150 is the calculated TDS concentration at Station 150

Calc TDS 160 is the calculated TDS concentration at Station 160

$Q_{allowable}$ is recalculated if the TDS concentration at exceeds 1,000 mg/L at Station 150 or 500 mg/L at Station 160 after July 25th

The maximum discharge capacity from WTP2 is 32.3 cfs; if $Q_{allowable}$ exceeds this value it is adjusted to 32.3 cfs.

The first step in calibrating the model was to account for the safety factors described above in the base-line model. To account for the EPA safety factor, the TDS concentration of Outfall 001 was assumed to be 4,086 mg/L which is 10 percent higher than the average effluent concentration that was used in the base-line model and the concentration of the ambient stream at Station 151 was assumed to be 6.7 percent higher than the predicted value. These types of safety factors would be employed by Teck and required by any new NPDES permit. This second version of the model provides a base-line estimate of the capacity of the system using realistic monitoring and safety factors that would be applied.

In an effort to make the model more conservative with respect to actual discharges, the model which included the safety factors was then modified to provide a more conservative calculation of the ambient TDS versus flow relationships that are depicted in Figures 2-2 through 2-5. This calibration was applied to account for potential errors that could be associated with the regression equations used to estimate ambient TDS concentrations. The results of equation modifications are shown for Station 9 in Figures 2-7 and 2-8. Similar adjustments were made for ambient TDS calculations for Station 12. This version of the model provides a more conservative estimate for the discharge capacity than the model version described above. It is assumed that this version of the model is the best estimate of the volume of discharge that could safely occur without exceeding instream TDS standards.

The base-line model that applied safety factors and the more conservative TDS versions of the model still showed a relatively large discrepancy between the predicted volume of water that could be discharged and the volume of water that was actually discharged by Teck in 2004, 2005, 2006, and 2007. These remaining differences are believed to be due to the problems associated with the clogging sand filters which could not be incorporated into the model. Table 2-7 shows the average differences between predicted allowable discharges and actual discharges at Outfall 001 for the years 2004, 2005, 2006 and 2007. Evaluation of these summary data as well as the data for each individual year (not shown) indicates that the largest discrepancies occur during the periods with the highest ambient stream flow, primarily in June and August. These are the periods when larger volumes could theoretically be discharged without exceeding in-stream TDS standards.

Although this is a predictive model with some inherent degrees of error, the discrepancies between predicted volumes for discharge and actual volumes of discharge are believed to be caused by the problems associated with the clogging filters prior to 2006, as well as the live-time monitoring system that Teck conservatively employs to calculate allowable discharges Teck's description of the discharge monitoring and control system indicated that more conservatism is applied to allowable discharge calculations when stream flows are more variable (i.e., in June and August). The description also indicates that large rain events, when discharges could be higher, are not incorporated into allowable discharges.

Table 2-7. Average Predicted Allowable Discharges Versus Actual Discharges for the Conservative TDS Model for 2004 though 2007

Month	$Q_{predicted}$ (cfs)	Q_{actual} (cfs)	Predicted Mgal	Actual Mgal	Difference Mgal	Difference %
June	29	17	562	329	-233	-41
Jul 1 - Jul 24	12	9	188	139	-49	-26
Jul 25-Aug 1	12	9	55	39	-16	-28
August	20	12	411	245	-165	-40
September	14	13	265	247	-18	-7
Total			1,481	1,000	-481	-32

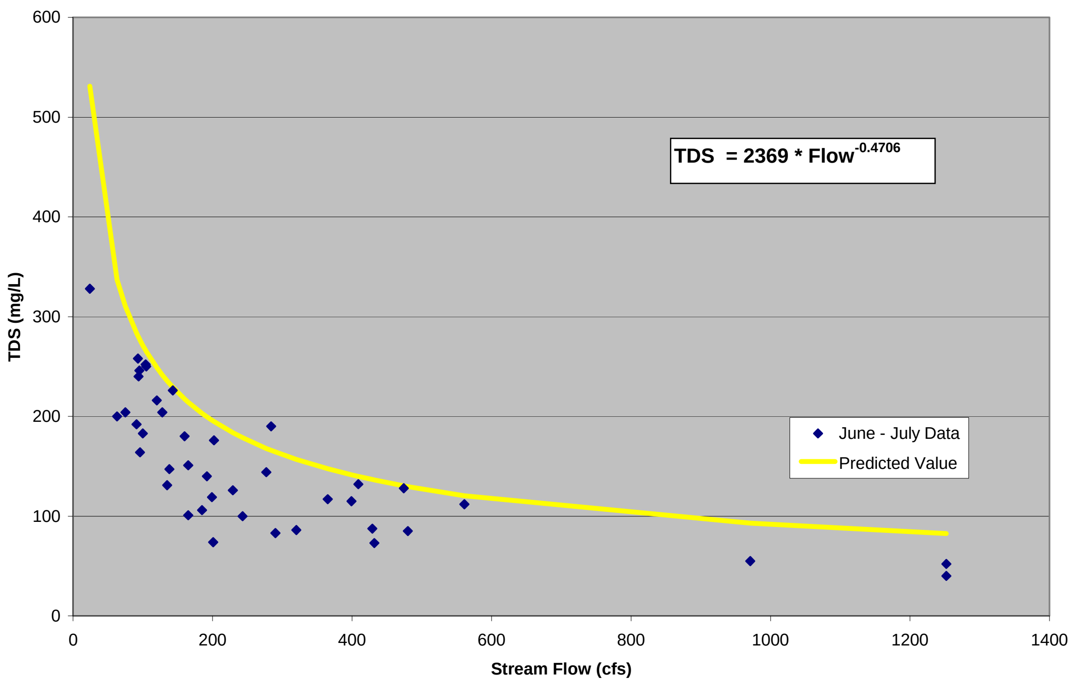

Figure 2-7. Modified Predictive Relationship between Stream Flow and TDS Concentration at Station 9 for June and July

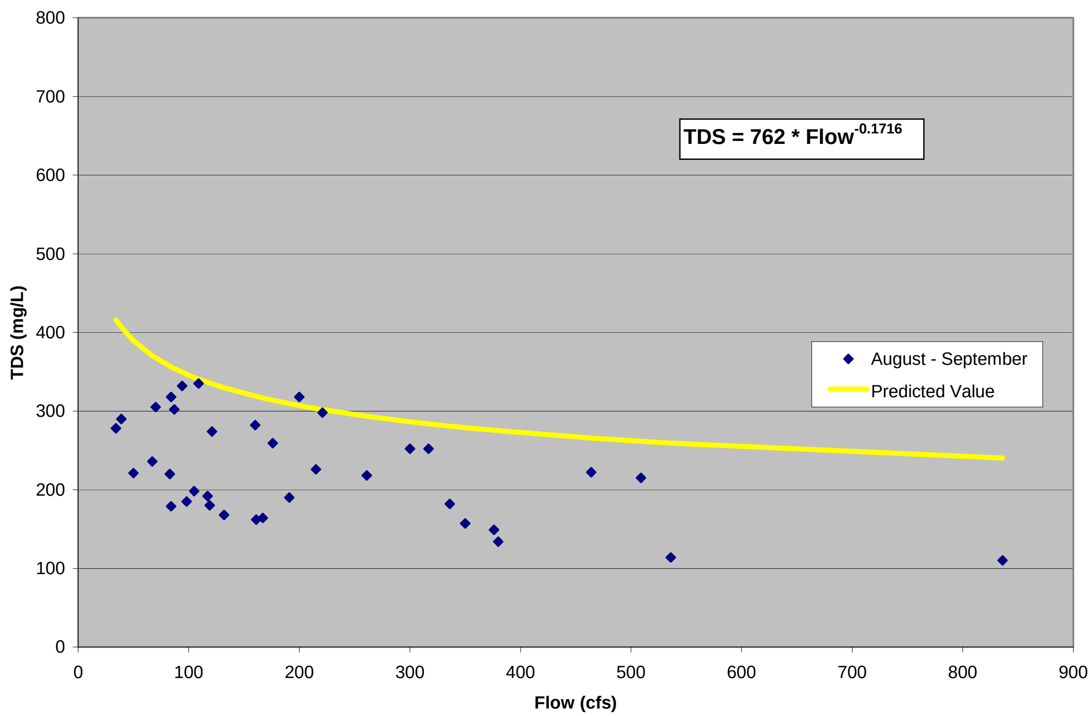

Figure 2-8. Modified Predictive Relationship between Stream Flow and TDS Concentration at Station 9 for August and September

3.0 Modeling Results

Table 3-1 shows results for long-term average annual estimated discharge that would be allowable based on the measured variability of annual flows in the Wulik River and for each model variant. Besides the statistical mean value, the table also shows the 10th and 90th percentile of the data. These values provide a relative comparison of the systems large variability that could be expected year to year.

Results for the base model provide a reasonable indication of the base-line capacity the system has to accept discharges of treated effluent and meet Alaska State Water Quality Standards. The mean annual long-term allowable discharge for the baseline model is 1,576 Mgal per year. The only assumption associated with this model is that Teck can only discharge a maximum of 32.3 cfs. This value would be larger if Teck had a greater capacity for discharge during very high stream flow events.

As can be seen in Table 3-1, applying the EPA and Teck safety factors to assure that in-stream State standards for TDS are met, reduces the long-term annual mean discharge by approximately 200 Mgal per year (1,368). Applying a more conservative approach to estimating ambient TDS in the base flow of the streams also reduces the estimated annual mean discharge to 1,285 Mgal per year. It is believed that these two model versions provide the best estimate of the volume of discharge that could safely occur without exceeding instream TDS standards.

A large drop in expected long-term average discharge (to 904 Mgal per year) occurs when the model is calibrated to account for differences in the actual amount that Teck discharged compared to the calculated amount that theoretically could be discharged. However, it is expected that the improvements made to the sand filter system in 2006 may have greatly improved their ability to discharge. It is also recognized that monitoring ambient stream conditions at several downstream stations and calculating an allowable discharge volume is difficult. However, the remaining difference between the calculated capacity for discharge and the actual discharge suggests that Teck may be able to enhance the volume of annual discharge by reviewing and perhaps modifying their current discharge calculation and monitoring system. This is especially relevant for discharge rate calculations during high stream flows in June and storm-generated events in August.

An additional model scenario was developed to model the differences in the estimated annual average discharge that could occur if Teck was able to reduce the TDS concentration of the effluent by using an enhanced treatment system. Current treatability studies have indicated that Teck could potentially reduce the TDS concentration of the treated effluent by employing aluminum or barium hydroxide precipitation and microfiltration. Preliminary data suggests that this enhanced treatment could reduce sulfate levels to 2,000 mg/L. This reduction in sulfate concentration would cause a corresponding lowering of the total TDS concentration. The final two modeling scenarios shown in Table 3-1 assume that the total TDS concentration of the effluent could be reduced to 3,000 mg/L (3,300 mg/L applying the EPA safety factor). These data suggest that the long-term annual volume of discharge could be 1,617 Mgal per year. The version that has been calibrated to account for the actual discharge levels shows that 1,138 Mgal per year could be discharged. As previously discussed, it is believed that this value would be higher if problems associated with clogging of the sand filter could be rectified or if a more efficient live time monitoring and operation model could be developed.

Table 3-1. Results from Five Discharge Scenarios for Outfall OO1

Scenario	Description	001 TDS Conc.	Long Term Expected Annual Discharge (Mgal/Yr)		
		mg/L	Mean	10th Percentile	90th Percentile
Baseline Model	No Calibration or Controls - Ambient Conditions	4,078	1,576	1,012	2,163
Safety Factors Applied	Teck and EPA safety factors applied	4,486	1,368	813	1,956
Conservative TDS	Safety Factors and Ambient TDS is conservatively estimated	4,486	1,285	724	1,887
Calibrated for Teck Actual Discharge	Safety Factors and Ambient TDS are conservatively estimated; and the model is calibrated for actual Teck discharge.	4,486	904	518	1,342
Enhanced Treatment	Safety Factors applied; assumes enhanced treatment	3,300	1,746	1,144	2,334
Conservative TDS and Enhanced Treatment	Safety Factors and Ambient TDS is conservatively estimated; assumes enhanced treatment	3,300	1,617	992	2,249
Calibrated for Teck Actual Discharge and Enhanced Treatment	Safety Factors and Ambient TDS is conservatively estimated; and the model is calibrated for Teck operational flow differences; assumes enhanced treatment	3,300	1,138	681	1,605

References

Chow, V. T. 1964. Handbook of Applied Hydrology, McGraw-Hill Book Company, 1964.

Appendix C

Effluent Limits for Discharge to the Chukchi Sea Under Alternatives C and D

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List of Tables

Mixing Zone Analysis for Discharge to the Chukchi Sea
Under Alternatives C and D

Under Alternatives C and D, treated effluent would be transported to the port facility by pipeline and discharged to the Chukchi Sea. Under these alternatives, a modified National Pollutant Discharge Elimination System (NPDES) permit would include effluent limits for pollutants consistent with the Alaska Marine Water Quality Standards (WQS) to protect the designated uses of the Chukchi Sea. The concentrations of metals and other constituents in the treated effluent would be expected to be similar to current levels.

This appendix describes a “mixing zone” analysis prepared for the marine discharge. The mixing zone is defined as the area within the receiving water where applicable WQS could be exceeded. The analysis is consistent with the approach EPA typically uses to develop NPDES permits. Because marine water is naturally high in TDS, there are, no marine WQS for total dissolved solids (TDS), and therefore TDS would not be a concern for discharge to the Chukchi Sea.

Water Quality Standards for Toxic Pollutants and pH

The first step in determining mixing zones is to identify the applicable WQS. The applicable standards are based on the designated uses of the receiving water, the Chukchi Sea. Under Alaska WQS, unless a particular water body has been reclassified or redesignated, all marine waters of the state are to be protected for the following uses:

- Water Supply (aquaculture, seafood processing and industrial uses)
- Water Recreation (contact and secondary recreation)
- Growth and Propagation of Fish, Shellfish, Aquatic Life and Wildlife
- Harvesting for Consumption of Raw Mollusks and Other Raw Aquatic Life.

The most stringent WQS for all parameters of concern are shown in Table C-1. For most constituents the most stringent water quality criteria are those for the *harvesting for consumption of raw mollusks and other raw aquatic life.* For mercury, the most stringent WQS is the human health criterion for *consumption of aquatic organisms*.

Table C-1. Applicable Marine Water Quality Standards for the Chukchi Sea at the Port Site

Parameter (in µg/L unless otherwise noted)	Acute	Chronic
Ammonia (mg/L) [1]	27	4.3
Cadmium[2]	40	8.8
Copper[2]	5.8	3.7
Chlorine	13	7.5
Chromium VI[2]	1,100	50
Cyanide[3]	1.0	1.0
Lead[2]	217	8.5
Mercury[2]	0.051[4]	
Nickel[2]	75	8.3
Selenium[2]	290	71
Silver[2]	2.3	None
Zinc[2]	95	86
pH (standard units)	Within the range of 6.5 – 8.5	

1 ammonia standards are based on the pH and salinity data collected at two off-shore sampling stations near the port site.
2 all metals standards are expressed as total recoverable.
3 the cyanide standard is expressed as free cyanide but is measured as weak acid dissociable (WAD) cyanide.
4 the mercury standard is based on the human consumption of organisms.

Mixing Zone Analysis

The next step in the process is to determine the maximum projected discharge concentration for each pollutant (see Table C-2)

This was accomplished based on guidance in EPA's *Technical Support Document for Water Quality-based Toxics Control* (TSD). The maximum observed effluent concentration from Outfall 001 monitoring data for 2003-2007 was multiplied by a multiplier (M) to determine the projected maximum concentration in the effluent (Ce). The value for "M" is a statistically derived value that is based on the variability in the effluent data. The Ce values were then compared to the applicable WQSs shown in table C-1 to determine the need for mixing zones, i.e., areas in the Chukchi Sea around the discharge where the WQS may be exceeded. Copper, chlorine, cyanide, nickel, and zinc exceeded both the acute and chronic water quality criteria. Ammonia only exceeded the chronic criterion. Considering the ambient concentration of each parameter (except copper), nickel required the largest dilution (16.95:1) to the meet the chronic criterion. This value was used to determine the physical size of the mixing zone as described in Section 3.5.3.3. For copper, there is uncertainty related to the validity of available background data, see Footnote 1 in Table C-2. For this analysis, copper was assumed to not be present in the ambient water. Teck continues to monitor background water chemistry, including copper, and the additional data would be used to support future permitting of a marine outfall.

Table C-2. Ce and Cm Values for Mixing Zone Determination

Parameter (in ug/L, unless otherwise noted)	Maximum Observed Effluent Concentration	n = # of samples	CV	M	Ce	Ambient Concentration[2]
Ammonia (mg/L)	10.7	105	0.2	1.15	12.3	NA
Cadmium	1.8	100	0.5	1.37	2.47	0.20
Copper[1]	22	108	1.3	1.78	39.2	See footnote 1
Chlorine	35	98	0.2	1.11	38.9	NA
Cyanide	12	205	0.7	1.22	14	NA
Chromium VI	13	46	1.7	3.32	43.2	NA
Lead	2.9	103	0.7	1.47	4.27	1.6
Mercury	0.0051	43	1.0	2.37	0.012	ND
Nickel	78	102	1.2	1.80	141	NA
Selenium	4.6	103	0.4	1.26	5.79	NA
Silver	0.50	77	1.9	2.53	1.27	NA
Zinc	158	101	0.4	1.30	205	20.1

CV = Coefficient of Variation; M = multiplier; Ce = maximum estimated effluent; concentration; NA= no data available; ND = not detected in any samples.

1 previous analyses for copper in both effluent and the receiving water have shown a potential to produce erroneously high values due to the particular analytical method used; additional study and monitoring of both the effluent and receiving water would be needed to formally conduct a mixing zone evaluation.

2 For this preliminary analysis, background levels of all pollutants with ND or NA were assumed to be zero since they are not expected to be found in the marine waters. If Teck applies for a marine discharge, they would be required to provide ambient monitoring data for all parameters for which a mixing zone is requested.

Appendix D

Subsistence

Red Dog Mine Extension – Aqqaluk Project
Supplemental Environmental Impact Statement

Appendix D – Subsistence
Draft

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Acronyms List

ADF&G	Alaska Department of Fish and Game
AEWC	Alaska Eskimo Whaling Comission
ANILCA	Alaska National Interest Land Conservation Act
ATV	All Terrain Vehicle
Corps	U.S. Army Corps of Engineers
DEIS	Draft Environmental Impact Statement
DMTS	DeLong Mountain Transportation System
EIS	Environmental Impact Statement
ESA	Endangered Species Act
KIC	Kikiktagruk Iñupiat Corporation
NAB	Northwest Arctic Borough
NRC	National Research Council
SEIS	Supplemental Environmental Impact Statement
SRB&A	Stephen R. Braund & Associates
TCAK	Teck Cominco Alaska, Incorporated
USEPA	United States Environmental Protection Agency
WAH	Western Arctic Caribou Herd

SUBSISTENCE APPENDIX

Forward

Appendix D is the source of the text found in Sections 3.12.1 (Subsistence – Pre-Mining Environment) and 3.12.2 (Subsistence – Baseline Conditions) of this report. Stephen R. Braund & Associates (SRB&A) condensed the following text in order to provide a shortened version for inclusion in the Supplemental Environmental Impact Statement (SEIS). Therefore, while much of Section 3.12 is repeated here, this appendix includes additional resource-specific text and data not found in Chapter 3.

Introduction

This appendix describes pre-mining and current (since Red Dog mine operations began in 1989) subsistence uses in the study area and analyzes the effects of the Red Dog Mine on subsistence uses of residents in the study area through 2007. For the subsistence analysis, the study area includes the communities of Kivalina, Kotzebue, and Noatak. Residents from these communities use the project area, which includes the road, mine, port site, and surrounding drainages, for subsistence activities, and they harvest resources that travel through or reside in the project area.

The study area is comprised of state, federal, and private lands. In Alaska, subsistence hunting and fishing are regulated under a dual management system by the State of Alaska and the Federal government. Much of the private land in the region is owned by the regional Native corporation (NANA) and the Kotzebue village corporation (Kikiktagruk Iñupiat Corporation [KIC]). Subsistence uses on NANA lands are limited primarily to shareholders, although some non-local recreational uses are allowed by permit. Hunting guides are not permitted to operate on NANA lands (NANA 2003). Subsistence activities on all lands in Alaska, including private lands, are subject to State and Federal subsistence regulations.

State law is based on Title 16 of Alaska Statute 16 and Title 5 of the Alaska Administrative Code, Chapters 01, 02, 85, 92, and 99, and regulates State subsistence uses. Under State law, "'subsistence uses' means the noncommercial, customary and traditional uses of wild, renewable resources by a resident domiciled in a rural [sic] area for direct personal or family consumption as food, shelter, fuel, clothing, tools, or transportation, for the making and selling of handicraft articles out of non-edible by-products of the fish and wildlife resources taken for personal or family consumption, and for customary trade, barter, or sharing for personal or family consumption" (Alaska Statute 16.05.940[33]).

Federal subsistence law is based on Title VIII of the 1980 Alaska National Interest Lands Conservation Act (ANILCA) and regulations found in 36 CFR 242.1 and 50 CFR 100.1. Under Federal law, "subsistence uses means the customary and traditional uses by rural Alaska residents of wild renewable resources for direct personal or family consumption as food, shelter, fuel, clothing, tools, or transportation; for the making and selling of handicraft articles out of non-edible byproducts of fish and wildlife resources taken for personal or family consumption; for barter, or sharing for personal or family consumption; and for customary trade" (ANILCA Title VIII Section 803).

The Alaska Federation of Natives describes subsistence as:

> the hunting, fishing, and gathering activities which traditionally constituted the economic base of life for Alaska's Native peoples and which continue to flourish in many areas of the state today. Subsistence is a way of life in rural Alaska that is vital to the preservation of communities, Tribal cultures, and economies. Subsistence resources have great nutritional, economical, cultural, and spiritual importance in the lives of rural Alaskans.… Subsistence, being integral to our worldview and among the strongest remaining ties to our ancient cultures, is as much spiritual and cultural, as it is physical (Alaska Federation of Natives 2005).

The majority of public State and Federal lands in the study area are open to subsistence hunting and fishing activities for residents in the study communities. Title VIII of ANILCA specifies that "rural residents engaged in subsistence uses shall have reasonable access to subsistence resources on the public lands" (ANILCA Title VIII Section 811). NANA shareholders, spouses and descendants of shareholders, and Natives who live outside the region but who "traditionally hunt in the region" may hunt and fish on NANA lands without a permit. Additionally, non-shareholders who have been permanent residents in the region for at least five years and who "have traditional and customary use of fish and game" may engage in hunting and fishing activities on NANA lands by permit (NANA 2003).

Subsistence uses are central to the customs and traditions of many cultural groups in Alaska, including people living in the Northwest Arctic Borough (NAB). Native Alaskans have relied on wild resources for food, clothing, and shelter for thousands of years. Today, residents participate in a "mixed, subsistence-market" economy, where families invest money into small-scale technologies to assist in harvesting wild foods (Alaska Department of Fish and Game [ADF&G] 2000). Cash from commercial fishing, trapping, and/or wage from public and private sector employment provides the means to purchase supplies (gas, transportation, and equipment) used in subsistence activities. Subsistence activities include hunting, fishing, trapping, gathering wood, and picking berries and plants.

Participation in subsistence activities promotes transmission of traditional knowledge from generation to generation and serves to maintain people's connection to the physical and biological environment. The subsistence lifestyle encompasses Iñupiaq cultural values such as sharing, respect for elders, respect for the environment, hard work, and humility. In addition to being culturally important, subsistence is a source of nutrition for residents in an area of Alaska where food prices are high. While some people earn income from employment, these and other residents rely on subsistence to supplement their diets throughout the year. Furthermore, subsistence activities support a healthy diet and contribute to residents' overall well-being.

Subsistence – Pre-Mining Environment

Subsistence Harvests

Several subsistence harvests studies in the three study communities of Kivalina, Kotzebue, and Noatak, documented residents' use of subsistence resources prior to the Red Dog Mine development. Initiated by the U.S. Atomic Energy Commission's environmental studies of the Cape Thompson area, Saario and Kessel (1966) documented Kivalina residents' subsistence uses from 1959-1961 (two study years of harvest data), and Foote and Williamson (1966) reported on the subsistence uses of Noatak from 1960-61 (one study year). As part of an effort to document subsistence harvests in five Native regions for the Joint Federal-State Land Use Planning Commission, Patterson (1974) compiled harvest estimates for these three study communities during the early 1970s. Burch (1985) conducted two Kivalina subsistence studies in 1964-1966 (two study years) and again in 1982-1984 (two study years). Braund and Burnham (1983) also documented Kivalina Dolly Varden char harvest amounts in 1982. A study in 1986 by Georgette and Loon (1993) documented pre-mine subsistence harvest in Kotzebue.

Kivalina

The community of Kivalina was first established in 1905 after the construction of a school on a narrow barrier island positioned between the mouth of the Wulik River and the Chukchi Sea (Burch 1985:2). Sod house outlines at the north end of the lagoon show that local inhabitants had been using the area as a summer camping ground prior to 1905 (Saario & Kessel 1966:1023). Burch (1985) reported that the original inhabitants included members of the *Kivalinarmiut* Society in addition to individuals from the Shismaref, Noatak Valley, and Kotzebue areas. Prior to 1905, the inhabitants of the Kivalina region lived inland along the Wulik and Kivalina rivers moving seasonally to follow the winter caribou herds and traveling to the coast in the spring for seal hunting (Saario & Kessel 1966:1023). For further information regarding the time frame prior to Euro-American contact and ethnohistory of the region, see Section 3.14 Cultural Resources.

Four separate studies, beginning in 1959 and representing seven harvest years, reported on the subsistence harvests of Kivalina residents prior to the development of the Red Dog Mine. In each of five study years (1964-65, 1965-66, 1971-72, 1982-83, and 1983-84), caribou, Dolly Varden char (referred to as "trout" by local residents), bearded seal, ringed seal, and beluga comprised the bulk of residents' harvests (Table 1). When harvested, as in 1983-84, bowhead also contributed to a large portion (15.6 percent) of the subsistence harvest.

Table 1: Selected Kivalina Harvests, Pre-mine Study Years

	Resource	Estimated Harvest				
		Number	Total Pounds[1]	Mean HH Pounds	Per Capita Pounds	% of Total Harvest
1964-65	Dolly Varden char		65,796	2,531	378	28.2%
	Ringed Seal	908	65,728	2,528	378	28.2%
	Bearded Seal	153	51,355	1,975	295	22.0%
	Caribou	256	36,338	1,398	209	15.6%
	Beluga	6	9,150	352	53	3.9%
	Whitefish		1,750	67	10	0.7%
	Vegetation		1,180	45	7	0.5%
	Salmon		997	38	6	0.4%
	Bird Eggs		496	19	3	0.2%
	Spotted Seal	4	408	16	2	0.2%
	Brown Bear	1	168	6	1	0.1%
1965-66	Caribou	1,010	144,434	5,555	830	53.6%
	Bearded Seal	119	41,044	1,579	236	15.2%
	Ringed Seal	467	35,447	1,363	204	13.2%
	Dolly Varden char		19,698	758	113	7.3%
	Beluga	12	18,690	719	107	6.9%
	Pacific Tom Cod		4,869	187	28	1.8%
	Walrus	3	3,270	126	19	1.2%
	Moose	4	2,040	78	12	0.8%
	Polar Bear	1	480	18	3	0.2%
	Berries		464	18	3	0.2%
	Brown Bear	2	438	17	3	0.2%
	Plants/Greens/Mushrooms		213	8	1	0.1%
1971-72[2]	Dolly Varden char		95,950		510	33.1%
	Caribou	513	69,768		371	24.1%
	Bearded Seal	125	52,500		279	18.1%
	Other Seal	500	40,000		213	13.8%
	Whitefish		12,000		64	4.1%
	Beluga	10	9,950		53	3.4%
	Walrus	3	2,310		12	0.8%
	Berries		1,480		8	0.5%
	Arctic Cod		1,200		6	0.4%
	Grayling		1,200		6	0.4%
	Plants/Greens/Mushrooms		1,102		6	0.4%
	Chum Salmon		600		3	0.2%
	Ducks	400	600		3	0.2%
	Bird Eggs		500		3	0.2%

	Resource	Estimated Harvest				
		Number	Total Pounds[1]	Mean HH Pounds	Per Capita Pounds	% of Total Harvest
	Polar Bear	1	372		2	0.1%
	Auk/Murre/Puffin	200	200		1	0.1%
1982-83	Dolly Varden char		48,341	1,029	179	23.0%
	Caribou	346	48,202	1,026	179	22.9%
	Bearded Seal	134	45,760	974	169	21.8%
	Beluga	27	43,050	916	159	20.5%
	Ringed Seal	172	13,070	278	48	6.2%
	Walrus	51	3,825	81	14	1.8%
	Moose	6	3,060	65	11	1.5%
	Berries		2,639	56	10	1.3%
	Geese	183	427	9	2	0.2%
	Ducks	134	272	6	1	0.1%
	Dall Sheep	2	255	5	1	0.1%
	Grayling		203	4	1	0.1%
	Coho Salmon		182	4	1	0.1%
	Unknown Salmon		140	3	1	0.1%
	Plants/Greens/Mushrooms		125	3	0	0.1%
	Spotted Seal	1	111	2	0	0.1%
1983-84	Caribou	564	76,652	1,631	284	30.2%
	Dolly Varden char		47,927	1,020	178	18.9%
	Beluga	28	44,910	956	166	17.7%
	Bowhead	1	39,600	843	147	15.6%
	Bearded Seal	60	19,862	423	74	7.8%
	Ringed Seal	109	7,066	150	26	2.8%
	Walrus	4	3,600	77	13	1.4%
	Pacific Tom Cod		3,009	64	11	1.2%
	Moose	6	2,970	63	11	1.2%
	Chum Salmon		1,162	25	4	0.5%
	Whitefish		1,126	24	4	0.4%
	Berries		1,093	23	4	0.4%
	Gray Whale	1	1,000	21	4	0.4%
	Polar Bear	2	795	17	3	0.3%
	Grayling		678	14	3	0.3%
	Geese	209	614	13	2	0.2%
	Brown Bear	2	517	11	2	0.2%
	Ducks	210	483	10	2	0.2%
	Unknown Salmon		262	6	1	0.1%
	Ptarmigan	242	160	3	1	0.1%

Notes: [1]Where specific harvest numbers existed 1971-72 Total Pounds data converted based on ADF&G Conversion Factors (ADF&G 2008b); [2]Harvest estimates represent an annual average over a period of years in the early 1970s.

Source: ADF&G 2008a; ADF&G 2008b; Burch 1985; Patterson 1974.

Blank cells indicate data not available

Stephen R. Braund & Associates 2008.

Resource availability was an important factor in the composition of resource harvests from year to year. In 1964-65 the ratio of caribou harvests to all harvests was the lowest of all study years, whereas in the following year caribou comprised over 50 percent of the total harvested subsistence resources (Table 2).

Residents compensated for low harvests of one resource by increasing their harvest efforts on other more available resources. Burch (1985:77) explained that in 1965-66, residents experienced the worst recorded fall harvest of Dolly Varden char (contributing 7.3 percent; Table 2), a major subsistence resource for both human and dog consumption. With the arrival of caribou shortly after the end of the fall fishery, Kivalina residents compensated for the low harvests of Dolly Varden char by increasing their harvest of caribou (53.6 percent).

Per capita harvest levels decreased from 1,838 pounds in 1959-60 to less than 1,000 pounds in 1982-83 and 1983-84. In general, per capita harvest levels for resources contributing the most to the overall harvest amounts, including caribou, bearded seal, other seals, and Artic char, declined between the 1960s and 1980s (Table 2). Only beluga harvests showed an increasing trend in harvest amounts. Burch (1985:111) noted that the decreased use of sled-dogs, major consumers of fish and other subsistence resources, must be taken into account as part of an explanation for the decrease in per capita harvest. When the total number of consumers (persons plus dogs) is analyzed in relationship to the total harvest, the pounds per consumer actually increased between the 1960s and 1980s (Burch 1985:Table 27).

Table 2: Kivalina Harvest Estimates by SRB&A Resource Category, Pre-mine Study Years

ADF&G Study Year	Resource	Estimated Harvest				
		Number	Total Pounds[2]	Mean HH Pounds	Per Capita Pounds	% of Total Harvest
1959-60	All Resources		266,581	12,117	1,838	100.0%
	Caribou	407[1]	55,352	2,306	382	20.8%
	Moose					
	Other Large Land Mammals					
	Bowhead					
	Beluga	14	13,930	580	96	5.2%
	Bearded Seal	117	49,140	2,048	339	18.4%
	Other Seal	478	35,372	1,474	244	13.3%
	Walrus	1	770	32	5	0.3%
	Polar Bear	1	372	16	3	0.1%
	Furbearers/Small Land Mammals	45	1	0	0	0.0%
	Waterfowl					
	Eggs					
	Upland Birds					
	Fish		109,400	4,558	754	41.0%
	Berries		1,463	61	10	0.5%
	Plants		782	33	5	0.3%
1960-61	All Resources		242,237	11,011	1,671	100.0%
	Caribou	619[1]	84,184	3,508	581	34.8%
	Moose					
	Other Large Land Mammals					
	Bowhead					
	Beluga	7	6,965	290	48	2.9%
	Bearded Seal	37[3]	15,540	648	107	6.4%

ADF&G Study Year	Resource	Estimated Harvest				
		Number	Total Pounds[2]	Mean HH Pounds	Per Capita Pounds	% of Total Harvest
	Other Seal	152[3]	11,248	469	78	4.6%
	Walrus					
	Polar Bear	0	0	0	0	0.0%
	Furbearers/Small Land Mammals	47	0	0	0	0.0%
	Waterfowl					
	Eggs					
	Upland Birds					
	Fish		124,300	5,179	857	51.3%
	Berries					
	Plants					
1964-65	All Resources		233,376	8,976	1,341	100.0%
	Caribou	256	36,338	1,398	209	15.6%
	Moose	0	0	0	0	0.0%
	Other Large Land Mammals	1	168	6	1	0.1%
	Bowhead	0	0	0	0	0.0%
	Beluga	6	9,150	352	53	3.9%
	Bearded Seal	153	51,355	1,975	295	22.0%
	Other Seal	912	66,136	2,544	380	28.3%
	Walrus	0	0	0	0	0.0%
	Polar Bear	0	0	0	0	0.0%
	Furbearers/Small Land Mammals	25	9	0	0	0.0%
	Waterfowl					
	Eggs		496	19	3	0.2%
	Upland Birds					
	Dolly Varden char		65,796	2,531	378	28.2%
	Other Non-Salmon Fish		1,750	67	10	0.7%
	Salmon		997	38	6	0.4%
	Berries & Plants		1,180	45	7	0.5%
1965-66	All Resources		269,497	10,365	1,549	100.0%
	Caribou	1,010	144,434	5,555	830	53.6%
	Moose	4	2,040	78	12	0.8%
	Other Large Land Mammals	2	438	17	3	0.2%
	Bowhead	0	0	0	0	0.0%
	Beluga	12	18,690	719	107	6.9%
	Bearded Seal	119	41,044	1,579	236	15.2%
	Other Seal	468	35,546	1,367	204	13.2%
	Walrus	3	3,270	126	19	1.2%
	Polar Bear	1	480	18	3	0.2%
	Furbearers/Small Land Mammals	49	9	0	0	0.0%
	Waterfowl	10	13	1	0	0.0%

ADF&G Study Year	Resource	Estimated Harvest				
		Number	Total Pounds[2]	Mean HH Pounds	Per Capita Pounds	% of Total Harvest
	Eggs	0	0	0	0	0.0%
	Upland Birds	16	11	0	0	0.0%
	Dolly Varden char		19,698	758	113	7.3%
	Other Non-Salmon Fish		4,907	189	28	1.8%
	Salmon		81	3	0	0.0%
	Berries		464	18	3	0.2%
	Plants		213	8	1	0.1%
1971-72[4]	All Resources		289,748		1,541	100.0%
	Caribou	513	69,768		371	24.1%
	Moose		0		0	0.0%
	Other Large Land Mammals		0		0	0.0%
	Bowhead		0		0	0.0%
	Beluga	10	9,950		53	3.4%
	Bearded Seal	125	52,500		279	18.1%
	Other Seal	500	40,000		213	13.8%
	Walrus	3	2,310		12	0.8%
	Polar Bear	1	372		2	0.1%
	Furbearers/Small Land Mammals	56	16		0	0.0%
	Waterfowl	600	800		4	0.3%
	Eggs		500		3	0.2%
	Upland Birds		0		0	0.0%
	Dolly Varden char		95,950		510	33.1%
	Other Non-Salmon Fish		14,400		77	5.0%
	Salmon		600		3	0.2%
	Berries		1,480		8	0.5%
	Plants		1,102		6	0.4%
1982	Dolly Varden char		47,243	945	182	
1982-83	All Resources		210,074	4,470	778	100.0%
	Caribou	346	48,202	1,026	179	22.9%
	Moose	6	3,060	65	11	1.5%
	Other Large Land Mammals	2	255	5	1	0.1%
	Bowhead	0	0	0	0	0.0%
	Beluga	27	43,050	916	159	20.5%
	Bearded Seal	134	45,760	974	169	21.8%
	Other Seal	174	13,273	282	49	6.3%
	Walrus	51	3,825	81	14	1.8%
	Polar Bear	0	0	0	0	0.0%
	Furbearers/Small Land Mammals	65	12	0	0	0.0%
	Waterfowl	323	736	16	3	0.4%
	Eggs		106	2	0	0.1%

ADF&G Study Year	Resource	Estimated Harvest				
		Number	Total Pounds²	Mean HH Pounds	Per Capita Pounds	% of Total Harvest
	Upland Birds	46	32	1	0	0.0%
	Dolly Varden char		48,341	1,029	179	23.0%
	Other Non-Salmon Fish		287	6	1	0.1%
	Salmon		325	7	1	0.2%
	Berries		2,639	56	10	1.3%
	Plants		125	3	0	0.1%
1983-84	All Resources		253,841	5,401	940	100.0%
	Caribou	564	76,652	1,631	284	30.2%
	Moose	6	2,970	63	11	1.2%
	Other Large Land Mammals	2	517	11	2	0.2%
	Bowhead	1	39,600	843	147	15.6%
	Beluga	28	44,910	956	166	17.7%
	Bearded Seal	60	19,862	423	74	7.8%
	Other Seal	110	7,152	152	26	2.8%
	Walrus	4	3,600	77	13	1.4%
	Polar Bear	2	795	17	3	0.3%
	Furbearers/Small Land Mammals	122	48	1	0	0.0%
	Waterfowl	438	1,126	24	4	0.4%
	Eggs		62	1	0	0.0%
	Upland Birds	242	160	3	1	0.1%
	Dolly Varden char		47,927	1,020	178	18.9%
	Other Non-Salmon Fish		4,829	103	18	1.9%
	Salmon		1,475	31	5	0.6%
	Berries		1,093	23	4	0.4%
	Plants	0	0	0	0	0.0%

Notes: All resources total may include additional harvested resource amounts not reported in other resource categories. ¹Does not include harvests in July or most of August; ²Where specific harvest numbers existed 1959-61 and 1971-72 Total Pounds data converted based on ADF&G Conversion Factors (ADF&G 2008b); ³Does not includes harvest in June and most of May; ⁴Harvest estimates represent an annual average over a period of years in the early 1970's.

Source: ADF&G 2008a; ADF&G 2008b; Burch 1985; Braund & Burnham 1983; Patterson 1974; Saario & Kessel 1966.

Blank cells indicate data not available

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Kotzebue

The oldest excavated archaeological site near present day Kotzebue dates to 1400 A.D and was likely settled due to the ability to access a nearby, stable subsistence resource base of fish, land mammals, and marine mammals (Georgette & Loon 1993:16). Prior to contact, inhabitants of the Kotzebue area participated in the annual trade fair at Sheshalik (*Sisualik*), continuing into the present day as a major distribution hub of the smaller communities in the NWAB (Northwest Arctic Borough). Burch (as cited in Georgette and Loon 1993:16) reported that at the time of Euro-American contact, the Kotzebue people, or *Qikqtagrunmiut* moved seasonally throughout the area in pursuit of seals, beluga, caribou, birds, and fish. For further information regarding the time frame prior to Euro-American contact and an ethnohistory of the region, see Section 3.14 Cultural Resources.At 1,068,208 pounds, Patterson's (1974) estimate of the total pounds harvested from 1971-72 is nearly identical to the 1,067,280 total pounds estimated by ADF&G for the 1986 study year (Table 3). However, the contributions of certain resources, notably caribou and salmon, toward the total yearly harvests were vastly different. Comparing harvest data from 1971-72 and 1986, caribou represented 63.7 percent of the total harvest in 1971-72 and 24.4 percent in 1986, while salmon accounted for 0.1 and 18.4 percent, respectively. The 1971-72 information was derived in part from a literature review (see Patterson 1974), whereas the ADF&G 1986 study was based on a survey among Kotzebue households. In 1986, caribou, salmon, bearded seal, and sheefish constituted the majority (72.4 percent) of Kotzebue residents' subsistence harvests (Table 4). Moose was the next highest contributor at 3.3 percent of the overall harvest. Caribou, at a harvest of 260,645 pounds, comprised nearly one-quarter of the community's total harvest, the most for a single resource. Georgette & Loon (1993:183) noted that Kotzebue harvest levels (per capita of 398 pounds) in 1986 were greater compared to harvest levels from Alaska communities (e.g., Barrow, Dillingham, Cordova) with similar populations.

Noatak

According to Foote & Williamson (1966), two Eskimo groups, the *Noatagmiut* and *Naupaktomiut*, inhabited the Noatak River valley at the time of Euro-American contact. Similar to other inhabitants in the area, these two groups moved seasonally between the Noatak River, Sheshalik, and the Chukchi Sea coast in pursuit of subsistence resources, including seals, salmon, caribou, beluga, Dall sheep, and small game. In 1905, Kotzebue missionaries chose the present village site along the Noatak River followed by the establishment of a school in 1908 (Foote & Williamson:1050). For further information regarding the time frame prior to Euro-American contact and an ethnohistory of the region, see Section 3.14 Cultural Resources.

The earliest comprehensive pre-mine subsistence harvest study for Noatak (Foote and Williamson 1966), conducted in 1960-61, shows over 82 percent of the harvest coming from caribou and salmon (Table 5). Much of the remainder of the harvest (16 percent) included beluga, bearded seal, and non-salmon fish. Waterfowl and berries contributed approximately 2,000 pounds each to the total harvest. An estimated 75,000 individual salmon were harvested that year for approximately 57 percent of the total harvest. However, Foote & Williamson estimated Noatak residents caught 60,000 (360,000 pounds) of these salmon for consumption by 500 sled-dogs, and another 12,000 were saved to feed to dogs left in the community over the summer. Overall harvest level estimates for 1971-72 are substantially lower than 1960-61, mostly due to decreased salmon harvests. Both studies reported similar harvest numbers for caribou, furbearers and small land mammals, waterfowl, and upland birds. Non-salmon fish harvests had higher reported total pound amounts in 1971-72, while marine mammal harvest pounds decreased. Table 6 shows that in 1971-72, caribou, Dolly Varden char, and chum salmon comprised over 85 percent of the community's total harvest. Moose and beluga were the fourth and fifth highest contributors to Noatak's subsistence harvest during that time period.

In terms of per capita pounds, the two most important marine resources in 1960-61, beluga and bearded seal, provided over 350 pounds combined (Table 5). Most of the marine mammal harvests occurred and were consumed while at summer camps in Sheshalik (Foote & Williamson 1966:1102). Caribou per capita harvest estimates equaled approximately 762 pounds per person. Foote & Williamson (1966:1106) estimated that caribou contributed to 84 percent of Noatak's winter diet in 1960-61.

Subsistence Use Areas

In addition to documenting Kivalina and Noatak's pre-mine subsistence harvest amounts, these same studies and others also recorded these communities' pre-mine subsistence use areas. Studies documenting Kivalina and Noatak pre-mine subsistence use areas include Saario and Kessel (1966), Foote and Williamson (1966), Braund and Burnham (1983), and Schroeder, Anderson, and Hildreth (1987). The study team did not locate any mapped data for pre-mine Kotzebue subsistence use areas.

Table 3: Kotzebue Harvest Estimates by Resource Category, Pre-Mine Study Years

ADF&G Study Year	Resource	Percentage of Households					Estimated Harvest				
		Use	Try to Harvest	Harvest	Give	Receive	Number	Total Pounds[1]	Mean HH Pounds	Per Capita Pounds	% of Total Harvest
1971-72[2]	All Resources							1,068,208		630	100.0%
	Caribou						5,000	680,000		401	63.7%
	Moose						60	32,280		19	3.0%
	Other Large Land Mammals						13	1,287		1	0.1%
	Bowhead									0	
	Beluga						50	49,750		29	4.7%
	Bearded Seal						260	109,200		64	10.2%
	Other Seal						90	7,200		4	0.7%
	Walrus						3	2,310		1	0.2%
	Polar Bear									0	
	Furbearers/Small Land Mammals						844	2,259		1	0.2%
	Waterfowl						556	848		0	0.1%
	Eggs									0	0.0%
	Upland Birds						1,831	1,827		1	0.2%
	Dolly Varden char[3]							10,000		6	0.9%
	Other Non-Salmon Fish							153,169		90	14.3%
	Salmon							1,296		1	0.1%
	Berries							14,865		9	1.4%
	Plants							1,917		1	0.2%
1986	All Resources	100	78	78	72	96		1,067,280	1,395	398	100.0%
	Caribou	88	50	45	40	58	1,917	260,645	341	97	24.4%
	Moose	42	27	8	7	34	65	34,721	45	13	3.3%
	Other Large Land Mammals						47	4,343	6	2	0.4%
	Bowhead	41	6	1	8	41	0	0	0	0	0.0%
	Beluga	19	13	3	5	17	20	20,165	26	8	1.9%
	Bearded Seal						537	202,427	265	75	19.0%
	Other Seal						641	52,317	68	20	4.9%

ADF&G Study Year	Resource	Percentage of Households					Estimated Harvest				
		Use	Try to Harvest	Harvest	Give	Receive	Number	Total Pounds[1]	Mean HH Pounds	Per Capita Pounds	% of Total Harvest
	Walrus	5	5	1	2	5	15	11,807	15	4	1.1%
	Polar Bear	8	3	2	2	6	17	6,398	8	2	0.6%
	Furbearers/Small Land Mammals	45	21	17	10	32	1,994	3,643	5	1	0.3%
	Waterfowl	52	39	39	20	17	6,259	13,869	18	5	1.3%
	Eggs	16	8	8	7	8	6,577	1,250	2	0	0.1%
	Upland Birds	41	34	32	13	16	3,097	2,168	3	1	0.2%
	Dolly Varden char[3]	59	38	33	16	29	7,503	24,759	32	9	2.3%
	Other Non-Salmon Fish						198,747	211,720	277	79	19.8%
	Salmon	85	51	49	30	44	32,128	195,981	256	73	18.4%
	Berries	81	57	57	21	40		19,139	25	7	1.8%
	Plants	21	17	17	8	6		1,600	2	1	0.1%

Notes: All resources total may include additional harvested resource amounts not reported in other resource categories. [1]Where specific harvest numbers existed, 1971-72 Total Pounds data converted based on ADF&G Conversion Factors (ADF&G 2008b); [2]Harvest estimates represent an annual average over a period of years in the early 1970's; [3]Reported as Trout.

Source: ADF&G 2008a; ADF&G 2008b; Patterson 1974.

Blank cells indicate data not available

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Table 4: Selected Kotzebue Harvest and Participation Rates, Pre-mine Study Years

	Resource	Percentage of Households					Estimated Harvest				
		Use	Try to Harvest	Harvest	Give	Receive	Number	Total Pounds[1]	Mean HH Pounds	Per Capita Pounds[4]	% of Total Harvest
1971-72[2]	Caribou						5,000	680,000		401	63.7%
	Sheefish							138,300		82	12.9%
	Bearded Seal						260	109,200		64	10.2%
	Beluga						50	49,750		29	4.7%
	Moose						60	32,280		19	3.0%
	Berries							14,865		9	1.4%

	Resource	Percentage of Households					Estimated Harvest				
		Use	Try to Harvest	Harvest	Give	Receive	Number	Total Pounds[1]	Mean HH Pounds	Per Capita Pounds[4]	% of Total Harvest
	Dolly Varden char[3]							10,000		6	0.9%
	Tomcod							8,000		5	0.7%
	Other Seal						90	7,200		4	0.7%
	Whitefish							2,647		2	0.2%
	Herring							2,500		1	0.2%
	Walrus						3	2,310		1	0.2%
	Plants/Greens/Mushrooms							1,917		1	0.2%
	Ptarmigan						1,819	1,819		1	0.2%
	Hare						350	1,540		1	0.1%
	Dall Sheep						13	1,287		1	0.1%
	Chum Salmon							1,146		1	0.1%
	Smelt							840		0	0.1%
	Ducks						554	831		0	0.1%
	Muskrat						350	630		0	0.1%
1986	Caribou	88	50	45	40	58	1,917	260,645	341	97	24.4%
	Salmon	85	51	49	30	44	32,128	195,981	256	73	18.4%
	Bearded Seal	47	20	15	14	34	443	185,871	243	69	17.4%
	Sheefish	76	45	43	33	50	23,742	130,580	171	49	12.2%
	Moose	42	27	8	7	34	65	34,721	45	13	3.3%
	Ringed Seal	17	10	10	5	7	440	32,580	43	12	3.1%
	Dolly Varden char[3]	59	38	33	16	29	7,503	24,759	32	9	2.3%
	Beluga	19	13	3	5	17	20	20,165	26	8	1.9%
	Spotted Seal	9	7	6	3	3	201	19,737	26	7	1.8%
	Berries	81	57	57	21	40		19,139	25	7	1.8%
	Pike	43	31	30	12	17	5,750	18,976	25	7	1.8%
	Whitefish	55	21	21	9	39	9,594	16,789	22	6	1.6%
	Pacific Tom Cod	43	32	31	22	13	67,233	14,119	18	5	1.3%
	Walrus	5	5	1	2	5	15	11,807	15	4	1.1%
	Flounder	10	7	7	1	2	10,678	11,746	15	4	1.1%
	Herring	33	30	29	14	5	54,366	9,786	13	4	0.9%

	Resource	Percentage of Households					Estimated Harvest				
		Use	Try to Harvest	Harvest	Give	Receive	Number	Total Pounds[1]	Mean HH Pounds	Per Capita Pounds[4]	% of Total Harvest
	Ducks	50	38	38	19	14	4,626	6,939	9	3	0.7%
	Geese	42	35	31	12	13	1,617	6,790	9	3	0.6%
	Polar Bear	8	3	2	2	6	17	6,398	8	2	0.6%
	Burbot	34	24	23	6	15	739	3,105	4	1	0.3%

Notes: [1]Where specific harvest numbers existed, 1971-72 Total Pounds data converted based on ADF&G Conversion Factors (ADF&G 2008b); [2]Harvest estimates represent an annual average over a period of years in the early 1970's; [3]Reported as Trout. [4]1971-72 per capita pounds estimated based on 1970 census data reporting a Kotzebue population of 1,696.

Source: ADF&G 2008a; ADF&G 2008b; Patterson 1974.

Blank cells indicate data not available

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Table 5: Noatak Harvest Estimates by Resource Category, Pre-mine Study Years

ADF&G Study Year	Resource	Estimated Harvest				
		Number	Total Pounds[1]	Mean HH Pounds	Per Capita Pounds[3]	% of Total Harvest
1960-61	All Resources		793,846	16,890	2,984	100.0%
	Caribou	1,491	202,776	4,314	762	25.5%
	Moose					
	Other Large Land Mammals					
	Bowhead					
	Beluga	52	51,740	1,101	195	6.5%
	Bearded Seal	99	41,580	885	156	5.2%
	Other Seal	122	6,100	130	23	0.8%
	Walrus					
	Polar Bear					
	Furbearers/Small Land Mammals	1,354	760	16	3	0.1%
	Waterfowl	500	2,000	43	8	0.3%
	Eggs					
	Upland Birds	250	250	5	1	0.0%
	Non-Salmon Fish		36,640	780	138	4.6%

ADF&G Study Year	Resource	Estimated Harvest				
		Number	Total Pounds[1]	Mean HH Pounds	Per Capita Pounds[3]	% of Total Harvest
	Salmon	75,000	450,000	9,574	1,692	56.7%
	Berries		2,000	43	8	0.3%
	Plants					
1971-72[2]	All Resources		336,668		1,149	100.0%
	Caribou	1,214	165,104		564	49.0%
	Moose	20	10,760		37	3.2%
	Other Large Land Mammals	5	443		2	0.1%
	Bowhead					0.0%
	Beluga	10	9,950		34	3.0%
	Bearded Seal	12	5,040		17	1.5%
	Other Seal	10	800		3	0.2%
	Walrus	3	2,310		8	0.7%
	Polar Bear					0.0%
	Furbearers/Small Land Mammals	1,329	2,856		10	0.8%
	Waterfowl	550	960		3	0.3%
	Eggs	0	0			0.0%
	Upland Birds	310	307		1	0.1%
	Dolly Varden char		73,200		250	21.7%
	Other Non-Salmon Fish		7,820		27	2.3%
	Salmon		52,698		180	15.7%
	Berries		3,860		13	1.1%
	Plants		560		2	0.2%

Notes: All resources total may include additional harvested resource amounts not reported in other resource categories. [1]Where specific harvest numbers existed 1960-61 and 1971-72 Total Pounds data converted based on ADF&G Conversion Factors (ADF&G 2008b) [2]Harvest estimates represent an annual average over a period of years in the early 1970's. [3]1971-72 per capita pounds estimated based on 1970 census data reporting a Noatak population of 293.

Source: ADF&G 2008b; Patterson 1974; Foote & Williamson 1966.

Blank cells indicate data not available

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Table 6: Selected Noatak Harvest Rates, Pre-mine Study Years

	Resource	Estimated Harvest				
		Number	Total Pounds[1]	Mean HH Pounds	Per Capita Pounds	% of Total Harvest
1971-72[2]	Caribou	1,214	165,104		563	49.0%
	Dolly Varden char		73,200		250	21.7%
	Chum Salmon		52,698		180	15.7%
	Moose	20	10,760		37	3.2%
	Beluga	10	9,950		34	3.0%
	Whitefish		7,620		26	2.3%
	Bearded Seal	12	5,040		17	1.5%
	Berries		3,860		13	1.1%
	Walrus	3	2,310		8	0.7%
	Muskrat	1,100	1,980		7	0.6%
	Other Seal	10	800		3	0.2%
	Ducks	500	750		3	0.2%
	Hare	150	660		2	0.2%
	Plants/Greens/Mushrooms		560		2	0.2%
	Brown Bear	4	344		1	0.1%
	Ptarmigan	300	300		1	0.1%
	Porcupine	27	216		1	0.1%
	Geese	50	210		1	0.1%

Notes: [1]Where specific harvest numbers existed, 1971-72 Total Pounds data converted based on ADF&G Conversion Factors (ADF&G 2008b); [2]Harvest estimates represent an annual average over a period of years in the early 1970's. [3]1971-72 per capita pounds estimated based on 1970 census data reporting a Noatak population of 293.

Source: ADF&G 2008b; Patterson 1974.

Blank cells indicate data not available

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Kivalina

Studies conducted by Saario and Kessel (1966), Foote and Williamson (1966), Braund and Burnham (1983), and Schroeder, Anderson, and Hildreth (1987) documented Kivalina's pre-mine subsistence use areas for varying time periods (Map 1). Of all the studies, Schroeder, Anderson, and Hildreth (1987; time period ca. 1925-1986) recorded the broadest extent of Kivalina's use areas. They documented a continuous use area extending north to south from the Delong Mountains to Kotzebue Sound, and west to east from the Chukchi Sea to the drainages surrounding the upper portion of the Noatak River. The study also reported subsistence use areas as far as Selawik Lake and in Shishmaref Inlet. Foote & Williamson (1966) recorded Kivalina's all resource use areas from 1950 to 1960, as well as spring, summer, fall, and winter use areas for a variety of subsistence resources including caribou, furbearers, marine mammals, waterfowl, fish, and berries. Kivalina residents' subsistence activities during this time period ranged from as far north as Point Hope in the spring to as far south as Rabbit Creek during the summer (Map 1). Winter, fall, and spring use areas were located as far inland as the foothills of the Delong Mountains (Foote and Williamson 1966).

The lifetime (ca. 1925-1986) caribou use area of Kivalina residents extended over an expansive landscape from Cape Thompson in the north to Cape Krusenstern in the south, and inland into the Noatak National Preserve and Delong Mountains (Map 2). Saario and Kessel (1966; time period pre-1962) and Braund and Burnham (1983; time period 1977-1982) reported intensive caribou use areas located between Singoalik River and Rabbit Creek and considerable distances inland along the Kivalina and Wulik rivers (Map 2). Both studies also reported occasional caribou use areas near Kisimilok Creek, used when caribou migrated south in the summer from their northern calving areas, and around the Mulgrave and Kakagrak hills. Kivalina residents' pre-mine bear and furbearer and small land mammal use areas occurred in areas similar to their lifetime caribou areas (Maps 3 and 4). From 1977-1982 trapping for fox, wolverine, and wolf primarily occurred along Iklukrok Creek and the Asikpak, Kivalina, and Wulik river drainages as well as along the coast and lagoons near the community.

Map 5 depicts Kivalina residents lifetime moose use areas along the coast from Sheshalik to Chariot and inland along the Kivalina and Wulik rivers. Braund and Burnham (1983) reported moose use areas along both rivers as well. Both studies reported sheep use areas to the northeast of the community in the Wulik Peaks and around Punupkahkroak Mountain, with lifetime use areas occurring between the Wulik Peaks and Sheep and Sivukat mountains (Map 3).

As shown on Maps 6 through 12, lifetime marine mammal use areas, including beluga, seal, walrus, and polar bear extended between Cape Thompson and Sheshalik. Seal and walrus use areas (Maps 7 and 8) extended farther out into the Chukchi Sea, while beluga and polar bear use areas (Maps 6 and 9) were located closer along the coastline. Saario and Kessel (1966; Map 10) documented marine mammal use areas several miles into the Chukchi Sea between Rabbit Creek and Cape Seppings. From 1977-1982, Kivalina residents' documented marine mammal (including bearded seal, other seal, walrus, and beluga) use areas continued in the same area as reported in 1966, from Rabbit Creek to Cape Seppings, extending approximately 20 miles out into the Chukchi Sea between these two points (Braund and Burnham 1983; Map 11). The maximum extent of their 1977-1982 bowhead use areas stretched from Imik Lagoon to Cape Thompson with intensive bowhead hunting occurring several miles out to the northwest of Kivalina (Map 12).

Kivalina residents' lifetime fishing use areas occurred along the Kivalina and Wulik rivers, in lagoons south of the community, in the waters near Sheshalik, and in Selawik Lake (Map 13). The majority of fishing sites reported by Saario and Kessel (1966) occurred along the Wulik River (Map 13). In the 1977-1982 time period, nearly all of Kivalina's documented fall fishing for Dolly Varden char and whitefish occurred along the Wulik River (Map 13). Whitefish high use seining areas were located near the mouth of the Wulik River, and Dolly Varden char high use seining areas were dispersed along the Wulik River from an area just north of the mouth up to the Mount Jarvis area.

Waterfowl lifetime use areas extended along the coast from Cape Thompson to Sheshalik and along the Wulik and Kivalina rivers (Map 14). Kivalina residents' 1977-1982 waterfowl use areas occurred near several lagoons, along the coast south and north of Kivalina, and inland along the Wulik and Kivalina rivers (Map 14). Egg harvesting occurred along the Kivalina and Wulik rivers, at Cape Thompson, and near Kotlik Lagoon (Map 15).

Map 16 shows Kivalina lifetime berry and plant use areas along the Kivalina and Wulik rivers and along the coast from south of Chariot to Sheshalik. Other berry and plant areas were located near Kotzebue and Shishmaref Inlet. Both Saario and Kessel (1966) and Braund and Burnham (1983) documented berry and plant harvesting areas along the Wulik and Kivalina rivers in addition to coastal areas from Rabbit Creek to Singoalik Lagoon (Map 16). Residents reported gathering wood along the coast between Cape Krusenstern and Cape Thompson, as well as along the Kivalina and Wulik rivers and around Imik and Kotlik lagoons (Map 17).

Noatak

Foote and Williamson (1966), Braund and Burnham (1983), and Schroeder, Anderson, and Hildreth (1987) recorded Noatak's pre-mine subsistence use areas. Braund and Burnham (1983) documented partial Noatak subsistence use areas for 1977-1982, focusing on use areas west of the community potentially affected by the development of the proposed Red Dog mine. As shown on Map 18, the range of Noatak's all resources lifetime (ca. 1925-1986) subsistence use areas stretched from Selawik River and Kotzebue Sound to the north beyond the Amatusuk Hills in the Brooks Range (Schroeder, Anderson, and Hildreth 1987). Noatak residents reported lifetime use areas as far as Point Hope to the west and as far east as the upper drainages of the Noatak River. Foote & Williamson (1966) mapped Noatak's 1950-1960 all resources use areas (Map 18). Their study described unmapped use areas extending to the east and north beyond the locations shown on Map 18. Foote and Williamson (1966) documented spring and summer use areas as far south as Sheshalik and Kotzebue. In the summer the majority of harvest activity occurred along the Noatak River or around the Sheshalik area. Autumn use areas expanded to the west and east of Noatak River. Residents traveled to the northernmost use areas in the Delong Mountains during the winter and spring months.

Noatak lifetime (ca. 1925-1986), caribou use areas extended over a continuous area west to east from the Chukchi Sea coast near Kivalina into the headwaters of the Noatak River, and north to south from the Amatusuk Hills to Cape Krusenstern (Map 19). Other caribou areas occurred east of Selawik Lake. During the period of 1977-1982, in addition to other undocumented areas, Noatak residents hunted caribou in the Mulgrave Hills as well as along the Wulik River and Ikalukrok Creek areas. Noatak residents' lifetime furbearer harvesting occurred in the same general area as their caribou use areas but extended farther north beyond the Amatusuk Hills (Map 20). Focusing on the area potentially affected by the Red Dog Mine, Braund and Burnham (1983) reported trapping areas between Noatak River and Ikalukrak Creek.

Map 21 depicts Noatak moose use areas from 1925-1986. Noatak harvesters hunted moose solely along the Noatak River drainage. Bear hunting also occurred along the Noatak River as well as west of the Noatak River between the Mulgrave Hills and Cape Krusenstern (Map 22). Sheep hunting occurred in the hills and mountains east of the Noatak River and in the Delong Mountains north of the community. From 1977-1982, similar to their Kivalina neighbors, Noatak harvesters reported hunting sheep around Punupkahkroak Mountain (Map 22).

Maps 23-28 depict lifetime marine mammal, including bowhead, beluga, seal, walrus, and polar bear subsistence use areas for Noatak residents. Bowhead use areas extended from Point Hope to Cape Krusenstern (Map 23), and polar bear areas occurred in a smaller area on the Chukchi Sea ice northwest of Kivalina (Map 27). Noatak harvesters searched for walrus up to 40 miles from the coast between Sheshalik and Kivalina (Map 26). Beluga harvesting took place along the Chukchi Sea coast from Cape Thompson to the vicinity of Ipiavik Lagoon, in Kotzebue Sound, and in Eschscholtz Bay (Map 24).

Residents also hunted for seals in the Chukchi Sea from Kivalina to Cape Krusenstern and in Kotzebue Sound from Sheshalik to Eschscholtz Bay (Map 25). Noatak residents' 1977-1982 partial marine mammal (bearded seal, walrus, beluga, and other seals) use areas extended along the coast from Ipiavik Lagoon south of Kivalina to Sheshalik (this study did not document subsistence uses south of Sheshalik due to the study focus on the Red Dog Mine area (Map 28).

Lifetime Noatak waterfowl use areas were documented in a large area from the hills east of the Noatak River to the Chukchi Sea coast. Residents reported hunting waterfowl as far south as Cape Blossom and as far north as the Wulik and Kelly rivers (Map 29). Lifetime egg use areas were concentrated along the Noatak River and in coastal areas from Cape Krusenstern to Sheshalik (Map 30). Braund and Burnham (1983) mapped partial Noatak waterfowl use areas near Kilikmak Creek, Imik and Ipiavik lagoons, and in a small area south of the Wulik River (Map 29).

Noatak lifetime (ca. 1925-1986) non-salmon fish use areas extended along the Noatak River from Kotzebue Sound to the mouth of Nimiuktuk River and along the coast near Sheshalik (Map 31). From 1977-1982 (partial use areas only), Noatak residents reported harvesting Dolly Varden char along a portion of the Wulik River near Mount Jarvis and along a small stretch of Rabbit Creek several miles inland from the coast (Map 31). Map 32 shows lifetime salmon harvest areas along the Noatak River to the mouth of Nimiuktuk River.

Map 33 depicts lifetime vegetation use areas along the Noatak River drainage from Kelly River to Agashashok River, and near the mouth of Noatak River. Other vegetation use areas occurred along the coastline from near Cape Krusenstern to Sheshalik. Noatak lifetime wood gathering took place from the mouth of the Noatak River to Kelly River (Map 34).

Subsistence – Baseline Conditions

All Resources

This section provides a description of current (since the beginning of Red Dog mine operations in 1989) subsistence uses by residents of the study communities and impacts on subsistence uses through 2007. Current subsistence harvest data are available for Kivalina (ADF&G 2008a; Magdanz, Braem, Robbins, Holen, Russell, and Koster 2008; Magdanz, Georgette, and Stanek 1995), Noatak (ADF&G 2008a; Magdanz et al. 2008) and Kotzebue (ADF&G 2008a; Whiting 2006). Stephen R. Braund & Associates (SRB&A) conducted subsistence mapping and traditional knowledge interviews in Kivalina and Noatak in 2008. Subsistence use area maps for Kivalina and Noatak are derived from SRB&A's resulting supplemental report (SRB&A forthcoming) and ADF&G use area data for 2007 (Magdanz et al. 2008). Subsistence use area information is available for Kivalina based on fieldwork conducted by SRB&A in 1998 (SRB&A 2000) and artial subsistence use areas are available for the three study communities based on fieldwork conducted by SRB&A in 2004 (SRB&A 2005) . During SRB&A's 2008 interviews in Kivalina and Noatak, respondents provided observations about changes in subsistence uses and resources over the last 20 years (i.e., since the mine started operations). Their responses are incorporated into this section to describe changes in subsistence uses and resources since the mine began. Table 7 shows the number of changes observations and the number of observers by resource category. Residents' observations about changes in subsistence resources are discussed for each resource under "Resource Changes." For each resource category, only changes observed 10 or more times are discussed in further detail. Other data on mine-related impacts to subsistence uses and current subsistence uses are from SRB&A (2000 and 2005) and the U.S. Army Corps of Engineers (Corps) 2005 Draft Environmental Impact Statement (DEIS).

Table 7: Number of Resource Change Observations and Observers by Resource Category

Resource Category	Resource Change Observations			Number of Observers (% of Respondents)		
	Kivalina	Noatak	Total	Kivalina	Noatak	Total
Caribou	108	131	239	37 (84%)	35 (83%)	72 (84%)
Moose	14	10	24	11 (25%)	9 (21%)	20 (23%)
Other Large Land Mammals	12	35	47	11 (25%)	20 (48%)	31 (36%)
Bowhead	44	16	60	29 (66%)	7 (17%)	36 (42%)
Beluga	66	35	101	34 (77%)	21 (50%)	55 (64%)
Bearded Seal	27	22	49	20 (45%)	11 (26%)	31 (36%)
Other Seal	1	4	5	1 (2%)	3 (7%)	4 (5%)
Walrus	14	3	17	10 (23%)	3 (7%)	13 (15%)
Polar Bear	7	0	7	4 (9%)		4 (5%)
Furbearers/Small Land Mammals	26	75	101	17 (39%)	31 (74%)	48 (56%)
Waterfowl	12	16	28	10 (23%)	12 (29%)	22 (26%)
Eggs	0	1	1		1 (2%)	1 (1%)
Upland Birds	2	26	28	2 (5%)	18 (43%)	20 (23%)
Dolly Varden Char	51	35	86	28 (64%)	13 (31%)	41 (48%)
Other Non-salmon Fish	12	4	16	7 (16%)	3 (7%)	10 (12%)
Salmon	17	23	40	11 (25%)	17 (40%)	28 (33%)
Berries	31	19	50	22 (50%)	11 (26%)	33 (38%)
Plants and Wood	2	4	6	2 (5%)	4 (10%)	6 (7%)
Totals	446	459	905	44	42	86

Stephen R. Braund & Associates, 2008.

Harvest Trends

Tables 8 through 19 provide current (after mine operations began in 1989) subsistence harvest data for each of the study communities. Subsistence harvest data are available for all resources for Kivalina (1992 and 2007), Kotzebue (1991, 2002, 2003, and 2004) and Noatak (1994 and 2007). Residents of the study communities harvested between 364 and 761 pounds of wild resources, as measured in usable pounds, per capita (based on available data) since the earliest current harvest study (1991 in Kotzebue, 1992 in Kivalina, and 1994 in Noatak). These numbers illustrate the continuing importance of subsistence foods in local residents' diets.

Recent subsistence harvest data for Kivalina, from 1992 and 2007, show 100 percent of households using subsistence resources during each year and total harvests equaling 261,765 and 255,344 pounds of wild food, respectively (Table 8). Kivalina residents harvested an estimated 761 per capita pounds of subsistence resources in 1992, and 594 per capita pounds in 2007. Dolly Varden char, bearded seal, and caribou were the top three species harvested during both study years and accounted for between 65 and 79 percent of the total harvest (Table 9). Similarly, in pre-mine studies Dolly Varden char, bearded seal, and caribou consistently ranked among three of the top four species harvested by Kivalina households (Table 2).

Kivalina's recent harvests, compared to pre-mine harvest levels, on initial review appear to have steadily decreased from 1,838 usable pounds per person in 1959-60 to 594 pounds in 2007 (Table 14). However, the per capita amounts in Table 14 do not take into account the pounds of subsistence resources fed to dogs, and as noted above (Pre-Mining Environment, Subsistence Harvests), one major factor in the decrease in subsistence harvests has been the shift from sled-dogs to snowmachines as the primary mode of transportation. This shift was already evident by 1983-84 when Burch (1985: Table 27) counted only 34 dogs in the village compared to 207 in 1965-66. Using Burch's adjustments for dog consumption, per

Table 8: Kivalina Estimated Harvests by Resource Category, Current Study Years

ADF&G Study Year	Resource	Percentage of Households					Estimated Harvest				
		Use	Try to Harvest	Harvest	Give	Receive	Number	Total Pounds	Mean HH Pounds	Per Capita Pounds	% of Total Harvest
1992	All Resources	100	98	98	90	98		261,765	3,636	761	100.0%
	Caribou	97	77	74	53	68	351	47,539	660	138	18.2%
	Moose	47	31	23	31	31	17	9,059	126	26	3.5%
	Other Large Land Mammals						3	200	3	1	0.1%
	Bowhead	90	65	5	48	89	1	13,250	184	39	5.1%
	Beluga	87	61	26	50	69	10	10,007	139	29	3.8%
	Bearded Seal	90	66	63	45	47	139	53,832	748	157	20.6%
	Other Seal						167	10,180	141	30	3.9%
	Walrus	76	45	37	37	60	28	21,201	294	62	8.1%
	Polar Bear	19	13	7	10	16	8	868	12	3	0.3%
	Furbearers/Small Land Mammals	44	45	36	26	21	72	5	0	0	0.0%
	Waterfowl	81	74	71	48	39	1,564	2,361	33	7	0.9%
	Eggs	68	40	39	32	50	3,866	820	11	2	0.3%
	Upland Birds	52	47	42	32	16	637	446	6	1	0.2%
	Dolly Varden char	100	87	87	65	65	21,149	69,793	969	203	26.7%
	Other Non-Salmon Fish							12,194	169	35	4.7%
	Salmon	63	44	42	37	37	937	5,081	71	15	1.9%
	Berries	95	84	84	53	37		4,612	64	13	1.8%
	Plants	50	44	40	21	26		211	3	1	0.1%
1996	Waterfowl			55			376	1085	16	3	
	Eggs			33			1413	424	6	1	
	Upland Birds			3			42	42	1	0	
2007	All Resources	100	95	95	90	100		255,344	3,152	594	100.0%
	Caribou	93	64	64	67	69	268	36,458	450	85	14.3%
	Moose	31	14	10	10	29	4	2,075	26	5	0.8%

ADF&G Study Year	Resource	Percentage of Households					Estimated Harvest				
		Use	Try to Harvest	Harvest	Give	Receive	Number	Total Pounds	Mean HH Pounds	Per Capita Pounds	% of Total Harvest
	Other Large Land Mammals		5	2	2		2	201	2	0	0.1%
	Bowhead	64	48	0	17	64	0	0	0	0	0.0%
	Beluga	88	52	38	45	76	22	21,890	270	51	8.6%
	Bearded Seal	83	64	62	67	64	229	96,188	1,188	224	37.7%
	Other Seal					29	77	5,830	72	14	2.3%
	Walrus	45	31	2	14	45	2	1,350	17	3	0.5%
	Polar Bear										
	Furbearers/Small Land Mammals	31	26	19	10	14	28	39	0	0	0.0%
	Waterfowl	81	67	64	50	64	1,101	3,319	41	8	1.3%
	Eggs	76	48	45	43	57	3,384	839	10	2	0.3%
	Upland Birds	29	17	17	14	12	233	233	3	1	0.1%
	Dolly Varden char	93	81	81	67	64	20,527	67,739	836	158	26.5%
	Other Non-Salmon Fish						33,243	7,596	94	18	3.0%
	Salmon	50	31	31	31	33	613	3,445	43	8	1.3%
	Berries	90	67	67	52	57		7,398	91	17	2.9%
	Plants	43	29	29	21	29		654	8	2	0.3%

Notes: All resources total may include additional harvested resource amounts not reported in other resource categories.

Source: Magdanz et al. 2008; ADF&G 2008a.

Blank cells indicate data not available

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Table 9: Selected Kivalina Harvest and Participation Rates, Current Study Years

	Resource	Percentage of Households					Estimated Harvest				
		Use	Try to Harvest	Harvest	Give	Receive	Number	Total Pounds	Mean HH Pounds	Per Capita Pounds	% of Total Harvest
1992	Dolly Varden char	100	87	87	65	65	21,149	69,793	969	203	26.7%
	Bearded Seal	90	66	63	45	47	139	53,832	748	157	20.6%
	Caribou	97	77	74	53	68	351	47,539	660	138	18.2%
	Walrus	76	45	37	37	60	28	21,201	294	62	8.1%
	Bowhead	90	65	5	48	89	1	13,250	184	39	5.1%
	Beluga	87	61	26	50	69	10	10,007	139	29	3.8%
	Moose	47	31	23	31	31	17	9,059	126	26	3.5%
	Ringed Seal	50	44	42	27	21	110	7,562	105	22	2.9%
	Berries	95	84	84	53	37		4,612	64	13	1.8%
	Chum Salmon	61	44	40	34	34	681	4,178	58	12	1.6%
	Humpback Whitefish	53	42	36	29	24	2,377	4,160	58	12	1.6%
	Saffron Cod	79	74	74	31	24	4,453	3,117	43	9	1.2%
	Arctic Cod	82	77	77	40	23	27,077	2,978	41	9	1.1%
	Spotted Seal	24	24	21	5	5	30	2,105	29	6	0.8%
	Geese	79	69	69	47	36	944	1,486	21	4	0.6%
	Polar Bear	19	13	7	10	16	8	868	12	3	0.3%
	Ducks	55	48	45	34	26	609	777	11	2	0.3%
	Murre Eggs	60	36	34	27	47	3,174	698	10	2	0.3%
	Grayling	60	50	48	19	18	716	644	9	2	0.2%
	Burbot	37	31	29	21	19	123	517	7	2	0.2%
2007	Bearded Seal	83	64	62	67	64	229	96,188	1,188	224	37.7%
	Dolly Varden char	93	81	81	67	64	20,527	67,739	836	158	26.5%
	Caribou	93	64	64	67	69	268	36,458	450	85	14.3%
	Beluga	88	52	38	45	76	22	21,890	270	51	8.6%
	Berries	90	67	67	52	57		7,398	91	17	2.9%
	Saffron Cod	81	74	74	64	38	25,824	5,423	67	13	2.1%
	Ringed Seal	48	36	33	31	29	71	5,280	65	12	2.1%

	Resource	Percentage of Households					Estimated Harvest				
		Use	Try to Harvest	Harvest	Give	Receive	Number	Total Pounds	Mean HH Pounds	Per Capita Pounds	% of Total Harvest
	Geese	81	67	64	45	64	1,028	3,142	39	7	1.2%
	Chum Salmon	45	29	29	31	31	401	2,406	30	6	0.9%
	Moose	31	14	10	10	29	4	2,075	26	5	0.8%
	Walrus	45	31	2	14	45	2	1,350	17	3	0.5%
	Whitefish	40	19	19	12	33	338	709	9	2	0.3%
	Grayling	33	26	24	17	14	786	708	9	2	0.3%
	Arctic Cod	31	29	21	14	21	6,279	691	9	2	0.3%
	Plants/Greens/Mushrooms	43	29	29	21	29		654	8	2	0.3%
	Chinook Salmon	7	5	5	2	5	41	502	6	1	0.2%
	Gull Eggs	60	38	33	31	45	1,663	416	5	1	0.2%
	Murre Eggs	76	43	40	38	55	1,626	390	5	1	0.2%
	Spotted Seal	5	7	5	2	0	4	378	5	1	0.1%
	Pink Salmon	19	5	5	10	19	120	251	3	1	0.1%

Source: Magdanz et al. 2008; ADF&G 2008a.

Blank cells indicate data not available

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Table 10: Kotzebue Estimated Harvests by Resource Category, Current Study Years

ADF&G Study Year	Resource	Percentage of Households					Estimated Harvest				
		Use	Try to Harvest	Harvest	Give	Receive	Number	Total Pounds	Mean HH Pounds	Per Capita Pounds	% of Total Harvest
1991	All Resources	99	97	95	84	94		2,163,033	2,674	593	100.0%
	Caribou	93	70	63	59	62	3,782	514,362	636	141	23.8%
	Moose	62	33	27	23	45	235	126,220	156	35	5.8%
	Other Large Land Mammals						48	4,385	5	1	0.2%
	Bowhead	61	2	0	16	61	0	0	0	0	0.0%
	Beluga	55	13	5	14	52	11	10,947	14	3	0.5%
	Bearded Seal						1,279	459,868	568	126	21.3%
	Other Seal						1,164	92,226	114	25	4.3%
	Walrus	13	4	2	6	12	12	9,344	12	3	0.4%
	Polar Bear	1	1	0	0	1	0	0	0	0	0.0%
	Furbearers/Small Land Mammals	28	18	17	8	15	2,273	2,511	3	1	0.1%
	Waterfowl	50	37	35	20	23	5,501	6,371	8	2	0.3%
	Eggs	24	19	17	9	8	5,275	852	1	0	0.0%
	Upland Birds	54	44	42	29	16	7,977	5,584	7	2	0.3%
	Dolly Varden char	79	43	42	33	56	20,165	66,543	82	18	3.1%
	Other Non-Salmon Fish							526,609	651	144	24.3%
	Salmon	90	53	51	42	68	45,489	274,202	339	75	12.7%
	Berries	92	84	83	48	54		56,319	70	15	2.6%
	Plants	41	34	33	18	25		2,888	4	1	0.1%
1997	Waterfowl			58			8,048	22,479	29	7	
	Eggs			24			6,837	1,990	3	1	
	Upland Birds			37			5,530	5,530	7	2	
2002	All Resources						94,326	1,404,325	5,032		100.0%
	Caribou			85			2,376	323,156	1,046		23.0%
	Moose			25			102	55,000	140		3.9%
	Other Large Land Mammals						13	504	3		0.0%
	Bowhead										

ADF&G Study Year	Resource	Percentage of Households					Estimated Harvest				
		Use	Try to Harvest	Harvest	Give	Receive	Number	Total Pounds	Mean HH Pounds	Per Capita Pounds	% of Total Harvest
	Beluga			7			14	13,930	88		1.0%
	Bearded Seal			47			533	233,790	686		16.6%
	Other Seal						798	71,747	215		5.1%
	Walrus			1			2	1,540	10		0.1%
	Polar Bear			0			0	0	0		0.0%
	Furbearers/Small Land Mammals						35	0	0		0.0%
	Waterfowl						4,319	11,747	33		0.8%
	Eggs						3,568	591	2		0.0%
	Upland Birds										
	Dolly Varden char			56			4,023	13,276	37		0.9%
	Other Non-Salmon Fish[2]			79			41,790	465,540	1,909		33.2%
	Salmon[1]			78			36,748	220,490	863		15.7%
	Berries										
	Plants										
2003	All Resources						55,095	892,782	2,996		100.0%
	Caribou			69			1,719	233,735	695		26.2%
	Moose			21			94	50,396	165		5.6%
	Other Large Land Mammals						4	312	3		0.0%
	Bowhead										
	Beluga			5			10	9,950	82		1.1%
	Bearded Seal			40			508	213,309	618		23.9%
	Other Seal						475	43,304	181		4.9%
	Walrus			2			3	2,310	19		0.3%
	Polar Bear			1			1	0	0		0.0%
	Furbearers/Small Land Mammals						26	0	0		0.0%
	Waterfowl						4,411	12,745	37		1.4%
	Eggs						5,558	943	3		0.1%
	Upland Birds										
	Dolly Varden char			45			5,606	18,500	52		2.1%

ADF&G Study Year	Resource	Percentage of Households					Estimated Harvest				
		Use	Try to Harvest	Harvest	Give	Receive	Number	Total Pounds	Mean HH Pounds	Per Capita Pounds	% of Total Harvest
	Other Non-Salmon Fish²			59			16,963	188,973	754		21.2%
	Salmon¹			55			19,717	118,304	389		13.3%
	Berries										
	Plants										
2004	All Resources						72,343	1,022,847	3,237		100.0%
	Caribou			76			1,915	260,459	743		25.5%
	Moose			22			95	51,215	135		5.0%
	Other Large Land Mammals						6	472	4		0.0%
	Bowhead										
	Beluga			5			8	7,960	74		0.8%
	Bearded Seal			40			486	204,272	638		20.0%
	Other Seal						336	31,113	106		3.0%
	Walrus			3			16	12,320	114		1.2%
	Polar Bear			1			1	0	0		0.0%
	Furbearers/Small Land Mammals						43	0	0		0.0%
	Waterfowl						4,552	12,864	33		1.3%
	Eggs						3,566	605	2		0.1%
	Upland Birds										
	Dolly Varden char			56			5,541	18,287	45		1.8%
	Other Non-Salmon Fish²			63			22,024	245,352	799		24.0%
	Salmon¹			68			27,448	164,689	499		16.1%
	Berries										
	Plants										

Notes: All resources total may include additional harvested resource amounts not reported in other resource categories. [1]Chum Salmon; [2]Sheefish

Source: ADF&G 2008a; Whiting 2006.

