Technical Paper No. 416

Integrating Local Traditional Knowledge and Subsistence Use Patterns with Aerial Surveys to Improve Scientific and Local Understanding of the Iliamna Lake Seals

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Weights and measures (metric)	
centimeter	cm
deciliter	dL
gram	g
hectare	ha
kilogram	kg
kilometer	km
liter	L
meter	m
milliliter	mL
millimeter	mm

Weights and measures (English)	
cubic feet per second	ft^3/s
foot	ft
gallon	gal
inch	in
mile	mi
nautical mile	nmi
ounce	oz
pound	lb
quart	qt
yard	yd

Time and temperature	
day	d
degrees Celsius	°C
degrees Fahrenheit	°F
degrees kelvin	K
hour	h
minute	min
second	s

Physics and chemistry	
all atomic symbols	
alternating current	AC
ampere	A
calorie	cal
direct current	DC
hertz	Hz
horsepower	hp
hydrogen ion activity (negative log of)	pH
parts per million	ppm
parts per thousand	ppt, ‰
volts	V
watts	W

General	
Alaska Administrative Code	AAC
all commonly accepted abbreviations	e.g., Mr., Mrs., AM, PM, etc.
all commonly accepted professional titles	e.g., Dr., Ph.D., R.N., etc.
at	@
compass directions:	
east	E
north	N
south	S
west	W
copyright	©
corporate suffixes:	
Company	Co.
Corporation	Corp.
Incorporated	Inc.
Limited	Ltd.
District of Columbia	D.C.
et alii (and others)	et al.
et cetera (and so forth)	etc.
exempli gratia (for example)	e.g.
Federal Information Code	FIC
id est (that is)	i.e.
latitude or longitude	lat. or long.
monetary symbols (U.S.)	$, ¢
months (tables and figures): first three letters	Jan,...,Dec
registered trademark	®
trademark	™
United States (adjective)	U.S.
United States of America (noun)	USA
U.S.C.	United States Code
U.S. state	use two-letter abbreviations (e.g., AK, WA)

Measures (fisheries)	
fork length	FL
mideye-to-fork	MEF
mideye-to-tail-fork	METF
standard length	SL
total length	TL

Mathematics, statistics	
all standard mathematical signs, symbols and abbreviations	
alternate hypothesis	H_A
base of natural logarithm	e
catch per unit effort	CPUE
coefficient of variation	CV
common test statistics	(F, t, χ^2, etc.)
confidence interval	CI
correlation coefficient (multiple)	R
correlation coefficient (simple)	r
covariance	cov
degree (angular)	°
degrees of freedom	df
expected value	E
greater than	>
greater than or equal to	?
harvest per unit effort	HPUE
less than	<
less than or equal to	?
logarithm (natural)	ln
logarithm (base 10)	log
logarithm (specify base)	$\log_2$, etc.
minute (angular)	'
not significant	NS
null hypothesis	H_O
percent	%
probability	P
probability of a type I error (rejection of the null hypothesis when true)	α
probability of a type II error (acceptance of the null hypothesis when false)	β
second (angular)	"
standard deviation	SD
standard error	SE
variance	
population	Var
sample	var

TECHNICAL PAPER NO. 416

INTEGRATING LOCAL TRADITIONAL KNOWLEDGE AND SUBSISTENCE USE PATTERNS WITH AERIAL SURVEYS TO IMPROVE SCIENTIFIC AND LOCAL UNDERSTANDING OF THE ILIAMNA LAKE SEALS

by

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Technical Paper series reports are available through the Alaska Resources Library and Information Services (ARLIS), the Alaska State Library and on the Internet: http://www.adfg.alaska.gov/sf/publications/. This publication has undergone editorial and professional review.

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FOREWORD

The North Pacific Research Board (NPRB) provided funding for project # 1116 and received a project final report in October 2013: *Integrating Local Traditional Knowledge and Subsistence Use Patterns with Aerial Surveys to Improve Scientific and Local Understanding of the Iliamna Lake Seals*.[1] Research and report preparation were cooperatively executed by the Alaska Department of Fish and Game (ADF&G) Division of Subsistence, National Marine Mammal Laboratory (NMML), University of Alaska Anchorage (UAA), and Bristol Bay Native Association (BBNA). Subsequent to that final report submission, ADF&G conducted a standard technical and editorial review of the report to publish in the Division of Subsistence Technical Paper series; this publication increases distribution of and access to the NPRB-funded project's research findings. Technical Paper series reports are available through the Alaska Resources Library and Information Services (ARLIS), the Alaska State Library, and on the internet: http://www.adfg.alaska.gov/sf/publications/.

This report was revised for publication in the Division of Subsistence Technical Paper series. Revisions include changes to follow ADF&G writing style guidelines used in Technical Paper series publications (e.g., use of acronyms and abbreviations, expressing weight in pounds [lb] versus kilograms [kg], specific word choice usage, etc.). Additionally, all graphics (tables, figures, and plates) were reassigned a reference that identifies the chapter number in which the graphic appears and its sequential placement within that chapter (i.e., Figure 5-5 appears in chapter 5 and is the fifth figure within that chapter). References cited were reviewed as well and updated to appear in the list of references cited or as footnotes per the style used in Technical Paper series publications.