Blank cells indicate data not available

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Table 11: Selected Kotzebue Harvest and Participation Rates, Current Study Years

	Resource	Percentage of Households					Estimated Harvest				
		Use	Try to Harvest	Harvest	Give	Receive	Number	Total Pounds	Mean HH Pounds	Per Capita Pounds	% of Total Harvest
1991	Caribou	93	70	63	59	62	3,782	514,362	636	141	23.8%
	Sheefish	85	60	60	47	50	77,571	426,642	527	117	19.7%
	Bearded Seal	63	36	32	34	39	963	404,338	500	111	18.7%
	Chum Salmon	86	51	49	40	63	44,283	266,586	330	73	12.3%
	Moose	62	33	27	23	45	235	126,220	156	35	5.8%
	Ringed Seal	28	16	16	13	13	914	67,649	84	19	3.1%
	Dolly Varden char	79	43	42	33	56	20,165	66,543	82	18	3.1%
	Berries	92	84	83	48	54	8,664	56,319	70	15	2.6%
	Spotted Seal	12	9	9	8	4	251	24,577	30	7	1.1%
	Saffron Cod	66	56	56	42	26	101,900	21,399	26	6	1.0%
	Herring	45	36	35	24	17	3,562	21,371	26	6	1.0%
	Pike	48	28	25	20	27	5,687	18,768	23	5	0.9%
	Humpback Whitefish	32	10	10	13	27	8,753	15,318	19	4	0.7%
	Beluga	55	13	5	14	52	11	10,947	14	3	0.5%
	Walrus	13	4	2	6	12	12	9,344	12	3	0.4%
	Burbot	36	24	23	12	16	2,063	8,664	11	2	0.4%
	Chinook Salmon	16	10	9	5	9	485	5,674	7	2	0.3%
	Ptarmigan	53	43	41	28	16	7,888	5,521	7	2	0.3%
	Bering Cisco	15	6	6	6	12	2,448	4,284	5	1	0.2%
	Broad Whitefish	20	6	6	5	15	2,346	4,106	5	1	0.2%
2002	Sheefish			79			41,790	465,540	1,909		33.2%
	Caribou			85			2,376	323,156	1,046		23.0%
	Bearded Seal			47			533	233,790	686		16.6%
	Chum Salmon			78			36,748	220,490	863		15.7%
	Moose			25			102	55,000	140		3.9%
	Spotted Seal			33			532	52,109	127		3.7%

	Resource	Percentage of Households					Estimated Harvest				
		Use	Try to Harvest	Harvest	Give	Receive	Number	Total Pounds	Mean HH Pounds	Per Capita Pounds	% of Total Harvest
	Ringed Seal			16			265	19,638	88		1.4%
	Beluga			7			14	13,930	88		1.0%
	Dolly Varden char			56			4,023	13,276	37		0.9%
	Geese						1,932	6,704	20		0.5%
	Ducks			49			2,305	4,334	11		0.3%
	Walrus			1			2	1,540	10		0.1%
2003	Caribou			69			1,719	233,735	695		26.2%
	Bearded Seal			40			508	213,309	618		23.9%
	Sheefish			59			16,963	188,973	754		21.2%
	Chum Salmon			55			19,717	118,304	389		13.3%
	Moose			21			94	50,396	165		5.6%
	Spotted Seal			17			351	34,355	144		3.8%
	Dolly Varden char			45			5,606	18,500	52		2.1%
	Beluga			5			10	9,950	82		1.1%
	Ringed Seal			11			121	8,949	37		1.0%
	Geese						2,278	7,983	24		0.9%
	Ducks			36			2,024	3,805	10		0.4%
	Walrus			2			3	2,310	19		0.3%
	Gull Eggs			30			4,373	700	2		0.1%
	Swan			11			50	561	2		0.1%
2004	Caribou			76			1,915	260,459	743		25.5%
	Sheefish			63			22,024	245,352	799		24.0%
	Bearded Seal			40			486	204,272	638		20.0%
	Chum Salmon			68			27,448	164,689	499		16.1%
	Moose			22			95	51,215	135		5.0%
	Spotted Seal			19			267	26,161	87		2.6%
	Dolly Varden char			56			5,541	18,287	45		1.8%

	Resource	Percentage of Households					Estimated Harvest				
		Use	Try to Harvest	Harvest	Give	Receive	Number	Total Pounds	Mean HH Pounds	Per Capita Pounds	% of Total Harvest
	King Crab			19			6,306	13,242	46		1.3%
	Walrus			3			16	12,320	114		1.2%
	Geese						2,375	8,233	22		0.8%
	Beluga			5			8	7,960	74		0.8%
	Ringed Seal			6			67	4,952	19		0.5%
	Ducks			41			2,101	3,950	9		0.4%

Source: ADF&G 2008a; Whiting 2006.

Blank cells indicate data not available

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Table 12: Noatak Estimated Harvests by Resource Category, Current Study Years

ADF&G Study Year	Resource	Percentage of Households					Estimated Harvest				
		Use	Try to Harvest	Harvest	Give	Receive	Number	Total Pounds	Mean HH Pounds	Per Capita Pounds	% of Total Harvest
1994	All Resources	93	93	93	87	84		174,851	2,082	461	100.0%
	Caribou	91	84	84	71	50	615	83,664	996	221	47.8%
	Moose	12	7	3	4	9	2	1,329	16	4	0.8%
	Other Large Land Mammals	6	2	2	2	4	1	106	1	0	0.1%
	Bowhead	46	9	0	19	46	0	0	0	0	0.0%
	Beluga	18	7	6	13	15	3	2,985	36	8	1.7%
	Bearded Seal	44	24	18	25	32	36	14,142	168	37	8.1%
	Other Seal	4		0	2	4	0	0	0	0	0.0%
	Walrus	6	2	2	3	4	1	951	11	3	0.5%
	Polar Bear	3	0	0	0	3	0	0	0	0	0.0%
	Furbearers/Small Land Mammals	21	15	12	10	9	41	0	0	0	0.0%
	Waterfowl	49	41	40	19	16	482	1,469	17	4	0.8%
	Eggs		7	7	0	0	116	19	0	0	0.0%
	Upland Birds	22	18	18	10	13	210	210	3	1	0.1%
	Dolly Varden char	87	81	79	75	38	4,629	15,276	182	40	8.7%
	Other Non-Salmon Fish						4,092	7,228	86	19	4.1%
	Salmon	69	62	62	47	37	7,613	45,564	542	120	26.1%
	Berries	66	59	59	28	37		1,666	20	4	1.0%
	Plants	22	15	15	7	13		172	2	0	0.1%
1997	Waterfowl			55			656	1,813	19	4	
	Eggs			24			569	159	2	0	
	Upland Birds			18			380	377	4	1	
1999	Caribou	96	74	72	61	62	683	92,902	938	224	
	Moose	18	4	3	4	14	4	2,367	24	6	
	Other Large Land Mammals		2	2	2	1	3	284	3	1	
	Furbearers/Small Land Mammals	0	0	8	0	0	38	0	0	0	
2002	Caribou	91	76	71	61	64	410	55,733	552	120	
	Moose	22	8	3	6	20	3	1,874	19	4	

ADF&G Study Year	Resource	Percentage of Households					Estimated Harvest				
		Use	Try to Harvest	Harvest	Give	Receive	Number	Total Pounds	Mean HH Pounds	Per Capita Pounds	% of Total Harvest
	Other Large Land Mammals	2	1	1	1	1	1	100	1	0	
	Furbearers/Small Land Mammals	5	5	5	0	0	16	0	0	0	
2007	All Resources	100	97	97	96	100		191,553	1,610	364	100.0%
	Caribou	97	73	66	78	88	442	60,061	505	114	31.4%
	Moose	46	16	9	27	46	11	5,691	48	11	3.0%
	Other Large Land Mammals						12	1,400	12	3	0.7%
	Bowhead	1	0	0	1	1	0	0	0	0	0.0%
	Beluga	81	8	4	60	81	6	5,773	49	11	3.0%
	Bearded Seal	81	20	20	54	79	60	24,990	210	47	13.0%
	Other Seal						11	878	7	2	0.5%
	Walrus	23	2	1	13	23	3	1,851	16	4	1.0%
	Polar Bear										
	Furbearers/Small Land Mammals	21	21	16	12	10	91	291	2	1	0.2%
	Waterfowl	59	44	38	39	42	1,120	2,889	24	5	1.5%
	Eggs	36	29	28	22	18	906	231	2	0	0.1%
	Upland Birds	30	23	17	14	21	221	216	2	0	0.1%
	Dolly Varden char	91	83	78	72	78	10,234	33,771	284	64	17.6%
	Other Non-Salmon Fish						8,934	17,710	149	34	9.2%
	Salmon	94	79	77	71	77	4,628	26,967	227	51	14.1%
	Berries	99	90	89	84	80		8,620	72	16	4.5%
	Plants	51	39	38	31	40		204	2	0	0.1%

Notes: All resources total may include additional harvested resource amounts not reported in other resource categories.

Source: Magdanz et al. 2008; ADF&G 2008a.

Blank cells indicate data not available

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Table 13: Selected Noatak Harvest and Participation Rates, Current Study Years

	Resource	Percentage of Households					Estimated Harvest				
		Use	Try to Harvest	Harvest	Give	Receive	Number	Total Pounds	Mean HH Pounds	Per Capita Pounds	% of Total Harvest
1994	Caribou	91	84	84	71	50	615	83,664	996	221	47.8%
	Chum Salmon	68	60	60	46	35	7,198	43,190	514	114	24.7%
	Dolly Varden char	87	81	79	75	38	4,629	15,276	182	40	8.7%
	Bearded Seal	44	24	18	25	32	36	14,142	168	37	8.1%
	Humpback Whitefish	22	18	16	16	10	1,684	3,537	42	9	2.0%
	Beluga	18	7	6	13	15	3	2,985	36	8	1.7%
	Berries	66	59	59	28	37		1,666	20	4	1.0%
	Unknown Salmon	4	3	3	3	3	225	1,349	16	4	0.8%
	Burbot	31	21	19	19	19	319	1,339	16	4	0.8%
	Moose	12	7	3	4	9	2	1,329	16	4	0.8%
	Geese	47	40	38	19	16	346	1,249	15	3	0.7%
	Coho Salmon	3	2	2	2	2	185	964	11	3	0.6%
	Walrus	6	2	2	3	4	1	951	11	3	0.5%
	Unknown Whitefish	10	12	9	7	3	357	732	9	2	0.4%
	Sheefish	35	7	6	13	34	98	537	6	1	0.3%
	Grayling	24	24	21	15	10	403	362	4	1	0.2%
	Bering Cisco	4	4	4	2	0	189	265	3	1	0.2%
	Ducks	21	21	21	9	0	136	220	3	1	0.1%
	Ptarmigan	22	18	18	10	13	210	210	3	1	0.1%
	Plants/Greens/Mushrooms	22	15	15	7	13		172	2	0	0.1%
2007	Caribou	97	73	66	78	88	442	60,061	505	114	31.4%
	Dolly Varden char	91	83	78	72	78	10,234	33,771	284	64	17.6%
	Chum Salmon	93	78	76	71	74	4,167	25,002	210	48	13.1%
	Bearded Seal	81	20	20	54	79	60	24,990	210	47	13.0%
	Whitefish	61	39	38	37	54	6,778	14,234	120	27	7.4%
	Berries	99	90	89	84	80		8,620	72	16	4.5%
	Beluga	81	8	4	60	81	6	5,773	49	11	3.0%
	Moose	46	16	9	27	46	11	5,691	48	11	3.0%
	Geese	54	43	34	36	38	543	2,016	17	4	1.1%
	Walrus	23	2	1	13	23	3	1,851	16	4	1.0%

	Resource	Percentage of Households					Estimated Harvest				
		Use	Try to Harvest	Harvest	Give	Receive	Number	Total Pounds	Mean HH Pounds	Per Capita Pounds	% of Total Harvest
	Coho Salmon	27	22	19	12	18	247	1,286	11	2	0.7%
	Sheefish	51	6	3	19	50	99	1,105	9	2	0.6%
	Grayling	28	27	27	16	6	1,222	1,100	9	2	0.6%
	Ducks	39	34	27	23	24	575	843	7	2	0.4%
	Char	8	6	4	2	4	132	578	5	1	0.3%
	Dall Sheep	9	6	3	3	7	5	550	5	1	0.3%
	Ringed Seal	14	6	6	11	11	7	489	4	1	0.3%
	Northern Pike	19	11	8	7	12	144	476	4	1	0.2%
	Muskox	6	2	1	1	6	1	390	3	1	0.2%
	Spotted Seal	6	4	3	2	2	4	389	3	1	0.2%

Source: Magdanz et al. 2008; ADF&G 2008a.

Blank cells indicate data not available

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Table 14: Kivalina Per Capita Harvests by Resource Category, All Study Years

	Pounds Usable Weight Per Capita									
	1959-60	**1960-61**	**1964-65**	**1965-66**	**1971-72**	**1982-83**	**1983-84**	**1992**	**1996**	**2007**
All Resources	1,838	1,671	1,341	1,549	1,541	778	940	761		594
Caribou	382	581	209	830	371	179	284	138		85
Moose			0	12	0	11	11	26		5
Other Large Land Mammals			1	3	0	1	2	1		0
Bowhead			0	0	0	0	147	39		0
Beluga	96	48	53	107	53	159	166	29		51
Bearded Seal	339	107	295	236	279	169	74	157		224
Other Seal	244	78	380	204	213	49	26	30		14
Walrus	5		0	19	12	14	13	62		3
Polar Bear	3		0	3	2	0	3	3		
Furbearers/Small Land Mammals	0	0	0	0	0	0	0	0		0
Waterfowl				0	4	3	4	7	3	8
Eggs			3	0	3	0	0	2	1	2
Upland Birds				0	0	0	1	1	0	1
Dolly Varden char			378	113	510	179	178	203		158
Other Non-Salmon Fish			10	28	77	1	18	35		18
Salmon			6	0	3	1	5	15		8
Berries	10			3	8	10	4	13		17
Plants and Wood	5			1	6	0	0	1		2

Source: Magdanz et al. 2008; ADF&G 2008a; Burch 1985; Saario & Kessel 1966.

Blank cells indicate data not available

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Table 15: Kivalina Composition of Wild Resource Harvests by Resource Category, All Study Years

	Percentage of Total Harvest								
	1959-60	**1960-61**	**1964-65**	**1965-66**	**1971-72**	**1982-83**	**1983-84**	**1992**	**2007**
All Resources	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Caribou	20.8%	34.8%	15.6%	53.6%	24.1%	22.9%	30.2%	18.2%	14.3%
Moose			0.0%	0.8%	0.0%	1.5%	1.2%	3.5%	0.8%
Other Large Land Mammals			0.1%	0.2%	0.0%	0.1%	0.2%	0.1%	0.1%
Bowhead			0.0%	0.0%	0.0%	0.0%	15.6%	5.1%	0.0%
Beluga	5.2%	2.9%	3.9%	6.9%	3.4%	20.5%	17.7%	3.8%	8.6%
Bearded Seal	18.4%	6.4%	22.0%	15.2%	18.1%	21.8%	7.8%	20.6%	37.7%
Other Seal	13.3%	4.6%	28.3%	13.2%	13.8%	6.3%	2.8%	3.9%	2.3%
Walrus	0.3%		0.0%	1.2%	0.8%	1.8%	1.4%	8.1%	0.5%
Polar Bear	0.1%	0.0%	0.0%	0.2%	0.1%	0.0%	0.3%	0.3%	
Furbearers/Small Land Mammals	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Waterfowl				0.0%	0.3%	0.4%	0.4%	0.9%	1.3%
Eggs			0.2%	0.0%	0.2%	0.1%	0.0%	0.3%	0.3%
Upland Birds				0.0%	0.0%	0.0%	0.1%	0.2%	0.1%
Dolly Varden char			28.2%	7.3%	33.1%	23.0%	18.9%	26.7%	26.5%
Other Non-Salmon Fish			0.7%	1.8%	5.0%	0.1%	1.9%	4.7%	3.0%
Salmon			0.4%	0.0%	0.2%	0.2%	0.6%	1.9%	1.3%
Berries	0.5%			0.2%	0.5%	1.3%	0.4%	1.8%	2.9%
Plants and Wood	0.3%			0.1%	0.4%	0.1%	0.0%	0.1%	0.3%

Source: Magdanz et al. 2008; ADF&G 2008a; Burch 1985; Patterson 1974; Saario & Kessel 1966.

Blank cells indicate data not available

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Table 16: Kotzebue Per Capita Harvests by Resource Category, All Study Years

	Pounds Usable Weight Per Capita			
	1971-72	**1986**	**1991**	**1997**
All Resources	630	398	593	
Caribou	401	97	141	
Moose	19	13	35	
Other Large Land Mammals	1	2	1	
Bowhead	0	0	0	
Beluga	29	8	3	
Bearded Seal	64	75	126	
Other Seal	4	20	25	
Walrus	1	4	3	
Polar Bear	0	2	0	
Furbearers/Small Land Mammals	1	1	1	
Waterfowl	0	5	2	7
Eggs	0	0	0	1
Upland Birds	1	1	2	2
Dolly Varden char	6	9	18	
Other Non-Salmon Fish	90	79	144	
Salmon	1	73	75	
Berries	9	7	15	
Plants and Wood	1	1	1	

Source: ADF&G 2008a; Whiting 2006; Patterson 1974.

Blank cells indicate data not available

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Table 17: Kotzebue Composition of Wild Resource Harvests by Resource Category, All Study Years

	Percentage of Total Harvest					
	1971-72	**1986**	**1991**	**2002**	**2003**	**2004**
All Resources	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Caribou	63.7%	24.4%	23.8%	23.0%	26.2%	25.5%
Moose	3.0%	3.3%	5.8%	3.9%	5.6%	5.0%
Other Large Land Mammals	0.1%	0.4%	0.2%	0.0%	0.0%	0.0%
Bowhead		0.0%	0.0%			
Beluga	4.7%	1.9%	0.5%	1.0%	1.1%	0.8%
Bearded Seal	10.2%	19.0%	21.3%	16.6%	23.9%	20.0%
Other Seal	0.7%	4.9%	4.3%	5.1%	4.9%	3.0%
Walrus	0.2%	1.1%	0.4%	0.1%	0.3%	1.2%
Polar Bear	0.0%	0.6%	0.0%	0.0%	0.0%	0.0%
Furbearers/Small Land Mammals	0.2%	0.3%	0.1%	0.0%	0.0%	0.0%
Waterfowl	0.1%	1.3%	0.3%	0.8%	1.4%	1.3%
Eggs	0.0%	0.1%	0.0%	0.0%	0.1%	0.1%
Upland Birds	0.2%	0.2%	0.3%			
Dolly Varden char	0.9%	2.3%	3.1%	0.9%	2.1%	1.8%
Other Non-Salmon Fish	14.3%	19.8%	24.3%	33.2%	21.2%	24.0%
Salmon	0.1%	18.4%	12.7%	15.7%	13.3%	16.1%
Berries	1.4%	1.8%	2.6%			
Plants and Wood	0.2%	0.1%	0.1%			

Source: ADF&G 2008a; Whiting 2006; Patterson 1974.

Blank cells indicate data not available

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Table 18: Noatak Per Capita Harvests by Resource Category, All Study Years

	Pounds Usable Weight Per Capita						
	1960-61	**1971-72**	**1994**	**1997**	**1999**	**2002**	**2007**
All Resources	2984	1149	461				361
Caribou	762	564	221		224	120	114
Moose		37	4		6	4	11
Other Large Land Mammals		2	0		1	0	3
Bowhead			0				0
Beluga	195	34	8				11
Bearded Seal	156	17	37				47
Other Seal	23	3	0				2
Walrus		8	3				4
Polar Bear			0				
Furbearers/Small Land Mammals	3	10	0		0	0	1
Waterfowl	8	3	4	4			5
Eggs			0	0			0
Upland Birds	1	1	1	1			0
Dolly Varden char		250	40				64
Other Non-Salmon Fish	138	27	19				34
Salmon	1692	180	120				51
Berries	8	13	4				16
Plants and Wood		2	0				

Source: Magdanz et al. 2008; ADF&G 2008a; Patterson 1974; Foote & Williamson 1966.

Blank cells indicate data not available

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Table 19: Noatak Composition of Wild Resource Harvests by Resource Category, All Study Years

	Percentage of Total Harvest			
	1960-61	**1971-72**	**1994**	**2007**
All Resources	100.0%	100.0%	100.0%	100.0%
Caribou	25.5%	49.0%	47.8%	31.7%
Moose		3.2%	0.8%	3.0%
Other Large Land Mammals		0.1%	0.1%	0.7%
Bowhead		0.0%	0.0%	0.0%
Beluga	6.5%	3.0%	1.7%	3.0%
Bearded Seal	5.2%	1.5%	8.1%	13.2%
Other Seal	0.8%	0.2%	0.0%	0.5%
Walrus		0.7%	0.5%	0.0%
Polar Bear		0.0%	0.0%	0.0%
Furbearers/Small Land Mammals	0.1%	0.8%	0.0%	0.2%
Waterfowl	0.3%	0.3%	0.8%	1.5%
Eggs		0.0%	0.0%	0.1%
Upland Birds	0.0%	0.1%	0.1%	0.1%
Dolly Varden char	4.6%	21.7%	8.7%	17.8%
Other Non-Salmon Fish	0.3%	2.3%	4.1%	9.3%
Salmon	56.7%	15.7%	26.1%	14.2%
Berries		1.1%	1.0%	4.5%
Plants and Wood		0.2%	0.1%	0.1%

Source: Magdanz et al. 2008; ADF&G 2008a; Patterson 1974; Foote & Williamson 1966.

Blank cells indicate data not available

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capita subsistence harvests in Kivalina were 710 (1965), 675 (1982), and 829 (1983). The 1992 harvest of 761 pounds per capita is within this range, although unadjusted for dog consumption. The 2007 figure of 594 pounds per capita is at the low end of the range of total Kivalina harvests and may reflect a decrease in harvest.

As Table 14 shows, per capita caribou harvests, equaling 138 and 85 pounds during recent study years (1992 and 2007), are substantially less than earlier per capita harvest amounts of 179 (in 1982-83) and 284 (in 1983-84) pounds. Based on the SRB&A 2008 subsistence change interviews, residents of Kivalina most often attribute this decrease in caribou harvests to the disruption of the caribou migration caused by the DeLong Mountain Regional Transportation System (DMTS) and traffic on this road (see "Caribou Resource Change," below).

Beluga harvests also appear to have decreased from pre-mine study levels. The1982-83 and 1983-84 beluga harvest levels are most representative of Kivalina pre-mine, summer and spring beluga harvests, because before resumption of bowhead whaling in 1966 Kivalina only harvested beluga in July. After 1966, Kivalina also harvested beluga in the spring in association with bowhead whaling hunting. In 1982-83 and 1983-84, Kivalina residents harvested 159 and 166 usable pounds per capita of beluga whale compared with only 29 and 51 pounds per capita in 1992 and 2007 respectively (Table 14). Based on the 2007 SRB&A resource change interviews, Kivalina residents attribute this decrease in harvests to the port site and port site noise diverting the summer beluga from their normal migratory route along the Kivalina coastline. They also reported that the 2007 harvests of 51 pounds per capita of beluga was an anomaly in that harvests during previous years were much lower. See "Beluga" below for additional information regarding residents' beluga harvests and related changes.

Table 10 shows harvest data for Kotzebue for five study years (1991, 1997, 2002, 2003, and 2004) by resource category and reports total yearly harvests ranging from 892,782 pounds in 2003 to 2,163,033 pounds in 1991. Per capita pounds are not available for the 2002, 2003, and 2004 study years. Mean household pounds ranged from 2,674 in 1991 to 5,032 in 2002. Caribou, sheefish, and bearded seal comprised the top three harvested species, by percent of total harvest, during each study year. Other major harvested species include chum salmon, moose, spotted seal, and Dolly Varden char (Table 11). In 1991, 99 percent of Kotzebue households reported using at least one resource, and at least 90 percent used caribou, berries, and salmon (Table 10). Compared to earlier harvest data for Kotzebue, harvest amounts have changed little; if anything, the data indicate an increase in residents' harvests of wild foods (Table 16). The total estimated pounds harvested in 1991 (after mine operations began) were higher than in any other study year (Table 10), and compared to the 1986 harvest data, the pounds of usable weight per capita were higher in 1991 for most resource categories (Table 16). In 1986 the mean household pounds of harvested wild foods (1,395) was less than in any recent study year (Table 3). Whiting (2006) notes that Fall and Utermohle's 1991 survey used a 10-year-old sample that had been used for a previous survey, biasing the sample towards "long-term households;" this may be one explanation for the higher Kotzebue harvest estimates seen in 1991. Furthermore, 2002, 2003, and 2004 data, funded by the Native Village of Kotzebue, includes only Native households; given that Native households in Kotzebue harvest substantially more wild foods than non-Native households (Georgette 1986 in Whiting 2006), the noticeably higher household harvest amounts for those study years are not surprising. The composition of subsistence harvests in Kotzebue has remained relatively steady, with caribou, bearded seal, and sheefish among the top harvested species during each post- and pre-mine study year (Table 17). However, the harvests of some species have declined. Beluga accounted for 4.7 and 1.9 percent of the total harvest during earlier study years (1971-72 and 1986), whereas during more recent study years, beluga harvests only accounted for between 0.5 and 1.1 percent of the harvest. Residents' observations regarding the decline in beluga availability are discussed in more detail in below ("Beluga Resource Change").

Current Noatak harvest data from 1994 and 2007 show that residents harvested 174,851 and 191,553 total pounds of subsistence foods during those years (Tables 12 and 13). The decline in per capita amounts from 1994 to 2007 (from 461 to 364) are evident almost entirely in their harvests of caribou, which dropped from 221 pounds per capita in 1994 to 114 pounds per capita in 2007. During the SRB&A 2008 interviews, residents of Noatak reported that declining harvests of caribou in recent years are due primarily to an increase in sport hunting activities along the Noatak River and changing migration routes (see "Caribou Resource Change," below). A brief comparison to earlier harvest data (Table 18) indicates that residents' subsistence harvests have declined over time, the most extreme case being the 2,964 per capita pounds of wild foods harvested in 1960-61 compared to the 364 per capita pounds harvested in 2007. However, Foote and Williamson (1966) reported that of 75,000 salmon harvested at Noatak from 1960-61, 72,000 were fed to dog teams. An undetermined number of salmon were harvested at Sheshalik for consumption by both humans and dogs. As snowmachines have replaced dogs as the primary mode of winter travel, it can be assumed that the majority of currently harvested foods are consumed by humans. Caribou harvests in 1960-61 were more than twice current yearly caribou harvests, and again, this can be attributed partly to declining caribou availability as reported by local residents. Foote and Williamson (1966) reported that 1960-61 was an especially successful year for caribou as their range had recently expanded to nearby lowlands. Also contributing to the 1960-61 numbers were the harvest of 52 beluga whales providing 195 pounds of meat per capita (Table 5). Residents of Noatak reported that beluga availability at Sheshalik has declined over the last 20 or more years (see discussion below, under "Beluga Resource Changes"). Despite changes in overall harvest numbers, uses of subsistence resources remain high. In 2007, 100 percent of households reported using at least one subsistence resource, and 97 percent reported harvesting at least one resource (Table 12).

Subsistence Use Areas

Current (1998-2007) subsistence use areas for Kivalina and Noatak for all resources are shown on Maps 35 and 36. Current subsistence use area maps include the lifetime use areas shown on Maps 1 through 34 (Schroeder et al. 1987) when possible, for comparison. The pre-mine use areas shown on Maps 1 through 34 represent a much longer time frame than the more recent use areas depicted on Maps 35 and 36. Some of the pre-mine data collected by Schroeder, Andersen & Hildreth represents uses from as early as 1925; however, use areas from Foote and Williamson (1966) and Braund & Burnham (1983) were for shorter time periods and show somewhat less extensive use of the land. Because resource availability fluctuates and changes over time, lifetime use areas are likely to be much larger than those recorded for a 10 year span. Future fluctuations in the availability of local resources may once again require a return to traditional areas not currently in use. The use of increasingly more powerful outboard motors and snow machines, as well as the addition of all-terrain vehicles (ATVs), has facilitated modern harvesters covering large distances in search of subsistence resources (Map 35).

Partial use area data depicting Kivalina, Kotzebue, and Noatak onshore and offshore subsistence uses between Kotlik Lagoon and Cape Thompson were collected by SRB&A for the 1995-2004 time period and are represented on Maps 37 through 39. This study focused on the potential port site expansion, so addressed a limited geographic area. Kivalina residents' partial use areas (Map 37) show high numbers of overlapping use areas occurring offshore between the port site and Cape Seppings, and on land around nearby lagoons and along the Kivalina and Wulik rivers. Kotzebue residents reported traveling as far as Cape Thompson for subsistence uses, although the majority of overlapping use areas reported by Kotzebue residents in the vicinity of Kivalina occurs along Rabbit Creek, Kotlik Lagoon, and along the shore to the port site (Map 38). Map 39 shows use areas reported by Noatak residents only in the vicinity of Kivalina. A high number of use areas were reported west of Noatak beyond the DMTS and along the coast to the port site. Because the SRB&A 2000 and 2005 reports provide only partial use area data, which are generally consistent with the last 10 year (1998-2007) use area data collected by SRB&A in 2008, these use areas are not discussed below under individual resource headings unless relevant.

Map 35 depicts Kivalina subsistence use areas from 1998-2007 for all resources, with 2007 use area data collected by ADF&G and lifetime (ca. 1925-1986) data also shown. Respondents reported subsistence uses over a continuous offshore area from Cape Krusenstern to Cape Thompson with use extending to Point Hope, and inland to the Delong Mountains and Noatak River. Fewer use areas also appear near

Kotzebue, Cape Lisburne, Point Lay and Selawik. The highest frequency of overlapping use areas are located directly west of the community in the Chukchi Sea for marine mammal harvests and in the lowland areas to the east of the community including the Kivalina and Wulik rivers for caribou, furbearers, fish, berries, and other resources. In 2007, Kivalina residents' subsistence use area extended along the coast from Cape Thompson towards Cape Krusenstern and inland from Rabbit Creek into the Delong Mountains.

Earlier studies documenting Kivalina's all resources use areas appear on Map 1. This map depicts the documented extent of Kivalina's all resources subsistence use prior to the development of the Red Dog Mine. Some of these studies (e.g., Saario & Kessel 1966) did not map use areas for all subsistence resources. Comparison of Maps 35 and 1 show that the majority of Kivalina's pre mine subsistence uses documented by Saario and Kessel (1966), Foote and Williamson (1966), and Braund and Burnham (1983) occur in the same general areas as the locations shown with the highest number of overlapping subsistence use areas on Map 35. Schroeder, Anderson, and Hildreth's (1987) documentation of Kivalina lifetime (ca. 1926-1986) subsistence use areas are similar to residents 1998-2007 use areas although their lifetime areas extended further to the east and do not show uses as extensively near Point Hope. For further comparison subsistence use areas see the individual "Subsistence Use Areas, Seasonal Round, and Harvest Patterns" discussions under each resource category heading below.

Current Noatak use areas are depicted on Map 36, which shows last 10 year (1998-2007) use areas as reported by Noatak respondents in 2008 for all resources, as well as 2007 use areas gathered by ADF&G and lifetime (ca. 1925-1986) data. Residents reported using an extensive area to pursue subsistence resources in the last 10 years, spanning north beyond the Red Dog Mine site and south to the southernmost waters of Kotzebue Sound. The use of two major hunting bases, one from Noatak and one from the seasonal camp at Sheshalik, is evident. In addition, residents travel to other communities, including Kivalina, Kotzebue, Point Hope, Noorvik, and Kiana, to participate in subsistence activities. The highest frequencies of overlapping use areas occur along the Noatak River; inland from the Noatak River west to the DMTS and east to the hills that border the "Noatak Flats;" and in Kotzebue Sound, especially in the waters surrounding Sheshalik to Cape Krusenstern (Sealing Point). Uses in 2007 were similar to those reported for the 1998-2007 time period, although no use areas were reported for the southern portion of Kotzebue Sound or along the coast beyond Kivalina, and several use areas were reported in the Selawik vicinity that were not captured for the 1998-2007 time period (Map 36).

Compared to earlier subsistence use area data for Noatak (Maps 18 and 36), current use areas do not extend as far north as those lifetime use areas collected by Schroeder, Andersen & Hildreth (1987) prior to mine operations. During SRB&A interviews in Noatak in 2008, elders and other subsistence users indicated that residents once traveled much farther north to trap furbearers and hunt caribou (SRB&A forthcoming). Residents stopped traveling as far north because the caribou herd began migrating closer to the community and such extensive travel was no longer necessary. Participation in trapping has also declined and many of those historic traplines that ran north of the Noatak River are no longer in use. Despite this, a number of individuals continue to trap furbearers in areas closer to Noatak.

Resource Change

The 1984 Environmental Impact Statement (EIS) (U.S. Environmental Protection Agency [USEPA] 1984) addressed potential effects of the mine on subsistence uses, including increased harvest pressure and competition in the mine area and along the road from local and non-local mine employees, changes in resource distribution due to mining activities, a decline in or displacement of subsistence resource populations due to interference with fish and wildlife cycles (i.e., disturbance of winter caribou grazing at the South Fork of Red Dog Creek), displacement of caribou related to disturbance from the DMTS, fewer opportunities to hunt and fish due to incompatible work schedules, and a decline in subsistence participation due to an increase in wage employment.

The 1984 EIS also discussed potential changes to subsistence resources resulting from mine operations. Potential effects to terrestrial mammals included habitat loss, mortality from mining activities, and attraction to mining facilities (see Section 3.9.2); effects to vegetation included loss of vegetation due to construction of facilities, traffic, and contamination related to dust and spills; and effects to fish included increased exposure to heavy metals (although the likelihood of this occurring was predicted to be low), increased sediment levels resulting from construction activities, and an increase in harvest pressure from mine employees (USEPA 1984).

Direct and indirect effects on wildlife, vegetation, and aquatic resources resulting from mine operations to date are addressed in Sections 3.7.2, 3.9.2, and 3.10.2. Effects include direct habitat loss associated with construction of the Red Dog mine, mine facilities, mine-related activities, and contamination from fugitive dust; wildlife disturbance due to mine-related noise and human activity; habituation of wildlife to mine facilities; wildlife mortality due to DMTS traffic (resulting in 22 animal deaths between 1998 and 2007); and an increased presence of metals in tundra near the mine and along the DMTS.

Caribou

Harvest Trends

Annual caribou harvests are subject to large variations in caribou distribution and hunting conditions and therefore are themselves highly variable. As shown in Table 14, for example, per capita harvests of caribou by Kivalina harvesters was 209 pounds per capita in 1964-65 and 830 pounds per capita the next year, 1965-66. With just nine harvest observation years in the last 50 years it is difficult to conclusively discern a trend within this large interannual variation.

ADF&G household studies documented Kivalina's 1992 and 2007 caribou subsistence harvests (Table 8). During these two study years, caribou per capita pounds equaled 138 and 85 pounds respectively. In 1992, caribou comprised 18.2 percent of the total harvest, and in 2007, caribou accounted for 14.3 percent of the community's total harvest. Of the top 20 species harvested, caribou was the third greatest contributor to Kivalina's total harvest during both years (Table 9). Compared to earlier caribou harvest data, per capita caribou amounts have decreased substantially from over 300 pounds per person in all but one study year in the 1960s, to 284 in 1983-84, to a low of 85 pounds in 2007 (Table 14). The 2007 caribou contribution of 14.3 percent of Kivalina's total harvest is the lowest of all study years. During ADF&G household surveys in 2008, 29 percent of Kivalina households reported that they harvested less land animals in 2007 than in previous years, and 26 percent reported that they did not harvest enough land animals to meet their needs (Magdanz et al. 2008). As discussed below under resource change, the lowest recorded harvest of 85 pounds per capita of caribou in 2007 coupled with local observations of displacement of caribou by DMTS road activity support the conclusion that there has been a decrease in caribou harvest not explained by natural variations in caribou distribution and hunting conditions.

Kotzebue harvests of caribou have remained high, with residents harvesting between 636 and 1,046 mean household pounds during the study years of 1991, 2002, 2003, and 2004 (Table 10). Caribou constitute a large percentage of residents' yearly resource harvests, accounting for between 23 and 26.2 percent of the total harvest during each study year. Comparison of recent caribou harvest data to harvest data collected before mine operations began show little change in harvests or participation over time (Tables 3 and 10). Harvest data for caribou in 1986 are similar to those reported after mine operations began, with harvest amounts slightly lower than in recent years. Residents harvested 97 pounds of caribou per capita in 1986 compared to 141 pounds per capita in 1991. The percentage of households attempting to harvest caribou rose between 1986 (50 percent) and 1991 (70 percent).

Caribou continues to be an important subsistence resource in Noatak, although harvests of caribou have declined since the 1990s. In 1994 and 1999, residents harvested 221 and 224 pounds of caribou per capita, respectively (Table 12). More recent studies in 2002 and 2007 show caribou providing approximately half the per capita amount observed in the 1990s, at 120 pounds in 2002 and 114 pounds in 2007. Older harvest data from 1960-61 show that caribou provided 762 pounds of caribou meat per capita that year (Table 18; Foote and Williamson 1966). During ADF&G household surveys for the 2007 study year, 59 percent of Noatak residents reported that they harvested less land animals in 2007 than in previous years, and 43 percent of households reported that they did not harvest enough land animals that year. Of those responses, 83 percent pertained to caribou (Magdanz et al. 2008).Foote and Williamson’s (1966) description of caribou hunting patterns from 1960 to 1961 suggest that caribou were widely available that year and in closer proximity to the village than in the past. Possible reasons for the recent decline in caribou harvests are discussed below (Caribou Resource Changes).

Subsistence Use Areas, Seasonal Round, and Harvest Patterns

Map 40 shows Kivalina last 10 year (1998-2007), 2007, and lifetime caribou subsistence use areas. For the past 10 years, residents reported an extensive use area from Cape Krusenstern to north of Point Hope, nearly as far as Cape Lisburne. Respondents search inland for caribou as far east as the Noatak River, and north into the Delong Mountains. The highest number of overlapping use areas occur along the Kivalina and Wulik rivers, DMTS, and coastline from Rabbit Creek to Kisimilok Creek. During the SRB&A interviews in 2008, Kivalina harvesters identified only 21 percent of their caribou use areas as always successful compared to 55 percent of always successful all resources use areas (SRB&A forthcoming). Conversely, only 16 percent of all resources use areas were described as unpredictable, compared to 39 percent of caribou use areas. In the last 10 years (1998-2007) residents most often travel to the Kivalina and Wulik rivers in search of caribou during August and September. While the Kivalina and Wulik rivers both show high use, individuals reported taking fewer trips by boat for caribou along the Kivalina River due to lower water levels. Higher water levels in the Wulik River allow residents to take multiple trips by boat along this waterway in search of caribou. Residents reported taking multiple trips to over 70 percent of their caribou use areas, and day trips (as opposed to overnight trips) to nearly 90 percent of their caribou use areas (SRB&A forthcoming). Respondents travel by boat and four-wheeler along the coast looking for caribou, and a number of respondents also travel the DMTS by four-wheeler in search of caribou. Most of residents’ caribou harvest activities to the north of the community along the coast towards Cape Seppings and Kisimilok Creek occur during late June and July as the caribou herd migrates south from northern feeding and calving grounds and goes to the coast seeking insect relief in the summer. Lowland areas east of Kivalina and north of Rabbit Creek also show a higher frequency of overlapping subsistence use areas than other inland caribou areas. Many Kivalina residents search for caribou in this area, primarily by snowmachine, beginning in November throughout the winter until April.

During ADF&G 2008 household surveys, Kivalina residents reported their 2007 caribou use area along the coast from Cape Thompson towards Cape Krusenstern and inland around Kivalina and Wulik rivers, Rabbit Creek, Mulgrave Hills, and lower half of DMTS (Map 40). Map 40 also shows Kivalina 1998 caribou use areas collected by SRB&A extending along the coast from Kivalina Lagoon to Cape Thompson during June and July, and a much larger inland caribou area accessed during September to April from Cape Seppings to Cape Krusenstern.

Direct comparisons of pre-mine use areas with more recent use areas are difficult due to the difference in study time periods (i.e., lifetime versus 1998-2007), and thus only general observations are discussed . Subsistence use area studies for caribou show that many of the caribou use areas documented by Saario and Kessel (1966) and Braund and Burnham (1983) occur in the areas of highest overlap reported by Kivalina residents during SRB&A 2008 interviews (Maps 2 and 40). Kivalina residents’ lifetime (ca. 1925-1986) caribou use areas extended farther to the north and east across the Noatak River than current (1998-2007) use areas (Map 40). A few respondents reported last 10 year caribou use areas towards Point Hope that were previously undocumented in earlier pre-mine subsistence use area studies.

Current (1998-2007 and 2007) Noatak use areas for caribou, as well as lifetime caribou use areas, are depicted on Map 41. Caribou hunting in Noatak generally occurs from August until April, with residents’ efforts intensifying in August and September, when they travel by boat along the local river system to harvest migrating caribou, and from January until March, when snowmachine conditions allow for more extensive overland hunting (SRB&A forthcoming). Residents generally reported taking day trips to hunt caribou, although in the fall time a number of residents indicated that they camp at locations along the river or stay in cabins in order to spend more time hunting, especially if they are focusing their efforts farther upriver. Overall, residents reported taking multiple yearly trips to 55 percent of their caribou use areas (SRB&A forthcoming). Some areas, such as those downriver from the community, are visited less often for caribou hunting. Last 10 year (1998-2007) caribou use areas extend along the Noatak River from the mouth to beyond Nimiuktuk River, although the highest number of river-based use areas occur between Nimiuktuk and Agashashok rivers (Map 41). Winter use areas extend overland both west and east of the Noatak River, with the highest numbers of overlapping subsistence use areas reported between the DMTS and Noatak River. Residents also reported hunting caribou in the last 10 years near Kotzebue, Buckland, and along the Kobuk River. Residents hunted along a similar stretch of the Noatak River in 2007 (Map 41), with some overland use extending toward but not reaching the DMTS. When asked to describe their caribou hunting success over the last 10 years (1998-2007), residents' responses indicated that success has declined in recent years. While more than half of their hunting areas were described as always or usually successful, more than one third were either unpredictable, seldom, or unsuccessful. In comparison, residents described only 20 percent of their all resources use areas as unpredictable, seldom, or unsuccessful (SRB&A forthcoming).

Pre-mine caribou use areas, shown on Maps 19 and 41, are similar to current use areas but are larger and extend farther north and east. As discussed above, residents of Noatak indicate that caribou have not always migrated through the Noatak area; several elders remembered a time when local hunter traveled beyond the Brooks Range to the north to harvest them (SRB&A forthcoming). Foote and Williamson documented this shift in use areas in their report on the Cape Thompson region, noting that caribou had recently returned to nearby lowlands and "few men therefore bothered to travel north of the Brooks Range (*seeyaleenik*) for furs or meat" (Foote and Williamson 1966). Future changes in caribou distribution could result in local residents once again traveling farther north to harvest the resource. Partial pre-mine use areas recorded for the 1977-1982 time period (Map 19), and only west of the Noatak River, are located on either side of the DMTS and lie within current high overlapping caribou use areas (Map 41).

Caribou Resource Changes

As discussed in Section 3.9.2, studies on the Western Arctic Caribou Herd (WAH), including a 2007 risk assessment, have addressed effects related to the Red Dog Mine since operations began. These studies concluded that caribou have experienced a small loss of winter habitat due to the construction of the mine, although this has not had a major effect on the resource due to the broad expanse of wintering grounds available to the herd. Somewhat higher levels of lead, copper, and arsenic were found in caribou harvested in the vicinity of the Red Dog mine; however, these findings were attributed to higher natural levels of minerals in that area and further studies are recommended to determine the relationship between mining activities and caribou health. Finally, traffic along the DMTS corridor was found to cause "limited, localized" effects on caribou movement and distribution, and nine caribou fatalities have occurred as a result of traffic collisions. Given the currently healthy population of the WAH, these fatalities have had no effect on overall population numbers.

Although changes in caribou related to the Red Dog Mine from a biological standpoint may be viewed as minimal, resulting effects of localized changes in resources on subsistence uses are greater. Because residents rely on only a portion of the expansive WAH range to harvest caribou, small changes in caribou availability can have large effects on subsistence uses. Subsistence users in the study communities have observed various changes in caribou since mine operations began, citing both mine-related and other causes.

During SRB&A fieldwork in 2008, respondents from Kivalina and Noatak were asked to share their observations regarding changes in subsistence resources. Residents' observations regarding changes in

Table 20: Observations of Caribou Resource Changes

Observation	Number of Observations			Percent of Observations		
	Kivalina	Noatak	Total	Kivalina	Noatak	Total
Migration changed or diverted	29	30	59	27%	23%	25%
Harvest less	10	11	21	9%	8%	9%
Resource Smaller/Skinnier	8	9	17	7%	7%	7%
Disease/Infection	6	8	14	6%	6%	6%
Resource in Smaller Groups	6	5	11	6%	4%	5%
More difficult	1	8	9	1%	6%	4%
Worse success	1	8	9	1%	6%	4%
Abnormal Resource Death	9	0	9	8%	0%	4%
Increase in Species Number	6	1	7	6%	1%	3%
Decrease in Species Number	2	4	6	2%	3%	3%
Further from Village	3	3	6	3%	2%	3%
Move to Different Areas	1	5	6	1%	4%	3%
Habitat Disturbed/Destroyed	1	4	5	1%	3%	2%
Declining/Damaged Feeding Habitat	4	1	5	4%	1%	2%
Change in Texture of Meat	5	0	5	5%	0%	2%
Closer to Village	0	5	5	0%	4%	2%
Later Migration/Arrival	0	5	5	0%	4%	2%
Harvest resource closer to community	0	4	4	0%	3%	2%
Use area changed	0	4	4	0%	3%	2%
Sharing Less	3	0	3	3%	0%	1%
Change in Habitat Location	1	2	3	1%	2%	1%
Take fewer trips	2	0	2	2%	0%	1%
Take shorter trips	1	1	2	1%	1%	1%
Harvest season changed	0	2	2	0%	2%	1%
Habitat Changed	2	0	2	2%	0%	1%
Change in Resource Behavior	0	2	2	0%	2%	1%
Contamination	1	1	2	1%	1%	1%
Farther from riversides/farther inland	0	2	2	0%	2%	1%
Take longer trips	0	1	1	0%	1%	0%
Use Less	0	1	1	0%	1%	0%
Travel farther to harvest resource	1	0	1	1%	0%	0%
Less difficult	1	0	1	1%	0%	0%
Dust on Vegetation	0	1	1	0%	1%	0%
Increase in Resource Size	0	1	1	0%	1%	0%
Resource Injury	0	1	1	0%	1%	0%
Resource appears unhealthy	1	0	1	1%	0%	0%
Earlier Migration/Arrival	0	1	1	0%	1%	0%
Abnormal Migratory Event	1	0	1	1%	0%	0%
Timing of Migration	1	0	1	1%	0%	0%
Taste	1	0	1	1%	0%	0%
Total Observations	108	131	239	100%	100%	100%
Total Number of Caribou Change Observers	37	35	73			
Total Number of Community Respondents	44	42	86			

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caribou are compiled in Table 20. Eighty-four percent of the 44 harvesters interviewed in Kivalina and 83 percent of the 42 harvesters interviewed in Noatak made observations of change in caribou (see Table 7). The principal caribou resource changes observed were: (1) migration changed or diverted; (2) harvest less; (3) resource smaller/skinnier; (4) disease/infection; and, (5) resource in smaller groups.

Migration/Distribution. Twenty-seven percent of Kivalina caribou change observations and 23 percent of Noatak caribou change observations concerned a change in migration or distribution of caribou (Table 20). Table 21 shows the perceived causes of changes in migration/distribution. Forty-six percent of Kivalina observations related to caribou migration/distribution cited that the DMTS or road traffic have caused the change compared with only 12 percent of Noatak observations (Table 21). Forty-four percent of Noatak observations related to a change in caribou migration/distribution indicated that sport hunting methods, including disturbance by airplanes, are responsible while only nine percent of Kivalina caribou change observations cited these reasons for the change in migration or distribution of caribou. In addition, 11 percent of Noatak and seven percent of Kivalina caribou change observations cited a change in caribou food availability as a cause of the change in caribou migration/distribution.

Table 21: Reasons for Change in Caribou – Migration Changed or Diverted

Cause	Number of Causes Mentioned			Percent of Causes Mentioned		
	Kivalina	Noatak	Total	Kivalina	Noatak	Total
Sport Hunting Methods Disturbing Migration Routes	4	13	17	9%	30%	20%
Traffic along DMTS	13	2	15	30%	5%	17%
DMTS	7	3	10	16%	7%	11%
Change in Food Availability	3	5	8	7%	11%	9%
I Do not Know	6	1	7	14%	2%	8%
Airplane Traffic Disturbance	0	6	6	0%	14%	7%
Boat Traffic Disturbance	0	5	5	0%	11%	6%
Disturbance	2	2	4	5%	5%	5%
Predators	3	1	4	7%	2%	5%
Mining Activities	2	1	3	5%	2%	3%
Traffic Disturbance	0	2	2	0%	5%	2%
Wildfires	0	1	1	0%	2%	1%
Habitat Disturbed/Destryoed	0	1	1	0%	2%	1%
Declining/Damaged Feeding	1	0	1	2%	0%	1%
Contact/Merging with Other Herds	1	0	1	2%	0%	1%
Noise related to mining activities	1	0	1	2%	0%	1%
Dust from mining activities	0	1	1	0%	2%	1%
Total	43	44	87	100%	100%	100%

Stephen R. Braund & Associates, 2008.

The 1984 EIS (USEPA 1984) did not predict a major change in caribou movement due to the DMTS, but it substantially underestimated levels of traffic along the DMTS (see Section 3.9.2). Furthermore, the National Research Council's (NRC) study on the cumulative effects of North Slope oil and gas activities reported that caribou have been found to avoid roads and other structures, and noted that "the presence of a road or pipeline alone, without vehicular or human activity, can elicit avoidance" (NRC 2003). Hunters from all three communities have reported changes in caribou movement during multiple studies, indicating that the caribou sometimes follow the road rather than cross it directly (SRB&A 2005), or that traffic along the DMTS, including ATV traffic from young local hunters, disrupts caribou movements and diverts them farther from local hunting grounds (SRB&A 2000 and 2005; U.S. Army Corps of Engineers 2005). As described in SRB&A (1998), residents indicated that caribou traditionally cross the Noatak River from the east near Noatak in the fall; once they have been informed of their crossing, residents in Kivalina expect the arrival of caribou within a couple of weeks. In more recent years, however, hunters observe that once caribou reach the road, they are diverted inland toward the mountains and only a few stragglers cross the road and reach the flats east of Kivalina where hunters have traditionally harvested them. One Kivalina hunter described changes in caribou related to the DMTS as follows:

> Our caribou are not migrating through as much as when they first built that road. There used to be thousands and thousands of caribou that come through here and to Kivalina, and I notice the caribou are always coming up through this side [south of road], and going up toward Atqasuk and Nuiqsut and Kaktovik. A few would cross but most go up behind the mine and head up that way. The first year they built this road, that is when everything changed.... Even right now. I would say it's all because of this road and trucks coming up and down too much. (SRB&A Kivalina Interview January 2008)

Residents from Noatak and Kotzebue have made similar observations regarding changes due to the DMTS (SRB&A 2005, forthcoming), while others believe the mine road has had little effect or that the caribou have now acclimated to the presence of the road (SRB&A 2005).

SRB&A 2008 interviews in Noatak indicate that a major current concern to residents is related to the effect of sport hunting activities on caribou distribution and migration:

> Usually, the [caribou hunting] success is further up. The areas where we usually wait for [the caribou,] they're not as heavy as before. Further up it seems like they're always on the mountainsides, up on the hills. We harvested just a real small amount this fall, and then they sent a guy to find where the big herd was, and they were way up there in their calving area still, way far away. And then later we heard that they were crossing the road, but they went further down, to Kotzebue area. We see a lot of planes up there, a lot of planes flying really low. We have an agreement that the planes are not supposed too fly a certain distance from the river and have to stay higher, but they don't listen. (SRB&A Noatak Interview January 2008)

In Noatak 14 of 19 observations attributing caribou migration changes to disturbances from sport hunting methods and airplane traffic, cited them as main causes of the change. Observations of caribou change in Noatak described an increase in sport hunting activity since 1998. In Noatak, 25 of 30 individuals reported that the change in migration had begun in 1998 or later, whereas in Kivalina 11 respondents described the start date of the change as 1989 (the year mine operations began). Residents also observed that caribou began crossing the Noatak River farther south and closer to the community within the last 20 years; however, this trend has been reversing in the last few years and caribou have generally been crossing farther from the community.

Other factors described by residents of the study communities as affecting caribou migration and distribution include the availability of lichen, increased recreational activity, changes in hunting methods, and pressure from wolves (SRB&A 2000, 2005, forthcoming, and U.S. Army Corps of Engineers 2005).

Harvest Less. Nine percent of Kivalina caribou change observations and eight percent of Noatak caribou change observations cited harvesting less caribou (Table 20). An additional 12 percent of Noatak observations regarding changes in caribou cited increased difficulty hunting and worse success. Seventy-three percent of Kivalina caribou observations and 33 percent of Noatak observations citing decreased harvests attributed the decline in harvest amounts to a change in caribou migration (Table 22) (see discussion above, under "Migration/Distribution").

Table 22: Reasons for Change in Caribou – Harvest Less

Causes	Number of Causes Mentioned			Percent of Causes Mentioned		
	Kivalina	Noatak	Total	Kivalina	Noatak	Total
Migration changed or diverted	8	6	14	73%	33%	48%
Employment/Lack of Time	1	2	3	9%	11%	10%
Decrease in Species Abundance	1	2	3	9%	11%	10%
Later Migration/Arrival	0	3	3	0%	17%	10%
Personal Reasons	1	1	2	9%	6%	7%
Change in subsistence Dependents	0	2	2	0%	11%	7%
Change in Resource Availability	0	1	1	0%	6%	3%
Farther from riversides/farther inland	0	1	1	0%	6%	3%
Total	11	18	29	100%	100%	100%

Stephen R. Braund & Associates, 2008.

Residents generally indicated that the amount of caribou harvested had changed because caribou are less available and harder to find, primarily due to changes in their migratory patterns. A hunter from Kivalina summarized this view saying,

> [The] success rate has gone down significantly. Before, it was always [successful], especially those times of year, especially in this area, Wulik River, you always got some. Especially October. Quite a few times up in here [Wulik] five miles...In the beginning [right after the road was built] our success was less, but to put food on the table we had to go further. The road has quite a bit to do with it. The patterns have changed considerable. (SRB&A Kivalina Interview January 2008)

In Noatak, six of the 11 individuals who reported harvesting less caribou indicated that the change started in 2004 or later, and six reported the change in migration/distribution to be a main cause of the decline (SRB&A forthcoming). In Kivalina, seven of 10 individuals who reported harvesting less caribou said that the change started in 2005, and eight individuals indicated that a change in migration/distribution was the main reason for the decreased harvests. SRB&A's 2000 and 2005 reports include few observations of changes in use, indicating that decreased harvests in Kivalina and Noatak may be a relatively new phenomenon. However, Tables 14 and 18 indicate that caribou harvests have been declining since the 1990s. The 1984 EIS (USEPA 1984) addressed the potential that there would be a decline in subsistence participation due to an increase in wage employment, or that incompatible work schedules would affect subsistence activities. Three individuals in Noatak and Kivalina reported harvesting fewer caribou due to employment responsibilities or lack of time, two respondents cited personal reasons for a decreased harvest, and two indicated that they harvested fewer caribou due to fewer household dependents. The remaining causes cited by Noatak and Kivalina respondents were related to outside factors, such as changes in the migration, distribution, and abundance of caribou. Thus, based on the SRB&A 2008 interviews, mine employment has had a minimal impact on residents' participation in subsistence activities, although some individuals reported having less time to hunt because of employment associated with Red Dog Mine.

Resource Smaller/Skinnier. Eight (of 44) Kivalina respondents and nine (of 42) Noatak respondents observed that caribou are smaller or skinnier (Table 20). Thirty-three percent of those residents citing a decrease in size of caribou did not know why the change has occurred (Table 23). Residents mentioned climate change, various types of disturbance, changes in feed, and contamination as reasons for the decrease in size. No single cause was cited more than twice. Noatak residents made similar comments regarding the decreasing size of caribou during interviews in 2005 (SRB&A 2005).

Table 23: Reasons for Change in Caribou – Resource Smaller/Skinnier

Causes	Number of Causes Mentioned			Percent of Causes Mentioned		
	Kivalina	Noatak	Total	Kivalina	Noatak	Total
I Do not Know	4	3	7	40%	27%	33%
Climate	0	2	2	0%	18%	10%
Disturbance	2	0	2	20%	0%	10%
Airplane Traffic Disturbance	0	2	2	0%	18%	10%
Declining/Damaged Feeding Habitat	2	0	2	20%	0%	10%
Predators	0	2	2	0%	18%	10%
Traffic along DMTS	2	0	2	20%	0%	10%
Change in Feeding	0	1	1	0%	9%	5%
Contaminated by ore dust from trucks	0	1	1	0%	9%	5%
Total	10	11	21	100%	100%	100%

Stephen R. Braund & Associates, 2008.

Disease/Infection. Six percent of Kivalina observations of caribou change and six percent of Noatak observations of caribou change cited increased disease or infection among caribou (Table 20). Furthermore, four percent of caribou change observations were related to abnormal resource deaths. Fifty percent of the Kivalina observations and 75 percent of the Noatak observations of increased disease/infection among caribou did not know the cause of the change (Table 24).

Table 24: Reasons for Change in Caribou – Increased Disease/Infection

Causes	Number of Causes Mentioned			Percent of Causes Mentioned		
	Kivalina	Noatak	Total	Kivalina	Noatak	Total
I Do not Know	3	6	9	50%	75%	64%
Contaminated by ore dust from trucks	2	1	3	33%	13%	21%
Contamination due to mining activities	1	0	1	17%	0%	7%
Increase in Species Number	0	1	1	0%	13%	7%
Total	6	8	14	100%	100%	100%

Stephen R. Braund & Associates, 2008.

During interviews in 2008, one Noatak hunter described his observations regarding changes in the health of caribou:

> You start noticing these big growths on them, big water sacs, like they're sick. We went up to this one caribou. Nice looking, in the water, got him out and big blotches on him. [It started happening] within the past 10 years. Not only down there, but further up the river, where people shoot them and just cut the guts out. They shot that caribou and it was not good. One thing I really noticed, whenever we skin the caribou and cut the joints off, it's always yellow. Not like before. The following year, we started seeing some pus in them. When you cut the joints, water comes off and now it's yellow. It started with the yellow, then they started getting the pussy stuff, and nowadays you see growths all over. Not all caribou are like that. Maybe one in 100 are like that. Every herd, there's one like that. [There were] three reported this year. (SRB&A Noatak Interview January 2008)

Five of the nine observations noting abnormal deaths did not give a reason; two observations cited ice blocking access to food and two cited contamination as possible reasons (SRB&A forthcoming). Residents of all three study communities have cited concerns about the possible contamination of caribou due to mine activities, particularly when they see caribou feeding near the road where dust has contaminated the tundra (SRB&A 2000 and 2005). As discussed, in Section 3.9.2, several studies have been conducted to determine the effects of mine activities on caribou health. Tissue sampling of caribou in the mine area determined that the mine did not substantially affect caribou health and a 2007 risk assessment reported that there was a low risk of contamination from consumption of caribou (Section 3.9.2). However, a number of residents have reported that they no longer hunt in certain areas, such as along the DMTS, due to concerns of contamination. In some cases, hearing someone talk about potential contamination led to that respondent avoiding a certain area. Thus, fear of contamination or perceived contamination due to mine activities has affected subsistence for some local hunters.

Caribou in Smaller Groups. Six percent of Kivalina observations of caribou change and four percent of Noatak observations of caribou change were that caribou tend to be in smaller groups (Table 20). Eighty-four percent of observations cited in Kivalina and 43 percent of observations in Noatak attribute it to the DMTS, traffic on the DMTS, or mining activities (Table 25). Residents reported that the diversion of caribou from the DMTS and noise related to mining activities causes the caribou to scatter, resulting in smaller groups of caribou rather than large herds. Noatak residents also attributed the change to caribou being chased by predators as well as disturbance from traffic not related to the mine (i.e., boats and airplanes).

Table 25: Reasons for Change in Caribou – Resource in Smaller Groups

Causes	Number of Causes Mentioned			Percent of Causes Mentioned		
	Kivalina	Noatak	Total	Kivalina	Noatak	Total
DMTS	5	2	7	42%	29%	37%
Traffic along DMTS	3	1	4	25%	14%	21%
Disturbance	2	0	2	17%	0%	11%
Traffic Disturbance	0	2	2	0%	29%	11%
Mining Activities	2	0	2	17%	0%	11%
Predators	0	1	1	0%	14%	5%
Change in Food Availability	0	1	1	0%	14%	5%
Total	12	7	19	100%	100%	100%

Stephen R. Braund & Associates, 2008.

Moose

Harvest Trends

As discussed in Section 3.9.2, moose expanded to the project area in the 1950s and is thus a relatively new subsistence resource available to local hunters. Although not harvested in quantities comparable to caribou, residents of the three study communities harvest moose at varying degrees to support their subsistence diet throughout the year. Of the three communities, Kotzebue residents harvest the most moose per capita (see Tables 8 - 13).

In 2007, moose comprised less than one percent of Kivalina's overall harvest (Table 8). Over all study years, moose contributed the greatest amount (3.5 percent) to Kivalina's total harvest in 1992, at 26 pounds per capita. By comparison, Kivalina households harvested five pounds of moose per capita in 2007. Although Kivalina's 2007 moose harvest amount decreased from 1992 harvest levels, moose has not historically been a major contributor to Kivalina's overall harvests, comprising between zero to 1.5 percent of the total harvest between 1964 and 1984 (Table 15). In 2007, 31 percent of Kivalina households reported using moose, and even fewer households (14 percent) attempted to harvest this subsistence resource.

In Kotzebue, moose has been the fifth most harvested species, by percent of total harvest, during each recent study year (1991, 2002, 2003, and 2004), accounting for between 3.9 and 5.8 percent of the total harvest during those years (Table 11). In 1991, 62 percent of households reported using moose, and 27 percent reported harvesting moose. In comparison to pre-mine harvest data, Kotzebue residents' harvests of moose have increased slightly. Residents harvested 13 pounds of moose per capita during the most recent pre-mine study year (1986), and 35 pounds per capita in 1991. Participation in moose hunting also rose between 1986 and 1991 (Tables 3 and 10).

During interviews with local Noatak hunters, residents indicated that they prefer caribou and often only hunt moose when they are low on caribou meat. However, one individual reported that because of the scarcity of caribou in recent years, moose had become more important as a supplement to her family's diet (SRB&A forthcoming). Noatak per capita harvests of moose were higher in 2007 than in any other recent study year (1994, 1997, 1999, and 2002) (Table 18). Moose harvest data are not available for the 1960-61 harvest study, but 1971-72 harvest data show Noatak harvests of 20 moose that year, accounting for 3.2 percent of the community's total harvest (Table 5). Harvests of moose in 2007 constituted three percent of the Noatak subsistence harvest.

Subsistence Use Areas, Seasonal Round, and Harvest Patterns

The majority of Kivalina residents' moose hunting areas are located along the Kivalina and Wulik rivers, although a few use areas also occur along the coast north and south of the community (Map 42). Residents travel by boat to the majority of their moose use areas during August and September. Respondents reported the highest number of moose use areas along the Wulik River from the mouth to the base of Mount Jarvis. A number of residents indicated that moose are too difficult to pursue and pack out of inland areas but if they are in need of meat, residents will harvest a moose if spotted along local rivers. Residents reported being always or usually successful at nearly half of their moose use areas, and having unpredictable or seldom success at the other half of moose use areas (SRB&A forthcoming). Respondents generally take day trips to moose use areas, with residents traveling to just over half of moose use areas between one and five times a year and an additional one-quarter of use areas not visited on a yearly basis. Kivalina households reported hunting moose during 2007 along stretches of both the Kivalina and Wulik rivers (Map 42). Earlier Kivalina subsistence use areas studies by Braund & Burnham (1983) and Schroeder, Andersen, and Hildreth (1987) show little change in residents' use areas for moose, with moose hunting occurring along the Kivalina and Wulik Rivers and along the coast several miles inland from Chariot to Sheshalik (Maps 5 and 42).

Current last 10 year (1998-2007) moose hunting by Noatak residents is limited primarily to the fall months of August and September (SRB&A forthcoming) and occurs along the Noatak River by boat, with the highest number of overlapping use areas reported between the Kelly and Agashashok rivers (Map 43). Some hunting occurs inland from the river by four-wheeler, foot, or snowmachine, and along various Noatak River tributaries (Map 43). Moose hunting success was described as unpredictable by Noatak residents in 36 percent of moose use areas; however, another 36 percent of use areas were described as always successful. Residents generally take a limited number of yearly trips, between zero and three, to hunt moose, or they look for them during the fall caribou hunt (SRB&A forthcoming). Some residents hunt the resource more frequently than others, and others do not hunt moose at all. Moose use areas as reported by Noatak residents for the 2007 ADF&G study year occur north along the Noatak River, with overland hunting reported west of the community toward the DMTS (Map 43). Noatak moose hunting areas have not changed much since mine operations began. Pre-mine lifetime use area data show moose hunting in a similar area along the Noatak River (Map 43).

Moose Resource Changes

Baseline conditions of moose are discussed in Section 3.9.2. Moose are found in the vicinity of the Red Dog Mine, including near Red Dog Creek, Ikalukrok Creek, and Wulik River. Impacts to moose to date include displacement due to mine-related noise and activity. However, no impacts on the overall population have occurred or are expected to occur in relation to the Red Dog Mine (see Section 3.9.2).

During SRB&A's 2008 interviews, 25 percent of harvesters interviewed in Kivalina and 21 percent of the harvesters interviewed in Noatak reported changes in moose (Table 7). Local observations of change in moose are divided in assessment of whether the species numbers are increasing or decreasing (Table 26). Similarly, residents' observations about the status of the moose population during 1998 interviews varied. Forty-three percent of Kivalina moose change observations and 20 percent of Noatak moose change observations cited a decrease in moose. Twenty-one percent of Kivalina observations and 20 percent of Noatak observations cited an increase in moose. Seventeen percent of observations were related to a decreased harvest of moose. No other types of observations were reported by more than two individuals.

Table 26: Observations of Moose Resource Change

Observation	Number of Observations			Percent of Observations		
	Kivalina	Noatak	Total	Kivalina	Noatak	Total
Decrease in Species Number	6	2	8	43%	20%	33%
Increase in Species Number	3	2	5	21%	20%	21%
Harvest less	1	3	4	7%	30%	17%
Move to Different Areas	2	0	2	14%	0%	8%
Harvest more	1	0	1	7%	0%	4%
Habitat Disturbed/Destroyed	0	1	1	0%	10%	4%
Habitat improved	0	1	1	0%	10%	4%
New Species in Region	0	1	1	0%	10%	4%
Moved into area	1	0	1	7%	0%	4%
Total Observations	14	10	24	100%	100%	100%
Total Number of Moose Change Observers	11	9				

Stephen R. Braund & Associates, 2008.

Other Large Land Mammals

Harvest Trends

Although local residents do not rely heavily on the harvests of Other Large Land Mammals (muskox, sheep, or bear) for subsistence, limited harvests of these resources continue and for a number of people these animals provide a desired and valued meat.

In 2007, Kivalina households harvested two Other Large Land Mammals for a total contribution of less than one pound per person and 0.1 percent of the total harvest (Table 8). Harvests of these resources in 1992 were similar. Other Large Land Mammals did not contribute to the top 20 species harvested by Kivalina residents during either study year (Table 9). In all previous study years from the 1960s to the early 1980s, Other Large Land Mammal harvests accounted for 0.2 percent or less of the total community harvest (Table 8).

Residents of Kotzebue harvested Other Large Land Mammals during each recent study year, with harvests varying from four animals harvested in 2003 to 48 animals harvested in 1991 (Table 10). Residents harvcested two pounds of Other Large Land Mammals per capita in 1986 and one pound per capita in 1991. The most recent (2002-2004) harvests of Other Large Land Mammals are substantially less than those reported for the 1986 and 1991 study years. Dall sheep was among one of the top harvested species in 1971-72 (Table 11).

Noatak harvests of Other Large Land Mammals were higher in 2007 than during any other study year, accounting for .7 percent of residents' subsistence harvests (Table 12). Residents harvested both black and brown bear, muskox, and Dall sheep (Magdanz et al. 2008). Both muskox and Dall sheep were among the top harvested species by percent of total harvest (Table 13); however, uses of these resources by Noatak households were relatively low, with nine percent using Dall sheep and six percent using muskox. Other study years (1994, 1997, 1999, and 2002) show Other Large Land Mammals providing between zero and one pound of useable weight per capita, compared to three pounds in 2007. Harvest data from 1971-72 show residents harvesting a total of five muskox, bear, or sheep, resulting in a total of 443 pounds of useable meat. This is higher than for most study years, but substantially lower than the 2007 total harvest of 1,400 pounds.

Subsistence Use Areas, Seasonal Round, and Harvest Patterns

Only four Kivalina respondents reported harvesting bear or Dall sheep in the last 10 years for a total of eight use areas. Respondents generally do not hunt these species on a yearly basis. When they do make specific trips for these resources, residents primarily take day trips to hunt for bear by boat during the fall months and for Dall Sheep later in the winter by snowmachine. These individuals reported subsistence use areas along the Kivalina and Wulik rivers, presumably for bear, and for Dall sheep farther inland near the Delong Mountain foothills (Map 44). Overlapping use areas occur within the Wulik Peaks area. Success for these two species is relatively low, with only 26 percent of use areas identified as always or usually successful (SRB&A forthcoming). Two Kivalina households reported 2007 Dall sheep use areas, one located along the coast near Chariot, and the other in the Delong Mountains north of the Kukpuk River. Both of these Dall sheep use areas appear in locations previously not documented in prior subsistence use area studies. Kivalina households did not report any 2007 bear subsistence use areas. Both pre-mine (Braund and Burnham 1983) and recent studies show Dall sheep use areas located in the same inland mountainous areas (Map 3). Residents' lifetime Dall sheep subsistence use areas occurred in a much larger area surrounding these areas (Map 44).

Current (1998-2007) Noatak use areas for muskox, sheep, and bear have been reported both west and east of the Noatak River, with the highest number of overlapping use areas reported in the hills northeast of the community, between the Noatak and Eli rivers, where a number of respondents reported harvesting Dall sheep (Map 45). In 2007 residents of Noatak hunted brown bear and Dall sheep (Map 45). Brown bear hunting occurred north of the community between Noatak and the DMTS and east of the Noatak River. Residents hunted sheep in an area similar to that reported for the 1998-2007 time period. Residents of Noatak reported hunting bear, Dall sheep, and muskox during the early spring (from February until April) and/or in the fall (September and October). While spring hunting occurs by snowmachine, fall hunting generally requires traveling by boat and, in the case of Dall sheep, hiking substantial distances. The majority of use areas identified by Noatak residents were visited once yearly or not every year (SRB&A forthcoming). While only one resident reported hunting muskox during SRB&A's 2008 interviews, this individual noted that there were a number of other residents in the community who currently participate in this subsistence activity; thus, muskox use areas are likely underrepresented. Residents described being relatively successful when hunting Other Large Land Mammals, with nearly three-quarters of respondents' use areas for this resource described as always successful.

Pre-mine, especially lifetime, Noatak hunting areas for sheep and bear are somewhat more extensive than current use areas, although Braund & Burnham's 1977-1982 partial use areas for the community show only one small use area west of the Red Dog Mine (Map 22). Lifetime bear hunting areas recorded prior to mine operations are shown on Maps 22 and 45 and occur over a large area extending along the Noatak River beyond Nimiuktuk River and inland east and west of the Noatak River; lifetime sheep hunting is shown in the mountains east of the Noatak River and north of the Red Dog Mine site. The lifetime use areas shown on Map 45 were recorded for a much longer time frame than current use areas, most of which lie within recorded pre-mine use areas. During interviews with Noatak residents, a number of people mentioned that hunting of brown bear has declined over time, which may explain the relatively smaller current use areas for this resource (see "Muskox, Sheep, Bear Resource Changes," below).

Other Large Land Mammals Resource Changes

Direct and indirect effects on Other Large Land Mammals resulting from the Red Dog Mine are discussed in Section 3.9.2. Research to date has not identified any overall changes to Other Large Land Mammals resulting from Red Dog Mine activities. Muskoxen and Dall sheep do not regularly occur in the mine area, although sightings of muskoxen have been reported near the mine. The brown bear population experienced a minor loss of winter denning habitat due to construction of the mine, and one den disturbance has been reported. Bears are sometimes found at the mine site, and mine personnel have used hazing to encourage bears to leave the area. No injuries were reported to occur due to these activities. No major impact to bears resulting from the Red Dog Mine has occurred or is expected to occur (see Section 3.9.2).

Twenty-five percent of Kivalina respondents and 48 percent of Noatak respondents provided observations about changes in bear and sheep (Table 7). No observations were made about muskox. The majority of observations were related to bear and brown bear, with only three observations relating to sheep (Table 27). The primary observation of change reported by Kivalina and Noatak residents was related to an increase in resource numbers (Table 28). Other observations included the resource being closer to the village, a decrease in resource number, and a decrease in resource size.

Table 27: Observations by Species (Muskox, Sheep, Bear) by Community

Species	Number of Observations		
	Kivalina	Noatak	Total
Brown bear	11	5	16
Dall sheep	1	2	3
Bear	0	28	28
Total	12	35	47

Stephen R. Braund & Associates, 2008.

Table 28: Observations of Bear and Sheep Resource Changes

Observation	Number of Observations			Percent of Observations		
	Kivalina	Noatak	Total	Kivalina	Noatak	Total
Increase in Species Number	4	19	23	33%	54%	49%
Closer to Community	0	9	9	0%	26%	19%
Decrease in Species Number	2	2	4	17%	6%	9%
Decrease in Resource Size	3	0	3	25%	0%	6%
Harvest less	0	2	2	0%	6%	4%
Habitat improved	0	2	2	0%	6%	4%
Move to Different Areas	2	0	2	17%	0%	4%
Change in Resource Behavior	0	1	1	0%	3%	2%
Abnormal Resource Death	1	0	1	8%	0%	2%
Total Observations	12	35	47	100%	100%	100%
Total Number of Bear and Sheep Change Observers	11	20				

Stephen R. Braund & Associates, 2008.

Increase in Species Number. An increase in species number accounted for 33 percent of Kivalina observations regarding changes in sheep or bear and 54 percent of Noatak observations (Table 28). Twenty-six percent of Noatak observations were that the resource has been closer to the community, as residents reported more bear coming into or near the community. Residents indicated that bears have been coming into or near the villages looking for food in the form of fish or garbage. Kivalina residents noted that bear problems are increasingly prevalent along the Wulik and Kivalina rivers and this has resulted in fewer people staying a fish camps to put up fish (SRB&A 2000). The high number of observations of changes in bear suggests that active subsistence harvesters who do not harvest bear, in addition to active harvesters of the species, are observing the increase in species.

Sixty-seven percent of Kivalina observations and 89 percent of Noatak observations citing an increase in species number attributed the change to fewer people hunting or harvesting the resource (Table 29) and all but one observer reported that fewer people hunting bear was the main cause of their increase (SRB&A forthcoming).

Table 29: Reasons for Change in Bear and Sheep – Increase in Species Number

	Number of Observations			**Percentage of Observations**		
	Kivalina	**Noatak**	**Total**	**Kivalina**	**Noatak**	**Total**
Fewer people hunting/harvesting resource	2	17	19	67%	89%	86%
Habitat improved	0	2	2	0%	11%	9%
I Do not Know	1	0	1	33%	0%	5%
Total	3	19	22	100%	100%	100%

Stephen R. Braund & Associates, 2008.

Bowhead Whale

Harvest Trends

Of the three study communities, Kivalina is the only one recognized by the Alaska Eskimo Whaling Commission (AEWC) as a bowhead whaling community. However, some residents of Noatak and Kotzebue travel to other communities, such as Kivalina and Point Hope, to participate on whaling crews, bringing the meat and *maktak* back to share with local households.

During April and May of each year, Kivalina whaling crews actively participate in the spring bowhead whale hunt. Kivalina last harvested a bowhead whale in 1995 (AEWC 1980-2007). Bowhead whales' regular migration route in the spring occurs in open leads several miles out from shore (see Section 3.9 Wildlife), and therefore residents' bowhead hunting success is often dependent on the stability of the ice conditions and which lead the bowhead whales are in. Even though the community has not harvested a whale in 13 years, a high percentage of households continue to try to harvest this resource. In 2007, 48 percent of households reported attempting to harvest bowhead whale (Table 8). Sixty-four percent used and received bowhead whale from friends and relatives in other whaling communities such as Point Hope and Barrow. During ADF&G study years when the community successfully harvested a bowhead whale (see 1984, 1992 ADF&G study years), this resource contributed a substantial amount to the overall harvest at 15.6 and 5.1 percent, respectively (Table 8). During those two years, bowhead was among the top five species, in terms of percent of total harvest (Table 9).

While few residents of Kotzebue harvest bowhead whales, use of bowhead whale in 1991 was high, with 61 percent of households using the resource and only two percent trying to harvest the resource (Table 10). These data reflect the extensive sharing and distribution network for subsistence foods among Iñupiat. Bowhead whale harvest and use data are not available for any of the proceeding study years. Pre-mine harvest data are similar to 1991 harvest data in that they indicate low participation (six percent of households) but high use (41 percent of households) of the resource.

During interviews with Noatak residents in 2008, hunters reported traveling either to Point Hope or Kivalina to participate in bowhead whale hunting (SRB&A forthcoming). Noatak uses of bowhead whales declined between 1994 and 2007. In 1994, 46 percent of surveyed households reported using bowhead whales and nine percent reported attempting to harvest bowhead whales. In 2007 only one percent of households used the resource, and no households went bowhead whale hunting (Table 12). Decreased harvests of bowhead whales by Kivalina hunters (see discussion below under "Bowhead Whale Resource Changes") may partly explain the decline in Noatak uses.

Subsistence Use Areas, Seasonal Round, and Harvest Patterns

Current and lifetime Kivalina and Noatak marine mammal use areas are depicted on Maps 46 and 47. They include use areas for bowhead and beluga whales, seals, walrus, and polar bears. Noatak use areas have changed little compared to lifetime data. Comparison of current and historic Kivalina marine mammal use area data suggests a movement farther offshore and toward Point Hope. From 1998-2007, Kivalina bowhead use areas, shown on Map 48, occurred between Rabbit Creek and Point Thompson from less than one-quarter of a mile from shore to as far as 21 miles, depending on the lead conditions.

Several residents also described joining local crews in Point Hope to hunt bowhead, which explains the use areas north of Cape Thompson. Most of the bowhead areas near Point Hope are located directly south of the community several miles into the ocean.

Kivalina residents have not harvested a bowhead in the last 10 years and thus the majority of their use areas (58 percent) were identified as unsuccessful (SRB&A forthcoming). Respondents generally reported better success while hunting bowheads at Point Hope. Nearly all of Kivalina's bowhead whaling activity occurs during April and May with residents traveling out on the ice by snowmachine to open leads where they hunt by boat. Residents camp at nearly half of their use areas from one to two weeks and an additional 21 percent from two to six nights (SRB&A forthcoming). Forty percent of bowhead use areas are not used on a yearly basis. Reasons for this include changes in lead conditions each year or residents who have traveled to Point Hope to hunt bowhead at some point in the last ten years. The highest number of overlapping bowhead use areas occur northwest of the community. In 1998, Kivalina respondents reported hunting bowhead from Ipiavik Lagoon to Cape Thompson (Map 48). During interviews in 1998, individuals described previous bowhead hunting areas south of the port that are no longer used because of noise and unstable ice conditions created by the port (SRB&A 2000:30). Braund and Burnham (1983) documented Kivalina's bowhead subsistence use areas from 1977-1982. As depicted on Map 12, the 1977-1982 bowhead use areas for Kivalina closely resemble those reported for 1998-2007 from Rabbit Creek to Cape Thompson. Although the distribution of bowhead use areas near Kivalina are nearly identical between these two studies, residents described harvesting fewer bowheads during the spring because thinning ice conditions have led to multiple open leads. Other respondents reported that port site noise and related activities (including spring preparation activities) are another cause for the diversion of bowhead migration further out from shore and decreased harvest. For further discussion of residents' explanations of changes in bowhead whales see the discussion under "Bowhead Whale Resource Changes".

Residents of Noatak have reported traveling by snowmachine to Kivalina and Point Hope to hunt bowhead whales with whaling crews in those communities during the spring (April/May) whaling season. Those respondents who participate in this activity generally reported traveling to these communities once a year or not every year, usually staying for at least one week (SRB&A forthcoming). Use areas for 1998-2007 show Noatak respondents hunting from both locations, with the highest number of overlapping use areas occurring north of Kivalina to Cape Seppings (Map 49). Residents did not report hunting bowhead whales during ADF&G household surveys for the 2007 study year (see Table 12). As discussed below ("Bowhead Whale Resource Changes"), Noatak residents indicated decreased success harvesting bowhead whales in recent years, and respondents reported being unsuccessful harvesting bowhead whales at over half of their use areas in the last 10 years. Bowhead whale use areas currently do not occur south of the port site, whereas pre-mine use areas show hunting as far south as Sealing Point (Maps 23 and 49). Residents of Noatak did not discuss any changes to bowhead whale use areas resulting from port site operations (see discussion below).

Bowhead Whale Resource Changes

The 1984 EIS addressed the potential effects of the port site on marine mammals, including bowhead whales, and predicted that marine mammals would generally avoid the area (USEPA 1984). However, the extent of effects was predicted to vary depending on each species' usual proximity to shore. As bowhead whales generally travel farther from shore, the 1984 EIS predicted that effects would be minimal except for the small number of whales traveling closer to shore.

According to the Corps in their 2005 DEIS, no major changes in migration routes have been recorded for any marine mammal species since the start of mine operations (U.S. Army Corps of Engineers 2005). The Corps (2005) concluded that decreased harvests by Kivalina hunters in recent years are not enough to determine that an impact or change has occurred, and port site operations such as loading, shipping, and barge activity do not occur until the water is open and after the spring whale hunt. Bowhead whales generally do not migrate close to the port site, traveling in leads in the spring which are usually at least three miles from shore (See Section 3.9.2), and local hunters observe that, in the presence of multiple leads in the ice, bowhead whales will travel in the lead farthest from shore (SRB&A 2000). Winter operations reportedly produce sounds detectable within a half a mile of the port and within 3.7 miles during maintenance work. In the fall, bowhead whales are even farther from shore as they migrate south. As noted in Section 3.9.2, studies have concluded that noise associated with open water port operations is detectable up to 16.5 miles from shore.

Kivalina residents in particular have noted local changes in bowhead whales. As stated above (under "Caribou Resource Changes"), small local changes in resources may have minimal effects on the health and abundance of that resource as a whole, but can have larger consequences for local hunters. Sixty-six percent of the harvesters interviewed in Kivalina and 17 percent of the harvesters interviewed in Noatak made observations about changes related to bowhead whales (Table 7). The principal bowhead resource change observations were: (1) harvest less; (2) migration changed or diverted; and (3) farther from shore (Table 30).

Table 30: Observations of Bowhead Whale Resource Changes

Observation	Number of Observations			Percent of Observations		
	Kivalina	Noatak	Total	Kivalina	Noatak	Total
Harvest less	13	1	14	30%	6%	23%
Migration changed or diverted	12	0	12	27%	0%	20%
Farther from Shore	9	3	12	20%	19%	20%
Worse success	0	4	4	0%	25%	7%
More difficult	0	3	3	0%	19%	5%
Use area changed	3	0	3	7%	0%	5%
Disease/Infection	3	0	3	7%	0%	5%
Harvest season changed	0	2	2	0%	13%	3%
Decrease in Species Number	0	2	2	0%	13%	3%
More Aggressive/Bold	2	0	2	5%	0%	3%
Take fewer trips	0	1	1	0%	6%	2%
Habitat Disturbed/Destroyed	1	0	1	2%	0%	2%
Increase in Species Number	1	0	1	2%	0%	2%
Total Observations	44	16	60	100%	100%	100%
Total Number of Bowhead Whale Change Observers	29	17				

Stephen R. Braund & Associates, 2008.

Harvest Less. As noted above, the U.S Army Corps of Engineers (2005) concluded in the 2005 DEIS that while harvests of bowhead whales by Kivalina hunters have decreased, they have not decreased enough to indicate that harvests have been impacted by the Red Dog Mine. According to the Corps, the average harvest of bowhead whales by Kivalina hunters previous to port site construction was one every four years; the average after construction was one every five years (U.S. Army Corps of Engineers 2005). During SRB&A 2008 interviews, 30 percent of Kivalina respondents reported harvesting fewer bowhead whales over the last 20 years (Table 30). A number of Noatak residents reported traveling to Kivalina to participate on whaling crews, and 50 percent of Noatak observations related to bowhead whale changes were either that they harvested less, had worse success, or had more difficulty harvesting bowhead whales. Residents indicated that circumstances surrounding unsuccessful harvests have changed. Six individuals cited less ice cover and more open leads as the reason for the decreased harvest (Table 31). Four individuals attributed the change to a migration change, and three indicated that the whales were farther from shore.

Table 31: Reasons for Change in Bowhead Whales – Harvest Less

	Number of Observations			Percent of Observations		
Causes	**Kivalina**	**Noatak**	**Total**	**Kivalina**	**Noatak**	**Total**
Less Ice Cover/More Open Leads	6	0	6	46%	0%	43%
Migration changed or diverted	4	0	4	31%	0%	29%
Farther from Shore	3	1	4	23%	100%	29%
Total Observations	13	1	14	100%	100%	100%

Stephen R. Braund & Associates, 2008.

During several subsistence and traditional knowledge studies, residents indicated that the ice has been thinner and more dangerous and that there have been more open leads in recent years (SRB&A 2000, 2005 and forthcoming). This has resulted in fewer opportunities to safely hunt bowhead whales. Several community members explained that multiple open leads cause bowhead whales to travel farther from the Kivalina coastline as they migrate north towards Point Hope and beyond. Because of these factors, Kivalina whaling crews are unable to establish trails to the leads where the bowheads are migrating and thus experience diminished chances for harvesting a whale. Residents commonly attributed these events to climate change. One hunter observed,

> We never get any [bowhead whales] for so many years because the ice conditions are bad. Because I believe that global warming is causing all the ice to be thin. Now we can't go far out because when it piles up there is no trail. I am always looking for a way to go out in the past few years. You can go out for one day, but there is no trail. That is why we didn't get belugas in winter time. No trail. It is not that they are not there, but the ice conditions, when it is thin for so many years, when it piles, it piles way high. When it is thick it just bumps up against [the shorefast ice] and when it is thin it breaks up and piles up. Just like piling up Styrofoam...Past few years now. Last time we had a whale was 1994. Since that time the ice condition was too thin. (SRB&A Kivalina Interview 2008)

All individuals who attributed less ice cover and more open leads for causing the decline in harvests cited this as a main cause of the change. Residents reported that the change started somewhere from 1988 to 1998, and they generally indicated that the change was ongoing (SRB&A forthcoming).

Migration Changed or Diverted. During SRB&A's 2008 interviews, 27 percent of Kivalina bowhead observations were related to a change or diversion of bowhead whale migration (Table 30). Noatak respondents did not report such a change. Sixty-seven percent of Kivalina observations identified noise or port site noise as the reason for the migration change or diversion, and the remaining third of observations attributed the change to the port site or related activities (Table 32).

Table 32: Reasons for Change in Bowhead – Migration Changed or Diverted

Causes	Number of Observations			Percentage of Observations		
	Kivalina	Noatak	Total	Kivalina	Noatak	Total
Port Site Noise	6		6	50%		50%
Port Site and related activities (e.g., barges)	4		4	33%		33%
Noise	2		2	17%		17%
Total Observations	12		12	100%		100%

Stephen R. Braund & Associates, 2008.

Local traditional knowledge is that bowhead whales are extremely sensitive to noise and changes in their environment, and some local hunters believe that the bowhead whales migrate farther from shore to avoid noise. Those residents citing a change in bowhead migration have attributed the change both to noise generated by the port site and to noise from onshore and offshore traffic and motors (SRB&A 2000, 2005, forthcoming). Those individuals citing noise and port site noise as a cause of the migration change all identified this as a main cause. Residents generally associated the start date of the migration change with the construction of the port site in 1989, although five individuals reported the start of the change to occur in 1995, 1996, or 1998 (SRB&A forthcoming). All Kivalina residents who reported a change in migration/distribution indicated that the change was ongoing.

Farther From Shore. Twenty percent of Kivalina bowhead observations and 19 percent of Noatak bowhead observations were that bowhead whales are farther from shore (Table 30). Residents attributed the majority of these observations (78 percent in Kivalina and 100 percent in Noatak) to less ice cover and more open leads (Table 33). As discussed above, hunters in both communities have noted that ice conditions have deteriorated in recent years causing unsafe travel and hunting circumstances. In addition, hunters observed that more open leads in the spring are resulting in bowhead whales traveling in the farthest leads and thus farther from shore. Less ice cover/more open leads was identified as the main cause of the change by six of seven Kivalina respondents and all three Noatak respondents who reported the change (SRB&A forthcoming). Residents reported the start date of the change to have occurred between 1988 and 2002, with 1998 being the most commonly cited start date. Residents reported observing the change in Kivalina and Point Hope whaling grounds, and the majority of respondents believed that the change was ongoing (SRB&A forthcoming).

Table 33: Reasons for Change in Bowhead - Farther from Shore

Cause	Number of Observations			Percent of Observations		
	Kivalina	Noatak	Total	Kivalina	Noatak	Total
Less Ice Cover/More Open Leads	7	3	10	78%	100%	83%
I Do not Know	2	0	2	22%	0%	17%
Total Observations	9	3	12	100%	100%	100%

Stephen R. Braund & Associates, 2008.

Beluga Whale

Harvest Trends

Beluga hunting is common among residents of Kivalina, Kotzebue, and Noatak; however the timing, location, and methods associated with these hunts are different. Residents of Kivalina hunt beluga during two separate seasons. Two distinct stocks of beluga migrate past Kivalina; the Beaufort Sea stock migrates north during April and May, while the Eastern Chukchi Sea stock migrates north past the community during July (See Section 3.9.2). Kivalina whaling crews first harvest the beluga in open leads during their spring migration in April and May. Later in July, community members harvest Eastern Chukchi Sea beluga stock in open water as they follow the coastline on their migration north. Kotzebue and Noatak residents hunt beluga in Kotzebue Sound and along the Chukchi Sea coast in the late spring (June) and summer in open water as the beluga migrate north.

As shown in Table 14, Kivalina beluga harvests expressed as usable pounds per capita vary widely by year: 96 (1959-60), 48 (1960-61), 53 (1964-65), 107 (1965-66), 53 (1971-72), 159 (1982-83), 166 (1983-84), 29 (1992), and 51 (2007). Burch (1985:54) explains that the increase in beluga harvests in 1982-83 and 1983-84 compared to earlier study years was in large part due to the addition of a second beluga hunting season in conjunction with the resumption of spring bowhead whale hunting after 1966 and the corresponding greater number of Beaufort Sea beluga harvested during the spring migration. During those two years, 50 of the 58 beluga taken were harvested during the spring migration. Prior to 1966, residents harvested beluga primarily in July (Burch 1985:53). In 1971-72, however, the harvest of 53 pounds per capita was similar to that of the two 1960 observation years, indicating the importance of interannual variability in hunting conditions.

Of the 22 belugas harvested by Kivalina residents in 2007, 18 were harvested during the summer (See Table 34). Ten beluga were harvested in 1992, all during the spring (Table 34). Summer beluga harvests during the 1960s and in 1982-83 and 1983-84 ranged from six beluga in 1964-65 to 14 in 1959-60. Compared to the 2007 summer catch these numbers show little change. However, many Kivalina residents explained that the 2007 summer harvest of beluga was unusually high compared to recent years, and that prior to 2007, residents had experienced difficulty harvesting belugas during the summer. They also explained that the 2007 beluga that were harvested in the summer came from the north, and respondents continued to maintain that the port site was an ongoing cause for the displacement of beluga from Kivalina. As shown in Table 34 and in Figure 1, zero summer belugas were harvested during the four years between 2003 and 2006. Aside from the 18 summer belugas harvested in 2007 and a harvest of three summer belugas in 2002, Kivalina residents have not harvested more than one beluga during any summer since 1982-83 (Table 34).

Table 34: Kivalina Beluga Harvest Amounts

Subsistence Year	Spring (Beaufort Sea) Stock	Mixed Stock	Summer (Eastern Chukchi) Stock
1955			6*
1956			6*
1958			16*
1959			14*
1960			7*
1964-65			6*
1965-66	7		5
1971-72		10**	
1982-83	23		4
1983-84	27		1
1987	4		0
1988	5		1
1989	0		0
1990	0		1
1991	0		1
1992	10		0
1993	3		0
1994	3		0

Subsistence Year	Spring (Beaufort Sea) Stock	Mixed Stock	Summer (Eastern Chukchi) Stock
1995	3		0
1996	7		0
1997	0		1
1998	0		0
1999	1		0
2000	43		1
2001	0		0
2002	0		3
2003	0		0
2004	1		0
2005	2		0
2006	0		0
2007	4		18

* Kivalina residents harvested only summer stock beluga whales until 1966

** The majority of these whales were harvested from the spring stock

Sources: ABWC (2008); Burch 1985; Frost and Suydam (In prep); Patterson 1974; Saario and Kessel 1966

Stephen R. Braund & Associates, 2008.

Figure 1: Kivalina Beluga Harvests by Stock

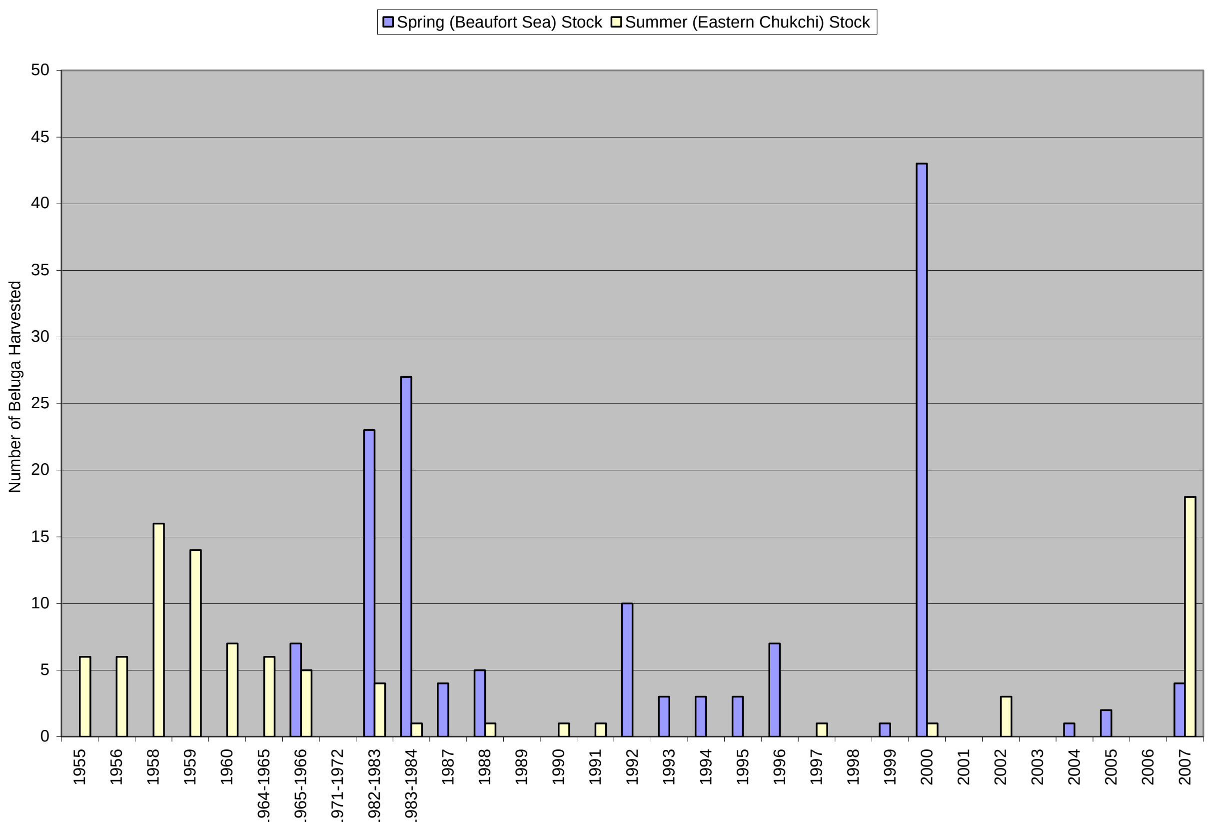


Figure 1 shows Kivalina spring and summer beluga harvests since 1955. Data are not available for every year. This figure suggests that residents began focusing on the spring beluga hunt after its resumption in 1966. However, an overall decline in spring beluga harvests beginning in 1987 did not result in residents harvesting more during the summer, despite reported efforts to do so. Thus, summer beluga harvests have declined and remained low regardless of success during the spring hunt. As indicated by the harvest of 18 belugas in the summer of 2007, residents will harvest substantial numbers of beluga during the summer months when they are available, and the decline in harvests is not due to a lessened desire for this resource. Further explanation of residents' observations regarding the displacement of beluga and other changes are discussed below ("Beluga Resource Changes").

Current beluga harvest data for Kotzebue indicate that beluga harvests have remained relatively the same since the first subsistence baseline study in 1991 when residents harvested 11 belugas, contributing to .5 percent of the community's total harvest that year (Table 10). Studies conducted in 2002, 2003, and 2004 show beluga accounted for between .8 and 1.1 percent of the total harvest. Compared to pre-mine beluga harvest data for Kotzebue (Table 16), harvests of beluga have declined from eight pounds per capita in 1986 to three pounds per capita in 1991. Residents of Kotzebue and Noatak both hunt beluga in Kotzebue Sound. Changes in beluga availability for Noatak residents (who generally hunt the resource from Sheshalik) are discussed below ("Beluga Resource Changes").

Noatak harvests and uses of beluga in 2007 were high compared to previous recent harvest data from 1994 (Table 12). It was an unusual year, according to residents interviewed in 2008. Whereas beluga harvests have declined in Kotzebue Sound due to changes in beluga distribution and availability (see discussion under "Beluga Resource Changes"), residents of Kotzebue and Noatak were surprised when a large pod of beluga whales appeared near Kotzebue in the spring of 2007. Residents of Noatak who were staying at Sheshalik and residents of Kotzebue were able to harvest belugas from this pod of whales. Four percent of Noatak households harvested six whales in 2007, and beluga products were distributed among 81 percent of households (Table 12). In 1994, three belugas were harvested by six percent of Noatak households and only 18 percent of households used the resource that year.

Table 35 shows combined beluga harvest data for Kotzebue and Noatak residents from 1987-2007. Only harvests from the Chukchi Sea (summer stock) are shown. Over time, harvests of beluga by residents of Kotzebue and Noatak have varied widely. However, the data indicate a decline in beluga harvests over the last 10 years. Noatak beluga harvest data from the 1960s and 1970s show Noatak residents harvesting substantially more belugas during those times (Table 5). From 1960-61, Noatak residents harvested 52 belugas, and in 1971-72, residents harvested 10 belugas. Figure 2 indicates that, despite two peak harvest years in 1996 and 2007, harvests of beluga by residents of Kotzebue and Noatak have been somewhat lower since 1990. Noatak residents hunt belugas both in Kotzebue Sound and with Kivalina residents during the spring and summer hunts. Explanations of changes in beluga migration, distribution, and availability in both the Kotzebue Sound and Kivalina areas are discussed below ("Beluga Resource Changes").

Table 35: Kotzebue and Noatak Beluga Harvests, 1987-2007, Chukchi Sea Stock

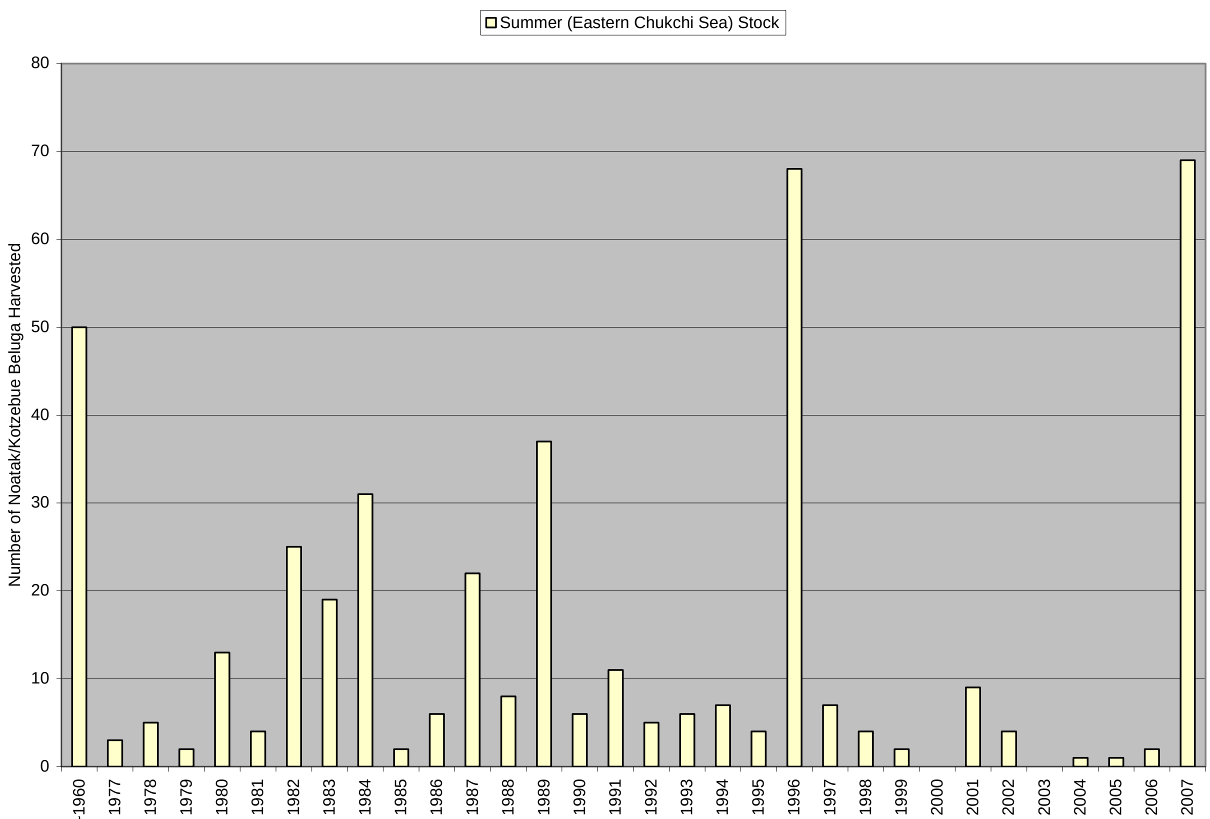
Year	# of Beluga Harvested	Year	# of Beluga Harvested
~1960	50	1992	5
1977	3	1993	6
1978	5	1994	7
1979	2	1995	4
1980	13	1996	68
1981	4	1997	7
1982	25	1998	4

Year	# of Beluga Harvested	Year	# of Beluga Harvested
1983	19	1999	2
1984	31	2000	0
1985	2	2001	9
1986	6	2002	4
1987	22	2003	0
1988	8	2004	1
1989	37	2005	1
1990	6	2006	2
1991	11	2007	69

Sources: ABWC (2008); Frost and Suydam (In prep)

Stephen R. Braund & Associates, 2008.

Figure 2: Kotzebue and Noatak Beluga Harvests



Subsistence Use Areas, Seasonal Round, and Harvest Patterns

Kivalina residents reported the majority of their current (1998-2007) beluga subsistence use areas in the Chukchi Sea from Kotlik Lagoon to Cape Thompson, and additional areas near Point Hope and Point Lay (Map 50). The highest number of overlapping use areas occur from the port site area north towards the Singoalik River and several miles offshore. During 2008 ADF&G household surveys, residents reported 2007 beluga subsistence use areas from Rabbit Creek to Chariot from the shoreline to approximately five miles out into the Chukchi Sea (Map 50). Summer beluga use areas were reported by Kivalina residents in 1998 along the coast from Kotlik Lagoon to Cape Thompson (Map 50). Kivalina beluga harvesters access their spring use areas by snowmachine and boat; boats are their primary mode of transportation during the summer migration. Residents reported staying at 32 percent of beluga use areas from one to two weeks and took same day trips to 46 percent of use areas (SRB&A forthcoming). Most of these day trips occur during the summer hunt while trips lasting one to two weeks occur while residents are at bowhead whaling camps during April and May. Residents reported that they do not use 42 percent of use areas on a yearly basis, and similar to bowhead whale hunting, some areas are not accessed each year due to changing ice conditions and because people sometimes travel to Point Hope to hunt belugas. Residents only described 39 percent of beluga use areas as always or usually successful, compared to three-quarters of use areas for all resources (SRB&A forthcoming). Over one-quarter of beluga use areas were characterized as seldom successful compared to only five percent of all resources use areas.

Pre-mine beluga subsistence use areas were documented along the coast from Cape Thompson all the way to Sheshalik (Maps 6 and 50). Braund & Burnham also documented pre-mine sea mammal use areas (including beluga) from Kotlik Lagoon to Cape Seppings for the time of 1977-1982 (Map 11). The existence of earlier beluga use areas near Sheshalik may be attributable to Kivalina residents who traveled south to harvest beluga at Sheshalik with relatives from Noatak and Kotzebue (see Map 11). As discussed above, Kivalina residents have reported that prior to the mine, summer beluga regularly migrated along the coast directly by Kivalina, but now are deflected out to sea or back south because of noise and activity related to the port site. According to many Kivalina residents, compared to the ease with which the beluga were harvested near the community prior to the port site development, the option of hunting beluga south of the port during the summer would require a substantial investment of time and money that many residents indicated they do not have (SRB&A 2000:35, 2005:33). For further discussion of beluga changes see "Beluga Resource Changes" below.

While some Noatak hunters travel to Kivalina and Point Hope to hunt beluga with whaling crews in those communities, the majority of beluga hunting by Noatak residents takes place while they are staying in seasonal camps at Sheshalik. Residents usually reported taking one yearly trip to Sheshalik and staying there for at least one week, harvesting various subsistence resources, including beluga and other marine mammals, during their stay (SRB&A forthcoming). The duration of residents' trips to Sheshalik varies. Those individuals with employment or other responsibilities in Noatak or elsewhere reported taking multiple trips of shorter duration, while others travel to Sheshalik in May or June and stay there until the end of the summer, traveling back to Noatak in time for the fall caribou hunting season. The majority of beluga hunting at Sheshalik occurs in June and July. Spring (April and May) hunting of beluga also occurs when local residents travel to Kivalina or Point Hope. The majority of residents reported taking fewer yearly trips to Sheshalik but staying from one week to more than two weeks. Beluga hunting, as well as hunting for bearded seal, ringed seal, and walrus occurs by boat in the waters of Kotzebue Sound and beyond. Map 51 shows last 10 year (1998-2007) Noatak beluga use areas throughout much of Kotzebue Sound and along the coast from Cape Krusenstern (Sealing Point) to Cape Thompson and at Point Hope. The highest number of overlapping beluga use areas reported by Noatak respondents occurs in the waters between Cape Krusenstern, Sheshalik, and Kotzebue. In 2007 residents reported hunting in a similar area, traveling along the coast south of Kotzebue and north past the port site (Map 51). Hunting areas were also reported substantial distances offshore from Cape Krusenstern. Pre-mine use area data are available in the form of lifetime beluga hunting areas (Maps 24 and 51), and partial "sea mammal" (seal, bearded seal, walrus, and beluga) use areas (Map 28); a comparison of pre-mine and current use area data indicate that Noatak beluga hunting areas have expanded over time. As discussed below under "Beluga Resource Changes," residents of Noatak have noted that beluga are less available than in the past, and the expansion of their search area for this resource is perhaps a reflection of that change. During interviews with Noatak residents, beluga hunters described being unsuccessful harvesting beluga in the last 10 years at over 40 percent of their use areas, and another third of use areas were described as "unpredictable" or "seldom" successful. Only 27 percent of use areas were always or usually successful, compared to the 80 percent of all Noatak use areas described as such (SRB&A forthcoming).

Beluga Resource Changes

Section 3.9.2 describes baseline conditions associated with beluga whales, including direct and indirect effects on beluga whales resulting from Red Dog Mine operations. Effects on beluga whales related to port site operations include displacement and disturbance due to associated noise (Section 3.9.2). In their 2005 DEIS, the Corps reported that no overall changes to marine mammal species have been observed (U.S. Army Corps of Engineers 2005). Any effects on beluga whales are reported to be localized near the port site (see Section 3.9.2). As discussed above, the 1984 EIS addressed the potential effects of noise and activities associated with the port site on marine mammals and predicted that marine mammals would avoid the area (USEPA 1984). The extent of this effect was largely dependent on the species' proximity to shore, and the 1984 EIS did not directly address beluga whales.

It is common knowledge among local hunters that beluga whales are sensitive to noise and, as such, avoid sources of noise. Observations of beluga whales avoiding outboard motors have been reported as early as the 1950s and 1960s, and residents observe that belugas associate outboard motor noise with danger (U.S. Army Corps of Engineers 2005). As reported by the Corps (2005), several studies show that while belugas may become habituated to certain noises and no longer react to them, noises that have repeated negative consequences for beluga may cause beluga to respond more defensively through avoidance. Furthermore, changes in ice conditions are known to affect beluga whales (Section 3.9.2).

Subsistence users in Kivalina have reported changes to their subsistence uses of beluga due to local changes in beluga migratory patterns and abundance (U.S. Army Corps of Engineers 2005, SRB&A 2000 and 2005). Although changes to migratory patterns are reportedly localized and overall changes in migration patterns have not occurred (Section 3.9.2), the changes have had noticeable effects on residents' ability to hunt and harvest this traditional and important subsistence resource. During SRB&A's 2008 interviews, 34 Kivalina respondents (77 percent of those interviewed) and 21 Noatak respondents (50 percent of those interviewed) provided observations about changes in beluga (Table 7). The principal beluga resource change observations were: (1) migration changed or diverted; and, (2) harvest less (Table 36).

Table 36: Observations of Beluga Resource Changes

Observation	Number of Observations			Percent of Observations		
	Kivalina	Noatak	Total	Kivalina	Noatak	Total
Migration changed or diverted	28	14	42	42%	40%	42%
Harvest less	16	2	18	24%	6%	18%
Decrease in Species Number	1	6	7	2%	17%	7%
Closer to Shore	6	0	6	9%	0%	6%
Worse success	0	4	4	0%	11%	4%
Abnormal Migratory Event	4	0	4	6%	0%	4%
Harvest more	3	0	3	5%	0%	3%
Use area changed	0	3	3	0%	9%	3%
Increase in Species Number	3	0	3	5%	0%	3%
Move to Different Areas	0	3	3	0%	9%	3%
Farther from Shore	2	1	3	3%	3%	3%
Take fewer trips	1	1	2	2%	3%	2%
Habitat Disturbed/Destroyed	1	0	1	2%	0%	1%
Skitish Behavior in Species	0	1	1	0%	3%	1%
Change in Resource Behavior	1	0	1	2%	0%	1%
Total Observations	66	35	101	100%	100%	100%
Total Number of Beluga Whale Change Observers	34	21				

Stephen R. Braund & Associates, 2008.

Migration Changed or Diverted. Forty-two percent of Kivalina beluga observations and 40 percent of Noatak beluga observations cited beluga migration changes (Table 36). Ninety-six percent of Kivalina beluga observations attributed the change to port site activities or port site noise (Table 37). Seven of the Noatak observations (55 percent) cited disturbance from traffic (boat, plane, or other) or noise (Table 37). Kivalina residents generally referred to beluga migration changes occurring near the port site, whereas Noatak residents discussed changes to beluga migration occurring in Kotzebue Sound, where Noatak residents have traditionally hunted the resource.

Table 37: Reasons for Change in Beluga - Migration/Diversion

Causes	Number of Observations			Percent of Observations		
	Kivalina	Noatak	Total	Kivalina	Noatak	Total
Port Site and related activities (e.g., barges)	16	0	16	57%	0%	39%
Port Site Noise	11	0	11	39%	0%	27%
Boat Traffic Disturbance	1	4	5	4%	31%	12%
Not using traditional hunting methods	0	2	2	0%	15%	5%
Predators	0	2	2	0%	15%	5%
I Do not Know	0	2	2	0%	15%	5%
Traffic Disturbance	0	1	1	0%	8%	2%
Airplane Traffic Disturbance	0	1	1	0%	8%	2%
Noise	0	1	1	0%	8%	2%
Total Observations	28	13	41	100%	100%	100%

Stephen R. Braund & Associates, 2008.

Kivalina residents have reported changes in beluga migration patterns near the port and have attributed this change to both noise from port site activities and other sources (e.g., boat and ATV traffic) (SRB&A 2000, 2005). According to hunters, belugas no longer migrate directly past Kivalina in the summer as they once did, but instead turn and migrate away from shore once they reach the area near the port site. Kivalina residents traditionally waited until the belugas reached the Kivalina area and hunted them as they passed by close to shore. However, residents indicate that they now must either go south of the port site or farther north to hunt belugas (SRB&A 2000). One individual reported that the change began after the port expansion occurred:

> [The change] is basically through the port site with the expansion. It drives them a lot farther out. It is usually how they work, with the barges and stuff [affecting the beluga]. It changed their migration. I was pretty young when they did that expansion. They are further out. They are both the main cause [barges and port site]. It is still going on. When they started building that port site [is when it started]. They started going more out, from there they are to watch them go through that channel and pass by before that expansion. After that expansion we haven't seen them. We used to see them on the other side of that channel, real close. They go along the beach and head out.

In Kivalina, 31 of 34 observations of why beluga migration/distribution changed cited port site noise or activities as main causes of the change (SRB&A forthcoming). Twenty-three respondents reported 1989 as the start date for this change, and those individuals who provided a location for the change indicated that the change occurred at the port site. Residents believe the change is ongoing (SRB&A forthcoming).

Noatak residents' observations regarding changes in beluga migration are different from those of Kivalina residents. Hunters in Noatak have traditionally harvested beluga while staying in seasonal camps or cabins located at Sheshalik. Beluga hunting usually occurs in Kotzebue Sound or along the coast past Cape Krusenstern ("Sealing Point") toward Kivalina, often while residents target bearded seal (*ugruk*). Thus, while Noatak residents hunt beluga during their summer migration before they reach the port site where Kivalina hunters report changes, they have also observed local changes in beluga migratory patterns in Kotzebue Sound. The change observed is generally that beluga no longer migrate into Kotzebue Sound as they once did, rather bypassing the sound altogether and continuing north toward Kivalina. Residents cited disturbance from boats, airplanes, and noise (related to increasing activity in Kotzebue Sound), as well as a declining use of traditional hunting methods (Table 37). As one hunter described,

> Last 10 years there was hardly any beluga in [Kotzebue Sound]. The boats would rush, so they would turn around and go back out…. They don't hunt the traditional way anymore. When there was a pod, they'd start circling on the outside here, they'd come through the outside and drive [the beluga] into the shallows. That's the traditional way [to hunt]. But now, in the open water, they want to shoot, want to get them right now [instead of waiting]. (SRB&A Noatak Interview January 2008)

Four residents cited boat traffic disturbance as a main cause of the change (SRB&A forthcoming). Hunters reported varying start dates for the change, with the earliest start date cited as 1970 and the latest, 2007. The 2007 start dates reflect a more recent change reported by Noatak residents; a pod of beluga whales migrated into Kotzebue Sound for the first time in many years, and local residents were able to harvest a substantial number of belugas during this event (SRB&A forthcoming).

Harvest Less. Residents of Kivalina reported harvesting less beluga over the last 20 years. Twenty-four percent of Kivalina observations of beluga change cited harvesting less beluga (Table 36). Eighty-eight percent of these observations attributed the declining harvests to a change in beluga migration (see discussion above, "Migration changed or Diverted") (Table 38). One Kivalina hunter observed,

> We are not getting the beluga we used to. We are not getting half of the beluga during the summer time. They started telling us the one who works in the towers started telling us they would see beluga coming up along the shore and as soon as they hit the port they head straight out to ocean. That is why we don't see beluga in the summertime. (SRB&A Kivalina Interview February 2008)

Table 38: Reasons for Change in Beluga – Harvest Less

	Number of Observations			Percent of Observations		
Cause	Kivalina	Noatak	Total	Kivalina	Noatak	Total
Migration changed or diverted	14	1	15	88%	50%	83%
Farther from Shore	1	1	2	6%	50%	11%
Less Ice Cover/More Open Leads	1	0	1	6%	0%	6%
Total Observations	16	2	18	100%	100%	100%

Stephen R. Braund & Associates, 2008.

Although it can be inferred from beluga harvest data and local observations that residents of Noatak have also experienced a decline in harvests of beluga, this change either started more than 20 years ago or residents did not believe that the change had occurred in recent memory and did not report it. Only two Noatak respondents reported a decline in their harvests of beluga (Table 36). These individuals attributed the change to a change in or diversion of beluga migration, and to belugas being farther from shore.

In Kivalina all 14 observations citing migration changed or diverted as a cause for harvesting less beluga cited this as a main cause for the change. Fourteen individuals reported the start date of the change to be 1989 or 1990 (SRB&A forthcoming). The majority of individuals who reported harvesting less beluga indicated that this change was ongoing.

Although harvests of beluga have declined, 2007 was a relatively high harvest year in Kivalina. While the belugas following the coast toward Kivalina in the summer migrated away from the coast upon reaching the port site, residents explained that a group of belugas arrived from the north and hunters were able to harvest 18 animals from this group. Residents provided two main explanations for this event. Some believed that orca (killer) whales had chased the belugas toward shore, while others thought that the belugas were a different stock that had arrived from Siberia.

Noatak residents experienced a similarly abnormal harvest year for belugas. As described above ("Migration Changed or Diverted), in 2007 a large number beluga whales migrated into Kotzebue Sound for the first time in a number of years, providing an opportunity for Noatak and Kotzebue hunters to harvest the resource.

Bearded Seal

Harvest Trends

Bearded seal (*ugruk*) regularly comprise a substantial portion of Kivalina's subsistence harvests. In 2007 bearded seal was the number one species harvested, and in 1992 it ranked second behind Dolly Varden char (Table 9). Kivalina households' estimated 2007 harvest of bearded seal accounted for 37.7 percent of the total harvest (higher than in any other study year) and contributed 224 pounds per capita toward their total per capita harvest of 594 pounds (Table 8). However, harvests of other major subsistence resources, such as caribou, were lower than in previous years. Current bearded seal harvests, at 224 and 157 pounds per person in 2007 and 1992, fall within the range of bearded seal per capita harvests (74 to 339 pounds) reported for previous study years beginning in 1959-60 (Table 14). During Kivalina household surveys in 2008, 21 percent of households reported that they did not harvest enough marine mammals; nearly one-third of their responses were related to bearded seal; 62 percent of Kivalina households reported that they harvested enough marine mammals in 2007.

Current harvest data indicate that bearded seal is one of the three most harvested resources, in terms of the percent of total harvest, by Kotzebue residents (Table 11). During four baseline study years (1991, 2002, 2003, and 2004) bearded seal has accounted for between 16.6 and 23.9 percent of the total subsistence harvests (Table 17). Bearded seal harvests have not changed considerably from earlier harvest data; in 1986, where bearded seal accounted for 19 percent of the community's total harvest (Table 3). Mean household pounds of bearded seal in 1986, as well as pounds per capita, were considerably lower than in more recent study years. Residents harvested 75 pounds of bearded seal per capita in 1986 compared to 126 pounds per capita in 1991.

Bearded seals are a key subsistence resource for residents of Noatak and are generally harvested from residents' seasonal camps at Sheshalik. Harvests of bearded seal accounted for 13 percent of the total subsistence harvest in 2007, and for 8.1 percent of harvests in 1994 (Table 12). A similar percentage of households harvested bearded seal during both years, although uses of bearded seal were somewhat lower in 1994. Reported harvests of bearded seal for 1970-1971 are substantially lower than in current study years; however, the 1960-61 data show Noatak residents harvesting 195 pounds of bearded seals per capita, higher than in 1994 (37 pounds) and 2007 (47 pounds) (Table 18). For the 2007 study year, the majority of residents (53 percent) reported that they harvested enough marine mammals; 12 percent reported that they did not harvest enough, and over half of those responses pertained to bearded seal. Foote and Williamson (1966) reported that edible products derived from whales and seals harvested at Sheshalik provided food for both humans and dogs, and the more recent decline in harvests may in part reflect the lower number of dogs in the community.

Subsistence Use Areas, Seasonal Round, and Harvest Patterns

Kivalina 1998-2007 bearded seal use areas are located from Cape Krusenstern to Cape Thompson with additional use areas at Point Hope and south of Sheshalik (Map 52). The highest frequency of overlapping use areas occurs along the coast up to five miles from shore between Rabbit Creek and Cape Seppings.

Respondents often referred to the waters between Kivalina and the port site as one of the main areas to find bearded seals due to the good feeding grounds located in that area. Residents travel by boat and conduct the majority of bearded seal hunting activities in this area each year, primarily in June, as the ice pack begins to break up and the seals migrate past Kivalina. Harvesters reported relatively high success at bearded seal use areas, identifying 93 percent of use areas as either always or usually successful (SRB&A forthcoming). Community members' high level of effort in their harvests of bearded seal reflects in the high number of trips they take over the relatively short harvest season to harvest this resource. Respondents reported traveling six or more times each year to 73 percent of their bearded seal use areas, compared to 34 percent of all resources use areas (SRB&A forthcoming). Nearly all trips to bearded seal use areas are same day trips. As depicted on Map 52, Kivalina households reported their 2007 bearded seal use areas in the same general area as their 1998-2007 bearded seal areas of highest overlap. Pre-mine seal (including bearded seal) and sea mammal (including bearded seal) subsistence use areas appear on Maps 7, 11, and 52. These use areas occur from Sheshalik to Cape Thompson and are similar to those current use areas shown for beluga (see Map 52).

As discussed above ("Beluga Whale"), the majority of Noatak residents' marine mammal hunting occurs while staying at the seasonal camp of Sheshalik. Residents hunt bearded seal primarily in June, with some hunting activities also occurring in May and into July. A small number of residents reported hunting for bearded seal in the winter and early spring, or in the fall, at different locations. Otherwise, hunting of bearded seal occurs by boat in open water or on floating ice. As with beluga, residents usually take once or twice yearly trips to Sheshalik, staying anywhere from one night to more than two weeks. Residents reported staying at least one week while using more than half of their bearded seal hunting areas (SRB&A forthcoming). When identifying last 10 year (1998-2007) use areas for bearded seal (Map 53), Noatak respondents generally reported hunting bearded seal in an area similar to their beluga hunting area, but with a high number of overlapping use areas throughout Kotzebue Sound and along the coast going north past Cape Krusenstern to the port site. During ADF&G's harvest surveys for the 2007 study year, residents of Noatak reported hunting in the upper portion of Kotzebue Sound and along the coast past Kivalina. Pre-mine seal hunting use areas are shown on Maps 25, 28 (partial "sea mammal" areas only), and 53 (lifetime use areas) and are similar to the current (1998-2007) use areas reported by Noatak residents, indicating little change in bearded seal hunting areas since mine operations began (Map 53). Current use areas extend farther past Kivalina to Cape Thompson and do not appear in Eschscholtz Bay. Success hunting bearded seal is relatively high, with residents describing nearly three-quarters of their hunting areas as always or usually successful; however, residents reported that over the last 10 years, 15 percent of areas had been unsuccessful, and another 12 percent of areas were described as unpredictable (SRB&A forthcoming). As discussed below ("Bearded Seal Resource Changes") residents have reported altered bearded seal distribution and hunting success in recent years due to changing ice conditions.

Partial bearded seal use areas reported by Kotzebue residents in the vicinity of Kivalina for the 1995-2004 time period indicate that Kotzebue residents hunt bearded seal north of Cape Krusenstern (Sealing Point) along the coast and offshore at considerable distances (SRB&A 2005). During interviews with Kotzebue residents in 2004, hunters indicated that the Rabbit Creek area is an important traditional and contemporary hunting ground for bearded seal (SRB&A 2005).

Bearded Seal Resource Changes

Baseline conditions of bearded seal are provided in Section 3.9.2, and the Corps 2005 DEIS addressed changes to marine mammals, including bearded seal, associated with the Red Dog Mine. No changes to bearded seals (*ugruk*) resulting from mine-related operations were reported in the 2005 DEIS (U.S. Army Corps of Engineers 2005). Bearded seals follow the ice pack north past Kivalina in the spring, before sea-based port site operations have begun, and south past Kivalina in the late fall, after sea-based port site operations have ceased (U.S. Army Corps of Engineers 2005). Bearded seals may occur in the port site area in small numbers year-round, but most follow the ice pack to other destinations. Studies have concluded that bearded seals are equally abundant offshore from the port site and at similar distances than elsewhere, and subsistence harvests of bearded seal have not changed due to port site activity (U.S. Army Corps of Engineers 2005). The 1984 EIS predicted local changes in marine mammal distribution due to avoidance of port site noises (see discussions under “Beluga Whale” and “Bowhead Whale”).

Local residents’ observations about changes in bearded seal are generally related to changes in ice conditions. During interviews with Kivalina residents in 1998, residents expressed that bearded seal feed in an area near the port site where the water is usually open during the spring migration and few people believed the port site had affected bearded seal (SRB&A 2000). Residents from Kivalina, Noatak, and Kotzebue all discussed changes in bearded seal distribution and availability related to changing ice conditions during interviews in 2004 and 2005 (SRB&A 2005). During SRB&A 2008 interviews, forty-five percent of Kivalina respondents and 26 percent of Noatak respondents made observations about changes in bearded seal over the last 20 years (Table 7). The principal resource change observation was that bearded seal are farther from shore (Table 39). Other changes identified by residents were increased difficulty (hunting), increase in species number, decrease in resource size, and worse success (Table 39).

Table 39: Observations of Bearded Seal Resource Changes

Observation	Number of Observations			Percent of Observations		
	Kivalina	**Noatak**	**Total**	**Kivalina**	**Noatak**	**Total**
Farther from Shore	4	6	10	14%	23%	19%
More difficult	3	3	6	11%	12%	11%
Increase in Species Number	5	0	5	18%	0%	9%
Decrease in Resource Size	1	4	5	4%	15%	9%
Worse success	0	4	4	0%	15%	7%
Abnormal Migratory Event	4	0	4	14%	0%	7%
Harvest more	3	0	3	11%	0%	6%
Use area changed	0	3	3	0%	12%	6%
Increase in Species Number	3	0	3	11%	0%	6%
Move to Different Areas	0	3	3	0%	12%	6%
Farther from Shore	2	1	3	7%	4%	6%
Take fewer trips	1	1	2	4%	4%	4%
Habitat Disturbed/Destroyed	1	0	1	4%	0%	2%
Skitish Behavior in Species	0	1	1	0%	4%	2%
Change in Resource Behavior	1	0	1	4%	0%	2%
Total Observations	28	26	54	100%	100%	100%
Total Number of Bearded Seal Change Observers	20	11				

Stephen R. Braund & Associates, 2008.

Farther from Shore. Seventy-five percent of the Kivalina observations and 100 percent of the Noatak observations cited less ice cover and more open leads as the reason bearded seal (*ugruk)* are farther from shore (Table 40). Because bearded seal follow the ice pack during their migration, yearly ice conditions determine residents’ hunting success. Respondents indicated that the ice pack has been farther from shore and thinner in recent years. As a result, bearded seal are less accessible to local hunters. Hunting of bearded seal is more dangerous because the ice is too thin to walk on safely. In the past, subsistence users shot and harvested seals on the ice; some hunters reported that they harvest more bearded seal in open water due to the changes. Respondents also noted that because the ice goes out faster, residents have less time to hunt them. One individual described the changing ice conditions and bearded seal distribution as follows:

> Because of the ice, they [*ugruk*] are way [out]. There’s the big ice, it melts, and it’s not good to walk on. We walk on the ice, and we shoot them on the ice. Mostly we’ve been getting them that

way [in the water] now. They've been going out earlier now, with the ice. It used to be cooler weather down there, now it's getting hot. They like the good ice, the white ice, and now it's getting further out, and closer to camp it's thinner. (SRB&A Noatak Interview January 2008)

Table 40: Reasons for Change in Bearded Seal – Farther from Shore

Cause	Number of Observations			Percentage of Observations		
	Kivalina	Noatak	Total	Kivalina	Noatak	Total
Less Ice Cover/More Open Leads	3	6	9	75%	100%	90%
Habitat Disturbed/Destroyed	1	0	1	25%	0%	10%
Total Observations	4	6	10	100%	100%	100%

Stephen R. Braund & Associates, 2008.

Other Seal

Harvest Trends

Harvests of Other Seal (consisting primarily of ringed and spotted seals) constituted 2.3 percent of the total Kivalina harvest in 2007 (Table 8). Other Seal per capita harvest levels equaled 14 pounds. As shown in Table 9, ringed seal is the number one species of Other Seal harvested by Kivalina households, with much fewer households reporting harvests of spotted seal. Since the earliest subsistence harvest data were collected in the early 1960s, harvests of Other Seal have decreased dramatically from a high of 28.3 percent of the total harvest in 1964-65, to 6.3 percent in 1982-83, to 2.3 percent in 2007 (Table 15). In 1985, Burch (1985:49) postulated that the decreased seal harvests (primarily ringed seal) may be due to an ever decreasing reliance on seal as an important source of dog food and heating fuel. During SRB&A 2008 interviews, Kivalina respondents did not report any changes in Other Seal that might explain the decrease in harvest amount. It is likely that Burch's assumptions in 1985 are correct and that the change in harvest levels is a result of a long term trend in lower demand, and that current harvest levels meet Kivalina residents' needs.

Kotzebue harvests of Other Seal are relatively high and both spotted and ringed seal were among the top six harvested species during all recent (1991, 2002, 2003, 2004) study years (Table 11). Residents harvested between 106 and 215 mean household pounds of Other Seal during the four recent studies (Table 10). Compared to pre-mine harvest data, harvests of Other Seal have not changed substantially (with the exception of Patterson's data that were not based on primary data collection) (Tables 16 and 17). Kotzebue residents harvested 20 pounds of Other Seal per capita in 1986, and 25 pounds of Other Seal per capita in 1991. Other Seal contributed 4.9 percent to the total Kotzebue harvest in 1986, although substantially fewer harvests were recorded for the 1971-72 harvest year (Table 17).

Noatak residents harvest comparatively fewer ringed or spotted seal and during SRB&A interviews in 2008, respondents indicated that ringed seal were generally harvested as a target of opportunity while hunting for the more preferred bearded seal (SRB&A forthcoming). No harvests of ringed seal were reported in 1994, and in 2007 residents reported harvesting a total of 11 Other Seal providing .5 percent of the year's total harvest, or two pounds per capita (Table 12). The 1971-72 data are similar, with an estimated harvest of 10 Other Seal (Table 5). However, in 1960-61 residents harvested 122 Other Seal. As with decreased harvests the resource in Kivalina, this may reflect the declining need of this resource to feed dog teams.

Subsistence Use Areas, Seasonal Round, and Harvest Patterns

Map 54 depicts Kivalina 1998-2007 Other Seal (primarily ringed seal) subsistence use areas from Cape Krusenstern to Cape Thompson. The use areas extend as far as 30 miles offshore. The highest numbers of Other Seal use areas were identified approximately 5 miles or less offshore between the northern end of Kivalina Lagoon south to Rabbit Creek. Kivalina harvesters often harvest other seal by boat during their pursuit of bearded seal and/or walrus from May through July, although a few residents also hunt them closer to Kivalina by snowmachine or foot throughout the winter months. Residents take day trips to all of their Other Seal use areas, of which over three-quarters are used four or more times a year (SRB&A forthcoming). Map 54 also shows Kivalina households 2007 ringed seal use areas reported during ADF&G household surveys. They identified ringed seal use areas located north of the port site along the coast towards Chariot. Kivalina subsistence use areas for seal and sea mammals documented prior to the development of the Red Dog Mine appear on Maps 7 and 11. Map 54 also includes lifetime seal use areas. These maps include use areas for ringed seals and other seals. For a description of these areas see the marine mammal "Subsistence Use Areas, Seasonal Round, and Harvest Pattern" discussions above.

Noatak residents generally reported hunting Other Seal (primarily ringed seal and the occasional spotted seal) while targeting bearded seal by boat during the months of May, June, and July; hence, last 10 year (1998-2007) use areas for bearded seal and Other Seal are nearly identical. As discussed above, bearded seal hunting primarily occurs while residents stay in seasonal camps at Sheshalik. Hunting for other seal was reported to occur in Kotzebue Sound and along the coast past Cape Krusenstern (Sealing Point) to Chariot (Map 55). The highest numbers of use areas occur in Kotzebue Sound between Sheshalik and Cape Blossom. A few residents also reported hunting Other Seal during the winter months on the Chukchi Sea coast or in the Noatak River when seals are present. Residents reported taking both day trips and overnight trips to hunt Other Seal. Overnight trips were likely reported for those use areas accessed while staying at Sheshalik (SRB&A forthcoming). ADF&G harvest data for 2007 depict Noatak ringed seal use areas for that year extending from south of Cape Blossom to north of Kivalina, similar to last 10 year use areas (Map 55) but not into the southern portion of Kotzebue Sound. Pre-mine use area data for seal and sea mammals (Maps 25 and 28) are very similar to last 10 year data for bearded seal (Map 53) and Other Seal (Map 55) and comparison of these maps indicate little change, other than a slight expansion along the coast beyond Kivalina, in seal hunting areas over time. Harvest success according to Noatak residents is high, with all Other Seal use areas characterized as always successful (SRB&A forthcoming).

Other Seal Resource Changes

As discussed in Section 3.9.2, port site activities do not appear to have affected the abundance or distribution of ringed, spotted, or other species of seals, despite ringed seals being present in large numbers in the port site vicinity throughout the winter months. Spotted seals occur periodically along the coast near the port site during the summer months, and both seal species migrate with the pack ice in the spring and fall. Studies conducted for the 2005 DEIS suggest that ringed seals have acclimated to port site noises and do not indicate any changes to ringed seal distribution in the port site area (see Section 3.9.2) (U.S. Army Corps of Engineers 2005). The DEIS for navigational improvements for the port (U.S. Army Corps of Engineers 2005) did not predict any major effects on subsistence uses of ringed, spotted or other seal resulting from port site operations. Few local harvesters have reported changes in Other Seals (SRB&A 2000, 2005, forthcoming). Two percent of Kivalina harvesters interviewed and seven percent of Noatak harvesters interviewed made observations about changes in other seal, including an increase in numbers, resource closer to village, and more dangerous hunting conditions (Tables 7 and 41). No more than two harvesters interviewed in Kivalina or Noatak cite any change in Other Seal.

Table 41: Observations of Other Seal Resource Changes

Observation	Number of Observations			Percent of Observations		
	Kivalina	Noatak	Total	Kivalina	Noatak	Total
Increase in Species Number	1	1	2	100%	25%	40%
Closer to Village	0	2	2	0%	50%	40%
More Dangerous Hunting Conditions	0	1	1	0%	25%	20%
Total	1	4	5	100%	100%	100%
Total Number of Other Seal Change Observers	1	3				

Stephen R. Braund & Associates, 2008.

Walrus

Harvest Trends

Residents of the study communities indicate that walrus hunting depends primarily on ice conditions and thus harvest success varies from year to year. Changes in walrus conditions related to climate conditions are discussed below ("Walrus Resource Changes").

Walrus harvests in 2007 comprised only half a percent of the total Kivalina subsistence harvest, at three pounds per person (Table 8). The 1992 harvest of 28 walrus, on the other hand, accounted for 8.1 percent of the total harvest and provided 62 pounds per person. Compared to other previous study years, the 2007 harvest is more representative of walrus' historical contribution to Kivalina harvests. From the 1960s to 1980s, walrus contributed between zero and 1.8 percent of the total harvest, with a per capita contribution of between zero and 19 pounds (Tables 14 and 15). Burch (1985:56) reported that periodically large pods of walrus are carried into the Kivalina region on the ice and increased harvests of walrus usually occur during this time. These events did not happen regularly, and Kivalina's usual harvest of walrus was approximately four animals per year (Burch 1985:57).

Kotzebue walrus harvests vary from year to year, with residents harvesting as few as two in 2002 and as many as 16 in 2004 (Table 10). Walrus harvests generally account for less than one percent of the total yearly harvest. Pre-mine walrus harvests are similar, with three recorded harvests in 1971-72 and 15 harvested walrus in 1986 (Table 3). Residents harvested four pounds of walrus per capita in 1986 and a similar three pounds per capita in 1991 (Table 16). Four percent of households attempted harvesting walrus in 1991, and five percent in 1986.

In Noatak walrus harvests accounted for .5 percent of the total harvest in 1994 and one percent of the harvest in 2007 (Table 12). One walrus was harvested in 1994, providing three pounds per capita that year, and three walrus were harvested in 2007, providing four pounds of usable weight per capita. Similarly, an estimated harvest of three walrus was reported from 1971-72 (Table 5). No walrus data are available from 1960-61.

Subsistence Use Areas, Seasonal Round, and Harvest Patterns

Kivalina respondents identified most of their walrus subsistence use areas from Cape Krusenstern north to Point Hope, with isolated use areas farther north towards Cape Lisburne and southwest of the community (Map 56). As evidenced by the high concentration of overlapping use areas, the majority of residents search for walrus from Rabbit Creek to Cape Thompson, up to approximately 10 miles from the shoreline. A number of respondents reported that walrus generally migrate past the Kivalina area during a short time frame in June and part of July and farther offshore than many other marine mammal species. As a result, several harvesters described having to travel over 30 miles from shore in their search of walrus. Several factors, including weather, winds, and the distance of the ice pack from shore, contribute to residents' success for this resource. Over the last 10 years (1998-2007) residents reported mixed success at walrus use areas with 17 percent of use areas described as seldom successful, 48 percent as either always or usually successful, and 34 percent as unpredictable (SRB&A forthcoming). As with other summer marine mammal harvests, residents take day trips by boat to hunt walrus. They reported varying numbers of trips to walrus use areas with 26 percent accessed once a year, 58 percent multiple times a year, and 16 percent not every year (SRB&A forthcoming). In 2007, Kivalina households reported walrus subsistence use areas up to 10 miles from shore between Rabbit Creek and Cape Thompson (Map 56). Pre-mine lifetime walrus use areas (Maps 8 and 56) for Kivalina are identical to those reported for seal (Map 7). These use areas occur from Sheshalik to Cape Thompson. Pre-mine "sea mammal" (including walrus) subsistence areas documented by Braund and Burnham (1983) are discussed above under bowhead whale "Subsistence Use Areas, Seasonal Round, and Harvest Patterns.

As with other marine mammals, Noatak residents usually hunt walrus while staying at Sheshalik. Similar to bearded seal hunting, the majority of walrus hunting occurs by boat in open water, in June and to a lesser extent in May and July. Residents indicated that traveling to Sheshalik to hunt walrus occurs once a year or not every year. Current (1998-2007) walrus use areas as reported by Noatak respondents are located in Kotzebue Sound and offshore at considerable distances beyond Cape Krusenstern (Sealing Point) to just south of Kivalina (Map 57). The highest number of overlapping use areas occurs offshore from Sheshalik and Cape Krusenstern. Partial 1995-2004 use areas recorded for Noatak respondents in the Kivalina area show walrus hunting as far north as Cape Seppings (SRB&A 2005). For the 2007 study year, Noatak residents reported hunting walrus offshore between the port site and Cape Blossom (south of Kotzebue), with hunting reported a considerable distance offshore from Cape Krusenstern (Map 57). Because walrus are generally located on the ice at great distances from shore, residents reported having less success harvesting them. The majority of walrus use areas identified by Noatak residents were described as unpredictable, seldom, or unsuccessful (SRB&A forthcoming). Pre-mine "lifetime" walrus use areas, shown on Maps 26 and 57, and partial "sea mammal" use areas (Map 28) are similar to the current use areas shown on Map 57, although last 10 year use areas were reported for the entirety of Kotzebue Sound, an area lacking in earlier use area maps. This is likely due to a number of residents who reported looking for walrus whenever they hunt other marine mammals such as bearded seal (SRB&A forthcoming).

Walrus Resource Changes

The 2005 DEIS addressed changes to walrus related to the Red Dog Mine (U.S. Army Corps of Engineers 2005). Because walrus typically do not visit the port site area, instead migrating past the port site between 30 and 40 miles from shore, existing or potential effects to subsistence uses of walrus resulting from mine-related activities are considered unlikely and there is no evidence that effects on walrus have occurred (U.S. Army Corps of Engineers 2005). Observations made by local residents regarding walrus indicate that walrus distribution and availability varies widely depending on ice and wind conditions (SRB&A 2000, 2005, forthcoming). During interviews with Kivalina hunters in 1998, residents reported that walrus harvests had increased in recent years; however, residents interviewed in 2004 reported a decline in walrus in the area due to changing ice conditions. Residents in Noatak and Kotzebue also observed that ice conditions affect the availability of walrus (SRB&A 2005). During interviews in 2008, twenty-three percent of harvesters interviewed in Kivalina and seven percent of harvesters interviewed in Noatak reported observing changes in walrus (Table 7). No more than three harvesters cite any one change in walrus. Observations include changes in residents' use of the resource, and changes in migration/distribution, abundance, and quality (Table 41).

Table 42: Observations of Walrus Resource Changes

Observation	Number of Observations			Percent of Observations		
	Kivalina	Noatak	Total	Kivalina	Noatak	Total
Migration changed or diverted	3	0	3	21%	0%	18%
Harvest less	1	1	2	7%	33%	12%
Decrease in Species Number	2	0	2	14%	0%	12%
Increase in Species Number	2	0	2	14%	0%	12%
Disease/Infection	2	0	2	14%	0%	12%
Farther from Shore	1	1	2	7%	33%	12%
More Dangerous Hunting Conditions	0	1	1	0%	33%	6%
Less Ice Cover/More Open Leads	1	0	1	7%	0%	6%
Habitat Disturbed/Destroyed	1	0	1	7%	0%	6%
Earlier Migration/Arrival	1	0	1	7%	0%	6%
Total Observations	14	3	17	100%	100%	100%
Total Number of Walrus Change Observers	10	3				

Stephen R. Braund & Associates, 2008.

Polar Bear

Harvest Trends

No Kivalina households reported hunting polar bears in 2007 (Table 8), although it is possible that harvests did occur among households not surveyed. In 1992 residents of Kivalina harvested eight polar bear, providing three pounds of meat per capita. Earlier harvest data from the 1960s through the 1980s show harvests of between zero and two polar bears during each study year (Table 2). Kotzebue residents do not hunt polar bear on a regular basis, although two harvests were reported during the four baseline study years (1991, 2002, 2003, 2004) (Table 10). The most recent pre-mine harvest data (1986) shows Kotzebue residents harvesting 17 polar bears that year (two pounds per capita) and indicates a decline in Kotzebue polar bear hunting since that time (Table 3). Harvests of polar bear have not been reported by Noatak households for any harvest study year; however, three percent of households reported receiving and using polar bear in 1994 (Table 12).

Subsistence Use Areas, Seasonal Round, and Harvest Patterns

Eight Kivalina respondents reported polar bear subsistence areas used from 1997-2008 (Map 58). Most respondents described harvesting polar bear by snowmachine during bowhead whaling activities in April and into May. Few individuals reported taking specific trips to harvest polar bear and as such reported harvest success at 66 percent of polar bear use areas was unsuccessful, seldom, or unpredictable (SRB&A forthcoming). Use areas appear south of Point Hope and in bowhead whaling areas from Ipiavik Lagoon to Chariot. The highest number of overlapping use areas occurs in the Chukchi Sea just west of the Singoalik River area. Kivalina households did not report hunting polar bear during ADF&G's 2008 household surveys. Kivalina's lifetime (1925-1986) polar bear use areas extended from Sheshalik north to Cape Thompson along the coast and several miles out onto the Chukchi Sea ice pack (Maps 9 and 58). Noatak residents have not reported hunting polar bears in recent years, likely because of their inland location; however, lifetime Noatak use areas for polar bear (Map 27) are located offshore between Cape Seppings and Kivalina.

Polar Bear Resource Changes

The Corps' 2005 DEIS addressed changes to polar bears resulting from the Red Dog Mine (U.S. Army Corps of Engineers 2005). Polar bears occur periodically in the port site area; however, their appearance in that area usually ceases before sea-based operations begin (U.S. Army Corps of Engineers 2005). No port-site related effects on polar bears have been recorded (ibid.). However, impacts related to climate change are of current concern, and polar bears were recently listed as threatened under the Endangered Species Act (ESA). Nine percent of Kivalina respondents made observations about changes in polar bear (Table 7). No harvesters interviewed in Noatak reported changes in polar bears. No more than two individuals cited any one change in polar bear. Observations were related to changes in polar bear distribution, abundance, and size (Table 43).

Table 43: Observations of Polar Bear Resource Changes

	Number of Observations			Percent of Observations		
	Kivalina	Noatak	Total	Kivalina	Noatak	Total
Less Ice Cover/More Open Leads	2		2	29%		29%
Farther from riversides/farther inland	2		2	29%		29%
Decrease in Species Number	1		1	14%		14%
Increase in Species Number	1		1	14%		14%
Decrease in Resource Size	1		1	14%		14%
Total Observations	7		7	100%		100%
Total Number of Polar Bear Change Observers	4					

Stephen R. Braund & Associates, 2008.

Furbearers and Small Land Mammals

Harvest Trends

In Kivalina the primary use for furbearer and small land mammal resources are for commercial or domestic uses, such as clothing and Native handicrafts, and for consumption. Thirty-one percent of Kivalina households reported using furbearer and small land mammal species in 2007, and 44 percent of households in 1992 (Table 8). Kivalina residents' harvest of furbearers and small land mammals primarily consists of wolf, wolverine and fox. Community members in general do not eat furbearers and small land mammals, and because ADF&G does not include furbearers not used for consumption in their harvest amounts, the contribution of furbearers and small land mammals to the percent of total harvest for all study years was less than one percent (Table 15).

Kotzebue (2002, 2003, and 2004) harvest data show that furbearers and small land mammals accounted for less than one percent of Kotzebue's total subsistence harvest (Table 10). Harvest participation for those years are not available, but in 1991, 28 percent of Kotzebue households reported using furbearers and small land mammals and 18 percent attempted to harvest furbearers and small land mammals. Comparing earlier furbearers/small land mammal data to current harvest data indicates a slight decrease in harvests and uses of these resources since that time (Tables 16 and 17). In 1986, 45 percent of households used furbearers and small land mammals, and the resource accounted for .3 percent of that year's total subsistence harvest (Table 3). Pounds per capita remained similar between 1986 and 1991, at one pound of furbearers/small land mammals per capita during both years.

Current Noatak harvests of furbearers and small land mammals are relatively low; however the most recent 2007 harvest data indicates an increase in residents' harvests of these resources. In 1994, 1999, and 2002, the number of furbearers and small land mammals harvested ranged from 16 in 2002 to 41 in 1994 (Table 12). However, in 2007, 21 percent of households tried to harvest furbearers and small land mammals and successful harvests amounted to 91 animals. Participation in furbearer hunting and trapping declined since the 1960s and 1970s, when residents harvested 1,354 and 1,329 animals, respectively (Table 5). Foote and Williamson (1966) reported that furbearer prices declined starting in the 1940s and, although locals were discouraged from participating in large scale trapping operations, residents still harvested 1,115 muskrat, 200 of which were eaten, and various other species of furbearing animals. The total number of small land mammals harvested for food was 320 (200 muksrats and 120 snowshoe hares). During SRB&A interviews with residents in 2008, several reported that hares have not been available in the area over the last 20 years, and thus harvests of this resource have declined (SRB&A forthcoming). Residents indicated that they continue to harvest beaver and muskrats for food.

Subsistence Use Areas, Seasonal Round, and Harvest Patterns

Map 59 shows 1998-2007, 2007, and lifetime Kivalina furbearer and small land mammal subsistence use areas. The 1998-2007 use areas were primarily identified as wolf, wolverine, and fox use areas. Current use areas extend from Point Hope to Cape Krusenstern, as far east as the Noatak River and northeast beyond the Delong Mountains into the Brooks Range. The greatest concentration of furbearer and small land mammal use areas are located in the low lying areas to the east of the community from an area just north of the Kivalina River to the foothills of the Wulik Peaks, and south towards the DMTS. Respondents often described looking for wolf or wolverine by snowmachine during day trips from November through March while searching for caribou. Just over one quarter of furbearer and small land mammal use areas are accessed on a yearly basis, while 51 percent of these use areas are accessed six or more times a year. Compared to the 76 percent of always or usually successful use areas for resources as a whole, residents reported relatively low success rates at furbearer and small land mammal use areas with only 32 percent of areas described as always or usually successful (SRB&A forthcoming). Residents explained that wolf and wolverine are difficult animals to hunt, and certain individuals had yet to harvest either animal in the last ten years, as evidenced by the 15 percent of unsuccessful use areas, a higher percentage than for resources as a whole. In 2008, Kivalina households reported furbearer subsistence use areas (Map 59) located in the same relative areas of higher overlap. These areas were reported west of Noatak to the Askipak River and northeast into the Wulik Peaks and towards the Kukpuk River. Earlier use area data indicate that Kivalina furbearer and small land mammal use areas have remained similar. Wolf, wolverine, and fox subsistence use areas documented for 1977-1982 appear along the Kivalina and Wulik River drainages (Map 4) and are located within the current use areas shown on Map 59. Residents' lifetime furbearer and small land mammal use areas also resemble their last 10 year (1998-2007) use areas (Maps 4 and 59); while these use areas are not located as far north or northwest as current use areas, they do extend farther east, to locations east of the Noatak River.

Current (1998-2007) Noatak furbearer and small land mammal use areas, including hunting and trapping areas, extend over a large area from Kivalina inland beyond the Red Dog Mine site, in the mountains east and west of the Noatak River, and south to the mouth of Noatak River (Map 60). Residents reported the highest number of overlapping use areas in various sloughs south of Noatak (used primarily to hunt beaver and muskrat by boat), in the Mulgrave Hills to and beyond the DMTS (for wolf and wolverine hunting and furbearer trapping) and along the Kelly River (where a number of respondents reported running traplines). In 2007 residents used an area similar to the 1998-2007 furbearer use areas shown on Map 60 but did not travel as far west (to the coast) or south (Map 60). An isolated search area was reported near Selawik. Although harvest activities were reported year-round, Noatak residents' harvests of furbearers and small land mammals generally occur during the winter (November to April) by snowmachine for trapping and hunting of wolf, wolverine, and other furbearers, and in the spring (April to June) by boat for hunting of muskrat and beaver. Trapping and hunting of furbearers and small land mammals intensifies from January until March and in May (SRB&A forthcoming). When trapping, residents generally take daily or weekly trips to check their traps, resulting in a high number of same day trips for furbearers and small land mammals. Specifically, Noatak harvesters reported taking six or more yearly trips to nearly half of their furbearer and small land mammal use areas (SRB&A forthcoming). Although some individuals reported staying at cabins or camping while setting their traps, almost all hunting and trapping activities take place from the community of Noatak.

Compared to lifetime pre-mine use areas (Maps 20 and 60), current Noatak furbearer use areas are similar but substantially smaller in that residents do not travel as far north or east as they once did. Braund and Burnham's partial use areas for fox, wolverine, and wolf are also depicted on Map 20 and show two limited use areas in the vicinity of the DMTS near the mine site. As discussed earlier under All Resources ("Subsistence Use Areas"), trapping is no longer as prevalent in Noatak as it once was due to a decline in fur prices beginning in the 1940s and 1950s (Foote and Williamson 1966), and although residents continue to trap and hunt furbearers, it is no longer economically viable to travel such extensive distances in pursuit of this resource. It is possible that residents may return to these traditional areas if there is a rise in fur prices or resurgence in trapping by local residents. Residents of Noatak did not report any changes in furbearer use areas related to the Red Dog Mine (see discussion below). Success rates for furbearers and small land mammals as reported by Noatak residents generally reflect residents' views that trapping is a somewhat unpredictable activity, with 29 percent of use areas described as such; however, 60 percent of use areas were described as either always or usually successful.

Furbearer and Small Land Mammal Resource Changes

Section 3.9.2 provides descriptions of baseline conditions for various species of furbearers and small land mammals, including wolf, wolverine fox, river otter, beaver, and ground squirrels. Many of these species occur near mine, road, and port site facilities. As discussed in Section 3.9.2, effects on furbearers and small land mammals include changes in prey availability, mortality due to collisions on the DMTS, attraction to mine facilities (in the case of red foxes), and disturbance due to mine-related activities. The species most likely to be affected by mine activities is wolverine, due to its sensitivity to human and development-related activities. However, overall population impacts to any individual species are unlikely due to the broad range of habitat (see Section 3.9.2). The 1984 EIS addressed potential impacts to small mammals and predicted that habitat loss resulting from construction activities would be minimal and localized, and small mammals would likely adapt to the presence of mine-related facilities (USEPA 1984).

Noatak and Kivalina residents interviewed in 2008 by SRB&A reported various changes in furbearers and small land mammals over the previous 20 years. Thirty-nine percent of Kivalina respondents and 74 percent of Noatak respondents made observations of change in furbearers and small land mammals (Table 7). The principal furbearer and small land mammal resource changes observed were: (1) increase in species number; (2) new species in the region; and, (3) decrease in species number (Table 44).

Table 44: Observations of Furbearer and Small Land Mammal Resource Changes

Observations	Number of Observations			Percent of Observations		
	Kivalina	Noatak	Total	Kivalina	Noatak	Total
Increase in Species Number	12	11	23	46%	15%	23%
New Species in Region	5	15	20	19%	20%	20%
Decrease in Species Number	3	15	18	12%	20%	18%
Moved into area	0	9	9	0%	12%	9%
Harvest less	0	8	8	0%	11%	8%
Closer to Village	2	4	6	8%	5%	6%
Harvest more	1	3	4	4%	4%	4%
Take fewer trips	0	2	2	0%	3%	2%
Worse success	0	2	2	0%	3%	2%
Further from Village	0	2	2	0%	3%	2%
Use area changed	0	1	1	0%	1%	1%
Decrease in Resource Size	1	0	1	4%	0%	1%
Resource appears unhealthy	0	1	1	0%	1%	1%
Fur less thick	0	1	1	0%	1%	1%
Move to Different Areas	1	0	1	4%	0%	1%
Moved out of area	0	1	1	0%	1%	1%
Change in Focus of Resource Harvest	1	0	1	4%	0%	1%
Total Observations	26	75	101	100%	100%	100%
Total Number of Furbearer and Small Land Mammal Change Observers	17	31				

Stephen R. Braund & Associates, 2008.

Increase in Species Number. Forty-six percent of Kivalina observations and 15 percent of Noatak observations cited increases in numbers of some furbearers and small land mammals (Table 44). Eighty-three percent of Kivalina observations cited an increase in the number of wolves, whereas in Noatak these observations were split between various species (Table 45).

Table 45: Observations of Furbearer and Small Land Mammal Resource Changes by Species – Increase in Species Number

Species	Number of Observations			Percent of Observations		
	Kivalina	Noatak	Total	Kivalina	Noatak	Total
Wolf	10	3	13	83%	25%	54%
Beaver	0	3	3	0%	25%	13%
Red fox	2	0	2	17%	0%	8%
Hare	0	2	2	0%	17%	8%
Foxes	0	1	1	0%	8%	4%

Otter	0	1	1	0%	8%	4%
Lynx	0	1	1	0%	8%	4%
Wolverine	0	1	1	0%	8%	4%
Total	12	12	24	100%	100%	100%

Stephen R. Braund & Associates, 2008.

In 10 out of 16 cases, Kivalina respondents did not know why there had been an increase in the numbers of furbearers and small land mammals. In Noatak, residents generally attributed the increase in resource numbers to fewer people hunting or harvesting the resource (Table 46).

Table 46: Reasons for Change in Furbearers and Small Land Mammals – Increase in Species Number

	Number of Observations			Percent of Observations		
	Kivalina	**Noatak**	**Total**	**Kivalina**	**Noatak**	**Total**
I Do not Know	10	2	11	63%	18%	42%
Fewer people hunting/harvesting resource	3	6	9	19%	55%	35%
Regulations [GENERAL]	2	0	2	13%	0%	8%
Habitat improved	0	2	2	0%	18%	8%
Cyclical Population Change	0	1	1	0%	9%	4%
Natural causes	1	0	1	6%	0%	4%
Total	16	11	26	100%	100%	100%

Stephen R. Braund & Associates, 2009.

New Species in the Region. One hundred percent of Kivalina observations and 93 percent of Noatak observations regarding new species of furbearers/small land mammals in the region were pertaining to beaver (Table 47). Only two Noatak respondents reported that marten were new to the region. Residents indicated that beaver were never in the area in past years, and instead of a general growth in their population, respondents believe that beaver are moving from the Kobuk area into river and creek systems near Noatak and Kivalina (Table 48). Residents expressed worry that increasing number of beaver dams in the area may affect trout populations. One resident described the recent arrival of beaver and marten into the area, saying,

> We never had beaver here, never paid attention, and within the last 10 years they migrated here from the Kobuk. They're a nuisance, they moved and took over the area. Along with the marten, kind of migrated from the Kobuk to here. (SRB&A Noatak Interview January 2008)

Table 47: New Species of Furbearers/Small Land Mammals Observed in Area

	Number of Observations			Percent of Observations		
Species	**Kivalina**	**Noatak**	**Total**	**Kivalina**	**Noatak**	**Total**
Beaver	5	14	19	100%	93%	95%
Marten	0	2	2	0%	7%	5%
Total	5	15	20	100%	100%	100%

Stephen R. Braund & Associates, 2008.

Table 48: Reasons for Change in Furbearers and Small land Mammals – New Species in Region

Cause	Number of Observations			Percentage of Observations		
	Kivalina	Noatak	Total	Kivalina	Noatak	Total
Moved into area	0	12	12	0%	86%	67%
I Do not Know	4	1	5	100%	7%	28%
Increase in Species Number	0	1	1	0%	7%	6%
Total	4	14	18	100%	100%	100%

Stephen R. Braund & Associates, 2008.

Decrease in Species Number. Twenty percent of Noatak observations and 12 percent of Kivalina observations noted a decrease in some furbearer and small land mammal species including hares, muskrat, and wolverine (Table 44). There is no consensus on the cause of the decline (Table 49).

Table 49: Reasons for Change in Furbearers and Small Land Mammals – Decrease in Species Number

Cause	Number of Observations			Percent of Observations		
	Kivalina	Noatak	Total	Kivalina	Noatak	Total
Climate	0	1	1	0%	8%	7%
Overharvesting of Species	0	2	2	0%	17%	13%
Predators	0	3	3	0%	25%	20%
Change in Food Availability	0	2	2	0%	17%	13%
I Do not Know	3	4	7	100%	33%	47%
Total	3	12	15	100%	100%	100%

Stephen R. Braund & Associates, 2008.

Waterfowl

Harvest Trends

Although waterfowl only accounted for 0.9 to 1.3 percent of Kivalina's total subsistence harvest in 1992 and 2007, over 80 percent of households reported use of this resource (Table 8). In 1992, 1996, and 2007, residents harvested seven, three, and eight per capita pounds respectively (Table 14). The earliest Kivalina subsistence harvest studies did not record waterfowl harvest amounts due to the prohibition of spring migratory bird hunting and residents' reluctance to report waterfowl harvest amounts. Later studies in the 1970s and 1980s reported waterfowl harvests comprising 0.3 to 0.4 percent of the total harvest (Table 15). According to this table, there is a slight trend of increasing waterfowl harvests, measured as a percentage of the total harvest of edible pounds, from 1971-72 to 2007.

Kotzebue waterfowl harvests have accounted for between .3 and 1.4 percent of the total subsistence harvest during recent (1991, 2002, 2003, and 2004) harvest studies (Table 10). Both ducks and geese were among the top species harvested, by percent of total harvest, during recent harvest surveys in 2002, 2003, and 2004 (Table 11). Earlier waterfowl harvest data for the 1986 study year are similar to current harvest data, with waterfowl accounting for 1.3 percent of the total harvest (Table 17). Although harvest numbers dropped in 1991, more recent waterfowl studies in 1997, 2002, 2003, and 2004 show a gradual increase in harvest levels. At 37 pounds, the mean household harvests of waterfowl were higher in 2003 than in any other study year for Kotzebue (Table 10). Per capita harvests have risen from one in pound per capita in 1986 to two pounds per capita in 1991 to seven pounds per capita in 1997 (Table 16).

Noatak harvests of waterfowl have remained relatively steady over recent years, with four pounds per capita harvested in 1994 and 1997 and five pounds per capita harvested in 2007 (Table 12). During the two study years of 1994 and 2007, waterfowl harvests accounted for .8 and 1.5 percent of the total harvest, respectively (Table 19). Older waterfowl harvest data from the 1960s and 1970s (Table 5) indicate that waterfowl hunting has not changed much over time. Eight per capita pounds of waterfowl were harvested in 1960-61, accounting for .3 percent of the harvest. Waterfowl also contributed to .3 percent of the total harvest from 1971-72 (Tables 18 and 19).

Subsistence Use Areas, Seasonal Round, and Harvest Patterns

Kivalina waterfowl subsistence use areas, depicted on Map 61, are located along the coast and lagoons from Cape Krusenstern to Chariot, with additional areas extending farther inland around the Kivalina and Wulik rivers. Residents generally access these areas by snowmachine beginning in April and May, and later by boat beginning in May and June and continuing to a lesser extent into July and August (SRB&A forthcoming). A few individuals also described hunting waterfowl offshore between Cape Krusenstern and Chariot and near Point Hope. Most of these areas represent eider-hunting activities while individuals are bowhead whaling. The highest concentrations of overlapping waterfowl use areas are located at the mouth of Rabbit Creek, along the coast and lagoons north of the port site to Singoalik River, and along the lower portions of both the Kivalina and Wulik rivers (Map 61). Kivalina residents travel to the majority of their waterfowl use areas (66 percent) between two and 20 times a year, and do not use 20 percent of hunting areas on a yearly basis (SRB&A forthcoming). Unlike the same day duration to most other subsistence use areas (84 percent for all resources), respondents camp overnight at 30 percent of waterfowl use areas and more than one night at an additional 16 percent of use areas. Harvesters were either always or usually successful at 86 percent of waterfowl use areas. Twenty-two Kivalina households reported waterfowl subsistence areas used during 2007 (Map 61) These areas are located in the same areas having the highest amount of overlap for the 1998-2007 time period. In 1998, Kivalina residents reported harvesting waterfowl in many of the same areas, namely along the coast and lagoons from Kotlik Lagoon to Singoalik Lagoon and up the Kivalina and Wulik Rivers (Map 61).Lifetime Kivalina waterfowl subsistence areas utilized prior to the development of the Red Dog Mine are located along the coast and lagoons from Sheshalik to Cape Thompson and the entire lengths of the Wulik and Kivalina rivers (Maps 14 and 61). Waterfowl subsistence areas for the time period of 1977-1982 are nearly identical to those areas with the highest overlap depicted on Map 61, extending from Rabbit Creek to Singoalik River and up the lower portions of the Kivalina and Wulik rivers. Neither of the pre-mine studies documented waterfowl subsistence use areas located in the Chukchi Sea.

Map 62 depicts Noatak waterfowl hunting areas as reported by respondents from 1998-2007. Residents hunt waterfowl from April to June (particularly in May), both by boat along the Noatak River and by snowmachine east and west of the community. In particular, residents reported a high number of overlapping use areas along the Noatak River between the mouths of Kelly and Agashashok rivers (including Sevisok Slough), in the flats east of Noatak, and around lakes west of the community. Residents also reported hunting waterfowl on the north side of the DMTS toward Wulik River, west to Imik and Kotlik lagoons, and at various spots while staying at Sheshalik. ADF&G 2007 waterfowl use areas reported by Noatak households (Map 62) are generally similar to those shown for the 1998-2007 time period, with one use area reported on Selawik Lake. Residents generally take fewer yearly trips to hunt waterfowl because of the limited hunting season; during SRB&A interviews with Noatak respondents, they reported taking from one to three trips per year to 51 percent of waterfowl use areas, and more than three trips to one-quarter of use areas. However, residents took more overnight trips to waterfowl use areas than for resources as a whole, staying at least one night away from the community at 41 percent of waterfowl use areas (SRB&A forthcoming).

Pre-mine lifetime use areas for waterfowl as reported by Noatak residents are shown on Maps 29 and 62 and generally depict the same extent of waterfowl hunting areas as those shown on Map 62, but are more continuous, spanning from the Kelly River to the mouth of the Noatak River and west of Noatak encompassing the entire Cape Krusenstern National Monument. Partial 1977-1982 use areas for waterfowl are also on Map 29 and show hunting activity on either side of the DMTS and on the coast between Ipiavik Lagoon and Kotlik Lagoon. During recent SRB&A interviews with Noatak residents, respondents did not report any changes to waterfowl use areas resulting from Red Dog Mine activities and reported continued use of several hunting locations near the DMTS (SRB&A forthcoming). Success rates for waterfowl hunting are high for Noatak residents, with nearly all (92 percent) use areas described as always or usually successful (SRB&A forthcoming).

Waterfowl Resource Changes

As discussed in the Corps 2005 DEIS, effects on waterfowl resulting from mine-related facilities and activities include habitat loss and changes in migratory routes (U.S. Army Corps of Engineers 2005). Both local residents and biologists have observed localized changes in migration routes near the port site barge loading facilities, where birds either divert around the port site and then return to shore north of the port site, or fly at higher altitudes once they reach the port site (U.S. Army Corps of Engineers 2005, SRB&A 2000 and 2005). The birds generally return to shore before reaching Kivalina residents' spring waterfowl hunting areas to the north of the port site (U.S. Army Corps of Engineers 2005). Few residents have reported effects on their harvests of waterfowl resulting from local change in migration (SRB&A 2000, 2005). Other documented effects on waterfowl include loss of habitat at the port site, along the DMTS, and at the Red Dog Mine; isolated mortalities along the road or at the mine site; and use of the tailings pond by migratory waterfowl (see Section 3.9.2). Mine employees implement hazing when waterfowl are seen in the tailings pond, and no injuries or fatalities have been reported as a result. The 1984 EIS addressed impacts to waterfowl related to the mine and reported potential loss of habitat and disturbance due to mine-related activities. Effects on subsistence harvests of birds were reported to be minor (U.S. Army Corps of Engineers 2005).

During interviews in 2008, 23 percent of Kivalina respondents and 29 percent of Noatak respondents observed changes in waterfowl (Table 7). Of the 12 observations made by harvesters in Kivalina, no one change was cited more than three times (Table 50) and therefore the causes of those changes are not discussed in further detail. In Noatak nine of the 16 observations about changes in waterfowl were that the respondent harvested less waterfowl or took fewer trips to hunt waterfowl than in the past (Table 50). No other change was cited more than three times. During ADF&G household surveys in 2008, 17 percent of Noatak households reported that they did not harvest enough birds in 2007; in 43 percent of cases, residents attributed this to harvest effort (Magdanz et al. 2008).

Table 50: Observations of Waterfowl Resource Changes

Observation	Number of Observations			Percent of Observations		
	Kivalina	Noatak	Total	Kivalina	Noatak	Total
Harvest less	0	5	5	0%	31%	18%
Take fewer trips	0	4	4	0%	25%	14%
Use area changed	1	2	3	8%	13%	11%
Decrease in Species Number	3	0	3	25%	0%	11%
Increase in Species Number	2	0	2	17%	0%	7%
Abnormal Resource Death	2	0	2	17%	0%	7%
Shallower Rivers/Lakes	0	1	1	0%	6%	4%
Decrease in Resource Size	1	0	1	8%	0%	4%
Change in Resource Behavior	1	0	1	8%	0%	4%
Physical Abnormalities	1	0	1	8%	0%	4%
Migration changed or diverted	0	1	1	0%	6%	4%
Earlier Migration/Arrival	0	1	1	0%	6%	4%
Move to Different Areas	0	1	1	0%	6%	4%
Abnormal Migratory Event	0	1	1	0%	6%	4%
Taste	1	0	1	8%	0%	4%
Total Number of Observations	12	16	28	100%	100%	100%
Total Number of Waterfowl Change Observers	10	12				

Stephen R. Braund & Associates, 2008.

Eggs

Harvest Trends

During both 1992 and 2007 harvest studies in Kivalina, egg harvests accounted for 0.3 percent of the total harvest for a total of 2 pounds per person (Table 8). Sixty-eight percent of Kivalina households used eggs in 1992, and 76 percent in 2007. Murre eggs were among the top 20 subsistence resource harvested in 1992, and both murre and gull eggs were among the top 20 resources in 2007 (Table 9). Earlier subsistence studies from 1964-65, 1971-72, and 1982-83 show eggs accounting for no more than 0.2 percent of the total yearly harvests (Table 15).

Egg harvests by Kotzebue residents have remained relatively consistent over recent study years (1991, 1997, 2002, 2003, and 2004), generally contributing .1 percent or less to the total subsistence harvest for those years (Table 10). Seventeen percent of households harvested eggs in 1991 and 24 percent in 1997. Comparing more recent study years to harvest data from 1986, when eggs accounted for .1 percent of the total harvest, indicates that harvests of this resource have changed little since that time (Table 17). Over time, Kotzebue harvests of eggs have provided between zero and one pound per capita.

Egg harvest data for Noatak indicate a possible increase in residents' use and harvest of eggs. In 2007, 28 percent of households harvested eggs, as opposed to 24 percent in 1997 and seven percent in 1994 (Table 12). Eggs accounted for .1 percent of the total harvest in 2007. Earlier harvest data from 1971-72 show zero harvests of eggs (Table 5).

Subsistence Use Areas, Seasonal Round, and Harvest Patterns

As shown on Map 63, Kivalina respondents reported two primary locations from which they harvest their subsistence supply of eggs. Residents travel by boat at the end of June and early July to harvest murre eggs from the cliffs at Cape Thompson (SRB&A forthcoming), and also harvest eggs, primarily gull eggs, near the mouths of the Kivalina and Wulik rivers. These locations show the highest concentration of overlapping use areas. Other egg harvest areas included the shoreline around Kivalina, Imikruk and Ipiavik lagoons. Residents reported taking one to three day trips a year to the majority (85 percent) of their egg use areas to harvest the desired amount of eggs (SRB&A forthcoming). Respondents reported no difficulties in egg harvests, identifying 91 percent of egg use areas as always successful. In 2007, Kivalina households harvested eggs in use areas located at Cape Thompson, Ipiavik Lagoon, and Wulik River mouth as well as one location further upriver. Kivalina's lifetime (1925-1986) egg use areas, depicted on Maps 15 and 63, include use areas at Cape Thompson, Kivalina and Kotlik lagoons, and Kivalina and Wulik rivers. These lifetime egg use areas occur farther along the Kivalina and Wulik rivers than current egg use areas (Map 63). However, respondents reported 1998-2007 egg use areas along Imikruk and Ipiavik lagoons, which Kivalina residents did not report using from 1925-1986.

During the month of June (some harvesting was reported as early as May or as late as August), Noatak residents travel by boat along riverways and sloughs, looking primarily for gull nests from which they harvest eggs. Residents usually take between one and three day trips each year in search of this resource, and reported being always or usually successful harvesting eggs at 87 percent of their identified egg use areas (SRB&A forthcoming). Thirteen percent of use areas were described as unpredictable, due to factors such as harvest timing and competition with other egg harvesters. Noatak egg harvesting areas for the 1998-2007 time period occur along the Noatak River and several surrounding tributaries, near Sheshalik, and on Chamisso Island in Kotzebue Sound (Map 64). The highest number of overlapping use areas as shown on Map 64 occur along the Noatak River between the community and the mouth of Kelly River. Residents reported harvesting eggs in a similar area in 2007 (Map 64), with one large use area reported near Selawik that was not recorded during SRB&A last 10 year interviews. Comparing current use areas to the pre-mine use areas depicted on Maps 30 and 64, egg use areas remain similar with the exception of pre-mine use areas reported along the coast from Sheshalik to Cape Krusenstern (Sealing Point) and around lakes east of the mouth of Noatak River.

Eggs Resource Changes

During interviews in 2008, 72 percent of Kivalina respondents and 51 percent Noatak respondents reported harvesting eggs during the last 10 year time frame (1998-2007) (SRB&A forthcoming). Only one individual provided an observation about changes in eggs (Table 7).

Upland Birds

Harvest Trends

Upland bird (primarily ptarmigan) harvests, along with Other Large Land Mammal harvests, contributed the least amount to Kivalina's overall harvests in 2007, accounting for only 0.1 percent (Table 8). Only 29 percent of Kivalina households reported using this resource in 2007, although half of households in 1992 reported use of upland birds. The 1983-84 harvest study was the only other study to report any harvest of upland birds, accounting for 0.1 percent of the total harvest (Table 2). During all study years, harvests of upland birds have provided between zero and one pound of usable weight per capita.

Current Kotzebue upland bird harvest data are available for the study years of 1991 and 1997 (Table 10). During both study years, residents harvested two pounds of upland birds per capita. In 1991, 42 percent of households harvested upland birds, and in 1997, 37 percent harvested the resource. A comparison of current and pre-mine harvest data show an increase in the total pounds of upland birds harvested (from 2,147 pounds in 1986 to 5,584 in 1991 and 5,530 in 1997), as well as twice the per capita pounds (Tables 3 and 10).

Noatak harvests of upland birds (ptarmigan) are similar to those of Kotzebue and amounted to an average of three pounds per household in 1994 and two pounds per household in 2007 (Table 12). Thirty percent of Noatak households used upland birds in 2007. Harvests from the 1960s and 1970s were slightly lower, with one pound harvested per capita during each study year (1960-61 and 1971-72) (Table 5).

Subsistence Use Areas, Seasonal Round, and Harvest Patterns

Kivalina's 1998-2007 upland bird subsistence use areas appear on Map 65. These use areas, all identified for ptarmigan, are located along various creek and river drainages in the Kivalina area, including Kisimilok Creek, Singoalik River, Asikpak River, Kivalina River, Wulik River, and Omikviorok River. The highest frequency of overlapping ptarmigan use areas occurs along the lower portion of the Wulik River. Residents indicated the willowed areas along rivers and creeks are often the best places to search for ptarmigan. Ptarmigan hunting occurs by snowmachine from October throughout the winter months and into April. Harvesters reported traveling to nearly three quarters of their use areas one to three times a year during day trips from the community, and they are either usually or always successful at 96 percent of these areas (SRB&A forthcoming). No other mapped use area data for upland birds are available.

In Noatak, ptarmigan hunting occurs primarily by snowmachine (nearby use areas are sometimes accessed on foot) during the winter months of January to April, although residents reported hunting them as early as October and as late as May (SRB&A forthcoming). Current (1998-2007) upland bird use areas reported by Noatak residents are depicted on Map 66 and represent hunting areas for ptarmigan. Use areas are located on either side of the Noatak River, at the mouth of the river, and near Kotzebue. The highest numbers of overlapping ptarmigan hunting areas are located close to Noatak on either side of the river. No other upland bird use area data are available. Residents generally take between one and three yearly trips to hunt ptarmigan, although almost one-quarter of use areas were reportedly visited between six and 20 times a year. No residents reported hunting ptarmigan at any given use area more than 20 times in a year, and no residents reported staying overnight away from the community to hunt ptarmigan. Harvest success as reported by Noatak respondents is relatively low when compared to their responses for resources as a whole. Only 38 percent of ptarmigan use areas were described as always successful, compared to 62 percent of all resources use areas (SRB&A forthcoming)

Upland Bird Resource Changes

Baseline conditions of birds are described in Section 3.9.2. This section notes that the 2007 risk assessment found willow ptarmigan feeding in the mine and port areas may be slightly more at risk for exposure to lead than other species. Otherwise, no effects on ptarmigan due to mine-related facilities or activities have been reported (U.S. Army Corps of Engineers 2005). Willow ptarmigan inhabit the area near the port site (U.S. Army Corps of Engineers 2005). Five percent of harvesters interviewed in Kivalina in 2008 and 43 percent of harvesters interviewed in Noatak reported changes in upland birds (Table 7). The only Kivalina observation, made by two Kivalina respondents, was that the number of ptarmigan had declined (Table 51) In Noatak the principal observation of change was (1) harvest less.

Table 51: Observations of Ptarmigan Resource Changes

	Number of Observations			Percent of Observations		
	Kivalina	Noatak	Total	Kivalina	Noatak	Total
Harvest less	0	12	12	0%	46%	43%
Further from Village	0	6	6	0%	23%	21%
Decrease in Species Number	2	2	4	100%	8%	14%
Habitat Disturbed/Destroyed	0	3	3	0%	12%	11%
Increase in Species Number	0	1	1	0%	4%	4%
Resource in Smaller Groups	0	1	1	0%	4%	4%
Move to Different Areas	0	1	1	0%	4%	4%
Total	2	26	28	100%	100%	100%
Total Number of Ptarmigan Change Observers	2	18				

Stephen R. Braund & Associates, 2008

Harvest Less. In Noatak nine of 12 individuals reporting that they harvest less ptarmigan cited personal and family reasons as the main causes for this decline (Table 52). A number of residents explained that ptarmigan hunting was something that they did when they were younger and that their children or grandchildren had taken over ptarmigan hunting duties. Others indicated that elders they once hunted ptarmigan for had passed away, so the need for ptarmigan had declined.

Table 52: Reasons for Change in Ptarmigan – Harvest Less

	Number of Observations			Percent of Observations		
Cause	Kivalina	Noatak	Total	Kivalina	Noatak	Total
Personal Reasons		5	5		42%	42%
Change in subsistence dependents		2	2		17%	17%
Further from Village		2	2		17%	17%
Need less		1	1		8%	8%
Change in subsistence providers		1	1		8%	8%
Development		1	1		8%	8%
Total		12	12		100%	100%

Stephen R. Braund & Associates, 2008

Dolly Varden Char

Harvest Trends

Along with caribou and bearded seal, Dolly Varden char (referred to locally as “trout”) constitute the majority of the yearly subsistence harvest for Kivalina residents. In both 1992 and 2007, Dolly Varden char accounted for 26 percent of the overall community harvest and was the number one and number two single species harvested for those years (Tables 8 and 9). Residents harvested 203 pounds of Dolly

Varden char in 1992 and 158 pounds per capita in 2007. Over 90 percent of Kivalina households used Dolly Varden char in 2007, and 100 percent used this resource in 1992. Aside from an unusually low harvest in 1965-66 (accounting for 7.3 percent of the harvest that year), Dolly Varden char harvests accounted for 18.9 to 33.1 percent of the total harvest during study years between 1964 and 1984 (Table 15). Dolly Varden char was the first or second most harvested subsistence species in each of the study years between 1964 and 1984, except for 1965-66 (Tables 1 and 9). Pre-mine per capita harvests, at 179 in 1983 and 178 in 1984, were similar to those reported in 1992 and 2007.

Harvests of Dolly Varden char by Kotzebue residents are not as large a contributor to the overall harvest as in the other study communities, but still an important contributor to residents' yearly harvests. Dolly Varden char accounted for 3.1 percent of Kotzebue's total harvest in 1991 and between .9 and 2.1 percent from 2002 to 2004 (Table 17). Similarly, harvest data from 1971-1972 and 1986 show Dolly Varden char accounting for between .9 and 2.3 percent of residents' total harvest for those years (Table 17). However, the percentage of households harvesting Dolly Varden char in 1986 (33 percent) was somewhat lower than in more recent years (between 42 and 56 percent of households) (Tables 3 and 10). Furthermore, per capita harvests of Dolly Varden char rose from nine pounds in 1986 to 18 pounds ibn 1991.

Dolly Varden char was among the top three harvested species in Noatak during two recent harvest surveys (1994 and 2007) (Table 13). Harvests of Dolly Varden char by Noatak residents accounted for 8.7 percent of the total subsistence harvest in 1994 and 17.6 percent in 2007. Furthermore, 91 percent of Noatak households used Dolly Varden char in 2007 and 83 percent attempted to harvest the resource (Table 12). Harvests of Dolly Varden char in 1971-1972 were substantially higher than in more recent years, with residents harvesting an estimated 250 pounds per capita (Table 18). Reasons for this may be related to declining harvests of fish for dog food, or variations in resource availability. During interviews in Noatak, seven residents reported decreased harvests in 2007 (SRB&A forthcoming)

Subsistence Use Areas, Seasonal Round, and Harvest Patterns

Kivalina residents' harvests of Dolly Varden char primarily occur along the Wulik River in the fall and throughout the winter months, and at the mouth of the Kivalina Lagoon in June (Map 67 and 68). As Map 67 shows, the Wulik River has the greatest concentration of overlapping use areas. A few individuals also reported Dolly Varden char use areas near Singoalik Lagoon, Kivalina River, and Ipiavik and Kotlik lagoons. Many of the subsistence resources harvested by Kivalina residents are seasonally available; however, Dolly Varden char is one of the few resources with multiple use areas accessed year round. Because this resource is available year round, residents reported a high number of trips per year to Dolly Varden use areas. Respondents reported taking six or more times yearly trips to over half of these areas compared to only 34 percent of all resources use areas (SRB&A forthcoming). Respondents identified 67 percent of all Dolly Varden char use areas are always successful and the remainder as being either usually successful or unpredictable. Early subsistence studies by Saario and Kessel (1966) and Braund and Burnham (1983) documented extended stays of several days at fall fish camps during which residents harvested large amounts of Dolly Varden char for the upcoming winter months. Duration of trip data for Kivalina's last 10 year Dolly Varden char use areas show residents take day trips to 98 percent of these use areas (SRB&A forthcoming). Faster and improved boat transportation as well as bears destroying upriver fish caches may explain in part this shift from extended camping toward day trips. The duration of trip represents residents' "usual" duration and a number of residents sometimes camp upriver while seining for Dolly Varden char in the fall, but more often than not the usual duration is one day. In 2007, Kivalina households harvested trout (Dolly Varden char) from the mouth of the Wulik River to Mount Jarvis, in the Kivalina Lagoon channels and other channels north of the community (Map 68). The majority of their Dolly Varden char use areas located on the Wulik River match the areas of highest overlap depicted for the 1998-2007 time period.

Saario & Kessel (1966) documented Kivalina fishing sites (Map 13), all located along the Wulik River, and presumably used to catch Dolly Varden char, the primary contributor to Kivalina's fish harvests (see

“Harvest Trends,” above). Similarly, Braund and Burnham (1983) show all but one of Kivalina’s 1977-1982 Dolly Varden char seining use areas located along the Wulik River (Map 13). Pre-mine lifetime fishing use areas (including Dolly Varden char, salmon, and other non-salmon fish) for Kivalina residents also appear on Map 13 and 68. This map shows fishing use areas along the Kivalina and Wulik rivers, along the coast from Ipiavik Lagoon to Asikpak River, and south of the community near Sheshalik and in Selawik Lake.

Current (1998-2007) Noatak use areas for Dolly Varden char (locally called “trout”) are located along a long expanse of the Noatak River, at Sheshalik, and along the Wulik River (Map 69). Residents harvest Dolly Varden char at Sheshalik during the spring in nets, and along the Noatak River in the summer with rod and reel, in the late summer/early fall with seine, and during the winter months with a jigging pole. As indicated by the variety of harvest methods associated with Dolly Varden char, residents’ harvests of this resource occur year round, peaking slightly in September/October, the fall seining season; June, when residents harvest Dolly Varden char at Sheshalik in nets and along the river with rod and reel; and from February to April, the primary months for ice fishing. Residents access their Dolly Varden char use areas by boat, snowmachine, and foot, depending on the timing and location of the harvest. The frequency of yearly trips to Dolly Varden char is high, with residents going more than 20 times a year to one-third of Dolly Varden char use areas. Another quarter of use areas are visited between six and 20 times per year, and only 19 percent are visited once per year. Many of those use areas visited one time per year are likely those located at Sheshalik, where residents often stay over two weeks.

ADF&G data showing 2007 Noatak use areas for “trout” (Map 70) depict the majority of harvest activity occurring along the Noatak River between the mouths of Eli and Kugururok rivers. Uses also occurred on the Wulik River and at the mouth of the Noatak River. Partial 1995-2004 use areas available in SRB&A (2005) show fish uses along the Wulik River, Rabbit Creek (Map 39; not pictured on Map 69) and at Kotlik Lagoon (Map 69). SRB&A (2005) indicates that residents reported traveling to these areas to harvest Dolly Varden char and rainbow trout by net, trap, or ice fishing. The only pre-mine data on Dolly Varden char use areas are partial and limited to uses west of the Noatak River (Map 31). Uses for the 1977-1982 time period occurred along the Wulik River and Rabbit Creek. Residents have reported fishing for Dolly Varden char at both of these locations since mining operations began. Residents generally reported high success rates at Dolly Varden char use areas, with 94 percent described as always or usually successful. However, a number of residents reported decreased success in recent years (see SRB&A forthcoming).

Dolly Varden Char Resource Changes

The 1984 EIS addressed potential effects to fish, including Dolly Varden char (locally referred to as “trout”) resulting from construction and operation of the Red Dog Mine (USEPA 1984). Potential effects raised included metal accumulation due to increased uses of Red Dog and Ikalukrok Creek by grayling, char, and salmon (although any potential for effects on humans were considered low). Other potential effects were discussed in relation to possible contamination due to construction and use of the road where it crossed fish bearing streams or rivers, as well as increased fishing pressure from local residents and mine employees at stream crossings.

Section 3.10.2.1 provides a baseline description of freshwater aquatic resources. Actual effects to fish resulting from the Red Dog Mine include loss of potential stream habitat at Red Dog Creek (although fish did not occur in that area of Red Dog Creek during pre-mining conditions), and higher overall numbers of fish downstream from the mine possibly due to improvements in water quality caused by wastewater treatment. Recent years have seen a decline in Dolly Varden char in the lower portion of Red Dog Creek because of improved water quality and resulting accessibility farther upstream from the mine site (See Section 3.10.2.1). Somewhat higher levels of metals were found in Dolly Varden char downstream from the DMTS; however, a risk assessment conducted in 2007 concluded that the potential for overall effects on fish due to exposure to metals at stream crossings was low. Another study sponsored by Maniilaq

Association concluded that metal concentrations in Dolly Varden char were not substantially different than for fish populations outside the mine area, and a 2002 study found that juvenile Dolly Varden char sampled in Red Dog Creek had higher levels of metals than in other local drainages (see Section 3.10.2.1 for further discussion and sources). Studies of effects of the mine on Dolly Varden char have generally been inconclusive due to the wide-ranging life-cycle of the resource. Dolly Varden char are anadromous, migrating from the sea to freshwater streams and rivers, and thus another potential source of effects on this species is the port site, located in the Chukchi Sea. Residents have expressed concern that development at the port site may cause fish to go elsewhere, lessening the availability of the resource to local subsistence users. The Corps' 2005 DeLong Mountain Terminal DEIS acknowledged that noises and habitat changes from construction drive fish away temporarily, but ultimately will not stop them from returning to their natal streams. Furthermore, fish return to habitat once disturbances stop (U.S. Army Corps of Engineers 2005). Reports of fish kills near the port site have not been linked to port site activities (see Section 3.10.2.1).

Dolly Varden char are a major source of subsistence food for residents of Kivalina, Noatak, and Kotzebue. Subsistence users in Kivalina have expressed concerns about potential contamination of Dolly Varden char through contamination of the watershed. Incidences such as residents being urged not to harvest the resource due to discharges from the mine (this reportedly occurred once in the 1980s) (SRB&A 2000), and observations of "fish kills" (SRB&A 2005) have made some residents even more concerned about the health of the resource and the health of local residents who use the resource. During SRB&A interviews with subsistence users in 2008, 65 percent of Kivalina harvesters and 32 percent of Noatak harvesters made observations about changes in Dolly Varden char (Table 7). Principal changes observed were: (1) physical abnormalities; (2) harvest less; (3) decrease in species number; (4) abnormal resource death; (5) change in texture of meat; and (6) move to different areas (Table 53).

Table 53: Observations of Dolly Varden Char Resource Changes

Observation	Number of Observations			Percent of Observations		
	Kivalina	Noatak	Total	Kivalina	Noatak	Total
Physical Abnormalities	11	0	11	22%	0%	13%
Harvest less	2	7	9	4%	20%	10%
Decrease in Species Number	2	7	9	4%	20%	10%
Abnormal Resource Death	7	1	8	14%	3%	9%
Change in Texture of Meat	8	0	8	16%	0%	9%
Move to Different Areas	2	3	5	4%	9%	6%
Climate affecting travel	3	0	3	6%	0%	3%
Habitat Disturbed/Destroyed	2	1	3	4%	3%	3%
Disease/Infection	0	3	3	0%	9%	3%
Later Migration/Arrival	0	3	3	0%	9%	3%
Shorter migration	3	0	3	6%	0%	3%
Take more trips	0	2	2	0%	6%	2%
Take shorter trips	2	0	2	4%	0%	2%
Worse success	0	2	2	0%	6%	2%
Habitat obstructed	0	2	2	0%	6%	2%
Increase in Species Number	2	0	2	4%	0%	2%
Decrease in Resource Size	2	0	2	4%	0%	2%
Take fewer trips	0	1	1	0%	3%	1%
More difficult	0	1	1	0%	3%	1%
Travel farther to harvest resource	1	0	1	2%	0%	1%
Use area changed	0	1	1	0%	3%	1%
Harvest season changed	0	1	1	0%	3%	1%

Observation	Number of Observations			Percent of Observations		
	Kivalina	Noatak	Total	Kivalina	Noatak	Total
Increase in Resource Size	1	0	1	2%	0%	1%
Change in Resource Behavior	1	0	1	2%	0%	1%
Resource Injury	1	0	1	2%	0%	1%
Abnormal Migratory Event	1	0	1	2%	0%	1%
Total Observations	51	35	86	100%	100%	100%
Total Number of Dolly Varden Char Change Observers	28	13				

Stephen R. Braund & Associates, 2008.

Physical Abnormalities. Eleven Kivalina observations cited physical abnormalities in Dolly Varden (Table 53), including physical deformities, open sores, patchy or peeling skin, and cysts with pus (SRB&A forthcoming). Nine of the 11 did not know the reason for the change (Table 54). No more than two persons cited any single reason. Related to the 11 observations of physical abnormalities in Dolly Varden char is eight observations of a change in the texture of Dolly Varden char meat made by Kivalina residents (Table 53). These residents observed that the fish are not as firm as they were in the past. As one individual described, "I saw some char like they are elders or something. They don't really cut very well. It looked good, but when you touch it, it is real soft and when you try and cut it, it is real soft" (SRB&A Kivalina Interview January 2008). In contrast to Kivalina subsistence users, Noatak residents did not note any changes in the texture or physical appearance of the resource, although three observations were made regarding diseases or infection of Dolly Varden char (Table 53).

Table 54: Reasons for Change in Dolly Varden Char – Physical Abnormalities

	Number of Observations			Percent of Observations		
	Kivalina	Noatak	Total	Kivalina	Noatak	Total
Water contaminated by mine	2		2	18%		18%
I Do not Know	9		9	82%		82%
Total	11		11	100%		100%

Stephen R. Braund & Associates, 2008.

Other Non-salmon Fish

Harvest Trends

According to Table 8, Kivalina households' 2007 harvests of Other Non-salmon Fish represented three percent of the total harvest for a total of 18 pounds per person. The 1992 Other Non-Salmon harvest levels were slightly higher than 2007, accounting for 4.7 percent of the total harvest and providing 35 pounds per person. In 1992, humpback whitefish, saffron cod, and arctic cod were the top species of Other Non-salmon Fish harvested for that year, and in 2007, saffron cod, whitefish, and grayling were the top three non-salmon fish harvested (Table 9). These species were also consistently among the top species of non-salmon fish harvested during earlier harvest studies from the 1960s to the 1980s (Table 1). Current (1992 and 2007) Other Non-salmon Fish harvests have increased compared to all previous study years except the 1971-1972 study (Tables 14 and 15).

As sheefish are a major subsistence resource for residents of Kotzebue, Other Non-salmon Fish contribute more to Kotzebue subsistence harvests than in the other study communities. Current harvest data show other non-salmon fish accounting for between 21.2 and 33.2 percent of the total harvest during four study years (1991, 2002, 2003, and 2004) (Table 10). Harvest studies from 2002-2004 were funded by the Native Village of Kotzebue and include fish harvest amounts only for chum salmon, Dolly Varden char, and sheefish. Top harvested non-salmon fish in 1991 included sheefish (which was the top harvested species in 2002, providing more household pounds than caribou), tom cod, herring, pike, whitefish, and cisco (Table 11). Similar species were among the top harvested resources in 1986, with sheefish accounting for 12.2 percent of the total harvest, considerably less than in recent years (Table 4). Residents in 1986 harvested fewer pounds of sheefish per capita (49 pounds) than in 1991 (117) (Table 16). The harvest data indicate a possible increase in sheefish harvests in the early 1990s which have stayed relatively consistent over the years.

Harvests of Other Non-salmon Fish by Noatak residents provided 4.1 percent of the total subsistence harvest in 1994 (19 pounds per capita) and 9.2 percent of the total harvest in 2007 (34 pounds per capita) (Table 12). Top harvested species of Other Non-salmon Fish during those years included whitefish, burbot, sheefish, grayling, Bering cisco, and northern pike (Table 13). Whitefish was the only species of Other Non-salmon Fish included among the top harvested species from 1971-1972, and Other Non-salmon Fish accounted for only 2.3 percent of the harvest that year (Tables 5 and 6). The harvest data provided in Tables 5 and 12 indicate an increase in Noatak residents' use of Other Non-salmon Fish.

Subsistence Use Areas, Seasonal Round, and Harvest Patterns

Kivalina residents reported Other Non-salmon Fish use areas along the Kivalina and Wulik Rivers, in Kivalina Lagoon, at the mouth of New Heart Creek, and in Kotzebue Sound south of Sheshalik (Maps 71 and 72). Community members identified the majority of their Other Non-salmon Fish use areas along the Wulik River and in Kivalina Lagoon directly next to the village. Many of the use areas reported in Kivalina Lagoon were reported as tomcod use areas. While Other Non-salmon Fish harvests occur throughout the year, the majority of harvest activities take place from September to November during which boat, snowmachine, and foot are the primary modes of transportation used (SRB&A forthcoming). Residents reported taking between two and 20 trips (almost exclusively day trips) to 67 percent of use areas. Residents reported a success rate of always or usually successful at 98 percent of their Other Non-salmon Fish use areas. During ADF&G 2008 household surveys, Kivalina residents provided whitefish subsistence use areas accessed during 2007 (Map 72). All of their whitefish use areas occur along the Wulik River and in the Kivalina Lagoon channel nearest to the community. Earlier fish use areas appear on Map 13. For a description of these use areas see under "Dolly Varden Char." Map 13 also depicts a whitefish seining area in Kivalina Lagoon near the mouth of the Wulik River used from 1977-1982.

Last 10 year (1998-2007) Noatak use areas for Other Non-salmon Fish are depicted on Map 73 and include use areas for whitefish, Arctic grayling, northern pike, and sheefish. Of these species, whitefish is the most commonly harvested. As with Dolly Varden char, harvests of Other Non-salmon Fish occur year round. Harvest activities peak in June/July, when residents set nets for whitefish at Sheshalik, and in September/October while seining for Dolly Varden char and whitefish along the Noatak River. Residents also harvest non-salmon fish through the ice in the winter time and with rod and reel, and thus residents' methods of travel to Other Non-salmon Fish use areas include boat, snowmachine, and to a lesser extent four-wheeler and foot. Residents generally take anywhere from one trip to more than 20 trips per year to Other Non-salmon Fish use areas; only 14 percent were not visited on a yearly basis. Although the majority of their harvest activities occur during same day trips, residents reported being absent for more than one week while visiting 19 percent of their use areas (SRB&A forthcoming). The majority of these use areas are located at Sheshalik or along the Noatak River while residents stay at cabins. Respondents generally reported high rates of success for Other Non-salmon Fish, with 89 percent of use areas described as always or usually successful (SRB&A forthcoming). Current use areas for other non-salmon fish are located along the Noatak River from the mouth to beyond Nimiuktuk River, at Sheshalik, and based out of several other communities including Kivalina (Wulik River), Kotzebue, and Noorvik (Map 73). In 2007 residents reported harvesting whitefish along the Noatak River between the mouths of Eli and Kugururok rivers, and at Sheshalik (Map 74). No pre-mine use area data are available for any species of fish other than Dolly Varden char.

Other Non-Salmon Fish Resource Changes

As discussed under “Dolly Varden Char,” and in Section 3.10.2, studies regarding the effects of the Red Dog Mine on freshwater fish have been somewhat inconclusive. The DEIS for navigational improvements at the port site (U.S. Army Corps of Engineers 2005) reported no evidence that changes to habitat or small spills related to the Red Dog Mine, port site, and DMTS, have resulted in effects on the population or harvests of local fish species. Arctic grayling have become increasingly present in Red Dog Creek, an occurrence attributed to improved water quality and other factors (See Section 3.10.2.1). Sixteen percent of Kivalina respondents and seven percent of Noatak respondents made observations about changes in other non-salmon fish (Table 7), including abnormal resource death, increase in species number, and increase in species size (Table 55). No single change was cited more than three times.

Table 55: Observations of Other Non-salmon Fish Resource Change

Observations	Number of Observations			Percent of Observations		
	Kivalina	Noatak	Total	Kivalina	Noatak	Total
Abnormal Resource Death	4	0	4	33%	0%	25%
Increase in Species Number	3	0	3	25%	0%	19%
Increase in Resource Size	3	0	3	25%	0%	19%
Harvest less	0	2	2	0%	50%	13%
New Species in Region	1	1	2	8%	25%	13%
Physical Abnormalities	1	0	1	8%	0%	6%
Later Migration/Arrival	0	1	1	0%	25%	6%
Total Observations	12	4	16	100%	100%	100%
Total Number of Other Non-Salmon Fish Change Observers	7	3				

Stephen R. Braund & Associates, 2008.

Salmon

Harvest Trends

Unlike their Noatak neighbors to the east, salmon have never accounted for a large portion of the subsistence harvest of Kivalina. Table 8 shows salmon contributing less than two percent to the overall subsistence harvest in 1992 and 2007. Chum salmon was the most harvested of the salmon species during these two years (Table 9). Comparisons to earlier harvest studies show that salmon comprised an even smaller amount, between zero and 0.6 percent, of the overall harvest than more recent years (Table 15). Per capita harvests have also risen, with residents harvesting one pound percapita in 1983, five pounds in 1984, 15 pounds in 1992, and eight pounds in 2007.

During recent (1991, 2002, 2003, and 2004) harvest studies in Kotzebue, chum salmon was the second most harvested species of fish in terms of its contribution toward total yearly harvests, and the fourth most harvested resource (Table 11). During four harvest studies (1991, 2002, 2003, and 2004), chum salmon accounted for between 12.3 (in 1991) and 16.1 (in 2004) percent of total Kotzebue subsistence harvests, providing between 330 and 863 mean household pounds of wild foods during each of those years (Table 11). The percentage of households using salmon in 1986 (85 percent) was similar to the percentage of households using salmon in 1991 (90 percent) (Tables 3 and 10). Per capita harvests have also remained similar, at 73 pounds in 1986 and 75 pounds in 1991. The mean household pounds of salmon harvested in 1986, at 256, was somewhat lower than in recent years.

Salmon is an important subsistence resource in Noatak, comprising 26.1 and 14.1 percent of the total harvest during the 1994 and 2007 study years (Table 12). As with the other communities, chum salmon is the primary species of salmon harvested; it was the second harvested species, in terms of its contribution toward the total harvest, in 1994, and the third harvested resource in 2007 (Table 13). Per capita pounds of harvested salmon were lower in 2007 (51 pounds) than in 1994 (120 pounds); while some Noatak residents interviewed in 2008 reported harvesting fewer salmon over the last 10 years, their explanations for the decline varied widely. Noatak's 1971-1972 harvest of salmon was not substantially different from more recent harvests; however, 1960-61 harvest data show Noatak residents harvesting 1,692 pounds of salmon per capita (Table 18). Foote and Williamson (1966) explain that the majority of these salmon were fed to dogs (see discussion under "All Resources").

Subsistence Use Areas, Seasonal Round, and Harvest Patterns

Kivalina salmon use areas for 1998-2007 are located along the Kivalina and Wulik rivers, in Kivalina Lagoon, and at the mouth of New Heart Creek (Map 75). Similar to the majority of their fish harvests, Kivalina respondents identified the bulk of their salmon use areas along the Wulik River. Access to 72 percent of these areas is by boat, with the remainder of areas, those located closest to Kivalina, accessed by four-wheeler and foot (SRB&A forthcoming). Residents travel more than six times per year to half of their salmon use areas, and are always successful at 73 percent of use areas. Like their other fish use areas, residents take day trips to nearly all salmon use areas. For 2007, Kivalina households reported salmon use areas along the Wulik River and in both Kivalina Lagoon channels (Map 76). Pre-mine fishing use areas, including salmon use areas, appear on Map 13. For a description of these use areas, see under "Dolly Varden Char."

In Noatak, harvests of salmon generally occur from July through September with net, rod and reel, and by seining, primarily along the Noatak River (Map 77). While residents access the majority of salmon use areas by boat, nearby fishing locations are often accessible by foot or four-wheeler (SRB&A forthcoming). Residents reported taking primarily day trips from the community to harvest salmon, although some reported staying for extended periods of time at Sheshalik or elsewhere during the salmon harvest. Residents generally reported taking multiple yearly trips to salmon use areas, with close to half visited more than three times per year, and another one-quarter visited two to three times yearly. During SRB&A interviews in 2008 documenting last 10 year (1998-2007) use areas, residents reported traveling south along the Noatak River to the mouth and north substantial distances to harvest salmon (Map 77). Other last 10 year use areas are located along the coast from Sheshalik and in front of Kotzebue. Noatak use areas reported during ADF&G household surveys for the 2007 study year are located along a somewhat smaller expanse of the Noatak River, along the coast from Sheshalik, and in front of Kotzebue (Map 78). Residents described 89 percent of their salmon use areas as always successful, substantially higher than the 62 percent for resources as a whole. No pre-mine Noatak salmon use area data are available for comparison.

Salmon Resource Changes

A discussion of potential impacts to anadramous fish resulting from the Red Dog Mine is under "Dolly Varden Char." Effects related to the port site, DMTS, and mine site are believed to be localized and temporary, associated mainly with noise and temporary changes to habitat (U.S. Army Corps of Engineers 2005; Section 3.10.2.2).

While residents generally discuss concerns related to contamination of fish in the context of Dolly Varden char, the source of most of their yearly fish harvests, effects on salmon are also a concern. During interviews in 2008, 25 percent of Kivalina harvesters interviewed and 40 percent of Noatak harvesters interviewed made observations about changes in salmon (Table 7). The principal changes cited were: (1) increase in species number; (2) harvest less; and (3) disease/infection (Table 56).

Increase in Species Number. No one reason for an increase in the number of salmon was cited by more than three respondents (Table 57). In Noatak, several people mentioned that the number of salmon running in the Noatak River increased once commercial fishing slowed down in Kotzebue Sound. As one individual observed, "There is an abundance of salmon nowadays due to the lack of commercial fishing. Our river's full of salmon" (SRB&A Noatak Interview January 2008).

Table 56: Observations of Salmon Resource Change

Observation	Number of Observations			Percent of Observations		
	Kivalina	Noatak	Total	Kivalina	Noatak	Total
Increase in Species Number	8	3	11	47%	13%	28%
Harvest less	0	6	6	0%	26%	15%
Disease/Infection	1	4	5	6%	17%	13%
Decrease in Species Number	3	0	3	18%	0%	8%
New Species in Region	3	0	3	18%	0%	8%
Migration changed or diverted	0	3	3	0%	13%	8%
Change in Harvest Methods	0	2	2	0%	9%	5%
Abnormal Resource Death	2	0	2	12%	0%	5%
Take fewer trips	0	1	1	0%	4%	3%
Habitat Changed	0	1	1	0%	4%	3%
Change in Habitat Location	0	1	1	0%	4%	3%
More males	0	1	1	0%	4%	3%
Later Migration/Arrival	0	1	1	0%	4%	3%
Total Observations	17	23	40	100%	100%	100%
Total Number of Salmon Change Observers	11	17				

Stephen R. Braund & Associates, 2008.

Table 57: Reasons for Change in Salmon – Increase in Species Number

Cause	Number of Observations			Percent of Observations		
	Kivalina	Noatak	Total	Kivalina	Noatak	Total
Less commercial fishing/hunting	0	3	3	0%	100%	38%
Natural causes	2	0	2	40%	0%	25%
I Do not Know	3	0	3	60%	0%	38%
Total Observations	5	3	8	100%	100%	100%

Stephen R. Braund & Associates, 2008.

Berries

Harvest Trends

Residents of the study communities have indicated that harvests of berries vary from year to year based on the amount of rain and snow the area receives. During years of abundant berry growth, berry harvests are substantial. Local residents generally try to harvest enough berries to last until the next berry picking season.

In recent harvest surveys (1992 and 2007), 90 percent or more of Kivalina households reported using berries (Table 8). Berry harvests comprised approximately two to three percent of the total harvest during these two years, for 13 to 17 pounds per person. In 2007, berries were the fourth most harvested resource after bearded seal, Dolly Varden char, and caribou (Table 9). Prior studies in the early 1960s, 1970s, and 1980s estimated berries contributing between 0.2 and 1.3 percent of the subsistence harvest of Kivalina residents (Table 15). Per capita amounts show an increasing trend in Kivalina households' use of berries from 1959 to 2007 (Table 14).

The most recent Kotzebue harvest data for berries are for the year 1991 and show a high percentage of households using (92 percent) and harvesting (83 percent) berries (Table 10). During that year, berries accounted for 2.6 percent of the total subsistence harvest, at 15 pounds per capita. In 1986 81 percent of households used berries and 57 percent harvested berries, with that year's berry harvest providing approximately seven pounds per capita (Table 3). Per capita harvests of berries rose to 15 pounds in 1991.

Noatak berry harvests rose dramatically between 1994 and 2007, with residents picking over five times as many berries in 2007 (Table 12). In 1994, harvests of berries provided four pounds per person and accounted for one percent of the total harvest, while in 2007 households harvested approximately 16 pounds of berries per person, which accounted for 4.5 percent of the total yearly harvest. Comparison to earlier harvest data from the 1960s and 1970s, when berries accounted for .3 and 1.1 percent of the total harvest, respectively, indicates a possible increase in residents' use and harvest of the resource (Table 19). Foote and Williamson (1966), who collected the 1960-61 harvest data, noted that the summer of 1960 was especially dry and produced few berries.

Subsistence Use Areas, Seasonal Round, and Harvest Patterns

Kivalina berry harvesters reported picking berries primarily during August and September by boat and four-wheeler along the coast and lagoons from Cape Krusenstern to Cape Seppings as well as by boat along Kivalina and Wulik rivers. An isolated berry picking area was reported along the DMTS (Maps 79 and 80). Map 79 shows berries, plants, and wood use areas combined, and Map 80 shows only berry use areas. The greatest concentration of overlapping berry use areas is found along the perimeters of Kivalina and Imikruk lagoons, and several miles along the Wulik River from the mouth. Residents travel to 80 percent of their berry use areas between two and 20 times a year (SRB&A forthcoming). Berry harvesters take day trips to 99 percent of their use areas and are always successful in their harvest efforts at 95 percent of these areas. Twenty-eight Kivalina households reported 2007 plant and berry picking areas between Rabbit Creek and Kisimilok Creek (Map 79). These households reported harvesting berries and plants at several lagoons between these two points, along the Wulik River, as well as a large inland area surrounding Kivalina River to the northeast of the community (Map 79). During 2008 SRB&A interviews, a number of respondents said they no longer harvest berries near the port site as they once had because of concern over ore dust contaminants resulting from trucking and port site activities. These same concerns were also expressed during 2004 interviews in Kivalina (SRB&A 2005:44). For additional discussion of berry use area changes see "Berries Resource Changes" below. Pre-mine berry and plant subsistence use areas documented by Saario and Kessel (1966) and Braund and Burnham (1983), shown on Map 16, are located along the Kivalina and Wulik rivers, and along Kivalina and Imikruk lagoons. Kivalina's lifetime berry and plant use areas cover a much more expansive area than more recent use areas, including the coastline and inland areas from Sheshalik to Cape Seppings, entire lengths of the Kivalina and Wulik rivers, and other areas near Kotzebue, Noorvik, and Shishmaref (Maps 16 and 79).

Noatak subsistence users described berry use areas for the 1998-2007 time period. Map 81 shows all berry, plant, and wood use areas with 2007 and lifetime data included. Map 82 shows only berry use areas. Residents harvest berries along the Noatak River, around the community, and at various other coastal locations between the mouth of Noatak River and Cape Krusenstern, at Rabbit Creek, and near the communities of Kivalina and Kotzebue. In addition, partial use areas documented for 1995-2004 show Noatak residents harvesting berries at Kotlik Lagoon (SRB&A 2005). The highest frequencies of 1998-2007 overlapping use areas shown on Map 82 are located around the community of Noatak, along the Noatak River between Kelly and Agashasok rivers, along Paul Slough, at Sheshalik, and around Krusenstern Lagoon (near Cape Krusenstern). Berry picking activities usually begin in July, peak in August, and continue into September. Residents generally travel by boat to access riverside or coastal areas and by foot or four-wheeler to access areas near the community or their camps at Sheshalik. A number of residents reported taking a second trip to Sheshalik in the summer, after the spring marine mammal hunt, and staying for several days to a couple of weeks to harvest berries and plants. Residents also take multiple yearly day trips from Noatak to pick berries close to the community and along the Noatak River. According to Noatak respondents, over 50 percent of their berry picking areas are visited at least twice per year. Berry and plant use areas reported by residents for the 2007 study year are located along the Noatak River, near Sheshalik and Cape Krusenstern, and near the communities of Kivalina and Kotzebue (Map 81). Pre-mine lifetime berry harvesting areas are located along the Noatak River, along the coast between Sheshalik and Cape Krusenstern, and at the mouth of the Noatak River (Map 81). Current use areas for berries occur along a substantially larger segment of the Noatak River (although pre-mine berry use areas are located in a slightly larger overland area east of the river), as well as in locations near other communities, indicating that Noatak berry use areas have changed little over the last 20 years. Harvest success for berries was described as always or usually at 92 percent of Noatak residents' berry picking areas. The main factors affecting berry success, according to Noatak residents, are precipitation levels and temperatures during the summer months. Dry, hot summers do not produce large quantities of berries.

Berries Resource Changes

Section 3.7.2 provides a baseline description of vegetation, including berries, and discusses effects on vegetation related to the Red Dog Mine. Operations related to the Red Dog Mine have affected vegetation (including berries) along the DMTS corridor and at the port site both directly and indirectly. Local uses of vegetation have also been affected. The main direct effect on vegetation is the construction of the port site, road, and mine site and the accompanying loss of vegetation in those areas. Another effect is contamination of vegetation from fugitive dust related to mine operations. As reported in Section 3.7.2, vegetation near the port site, road, and mine facilities have higher levels of metal and dust concentrations; the highest concentrations of dust are located along the DMTS near the port site, and on the north side of the road. Residents once harvested berries at the port site, but many now avoid that area due to concerns of contamination (SRB&A 2005). Others choose to continue picking berries in the port site vicinity. Subsistence users in Kivalina have noticed changes in the color and health of vegetation along the road and near the port and blamed the changes on increased amounts of dust and metals. One person described flying over the port sight and seeing a "perfect circle around it of brown and orange" (SRB&A 2005).

Contamination of berries is still a concern to residents and was raised during 2007 scoping meetings. During SRB&A interviews in 2008, 50 percent of Kivalina harvesters interviewed and 22 percent of Noatak harvesters interviewed made observations about change in berries (Table 7). The principal changes observed in berries were: (1) use area changed; (2) habitat disturbed/destroyed; (3) decrease in species number; and (4) increase in species number (Table 58). Residents also pointed out various changes related to the health or quality of berries, including dust on vegetation, decrease in resource size, change in texture or color, change in taste, increase in resource size, contamination, physical abnormalities, resource appears unhealthy, and resource no longer edible.

Table 58: Observations of Berries Resource Changes

Observation	Number of Observations			Percent of Observations		
	Kivalina	Noatak	Total	Kivalina	Noatak	Total
Use area changed	9	0	9	29%	0%	18%
Habitat Disturbed/Destroyed	6	1	7	19%	5%	14%
Decrease in Species Number	2	4	6	6%	21%	12%
Increase in Species Number	2	3	5	6%	16%	10%
Dust on Vegetation	3	0	3	10%	0%	6%
Decrease in Resource Size	0	3	3	0%	16%	6%
Change in texture/color of Berries/Plants	3	0	3	10%	0%	6%
More difficult	0	2	2	0%	11%	4%
Worse success	0	2	2	0%	11%	4%
Taste	2	0	2	6%	0%	4%
Harvest more	0	1	1	0%	5%	2%
Harvest less	1	0	1	3%	0%	2%
Resource Distributed over Larger Area	0	1	1	0%	5%	2%

Observation	Number of Observations			Percent of Observations		
	Kivalina	Noatak	Total	Kivalina	Noatak	Total
Increase in Resource Size	0	1	1	0%	5%	2%
Contamination	1	0	1	3%	0%	2%
Physical Abnormalities	0	1	1	0%	5%	2%
Resource appears unhealthy	1	0	1	3%	0%	2%
Resource No Longer Edible	1	0	1	3%	0%	2%
Total Observations	31	19	50	100%	100%	100%
Total Number of Berries Change Observers	22	11				

Stephen R. Braund & Associates, 2008.

Nine Kivalina harvesters reported a berry use area change. All nine attributed the change to dust from mine-related activities (Table 59). Residents indicated that there are areas where they used to harvest berries that they no longer use due to observed or perceived contamination resulting from port site/barge activities, mine activities and traffic along the DMTS. One person described the area affected as "a two mile radius around the port and the road, the sides of the road, and the mine" (SRB&A Kivalina Interview January 2008).

Table 59: Reasons for Change in Berries – Use Area Changed

Cause	Number of Observations		
	Kivalina	Noatak	Total
Contaminated by ore dust from trucks	6		6
Contamination due to mining activities	1		1
Contaminated by ore dust from barges and port	2		2
Total	9		9

Stephen R. Braund & Associates, 2008.

Plants and Wood

Harvest Trends

In 2007, 43 percent of Kivalina households used plants and wood, primarily plants, and plants and wood accounted for 0.3 percent of the overall harvest (Table 8). In 1992, a slightly greater percent of households (50 percent) reported use of plants for 0.1 percent of the total harvest. As shown in Table 15, Kivalina residents' use of plants and wood has changed little since the 1959-60 study, comprising between zero and 0.4 percent of the total harvest during following study years, and providing between zero and two pounds of usable weight per capita.

In 1991 Kotzebue households' harvests of plants and wood contributed .1 percent to that year's total subsistence harvest, providing approximately one pound of plants per capita (Table 10). One-third of Kotzebue households harvested plants, and 41 percent reported using plants. Plants accounted for .1 percent of the total harvest in 1986, and for .2 percent of the harvest in 1971-1972 (Table 17). Given the available data, Kotzebue residents' harvests of plants have not changed substantially, although a smaller percentage of households used and harvested plants in 1986 (Table 3).

Noatak residents' harvests of plants and wood have accounted for .1 percent of the total subsistence harvest during recent study years, providing less than one pound per capita (1994 and 2007) (Table 12). Uses of plants rose in 2007 from 1994, with 51 percent of households using the resource in 2007 as opposed to only 22 percent in 1994. The total amount of plants harvested, however, was similar during both years. Compared to earlier plant harvest data from the 1970s (1960-61 plant harvest data are not available) (Table 5), plant and wood harvests have declined somewhat; however, this may be a result of fewer residents harvesting wood for fuel in recent years.

Subsistence Use Areas, Seasonal Round, and Harvest Patterns

Kivalina 1998-2007 plants and wood subsistence use areas are primarily located at the north end of Kivalina Lagoon and along Kivalina and Wulik rivers, with a few additional areas along the beach north of Kivalina, and near Rabbit Creek, Kotlik Lagoon and Noatak (Map 83). Residents reported traveling to the majority of these use areas by boat and four-wheeler to harvest plants in July and August, although several were used to harvest driftwood. The highest number of plant and wood subsistence use areas occurs at the northern and southern end of Kivalina Lagoon and along the lower portion of the Wulik River. Similar to the duration and success at berry use areas, Kivalina residents take day trips to 97 percent of plant use areas and are always successful at all plant use areas (SRB&A forthcoming). Unlike their berry use areas, residents take far fewer trips to harvest plants, traveling three or fewer times a year to 89 percent of plant use areas. Kivalina's 2007 and lifetime berry and plant use areas appear on Map 79. Map 16 shows pre-mine berry and plant subsistence areas used by Kivalina residents, which are discussed under "Berries."

Noatak residents reported harvesting plants, including sourdock (wild spinach), wild potato (*masu*), Hudson's Bay tea, stinkweed, and wild onion; and wood from 1998-2007 at various locations along the Noatak River, along the coast from Sheshalik to Cape Krusenstern (Sealing Point), and near Kotzebue (Map 84). Harvesting of these resources occur year-round. The highest frequency of overlapping use areas reported by Noatak residents occurs on either side of the Noatak River in the vicinity of Noatak. Residents travel into the hills west of Noatak, as well as east of the river, to harvest wood primarily during the late fall and winter months; and during the summer they gather plants at various preferred locations along the river (including on islands) and between Sheshalik and Cape Krusenstern. Residents generally take only a few trips per year to harvest plants, as they are not harvested in large quantities. During interviews, respondents indicated that they took no more than three trips to 82 percent of plant and wood use areas. Most of these trips were day trips from the community; however, as discussed above ("Berries"), a number of people take trips to Sheshalik during the summer and stay for extended periods of time (from several nights to more than two weeks), exclusively to harvest berries and plants along the coast. Others harvest berries and plants while at Sheshalik in the spring and early summer. Berry and plant use areas for the 2007 ADF&G study year are depicted on Map 81 and are located in similar areas to the last 10 year berry and plant use areas shown. Pre-mine lifetime use areas for wood are shown on Maps 34 and 81 and depict uses along the Noatak River from Kelly River to the mouth. Several Noatak residents indicated that fewer residents currently harvest wood due to the increasing use of stove oil for heat (SRB&A forthcoming). Success rates for plants and wood as reported by Noatak respondents were high (83 percent of use areas were described as always successful); however, several people commented that finding *masu* takes experience and knowledge.

Plants and Wood Resource Changes

The discussions under "Berries Resource Changes" and in Section 3.7.2 (Vegetation), describe changes in harvests of vegetation resulting from the Red Dog Mine and related operations. Residents have primarily voiced concerns about effects of the Red Dog Mine on berries; however, effects to wild harvested plants are similar. During SRB&A interviews with residents in 2008, five percent of Kivalina respondents and 10 percent of Noatak respondents made observations about changes in plants and wood (Table 7). No more than three observations were made in either community regarding any one change in plants and wood (Table 60).

Table 60: Observations of Plants and Wood Resource Changes

Observations	Number of Observations			Percent of Observations		
	Kivalina	Noatak	Total	Kivalina	Noatak	Total
Harvest less	0	3	3	0%	75%	50%
Decrease in Species Number	1	1	2	50%	25%	33%
Dust on Vegetation	1	0	1	50%	0%	17%

Total Observations	2	4	6	100%	100%	100%
Total Number of Plants and Wood Change Observers	2	4				

Stephen R. Braund & Associates, 2008.

Subsistence and Employment

SRB&A interviews included a brief questionnaire regarding residents' employment history related to the Red Dog Mine, including Teck Cominco Alaska, Incorporated (TCAK) and their subcontractors, and those companies' subsistence leave policies. Researchers asked Kivalina and Noatak respondents if they had worked for any company associated with Red Dog Mine, whether or not that company had a subsistence leave policy, and if the policy worked for the respondent. Table 61 summarizes both communities' responses.

Table 61: Subsistence Leave Policy Responses, Kivalina and Noatak

	Did Company Have a Subsistence Leave Policy?					Did Policy Work?				
Company Name/Type	**# of Employment Experiences**	**Yes**	**No**	**Do not know**	**Total**	**Number of records citing policy existed**	**Policy worked**	**Policy did not work**	**Do not know if policy worked**	**Total**
Teck Cominco	40	34%	37%	29%	100%	16	44%	6%	50%	100%
NANA	15	33%	33%	33%	100%	5	20%	20%	60%	100%
Current contractors	12	0%	82%	18%	100%	0	--	--	--	--
Construction contractors	22	10%	55%	35%	100%	2	100%	0%	0%	100%
Other companies	9	25%	38%	38%	100%	3	33%	33%	33%	100%
Total	98	24%	46%	30%	100%	26	42%	12%	46%	100%
Number of respondents = 58										

Stephen R. Braund & Associates, 2008.

A total of 58 respondents provided 98 employment experiences related to Red Dog Mine. Of the 98 experiences, 24 percent had a subsistence leave policy, 46 did not have a subsistence leave policy, and 30 percent were unknown. Of the 26 records citing that a subsistence leave policy existed, respondents reported that 42 percent said the policy worked, 12 percent said the policy did not work, and 46 percent did not know if the policy worked. A number of individuals who did not know whether a policy existed reported working temporary/seasonal jobs and were unaware of a subsistence leave policy or did not ask about one because their goal was to work as much as possible for the duration of their temporary/seasonal job. Several individuals reported the company they worked for did not have a subsistence leave policy, and that they would carry out their subsistence activities during their off weeks or during their paid time off. One person describing their employment experience with TCAK said,

> We had PTO – paid time off. It was only two weeks on, one week off. That one week we would do our subsistence. If we needed time off, we took PTO. It builds up, depending on how much you work. I wouldn't say much for [Name] (Construction), it was kind of like a contract. And Cominco is different, they're long term and they have a human resources office. Teck Cominco, they have everything there, human resources, people you can go talk to. (SRB&A Noatak Interview January 2008)

Researchers also asked respondents if the subsistence leave policies could be improved. Individuals recommended that companies without subsistence leave policies should incorporate one into their company. Others provided general recommendations that the companies should be more lenient towards employees needing time off for subsistence purposes or allow employees to accrue subsistence leave hours, and others provided specific suggestions regarding subsistence leave including the following:

> Just in regards to Kivalina side, whaling is usually the best time of the year like March, April, and May and they could grant the Kivalina guys more paid leave for hunting and whaling. Whaling season. (SRB&A Kivalina Interview January 2008)

> Yeah, [employees should get] at least two days off. Two to three days off to hunt caribou. I was a hopper crew operator and mill operator. (SRB&A Kivalina Interview January 2008)

In general, respondents were unsure if a subsistence leave policy even existed or stated that the companies they worked for never had such a policy. As depicted in Table 61, in 30 percent of employment experiences residents did not know whether a subsistence leave policy existed. Lack of communication between the companies and their employees regarding subsistence leave appears to be the primary reason for respondents' uncertainty.

MAPS

Map projection: NAD 1983 UTM Zone 3

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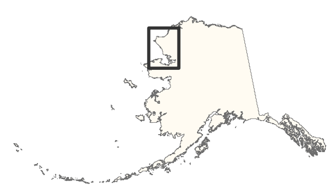
Map 1: Pre-Mine Subsistence Use Areas Kivalina, All Resources

Lifetime (circa 1925-1986) Subsistence Use Areas
16 Kivalina harvesters
All Resources

1977-1982 Subsistence Use Areas
19 Kivalina harvesters, 8 Noatak harvesters, 4 Kotzebue harvesters
All Resources (partial) *



* 1977-1982 data only addressed use areas potentially affected by Red Dog Project development.

1950-1960 Subsistence Use Areas
Unspecified number of harvesters
All Resources (partial)

Previous to 1962 Subsistence Use Areas
Unspecified number of harvesters
All Resources (partial)

For all data sets, other areas may have been used for resource harvesting.

National Park Service Lands

DeLong Mountain Transportation System (DMTS)

Sources:
Lifetime: Schroeder, R., D. B. Anderson (ADF&G) and G. Hildreth (Maniilaq Association) 1987.
1977-1982: Braund, S.R. and D.C. Burnham 1983.
1950-1960: Foote, D.C. and H.A. Williamson 1966.
Previous to 1962: Saario, D.J. and B. Kessel 1966.

Map 2: Pre-Mine Subsistence Use Areas Kivalina, Caribou

Lifetime (circa 1925-1986) Subsistence Use Areas
16 Kivalina harvesters Caribou

1977-1982 Subsistence Use Areas
19 Kivalina harvesters, 8 Noatak harvesters, 4 Kotzebue harvesters, Caribou (partial) *

Previous to 1962 Subsistence Use Areas
Unspecified number of harvesters Caribou (partial)

* 1977-1982 data only addressed use areas potentially affected by Red Dog Project development.

For all data sets, other areas may have been used for resource harvesting.

National Park Service Lands

DeLong Mountain Transportation System (DMTS)

Sources:
Lifetime: Schroeder, R., D. B. Anderson (ADF&G) and G. Hildreth (Maniilaq Association) 1987.
1977-1982: Braund, S.R. and D.C. Burnham 1983.
Previous to 1962: Saario, D.J. and B. Kessel 1966.

Map projection: NAD 1983 UTM Zone 3

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Map 3: Pre-Mine Subsistence Use Areas Kivalina, Other Large Land Mammals

Lifetime (circa 1925-1986) Subsistence Use Areas

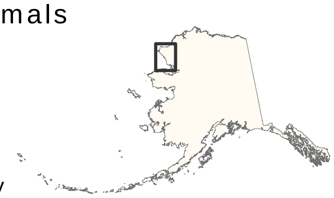
16 Kivalina harvesters Bear

16 Kivalina harvesters Sheep

1977-1982 Subsistence Use Areas

19 Kivalina harvesters, 8 Noatak harvesters, 4 Kotzebue harvesters Sheep (partial) *

* 1977-1982 data only addressed use areas potentially affected by Red Dog Project development.



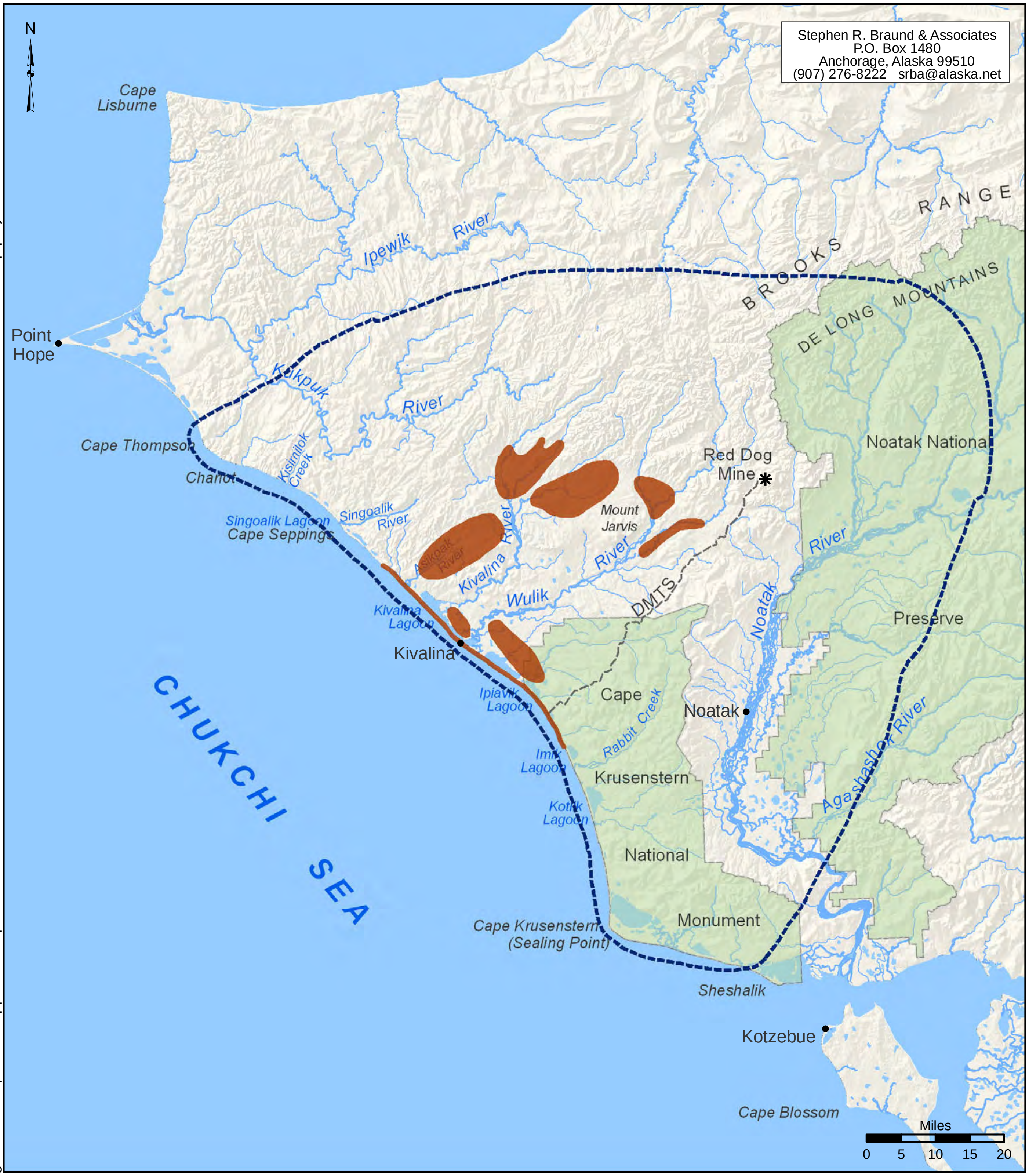
For all data sets, other areas may have been used for resource harvesting.

National Park Service Lands

DeLong Mountain Transportation System (DMTS)

Sources:
Lifetime: Schroeder, R., D. B. Anderson (ADF&G) and G. Hildreth (Maniilaq Association) 1987.
1977-1982: Braund, S.R. and D.C. Burnham 1983.

Map projection: NAD 1983 UTM Zone 3



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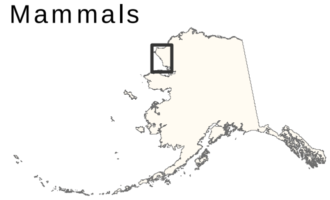
Map 4: Pre-Mine Subsistence Use Areas Kivalina, Furbearers and Small Land Mammals



Lifetime (circa 1925-1986) Subsistence Use Areas

16 Kivalina harvesters
Furbearers and Small Game

1977-1982 Subsistence Use Areas

19 Kivalina harvesters, 8 Noatak harvesters, 4 Kotzebue harvesters
Trapping (fox, wolverine, wolf) (partial) *

* 1977-1982 data only addressed use areas potentially affected by Red Dog Project development.

For all data sets, other areas may have been used for resource harvesting.

National Park Service Lands

DeLong Mountain Transportation System (DMTS)

Sources:
Lifetime: Schroeder, R., D. B. Anderson (ADF&G) and G. Hildreth (Maniilaq Association) 1987.
1977-1982: Braund, S.R. and D.C. Burnham 1983.

Map 5: Pre-Mine Subsistence Use Areas Kivalina, Moose

Lifetime (circa 1925-1986) Subsistence Use Areas

16 Kivalina hunters
Moose

1977-1982 Subsistence Use Areas

19 Kivalina harvesters, 8 Noatak harvesters, 4 Kotzebue harvesters
Moose (partial) *

* 1977-1982 data only addressed use areas potentially affected by Red Dog Project development.

For all data sets, other areas may have been used for resource harvesting.

National Park Service Lands

DeLong Mountain Transportation System (DMTS)

Sources:
Lifetime: Schroeder, R., D. B. Anderson (ADF&G) and G. Hildreth (Maniilaq Association) 1987.
1977-1982: Braund, S.R. and D.C. Burnham 1983.

Map 6: Pre-Mine Subsistence Use Areas Kivalina, Beluga

Lifetime (circa 1925-1986)
Subsistence Use Areas

16 Kivalina harvesters
Beluga

Other areas may have been used for resource harvesting.

National Park Service Lands

DeLong Mountain Transportation System (DMTS)

Source:
Lifetime: Schroeder, R., D. B. Anderson (ADF&G) and G. Hildreth (Maniilaq Association) 1987.

Map projection: NAD 1983 UTM Zone 3

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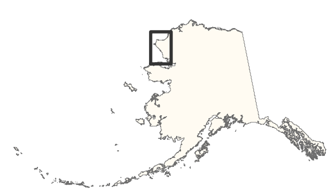
Map 7: Pre-Mine Subsistence Use Areas Kivalina, Seal

Lifetime (circa 1925-1986)
Subsistence Use Areas

16 Kivalina harvesters
Seal



Other areas may have been used for resource harvesting.

National Park Service Lands

DeLong Mountain Transportation System (DMTS)

Source:
Lifetime: Schroeder, R., D. B. Anderson (ADF&G) and G. Hildreth (Maniilaq Association) 1987.

Map 8: Pre-Mine Subsistence Use Areas Kivalina, Walrus

<ins>Lifetime (circa 1925-1986)</ins>
<ins>Subsistence Use Areas</ins>

16 Kivalina harvesters
Walrus

Other areas may have been used for resource harvesting.

National Park Service Lands

DeLong Mountain Transportation System (DMTS)

<ins>Source</ins>:
Lifetime: Schroeder, R., D. B. Anderson (ADF&G) and G. Hildreth (Maniilaq Association) 1987.

Map projection: NAD 1983 UTM Zone 3

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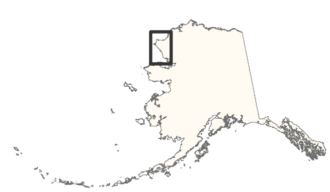
Map 9: Pre-Mine Subsistence Use Areas Kivalina, Polar Bear

Lifetime (circa 1925-1986)
Subsistence Use Areas

16 Kivalina harvesters
Polar Bear



Other areas may have been used for resource harvesting.

National Park Service Lands

DeLong Mountain Transportation System (DMTS)

Source:
Lifetime: Schroeder, R., D. B. Anderson (ADF&G) and G. Hildreth (Maniilaq Association) 1987.

Map projection: NAD 1983 UTM Zone 3

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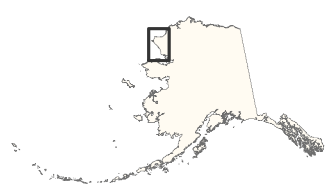
Map 10: Pre-Mine Subsistence Use Areas Kivalina, Sea Hunting

Previous to 1962 Subsistence Use Areas

Unspecified number of harvesters
Sea Hunting (partial)



Other areas may have been used for resource harvesting.

National Park Service Lands

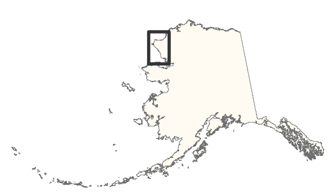
DeLong Mountain Transportation System (DMTS)

Source:
Previous to 1962: Saario, D.J. and B. Kessel 1966.

Map 11: Pre-Mine Subsistence Use Areas Kivalina, Sea Mammals

1977-1982 Subsistence Use Areas

19 Kivalina harvesters, 8 Noatak harvesters, 4 Kotzebue harvesters Sea Mammals (partial) *



* 1977-1982 data only addressed use areas potentially affected by Red Dog Project development.

Other areas may have been used for resource harvesting.

National Park Service Lands

DeLong Mountain Transportation System (DMTS)

Source:
1977-1982: Braund, S.R. and D.C. Burnham 1983.

Map projection: NAD 1983 UTM Zone 3

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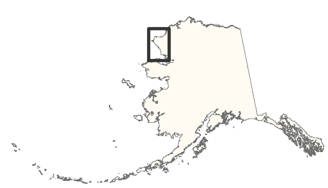
Map 12: Pre-Mine Subsistence Use Areas Kivalina, Bowhead

Lifetime (circa 1925-1986) Subsistence Use Areas

16 Kivalina harvesters Bowhead

1977-1982 Subsistence Use Areas

19 Kivalina harvesters, 8 Noatak harvesters, 4 Kotzebue harvesters Bowhead (partial) *



* 1977-1982 data only addressed use areas potentially affected by Red Dog Project development.

For all data sets, other areas may have been used for resource harvesting.

National Park Service Lands

DeLong Mountain Transportation System (DMTS)

Sources:

Lifetime: Schroeder, R., D. B. Anderson (ADF&G) and G. Hildreth (Maniilaq Association) 1987.

1977-1982: Braund, S.R. and D.C. Burnham 1983.

Map 13: Pre-Mine Subsistence Use Areas Kivalina, Fish

Lifetime (circa 1925-1986) Subsistence Use Areas
16 Kivalina harvesters Fish

1977-1982 Subsistence Use Areas
19 Kivalina harvesters, 8 Noatak harvesters, 4 Kotzebue harvesters, Char and Whitefish (partial) *

Previous to 1962 Subsistence Use Areas
Unspecified number of harvesters Fishing Sites (partial)

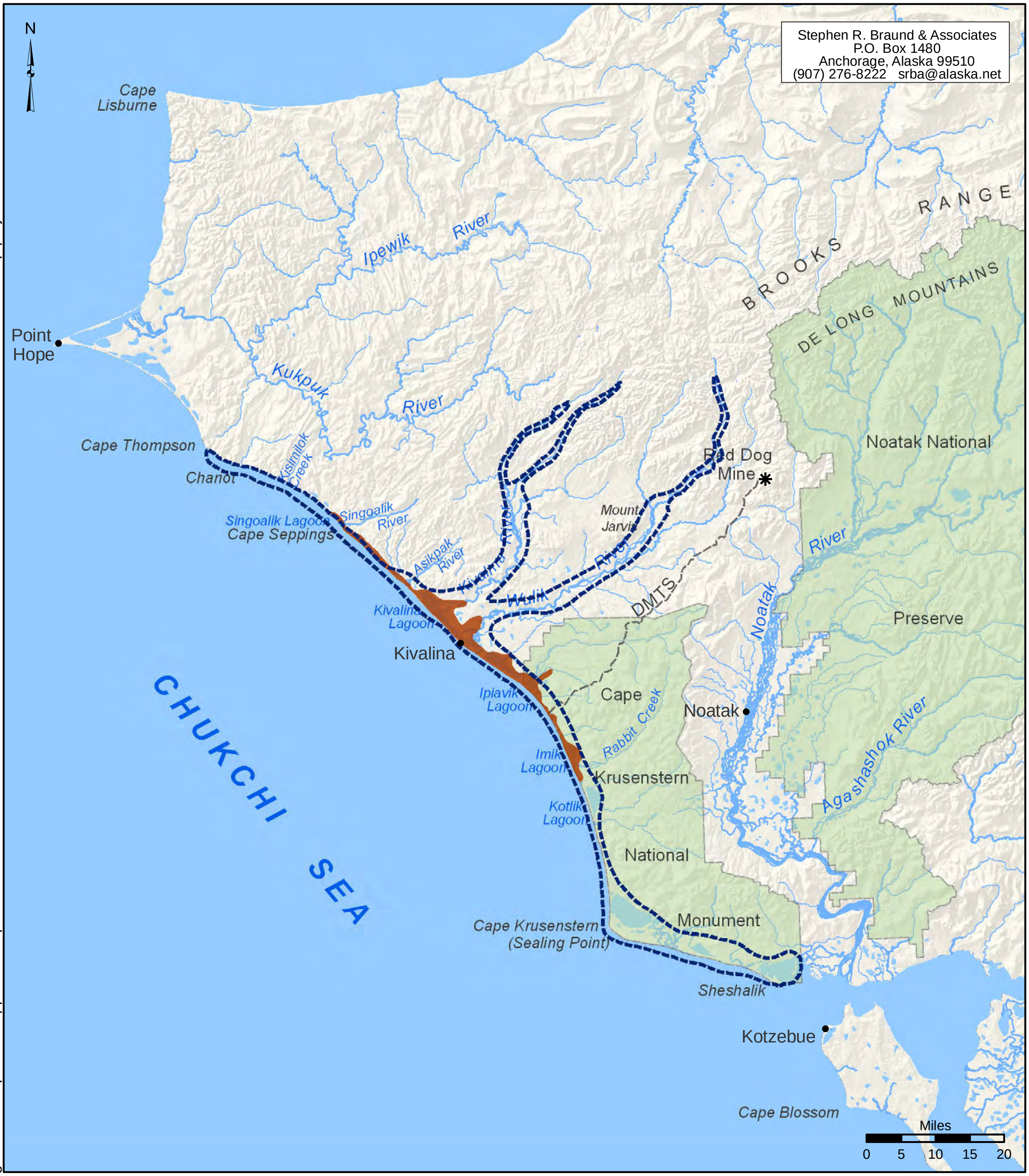
* 1977-1982 data only addressed use areas potentially affected by Red Dog Project development.

For all data sets, other areas may have been used for resource harvesting.

National Park Service Lands

DeLong Mountain Transportation System (DMTS)

Sources:
Lifetime: Schroeder, R., D. B. Anderson (ADF&G) and G. Hildreth (Maniilaq Association) 1987.
1977-1982: Braund, S.R. and D.C. Burnham 1983.
Previous to 1962: Saario, D.J. and B. Kessel 1966.



Map projection: NAD 1983 UTM Zone 3

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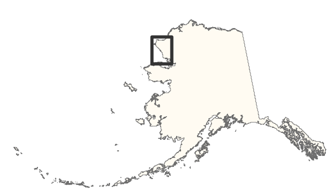
Map 14: Pre-Mine Subsistence Use Areas Kivalina, Waterfowl

Lifetime (circa 1925-1986) Subsistence Use Areas

16 Kivalina harvesters Waterfowl

1977-1982 Subsistence Use Areas

19 Kivalina harvesters, 8 Noatak harvesters, 4 Kotzebue harvesters Waterfowl, Greens and Berries (partial) *



* 1977-1982 data only addressed use areas potentially affected by Red Dog Project development.

For all data sets, other areas may have been used for resource harvesting.

National Park Service Lands

DeLong Mountain Transportation System (DMTS)

Sources:

Lifetime: Schroeder, R., D. B. Anderson (ADF&G) and G. Hildreth (Maniilaq Association) 1987.

1977-1982: Braund, S.R. and D.C. Burnham 1983.

Map projection: NAD 1983 UTM Zone 3

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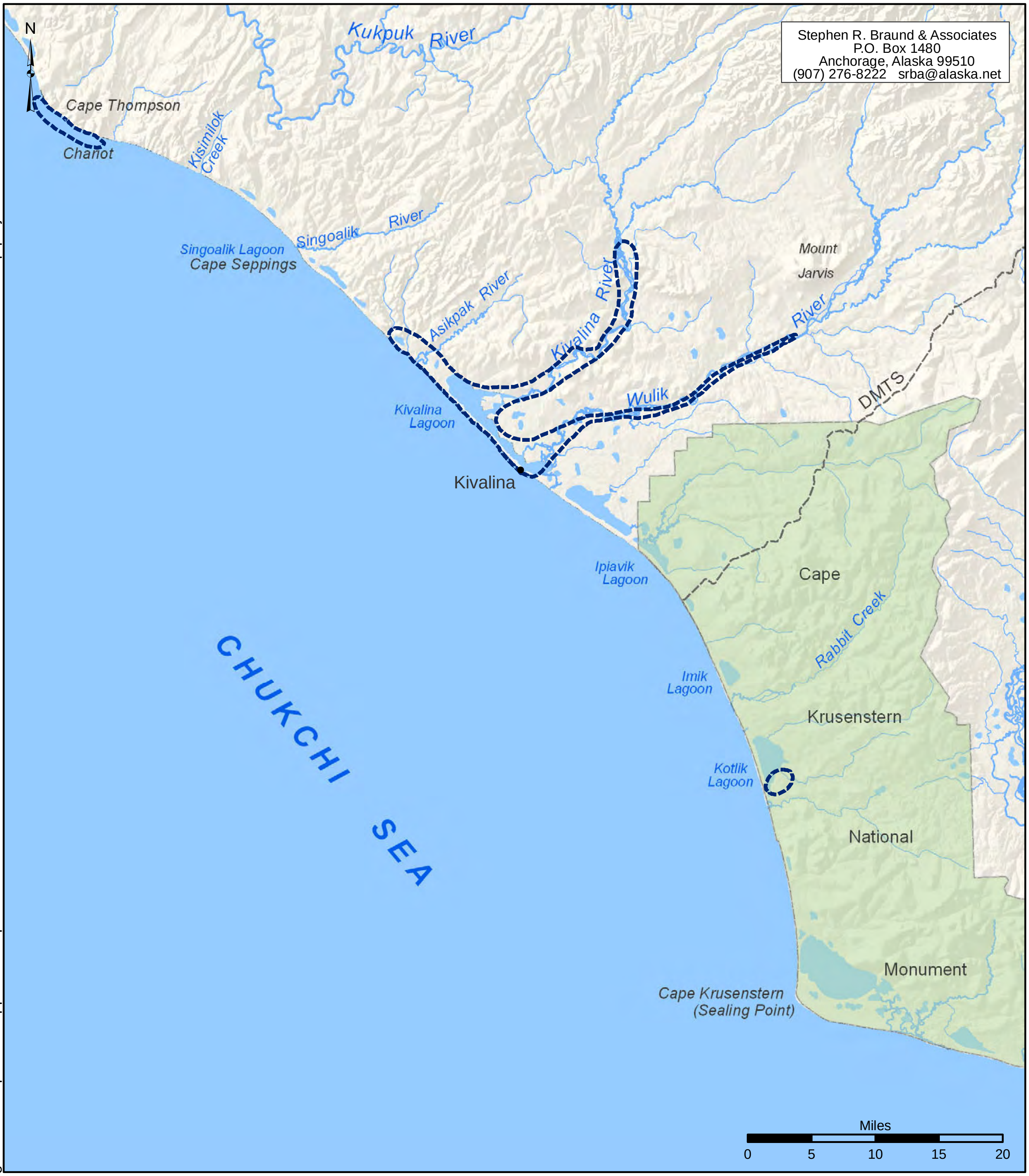
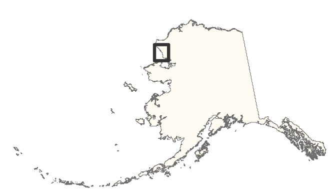


Map 15: Pre-Mine Subsistence Use Areas Kivalina, Eggs

Lifetime (circa 1925-1986)
Subsistence Use Areas

16 Kivalina harvesters
Eggs



Other areas may have been used for resource harvesting.

National Park Service Lands

DeLong Mountain Transportation System (DMTS)

Source:
Lifetime: Schroeder, R., D. B. Anderson (ADF&G) and G. Hildreth (Maniilaq Association) 1987.

Map projection: NAD 1983 UTM Zone 3

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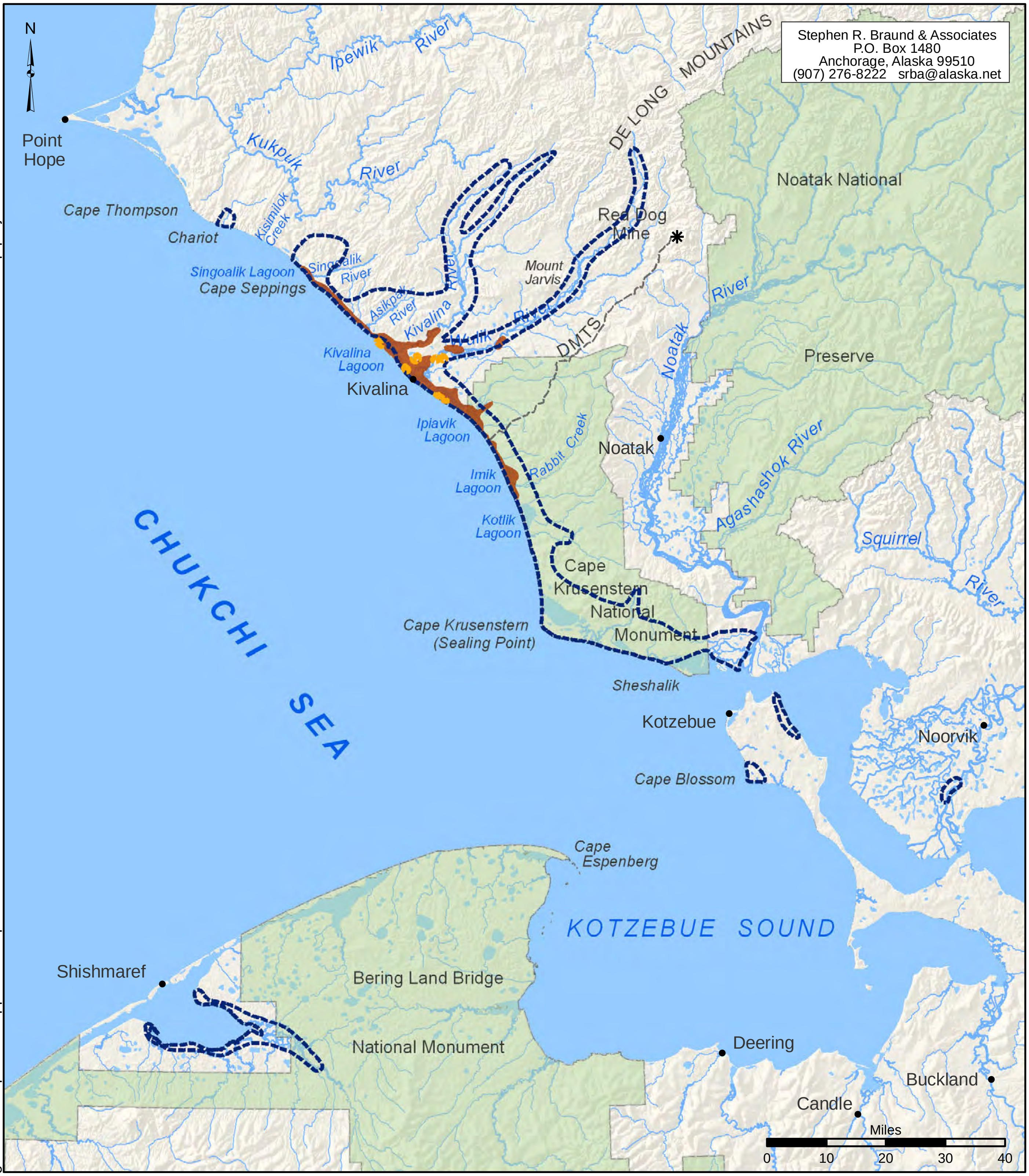
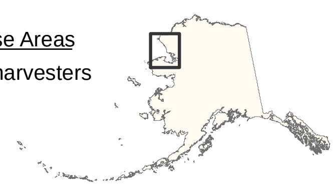


Map 16: Pre-Mine Subsistence Use Areas Kivalina, Berries and Plants

Lifetime (circa 1925-1986) Subsistence Use Areas
16 Kivalina harvesters Vegetation

1977-1982 Subsistence Use Areas
19 Kivalina harvesters, 8 Noatak harvesters, 4 Kotzebue harvesters, Berries and Greens (partial) *

Previous to 1962 Subsistence Use Areas
Unspecified number of harvesters Berries (partial)



* 1977-1982 data only addressed use areas potentially affected by Red Dog Project development.

For all data sets, other areas may have been used for resource harvesting.

National Park Service Lands

DeLong Mountain Transportation System (DMTS)

Sources:
Lifetime: Schroeder, R., D. B. Anderson (ADF&G) and G. Hildreth (Maniilaq Association) 1987.
1977-1982: Braund, S.R. and D.C. Burnham 1983.
Previous to 1962: Saario, D.J. and B. Kessel 1966.

Map projection: NAD 1983 UTM Zone 3

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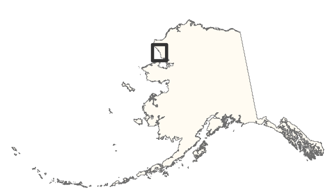
Map 17: Pre-Mine Subsistence Use Areas Kivalina, Wood

Lifetime (circa 1925-1986)
Subsistence Use Areas

16 Kivalina harvesters
Wood



Other areas may have been used for resource harvesting.

National Park Service Lands

DeLong Mountain Transportation System (DMTS)

Source:
Lifetime: Schroeder, R., D. B. Anderson (ADF&G) and G. Hildreth (Maniilaq Association) 1987.

Map projection: NAD 1983 UTM Zone 3

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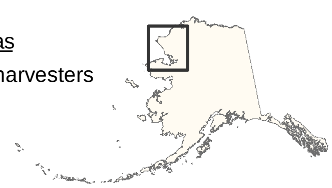
Map 18: Pre-Mine Subsistence Use Areas Noatak, All Resources

Lifetime (circa 1925-1986) Subsistence Use Areas
25 Noatak harvesters All Resources

1977-1982 Subsistence Use Areas
19 Kivalina harvesters, 8 Noatak harvesters, 4 Kotzebue harvesters, All Resources (partial) *

1950-1960 Subsistence Use Areas
Unspecified Number of harvesters All Resources (partial)



* 1977-1982 data only addressed use areas potentially affected by Red Dog Project development.

For all data sets, other areas may have been used for resource harvesting.

National Park Service Lands

DeLong Mountain Transportation System (DMTS)

Sources:
Lifetime: Schroeder, R., D. B. Anderson (ADF&G) and G. Hildreth (Maniilaq Association) 1987.
1977-1982: Braund, S.R. and D.C. Burnham 1983.
1950-1960: Foote, D.C. and H.A. Williamson 1966.

Map projection: NAD 1983 UTM Zone 3

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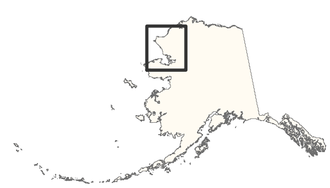
Map 19: Pre-Mine Subsistence Use Areas Noatak, Caribou

Lifetime (circa 1925-1986) Subsistence Use Areas

25 Noatak harvesters Caribou

1977-1982 Subsistence Use Areas

19 Kivalina harvesters, 8 Noatak harvesters, 4 Kotzebue harvesters Caribou (partial) *



* 1977-1982 data only addressed use areas potentially affected by Red Dog Project development.

For all data sets, other areas may have been used for resource harvesting.

National Park Service Lands

DeLong Mountain Transportation System (DMTS)

Sources:
Lifetime: Schroeder, R., D. B. Anderson (ADF&G) and G. Hildreth (Maniilaq Association) 1987.
1977-1982: Braund, S.R. and D.C. Burnham 1983.

Map projection: NAD 1983 UTM Zone 3

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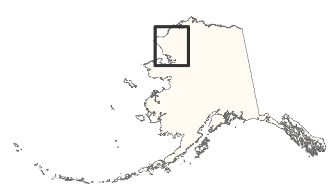
Map 20: Pre-Mine Subsistence Use Areas Noatak, Furbearers

Lifetime (circa 1925-1986) Subsistence Use Areas

25 Noatak harvesters
Furbearers

1977-1982 Subsistence Use Areas

19 Kivalina harvesters, 8 Noatak harvesters, 4 Kotzebue harvesters
Trapping (partial fox, wolverine, wolf) (partial) *



* 1977-1982 data only addressed use areas potentially affected by Red Dog Project development.

For all data sets, other areas may have been used for resource harvesting.

National Park Service Lands

DeLong Mountain Transportation System (DMTS)

Sources:
Lifetime: Schroeder, R., D. B. Anderson (ADF&G) and G. Hildreth (Maniilaq Association) 1987.
1977-1982: Braund, S.R. and D.C. Burnham 1983.

Map projection: NAD 1983 UTM Zone 3

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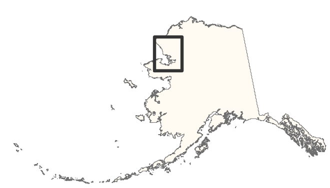
Map 21: Pre-Mine Subsistence Use Areas Noatak, Moose

Lifetime (circa 1925-1986)
Subsistence Use Areas

25 Noatak harvesters
Moose



Other areas may have been used for resource harvesting.

National Park Service Lands

DeLong Mountain Transportation System (DMTS)

Source:
Lifetime: Schroeder, R., D. B. Anderson (ADF&G) and G. Hildreth (Maniilaq Association) 1987.

Map 22: Pre-Mine Subsistence Use Areas Noatak, Other Large Land Mammals

Lifetime (circa 1925-1986) Subsistence Use Areas

25 Noatak harvesters
Bear

25 Noatak harvesters
Sheep

1977-1982 Subsistence Use Areas

19 Kivalina harvesters, 8 Noatak harvesters, 4 Kotzebue harvesters
Sheep (partial) *

* 1977-1982 data only addressed use areas potentially affected by Red Dog Project development.

For all data sets, other areas may have been used for resource harvesting.

National Park Service Lands

DeLong Mountain Transportation System (DMTS)

Sources:
Lifetime: Schroeder, R., D. B. Anderson (ADF&G) and G. Hildreth (Maniilaq Association) 1987.
1977-1982: Braund, S.R. and D.C. Burnham 1983.

Map 23: Pre-Mine Subsistence Use Areas Noatak, Bowhead

Lifetime (circa 1925-1986)
Subsistence Use Areas

25 Noatak harvesters
Bowhead

Other areas may have been used for resource harvesting.

National Park Service Lands

DeLong Mountain Transportation System (DMTS)

Source:
Lifetime: Schroeder, R., D. B. Anderson (ADF&G) and G. Hildreth (Maniilaq Association) 1987.

Map projection: NAD 1983 UTM Zone 3

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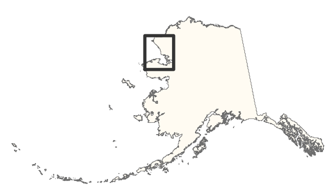
Map 24: Pre-Mine Subsistence Use Areas Noatak, Beluga



Lifetime (circa 1925-1986)
Subsistence Use Areas

25 Noatak harvesters
Beluga

Other areas may have been used for resource harvesting.

National Park Service Lands

DeLong Mountain Transportation System (DMTS)

Source:
Lifetime: Schroeder, R., D. B. Anderson (ADF&G) and G. Hildreth (Maniilaq Association) 1987.

Map projection: NAD 1983 UTM Zone 3

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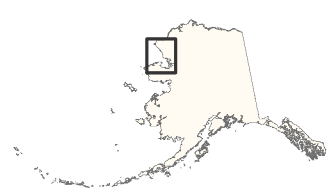
Map 25: Pre-Mine Subsistence Use Areas Noatak, Seal

Lifetime (circa 1925-1986)
Subsistence Use Areas

25 Noatak harvesters
Seal

25 Noatak harvesters
Seal (in the Noatak River)



Other areas may have been used for resource harvesting.

National Park Service Lands

DeLong Mountain Transportation System (DMTS)

Source:
Lifetime: Schroeder, R., D. B. Anderson (ADF&G) and G. Hildreth (Maniilaq Association) 1987.

Map projection: NAD 1983 UTM Zone 3

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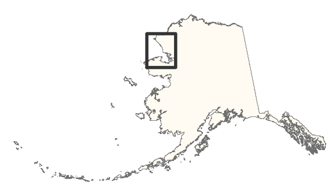
Map 26: Pre-Mine Subsistence Use Areas Noatak, Walrus

Lifetime (circa 1925-1986)
Subsistence Use Areas

25 Noatak harvesters
Walrus



Other areas may have been used for resource harvesting.

National Park Service Lands

DeLong Mountain Transportation System (DMTS)

Source:
Lifetime: Schroeder, R., D. B. Anderson (ADF&G) and G. Hildreth (Maniilaq Association) 1987.

Map projection: NAD 1983 UTM Zone 3

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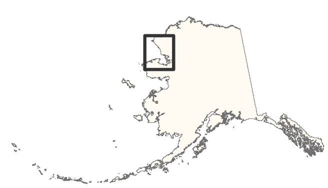
Map 27: Pre-Mine Subsistence Use Areas Noatak, Polar Bear

Lifetime (circa 1925-1986)
Subsistence Use Areas

25 Noatak harvesters
Polar Bear

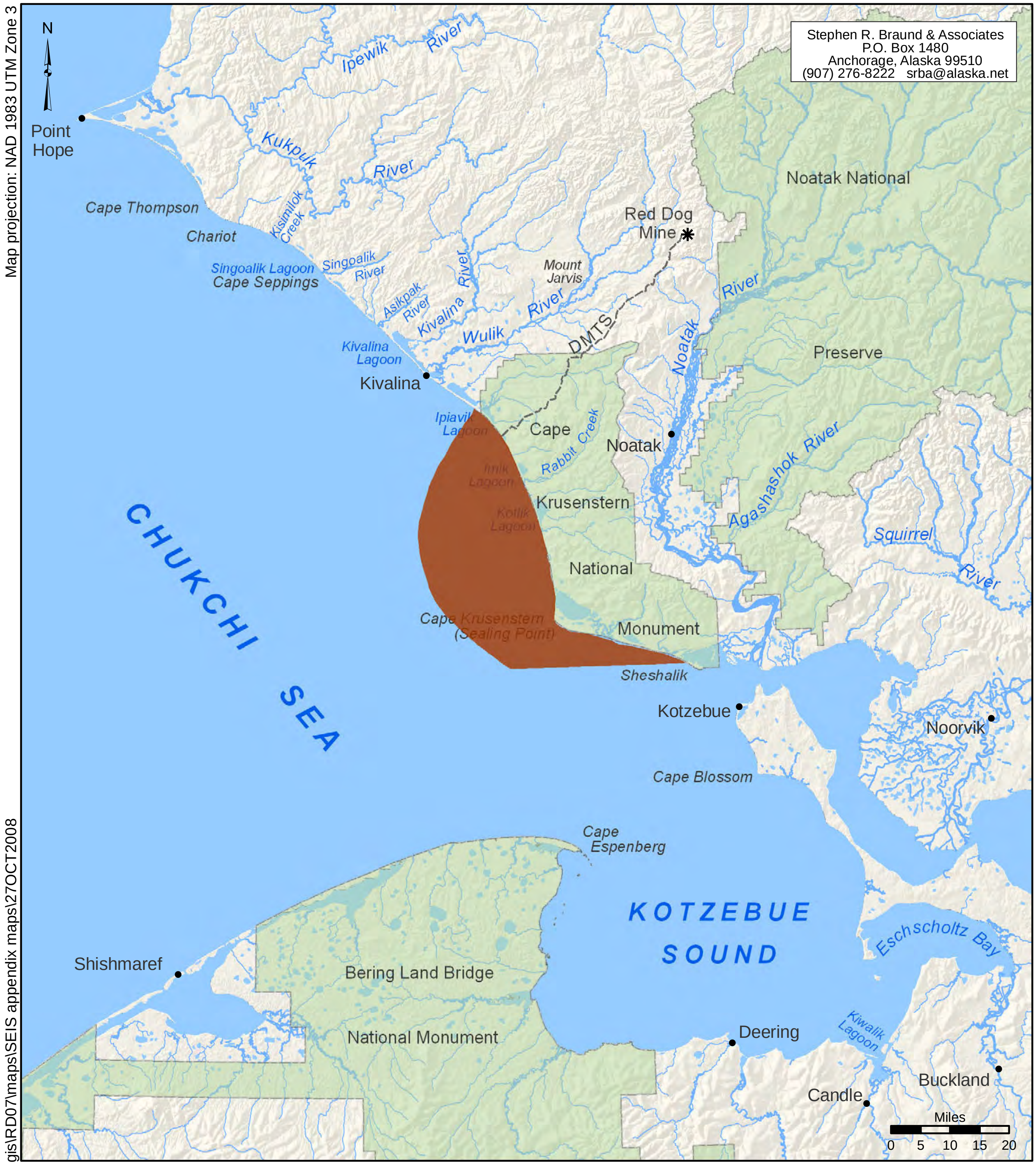


Other areas may have been used for resource harvesting.

National Park Service Lands

DeLong Mountain Transportation System (DMTS)

Source:
Lifetime: Schroeder, R., D. B. Anderson (ADF&G) and G. Hildreth (Maniilaq Association) 1987.



Map 28: Pre-Mine Subsistence Use Areas Noatak, Sea Mammals

1977-1982 Subsistence Use Areas

19 Kivalina harvesters, 8 Noatak harvesters, 4 Kotzebue harvesters Sea Mammals (partial) *

* 1977-1982 data only addressed use areas potentially affected by Red Dog Project development.

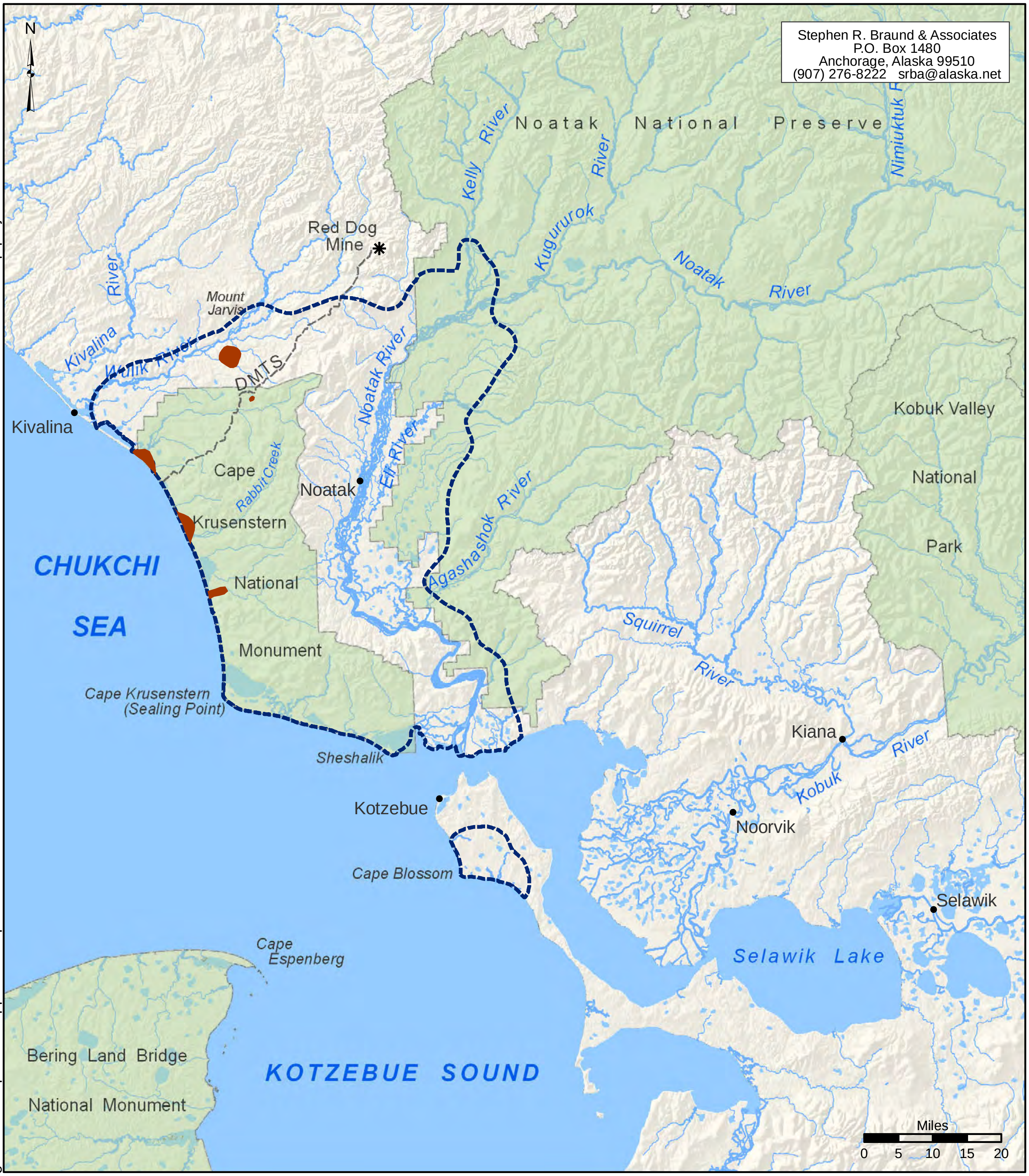
Other areas may have been used for resource harvesting.

National Park Service Lands

DeLong Mountain Transportation System (DMTS)

Source:
1977-1982: Braund, S.R. and D.C. Burnham 1983.

Map projection: NAD 1983 UTM Zone 3



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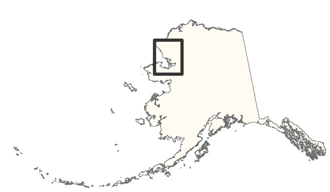
Map 29: Pre-Mine Subsistence Use Areas Noatak, Waterfowl

Lifetime (circa 1925-1986) Subsistence Use Areas

25 Noatak harvesters
Waterfowl

1977-1982 Subsistence Use Areas

19 Kivalina harvesters, 8 Noatak harvesters, 4 Kotzebue harvesters
Waterfowl (partial) *



* 1977-1982 data only addressed use areas potentially affected by Red Dog Project development.

For all data sets, other areas may have been used for resource harvesting.

National Park Service Lands

DeLong Mountain Transportation System (DMTS)

Sources:

Lifetime: Schroeder, R., D. B. Anderson (ADF&G) and G. Hildreth (Maniilaq Association) 1987.
1977-1982: Braund, S.R. and D.C. Burnham 1983.

Map 30: Pre-Mine Subsistence Use Areas Noatak, Eggs

Lifetime (circa 1925-1986)
Subsistence Use Areas

25 Noatak harvesters
Eggs

Other areas may have been used for resource harvesting.

National Park Service Lands

DeLong Mountain Transportation System (DMTS)

Source:
Lifetime: Schroeder, R., D. B. Anderson (ADF&G) and G. Hildreth (Maniilaq Association) 1987.

Map projection: NAD 1983 UTM Zone 3

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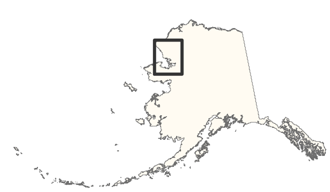
Map 31: Pre-Mine Subsistence Use Areas Noatak, Non-Salmon Fish

Lifetime (circa 1925-1986) Subsistence Use Areas

25 Noatak harvesters Non-Salmon Fish

1977-1982 Subsistence Use Areas

19 Kivalina harvesters, 8 Noatak harvesters, 4 Kotzebue harvesters Dolly Varden char (partial) *



* 1977-1982 data only addressed use areas potentially affected by Red Dog Project development.

For all data sets, other areas may have been used for resource harvesting.

National Park Service Lands

DeLong Mountain Transportation System (DMTS)

Sources:

Lifetime: Schroeder, R., D. B. Anderson (ADF&G) and G. Hildreth (Maniilaq Association) 1987.

1977-1982: Braund, S.R. and D.C. Burnham 1983.

Map projection: NAD 1983 UTM Zone 3

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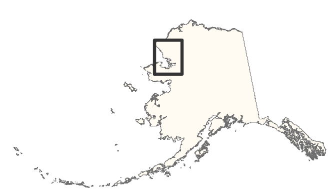
Map 32: Pre-Mine Subsistence Use Areas Noatak, Salmon

Lifetime (circa 1925-1986)
Subsistence Use Areas

25 Noatak harvesters
Salmon



Other areas may have been used for resource harvesting.

National Park Service Lands

DeLong Mountain Transportation System (DMTS)

Source:
Lifetime: Schroeder, R., D. B. Anderson (ADF&G) and G. Hildreth (Maniilaq Association) 1987.

Map projection: NAD 1983 UTM Zone 3

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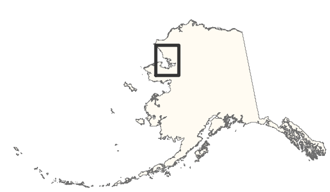
Map 33: Pre-Mine Subsistence Use Areas Noatak, Vegetation



Lifetime (circa 1925-1986)
Subsistence Use Areas

25 Noatak harvesters
Vegetation

Other areas may have been used for resource harvesting.

National Park Service Lands

DeLong Mountain Transportation System (DMTS)

Source:
Lifetime: Schroeder, R., D. B. Anderson (ADF&G) and G. Hildreth (Maniilaq Association) 1987.

Map projection: NAD 1983 UTM Zone 3

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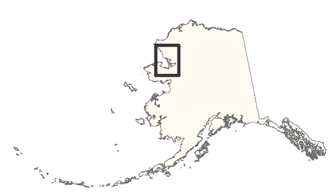
Map 34: Pre-Mine Subsistence Use Areas Noatak, Wood

Lifetime (circa 1925-1986)
Subsistence Use Areas

25 Noatak harvesters
Wood

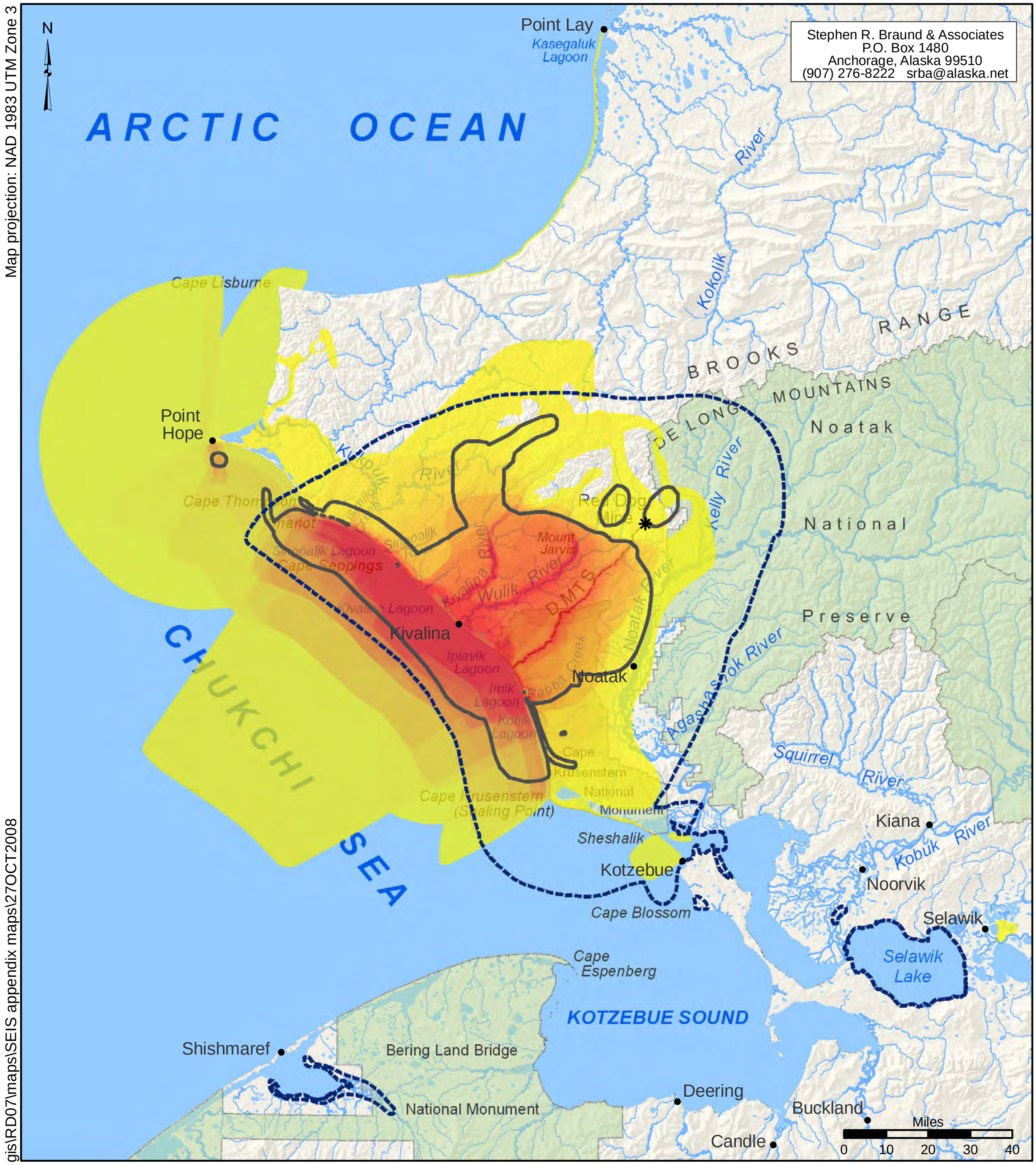


Other areas may have been used for resource harvesting.

National Park Service Lands

DeLong Mountain Transportation System (DMTS)

Source:
Lifetime: Schroeder, R., D. B. Anderson (ADF&G) and G. Hildreth (Maniilaq Association) 1987.



Map 35: 1998-2007 and Lifetime Subsistence Use Areas Kivalina, All Resources

1998-2007 Overlapping Subsistence Use Areas
High
Low
1194 Use Areas
43 Harvesters
All Resources

2007 Subsistence Use Areas
301 Use Areas
35 Households
All Resources

Lifetime (circa 1925-1986) Subsistence Use Areas
16 Kivalina harvesters
All Resources

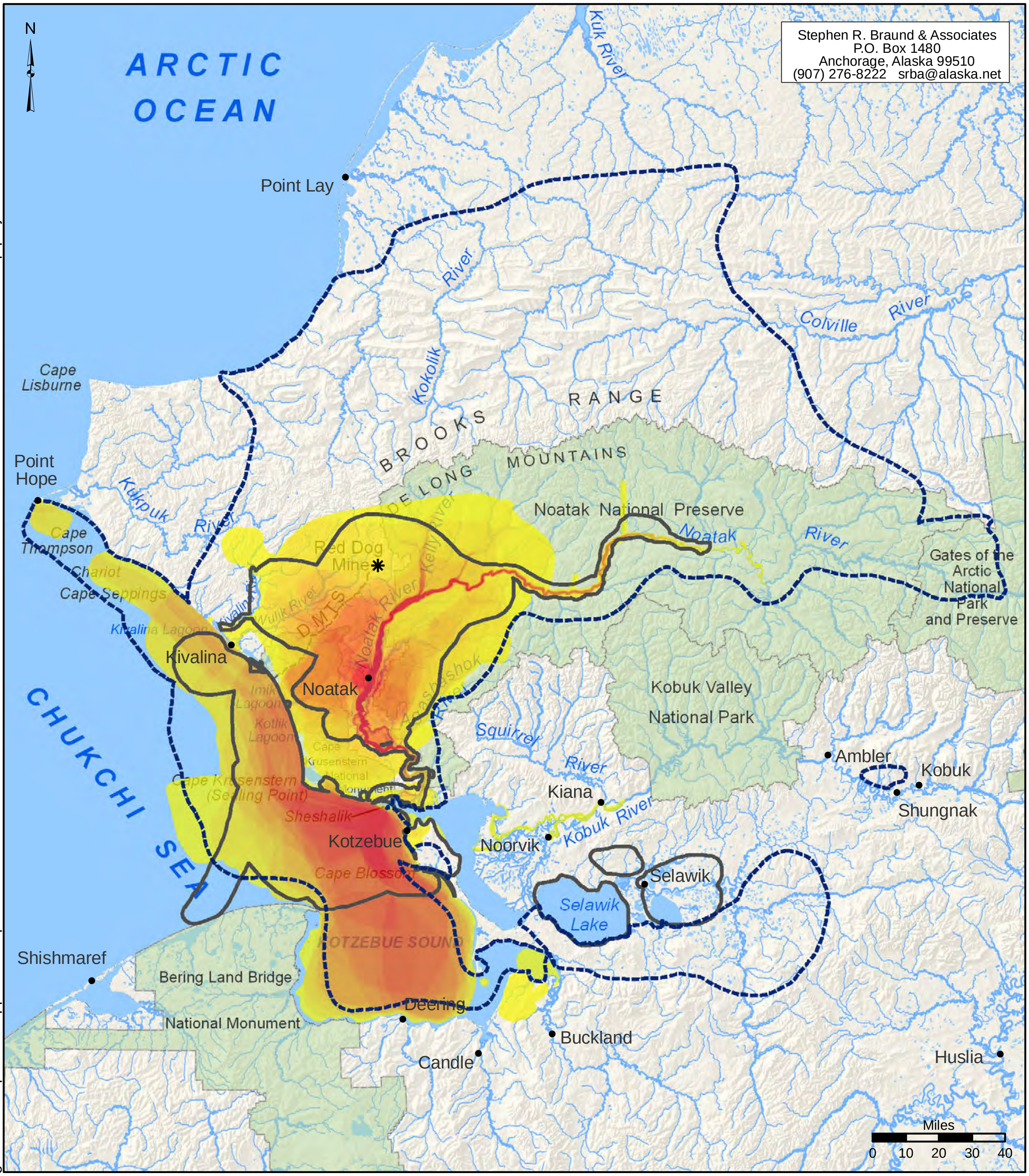
For all data sets, other areas may have been used for resource harvesting.

National Park Service Lands

DeLong Mountain Transportation System (DMTS)

Sources:
1998-2007: Stephen R. Braund and Associates (SRB&A) Forthcoming.
2007: Magdanz et al. 2008.
Lifetime: Schroeder, R., D. B. Anderson (ADF&G) and G. Hildreth (Maniilaq Association) 1987.

Map projection: NAD 1983 UTM Zone 3



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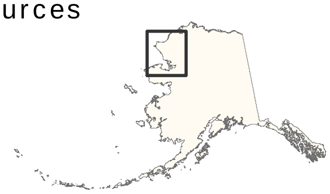
Map 36: 1998-2007 and Lifetime Subsistence Use Areas Noatak, All Resources

1998-2007 Overlapping Subsistence Use Areas
High
Low
948 Use Areas
41 Harvesters
All Resources

2007 Subsistence Use Areas
378 Use Areas
82 Households
All Resources

Lifetime (circa 1925-1986) Subsistence Use Areas
25 Noatak harvesters
All Resources



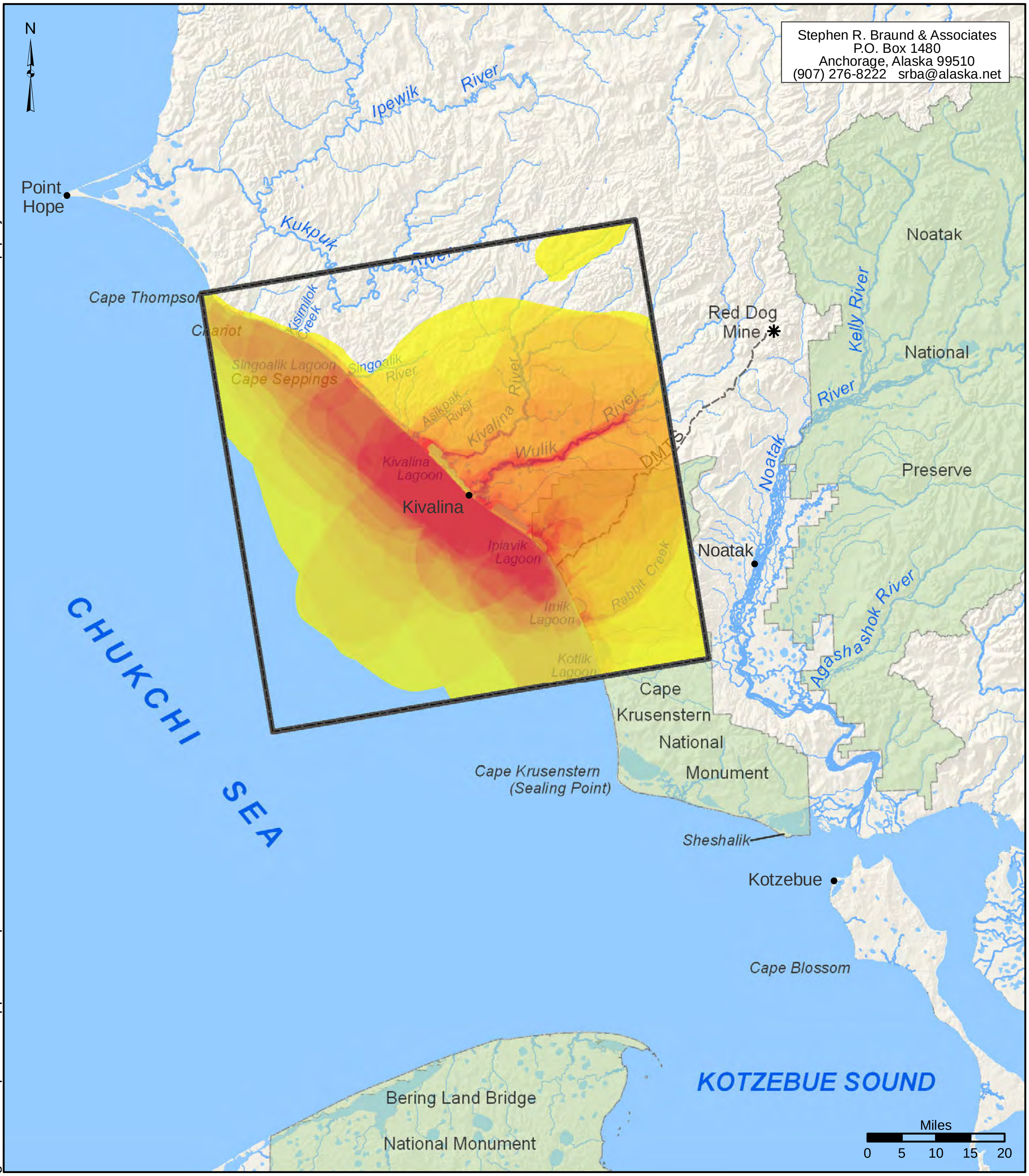
For all data sets, other areas may have been used for resource harvesting.

National Park Service Lands

DeLong Mountain Transportation System (DMTS)

Sources:
1998-2007: Stephen R. Braund and Associates (SRB&A) Forthcoming.
2007: Magdanz et al. 2008.
Lifetime: Schroeder, R., D. B. Anderson (ADF&G) and G. Hildreth (Maniilaq Association) 1987.

Map projection: NAD 1983 UTM Zone 3



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Map 37: 1995-2004 Partial Subsistence Use Areas Kivalina, All Resources

1995-2004 Overlapping Subsistence Use Areas

High
Low

417 Use Areas
24 Harvesters
All Resources (partial)

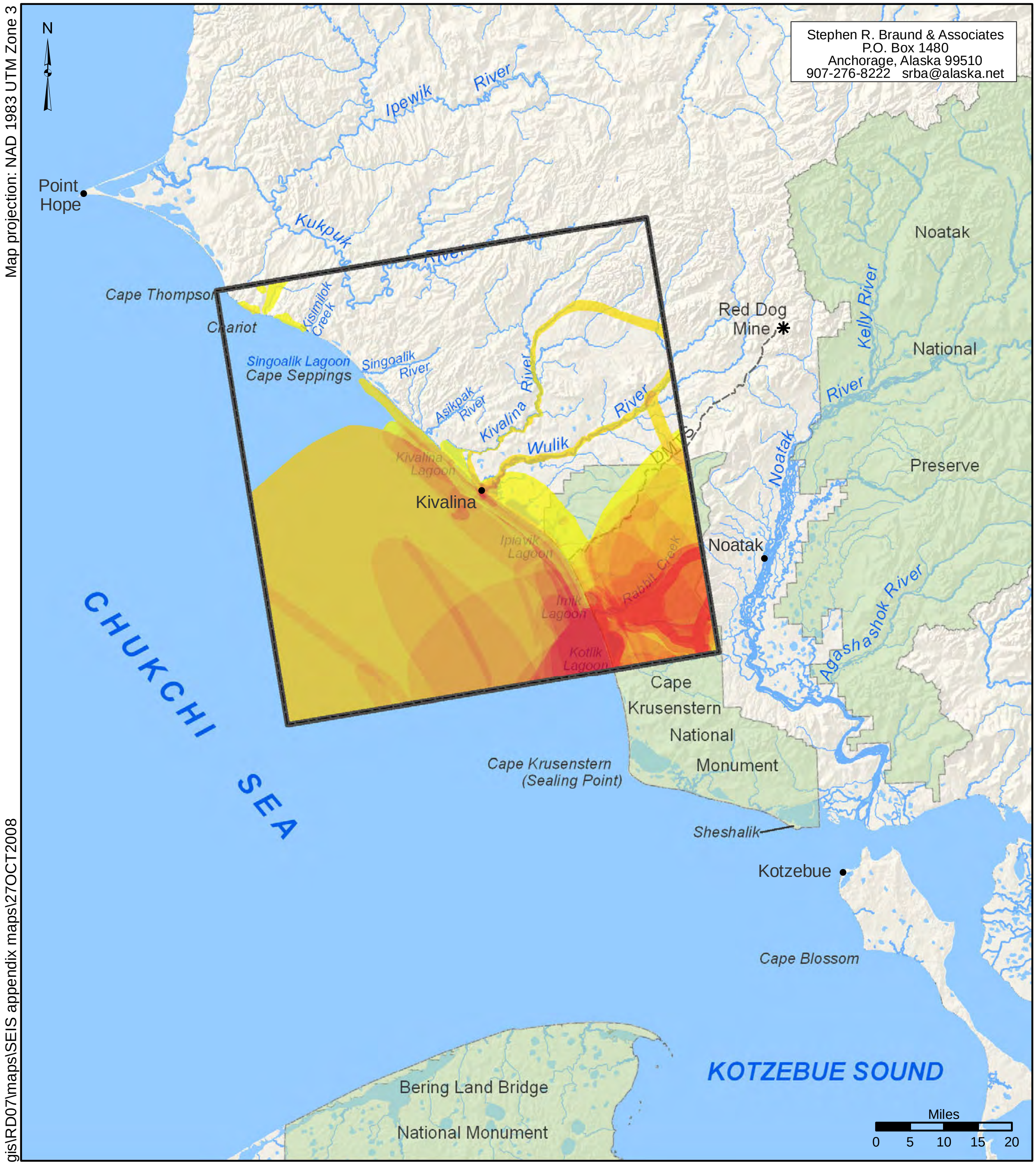
This map focuses on last 10 year (1995-2004) subsistence use areas in the Cape Seppings to Rabbit Creek area (including nearby associated use areas) but do NOT represent a comprehensive description of Kotzebue subsistence activities. Other areas are also used for resource harvesting.

Project Area

National Park Service Lands

DeLong Mountain Transportation System (DMTS)

Source:
1995-2004: Stephen R. Braund and Associates (SRB&A) 2005.



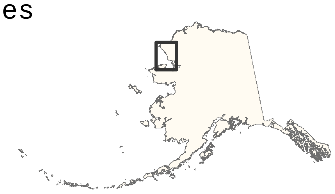
Map 38: 1995-2004 Partial Subsistence Use Areas Kotzebue, All Resources

1995-2004 Overlapping Subsistence Use Areas

High
Low

155 Use Areas
27 Harvesters
All Resources (partial)

This map focuses on last 10 year (1995-2004) subsistence use areas in the Cape Seppings to Rabbit Creek area (including nearby associated use areas) but do NOT represent a comprehensive description of Kotzebue subsistence activities. Other areas are also used for resource harvesting.



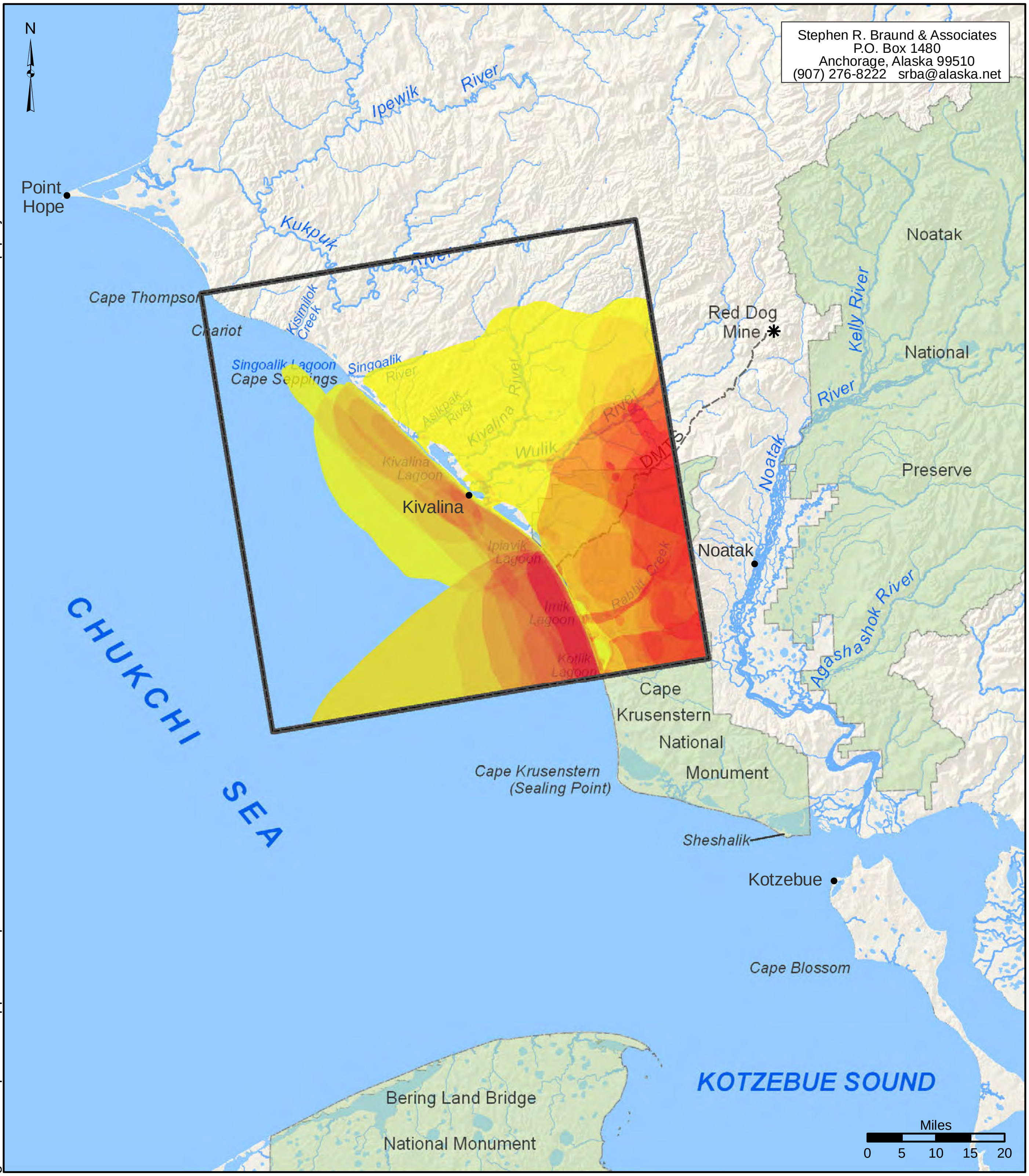
Project Area

National Park Service Lands

DeLong Mountain Transportation System (DMTS)

Source:
1995-2004: Stephen R. Braund and Associates (SRB&A) 2005.

Map projection: NAD 1983 UTM Zone 3



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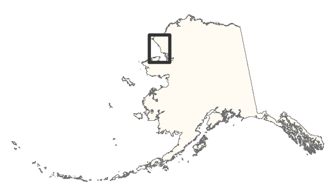
Map 39: 1995-2004 Partial Subsistence Use Areas Noatak, All Resources

1995-2004 Overlapping Subsistence Use Areas

High
Low

101 Use Areas
19 Harvesters
All Resources (partial)

This map focuses on last 10 year (1995-2004) subsistence use areas in the Cape Seppings to Rabbit Creek area (including nearby associated use areas) but do NOT represent a comprehensive description of Kotzebue subsistence activities. Other areas are also used for resource harvesting.



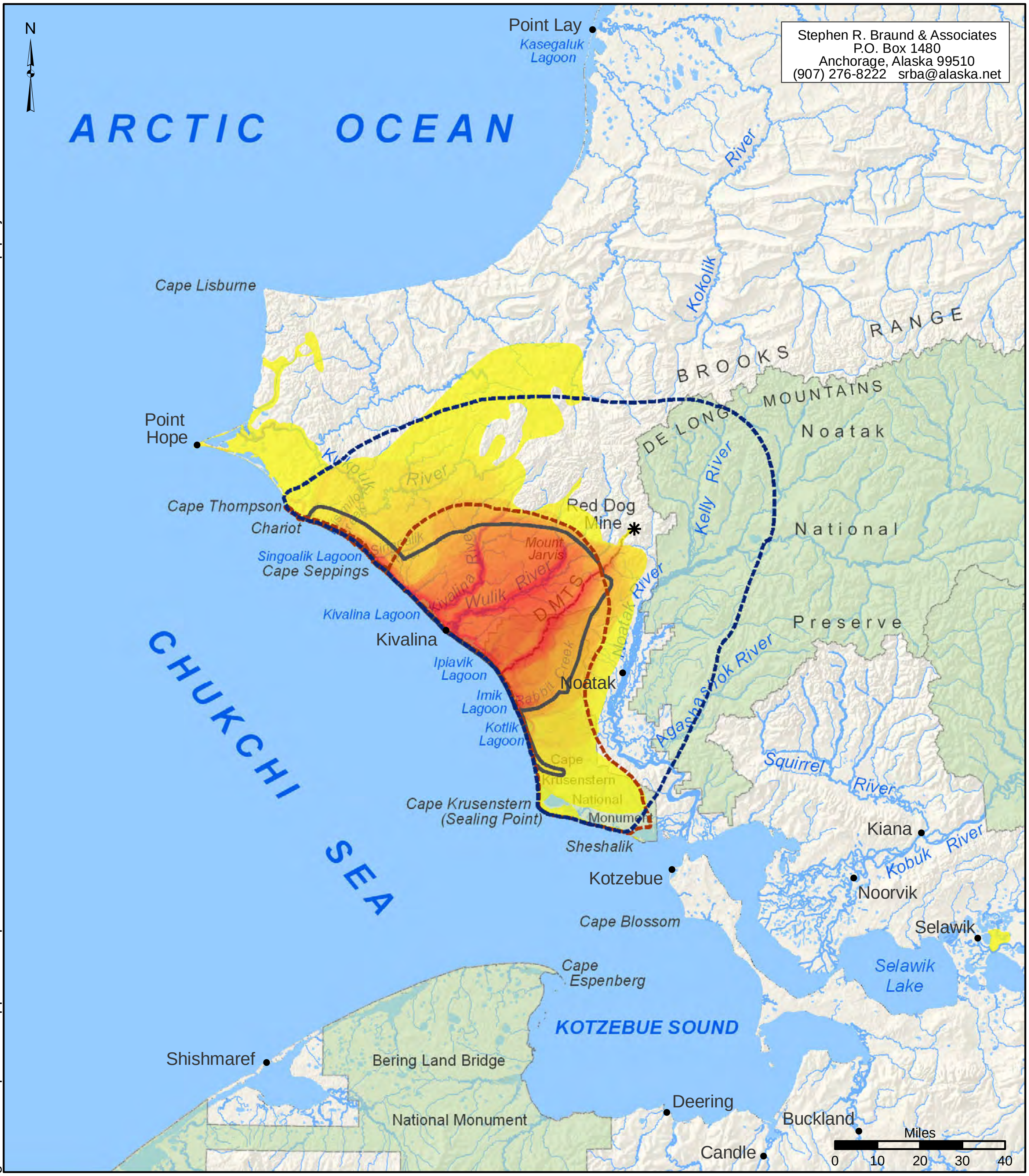
Project Area

National Park Service Lands

DeLong Mountain Transportation System (DMTS)

Source:
1995-2004: Stephen R. Braund and Associates (SRB&A) 2005.

Map projection: NAD 1983 UTM Zone 3



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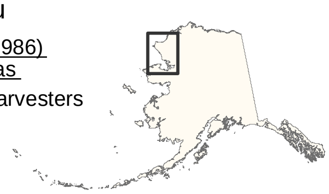
Map 40: 1998-2007 and Lifetime Subsistence Use Areas Kivalina, Caribou

1998-2007 Overlapping Subsistence Use Areas
High
Low
207 Use Areas
40 Harvesters
Caribou

2007 Subsistence Use Areas
42 Use Areas
25 Households
Caribou

1998 Subsistence Use Areas
7 Group Workshops
19 Harvesters
Caribou

Lifetime (circa 1925-1986) Subsistence Use Areas
16 Kivalina harvesters
Caribou



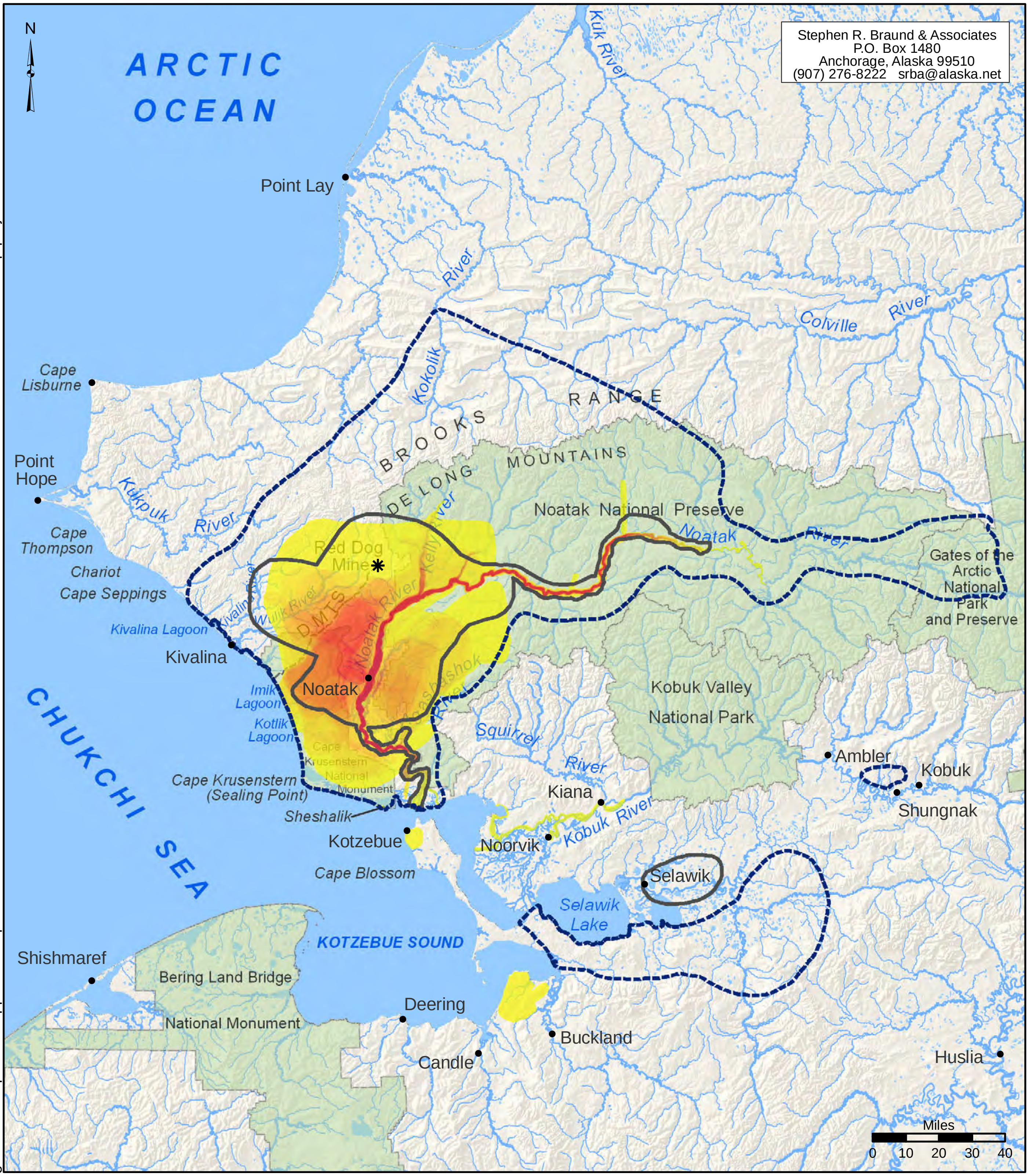
For all data sets, other areas may have been used for resource harvesting.

National Park Service Lands

DeLong Mountain Transportation System (DMTS)

Sources:
1998-2007: Stephen R. Braund and Associates (SRB&A) Forthcoming.
2007: Magdanz et al. 2008.
1998: SRB&A 2000.
Lifetime: Schroeder, R., D. B. Anderson (ADF&G) and G. Hildreth (Maniilaq Association) 1987.

Map projection: NAD 1983 UTM Zone 3



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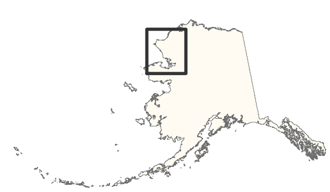
Map 41: 1998-2007 and Lifetime Subsistence Use Areas Noatak, Caribou

1998-2007 Overlapping Subsistence Use Areas
High – Low
108 Use Areas
33 Harvesters
Caribou

2007 Subsistence Use Areas
77 Use Areas
61 Households
Caribou

Lifetime (circa 1925-1986) Subsistence Use Areas
25 Noatak harvesters
Caribou

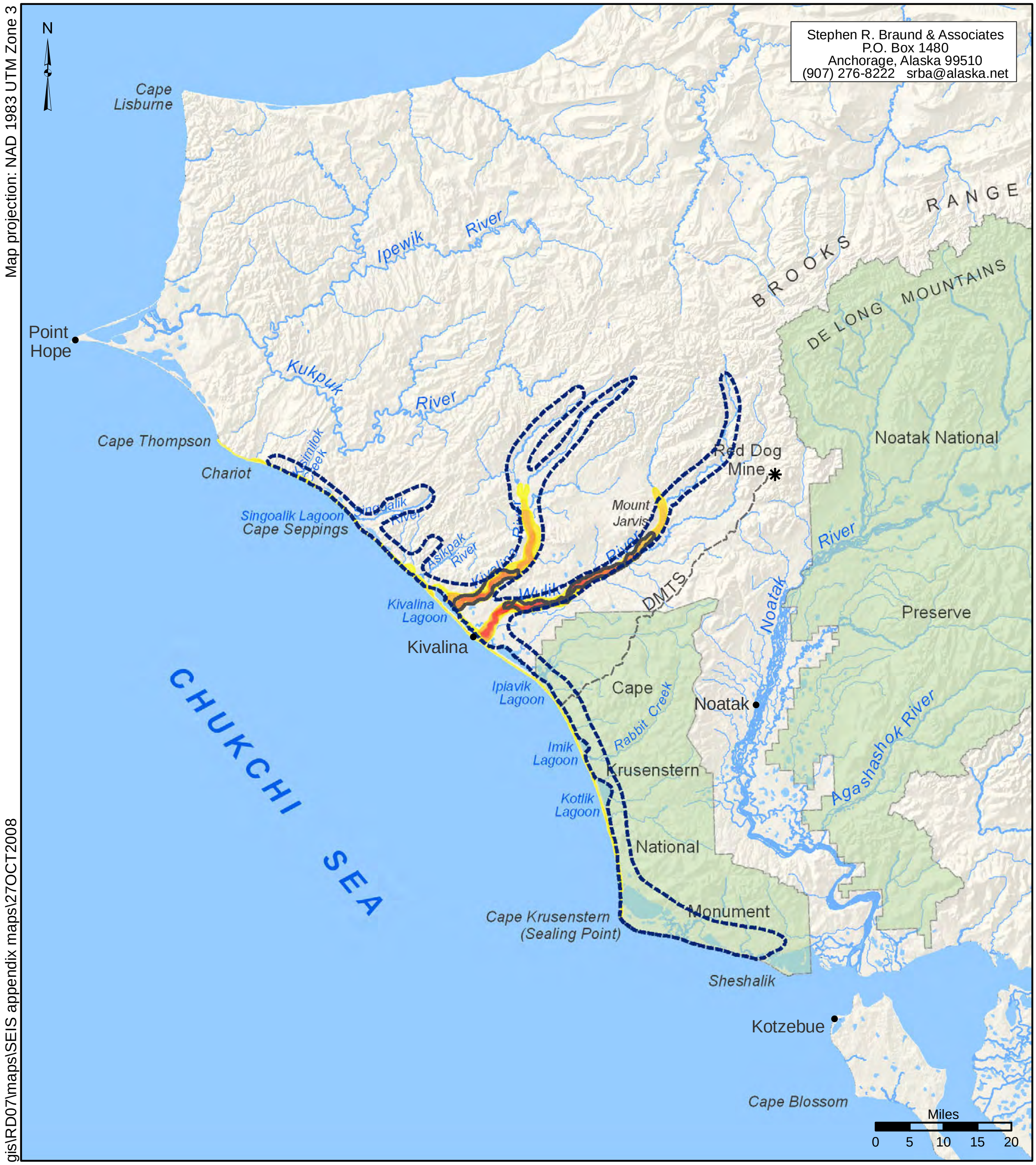


For all data sets, other areas may have been used for resource harvesting.

National Park Service Lands

DeLong Mountain Transportation System (DMTS)

Sources:
1998-2007: Stephen R. Braund and Associates (SRB&A) Forthcoming.
2007: Magdanz et al. 2008.
Lifetime: Schroeder, R., D. B. Anderson (ADF&G) and G. Hildreth (Maniilaq Association) 1987.

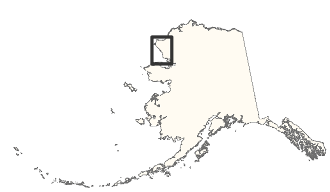


Map 42: 1998-2007 and Lifetime Subsistence Use Areas Kivalina, Moose

1998-2007 Overlapping Subsistence Use Areas
High
Low
37 Use Areas
20 Harvesters
Moose

2007 Subsistence Use Areas
4 Use Areas
4 Households
Moose

Lifetime (circa 1925-1986) Subsistence Use Areas
16 Kivalina harvesters
Moose



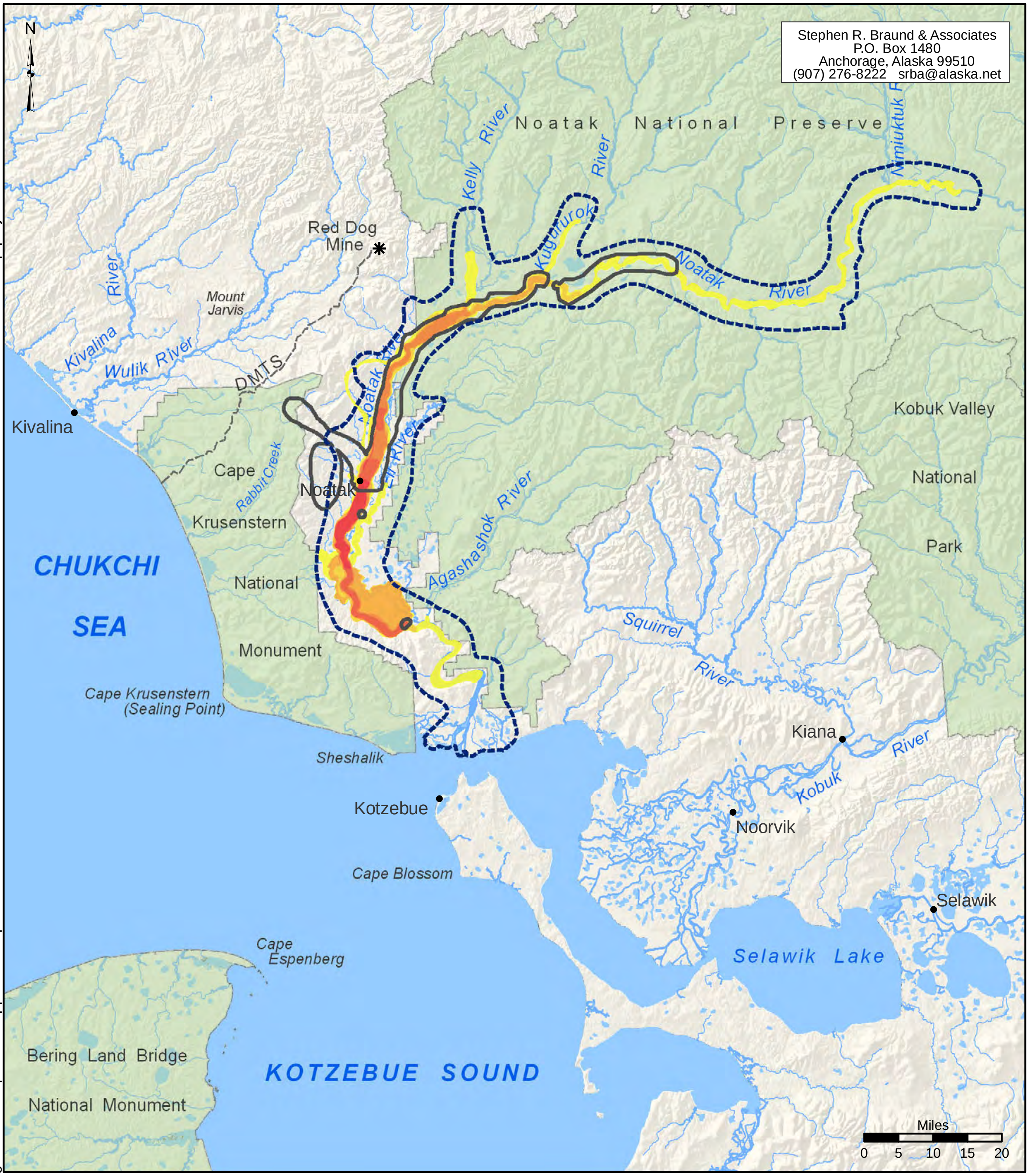
For all data sets, other areas may have been used for resource harvesting.

National Park Service Lands

DeLong Mountain Transportation System (DMTS)

Sources:
1998-2007: Stephen R. Braund and Associates (SRB&A) Forthcoming.
2007: Magdanz et al. 2008.
Lifetime: Schroeder, R., D. B. Anderson (ADF&G) and G. Hildreth (Maniilaq Association) 1987.

Map projection: NAD 1983 UTM Zone 3



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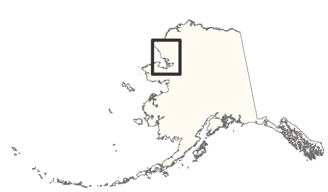
Map 43: 1998-2007 and Lifetime Subsistence Use Areas Noatak, Moose

1998-2007 Overlapping Subsistence Use Areas
High
Low
13 Use Areas
11 Harvesters
Moose

2007 Subsistence Use Areas
13 Use Areas
13 Households
Moose

Lifetime (circa 1925-1986) Subsistence Use Areas
25 Noatak harvesters
Moose



For all data sets, other areas may have been used for resource harvesting.

National Park Service Lands

DeLong Mountain Transportation System (DMTS)

Sources:
1998-2007: Stephen R. Braund and Associates (SRB&A) Forthcoming.
2007: Magdanz et al. 2008.
Lifetime: Schroeder, R., D. B. Anderson (ADF&G) and G. Hildreth (Maniilaq Association) 1987.

Map 44: 1998-2007 and Lifetime Subsistence Use Areas Kivalina Other Large Land Mammals

1998-2007 Overlapping Subsistence Use Areas

High 8 Use Areas
4 Harvesters
Other Large
Low Land Mammals

2007 Subsistence Use Areas

2 Use Areas
2 Households
Sheep

Lifetime (circa 1925-1986) Subsistence Use Areas

16 Kivalina harvesters, Bear

16 Kivalina harvesters, Sheep

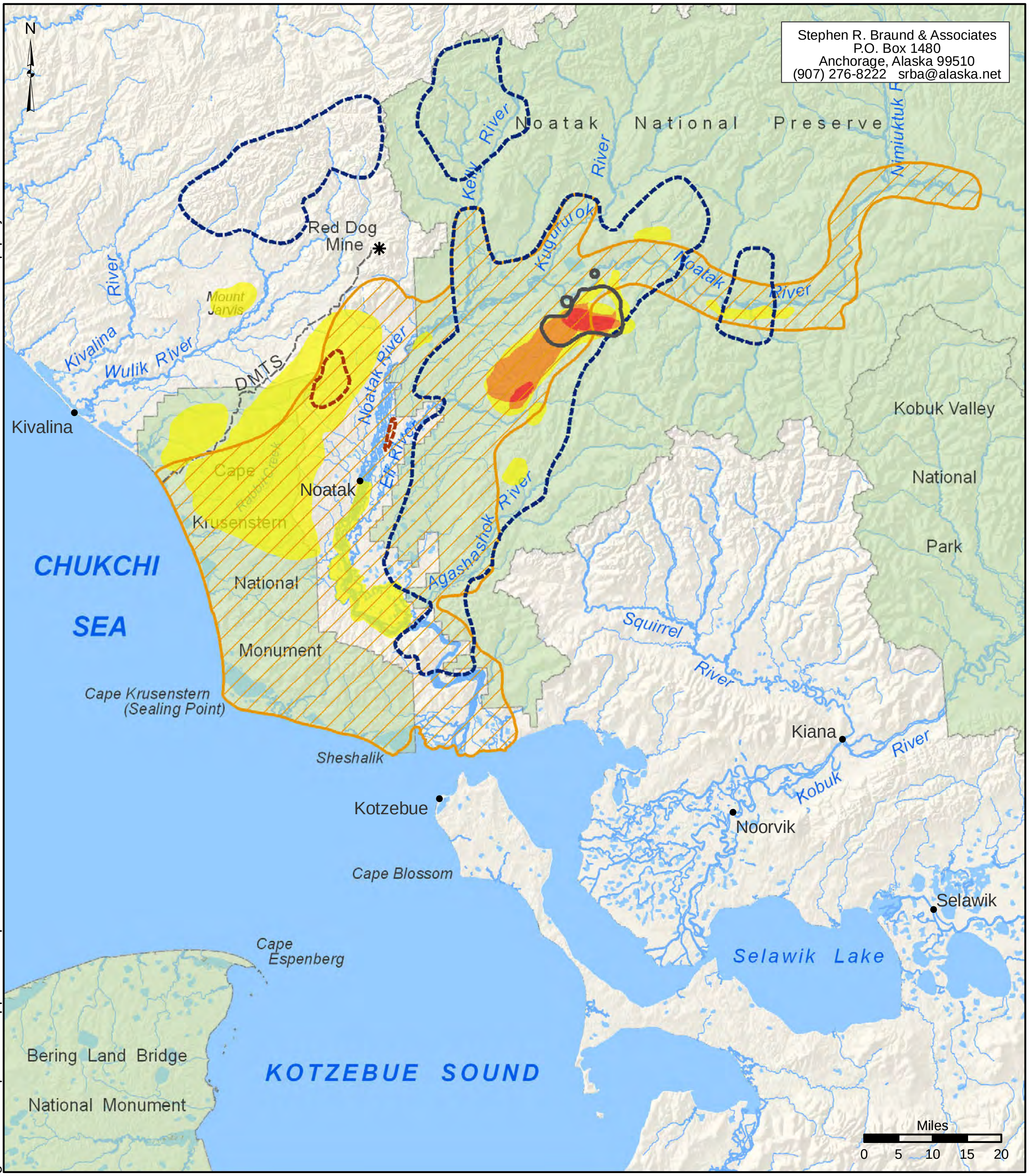
For all data sets, other areas may have been used for resource harvesting.

National Park Service Lands

DeLong Mountain Transportation System (DMTS)

Sources:
1998-2007: Stephen R. Braund and Associates (SRB&A) Forthcoming.
2007: Magdanz et al. 2008.
Lifetime: Schroeder, R., D. B. Anderson (ADF&G) and G. Hildreth (Maniilaq Association) 1987.

Map projection: NAD 1983 UTM Zone 3



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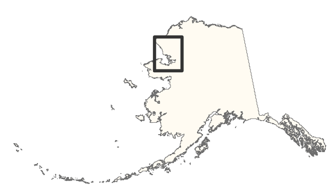
Map 45: 1998-2007 and Lifetime Subsistence Use Areas Noatak
Other Large Land Mammals



1998-2007 Overlapping Subsistence Use Areas

High 15 Use Areas
7 Harvesters
Other Large
Low Land Mammals

2007 Subsistence Use Areas

2 Use Areas
2 Households
Brown Bear

4 Use Areas
3 Households
Sheep

Lifetime (circa 1925-1986) Subsistence Use Areas

25 Noatak harvesters, Bear

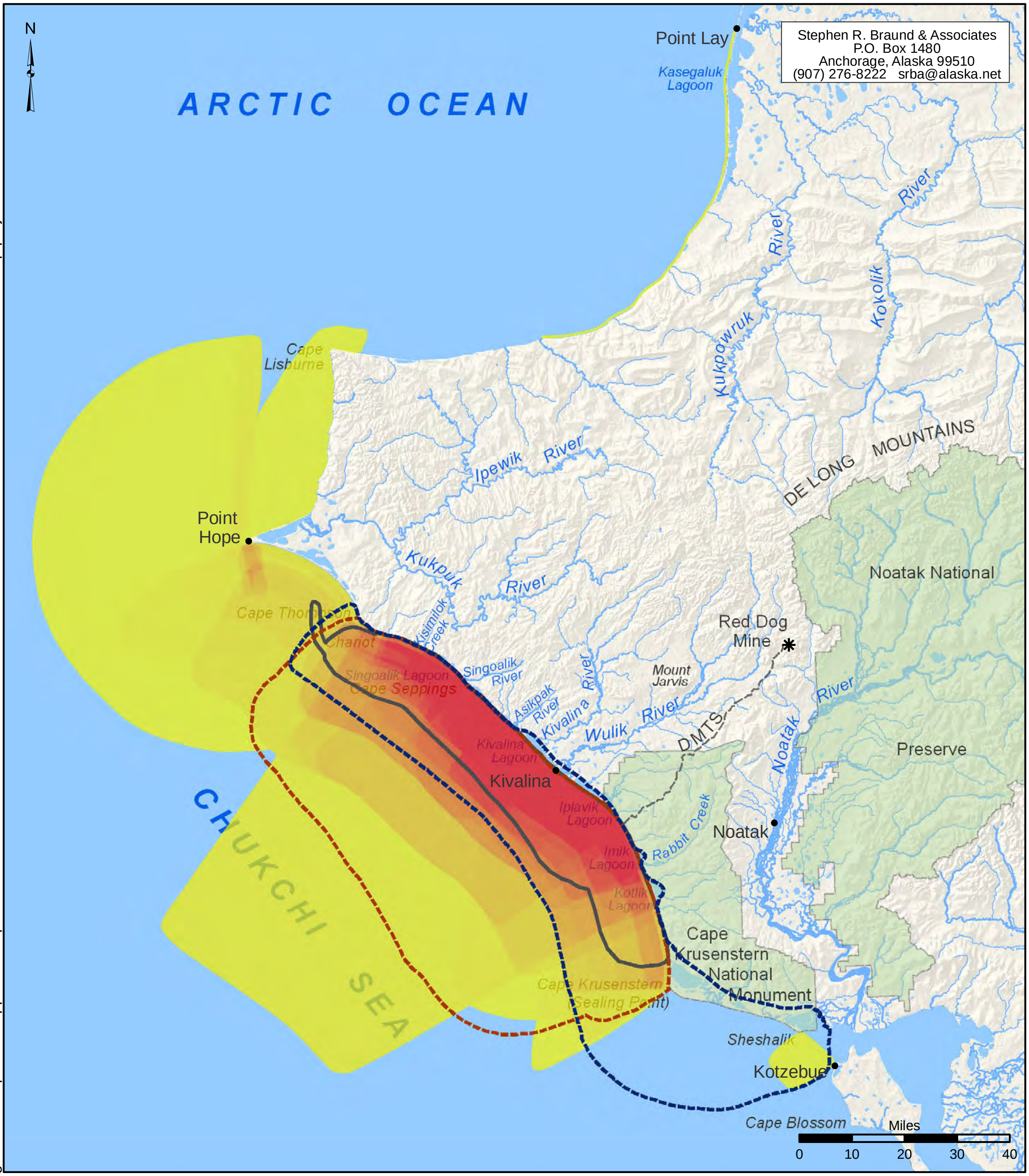
25 Noatak harvesters, Sheep

For all data sets, other areas may have been used for resource harvesting.

National Park Service Lands

DeLong Mountain Transportation System (DMTS)

Sources:
1998-2007: Stephen R. Braund and Associates (SRB&A) Forthcoming.
2007: Magdanz et al. 2008.
Lifetime: Schroeder, R., D. B. Anderson (ADF&G) and G. Hildreth (Maniilaq Association) 1987.



Map 46: 1998-2007 and Lifetime Subsistence Use Areas Kivalina, Marine Mammals

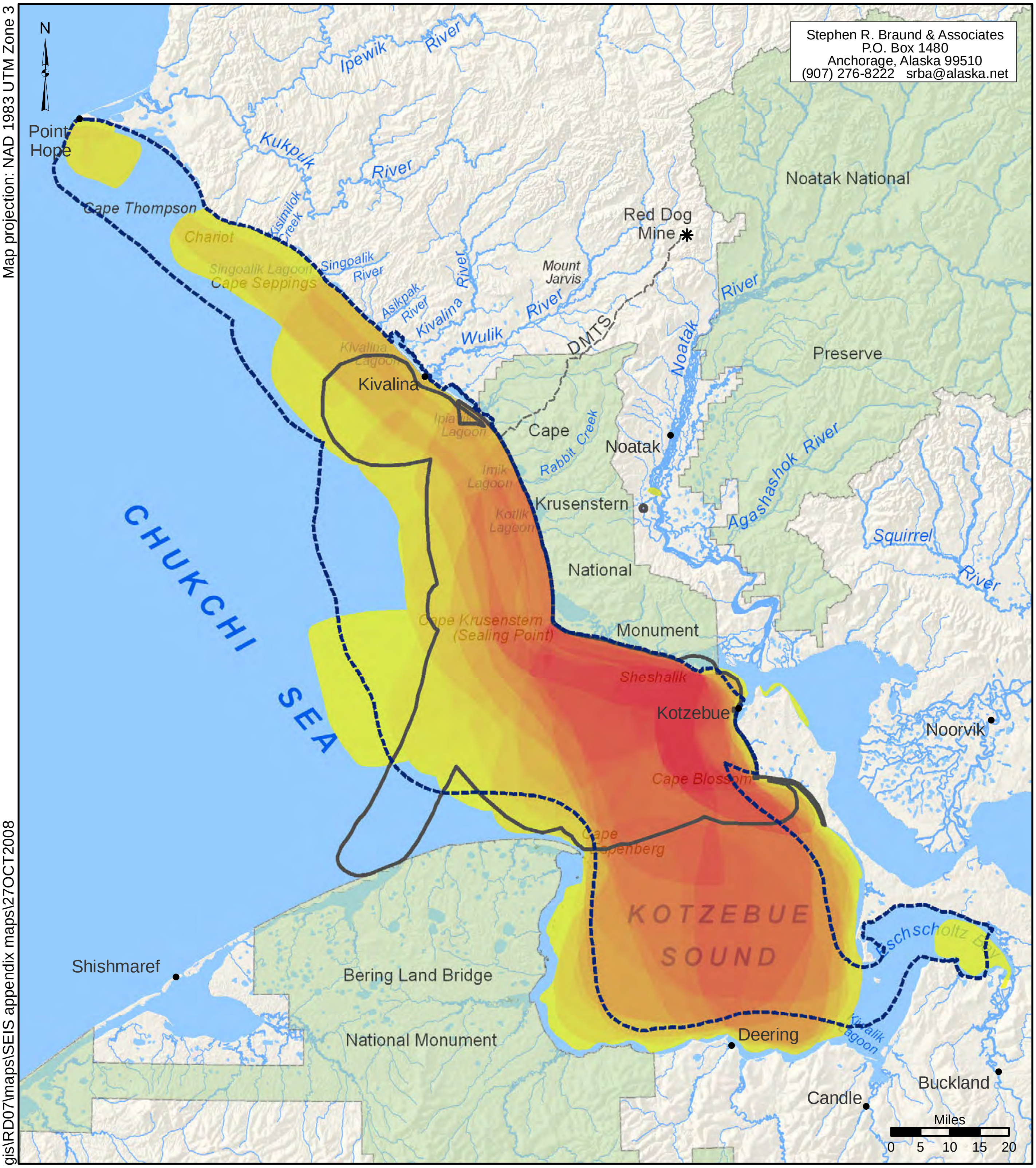
1998-2007 Overlapping Subsistence Use Areas	2007 Subsistence Use Areas	1998 Subsistence Use Areas	Lifetime (circa 1925-1986) Subsistence Use Areas
High / Low — 230 Use Areas, 34 Harvesters, Marine Mammals	66 Use Areas, 27 Households, Marine Mammals	7 Group Workshops, 19 Harvesters, Marine Mammals	16 Kivalina harvesters, Marine Mammals

For all data sets, other areas may have been used for resource harvesting.

National Park Service Lands

DeLong Mountain Transportation System (DMTS)

Sources:
1998-2007: Stephen R. Braund and Associates (SRB&A) Forthcoming.
2007: Magdanz et al. 2008.
1998: SRB&A 2000.
Lifetime: Schroeder, R., D. B. Anderson (ADF&G) and G. Hildreth (Maniilaq Association) 1987.



Map 47: 1998-2007 and Lifetime Subsistence Use Areas Noatak, Marine Mammals

1998-2007 Overlapping Subsistence Use Areas
High / Low
111 Use Areas
22 Harvesters
Marine Mammals

2007 Subsistence Use Areas
29 Use Areas
18 Households
Marine Mammals

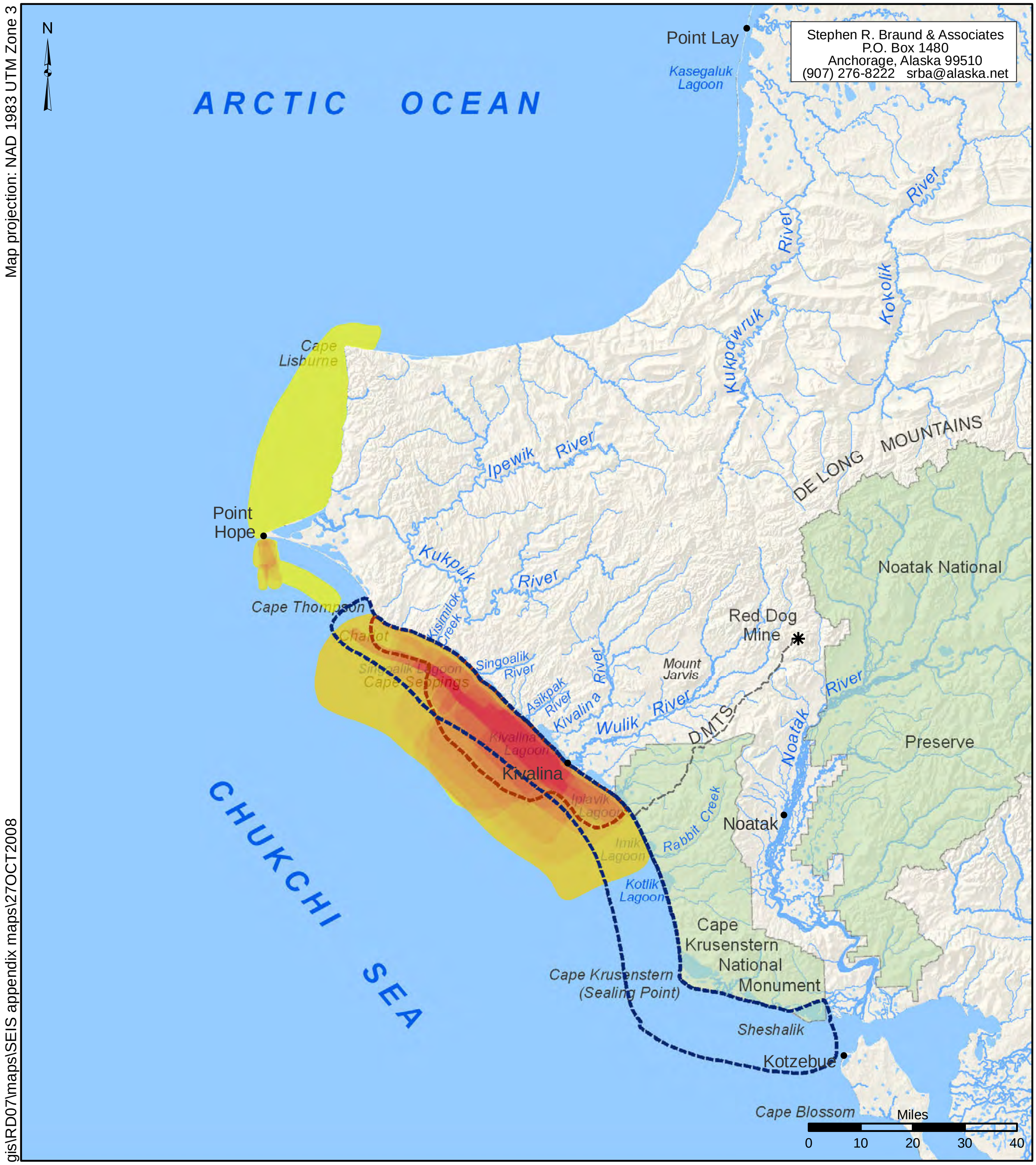
Lifetime (circa 1925-1986) Subsistence Use Areas
25 Noatak harvesters
Marine Mammals

For all data sets, other areas may have been used for resource harvesting.

National Park Service Lands

DeLong Mountain Transportation System (DMTS)

Sources:
1998-2007: Stephen R. Braund and Associates (SRB&A) Forthcoming.
2007: Magdanz et al. 2008.
Lifetime: Schroeder, R., D. B. Anderson (ADF&G) and G. Hildreth (Maniilaq Association) 1987.



Map 48: 1998-2007 and Lifetime Subsistence Use Areas Kivalina, Bowhead

1998-2007 Overlapping Subsistence Use Areas
High
Low
47 Use Areas
30 Harvesters
Bowhead

1998 Subsistence Use Areas
7 Group Workshops
19 Harvesters
Bowhead

Lifetime (circa 1925-1986) Subsistence Use Areas
16 Kivalina harvesters
Bowhead

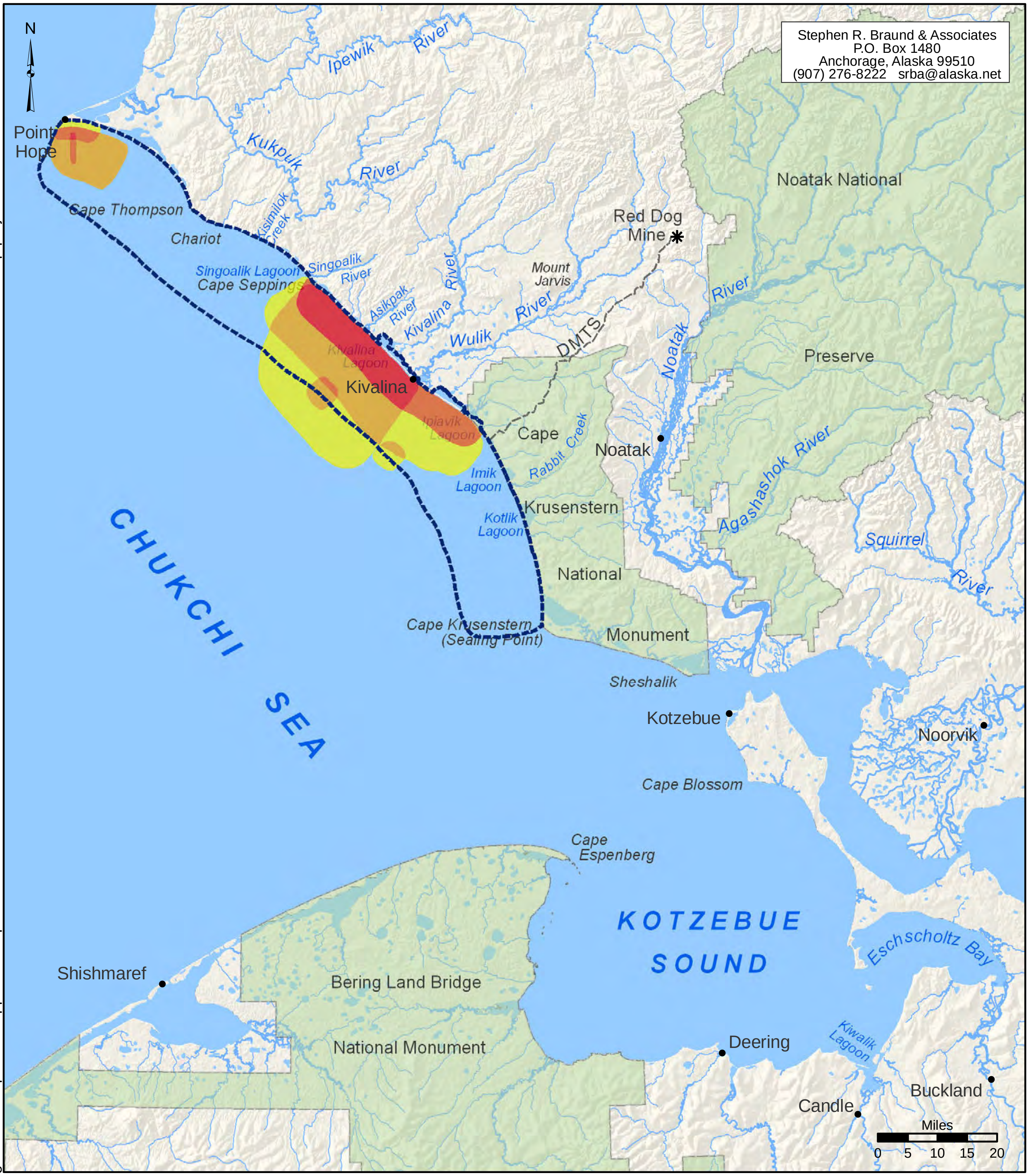
For all data sets, other areas may have been used for resource harvesting.

National Park Service Lands

DeLong Mountain Transportation System (DMTS)

Sources:
1998-2007: Stephen R. Braund and Associates (SRB&A) Forthcoming.
1998: SRB&A 2000.
Lifetime: Schroeder, R., D. B. Anderson (ADF&G) and G. Hildreth (Maniilaq Association) 1987.

Map projection: NAD 1983 UTM Zone 3



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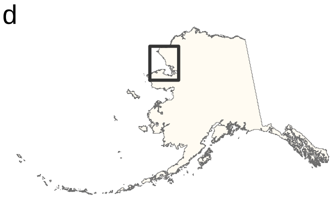
Map 49: 1998-2007 and Lifetime Subsistence Use Areas Noatak, Bowhead

1998-2007 Overlapping Subsistence Use Areas

High
10 Use Areas
9 Harvesters
Bowhead
Low

Lifetime (circa 1925-1986) Subsistence Use Areas

25 Noatak harvesters
Bowhead



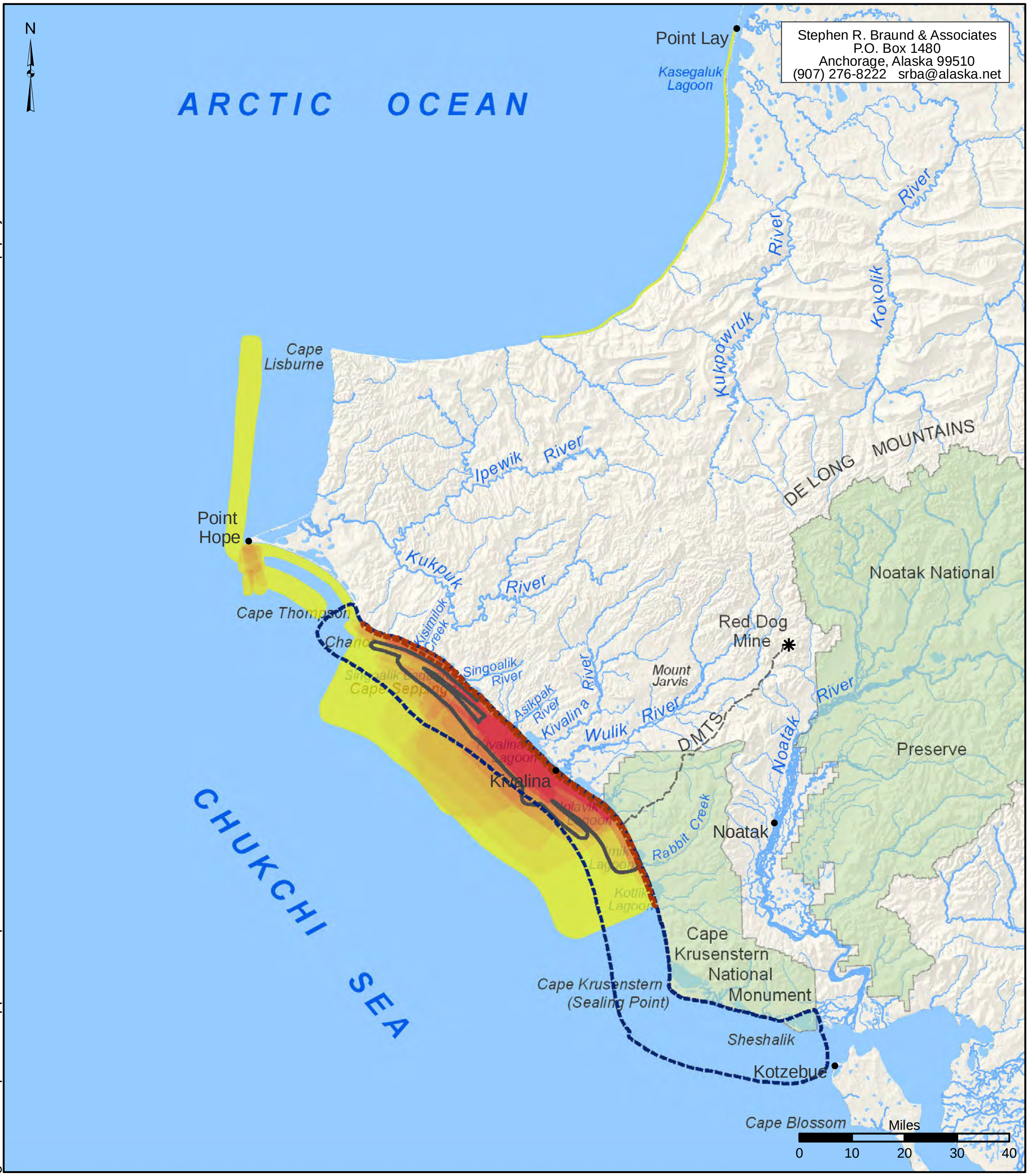
For all data sets, other areas may have been used for resource harvesting.

National Park Service Lands

DeLong Mountain Transportation System (DMTS)

Sources:
1998-2007: Stephen R. Braund and Associates (SRB&A) Forthcoming.
Lifetime: Schroeder, R., D. B. Anderson (ADF&G) and G. Hildreth (Maniilaq Association) 1987.

Map projection: NAD 1983 UTM Zone 3



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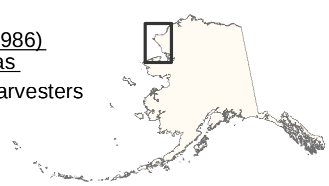
Map 50: 1998-2007 and Lifetime Subsistence Use Areas Kivalina, Beluga

1998-2007 Overlapping Subsistence Use Areas
High
Low
71 Use Areas
32 Harvesters
Beluga

2007 Subsistence Use Areas
22 Use Areas
16 Households
Beluga

1998 Subsistence Use Areas
7 Group Workshops
19 Harvesters
Beluga

Lifetime (circa 1925-1986) Subsistence Use Areas
16 Kivalina harvesters
Beluga



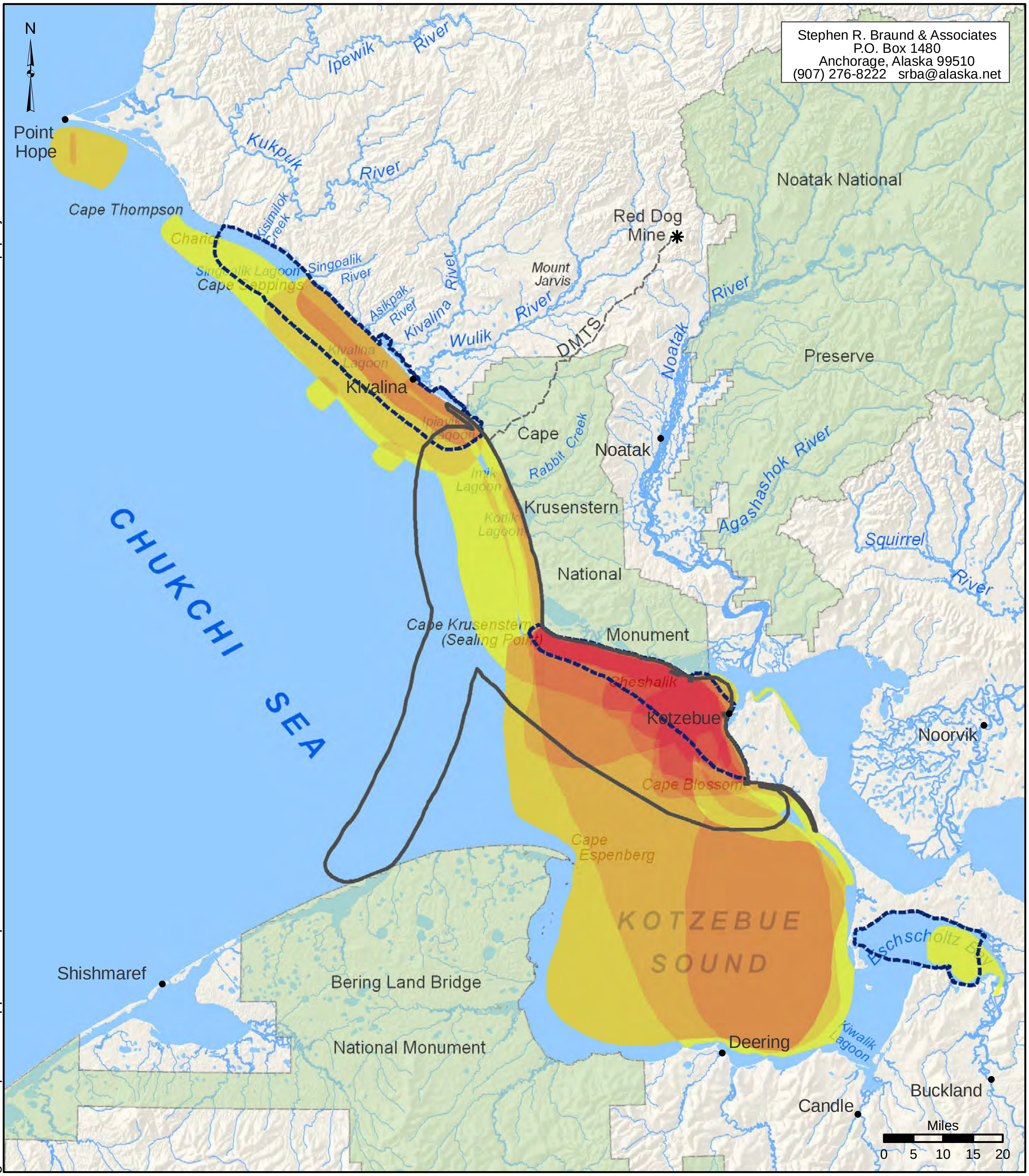
For all data sets, other areas may have been used for resource harvesting.

National Park Service Lands

DeLong Mountain Transportation System (DMTS)

Sources:
1998-2007: Stephen R. Braund and Associates (SRB&A) Forthcoming.
2007: Magdanz et al. 2008.
1998: SRB&A 2000.
Lifetime: Schroeder, R., D. B. Anderson (ADF&G) and G. Hildreth (Maniilaq Association) 1987.

Map projection: NAD 1983 UTM Zone 3



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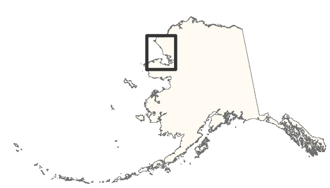
Map 51: 1998-2007 and Lifetime Subsistence Use Areas Noatak, Beluga

1998-2007 Overlapping Subsistence Use Areas
High
Low
35 Use Areas
17 Harvesters
Beluga

2007 Subsistence Use Areas
7 Use Areas
7 Households
Beluga

Lifetime (circa 1925-1986) Subsistence Use Areas
25 Noatak harvesters
Beluga



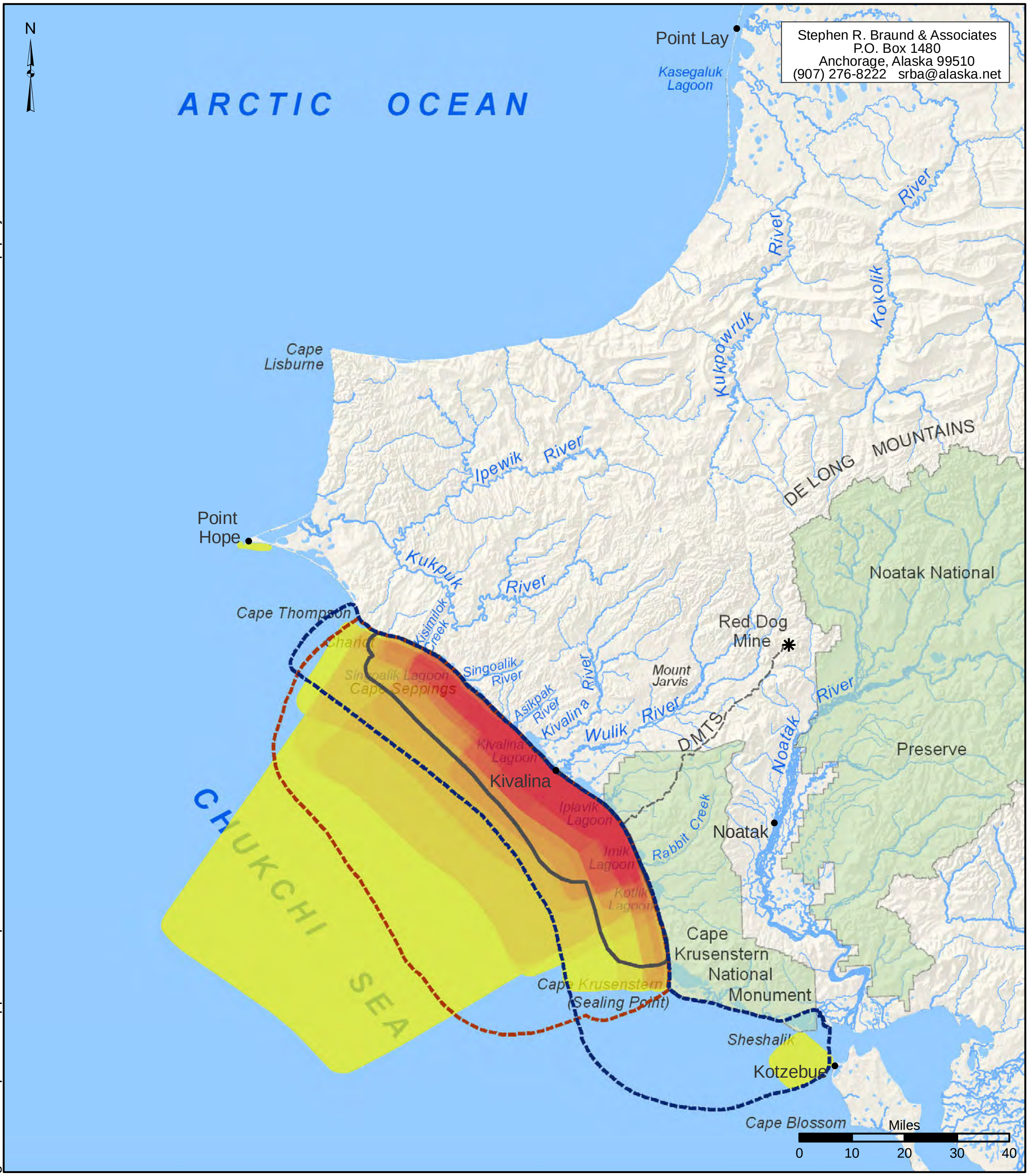
For all data sets, other areas may have been used for resource harvesting.

National Park Service Lands

DeLong Mountain Transportation System (DMTS)

Sources:
1998-2007: Stephen R. Braund and Associates (SRB&A) Forthcoming.
2007: Magdanz et al. 2008.
Lifetime: Schroeder, R., D. B. Anderson (ADF&G) and G. Hildreth (Maniilaq Association) 1987.

Map projection: NAD 1983 UTM Zone 3



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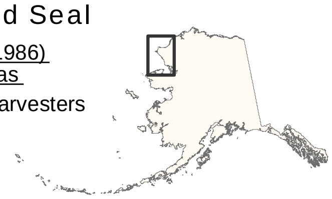
Map 52: 1998-2007 and Lifetime Subsistence Use Areas Kivalina, Bearded Seal

<u>1998-2007 Overlapping Subsistence Use Areas</u>
High
Low
40 Use Areas
29 Harvesters
Bearded Seal

<u>2007 Subsistence Use Areas</u>
26 Use Areas
24 Households
Bearded Seal

<u>1998 Subsistence Use Areas</u>
7 Group Workshops
19 Harvesters
Bearded Seal

<u>Lifetime (circa 1925-1986) Subsistence Use Areas</u>
16 Kivalina harvesters
Seal



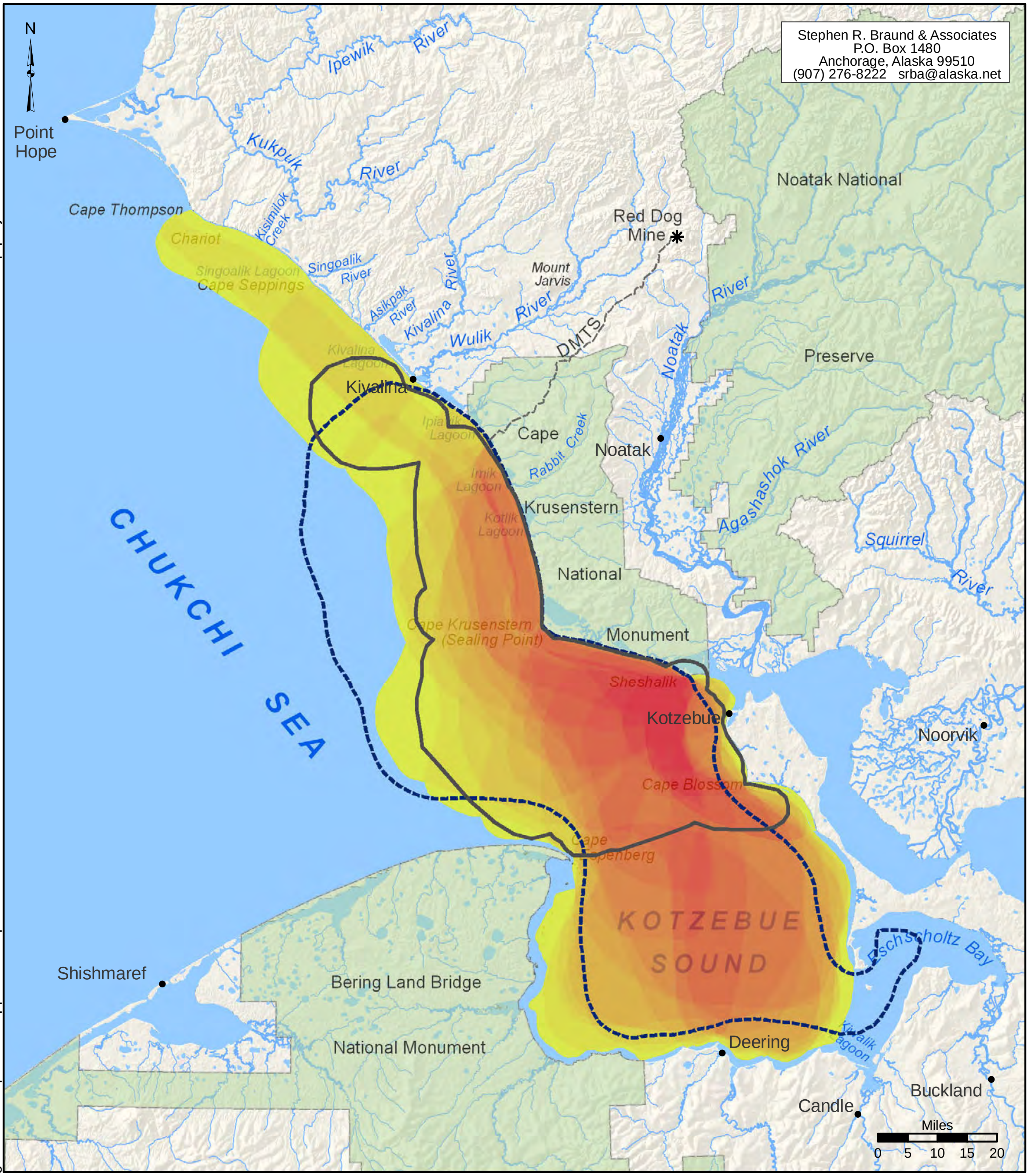
For all data sets, other areas may have been used for resource harvesting.

National Park Service Lands

DeLong Mountain Transportation System (DMTS)

Sources:
1998-2007: Stephen R. Braund and Associates (SRB&A) Forthcoming.
2007: Magdanz et al. 2008.
1998: SRB&A 2000.
Lifetime: Schroeder, R., D. B. Anderson (ADF&G) and G. Hildreth (Maniilaq Association) 1987.

Map projection: NAD 1983 UTM Zone 3



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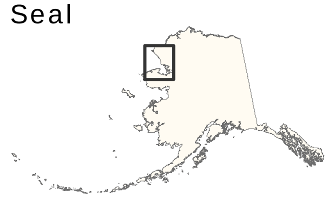
Map 53: 1998-2007 and Lifetime Subsistence Use Areas Noatak, Bearded Seal

1998-2007 Overlapping Subsistence Use Areas
High
Low
28 Use Areas
21 Harvesters
Bearded Seal

2007 Subsistence Use Areas
16 Use Areas
15 Households
Bearded Seal

Lifetime (circa 1925-1986) Subsistence Use Areas
25 Noatak harvesters
Seal

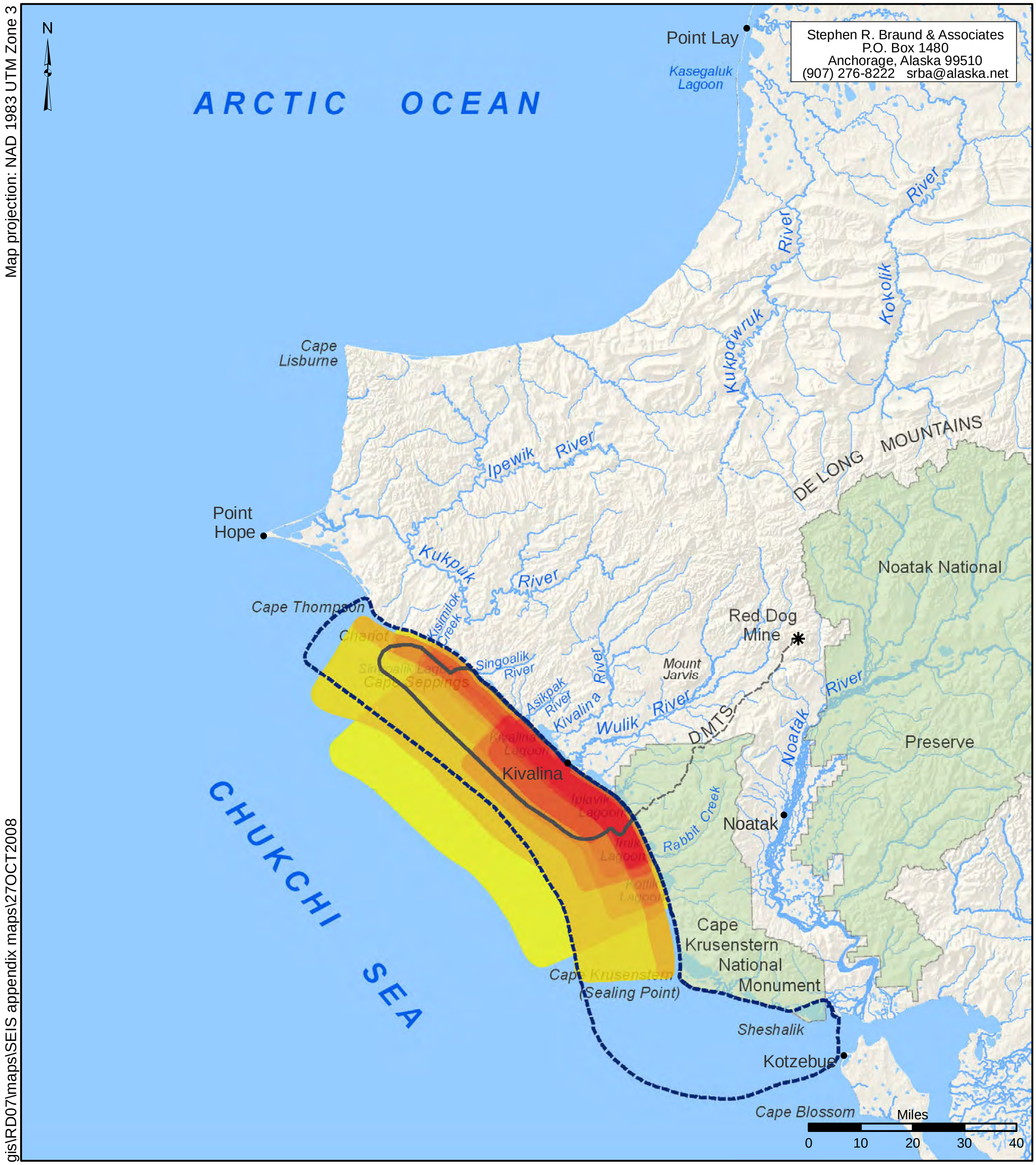


For all data sets, other areas may have been used for resource harvesting.

National Park Service Lands

DeLong Mountain Transportation System (DMTS)

Sources:
1998-2007: Stephen R. Braund and Associates (SRB&A) Forthcoming.
2007: Magdanz et al. 2008.
Lifetime: Schroeder, R., D. B. Anderson (ADF&G) and G. Hildreth (Maniilaq Association) 1987.



Map 54: 1998-2007 and Lifetime Subsistence Use Areas Kivalina, Other Seal

1998-2007 Overlapping Subsistence Use Areas

High
Low

31 Use Areas
21 Harvesters
Other Seal

2007 Subsistence Use Areas

12 Use Areas
11 Households
Ringed Seal

Lifetime (circa 1925-1986) Subsistence Use Areas

16 Kivalina harvesters
Seal

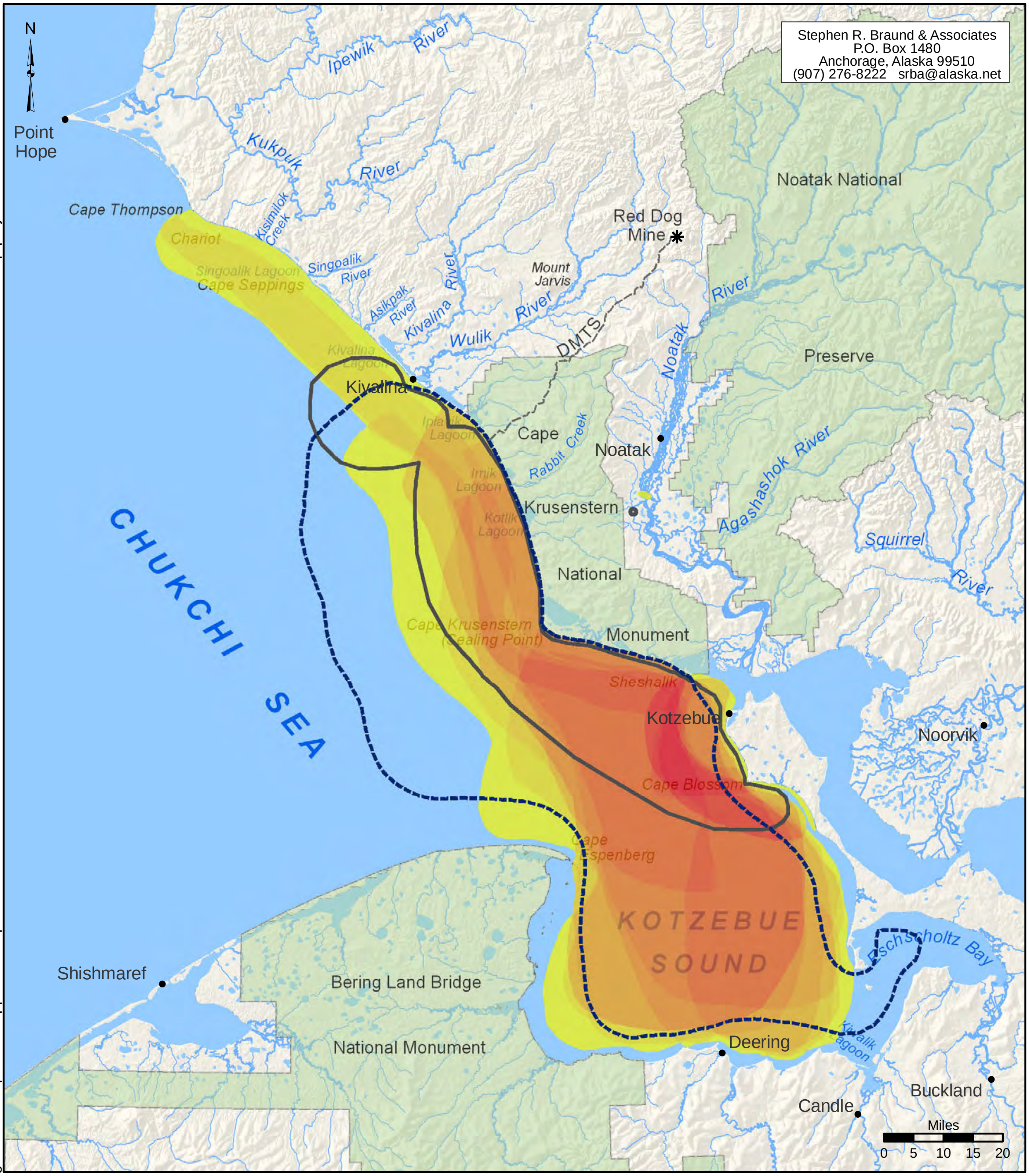
For all data sets, other areas may have been used for resource harvesting.

National Park Service Lands

DeLong Mountain Transportation System (DMTS)

Sources:
1998-2007: Stephen R. Braund and Associates (SRB&A) Forthcoming.
2007: Magdanz et al. 2008.
Lifetime: Schroeder, R., D. B. Anderson (ADF&G) and G. Hildreth (Maniilaq Association) 1987.

Map projection: NAD 1983 UTM Zone 3



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Map 55: 1998-2007 and Lifetime Subsistence Use Areas Noatak, Other Seal

1998-2007 Overlapping Subsistence Use Areas

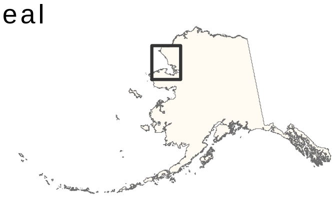
High
14 Use Areas
12 Harvesters
Other Seal
Low

2007 Subsistence Use Areas

4 Use Areas
4 Households
Ringed Seal

Lifetime (circa 1925-1986) Subsistence Use Areas

25 Noatak harvesters
Seal

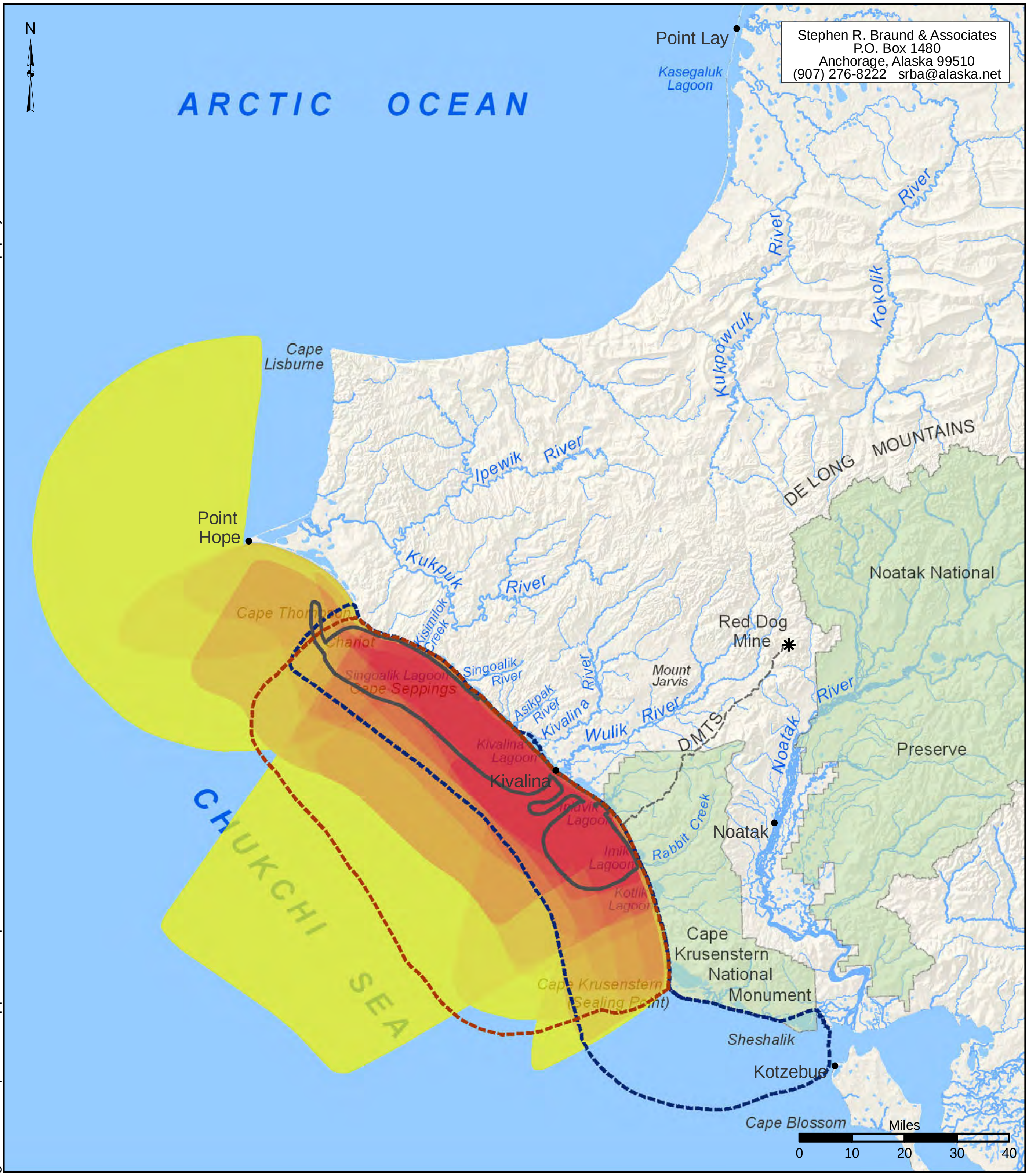


For all data sets, other areas may have been used for resource harvesting.

National Park Service Lands

DeLong Mountain Transportation System (DMTS)

Sources:
1998-2007: Stephen R. Braund and Associates (SRB&A) Forthcoming.
2007: Magdanz et al. 2008.
Lifetime: Schroeder, R., D. B. Anderson (ADF&G) and G. Hildreth (Maniilaq Association) 1987.



Map projection: NAD 1983 UTM Zone 3

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Map 56: 1998-2007 and Lifetime Subsistence Use Areas Kivalina, Walrus

1998-2007 Overlapping Subsistence Use Areas
High
Low
31 Use Areas
26 Harvesters
Walrus

2007 Subsistence Use Areas
6 Use Areas
6 Households
Walrus

1998 Subsistence Use Areas
7 Group Workshops
19 Harvesters
Walrus

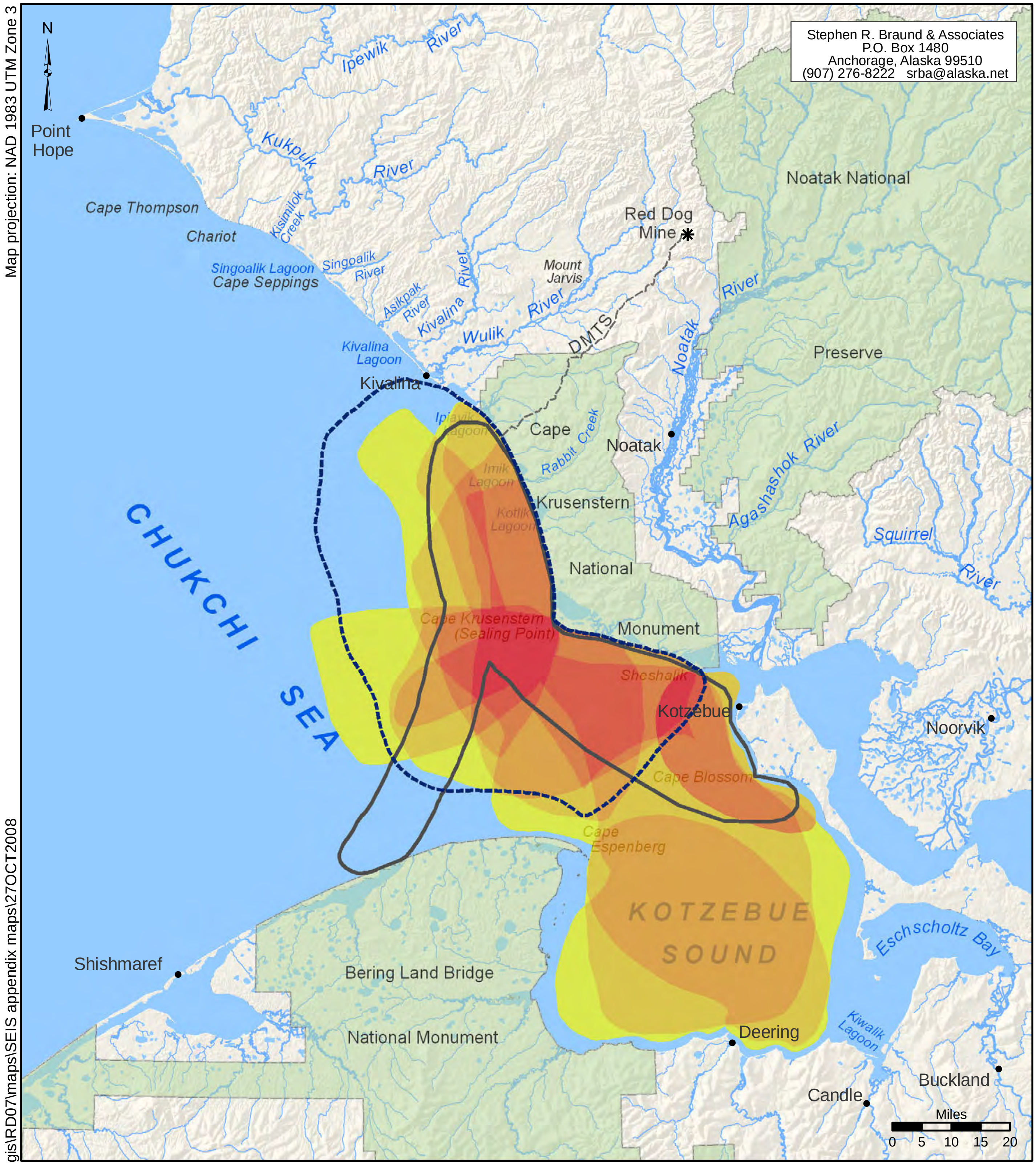
Lifetime (circa 1925-1986) Subsistence Use Areas
16 Kivalina harvesters
Walrus

For all data sets, other areas may have been used for resource harvesting.

National Park Service Lands

DeLong Mountain Transportation System (DMTS)

Sources:
1998-2007: Stephen R. Braund and Associates (SRB&A) Forthcoming.
2007: Magdanz et al. 2008.
1998: SRB&A 2000.
Lifetime: Schroeder, R., D. B. Anderson (ADF&G) and G. Hildreth (Maniilaq Association) 1987.



Map 57: 1998-2007 and Lifetime Subsistence Use Areas Noatak, Walrus

1998-2007 Overlapping Subsistence Use Areas
High
Low
11 Use Areas
10 Harvesters
Walrus

2007 Subsistence Use Areas
2 Use Areas
2 Households
Walrus

Lifetime (circa 1925-1986) Subsistence Use Areas
25 Noatak harvesters
Walrus

For all data sets, other areas may have been used for resource harvesting.

National Park Service Lands

DeLong Mountain Transportation System (DMTS)

Sources:
1998-2007: Stephen R. Braund and Associates (SRB&A) Forthcoming.
2007: Magdanz et al. 2008.
Lifetime: Schroeder, R., D. B. Anderson (ADF&G) and G. Hildreth (Maniilaq Association) 1987.

Map projection: NAD 1983 UTM Zone 3

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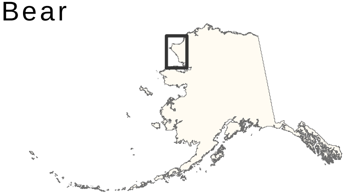
Map 58: 1998-2007 and Lifetime Subsistence Use Areas Kivalina, Polar Bear

1998-2007 Overlapping Subsistence Use Areas

High
10 Use Areas
8 Harvesters
Polar Bear
Low

Lifetime (circa 1925-1986) Subsistence Use Areas

16 Kivalina harvesters
Polar Bear



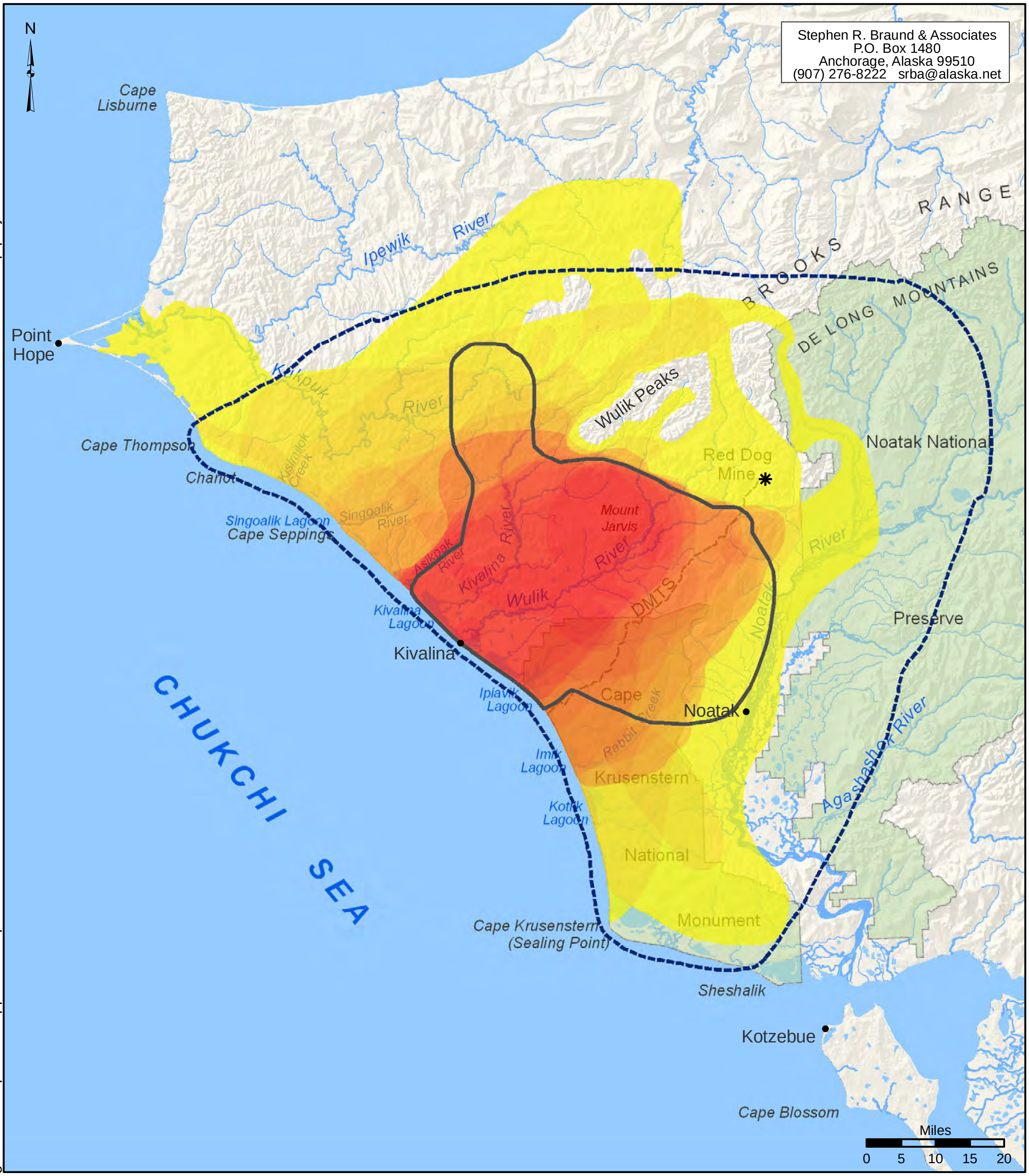
For all data sets, other areas may have been used for resource harvesting.

National Park Service Lands

DeLong Mountain Transportation System (DMTS)

Sources:
1998-2007: Stephen R. Braund and Associates (SRB&A) Forthcoming.
Lifetime: Schroeder, R., D. B. Anderson (ADF&G) and G. Hildreth (Maniilaq Association) 1987.

Map projection: NAD 1983 UTM Zone 3



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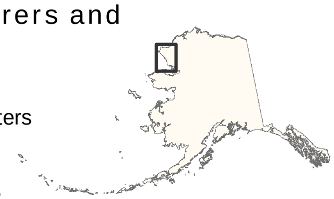
Map 59: 1998-2007 and Lifetime Subsistence Use Areas Kivalina, Furbearers and Small Land Mammals



1998-2007 Overlapping Subsistence Use Areas

High / Low — 27 Use Areas, 20 Harvesters, Furbearers and Small Land Mammals

2007 Subsistence Use Areas

8 Use Areas
7 Households
Furbearers

Lifetime (circa 1925-1986) Subsistence Use Areas

16 Kivalina harvesters
Furbearers

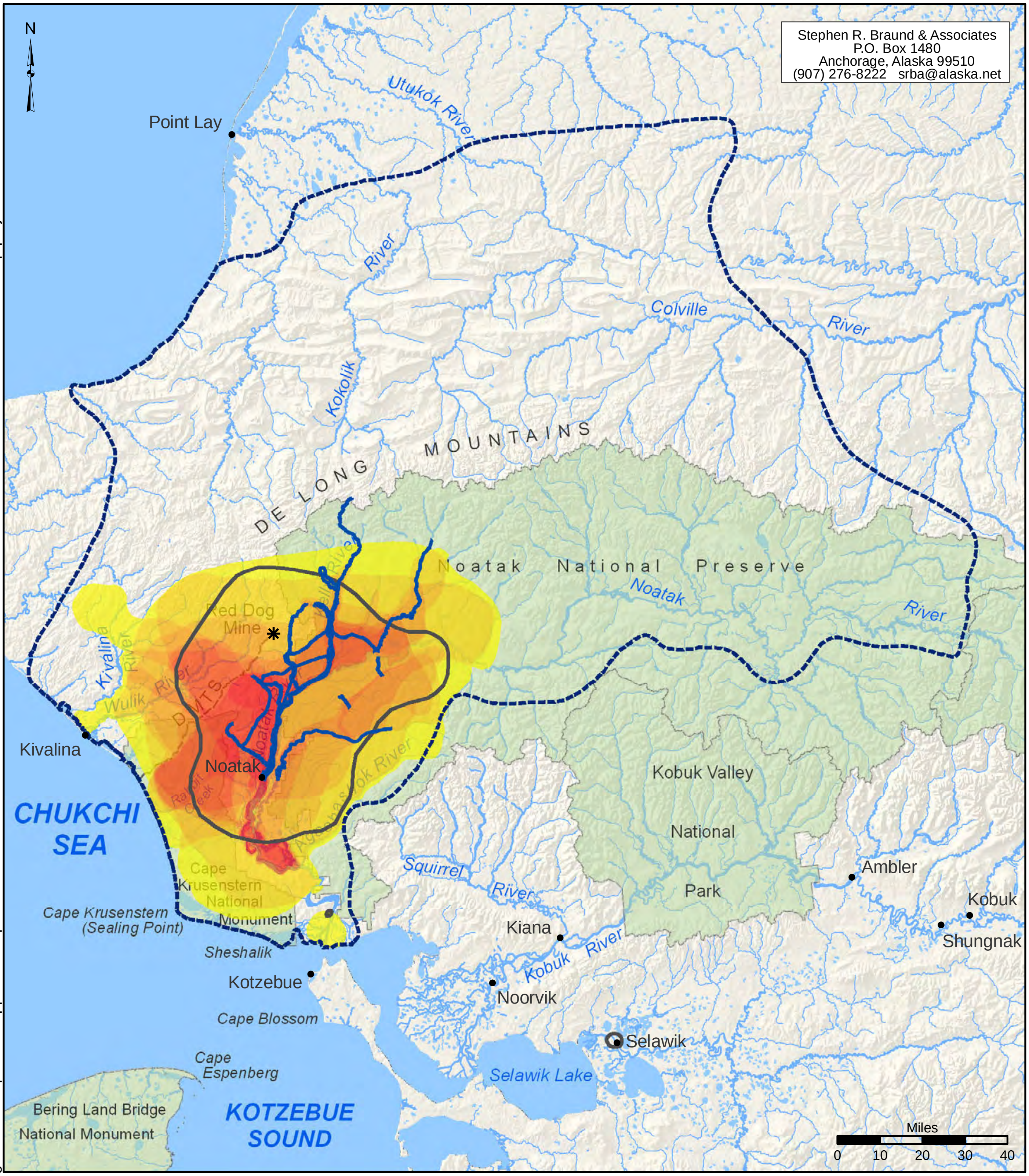
For all data sets, other areas may have been used for resource harvesting.

National Park Service Lands

DeLong Mountain Transportation System (DMTS)

Sources:
1998-2007: Stephen R. Braund and Associates (SRB&A) Forthcoming.
2007: Magdanz et al. 2008.
Lifetime: Schroeder, R., D. B. Anderson (ADF&G) and G. Hildreth (Maniilaq Association) 1987.

Map projection: NAD 1983 UTM Zone 3



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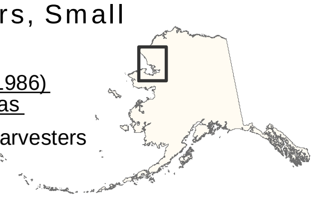
Map 60: 1998-2007 and Lifetime Subsistence Use Areas Noatak, Furbearers, Small Land Mammals and Traplines



1998-2007 Overlapping Subsistence Use Areas
High 84 Use Areas
21 Harvesters
Furbearers and
Low Small Land Mammals

SRB&A 1998-2007 data
25 Traplines
6 Harvesters
Furbearers and
Small Land Mammals

2007 Subsistence Use Areas
22 Use Areas
16 Households
Furbearers

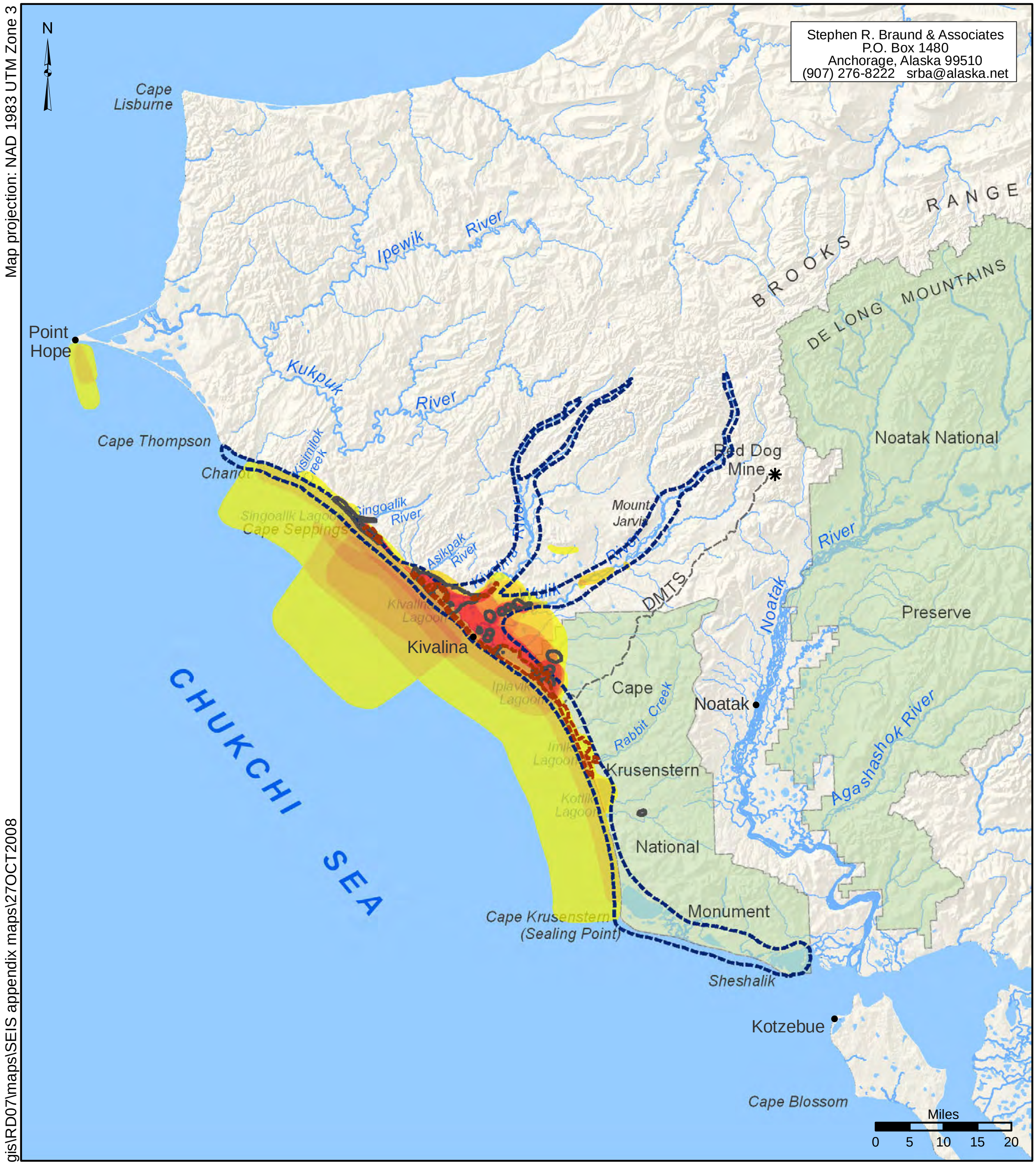
Lifetime (circa 1925-1986) Subsistence Use Areas
25 Noatak harvesters
Furbearers

For all data sets, other areas may have been used for resource harvesting.

National Park Service Lands

DeLong Mountain Transportation System (DMTS)

Sources:
1998-2007: Stephen R. Braund and Associates (SRB&A) Forthcoming.
2007: Magdanz et al. 2008.
Lifetime: Schroeder, R., D. B. Anderson (ADF&G) and G. Hildreth (Maniilaq Association) 1987.



Map 61: 1998-2007 and Lifetime Subsistence Use Areas Kivalina, Waterfowl

1998-2007 Overlapping Subsistence Use Areas
High / Low
112 Use Areas
33 Harvesters
Waterfowl

2007 Subsistence Use Areas
43 Use Areas
22 Households
Waterfowl

1998 Subsistence Use Areas
7 Group Workshops
19 Harvesters
Waterfowl

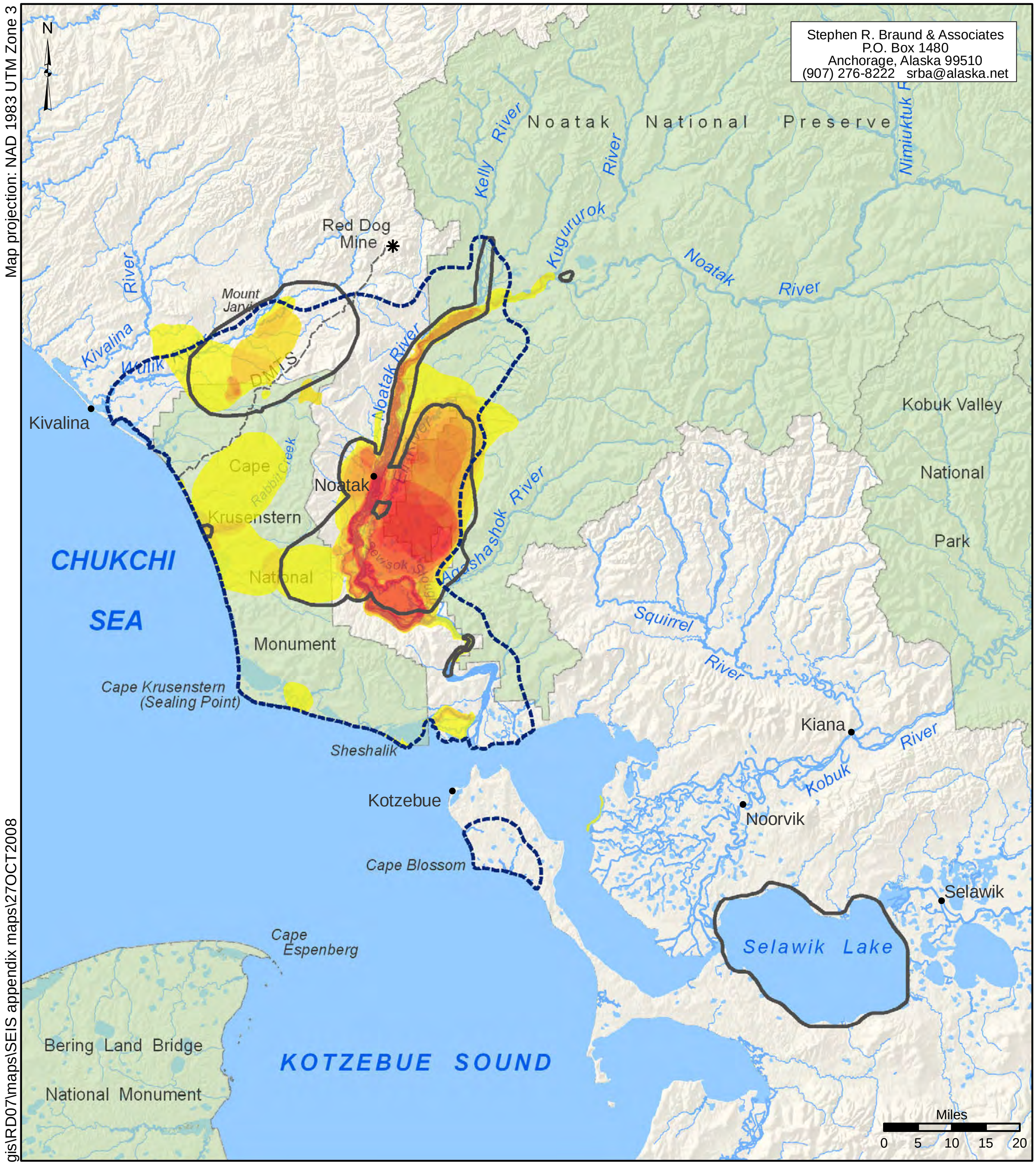
Lifetime (circa 1925-1986) Subsistence Use Areas
16 Kivalina harvesters
Waterfowl

For all data sets, other areas may have been used for resource harvesting.

National Park Service Lands

DeLong Mountain Transportation System (DMTS)

Sources:
1998-2007: Stephen R. Braund and Associates (SRB&A) Forthcoming.
2007: Magdanz et al. 2008.
1998: SRB&A 2000.
Lifetime: Schroeder, R., D. B. Anderson (ADF&G) and G. Hildreth (Maniilaq Association) 1987.



Map 62: 1998-2007 and Lifetime Subsistence Use Areas Noatak, Waterfowl

1998-2007 Overlapping Subsistence Use Areas
High
Low
93 Use Areas
25 Harvesters
Waterfowl

2007 Subsistence Use Areas
46 Use Areas
37 Households
Waterfowl

Lifetime (circa 1925-1986) Subsistence Use Areas
25 Noatak harvesters
Waterfowl

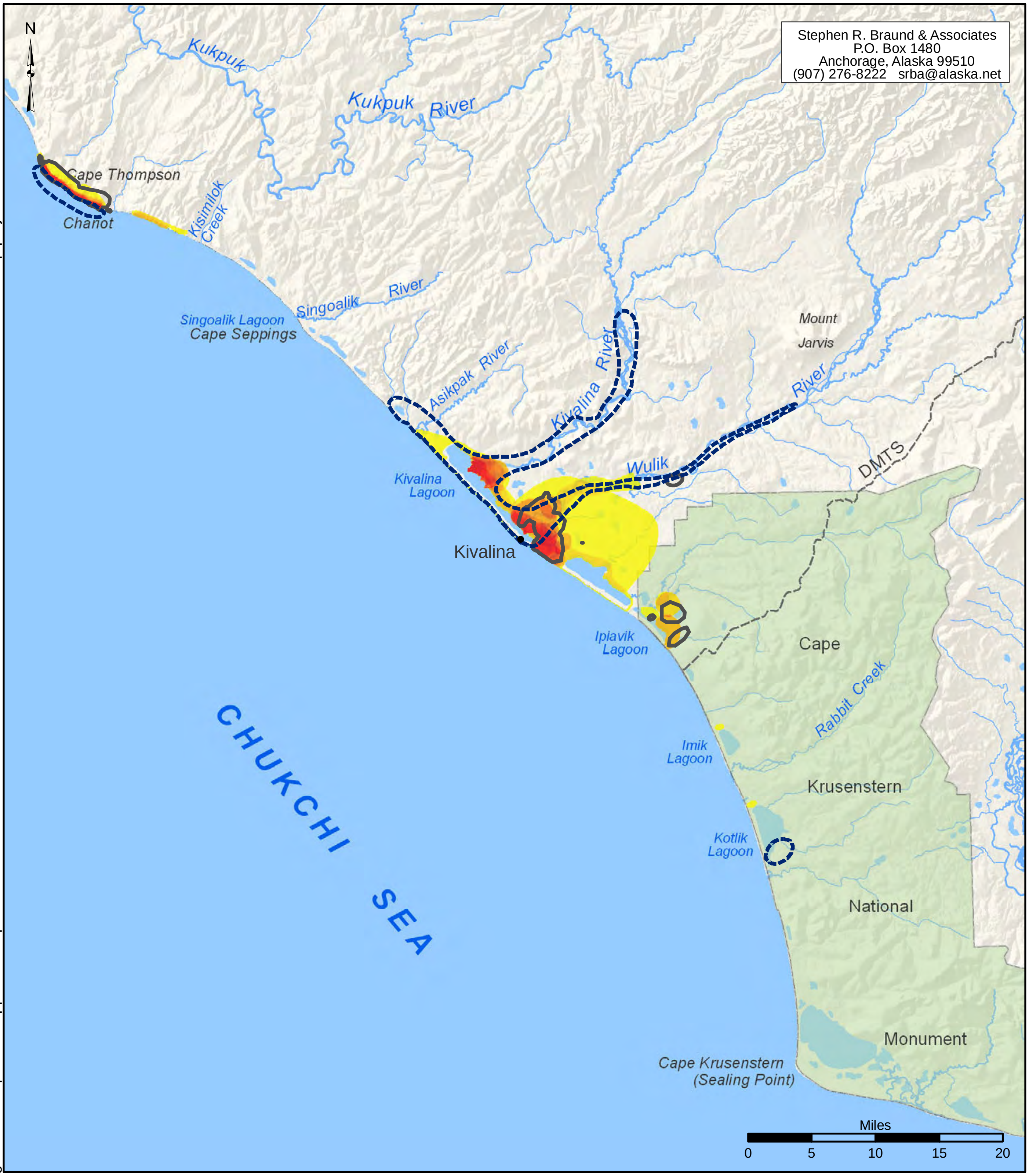
For all data sets, other areas may have been used for resource harvesting.

National Park Service Lands

DeLong Mountain Transportation System (DMTS)

Sources:
1998-2007: Stephen R. Braund and Associates (SRB&A) Forthcoming.
2007: Magdanz et al. 2008.
Lifetime: Schroeder, R., D. B. Anderson (ADF&G) and G. Hildreth (Maniilaq Association) 1987.

Map projection: NAD 1983 UTM Zone 3



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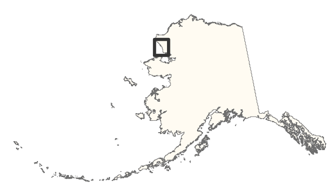
Map 63: 1998-2007 and Lifetime Subsistence Use Areas Kivalina, Eggs

1998-2007 Overlapping Subsistence Use Areas
High
Low
78 Use Areas
31 Harvesters
Eggs

2007 Subsistence Use Areas
28 Use Areas
15 Households
Eggs

Lifetime (circa 1925-1986) Subsistence Use Areas
16 Kivalina harvesters
Eggs



For all data sets, other areas may have been used for resource harvesting.

National Park Service Lands

DeLong Mountain Transportation System (DMTS)

Sources:
1998-2007: Stephen R. Braund and Associates (SRB&A) Forthcoming.
2007: Magdanz et al. 2008.
Lifetime: Schroeder, R., D. B. Anderson (ADF&G) and G. Hildreth (Maniilaq Association) 1987.

Map projection: NAD 1983 UTM Zone 3

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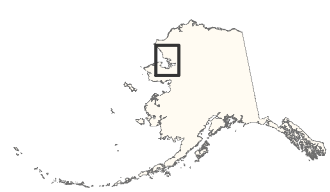
Map 64: 1998-2007 and Lifetime Subsistence Use Areas Noatak, Eggs

1998-2007 Overlapping Subsistence Use Areas
High
Low
36 Use Areas
21 Harvesters
Eggs

2007 Subsistence Use Areas
24 Use Areas
24 Households
Eggs

Lifetime (circa 1925-1986) Subsistence Use Areas
25 Noatak harvesters
Eggs

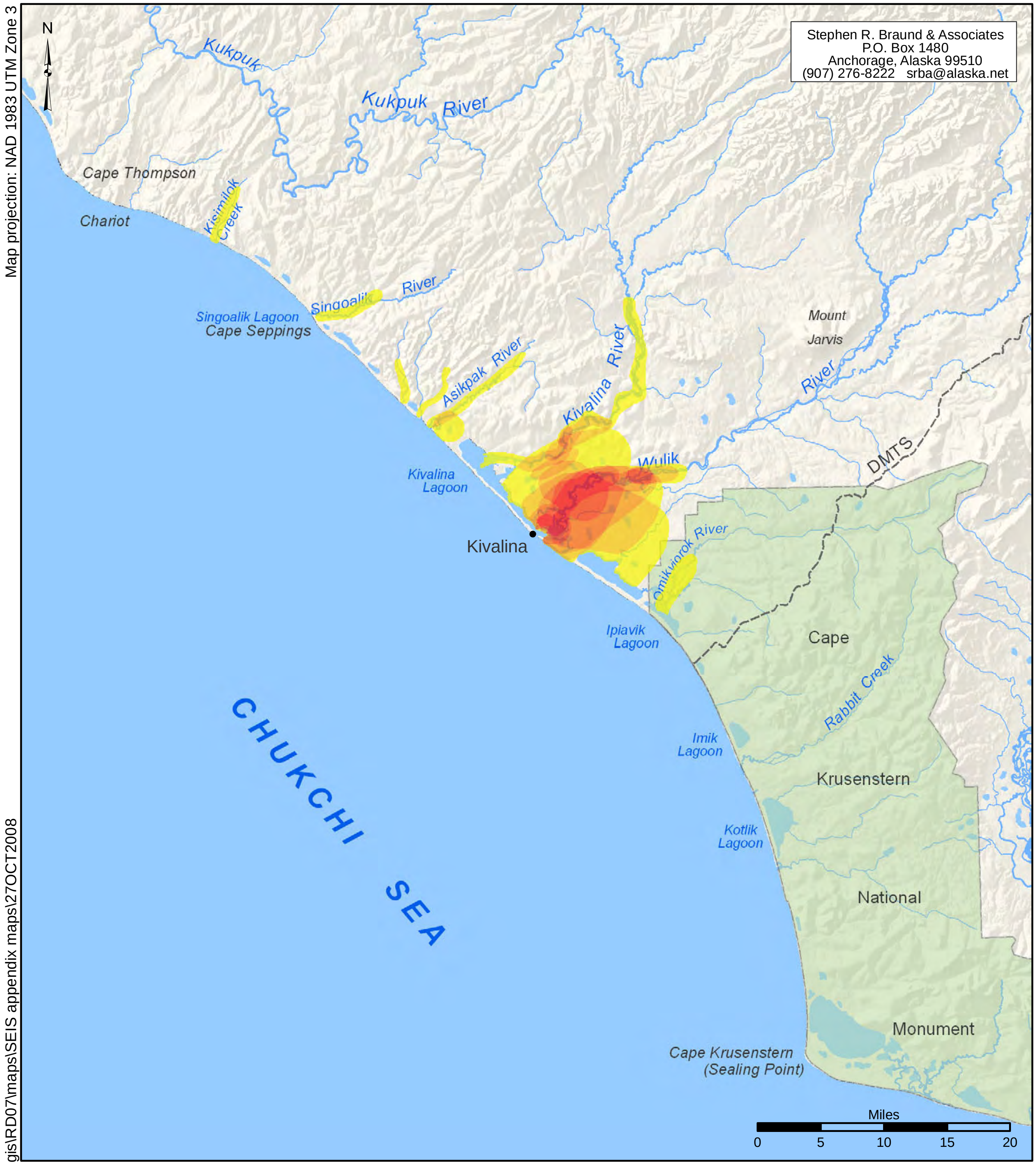


For all data sets, other areas may have been used for resource harvesting.

National Park Service Lands

DeLong Mountain Transportation System (DMTS)

Sources:
1998-2007: Stephen R. Braund and Associates (SRB&A) Forthcoming.
2007: Magdanz et al. 2008.
Lifetime: Schroeder, R., D. B. Anderson (ADF&G) and G. Hildreth (Maniilaq Association) 1987.

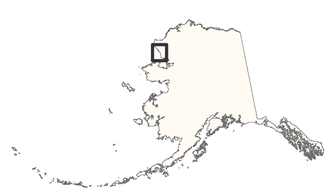


Map 65: 1998-2007 Subsistence Use Areas Kivalina, Upland Birds

1998-2007 Overlapping Subsistence Use Areas

High / Low

23 Use Areas
13 Harvesters
Upland Birds



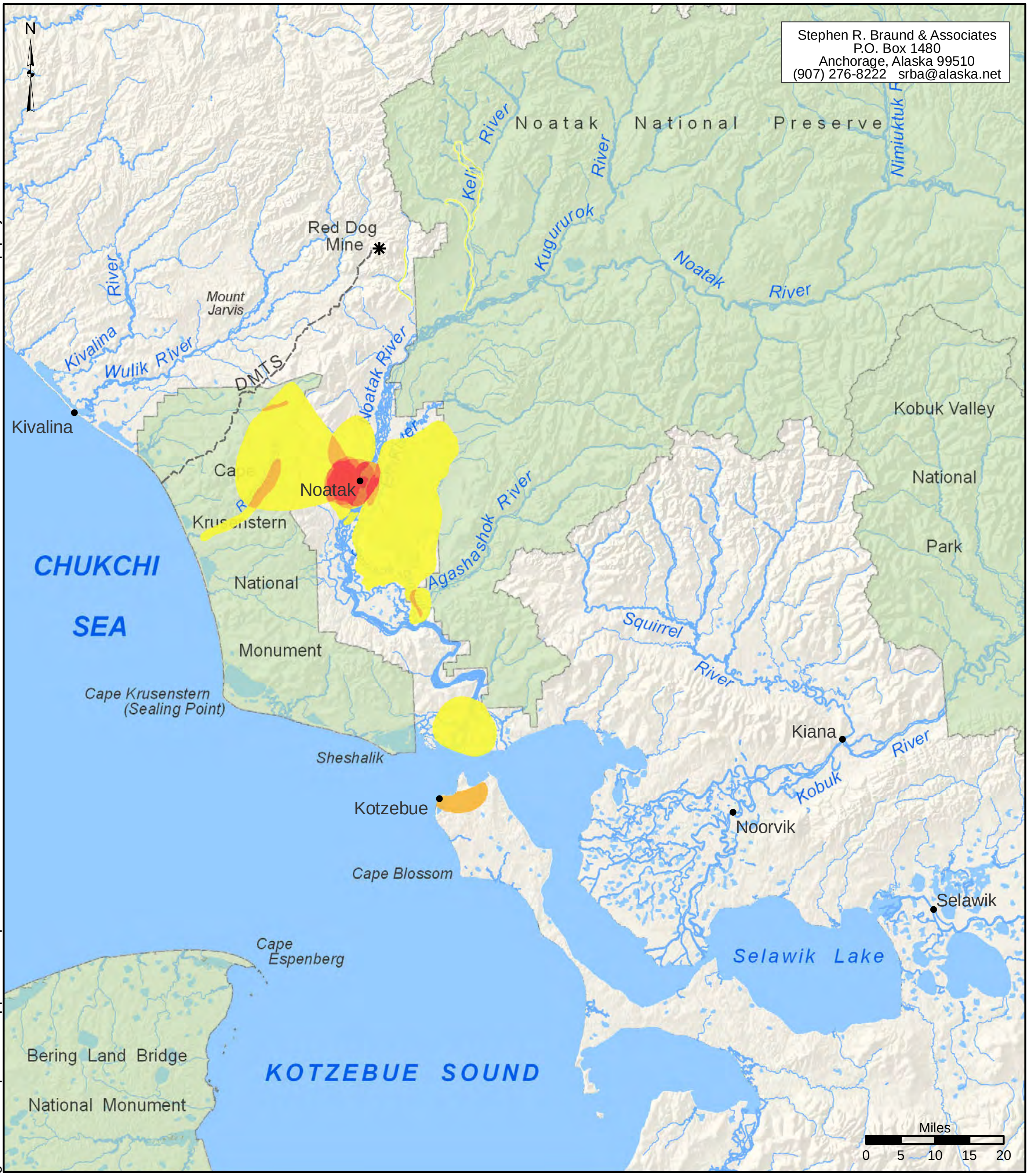
For all data sets, other areas may have been used for resource harvesting.

National Park Service Lands

DeLong Mountain Transportation System (DMTS)

Source:
1998-2007: Stephen R. Braund and Associates (SRB&A) Forthcoming.

Map projection: NAD 1983 UTM Zone 3



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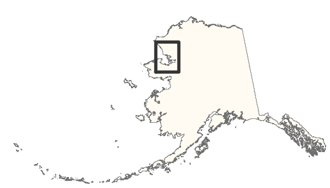
Map 66: 1998-2007 Subsistence Use Areas Noatak, Upland Birds

1998-2007 Overlapping Subsistence Use Areas

High

Low

26 Use Areas
14 Harvesters
Upland Birds



For all data sets, other areas may have been used for resource harvesting.

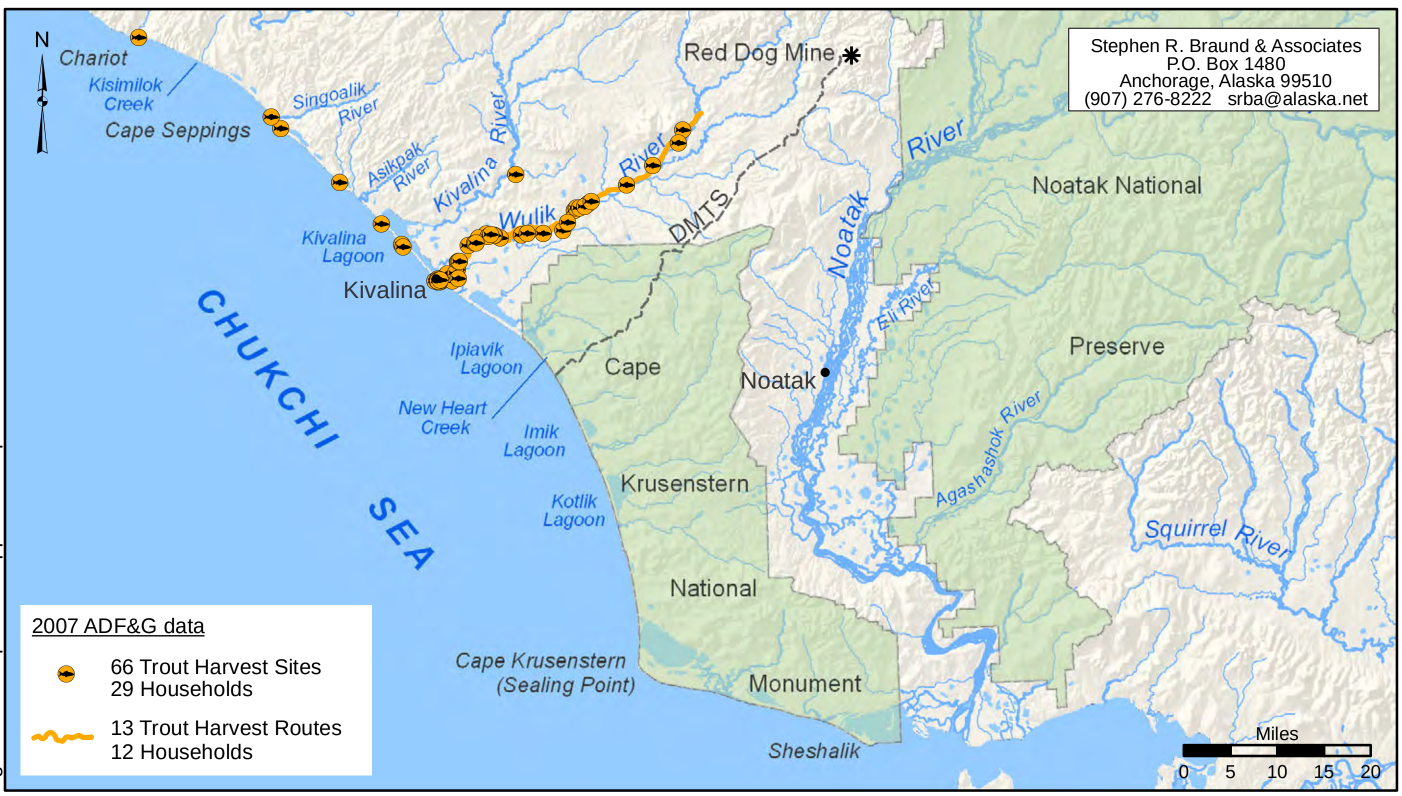
National Park Service Lands

DeLong Mountain Transportation System (DMTS)

Source:
1998-2007: Stephen R. Braund and Associates (SRB&A) Forthcoming.

Map projection: NAD 1983 UTM Zone 3

Map 67: 1998-2007 Subsistence Use Areas Kivalina, Dolly Varden Char (Trout)



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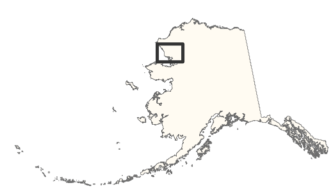
Map 68: 2007 Subsistence Use Areas Kivalina, Dolly Varden Char (Trout)

For all data sets, other areas may have been used for resource harvesting.

National Park Service Lands

DeLong Mountain Transportation System (DMTS)

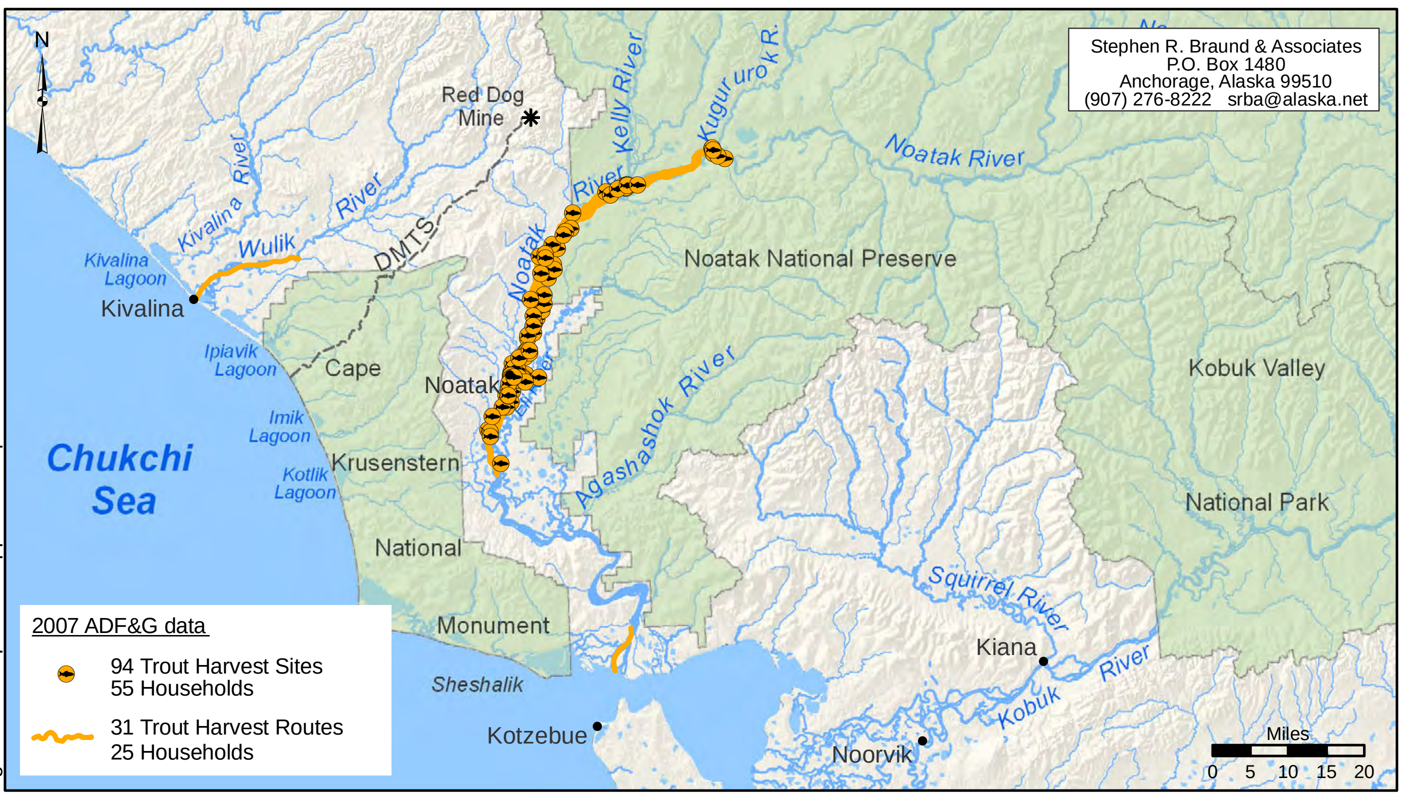


Sources:

1998-2007: Stephen R. Braund and Associates (SRB&A) Forthcoming.
2007: Magdanz et al. 2008.

Map projection: NAD 1983 UTM Zone 3

Map 69: 1998-2007 Subsistence Use Areas Noatak, Dolly Varden Char (Trout)



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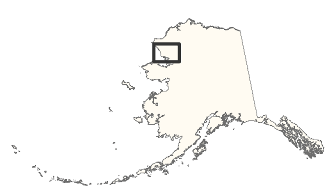
Map 70: 2007 Subsistence Use Areas Noatak, Dolly Varden Char (Trout)

For all data sets, other areas may have been used for resource harvesting.

National Park Service Lands

DeLong Mountain Transportation System (DMTS)



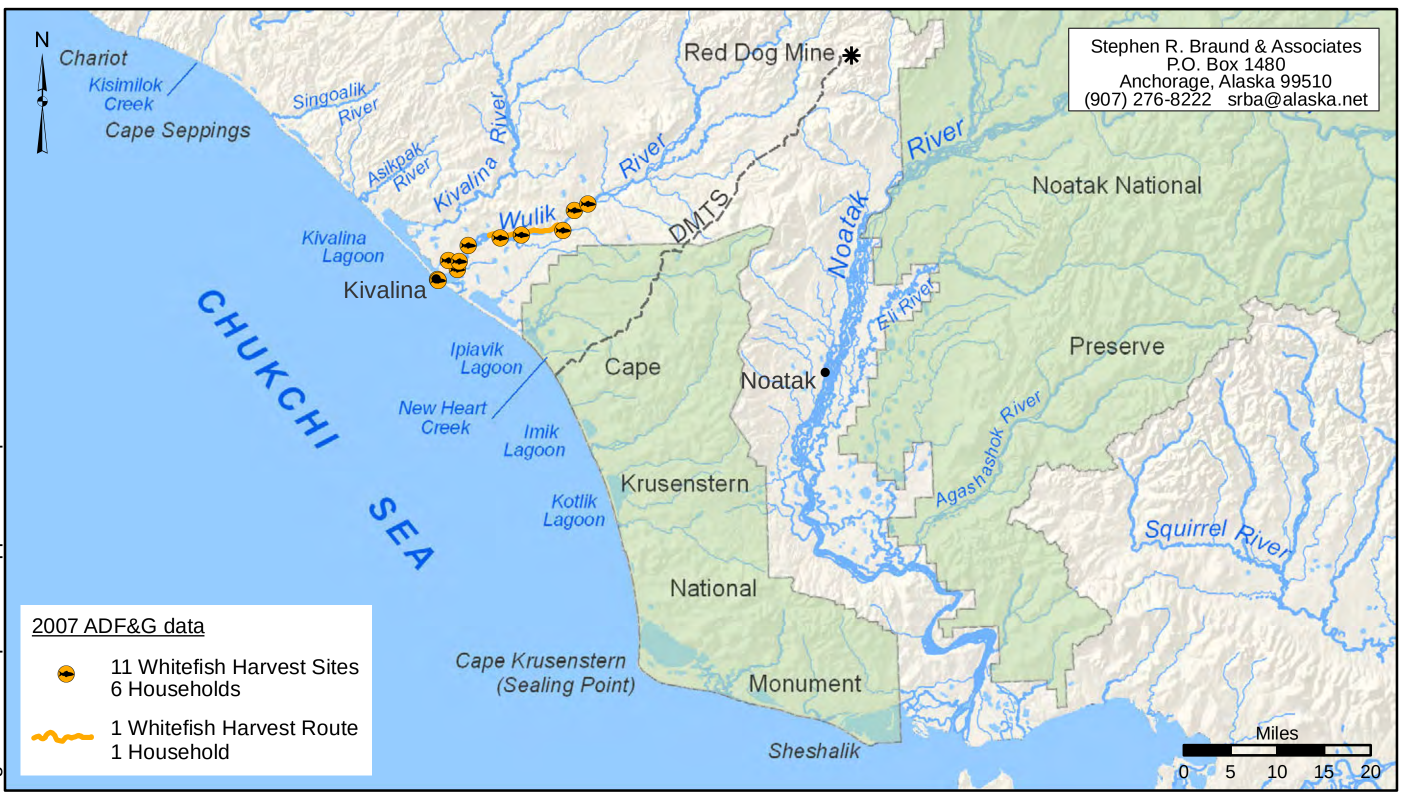
Sources:

1998-2007: Stephen R. Braund and Associates (SRB&A) Forthcoming.

2007: Magdanz et al. 2008.

Map projection: NAD 1983 UTM Zone 3

Map 71: 1998-2007 Subsistence Use Areas Kivalina, Other Non-Salmon Fish



Map 72: 2007 Subsistence Use Areas Kivalina, Whitefish

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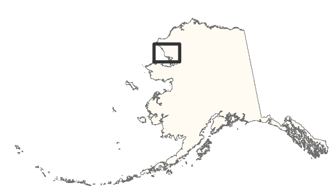
For all data sets, other areas may have been used for resource harvesting.

National Park Service Lands

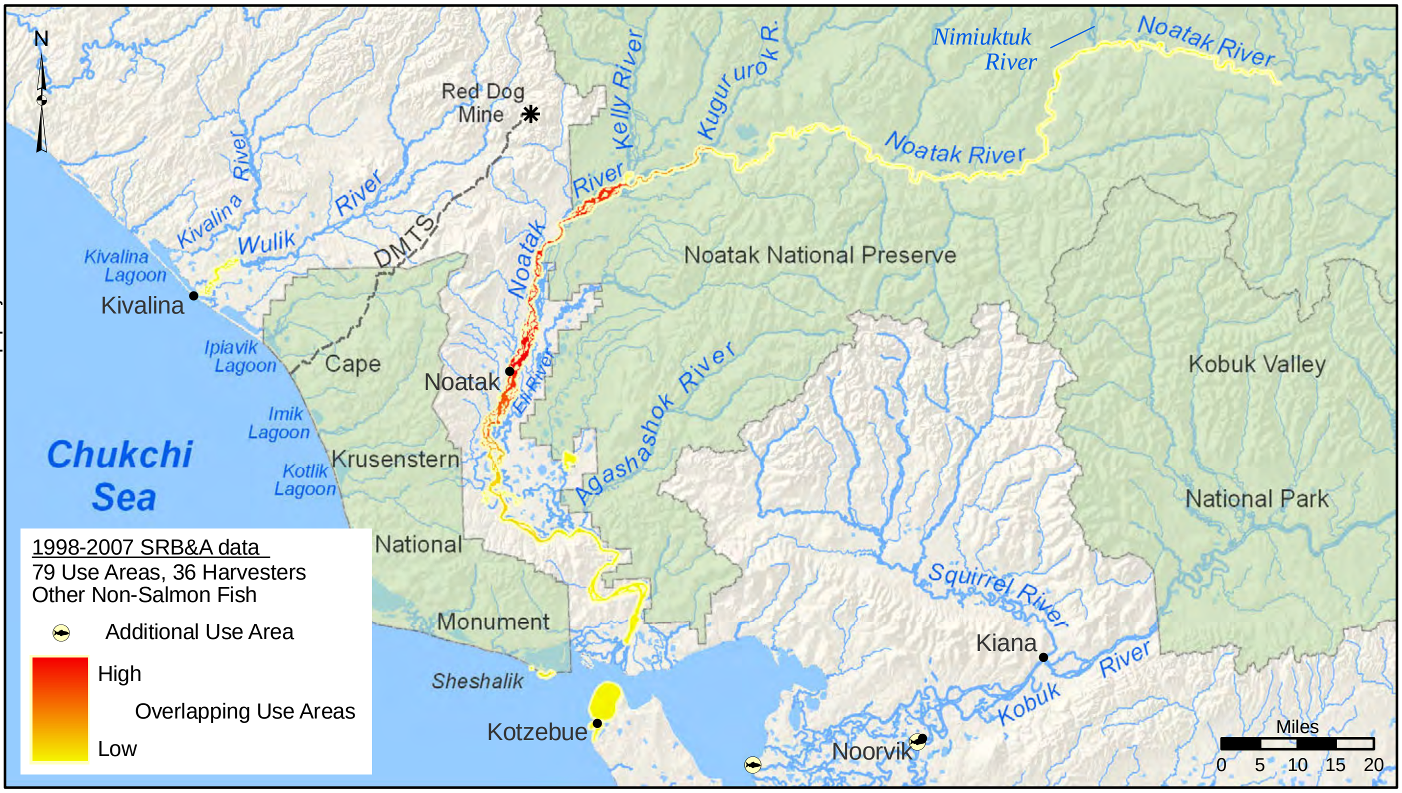
DeLong Mountain Transportation System (DMTS)



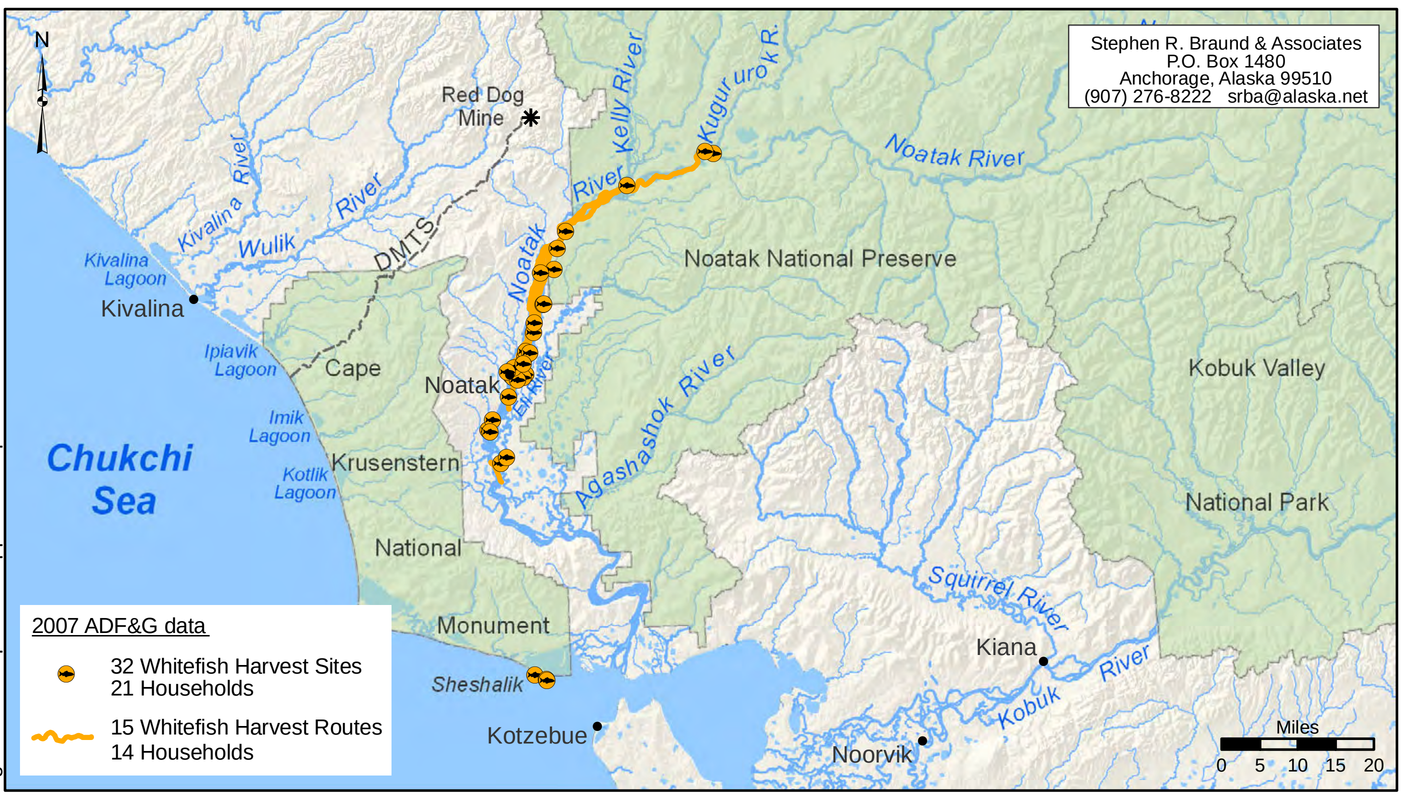
Sources:

1998-2007: Stephen R. Braund and Associates (SRB&A) Forthcoming.
2007: Magdanz et al. 2008.

Map projection: NAD 1983 UTM Zone 3



Map 73: 1998-2007 Subsistence Use Areas Noatak, Other Non-Salmon Fish



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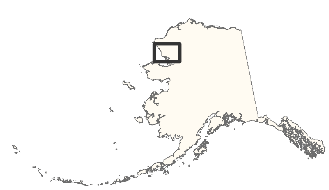
Map 74: 2007 Subsistence Use Areas Noatak, Whitefish

For all data sets, other areas may have been used for resource harvesting.

National Park Service Lands

DeLong Mountain Transportation System (DMTS)



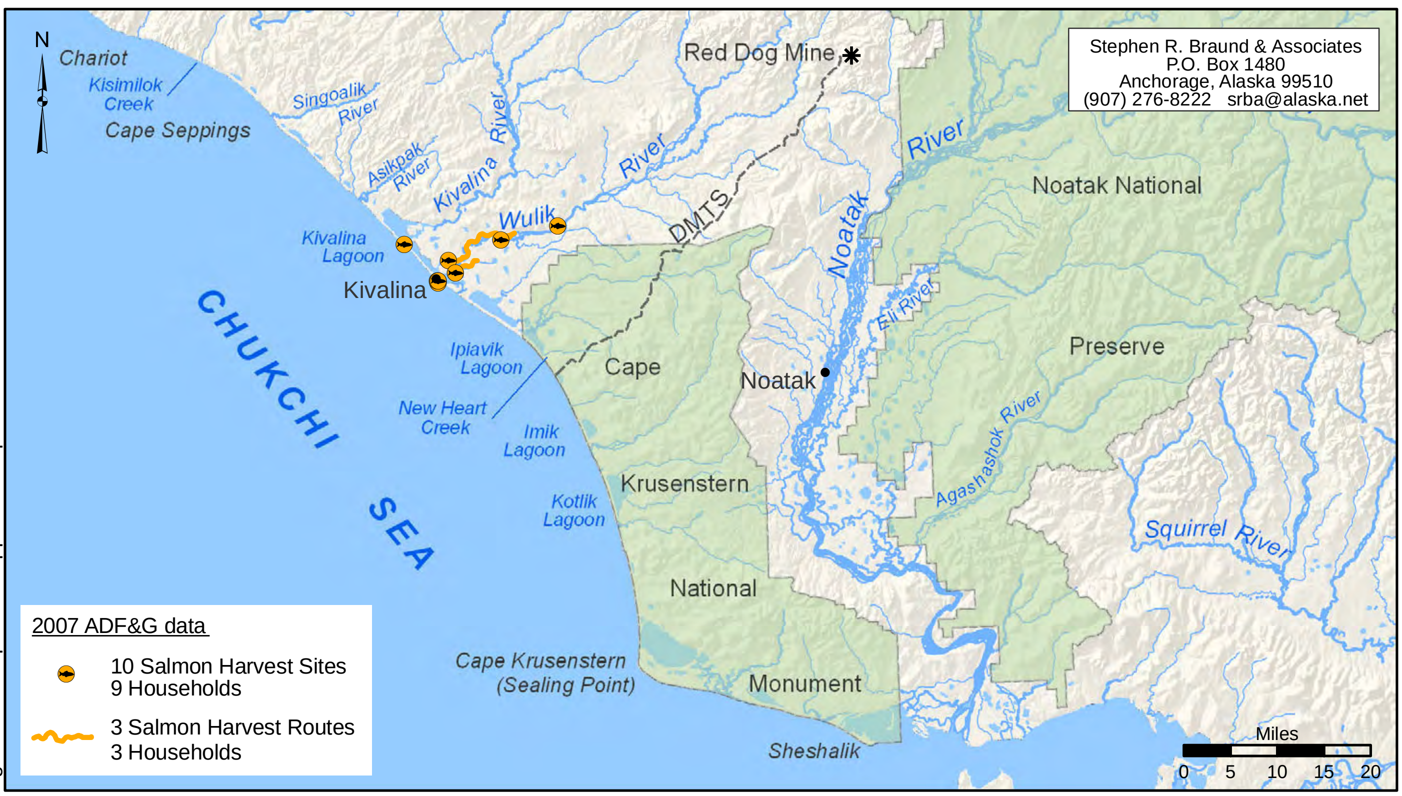
Sources:

1998-2007: Stephen R. Braund and Associates (SRB&A) Forthcoming.

2007: Magdanz et al. 2008.

Map projection: NAD 1983 UTM Zone 3

Map 75: 1998-2007 Subsistence Use Areas Kivalina, Salmon



Map 76: 2007 Subsistence Use Areas Kivalina, Salmon

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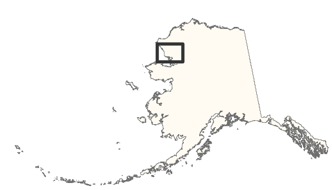
For all data sets, other areas may have been used for resource harvesting.

National Park Service Lands

DeLong Mountain Transportation System (DMTS)



Sources:
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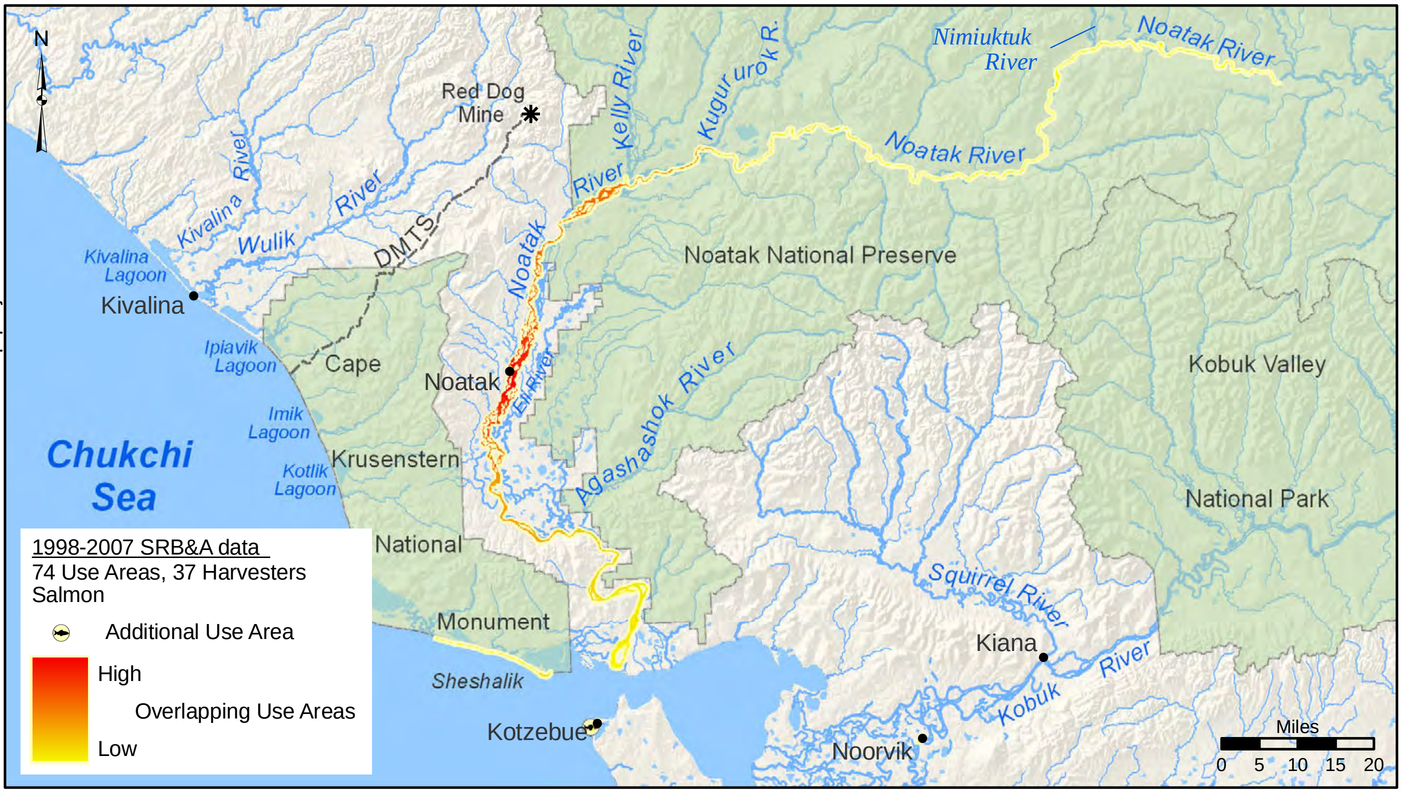
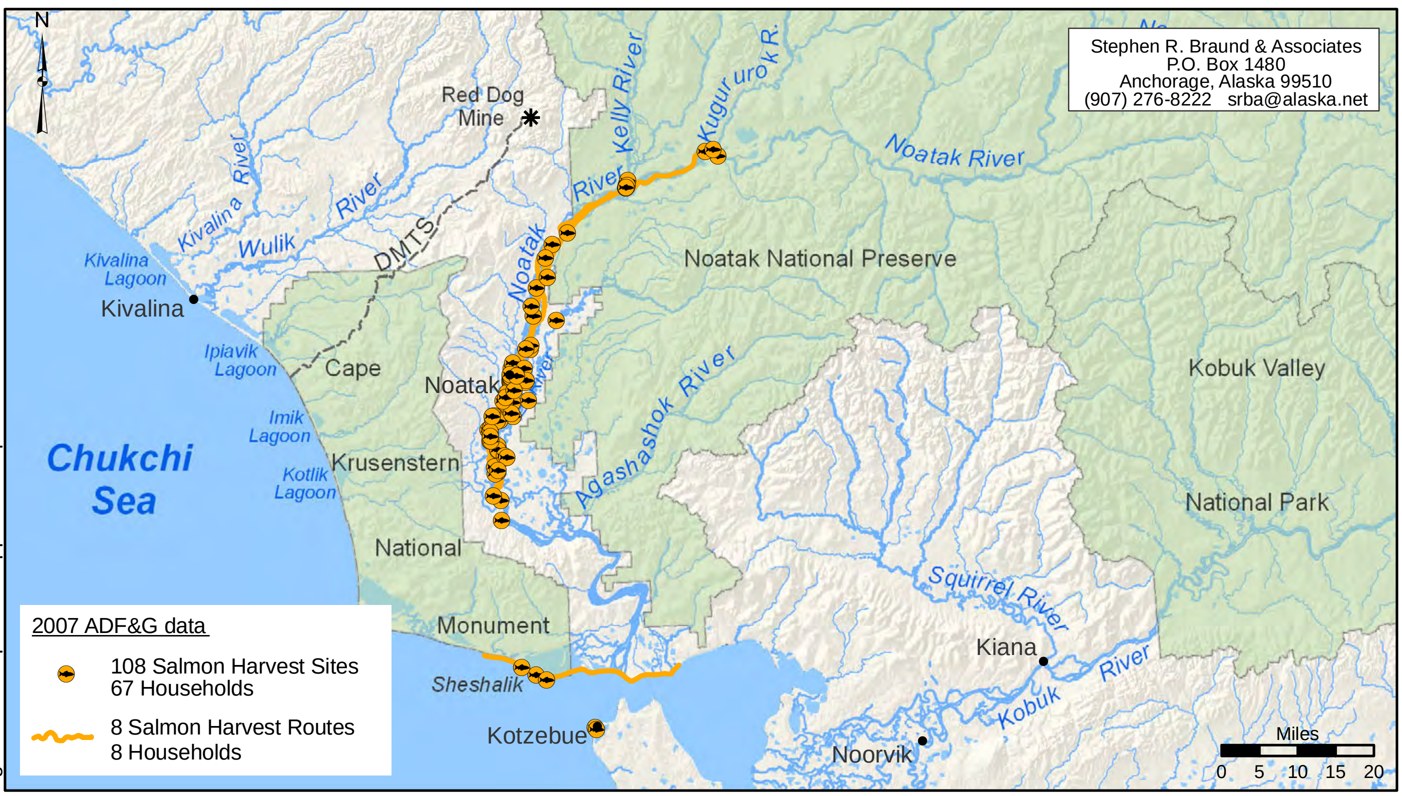
2007: Magdanz et al. 2008.

Map projection: NAD 1983 UTM Zone 3



Map 77: 1998-2007 Subsistence Use Areas Noatak, Salmon



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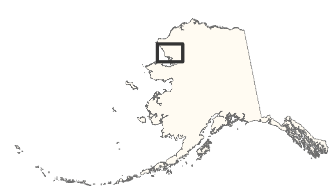
Map 78: 2007 Subsistence Use Areas Noatak, Salmon

For all data sets, other areas may have been used for resource harvesting.

National Park Service Lands

DeLong Mountain Transportation System (DMTS)

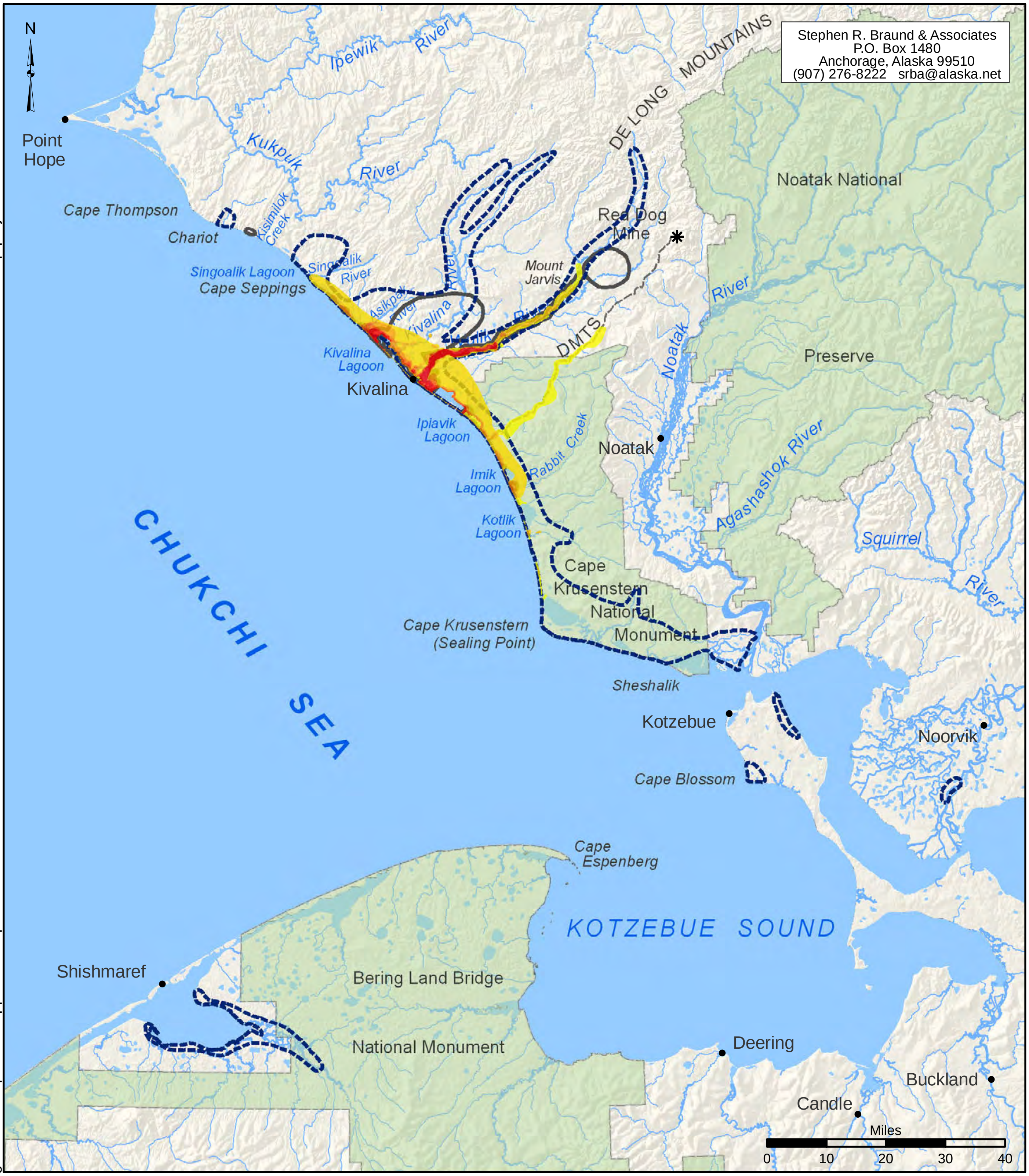


Sources:

1998-2007: Stephen R. Braund and Associates (SRB&A) Forthcoming.

2007: Magdanz et al. 2008.

Map projection: NAD 1983 UTM Zone 3



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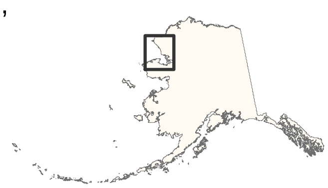
Map 79: 1998-2007 and Lifetime Subsistence Use Areas Kivalina, Berries, Plants and Wood

1998-2007 Overlapping Subsistence Use Areas
High
Low
201 Use Areas
37 Harvesters
Berries, Plants and Wood

2007 Subsistence Use Areas
107 Use Areas
28 Households
Berries and Plants

Lifetime (circa 1925-1986) Subsistence Use Areas
16 Kivalina harvesters
Vegetation



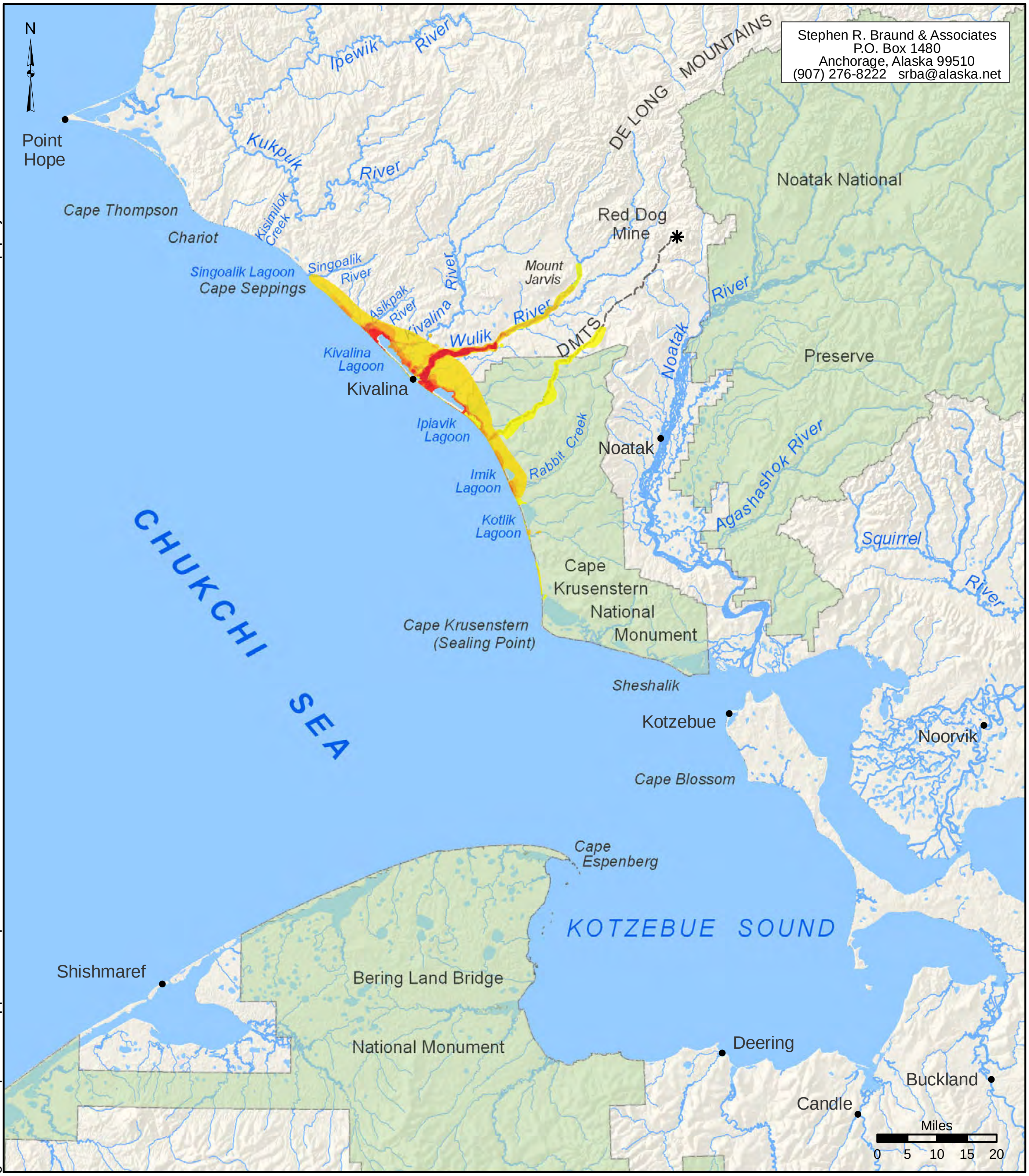
For all data sets, other areas may have been used for resource harvesting.

National Park Service Lands

DeLong Mountain Transportation System (DMTS)

Sources:
1998-2007: Stephen R. Braund and Associates (SRB&A) Forthcoming.
2007: Magdanz et al. 2008.
Lifetime: Schroeder, R., D. B. Anderson (ADF&G) and G. Hildreth (Maniilaq Association) 1987.

Map projection: NAD 1983 UTM Zone 3



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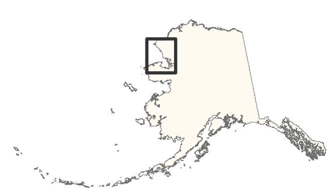
Map 80: 1998-2007 Subsistence Use Areas Kivalina, Berries

1998-2007 Overlapping Subsistence Use Areas

High
Low

175 Use Areas
36 Harvesters
Berries



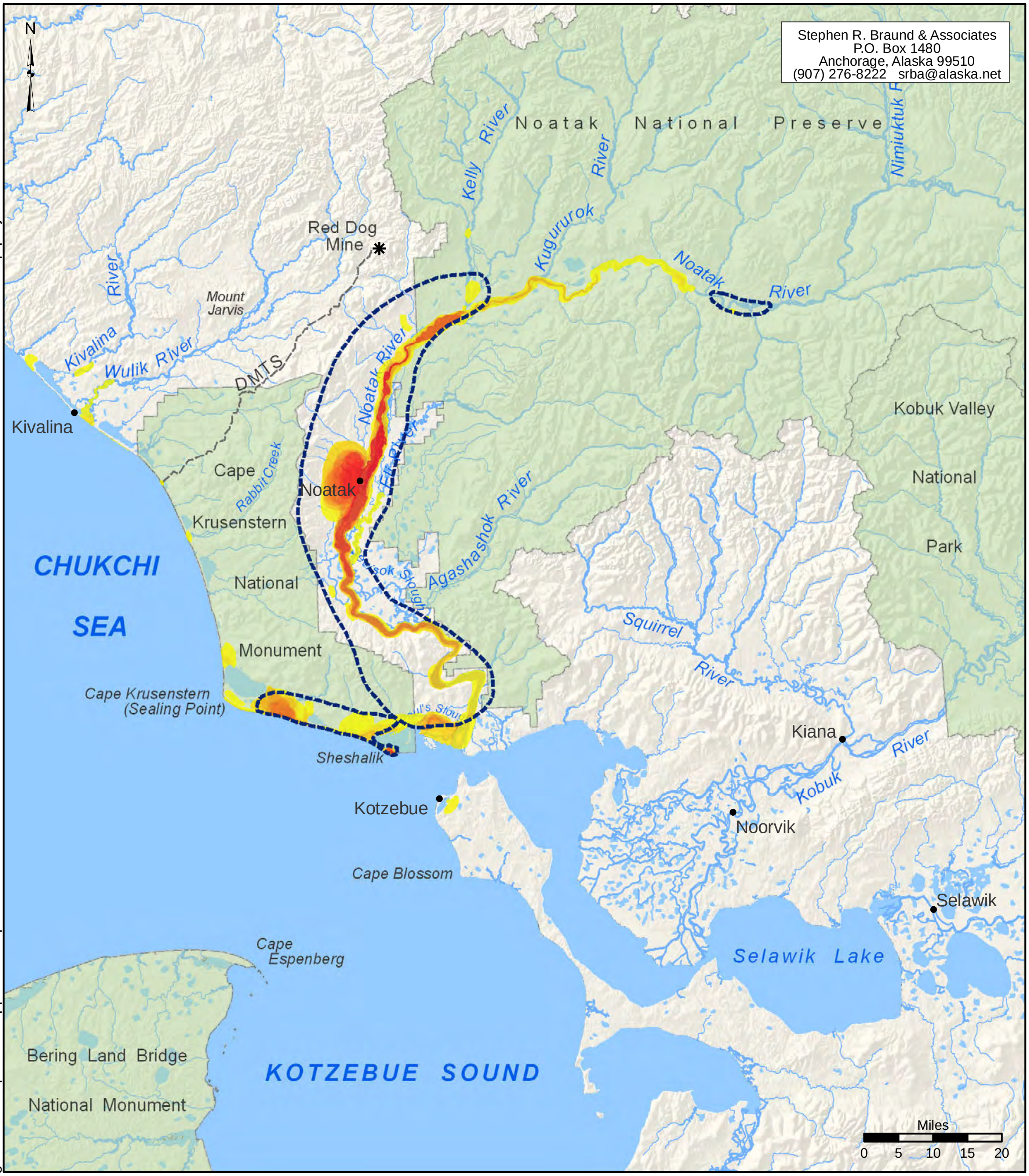
For all data sets, other areas may have been used for resource harvesting.

National Park Service Lands

DeLong Mountain Transportation System (DMTS)

Source:
1998-2007: Stephen R. Braund and Associates (SRB&A) Forthcoming.

Map projection: NAD 1983 UTM Zone 3



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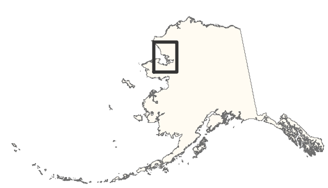
Map 81: 1998-2007 and Lifetime Subsistence Use Areas Noatak, Berries, Plants and Wood

1998-2007 Overlapping Subsistence Use Areas
High
Low
213 Use Areas
35 Harvesters
Berries, Plants and Wood

2007 Subsistence Use Areas
174 Use Areas
76 Households
Berries and Plants

Lifetime (circa 1925-1986) Subsistence Use Areas
25 Noatak harvesters
Vegetation



For all data sets, other areas may have been used for resource harvesting.

National Park Service Lands

DeLong Mountain Transportation System (DMTS)

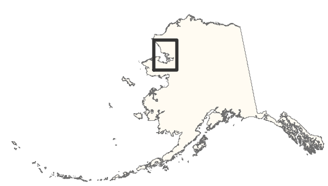
Sources:
1998-2007: Stephen R. Braund and Associates (SRB&A) Forthcoming.
2007: Magdanz et al. 2008.
Lifetime: Schroeder, R., D. B. Anderson (ADF&G) and G. Hildreth (Maniilaq Association) 1987.

Map 82: 1998-2007 Subsistence Use Areas Noatak, Berries

1998-2007 Overlapping Subsistence Use Areas

High
Low

144 Use Areas
34 Harvesters
Berries

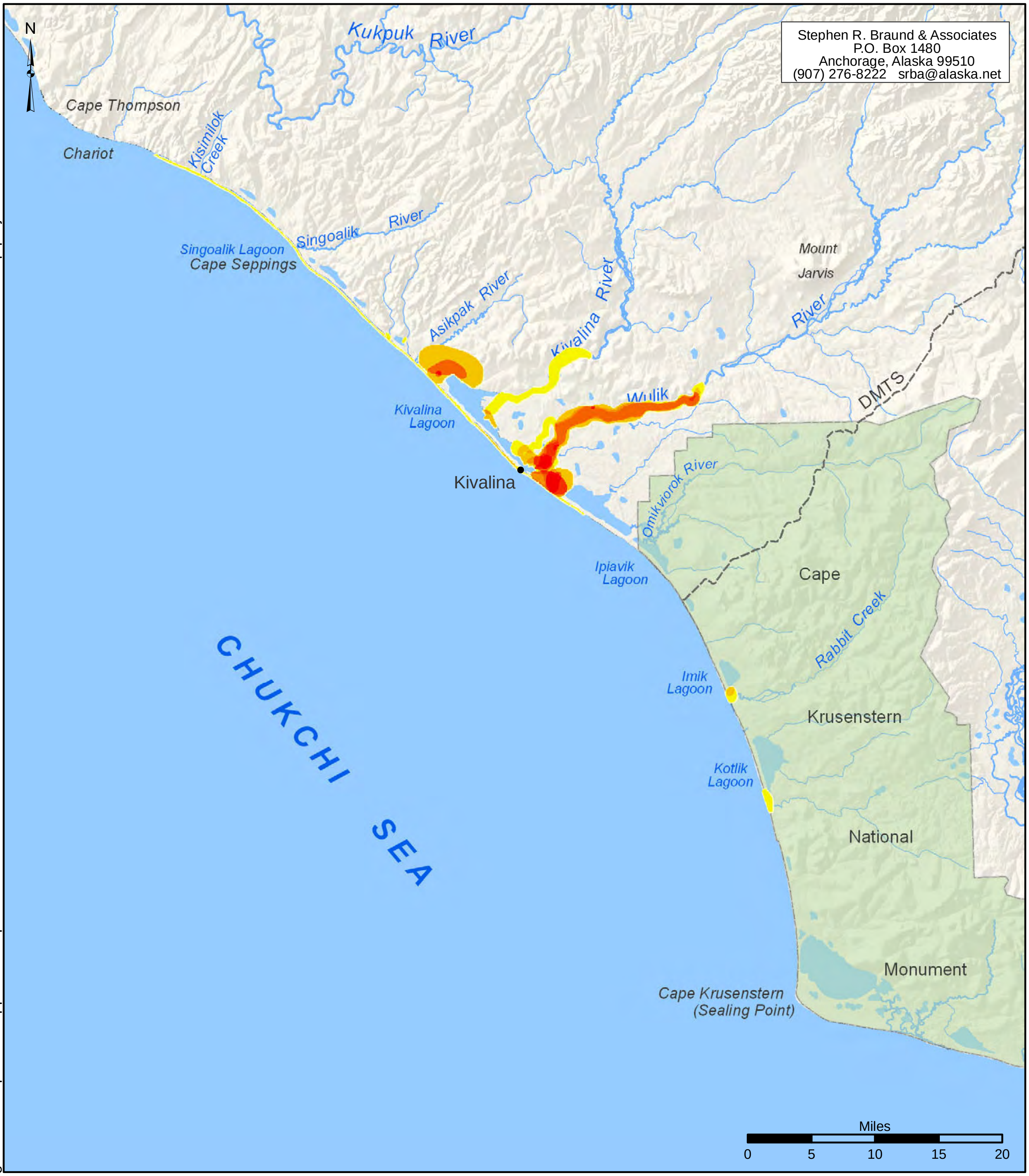


For all data sets, other areas may have been used for resource harvesting.

National Park Service Lands

DeLong Mountain Transportation System (DMTS)

Source:
1998-2007: Stephen R. Braund and Associates (SRB&A) Forthcoming.



Map 83: 1998-2007 Subsistence Use Areas Kivalina, Plants and Wood

1998-2007 Overlapping Subsistence Use Areas

High
Low

38 Use Areas
20 Harvesters
Plants and Wood

For all data sets, other areas may have been used for resource harvesting.

National Park Service Lands

DeLong Mountain Transportation System (DMTS)

Source:
1998-2007: Stephen R. Braund and Associates (SRB&A) Forthcoming.

Map projection: NAD 1983 UTM Zone 3

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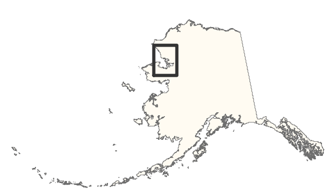
Map 84: 1998-2007 Subsistence Use Areas Noatak, Plants and Wood

1998-2007 Overlapping Subsistence Use Areas

High
Low

86 Use Areas
30 Harvesters
Plants and Wood



For all data sets, other areas may have been used for resource harvesting.

National Park Service Lands

DeLong Mountain Transportation System (DMTS)

Source:
1998-2007: Stephen R. Braund and Associates (SRB&A) Forthcoming.

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Appendix E

Methods Used for Health Effects Analysis

Table of Contents

Methods Used for Health Effects Analysis

1. Background

The original Environmental Iimpact Statement (EIS) for the Red Dog Mine did not include a Public Health section. The discussion of health was restricted to the topic of environmental contaminants. Maniilaq Association, a non-profit Alaska Native tribal consortium responsible for administering health, social, cultural, and community services in the Northwest Arctic Borough (NWAB) region participated in this Supplemental EIS (SEIS). Maniilaq represents nine tribal governments as a cooperating agency to help provide a more complete evaluation of the proposed action's potential health effects. This section of the SEIS describes baseline health conditions, provides an assessment of the possible environmental health effects of alternatives, and suggests potential mitigation measures that could enhance positive and reduce negative health effects.

2. Definitions

Environmental Health: the interrelationships between people and their environment that promote human health and well-being and foster a safe and healthful environment.

Health: a state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity (WHO 1946).

Health Effects: effects either positive or negative resulting from the activities described in the Health Impact Assessment.

Health Impact Assessment: a combination of procedures, methods, and tools by which a policy, program, or project may be judged as to its potential effects on the health of a population, and the distribution of those effects within the population (WHO 1999).

Public Health: the approach to medicine concerned with the health of the community as a whole.

3. Information Sources

The analysis of health effects in the SEIS draws on the following sources of information:

a. public testimony during SEIS scoping hearings;
b. published peer-reviewed public health data;
c. public health databases and monitoring programs;
d. subsistence and cultural study done by Alaska Department of Fish and Game (ADF&G) and TetraTech for this SEIS;
e. interviews with stakeholders;
f. professional opinion; and
g. environmental contaminants data collected by Teck Cominco as part of the Fugitive Dust Risk Assessment.

4. Methodology

The health effects analysis draws on the process of "Health Impact Assessment" (HIA). A current description of the principles and process of HIA was recently published by the International Association of Impact Assessment (Quigley et al. 2006). The International Finance Corporation published

Performance Standards for Community Health, Safety, and Security in 2006 and in 2007 released updated Guidance Notes for this Standard (IFC 2006, 2007). Aspects of these approaches are used in the analysis of potential health impacts below.

The scope of health effects included in the SEIS was determined through evaluating: (1) prevalent illnesses, health disparities and vulnerabilities in the NWAB population; (2) projected impacts (socioeconomics, community infrastructure and services, subsistence, air quality, and water quality) on resource areas that might affect health; (3) public testimony; and (4) accepted mechanisms of health and illness. This evaluation was used to generate a general categorization of health issues relevant to the National Environmental Policy Act (NEPA) process for the SEIS: subsistence and nutrition; social determinants of health (e.g., psychological health, suicide, substance abuse, smoking); accidents and injuries; non-communicable diseases (e.g., cancer, diabetes, metabolic disorders, cardiovascular disease); respiratory diseases (e.g., chronic pulmonary disease); infectious disease; and environmental contaminants.

A “logic framework” was then used to delineate potential pathways between mine-related impacts and health effects (Cole et al. 2005). The baseline health status, change over time, and drivers, or determinants of health were then defined using published and unpublished public health data. The pathways were analyzed in greater depth through a synthesis of the available public health data, literature from analogous populations, accepted mechanisms of health and disease, and the impacts analysis for other resources, resulting in the “effects of disturbances” discussion below.

The results of the analysis then underwent peer review by public health professionals.

5. Limitations

a. Lack of data at the village and region-level on the prevalence of some health problems, and change in these problems over the life of the mine.
b. Lack of studies that have directly investigated the potential health effects related to the mine.
c. Because Red Dog Mine has been in operation since 1989, many impacts are already in play, and differences in health effects between the proposed alternatives may therefore be more subtle.
d. Pathogenesis, or mechanism of causation, of many health problems is complex and multifactoral. Although it may be possible to identify adverse or beneficial effects of mining, it is not always possible to determine the relative contribution of mining vs. non-mining impacts to a given health problem.
e. Small population size at the village and region level prevents the acquisition of statistically significant data for some health indices.
f. EPA must determine what health effects are cognizable under NEPA. Given the statutory constraints on the NEPA process, there may be other direct or indirect effects of mining, which EPA does not consider to lie within the scope or purview of the NEPA process, but which may nevertheless be relevant for the purposes of planning, policy, occupational and public health programs.
g. Some of the data sources cited in the text report health statistics for Alaska Native residents of the region only. According to the 2000 Census, Alaska Natives make up 85.8% of the NWAB population; 96.6% of the Kivalina population; and 96% of the population of Noatak. Because of statistical limitations given the small size and limited available data specific to the non-Native population, it is often not possible to make valid assessments of differential effects on Native versus non-Native populations in the region.

6. Health Impact Assessment Team

The health effects analysis, was undertaken by a multidisciplinary team comprising representatives of tribal, state, and federal health professionals, and led by Maniilaq Association.

a. Aaron Wernham, MD, MS, Alaska Intertribal Council; Project Director
b. Jackie Hill, Maniilaq Association
c. James Berner, MD, Alaska Native Tribal Health Consortium (ANTHC)
d. Michael Brubaker, MS, ANTHC
e. Kyla Hagen MPH, MS, ANTHC
f. Candace Rutt, PhD, U.S. Centers for Disease Control and Prevention (CDC)
g. Laura Biazzo, MPC, CDC National Center for Environmental Health (NCEH)
h. Sarah Heaton, MPH, CDC NCEH
i. Arin Freeman, BS, CDC NCEH
j. Lori Verbrugge, PhD, State of Alaska, Department of Health and Social Services
k. Juliana Grant, MD, MPH, Agency for Toxic Substances and Disease Registry (ATSDR)
l. Richard Kauffman, MSPH, ATSDR

7. Area and Populations Considered in the Analysis of Health Effects

The health care data used in this section are defined by one of three geographical boundaries: 1) the *Northwest Arctic Borough* (66.900000° North Latitude and -162.583330° West Longitude) comprising approximately 39,000 square miles along the Kotzebue Sound, Wulik, Noatak, Kobuk, Selawik, Buckland and Kugruk Rivers; 2) the *Maniilaq Service Area* covers generally the same geographic area as the NWAB, with the exception of the village of Point Hope which although served by Maniilaq Association is part of the North Slope Borough; and 3) *Kotzebue Service Unit*, the geographical designation for the NWAB used by the Indian Health Service (IHS).

The types of impacts that result from the activities at Red Dog Mine are classified as follows:

a. *Physical Impacts:* such as water discharges and fugitive dust. These are most likely for villages closest to the mine and downstream from the mine.
b. *Subsistence Impacts:* from mine-related activities on subsistence resources and subsistence users within the region.
c. *Economy, Employment, and Social Impacts:* such as acculturation and transition to new value systems based on cash rather than subsistence.
d. *Downstream Impacts:* such as shipping and smelting that occurs in geographic regions outside the planning area. These regions are not included in the health analysis because the scope of the SEIS is local and regional.
e. *Occupational Impacts:* occupational health effects such as worker exposure to toxins are discussed in a separate section of the SEIS.

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Appendix F

Kivalina and Noatak Community Descriptions

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Kivalina and Noatak Community Descriptions

Prepared by:
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University of Alaska Anchorage
3211 Providence Drive
Anchorage, Alaska 99508

1.0 Kivalina

1.1 Background & History

The city of Kivalina is located at the tip of an eight-mile barrier reef located between the Chukchi Sea and the Kivalina River, 80 miles northwest of Kotzebue. The current town site has a long history as a stopping point for seasonal travelers and hunters but was not the original location of the community. In 1847, the Russian Navy recorded the existence of a community named Kivualinamut, located at the north end of the Kivalina Lagoon. The current town site was settled as a permanent community in 1905 when the Bureau of Indian Affairs constructed a school on the island and mandated compulsory attendance. Kivalina was incorporated as a city in 1969 (ADCA 2008). The community is primarily accessed by small plane and small boats; snowmachines and all-terrain vehicles (ATV) are common forms of local transportation. Daily flights from Kotzebue transport mail and groceries while fuel and other bulk items are delivered yearly by barge (Kivalina website http://kivalinacity.com/).

In recent years, the city of Kivalina has been faced with issues of serious coastal erosion and damage by wind-driven ice compromising the town site and creating space constraints for the growing community. The relocation of the community has been discussed since 1953, and the vote to relocate became unanimous in 1992 (Kivalina website). Relocation was scheduled to begin in 2006 and a site was selected by the community just across the channel from the current village. The site would provide similar access to the Chukchi Sea and traditional areas used for hunting and harvest. However, the long-term stability of the new site has been called into question due to forecast impacts of climate change and continued erosion. The village continues to work with the U.S. Army Corps of Engineers to finalize a location for the new community that meets both standards of long-term stability and providing the ability to maintain traditional ways of life. In the meantime, stopgap measures are being implemented to protect homes and infrastructure from winter storms. The relocation is estimated to cost $102 million (ADCA 2008). The source of the money to fund this project is a longstanding issue that has yet to be resolved.

1.2 Demographics

In 2008, the population of Kivalina was 389. The population reflects a 23 percent increase since 1990, up from 317 in 1990 and 277 in 2000 (U.S. Census 1990, 2000; ADCA). This growth results from natural increase. A net total of 13 people moved away from the village between 1990 and 2000, yielding a net migration rate of -4.2 percent (ISER 2007). This rate is similar to the borough average of -4.7 percent. In 2000, the population of Kivalina was 96.6 percent Inupiat Eskimo (U.S. Census 2000).

1.3 Employment

According to the U.S. Census, the total potential workforce of Kivalina, defined as age 16 and higher, was 235 people in 2000 and of those, 82 were employed in wage labor. An additional 125 people were not in the labor force and 28 people were unemployed and seeking work. Many of the residents of Kivalina were engaged in traditional subsistence activities during this time, which is not reflected in the employment data. The unemployment rate for the community was 25.5 percent, higher than that of the Northwest Arctic Borough, which was 15.6 percent during the same time period (ADCA 2008). Of the 82 employed individuals, 37 (45 percent) were private wage or salary workers while the government employed 45 (55 percent) (U.S. Census 2000). Education, health and social services employed the largest number of people in the community (See Table 1).

Table F-1 Kivalina Employment by Industry

Employment by Industry, 2000	Number of People	Percentage of Total
Education, Health, Social Services	25	30.5%
Public Administration	14	17.1%
Agriculture, Fishing, Hunting, Timber, Mining	13	15.9%
Other Services (except Public Administration)	8	9.8%
Construction	7	8.5%
Transportation, Warehousing, Utilities	5	6.1%
Arts, Entertainment, Recreation, Accommodation, Food Services	4	4.9%
Retail Trade	4	4.9%
Professional, Scientific, Management, Administrative, Waste Management	2	2.4%

Source: U.S. Census 2000

1.4 Income

In 1999, the per capita income in Kivalina was $10,980. Despite a growth of 25.2 percent from the 1989 per capita income of $8,767, Kivalina still had one of the lowest per capita incomes in the Northwest Arctic Borough second only to Selawik. (U.S. Census 2000) The median household income in Kivalina was $40,496, and 26.4 percent of residents were below the poverty line. In comparison, the statewide average per capita income in 2000 was $29,762 with a median household income of $67,733 and 9.4 percent of people living below the poverty line at that time (U.S. Census 2000). The per capita income in Anchorage in 2000 was $33,212, with a median household income of $72,954 and 7.4 percent of the population living below the poverty line (U.S. Census 2000) All figures are reported in 2008 dollars. For more details on income see Socioeconomics (Section 3.17 in the body of the SEIS).

1.5 Subsistence

Kivalina is a traditional Inupiat Eskimo village with a mixed economy that is largely based on traditional subsistence activities and some wage employment. Seal, walrus, salmon, whitefish, and caribou are all used for food and cultural activities. Kivalina also has the distinction of being the only community in the Northwest Arctic Borough to traditionally hunt bowhead whale (ADCA). In 2007, Kivalina's total subsistence harvest of all resources was 594 usable pounds per capita, a decrease from the 1992 harvest of 761 usable pounds per capita (Table 3.12-2, Section 3.12.2.1). See Section 3.12.2.1 on subsistence for a more detailed analysis of subsistence practices in the community.

1.6 Infrastructure

The Wulik River provides water for the city of Kivalina via a three-mile, surface transmission line. Water is treated and filtered and stored in one 500,000 gallon and one 670,000 gallon steel tanks. Residents then haul water from this tank for personal use. The water tanks are refilled annually during July and August and the city often runs out of water in the first few months of the year, keeping some water in reserve to service the school. After the tanks run out, residents haul their own water directly from the river. The water service is supplied on a pay per use basis collected by a coin operated system. The system is currently out of order, however, and fees are now collected by operations personnel. Other sources of water include the Kivalina River or rainwater collection, but these require greater individual effort and can be more expensive (Kivalina website). The city also runs a municipal washeteria, although this building is not insulated and freezes every winter. The operation and maintenance of the washeteria are important to the city government as it is a key source of revenue (Kivalina City Administrator, personal communication, 2008).

Based on surveys from the 2000 U.S. Census, 90.9 percent of the residents of the community lack complete plumbing and a complete kitchen although about half of the residents reported that they have tanks, which provide running water for their kitchen, percentages which remain unchanged today. In 1990, 7.6 percent of residents in the community used individual septic tanks for sewage while 90.9 percent used honey buckets (U.S. Census 2000). Residents are responsible for hauling their own honey buckets to the bunker disposal area.

Housing availability in Kivalina is an issue of concern. According to the 2000 U.S. Census, there were a total of 80 housing units in the village, of which only two units were vacant. Many of these homes are built two and three houses to a lot to use all available space. Of the total occupied housing units in Kivalina, 82.1 percent are family households, with an average family size of 5.5 people. The total average household size for the community is 4.83 people per home. Excluding Kotzebue[1], the average household size of the nine villages in the region is 4.38 people per home. Of the occupied housing units, 79.5 percent were owner occupied and 20.5 percent were rented. The majority of rental homes are owned by the school district and serve to house teachers in the community. The 2000 median home value in Kivalina was $56,000, increasing from $45,000 in 1990. Median rent paid decreased from $625 to $544 per month between 1990 and 2000 (U.S. Census 2000). Many of the homes in Kivalina were built by the Northwest Inupiat Housing Authority (NWIHA), the receiving agency in the region for funding from the Housing and Urban Development (HUD) federal program. Since the passage of the Native American Housing Assistance and Self Determination Act (NAHASDA) in 1996, however, Kivalina has opted to manage their own housing program, receiving funds from NAHASDA directly in the form of capital project grants. The NWIHA still has direct responsibility for 15 homes in Kivalina that were funded prior to the 1996 NAHASDA Act and there are also a few privately built homes in Kivalina.

Residents of Kivalina heat their homes using fuel oil. Electric power is provided by the Alaska Village Electric Cooperative (AVEC). In 2000, 20.8 percent of residents lacked phone service (U.S. Census 2000).

Health care in Kivalina is provided through a clinic run by the Maniilaq Association in conjunction with the Maniilaq Health Center in Kotzebue. The clinic has full plumbing; however, the flush toilets are not yet operational. Emergency services are provided by volunteers and a health aid with emergency transportation is available by sea or air. Refer to Section 3.13 for a more detailed discussion on health in the region.

The Northwest Arctic Borough provides preschool through 12th grade educational services in Kivalina through the McQueen School. The school currently has 123 students and nine teachers. The building, which was constructed in the 1970s, is the only building in town with fully functional plumbing; it is also used to provide accommodations to visitors to the village.

[1] It should be noted that the mean value does not reflect the per capita income of Kotzebue, as the size and role as the regional hub results in unique characteristics that make a comparison less informative.

1.7 History of Relationship between Kivalina and Red Dog Mine

Kivalina is located about 52 air miles west of the Red Dog Mine and 17 miles northwest of the DeLong Mountain Regional Transportation System (DMTS) port site facility on the Chukchi Sea. The mine, located on Middle Fork Red Dog Creek, is upstream of the village and Red Dog Creek flows into Ikulukrok Creek and ultimately to the Wulik River approximately 50 miles from the Kivalina municipal water intake station.

The relationship between the village of Kivalina and the Red Dog Mine has been complex and multifaceted. Due to its proximity to the mine, residents of Kivalina are given priority for employment at the mine and there are currently about 12 Kivalina residents employed at the Red Dog Mine, including NANA/Lynden and NANA Management Services. See Section 3.17.2 in the body of the SEIS for a comparison of employment across all communities in the borough.

The location of the mine upstream of the village has caused concern in the village regarding water quality in the Wulik River into which Red Dog Mine wastewater is discharged (Red Dog Mine Extension – Kivalina Scoping Transcript). Concerns have also been raised about the accessibility and health of subsistence resources such as caribou and berries that may be affected by traffic along the DMTS, as well as lead and zinc concentrate dust generated near the mine and access road, and water discharged from the tailings impoundment (Kivalina website). Both of these effects and others have created concerns within the community regarding the ability to preserve their traditional subsistence way of life.

As a result, Kivalina is one of the only villages in the Borough to vocally oppose the Red Dog Mine, which is believed by some to have also strained Kivalina's relationship with other communities and organizations within the Borough. This opposition was most pronounced in a 2004 lawsuit filed by the members of the Kivalina Relocation Planning Committee against the Red Dog Mine for more than 2,400 violations of its National Pollutant Discharge Elimination System (NPDES) permit issued under the Clean Water Act. The case was settled out of court in May of 2008.

The community of Kivalina also had the opportunity to share its concerns during the SEIS scoping process during fall 2007. Questions and comments, both oral and written, reflect the continued concerns of individuals in the community regarding the mine. These ranged from issues such as the permitting procedure for water discharged by the mine, first hand accounts of dead fish in the Wulik River, observations of dust near the DMTS road and related health concerns, and economic benefits of the mine. One overarching issue that was brought up multiple times was the ability of the community to control its own fate and be a part of the decision making process. One speaker commented, "We're asked to comment and we do at every meeting. Every public meeting. Any meeting we comment. And I always feel that we're never heard. We're never heard." (Red Dog Mine Extension – Kivalina Scoping Transcript, p. 30) Similarly, another resident stated "a lot of these concerns that we have expressed that we've been talking about all these years have never been adequately addressed ever" (Red Dog Mine Extension – Kivalina Scoping Transcript, p. 72).

1.8 Municipal Information

The governing bodies in Kivalina are the Kivalina City Council and the Kivalina Indian Reorganization Act Council which serves as the tribal government; each has seven members. In 2005, the city of Kivalina generated the bulk of its operating revenue from service charges for water service provided to the school and enterprise revenue such as water and cable services (Table 2). In recent years, cable service has been discontinued because residents have switched to satellite television. Revenue per capita for this same year was $584 (ADCA).

Table F-2 Kivalina Municipal Revenue

Kivalina Municipal Revenue (2005)	
Revenue from Service Charges	$142,748
Enterprise Revenue:	
Water	$61,392
Cable	$4,455
Other Local Revenue	$18,569
Other State Revenue	$10,249
Local Tax Revenue (2% sales tax)	$4,066
Bingo Net Revenue	-$16,422
Total Operating Revenue	**$225,057**

Source: ADCA 2008

In addition to these sources of funding, the City of Kivalina also received over $25 million in capital project grants since 1992 (Table 3). These grants were used for a variety of specific purposes, ranging from infrastructure improvement to relocation efforts.

Table F-3 Kivalina Capital Project Grants

Capital Project Grants (1992-2008)	Funds received
Infrastructure (Utilities, airport, etc.)	$ 10,784,434
Erosion Control	$7,952,632
Housing	$ 5,472,314
Relocation Efforts	$742,127
Miscellaneous	$55,000

Source: ADCA 2008

The largest portion of municipal expenditures by the City of Kivalina in 2005 were public service projects including roads construction and maintenance, the water system, the health clinic and other miscellaneous public services. Operating expenditures for the city totaled $290,833 (Table 4), roughly $755 per person (ADCA).

Table F-4 Kivalina Municipal Expenditures (2005)

Project	Cost
Subtotal Public Service	**$215,616**
Roads	$610
Water	$79,490
Clinic	$11.396
Miscellaneous Public Services	$124,140
Subtotal General Government	**$74,450**
Council/Assembly	$16,444
Administration/Finance	$58,006
Subtotal Public Safety	**$767**
Police	$767
Total Operating Expenditures	**$290,833**

Source: ADCA 2008

1.9 Infrastructure and Service Needs

When compared with its sister villages in the Northwest Arctic Borough, Kivalina lags behind in the development of infrastructure and utilities services, such as a piped water system and sewer system in all homes. This is the direct result of the relocation effort anticipated for many years that discourages investments in large capital projects that will then need to be moved or abandoned when the village is relocated.

The most pressing financial need in the community is to secure funding and resources for the relocation. The community has already received $742,000 primarily from the Alaska Department of Commerce, Community and Economic Development for the evaluation of different locations for the new town site, and to create a plan for water and sewer systems in the proposed sites. However, until the site selection is finalized and the source of funding for the move has been identified, these projects will not be able to move forward.

2.0 Noatak

2.1 Background & History

The village of Noatak is located on the west bank of the Noatak River, 55 miles north of Kotzebue. The village was established on its current site in the 19th century as a subsistence fishing and hunting camp, although the location was used for several hundred years before that time (ADCA 2008). A post office was built in 1940. The village is currently unincorporated and has no official city government; community decisions are made by the Noatak IRA Council. The community is primarily accessed by small plane, and small boats; snowmachines and all-terrain vehicles (ATV) are common forms of local transportation. Daily flights from Kotzebue provide mail service and transport groceries and other cargo (ADCA). There is no barge service to Noatak at this time.

2.2 Demographics

The current population of Noatak is 489 (ADCA). Population increased by 47 percent over the last 28 years, growing from 333 people in 1990 to 428 people in 2000 (U.S. Census 2000). In that time, a net of 17 people migrated into the community, resulting in a migration rate of +5 percent, which is notably different from the Borough-wide rate of -4.7 percent (ISER 2008). In 2000, the population was 96 percent Native Inupiat Eskimo (U.S. Census 2000).

2.3 Employment

In 2000, the potential workforce in Noatak, defined as persons age 16 and older, was 258 people. Of those, 106 were employed, 36 were unemployed and seeking work, and 116 people were unemployed and not seeking work (U.S. Census 2000). This resulted in an unemployment rate in the community of 25.4 percent. It is important to note that Noatak is a traditional Inupiat community where subsistence activities make up a large portion of the economy, but are not reflected in wage-based employment data.

In 2000, the local, state and federal governments were the largest employers in the community, providing 59 percent of the jobs. The remaining 41 percent of workers were employed by private companies or were self employed (U.S. Census 2000). Major employers in the community included the Maniilaq Association, the four local general stores, commercial fishing, NANA Inc., and the Red Dog Mine, as well as fishing and hunting guiding outfits (Maniilaq website). Fifteen licensed businesses in the community offer services in seven different lines of business including trade, accommodation and food services, and rentals and leasing (ISER 2008). Table 5 shows employment by industry in Noatak in 2000.

Table F-5 Noatak Employment

Employment by Industry in 2000	Number of People	Percentage of Total
Education, Health, Social Services	43	40.6%
Agriculture, Fishing, Hunting, Timber, Mining	20	18.9%
Public Administration	15	14.2%
Retail Trade	8	7.5%
Finance, Insurance, Real Estate, Rental & Leasing	6	5.7%
Transportation, Warehousing, Utilities	5	4.7%
Other Services (except Public Administration)	5	4.7%
Construction	4	3.8%

Source: 2000 U.S. Census

2.4 Income

Per capita income in Noatak in 1999 was $12,686 increasing from $12,509 in 1989. This reflects a 1.4 percent increase in per capita income during this time. When compared to the other ten villages in the borough, Noatak's per capita income fell below the mean of $13,699[2]. The mean household income in 1999 in Noatak was $40,496 (U.S. Census 2000). At that time, 22 percent of the population was living below the poverty line (U.S. Census 2000). In comparison, the statewide average per capita income in 2000 was $29,762 and the median household income was $67,733 with 9.4 percent of people living below the poverty line (U.S. Census 2000). Similarly, the per capita income in Anchorage in 2000 was $33,212, with a median household income of $72,954 and 7.4 percent of the population living below the poverty line (U.S. Census 2000) All figures are reported in 2008 dollars. For more details on income see the Socioeconomic discussion (Section 3.17.2) in the body of the SEIS.

2.5 Subsistence

As mentioned previously, Noatak has a mixed cash economy in which both subsistence activities and wage employment support the way of life in the community. Traditional subsistence activities are also an integral part of the Inupiat culture. One of the most common subsistence activities includes traveling to seasonal fish camps at Sheshalik, an area along the coast south of Cape Krusenstern, during the summer. Chum salmon, whitefish, caribou, moose, bearded seal, and waterfowl are all key subsistence resources used by Noatak residents (ADCA). In 2007, Noatak harvested 364 usable pounds per person of all subsistence resources, a decline from the 1994 harvest of 461 usable pounds per capita (SEIS Table 3.12-4, Section 3.12.2.1). See Section 3.12 on subsistence resources for detailed discussion of subsistence hunting and usage patterns in Noatak.

2.6 Infrastructure

Noatak has made strides in improving community infrastructure over the last 30 years. Water is obtained from the Noatak River, treated, and then piped into homes and businesses by way of a recirculating water system. This system serves 90 percent of homes in the community and is operational year round (Noatak Utilities Manager, personal communication, 2008). Conditions have dramatically improved since conditions in 1990 when U.S. Census data showed that 100 percent of households in the community

[2] It should be noted that the mean value does not reflect the per capita income of Kotzebue, as the size and role as the regional hub results in unique characteristics that make a comparison less informative.

lacked complete plumbing and a complete kitchen. Homes that do not use utilities services due to a lack of plumbing haul water directly from a central distribution point.

Sewage is removed from homes by way of a parallel piped system, which serves the same structures as the piped water system. The piped sewer system leads to a disposal system in a sewage lagoon with three lift stations (Maniilaq Association Website). The remaining ten percent of households not connected to the sewer system continue to use honey buckets. This represents a large improvement from 1990 when the U.S. Census reported 100 percent of households used a honey bucket system for sewage disposal. The community also made additional infrastructure improvements with the construction of a new landfill near the airstrip. The Village Council runs water, sewer and landfill services, managing infrastructure maintenance as well as billing services. The Noatak Utilities Manager sends out roughly ten disconnect notices per billing period to households who are not up to date in their payments. These notices resulted in the disconnection of four homes over the last year, all of which have since been reconnected after their accounts were settled (Noatak Utilities Manager, personal communication, 2008).

People who do not qualify for HUD housing as the result of income limits have the option of applying for housing through the Bureau of Indian Affairs' Home Improvement Program (BIA HIP). Housing through this program can be more difficult to acquire as applicants compete with other applicants on a statewide basis as opposed to NWIHA which is administered on a community and borough level. If people are unsuccessful with both of these programs, they will often choose to stay in their current situation and apply to both of these programs again the following year. The Rural Alaska Community Action Program Inc. program also provides housing assistance, which primarily takes the form of housing renovations as opposed to new housing projects (NWIHA Administrator, personal communication, 2008).

According to the 2000 U.S. Census, 85 percent of the households in the community used fuel oil to heat their homes. The remaining 15 percent used wood for heating, although this percentage decreased from 62.2 percent in 1990 (U.S. Census 1990, 2000). Electricity in the community is supplied by the Alaska Village Electric Cooperative (AVEC). In 1990, 70.6 percent of the households in the community lacked phone service although by 2000, that percentage had fallen to 15 percent.

According to the U.S. Census, 106 housing units existed in Noatak in 2000 and100 were occupied; 75 percent of occupied units were owner-occupied, while 25 percent were tenant-occupied (U.S. Census 2000). Most of these homes were initially constructed by the Northwest Inupiat Housing Authority (NWIHA), the receiving agency for funds from the Native American Housing Assistance Self Determination Act and Housing and Urban Development federal programs. By opting to participate in the NWIHA, the money that is allocated to the community of Noatak is administered by the NWIHA which pools funds from the 11 communities it represents and redistributes it among villages based on needs year to year. The NWIHA most recently built five new homes in Noatak and currently owns approximately 25 homes in the community (NWIHA Administrator, personal communication, 2008).

Many of the occupants of these homes are participating in the Mutual Help Program, where residents make monthly payments with the goal of purchasing their home from the NWIHA over 25 years. To initially qualify for housing assistance, households must fall within the HUD income limits. After a resident qualifies for a home, monthly payments are calculated annually as a percentage of the total household income. Should a household income increase above the HUD income limits, the monthly payments will also increase, allowing the household to pay off their home ahead of schedule. Although most homes were built by the NWIHA, there are four privately built homes in Noatak, two of which were built by current or past Red Dog Mine employees (A. Ashby, personal communication). Ninety of the households in Noatak are considered family households, with an average household size of 4.28 people. The median value of owned homes in Noatak in 2000 was $63,800, which increased from the 1990 median value of $50,7000 (U.S. Census 2000). The average rent paid in Noatak in 2000 was $588 per month (U.S. Census 2000).

Healthcare in Noatak is provided by the Maniilaq Association through a local clinic and the regional health center in Kotzebue. The clinic was expanded and renovated in 1994, and the village has since requested a new clinic. In 2002, the community received a grant of nearly $2 million through the Alaska Native Tribal Health Consortium and the Denali Commission who partnered with Maniilaq to design and construct a new clinic, which is now fully operational (ADCA).

Preschool through 12th grade education is provided in the community by the Napaaqtugmiut School as part of the Northwest Arctic Borough School District. The school currently has 157 students and 12 teachers (ADCA). Due to severe overcrowding, and the fact that the elementary wing of the school is located on land controlled by the Alaska Department of Transportation and Public Facilities and is on the direct approach of the airstrip, construction of a new school is currently in progress (NWABSD website). The community recently received several grants totaling more than $27 million to build the school on a different site. The land for the new school building was donated by NANA.

Noatak also has a post office, a community hall, and four general stores in the community. In addition, the Alaska National Guard has a small armory and post located in the community (ADCA).

2.7 History of Relationship between Noatak and Red Dog Mine

The Village of Noatak is located about 40 miles south of the Red Dog Mine. The mine is located in the Red Dog Creek and Wulik River drainages. However, the proximity of the mine to the Noatak River is a source for concern for many of the members of the Noatak community.

Currently, 17 residents of Noatak are employed at the Red Dog Mine, including NANA/Lynden and NANA Management Services (SEIS Table 3.17-21). This places Noatak third behind Kotzebue and Noorvik in number of residents employed. Section 3.17.2 of the body of the SEIS presents information about the distribution of employees across all communities in the Northwest Arctic Borough. Because of their proximity to the mine, residents of Noatak have a hiring preference at the Red Dog Mine. According to the Noatak Utilities Manager, employment at the Red Dog Mine also has an effect on the provision of utilities services in the community. People who are employed at the mine “tend to come in and pay whenever they are in town; they pay more regularly.” This is also supported by the fact that no disconnect notices have been sent out to Red Dog Mine employees (Noatak Utilities Manager, personal communication, 2008).

The autumn 2007 scoping meeting and comment period provides a picture of the major concerns that community members felt regarding the Red Dog Mine. In addition to making comments, a large number of questions were posed during this meeting as residents sought to better understand the regulatory and decision making processes. Of the issues discussed, a consistent concern was the issue of preserving water quality in the Noatak River and the potential contamination of the river from water in the tailings pond at the mine. Residents asked many questions to better understand the permitting process of the dam that forms the pond. They also brought up concerns that climate change and specifically permafrost thaw might change the conditions to the extent that contamination could occur in the future (Red Dog Mine Extension – Noatak Scoping Transcript).

Another issue that was discussed by multiple residents related to local control and governance and the importance the village placed on being allowed to be a full participant in and beneficiary of the mine’s development process (Red Dog Mine Extension – Noatak Scoping Transcript). Several residents felt that they had been “left behind” by the development of the mine, both in terms of economics and in decision-making power (Red Dog Mine Extension – Noatak Scoping Transcript, p. 15). Another resident commented that he did not “really know whose interest that the EPA stands in. Is it Teck Cominco’s interest, NANA’s interest, or our people, our subsistence way of life, our environment.” (Red Dog Mine Extension – Noatak Scoping Transcript, p. 40). Furthermore, several residents expressed feelings of powerlessness to influence the development at the mine, stating "we are trying so hard to go with the main flow, you know. It's going to be real hard to stop Aqqaluk trust deposit from going forward, I am sure I mean, this is a small tribe… and it's a small village we try to hold on to" (Red Dog Mine Extension – Noatak Scoping Transcript, p. 42).

2.8 Municipal Information

Noatak is an unincorporated city and does not have a municipal government. Because the community does not have a formal municipal government, municipal revenues and expenditures are not readily available. Capital project grants are one the major sources of funding for projects within the community. Noatak has received over $58 million in state and federal capital project grants since 1989, with an additional $14 million planned by the FAA for runway construction and improvements at the airport in the next year. These grants have been used for a variety of purposes, ranging from infrastructure improvement to erosion control (Table 6).

Table F-6 Noatak Capital Project Grants

Capital Project Grants (1989-2008)	Funds received
Education	$36,554,749
Planned Airport Improvements	$14,070,000
Infrastructure (Electricity, Sewer, Water, etc.)	$13,947,585
Housing	$7,906,224
Erosion Control	$215,000

Source: ADCA 2008

2.9 Infrastructure and Service Needs

The major capital project needs in Noatak center on improvements in utilities and infrastructure. The village is currently seeking funding to build a washeteria. They are also seeking funds to create a master plan to upgrade their water supply, expand the piped water system and install plumbing in those buildings that currently lack facilities. Capital project grants to build a new school and to construct a new runway at the airport have already been funded (ADCA).

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Appendix G

Social Conditions

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Social Conditions

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1.1 Conceptual Framework

Human development and well being are expanding arenas for academic and policy research. "Human development" usually refers to components of human welfare, including measures of health, education, and standard of living. In assessing human development, the Arctic Human Development Report (AHDR) observed the following:

> Most Arctic Residents value fate control or the ability to determine their own destinies. Highly valued also is cultural continuity in the sense of nurturing traditional values and ways of life, even while embracing some of the obvious benefits of modernization. Close relationships with the natural world together with a sense of belonging to the land (and the sea) are important as well. Many of the Arctic's residents would not want to exchange this way of life for the lifestyles of residents of southern metropolises, even though such a life may offer higher standards of living in material terms (AHDR 2004).

The AHDR therefore expands the dimensions of human development and well being within the Arctic to include: standard of living, health, education, ties to nature, cultural continuity, and fate control. AHDR left it to future research to develop indicators to measure these components of human welfare. These six aspects of human development are discussed in greater detail, along with the effects of operations of the Red Dog Mine on these aspects in the remainder of this appendix.

1.1.1 Survey of Living Conditions in the Arctic Data

The Survey of Living Conditions in the Arctic (SLiCA) interviewed over 580 Native people in three regions in Alaska: the Bering Strait Region; the North Slope Region; and the Northwest Arctic region. This data set provides valuable insight into activities, ways of life, and values of the Native Iñupiat of Alaska. The lengthy, face-to-face interviews generated as many as 950 variables per respondent. SLiCA survey results show that, despite widespread poverty (in terms of traditional measures of income), 90 percent of respondents are satisfied with their life as a whole. The primary factors predicting life satisfaction are:

- family ties;
- social support networks;
- income and employment;
- subsistence activities; and
- local control of resources.

The biggest problem, cited by 83 percent of respondents, is unemployment. Forty-two percent have considered moving to another community, and the most frequently cited motive is better job opportunities. Yet 77 percent of households prefer to combine wage paying jobs with subsistence activities. Subsistence and social relationships are the most important reasons people choose to remain in small communities, despite the lower (cash-based) standard of living (Poppel et al. 2007).

Jobs and income are also important factors for well-being. Closer analysis, however, shows that the effects of employment and income on subjective well being are mixed. Consistent with the findings of Lane (2000), the benefits of increasing income are concentrated at the low end of the income distribution, with diminishing returns to well being as income rises. Results from SLiCA research indicates the threshold is around 60 percent of the median personal income in the respective region. For people with income below that 60 percent level, increasing income correlates with increasing subjective well being, but the correlation largely disappears above that level (Poppel et al. 2007).

The relationship between employment and subjective well being is even more complicated. While the raw correlation in SLiCA data between employment and subjective well being is positive, Martin (2005) identified a negative correlation when using more variables. "The negative relationship may be because jobs take time away from participating in family, social and community activities that are [more] important for satisfaction" (Martin 2005: 142).

1.2 Standard of Living

Income and employment are discussed at length in the body of the SEIS (Section 3.17). This appendix provides supplemental information that has been considered in the analysis, including the cost of living and the social impacts of jobs and employment.

1.2.1 Cost of Living

The primary components of cost of living are housing, energy, and food. Table G-1 shows average monthly housing and utility costs for owner-occupied homes from the 2000 U.S. Census, reported in 2008 dollars. Anchorage is higher than the Alaska average, due to higher non-energy housing costs. Northwest Arctic Borough (NWAB) communities are below the Alaska average, because in general, their non-energy housing costs are lower. Table G-2 reveals one reason that housing costs tend to be lower in remote rural Alaska. In 2000, 32 percent of households in remote rural Alaska were owned free and clear, with no rent or mortgage, compared to only 16 percent in non-rural areas. Only 27 percent of remote rural homes were owned with a mortgage or loan, compared to 47 percent in non-rural areas. The proportion of renters was about the same.

Energy costs, which make up a large share of total household costs – especially for rural households – have increased substantially since 2000. As a result, these 2000 aggregate numbers do not reflect the current reality. Energy costs increased more since 2000 for rural Alaska communities than for urban areas. As a result, ownership costs in the NWAB have moved closer to the Alaska average. Table G-3 shows median annual home energy costs by region for 2000 and 2008, estimated for 2008 based on consumption levels in 2000 at May 2008 prices. Since 2000, the median real cost of home energy for Anchorage households increased less than 50 percent, while in remote rural Alaska—which includes the NWAB—it increased by over 130 percent.

Table G-1. Average Selected Monthly Owner Costs for Specified Owner-occupied Housing Units, 2000 (2008 dollars)[1]

Anchorage	**$1,689**
Alaska	**$1,406**
Kotzebue	$1,313
Northwest Arctic Borough	**$947**
Kiana city	$876
Noatak	**$827**
Noorvik	$791
Kobuk	$768
Buckland	$768
Selawik	$682
Ambler	$670
Deering	$660
Shungnak	$632
Kivalina	**$620**

Source: U.S. Census Bureau

Table G-2. Home Ownership in Alaska, 2000

	Non-rural	Remote Rural
Owned free and clear	16%	32%
Owned with mortgage or loan	47%	27%
No cash rent	4%	8%
With cash rent	33%	32%

Source: U.S. Census Bureau, IPUMS (Ruggles et. al 2008)

Table G-3. Median Annual Home Energy Costs*, for Households That Pay (2008 dollars)

	Anchorage	Kenai & Mat-Su	Mid-Size & Roaded	Remote Rural	Total
2000	$1,866	$2,239	$2,488	$3,284	$2,239
2008**	$2,735	$3,465	$4,934	$7,586	$3,504
% increase of median	47%	55%	98%	131%	56%

* Includes costs for electricity, gas, and heating fuel, but not gasoline or other fuel for transportation.
** Estimated at 2000 consumption levels at May 2008 prices (Haley et al. 2008)
Sources: U.S. Census Bureau (IPUMS), Institute of Social and Economic Research (Haley et al. 2008)

[1] The U.S Census Bureau defines **selected monthly owner costs** as "the sum of payments for mortgages, deeds of trust, contracts to purchase, or similar debts on the property (including payments for the first mortgage, second mortgage, home equity loans, and other junior mortgages); real estate taxes; fire, hazard, and flood insurance on the property; utilities (electricity, gas, and water and sewer); and fuels (oil, coal, kerosene, wood, etc.). It also includes, where appropriate, the monthly condominium fees or mobile home costs (installment loan payments, personal property taxes, site rent, registration fees, and license fees)." **Specified owner-occupied housing units** are defined as "1-family houses on less than 10 acres without a business or medical office on the property. The data for 'specified units' exclude mobile homes, houses with a business or medical office, houses on 10 or more acres, and housing units in multiunit buildings."

Table G-4 shows the estimated average monthly electric bill paid by customers in Kotzebue, Kivalina and Noatak, after the Power Cost Equalization (PCE) subsidy.[2] In 2008 dollars, the average monthly bills range from about $60 to $200, and are typically between $100 and $150. Kivalina and Noatak have both seen increases in their electric bills since 2000. In contrast, Kotzebue's average monthly bill declined by almost half. This can be attributed primarily to an increase of Kotzebue's PCE subsidy from $0.0919 per kWh in 2005 to $0.1731 per kWh in 2006.

Table G-4. Estimated Average Net Monthly Electric Bill for Residential Customers (2008 dollars)

Fiscal Year	Kotzebue	Kivalina	Noatak
2000	$115.68	$89.93	$137.84
2001	$110.81	$117.84	$144.91
2002	$118.24	$142.90	$125.99
2003	$110.99	$107.25	$129.72
2004	$127.46	$141.43	$194.41
2005	$114.10	$131.45	$159.45
2006	$67.31	$82.05	$106.13
2007	$57.74	$116.18	$156.29

Source: Alaska Energy Authority and ISER calculations

The Cooperative Extension food cost survey in March, 2008, shows current cost comparisons between Kotzebue and Anchorage for food, electricity, heating oil and gasoline. As Table G-5 shows, current electric costs in Kotzebue are much higher than in Anchorage, even after being offset by the PCE subsidy. Heating oil costs $4.45 per gallon in Kotzebue. For comparison, the energy-equivalent amount of natural gas in Anchorage would cost about $1.08. At the time of the survey, gasoline cost $5.50 per gallon in Kotzebue compared to $3.30 per gallon in Anchorage. The cost of food for a typical family of four in Kotzebue is nearly twice the cost of food for a similar family in Anchorage.

Table G-5. Cost of Food, Electricity, and Fuel for Kotzebue and Anchorage, March 2008

	Weekly Food Cost (family of 4)	Electricity (1000 kWh)	Heating (oil or gas)*	Gasoline
Kotzebue	$261.73	$154.01	$4.45	$5.50
Anchorage	$134.05	$128.82	*$1.08*	$3.30

* Price for Kotzebue is per gallon of heating oil; price for Anchorage is the cost of the energy-equivalent quantity of natural gas (1.348 CCF).
Source: University of Alaska Fairbanks Cooperative Extension Service Food Cost Survey, March 2008, U.S. Energy Information Administration, Enstar Natural Gas Company, and ISER calculations

Although none of the smaller communities in the NWAB were included in the survey, their costs are higher than Kotzebue because of additional transportation costs and decreased economy of scale. For example, on October 22, 2008 fuel prices in Noatak were $9.79 per gal for heating oil and $10.99 per gallon of gasoline; Kivalina residents were paying $7.75 per gallon of heating fuel and $7.15 per gallon of gasoline. Ambler fuel prices are more volatile because fuel is flown in by airplane. Gasoline in Ambler on the same day was $9.40 per gallon of heating fuel and $9.60 per gallon of gasoline. Kotzebue prices had

[2] We calculated these figures from average kWh sold, average gross billed, and fiscal year-end PCE amount, by subtracting from the average gross billed the average kWh sold (to a maximum of 500) times the PCE amount. We adjusted the numbers to 2008 dollars using the Anchorage CPI.

climbed to $6.36 per gallon of heating oil and $5.85 for gasoline.[3] Communities with barged in fuels that must last the whole iced over winter season are locked into these high prices based on summer delivery prices. They will see no relief as oil prices decline.

1.2.2 Impacts of Existing Red Dog Mine Operations on Cost of Living

The Red Dog Mine transports workers and supplies directly to the mine site thus reducing the potential for direct effects on the cost of living in the NWAB. Food, housing and energy provided to mine employees while at the mine may lower the cost of living for individuals or families with members employed at the mine site. Similarly, wages from mine employment helps individual families cope with the high costs of living and the costs of energy in particular. Payments in lieu of taxes (PILT) made to the NWAB also helps the borough cope with rising energy expenditures and pay the local contribution for schools that may otherwise have to be paid by residents of the borough through taxes.

1.3 Health

1.3.1 Background

Most health and social services programs offered in the NWAB are managed by Maniilaq Association (Maniilaq), a non-profit corporation. Maniilaq represents 12 federally-recognized tribes located in Northwest Alaska including all the villages in the NWAB plus Point Hope. Maniilaq manages social and health services for about 6,500 people. Maniilaq also coordinates tribal and traditional assistance programs, as well as environmental and subsistence protection services.

Maniilaq Association is one of the largest employers in the region with approximately 550 workers and is therefore a key component of the regional economy. Maniilaq health service facilities and programs including a health center, dental clinic, eye clinic, laboratory, Social Services Department, pharmacy, physical therapy, radiology, and 11 remote village clinics.

There are no direct economic linkages between Maniilaq operations and the Red Dog Mine. Maniilaq provides health and social services to mine employees that reside in the region and their families. However, there is no indication that the presence of the mine related population has any positive or negative impact on Maniilaq services in terms of cost or availability of services. In 2007, TCAK made a $106,500 contribution to Maniilaq Association in support of its cancer treatment program.

1.3.2 Health and Well Being

Section 3.13 of the SEIS discusses health indicator data for the NWAB and the linkages between social conditions and health outcomes. The SLiCA and the Social Transitions in the North (STN) survey yield additional perspective on the linkage between health and wellbeing. Martin (2007) found that health is an important indicator of well being. Well being is broader than health and includes opportunities for jobs, subsistence and participation in community life. Data from the surveys indicate that people who live in households that mix jobs and subsistence are healthier than people who live in households that do only one or the other. Respondents who reported giving and receiving subsistence foods and eating meals with relatives from other households also reported higher levels of health. Health is also a predictor of satisfaction with one's life as a whole (Martin 2005).

[3] Grant Hildreth, Northwest Arctic Borough Planning Commission, personal communication, October, 2008 based on his conversations with fuel suppliers.

Haley and Magdanz (2008) analyzed SLiCA data to examine the effects of full time employment on social ties. They found that while high income households enjoy more social support than low income households, there is no difference in social support by employment status. Strong ties with family not living in the household do not vary by income or employment status, but “bridging” ties to diverse people outside the community are higher in high income households and higher for those who are employed full time.

1.3.3 Impacts of Existing Red Dog Mine Operations on Health and Wellbeing

The effects of existing Red Dog Mine operations on people on- and off-site are discussed in detail in the body of the SEIS (Section 3.13).

1.4 Education

1.4.1 Northwest Arctic Borough School District

Education in the region is provided by Northwest Arctic Borough School District. The district operates thirteen schools in eleven communities, with total enrollment in the district averaging over 2,000 students a year for the past 10 years. Schools in the district range in size from 43 students in Kobuk to 850 in Kotzebue (NWABSD website). The school district currently employs 185 teachers with an average class size of 18 students per class (NWABSD website).

Ninety-five percent of the students in the school district are Iñupiat. Excluding Kotzebue, this percentage increases to 98 percent Iñupiat Alaskans. This is much greater than the statewide average Alaska Native population of 23 percent, and the average in the Anchorage School District of 13 percent (AK DEED).

Funding for the Northwest Arctic Borough School District comes from several sources. The district’s FY 2008 operating budget reports annual operating revenue of $45.8 million. Of that, $26.1 million came from the Alaska state aid programs (AK DEED). Contributions from the NWAB general fund totaled $3.8 million, which is approximately twice the required minimum local contribution.

Roughly 65 percent of the school districts funds are directed toward instructional expenditures. The district is also in the process of renovating or rebuilding the Ambler School, Kotzebue Middle/High School, the Napaaqtugmiut School in Noatak, and the Kiana School. While the school district is able to bond for school construction and then request reimbursement from the State, the NWAB can fund the local contribution and bond for school construction largely as a result to the PILT payments received from the Red Dog Mine operation. This gives local residents more control of their schools than communities in the unorganized borough with insufficient local revenues to support education.

The Northwest Arctic Borough School District employs 17 Alaska Native teachers out of its pool of 184 certified staff, or 9.2 percent. This compares with 9.0 percent for the North Slope School District, but is about half of the Lower Kuskokwim and Lower Yukon School Districts. It is twice the rate of the Bering Straits School District (Table G-6). These five districts average 12.7 percent Alaska Native teachers. However, the Northwest Arctic Borough School District numbers improved in recent years with three new Alaska Native teachers hired in the last three years. The statewide average for Alaska Native teachers is 4.5 percent.

Education research has linked high teacher turnover with lower student achievement. Some turnover is inevitable, as teachers retire, quit teaching, or move to other districts—and up to a point turnover is good, bringing in new teachers and ideas. In addition to being linked to lower student achievement, recruiting new teachers is expensive. There is no broad agreement about how much annual turnover is too much—

some think more than 5 percent is too much—but most educators agree that by 20 percent, turnover is worrisome.

Higher teacher turnover is a chronic problem in Alaska rural school districts. Hiring Alaska educated teachers and specifically Alaska educated teachers from rural Alaska tends to reduce teacher turnover and improve student achievement. The Northwest Arctic Borough School District teacher turnover declined slightly from an average of 25 percent for the years FY 1999 to FY 2003 to an average of 22 percent for the years FY2003 to FY 2007. With the exception of the Lower Kuskokwim School District with 20 percent teacher turnover, the Northwest Arctic Borough School District compares more favorably than the other rural school districts in its region. It is similar to rural school districts statewide but over twice as high as urban districts that average 10 percent teacher turnover. The education scholarships offered by Teck have the potential to increase Native teacher hire and decrease teacher turnover.

1.4.2 Post-secondary Education

Two institutions, the Alaska Technical Center (ATC) and the Chukchi Community College, provide post-secondary education in the Northwest Arctic Borough. Both schools are located in Kotzebue. Along with two other regional organizations, the Northwest Arctic School District and Maniilaq Association, they comprise the Northwest Arctic Higher Education Consortium to provide an integrated system of post-secondary and vocational education to serve the needs of regional residents and employers.

The ATC is an adult vocational and technical education training facility operated by the Northwest Arctic Borough School District with state funding. It was built in 1981 as a way to help meet local demands for employment, particularly those opportunities anticipated by the potential opening of the Red Dog Mine. The ATC provides four areas of emphasis: office occupations, building industrial technology, industrial mine maintenance, and health occupations. The ATC program also provides a variety of short-term training opportunities depending on employment needs and demands. ATC collaborates in partnerships with industry and state agencies to respond to anticipated regional training needs and opportunities for job growth. For example, a recent partnership between ATC, NANA, and Plumbers and Pipefitters Local 375 provided a welder training program while introducing students to careers in the trades such as pipeline work. Programs are designed to mimic the workday schedule, with classes starting at 8:30 a.m. each morning and continuing through 4:30 p.m., helping students adjust to the workplace environment.

The ATC also provides basic skills instruction to adults in reading, writing, and mathematics in preparation for transitioning into the labor market, higher education, or vocational training. The GED preparation program assists students in all relevant areas including English, reading, science, social studies and mathematics.

In 2006, the ATC GED program had 323 participants enrolled: Kotzebue (161), Noorvik (50), Selawik (33), Kiana (23), Kivalina (22), Deering (20), Ambler (11), Kobuk (10), Buckland (8), Noatak (6), and Shungnak (4). In the 2005-06 school year, the program had 44 graduates, both young and older adults, and approximately 30 graduated in 2007.

The Chukchi Community College, which is affiliated with the University of Alaska Fairbanks, works in conjunction with ATC to provide postsecondary education services to the region. Students in this college primarily attend classes via satellite-assisted audio conference, and use tools such as fax machines and email to correspond and interact with professors and fellow students (Chukchi Community College website). This allows many of these students to attend classes in their home village. By using distance learning tools, the college is able to offer two and four-year degrees in teaching, rural development, health, social work, and computers (Chukchi Community College website).

1.4.3 Educational Attainment

The adult population in the NWAB has a comparatively low rate of educational attainment: 72 percent of adults over the age of 25 have graduated from high school according to the 2000 U.S. Census (Table G-6).

Table G-6. Educational Attainment, 2000

	High School	College
Northwest Arctic Census Area	72%	13%
Alaska	88%	25%
Anchorage	90%	29%
Nome Census Area[1]	75%	15%
Bethel Census Area [2]	71%	13%
North Slope Census Area	78%	17%

[1] Includes the Bering Strait REAA, Nome School District

[2] Includes the Lower Kuskokwim REAA, the Kuspuk REAA and the Yupiit REAA.

The trend over the last 30 years, however, has been improving. The percent of high school graduates in the Northwest Arctic region rose sharply between 1970 and 1980, increasing from 24 percent to almost 50 percent. High school graduation levels continued to rise in the 1990s, but at a slower pace, growing from around 50 percent in 1980 to around 65 percent in 1990. Since 1990, educational levels among Northwest Arctic region residents have lagged behind many other areas of the state, reaching 72 percent of adults with a high school diploma in 2000 compared with 88 percent for Alaska's general population and 78 percent for other rural Alaska census areas.

Based on more recent data school attendance in the NWAB is lower than in Alaska as a whole, and lower than in the comparable school districts of other parts of rural Alaska (Alaska Department of Education 2006). Graduation rates are comparable to those of peer school districts, although still lower than in Alaska as a whole. Dropout rates in the Northwest Arctic Borough are lower than in peer school districts and appear to be approaching the average dropout rate across the state of Alaska.

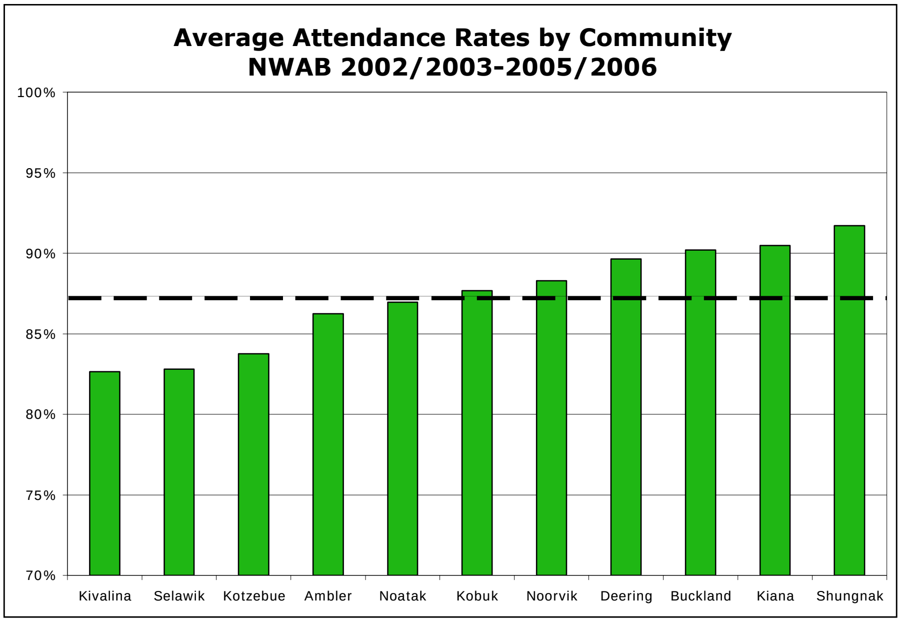
Figure G-1 shows school attendance rates by community, with no school in the Borough reaching the school attendance rates in the rest of the state (93 percent). In the communities of Kivalina and Noatak, graduation, attendance rates, and dropout rates vary greatly from year to year, but between the 2002/2003 and 2005/2006 school years, average attendance rates in the two communities have been 83 percent and 87 percent, respectively. These are in comparison to the borough average of 86 percent. It should be noted that because of the small number of students at these schools, the degree of variation in the data is quite high.

According to the SLiCA (Poppel et al. 2007), the percentage of the total population within the NWAB that has completed either vocational school or a college program is 36 percent. This percentage is relatively high compared to the North Slope Borough (25 percent) and the Bering Strait Region (18 percent).

1.4.4 Effects of Existing Red Dog Mine Operations on Education

The presence of the Red Dog Mine in the region has affected educational services and the level of education in the population in several ways. The Teck agreement with NANA stipulates measures for the education, training and employment of NANA shareholders at the Red Dog Mine. The 1982 agreement also provided for the establishment of a NANA-Teck joint employment and training committee, which supervises the hiring, training, and promotion of NANA shareholders.

As discussed below in Section 1.4.4.2, Teck provides support for education through its payments in lieu of taxes to the NWAB, which in turn, is an important source of funding for the Northwest Arctic Borough School District. Teck also provides direct funding to the school district.



Source: Alaska Department of Education 2002/2002 - 2005/2006 Report Card to the Public [4]

Figure G-1. School Attendance Rates by Community

Teck also supports several ongoing educational programs within the region. These include a School-to-Work program, a partnership with the University of Alaska, Alaska Native Science and Engineering Program, and full college scholarships for NANA shareholders. These programs are designed to help motivate students to graduate from high school, which is a minimum requirement for employment at the Red Dog Mine.

The School-to-Work program also incorporates Career Awareness and Job Shadow programs for high school students in the region. These programs serve to introduce students to the mine and help make them aware of job opportunities at the mine after graduation. As part of the Career Awareness Program, students travel to the Red Dog Mine for a two and a half day visit, during which they tour the mine and hear presentations from each department. After participating in the Career Awareness Program, juniors and seniors are invited to apply to the Job Shadow Program, where they have the opportunity to spend three and a half days at the mine, shadowing mine employees in individual departments. Teck provides transportation to and from the mine and housing for the students during their visit.

An estimated 80 students from the Northwest Arctic Region are selected each year for the Career Awareness program and roughly one-third of those students subsequently participate in the Job Shadow Program. The mine has hosted approximately 550 students over the life of the program.

[4] Attendance rates for the community of Kotzebue represent the weighted average of attendance rates at June Nelson Elementary School and Kotzebue Middle and High School.

In addition to the Career Awareness and Job Shadow Programs, Teck also supports high school students and those seeking higher education in the fields of science and engineering through its partnership with the University of Alaska's Alaska Native Science and Engineering Program. In this program, students receive mentorship, summer programming, and follow-up support throughout high school and college to help them obtain an undergraduate degree in the field of science and engineering.

While the trend of higher educational attainment in the Borough cannot be directly attributed to any of these programs, there is some evidence that employment at the Red Dog Mine provides motivation for youth to graduate from high school, as it is a minimum requirement to work at the mine. A survey of high school students in 1992 found that 47 percent of the respondents in the NWAB aspired to work at the mine (Hamilton and Seyfrit 1994). While this study predates many of the education programs now in place, it does indicate that working at the mine could be a motivating factor for educational attainment within the region.

1.4.4.1 Support of Higher Education

In addition to programs supporting K-12 education, Teck also supports higher education for NANA shareholders by providing scholarships for students who want to pursue post-secondary education. Teck's first priority for these scholarships is given to those students who are pursuing studies that relate to employment at the Red Dog Mine, such as in mining operations, or apprenticeships for trades such as heavy duty mechanic, electrical, millwright and power generation. Many of the recipients of these scholarships study at technical and vocational schools throughout the state. Despite the emphasis on studies that pertain to employment at Red Dog, Teck also supports students in other fields as well, including education, healthcare and in fields related to employment at other NANA companies. Current scholarship recipients attend both two- and four-year programs at schools in- and out-of-state. It is common, however, for students on scholarship to return to the Northwest Arctic region and work seasonally at the mine while completing their studies. Teck strives to encourage this.

In addition to providing scholarships, Teck works closely with the ATC to support programs that provide training for working at the Red Dog Mine. From the mid 1990s through 2002, this partnership was particularly close; Teck provided monetary support for the school and awarded scholarships, while also providing transportation for students to and from and assisting in the selection of students for the program.

Staff from the ATC continues to work closely with Teck personnel to place ATC graduates in jobs at Red Dog. The Teck human resources staff passes along information on upcoming job openings and training needs. According to an ATC representative, 18 of 20 graduates participating in the 14-week spring session for millwright maintenance training under the Industrial Mine Technology program were placed in Red Dog related positions (D. Atoruk, personal communication).

1.4.4.2 Work Force Education

A high school diploma is the minimum education requirement for employment at the Red Dog Mine; however, many of the employment opportunities at the mine require additional training and education to successfully work and advance professionally. To facilitate continuing education, Teck provides on- and off-site education and training programs for shareholders including flexible work schedules and support for continuing education.

On-the-job training is one of the largest pieces of Teck's workforce education programs. In 2007, Teck provided over 15,500 hours of on-the-job training for shareholders. This training occurred in every area of operation, including trade apprenticeships and opportunities in advanced technical training in geological, metallurgical and environmental fields. The bulk of these trainings, totaling roughly 11,000 to 12,000 hours, were directed towards 150 shareholder employees working in the departments of mill operations, mine operations, and the trade departments including heavy equipment, maintenance, power, millwright, and electrical (R. Sheldon, personal communication). These programs are designed to advance shareholders from a minimal skill level to becoming highly skilled in their profession. The success rate of shareholders completing the apprenticeship training has increased from a 30 percent completion rate in the early years of the mine, to a 70 to 75 percent completion rate in recent years (R. Sheldon, personal communication).

The incentives that Teck provides to pursue higher education may or may not be having a substantial impact on college degree attainment in the region. The high school diploma required for employment at the Red Dog Mine appears to have motivated an increase in high school diploma attainment in the region. However, employment at Red Dog does not necessarily provide a direct incentive to pursue higher education because a shareholder does not need a college degree to make a good salary at Red Dog since even starting salaries are much higher than most alternatives in the Northwest Arctic Borough. Furthermore, individuals motivated to pursue post-secondary education may not choose a career in mining and can take advantage of several other potential sources of scholarship money beyond the scholarships that Teck offers so as not to commit themselves to a career in the mining profession.

1.5 Ties to Nature

Knowledge of and respect for the land, sea, and animals are core Iñupiat values. Time on the land and sea is both a means to acquiring knowledge and an affirmation of connection and identity. Participation in subsistence activities and reliance on subsistence foods in the household diet are important in establishing and maintaining ties to nature. Subsistence harvests, use areas, and observed changes in wildlife are well documented in Section 3.12.

Residents of the NWAB report higher rates of participation in outdoor activities, including snowmobiling, dog sledding, hiking, walking and jogging, boating and “being out in the country,” than their neighbors to the north and south. In Kotzebue, 67 percent of Iñupiat adults went snowmobiling or dog sledding in the prior year, and 58 percent went boating or kayaking. In the outlying villages, the figures were 80 percent and 66 percent, respectively. They also report higher rates of being away from the community for a month or more for purposes to hunt or fishing or go to a camp or cabin: 10 percent overall. (Poppel et al. 2007).

1.6 Cultural Continuity

Cultural continuity is a key aspect of community well being in Arctic Alaska. This factor is particularly important when considering potential development projects that could irreversibly alter the lifestyle of a culture that has been maintained for centuries. A careful look at the prevalence and retention of Iñupiat culture in the villages around the Red Dog Mine is necessary to understand the effects that may have occurred as a result of existing operations and the potential impacts that could occur if mining operations were extended.

The Iñupiat people have survived and subsisted in northern Alaska for thousands of years. Historically skilled hunters and gatherers who subsisted primarily on whale, fish, caribou, moose, berries, and root plants, these ancestors occupied and survived off the land prior to contact with Russian explorers in 1818. The Iñupiat in the region today still take part in many of the same subsistence activities and share many of the same values as those of their ancestors. The population of the NWAB region is 85.5 percent Alaska Native according to the 2000 U.S. Census, and the Iñupiat way of life still provides framework and values for everyday life.

Over the last century and a half, however, this everyday life has undergone dramatic changes. In the late 19th and early 20th century, Western disease epidemics arrived along with explorers, whalers, traders and missionaries. Schools and churches promoted Western culture and suppressed the Iñupiaq language and culture. Mid-century, the introduction of mandatory schooling pushed semi-nomadic families into permanent settlements and houses, accompanied by increasing reliance on store-bought goods. Increasing access to Western goods has been accompanied by increasing access to Western ills, specifically alcohol and drug abuse and domestic violence (see Section 3.13.2.1). In the latter part of the century the introduction of water, sewer, electricity, telephone, cable television improved the standard of living, while the need to pay for these goods and services prompted communities to increasing participating in the cash economy. Although subsistence continues to have a strong economic, cultural, and social significance, the need for wages and employment has driven change and development in the region.

In response to these developments, Iñupiat leaders in the 1980s in the Northwest Arctic sought to refocus the way of life to reflect core Iñupiat values. These leaders felt that despite being better off physically and materially, there was a serious decline in the quality of life and social well-being. This prompted a movement toward social change, based on Native culture and centered on individual lifestyle changes and healthy personal habits. In 1981, the movement culminated in the codification of traditional Iñupiat values in the Iñupiat *Ilitqusiat*, which translates roughly as "the wisdom and lessons of the Iñupiat people" (McNabb 1991, p. 63). These are comprised of daily living principles prescribed by elders that characterize a healthy, productive Iñupiat way of life. Ilitqusiat also speaks to the inner spirit of a person—that which makes an individual unique and special. Elders suggested that if Iñupiat are closely connected to their inner spirit, they will be happier, more productive members of society, and be able to better help others in their family and community (ibid.). This movement was a key step in the preservation of the Iñupiat culture in the Northwest Arctic.

Furthermore, the Iñupiat Ilitqusiat "seeks to assert and validate Iñupiaq ethnic identity, reactivate and preserve Iñupiat skills, and solve pressing social problems by using traditional wisdom that is part of the essential heritage of the Iñupiat." (McNabb 1991) The movement is based on a set of cultural values chosen for their essence of what it means to be Iñupiat, depicted by the ancient traditional lifestyle of the Iñupiaq people. The foundation for the Iñupiat Ilitqusiat movement is based upon these core Iñupiat principles:

> Know the Iñupiaq language
> Share with others and try to be helpful
> Treat all people with respect
> Cooperate with others
> Respect the Elders
> Treat children with love
> Work hard and avoid idleness
> Know your family tree
> Avoid unnecessary conflict
> Respect all animals
> Don't lose your sense of humor
> Meet your obligations to your family
> Respect successful hunters
> Learn Iñupiat domestic skills
> Trust in a spiritual power greater than yourself
>
> —(*NUNA*, 2(3) 1981)

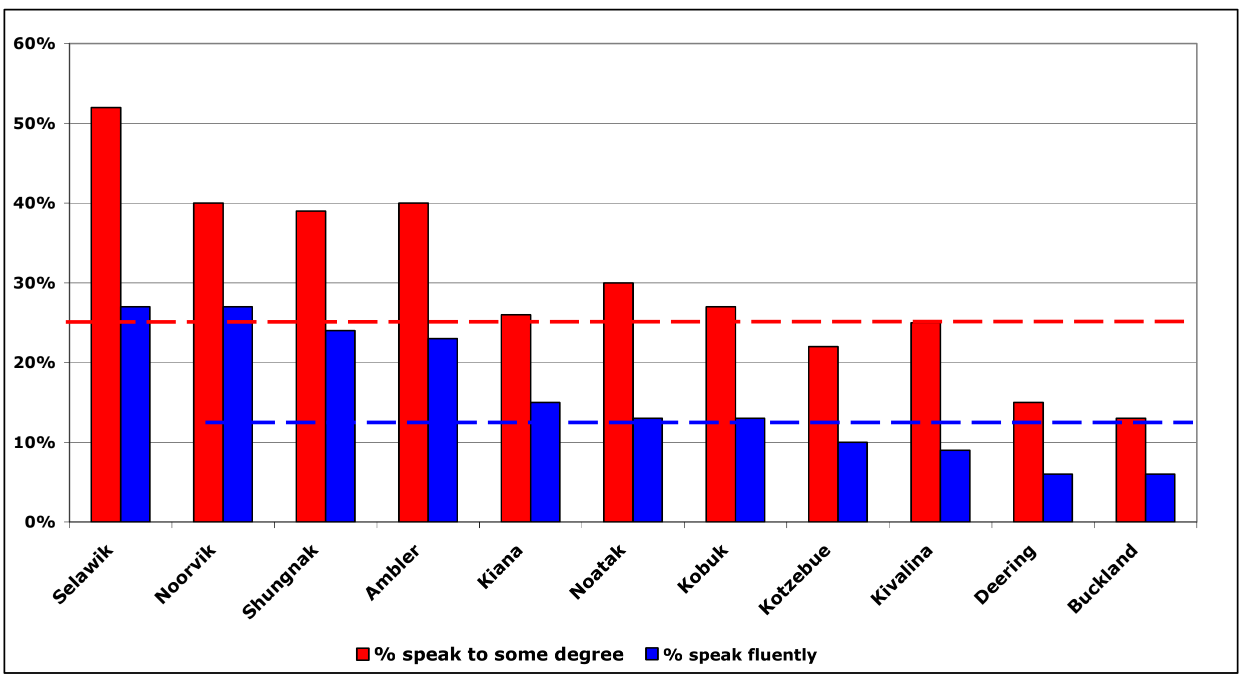
Understanding these values is of great importance in framing the relationships, challenges and rewards involved with the continued development in the region. Evaluating the degree of cultural continuity in a community or a region is not a simple task. The primary indicator that is commonly used as a proxy for the degree of cultural continuity is that of Native language retention in the community. The SLiCA data (Poppel et al. 2007) provides additional information that may contribute to understanding cultural continuity.

1.6.1 Language Retention

The SLiCA data (Poppel et al. 2007) indicates that 33 percent of residents in the Northwest Arctic Region report that they speak Iñupiaq very well and 41 percent report that they understand it very well. These values are just above the average among Arctic communities across northern Alaska, including the North Slope Region and the Bering Strait Region: overall, 32 percent of respondents report that they speak Iñupiaq very well and 39 percent report that they understand it very well.

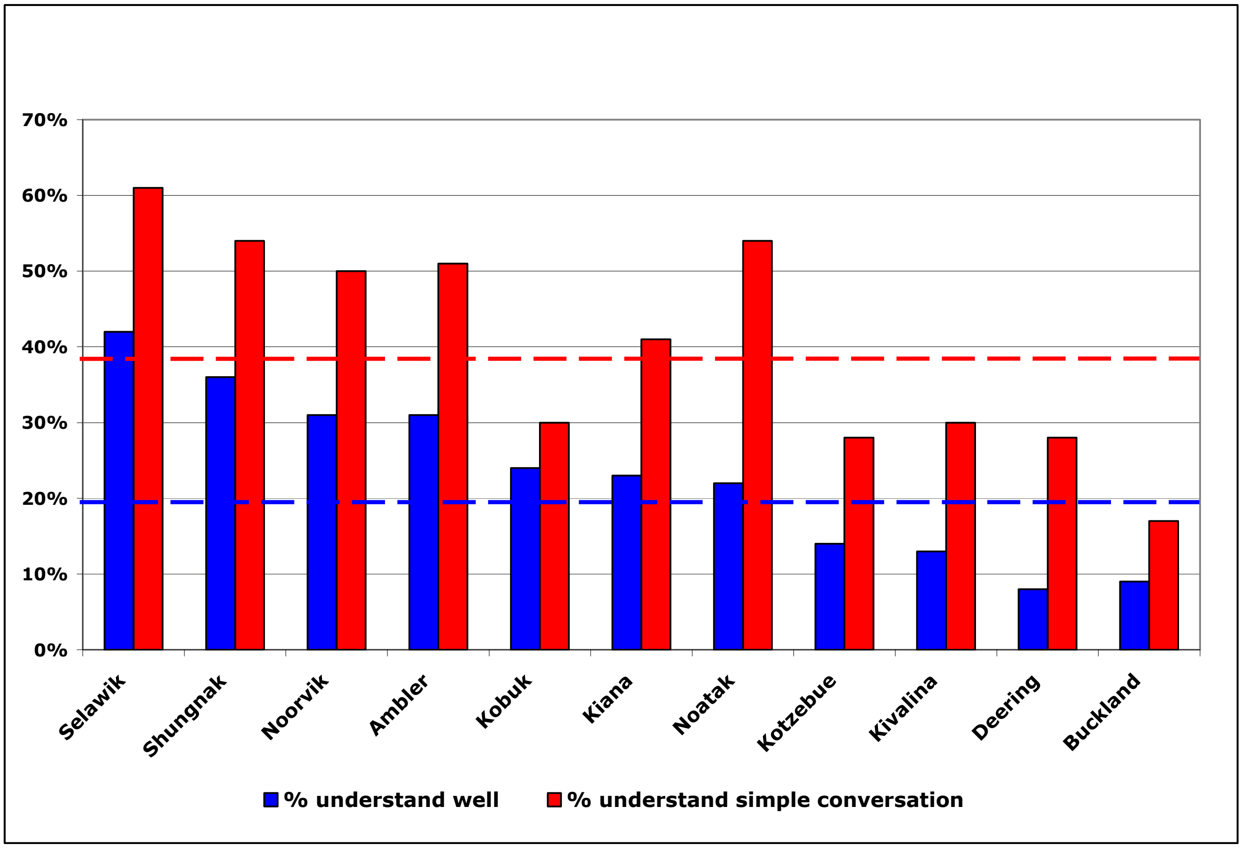
The degree of language retention varies across communities. Only 16 percent of respondents from the regional hub of Kotzebue reported that they speak Iñupiaq very well, and 20 percent indicated that they could understand it well. This is in comparison to response rates in the ten villages of the region where 41 percent replied that they could speak well and 53 percent could understand it very well.

The Aqqaluk Trust Language Survey (2005) provides greater detail of language retention at the community level (Figure G-2). The communities that have high rates of fluency also tend to have higher percentages of residents who are able to speak at least a little Iñupiaq. Figure G-3 also shows reported ability to understand the Iñupiaq language by community. The pattern for residents able to understand simple conversations in Iñupiaq is similar in both cases. Deering, Buckland, and Kivalina tend to have the lowest percentages in both of these measures. In analyzing data from the Aqqaluk Trust Language Survey, it is important to note that the categories in dividing degrees of fluency are different between this study and the SLiCA data set, and thus the results of the two surveys can not be directly compared.



Source: Aqqaluk Trust Language Survey 2005

Figure G-2. Iñupiaq Language Speaking Ability by Community, NWAB



Source: Aqqaluk Trust Language Survey 2005

Figure G-3. Ability to Understand Iñupiaq Language by Community, NWAB

It is important to note that both the Survey of Living Conditions in the Arctic and the Aqqaluk Trust Language Survey provide a snapshot of language retention at one point in time, thus missing the historical context in which these patterns emerged. Factors such as the degree to which the Iñupiaq language was permitted in schools during the early history of western education in the region can have a dramatic impact on the continued ability of residents to speak and understand the language today. In an effort to counter loss of the language over time, NANA has worked the Rosetta Stone Endangered Language Program to develop an Iñupiaq language version of the Rosetta Stone program.

1.6.2 Other Measures of the Traditional Way of Life

The subsistence way of life is a key element of indigenous identity, as subsistence serves a wide range of economic, social and cultural functions in Iñupiat society, including:

> Food and nutrition; economic production, consumption, cost of living and economic security; sharing, social ties, and cultural identity; values and spiritual resilience; social capital in the form of reciprocity, trust, cooperation and leadership; and physical and mental health. Time on the land promotes observation-based knowledge, skills, experience, and judgment; hunting provides a positive outlet and valued social role for young men; and self-reliance promotes a sense of efficacy and fate control (Haley & Magdanz 2008).

Of the top five key activities and customs identified in SLiCA as important to cultural identity, four were related to subsistence: hunting, gathering, food preparation, and consumption. The Northwest Arctic region reported the highest levels of participation in subsistence activities, with 84 percent of Alaska

Native adults in Kotzebue and 95 percent in the villages reporting participation in one or more types of subsistence activities in the past year ((Poppel et al. 2007). Fifty-seven percent of households in Kotzebue and 70 percent of households in the NWAB villages reported that subsistence foods comprised more than half of their household consumption (Poppel et al. 2007).

Ninety-six percent of respondents in the Northwest Arctic region reported applying traditional values in their everyday lives, in comparison to 90 percent in the North Slope Region, 91 percent in the Bering Strait Region and 95 in Arctic Alaska overall (Poppel et al. 2007). Eighty-seven percent of respondents said that they apply traditional skills in their lives, equal to the overall Arctic Alaska average of 86 percent. This percentage was even higher in the villages than in the regional hub of Kotzebue. However, the percentage of respondents who indicated that they took part in some cultural event, such as a Native festival, listening to or telling a Native story, taking part in Native dance or in Native games tended to be lower in the Northwest Arctic region than in Alaska overall (Poppel et al. 2007).

In addition to taking part in and incorporating traditional cultural values into everyday life, the transmission of those values to future generations is a key piece in the continuity of culture over time. SLiCA data suggests that 80 percent of children in the Northwest Arctic region are learning traditional skills, a value that is lower than the Arctic Alaska average of 88 percent. Analysis of the SLiCA data suggests that residents of the NWAB are relatively satisfied with the strength of the Iñupiat culture in the region when compared to other regions in northern Alaska. However, 77 percent of respondents indicated that they were satisfied with the promotion of cultural values in the region compared to 72 percent in the Bering Strait Region, 89 percent in the North Slope Region, and 78 percent in Alaska on the whole (Poppel et al. 2007).

1.6.3 Effects of Existing Operations on Cultural Continuity

Evaluating the effects that the Red Dog Mine has had on cultural continuity within the region is a key piece of understanding the full impact of development in the region. In the face of impending change to the region as the result of the development at the Red Dog Mine, residents voiced a variety of concerns in two 1984 public hearings in Anchorage and Kotzebue regarding the way the development could play out. One of the central concerns raised in the hearings was the protection of the traditional way of life of the Iñupiat people. While this concept is difficult to directly quantify, indicators such as language retention, participation in subsistence activities, and cultural transmission provide a picture of the choices that people have made since the opening of the mine in 1989.

1.6.3.1 Effects on the Traditional Way of Life

The “Social Transitions in the North” survey (STN, conducted 1993, 1994, and 1995) and the SLiCA data provide some evidence on the health of the Iñupiat culture in the Northwest Arctic Borough since the development of Red Dog. As previously discussed, however, these studies provide a snapshot of the state of cultural integrity at the time that they were conducted, and do not provide a historical perspective of how these values have changed over time. Finally, while these surveys allow researchers to evaluate the activities of fully employed versus non-fully employed individuals, they cannot support an evaluation of the activities and perspectives of Red Dog employees in particular.

Analysis of the SLiCA data suggests that there is no significant difference in language retention between people who are employed full time and those who are not. The percentage of people who reported that they could speak (33 percent) or understand (41 percent) Iñupiaq very well does not vary with full time employment. This suggests that employment at Red Dog mine does not negatively affect cultural factors such as language retention. However, language retention within a community is a factor that might be expected to change slowly over time, as elders who are fluent in the language pass away and the cultural knowledge is passed on to younger generations. The twenty years that have passed since the mine has been in existence may not have been enough time for this potential impact to be detected in the communities.

Furthermore, a key aspect of the traditional way of life for the Iñupiat people is the participation in hunting, preparing, and eating subsistence resources. An analysis of data from the STN survey indicates that respondents who ate more subsistence food worked for pay, on average, slightly less than those who ate less subsistence food. The average number of months in which the respondent worked at least two weeks for pay was slightly smaller for those respondents for whom at least half of the meat and fish eaten in the past year was subsistence food.[5]

Analysis of SLiCA data produces similar results: households whose meat and fish was at least half subsistence food had a slightly smaller percentage of adults in the household who worked full time. This difference is statistically significant at the 5 percent level across all three Alaska regions included in SLiCA, the North Slope, Bering Strait and Northwest Arctic, but not for solely Northwest Arctic households. However, there is no significant difference in the prevalence of full time employment when comparing by level of subsistence harvest rather than consumption. Fully employed persons place less emphasis on hunting, fishing, gathering and eating traditional foods as an important source of their Iñupiat identity than do people with less than full time employment. But there is no difference in the percentage of people that report applying traditional Iñupiat values in their personal life.

Despite some differences in the consumption of subsistence food between those respondents who work for pay and those who do not, residents of all types believe that cultural values are strong in the region and that they should be passed on to younger generations. There is no significant difference in the degree of satisfaction with the job the community is doing in promoting traditional values: most people are somewhat or very satisfied with their community's commitment to practicing traditional culture. People who worked in a full time job for pay are equally as likely to respond that children should be taught traditional skills at home, although they are more likely to believe that they should learn traditional skills other places as well (Poppel et al. 2007). This data suggests that employment at the Red Dog Mine does not inhibit the transmission of cultural values to younger generations, but could also reflect the fact that individuals who work full time jobs may have less time available to take part in teaching these values.

Beyond these measures of cultural continuity, it is also necessary to consider other potential impacts on the cultural fabric of communities in the Northwest Arctic region. Since the development of the Red Dog Mine, issues such as the creation of internal conflict within communities, migration of residents out of the communities, and increased stress on the time commitments of community leaders have all been posed as potential impacts related to the mine. Supplemental EIS hearings, held by EPA and the state of Alaska in the fall 2007, provide perspective on current local perceptions and concerns regarding the Red Dog Mine. These hearings highlighted many concerns and differences of opinion in the community regarding the mine. When commenting about a 2004 lawsuit filed by the Kivalina Relocation Planning Committee against Teck for Clean Water Act violations, one resident stated "I am a Kivalina resident, but I do not really support the lawsuit that these six people brought up. And a lot of people-- a lot of people not only in the NANA region, but in the State read about that and they think it's the whole community (Red Dog Mine Extension Scoping Transcript 2007, p. 52)."

This comment is particularly significant, as one of the core Iñupiat values is "avoiding unnecessary conflict." Internal differences among community members are often very private and dealt with in a non-

[5] The difference was statistically significant at the 5% level for the first and second years of the survey, and at the 10% level for the third year.

confrontational manner. The fact that a community member would voice disagreement in a public setting such as federal SEIS hearing suggests the degree of emotion felt about the mine.

1.6.3.2 Migration

Outward migration has the potential to impact the social dynamics, and in turn, the cultural integrity of communities. A 1990s study in the region found that there was a higher tendency for young women to migrate out of rural areas than young men (Hamilton and Seyfrit 1994). The change in the gender ratios in the villages is often associated with an increase in social issues such as substance abuse, and high rates of teen pregnancy (ibid.). For both genders, 63 percent of students, and a higher number of female students, expected to move out of their home region (ibid., p. 190). The study also notes that the individuals who are most likely to leave are also those who tend to be energetic and ambitious. Thus, their absence has higher qualitative impacts on their home communities than the numbers might suggest (ibid.). We have no evidence either way whether the availability of jobs at Red Dog has the intended effect of encouraging ambitious young people to remain in the community.

The option of commuting from Anchorage to jobs at Red Dog might also make it easier to move out of the region. Between 1990 and 2000, the net migration rate out of the Northwest Arctic Region was -4.7 percent. This represents a larger number of people leaving the region than in the North Slope Region which had a net migration rate of positive 3.5 percent (though it has declined since 2000, due to declining borough property tax revenues from oil), but is not as high as the net migration rate in the Nome Census Area which was -8.6 percent. The Long Distance Commuting (LDC) program at the Red Dog Mine, providing free transportation between Anchorage and the mine site as well as from NWAB communities, has the potential to make outward migration more likely among Red Dog employees. The program provides additional flexibility to choose a home away from the region, and enables workers to migrate from their home village with fewer financial constraints. Similarly, the increased wage income from mine employment combined with economic factors such as housing availability or the high cost of living in the Northwest Arctic Borough may also make outward migration by Red Dog employees more prevalent. Teck records indicate that, since 1989, 20 Kotzebue residents that worked at the Red Dog Mine have moved out of the region. Twelve Ambler residents migrated out of the community as did nine Noorvik residents. A total of 60 Teck employees have moved out of the region over the life of the mine. (See Section 3.17, Table 3.17-20 for the numbers of migrated employees by community.) But this data does not tell us whether the rate of out-migration for Red Dog employees is any higher or lower than for other types of employees or for the unemployed in the region.

From the point of view of individual wellbeing, the option to stay or move is always better than not having a choice. An analysis of SLiCA data finds no relationship between full time employment and the desire to move, though it does not separate Red Dog Mine employees from other employed individuals who may have different options and incentives to remain in the community (Poppel et al. 2007). This leaves the impacts of the Red Dog Mine on migration patterns within the community inconclusive at this time.

Conversely, another potential impact on the cultural integrity of the region is in-migration due to the mine. One of the key concerns brought up at the 1984 public hearings regarding the development of the Red Dog Mine site was the possibility of an influx of people from outside into communities and villages (Public Hearing Transcripts 1984). These individuals have the potential to bring stronger influences of western culture, which could further alter local culture. With this concern in mind, the mine and its related infrastructure was purposefully located away from any established villages to avoid directly impacting any one community. These interactions, however may still take place at the mine site between local and non-local employees.

The greatest impact was anticipated in Kotzebue as it serves as a gateway to the region, including the Red Dog Mine. While Kotzebue's population has grown each decade between 1980 and 2000, the growth has not been noticeably different than other rural hubs. Kotzebue does have a lower percentage of residents who speak and understand the Iñupiaq language than is average in the region, but there is no reason to believe that this is due to an influx of outside individuals related to the Red Dog Mine rather than the result of being a larger city with more contact with western culture.

1.7 Fate Control

1.7.1 Government and Public Services in the Northwest Arctic Borough

1.7.1.1 Overview

The Northwest Arctic Region is comprised of approximately 39,000 square miles along the Kotzebue Sound, and the Wulik, Noatak, Kobuk, Selawik, Buckland and Kugruk Rivers. It is governed by the Northwest Arctic Borough and is the second-largest borough in Alaska after the North Slope Borough. The region contains eleven communities (Ambler, Buckland, Deering, Kiana, Kivalina, Kobuk, Kotzebue, Noatak, Noorvik, Selawik, and Shungnak; all communities except Noatak are incorporated cities with municipal governments. The population of the region is predominately Iñupiaq Alaskan and the tribal Indian Reorganization Act (IRA) councils play a role in the governance of most communities although Ambler, Kiana and Kobuk are governed by traditional councils. According to the NANA Lands Department, about 76 percent of the land in the region is federally owned and managed as parks, preserves and wildlife refuges. Other major landowners include the State of Alaska, the NANA Regional Corporation, and the Kikiktagruk Iñupiat Corporation. As a major landowner, the NANA regional corporation also plays a key leadership role in the region.

1.7.1.2 Northwest Arctic Borough

The NWAB is a home rule borough, incorporated in 1986. According to the Alaska Constitution, a home rule borough can exercise any power not specifically prohibited by state law or by the borough's charter, which defines its powers and duties and is adopted by voter approval. The Borough is governed by a mayor who is elected to a three-year term and an 11 member Assembly whose members are also each elected to a three-year term. The Assembly holds meetings once a month in Kotzebue. The Borough is responsible for holding yearly elections in October, during which the residents also vote on members the School Board. Planning commission members are appointed by the mayor and confirmed by the assembly.

The Northwest Arctic Borough provides a variety of services to the region including public safety, planning and zoning, the public library in Kotzebue, the regional Department of Motor Vehicles and regional economic development. One of the key functions of the Borough is to support education through the Northwest Arctic Borough School District. The Borough also participates in both the Higher Education Consortium and the Northwest Arctic Leadership Team with the Maniilaq Association, the Northwest Arctic Borough School District and NANA.

1.7.1.3 Northwest Arctic Borough Revenue

The NWAB receives revenue from a variety of sources but TCAK PILT is the primary General Fund revenue source. An average of 68 percent of the NWAB's General Fund revenues came from the TCAK PILT during fiscal years 2002-2007 (Table G-7, Figure G-4). Borough usage fees, which are fees paid by the NWAB School District to rent NWAB buildings in Kotzebue, contributed an average of 22 percent of

General Fund revenues during the same period. When Borough usage fees are excluded, the TCAK PILT constitutes an average of 87 percent of General Fund revenue.

The Northwest Arctic Borough does not levy any taxes on its residents, although some communities within the borough have sales taxes (ADCCED 2008).

Table G-7. Northwest Arctic Borough General Fund Revenues

	2002	2003	2004	2005	2006	2007
Teck PILT	4,200,000	5,500,000	6,403,000	6,228,000	6,328,000	8,721,473
Borough usage fee	1,799,920	1,799,920	1,799,920	1,799,920	2,126,016	2,126,016
Other Local Revenue	126,189	108,115	235,752	261,359	211,953	475,501
State Revenue	145,874	158,084	79,251	-	5,838	633,267
Federal PILT	466,127	489,334	562,212	577,210	590,115	636,441
Total Revenue	6,738,110	8,055,453	9,080,135	8,866,489	9,261,922	12,592,698

Source: Northwest Arctic Borough, Basic Financial Statements and Supplementary Information, FY 2002-2007

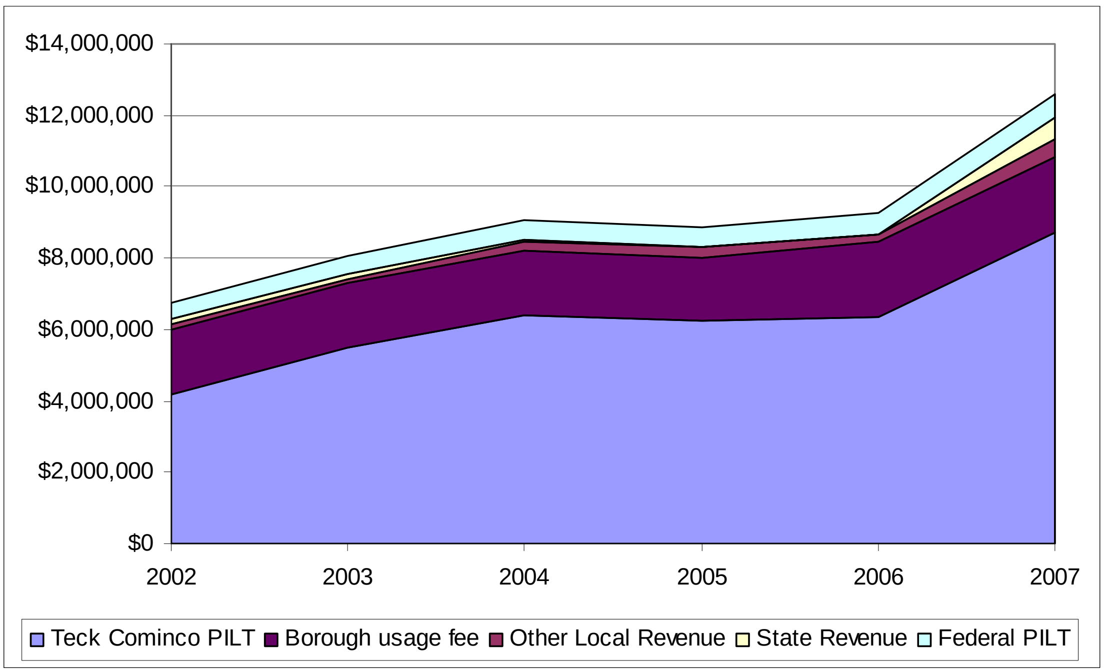


Figure G-4. Northwest Arctic Borough General Fund Revenues

The NWAB has spent an average of $3.4 million per year on education from Fiscal Year 2002-2007 (Table G-8, Figure G-5). Additionally, an annual average of $1.7 million has been transferred to the NWAB School District to pay debt service on capital projects. Over this time period, education expenses have constituted 65 percent of General Fund expenditures. General Fund expenditures on government, public services, planning, and economic development have grown in proportion with total General Fund expenditures during the time period.

Table G-8. Northwest Arctic Borough General Fund Expenditures

	2002	2003	2004	2005	2006	2007
General government	1,677,918	1,851,271	1,919,880	1,950,230	2,220,429	2,240,237
Planning	440,867	180,364	208,607	324,194	423,750	279,915
Public services	196,578	129,493	229,786	279,585	453,207	486,569
Education	3,270,929	3,284,194	3,358,143	3,408,695	3,629,883	3,620,710
Economic development	180,063	177,484	204,663	228,290	199,609	202,607
Other transfers	825,615	2,325,223	941,644	2,109,521	2,019,077	2,146,084
Total expenditures	6,591,970	7,948,029	6,862,723	8,300,515	8,945,955	8,976,122

Source: Northwest Arctic Borough, Basic Financial Statements and Supplementary Information, FY 2002-2007

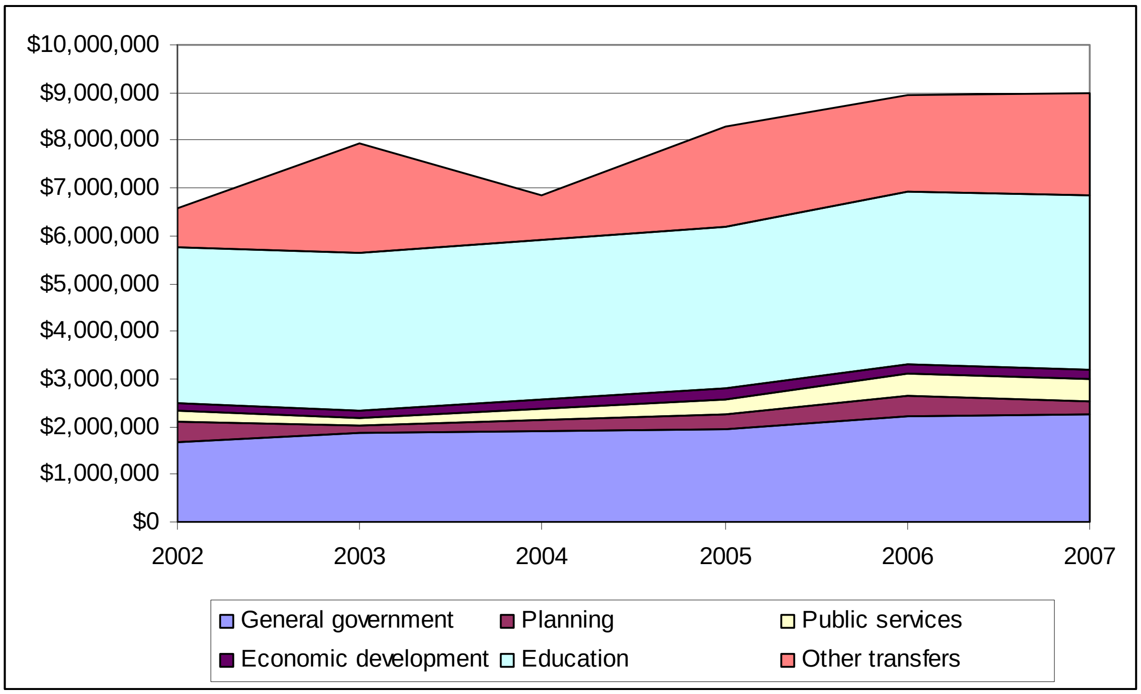


Figure G-5. Northwest Arctic Borough General Fund Expenditures

The Northwest Arctic Borough is working to develop short and long-term plans for the possibility of the closure and loss of revenue of Red Dog Mine. A savings account was established for short term use if mining operations cease. Long-term revenue prospects are much less certain. Increased state and federal revenue would likely be part a longer-term plan; dissolving the borough is another option if local revenues are insufficient to support education funding.

1.7.1.4 Municipal and Tribal Services and Finances

All of the communities in the NWAB are second-class cities, with the exception of Noatak, which is an unincorporated community. Ten of the eleven communities in the Northwest Arctic Borough have both a municipal government and a tribal council (Noatak has only a tribal council). Neither the municipal governments nor tribal councils have direct links to the Red Dog Mine. The division of services provided by each entity is generally clear, with separate funding sources and administrative bodies. Kiana is somewhat unique in that a single individual serves as the executive director of both the municipality and the tribal council, although each governing entity still has distinct revenue sources and the tribal council has a governing board. The NWAB provides services municipal services in consultation with the Noatak tribal council for services not directly provided by the Noatak tribal council.

Eight of the eleven communities have a sales tax, ranging from two percent to six percent. Kotzebue levies two special taxes, a six percent bed tax and a six percent alcohol tax. Services provided by municipalities commonly include water and sewer utilities, landfill operations, and cable television services, in addition to capital improvement projects. State and federal revenue often comes in the form of capital project funding. Table G-9 provides an overview of regional community municipality revenues and expenditures for FY 2005. Additional detail characterizing the communities of Noatak and Kivalina is presented in Appendix D.

Table G-9. Municipal Revenues and Expenditures, Fiscal Year 2005

	Local Revenues	Outside Operating Revenues	Outside Capital Revenues	Total Revenues	Operating Expend.	Capital Expend.	Total Expend.
Ambler	$208,767	$10,940	$28,790	$277,287	$251,444	$42,683	$294,197
Buckland	702,416	0	0	702,416	668,226	707	668,933
Deering	367,613	44,698	100,022	512,333	476,322	0	476,322
Kiana	681,182	6,166	44,792	732,140	657,404	0	657,404
Kivalina	214,808	10,249	0	225,057	290,833	0	290,833
Kobuk	201,052	1,241	25,000	227,293	226,380	0	226,380
Kotzebue	6,386,286	153,487	343,624	6,883,397	6,505,656	512,094	7,017,750
Noorvik	485,751	0	0	485,751	579,930	0	579,930
Selawik	547,801	35,503	23,397	606,701	601,457	3,635	605,092
Shungnak	141,970	35,288	70,135	247,393	220,566	17,744	238,310

Source: Alaska Department of Commerce, Community, and Economic Development, Community Database
Note: Noatak is an unincorporated community and thus has no municipal finances. Water and sewer utilities, as well and landfill operation are handled by the local Village Council.

Seven of the communities (Ambler, Buckland, Deering, Kivalina, Kobuk, Noorvik, and Shungnak) have contractual agreements with the Maniilaq Association to provide services to community residents. Maniilaq receives per-community funding from the Bureau of Indian Affairs based on tribal enrollment in each community. Funding generally ranges from $70,000 to $150,000 per community. These funds are pooled by Maniilaq, and combined with funds from other sources, to pay for and implement community service programs such as food preservation, housing improvements, realty rights protection, subsistence hunting, traditional foods, tribal environmental protection, and the newly reinstated Village Public Safety Officer Program. Additionally, these communities receive monthly payments or a lump sum from Maniilaq under the Aide-to-Tribal Governments program. These payments cover tribal administration salaries and costs.

1.7.2 NANA Native Corporation

While not a government entity, the NANA Regional Corporation plays a significant role in the organization and delivery of public services in the Borough with input into programs such as workforce education, land use and the provision of services in the villages. NANA was established in 1971 under the Alaska Native Claims Settlement Act (ANCSA) as one of 13 Native-owned regional corporations. In addition to settling Native land claims to clear the way for the construction of the TransAlaska pipeline, one of the purposes of ANCSA was to foster economic development in Alaska, particularly in rural areas. Under ANCSA, individual villages also have the opportunity to incorporate village corporations. In the Northwest Arctic, only the city of Kotzebue chose to do so, creating the Kikiktagruk Iñupiat Corporation (KIC). The remaining villages of the region pooled their assets through NANA to simplify land ownership and reduce administrative costs. Through the ANCSA process, NANA received both surface

(2,246,075 acres) and subsurface (161,260 acres) title to lands in northwest Alaska, about 10 percent of the Borough ("This is NANA" 2008). In addition to lands, NANA received $44 million in cash. As one of the largest landholders and top five employers in the region, NANA plays a key leadership, making land use decisions and serving on both the Northwest Arctic Leadership Team and the Higher Education Consortium.

Currently, there are over 11,000 NANA shareholders, 45 percent of whom live outside the borough. NANA is one of three regional corporations that voted to issues new shares to descendents of original shareholders born after 1971 (Thomson 1999). An elected board of directors makes up the governing body of the corporation. The board is responsible for making business decisions and meeting shareholders' needs.

The NANA Regional Corporation serves as the parent company for the NANA Development Corporation, which is the business arm of the organization. Its biggest asset is ownership of the land and mineral rights of the Red Dog Mine, which is leased for operations to Teck. The corporation also has a non-profit arm called the Aqqaluk Trust with a mission to preserve and enhance the Iñupiat culture of the region. The trust provides scholarships for post-secondary education, grants for projects that promote Iñupiat values and culture, and a summer camp program to teach children traditional skills and traditional Iñupiat values.

Over 80 percent of the residents in the region are NANA shareholders. As a result, NANA has a vested interest in many aspects of life for residents in the Northwest Arctic Borough. This includes making land use decisions and providing support for services in many of the villages. For example, NANA recently donated the land for the new Noatak village school construction (NWABSD website). NANA also donated land for the construction of water and sewer systems in several communities. In addition, NANA plays a major role on the Northwest Arctic Leadership Team (NWALT), a collaborative group with representatives from The NWAB, the Northwest Arctic School District, NANA, and the Maniilaq Association. Formed in 2004, the NWALT serves as an advisory team, allowing each organization to share their goals, and for the team to seek common ground and support. These same four organizations are participants in the Higher Education Consortium, formed to help provide a more integrated system of post-secondary and vocational education to meet the needs of regional residents and employers. In efforts to achieve their goal of 100 percent shareholder hire at the Red Dog Mine, the development of education programs is important to helping NANA reach this goal to increase the number of shareholders who are eligible for employment. NANA president Marie Greene currently serves as the Consortium Chair.

1.7.3 Fate Control in the Northwest Arctic Region

The SLiCA data (Poppel et al. 2007) provide a snapshot of current local participation in civic activities and perceptions of local control in the Northwest Arctic Borough. When compared to the North Slope Region and the Bering Strait Region, the Northwest Arctic appears to have low to average participation in civic activities and politics and a moderate perception of control of their local environment and resources, including notably, the development at the Red Dog Mine.

Participation in public elections in the Northwest Arctic Borough varies by election type, but at most levels of government (national, state, city, traditional council) the percentage of voter participation is lower than that of peer regions. The only level at which the NWAB region has comparable rates of voter participation is in the Native regional corporation elections. Here, 63 percent of participants responded that they voted in the last election compared to an average of 61 percent for the three SLiCA Alaska regions. Participation in elections at all levels of government in the ten villages is higher than that of

Kotzebue and is comparable to the Alaska average. Once again, there is an exception with Native regional corporation elections where both Kotzebue and the villages had a voter participation rate of 63 percent[6].

In addition to civic participation, the SLiCA data set also provides insight into how respondents perceived local control in resource management and environmental protections. In these measures, the level of satisfaction felt by respondents from the NWAB is comparable to that of the North Slope Borough. The level of dissatisfaction reached levels as high as 49 percent of respondents when asked if they felt like their values were reflected in resource management actions. The Bering Strait Region showed much higher levels of dissatisfaction. Table G-10 presents the percentage of respondents who were dissatisfied with resource management in each region.

Table G-10. Perceptions of Native Control of Resource Management in Arctic Alaska

	Northwest Arctic	Bering Strait	North Slope	Alaska Average
Percent of respondents who feel that fish and wildlife management did not share their same idea of right and wrong	49	58	49	53
Dissatisfaction with influence indigenous people have on management of natural resources like fish and game	21	37	13	26
Dissatisfaction with influence indigenous people have on management of natural resources like oil & minerals	39	59	35	47
Dissatisfaction with influence indigenous people have to reduce environmental problems	32	43	30	36

Source: The Survey of Living Conditions in the Arctic (Poppel et al. 2007)

Forty-nine percent of survey participants in the NWAB responded that they felt that the managers of fish and wildlife in the region did not share their same idea of right and wrong. Twenty-one percent of respondents in the Northwest Arctic Region reported dissatisfaction with Native influence on the management of resources such as fish and game in the region. However, 39 percent were dissatisfied with the influence that Native people had on the management of natural resources such as oil and minerals and 32 percent were dissatisfied with the influence of Native people in the region to reduce environmental problems. As the Red Dog Mine is the only major developed mine in the region, these values are indicative of local perceptions of Native control of the Red Dog development. It is also interesting to note that levels of dissatisfaction regarding Native influence over environmental problems were higher in the Kotzebue (39 percent) than in the ten villages (29 percent).

1.7.4 Effects of Existing Operations on Fate Control

1.7.4.1 Impact of Red Dog Mine on the Northwest Arctic Borough

The NWAB was incorporated as a first class borough in 1986 and adopted a home rule charter in 1987. One key requirement for borough formation in the State of Alaska is that “the economy must have the human and financial resources capable of providing municipal services (AS 29.05.031(a)(3); 3 AAC 110.180).” In addition, all organized boroughs must operate school districts on an area wide basis and exercise planning and land use regulation throughout the region (Brockhorst, 2000, p. 6). Thus, to be successfully incorporated as a borough, the Northwest Arctic Region needed to show that it was

[6] SLiCA data does not provide direct information on participation in Borough elections because of formatting in the survey questions.

economically capable of contributing the minimum local contribution amount to support the regional school district.

The Red Dog Mine played an important role in making the formation of the Northwest Borough possible, helping the region gain a valuable tool for self-determination and local control. Initially, the Red Dog area was within the jurisdiction of the North Slope Borough, which had organized in 1972. When the Northwest Arctic Borough organized, they petitioned the local boundary commission to move the boundary to include Red Dog in NWAB. This was approved in 1986 and incorporated approximately 5,600 square miles of territory from the North Slope Borough into the Northwest Arctic. Although the Borough was incorporated two years prior to the start of operations at the Red Dog Mine, the anticipated revenue to the borough from the mine, in the form of PILT, was a key factor that allowed the Borough to show it was able to fulfill its financial requirements. The PILT that was negotiated with Teck currently provides the largest source of funding for the borough and plays a substantial role in helping it to remain financially solvent and meet its obligations as a borough. Refer to Table 3.17-30 for details on all of the Borough's sources of revenue.

Over the past 20 years, the expansion of both the Borough staff and services has paralleled the increasing amounts of Teck's PILT. In recent years, the PILT has grown substantially, making Teck the largest single revenue source for the NWAB (Table 3.17-30). Revenue increases allowed the NWAB to expand from nine employees to fifteen, and increase funding for its four major departments: public services, planning, economic development, and education.

Without PILT funds from the Red Dog Mine, the NWAB would be more reliant on state and federal funds. For example, as noted by an NWAB official, the ongoing efforts to relocate Kivalina (due to severe coastal erosion) would be completely dependent on state and federal aid if the NWAB did not have significant revenue from the Red Dog Mine. These funds are not only important logistically, but give the region a sense of self-reliance and self-determination.

An analysis of SLiCA data shows that people working full time jobs for pay were significantly more likely to attend community or political meetings, write letters to the editor or volunteer in the local school. They were also engaged in more civic activities.

1.7.4.2 Local Control of Resource Development through NANA

The partnership between NANA and Teck is a unique relationship among resource development companies and indigenous people. Often, large resource extraction projects can have "severe and adverse social and cultural impacts on indigenous peoples… in some cases these are so severe as to threaten social and cultural survival" (O'Faircheallaigh 1991, p. 243). Several factors that placed the residents of the Northwest Arctic region in a more powerful position were the fact that "the NANA people owned the land and had full title rights to the area, the formal agreement provided for sharing of the financial benefits and details of the education and training commitments, and the recognition of the importance of maintaining the social and cultural values of the subsistence lifestyle in the communities" (Bittman & Horswill 2004, p. 6).

In 1974, NANA filed 14(h) land selections under ANCSA on the Red Dog Mine property. While shareholders at that time were not interested in mining, fearing effects on subsistence hunting and fishing resources, NANA wanted to control the rights to development. The claim was not resolved, however, until a 1980 Bureau of Land Management ruling allowed NANA to secure the title to the Red Dog Mine site. During the litigation period, NANA conducted region-wide discussions on potential mineral development. These included a series of shareholder meetings in local communities seeking approval to pursue mining with the promise of jobs and protection of ancestral lands. By the 1978 annual shareholder meeting, shareholders views changed and a majority voted to allow mining in their region. The public hearings for the Environmental Impact Statement on the Red Dog Mine in 1984 demonstrate that subsistence effects were a primary concern of many of the people in the region (Public Hearing Transcripts for Environmental Impact Statement, Red Dog Mine Project in Northwest Alaska – May 2,1984, p. 14). However, the elders of the region highlighted the need for development to create jobs and draw regional investment (NANA & Mining, accessed 2008). The history of the development of the Red Dog Mine is significant because resource development could not go forward without approval from NANA shareholders, giving the Native people of the region an uncommon and substantial degree of control.

As previously discussed, SLiCA data indicate that residents of the region are only somewhat satisfied with Native influence on the development of oil and mineral resources, with 39 percent expressing dissatisfaction. The degree of local control and involvement can also be seen in the fact that while voting in elections is relatively low compared to peer regions in Alaska, voting in the Native regional corporation elections is comparable to the average for arctic communities in Alaska.

However, the degree to which residents feel that they have control of mineral resources in their region is not uniform throughout the region. The 2007 public scoping hearings for the Supplemental Environmental Impact Statement for the Aqqaluk expansion to the Red Dog Mine provide perspective on current feelings regarding the Red Dog Mine. Several comments reflected the fact that the mine is an “important economic asset to the Northwest Region” and is responsible for “providing jobs and income that support many families” (Red Dog Mine Extension Scoping Transcript, 2007, p. 33, 22). The views expressed in the comments and questions made by multiple members of the communities of Kivalina and Noatak, however, demonstrate that there are some feelings of powerlessness and frustration regarding the development at the Red Dog Mine. This is notable as Kivalina and Noatak are the two communities in closest proximity to the mine. A more in depth discussion of the history of these communities and their relationship with the Red Dog Mine can be found in Appendix D. Comments from the SEIS scoping process suggest that while control of resource development is strong on a regional level through NANA, the feelings of control do not necessarily reach the level of the local villages.

Several key advisory committees help address challenges, oversee effects of the mining operations, and carry out terms of the 1982 NANA/ [Teck] agreement. The Red Dog Management Committee, comprised of senior NANA and Teck representatives, meets quarterly to oversee general operations performance and review future plans. The 12-member committee plays a major role in management with authority to stop any mine operations having an adverse effect on the environment or subsistence resources.

The Subsistence Committee, also formed by the 1982 NANA/Teck agreement, was established to oversee subsistence matters and make certain that activities that occur at the mine do not harm or interfere with subsistence and environmental resources that sustain the Iñupiaq way of life. The Committee is comprised of eight Elders and hunters from Noatak and Kivalina, and advises the Management Committee on major issues such as the timing of road closures for caribou migration, environmental permit renewals to minimize effects on caribou migration or fish and waterfowl habitat, and communicating emerging issues of concern. The Committee also played a role in determining the location of the DeLong Mountain Transportation System (DMTS) road to lessen impacts on animal migration (Alaska Department of Environmental Conservation 2002 p. 46). The NANA/Teck agreement stipulates that the Subsistence Committee meet a minimum of four times a year to discuss mine operations (Alaska Department of Environmental Conservation 2002, p. 46).

The Subsistence Committee provides an important structure to provide direct local input into mine management decisions. Public record of a meeting between the Subsistence Committee, Teck representatives and the Alaska Department of Environmental Conservation during the preparation of the DMTS Fugitive Dust Risk Assessment in 2005 gives insight into a forum where committee members were able to give comments and ask questions directly to Teck representatives (Subsistence Committee

(2005)). It is unclear, however, how well this structure functions to affect mine operations and provide the locals residents of Kivalina and Noatak with a sense of local control over resource development on nearby land. Based on the continued levels of frustration and feelings of powerlessness expressed at the SEIS Scoping hearings in these communities, there appears to be a need for the effectiveness of this program to be carefully examined and improved upon to give local residents better access to information regarding the mine and a forum to discuss environmental management issues.

1.7.4.3 Recognition of Local Knowledge

Finally, the recognition and incorporation of local knowledge is a key aspect of maintaining a sense of fate control and self-determination for the people in the region. Despite being one of the world's most significant zinc deposits, the actual footprint of Red Dog Mine is comparatively small, with the ore body occupying only one half square mile of land (NANA and Teck Cominco Ltd. n.d. p. 3). Beyond the landscape changes brought about by the process of ore extraction, mining can also affect subsistence activities through pollution of waterways and habitat, dispersal of game or disruption of breeding patterns (O'Faircheallaigh 1991). Iñupiaq people living in the Northwest Arctic Borough have occupied the region for over 10,000 years, observing patterns in and living off of the resources of the land and ocean around them. Changes in the patterns and quality of subsistence resources have been noted by the Native people of the region, observations that, while not in the context of modern scientific methods, are based in a long tradition of usage.

More recently, environmental impacts have been reported by the NWAB communities, most notably Kivalina (Kivalina, 2001). These include lead, zinc and cadmium dust pollution along the haul road, spills of diesel fuel and metals concentrates, and the presence of elevated levels of total dissolved solids in the Red Dog Mine discharge. Beluga whale migration patterns have shifted and some residents have attributed this to Red Dog's shallow water barge dock. Kivalina residents also attest that caribou migration patterns have been disrupted due to mine activity and pollution (Kizzia 2005, p. B1). Foxes without tails were also seen around the mine (Subsistence Committee 2005, p. 1). Observations of changes in water quality and fish health in the Wulik River prompted six Kivalina residents to sue Teck over violations of the mine's National Pollutant Discharge Elimination System wastewater discharge permit. One Kivalina resident stated that the lawsuit was the only way to make Teck listen to their concerns.

The current SEIS procedure examining the proposed Aqqaluk expansion at the Red Dog Mine has been a valuable process in gathering local observations and knowledge regarding environmental impacts of the Red Dog Mine. Residents have had opportunity through scoping meetings and comment periods to share their perspectives regarding potential changes in the land, water, and resources that are integral to their everyday lives. Even as many of these factors are being evaluated by scientists and engineers, sensitivity and respect for traditional knowledge in this process is an important aspect of supporting local control of resource development in the region.

1.8 Environmental Effects of Proposed Action and Alternatives

1.8.1 Effects of Alternative A – No Action Alternative

The Red Dog mine has had [positive] effects on education, local governance and regional income, and negligible or uncertain effects on health, ties to nature, and cultural continuity. Social scientists have repeatedly found that in the mixed economy, local jobs and income are compliments to participation in subsistence, not substitutes. There is no evidence that employment accelerates the loss of Iñupiaq language. And concern about potential negative cultural effects galvanized a proactive collective response, the Iñupiat Ilitqusiat movement, to strengthen Iñupiat cultural values and identity.

As discussed above, discontinuing mining operations in 2012 would mean simultaneous losses of employment for residents, PILT to the NWAB, royalties to NANA and dividends to NANA shareholders. The cumulative shock to household budgets, local businesses and public services would likely constitute an economic recession in the region and strain family and community systems, as well as social service agency workloads. The loss of PILT to the borough would decrease the resources for and efficacy of local government and erode the sense of fate-control. If the borough was unable to raise enough revenue from other sources to pay its local share for schools, it could be forced to un-incorporate.

1.8.1.1 Effects on Kivalina and Noatak

The social effects on Kivalina and Noatak are directly parallel to the regional effects discussed above; more pronounced effects related to loss of employment would be expected as these communities rely more on Red Dog Mine for local employment and income. Although the mine has been a source of disharmony within the community of Kivalina, it is not likely that termination of mining operations would resolve these conflicts; more likely, new conflicts related to mine reclamation and adjusting to the decline in the village economy would take the place of current controversies over environmental issues.

1.8.2 Effects of Alternative B – Applicant's Proposed Action

Alternative B would extend mine operations to 2031. Not only would the current level of mine benefits continue, but with increasing royalties to NANA local income from dividends may increase substantially (see SEIS Section 3.17). While on the whole increases in income would be beneficial, sudden large increases in income can also be socially disruptive and create transitional problems for financial management, planning and investment, not to mention attendant social problems such as increases in alcohol consumption, property crime and violence, and environmental problems from new consumption, such as many more trucks on village roads or rising demand for solid waste disposal. Potential effects on migration and work patterns are uncertain. The end of mining operations in 2031 would bring about the second half of the boom/bust cycle similar described under Alternative A. In this case, the bust would occur falling from a higher peak; however, there would be ample time for NWAB, NANA, and individuals to plan for the inevitable end of operations and prepare both fiscally, psychologically, and emotionally.

1.8.2.1 Effects on Kivalina and Noatak

The social effects on Kivalina and Noatak are directly parallel to the regional effects discussed above, with more pronounced effects related to employment as these communities rely more on Red Dog Mine for employment and income.

1.8.3 Effects of Alternative C – Concentrate Pipeline

Alternative C is similar to Alternative B, with somewhat higher capital costs and lower levels of employment, resulting in slightly more moderate effects on regional income. The social effects are substantially the same.

1.8.3.1 Effects on Kivalina and Noatak

Alternative C is similar to Alternative B, with somewhat lower employment.

1.8.4 Effects of Alternative D – Enhanced Dust Control

Alternative D is similar to Alternative B, with somewhat higher capital costs and slightly smaller effects on regional income. The social effects are substantially the same.

1.8.4.1 Effects on Kivalina and Noatak

The social effects are directly parallel to the regional effects discussed above, and substantially the same as in alternatives B and C with minor variations in employment levels.

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