Specific relatively minor content changes were also made throughout the report; most changes involved updating tables or figures (including maps) and associated captions. Generally, changes related to:

- Removing clarifying information from captions and including information on the table or figure as a footnote, or adding other relevant clarifying information about data in a footnote;
- Updating graphic captions to clarify description of graphic data;
- Updating wording in header columns and rows;
- Adding columns or rows to reflect sampled and/or estimated results and number of valid responses;
- Adjusting cell spacing to improve visibility of text in a table; and
- Combining results from 2 study years into a single graphic, or separating results from 2 study years into multiple graphics.

The maps presented in this Technical Paper series publication have each been assigned a single figure designation and caption whereas many maps were scaled down and combined into a single graphic in the October 2013 final project report. Many maps have been slightly updated—typically to correct place name spelling or add place name labels.

Some graphics in the project # 1116 final report were replaced with an updated version, and others were deleted from this report. Associated narrative was updated accordingly, and significant changes are marked in the left margin with a paragraph symbol (¶). Listed below are important specific graphic replacements and deletions:

- Figure 2 (Figure 2-2): replaced with a figure published originally in an ADF&G Division of Commerical Fisheries report (see source in the chapter) and associated caption.

1. Burns, J. M., J. M. Van Lanen, D. Withrow, D. Holen, T. Askoak, H. Aderman, G. O'Corey-Crowe, G. Zimpelman, and B. Jones. 2013. "*Integrating Local Traditional Knowledge and Subsistence Use Patterns with Aerial Surveys to Improve Scientific and Local Understanding of the Iliamna Lake Seals.*" Report to the North Pacific Research Board, Project 1116 Final Report: n.p. http://s3.nprb.org/projects/a42b7368-eca2-4819-b249-6eb4209de5bc/1116_fianl%20report_May14.pdf

- Table 2 (Table 4-1): replaced with version that updated survey dates and added source information.
- Table 6 (Table 5-2): replaced with version that reformatted data presentation and added footnote clarification.
- Figure 13 (Figure 5-8): replaced with version that updated peak August count data.
- Figure 15 (Figure 5-10): replaced with version that updated historical aerial survey count data.
- Figure 19 (Figure 5-15): replaced with version that updated seal pup count data and corrected calculation of proportion of seal pups counted out of total seal count.
- Figure 24 (Figure 5-19): updated map legend.
- Table 13 (Table 5-9): replaced with version that included use pattern data that appeared formerly in Figure 36.
- Table 14 (Table 5-10): replaced with version that included use pattern data that appeared formerly in Figure 36.
- Figure 36: deleted; use pattern data added to revised tables (5-9 and 5-10).
- Figure 25 (Figure 5-33 and Figure 5-34): single figure replaced with 2 separate figures that presented harvest data in new formats.
- Table 15 (Table 5-11, Table 5-12, and Table 5-13): single table replaced with 3 separate tables that presented use pattern in new formats.
- Tables 16–22 (tables 5-14 through 5-20): replaced with expanded version that presented use pattern and harvest data for all marine mammal species.
- Table 24 (tables 5-22 through 5-25): single table replaced with 4 separate tables that presented reasons for less or more use of marine mammal resources in 2010 and 2011 in new formats.
- Figure 38 (Table 5-26): figure removed and replaced with table that presented historical estimated and reported harvests of freshwater harbor seals.

Other changes to narrative that are not directly related to the cited graphics changes will also be marked in the left margin by a paragraph symbol (¶). Also, the report content and overall organization were assessed and Chapter 8 ("Publications and Presentations") from the October 2013 project final report was removed.

The ADF&G technical and editorial review was organzied by ADF&G Subsistence Resource Specialist James M. Van Lanen, who participated in revison activities and whose efforts arranged follow-up communication with partners from NMML, UAA, and BBNA. Cartography assistance by ADF&G Subsistence Resource Specialist Bronwyn Jones provided updated maps for this Technical Paper series publication. Information Management assistance to review data was provided by ADF&G Research Analyst Marylynne Kostick. The review and revision process was led by ADF&G Publications Technician Mary Lamb. The division's Subsistence Program Manager, James A. Fall, also contributed review feedback and recommendations.

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ABSTRACT

This project was designed to gather and synthesize information about the ecology of the seals within Iliamna Lake through a combination of aerial surveys, biological sampling, and ethnographic research. Findings from all research modalities were integrated into project findings. We found broad agreement about seal ecology across methodological approaches, with the combined findings stronger than those provided by any single source. For example, while there was close agreement on the abundance of seals in the lake during midsummer from aerial surveys and interviews, the ethnographic interviews provided more nuanced insight into the seasonal movements and behaviors of the seals than would have been possible to discern from aerial surveys alone. Indeed, reports that seals utilize subnivian spaces as haul outs during the time when the lake is covered by ice might account for the very low abundance of seals observed during wintertime aerial surveys. Likewise, insight into the stock of origin and population discreetness provided by genetic analysis illuminates the local understanding of population isolation, which differed among lake communities. Similarly, analysis of tissue samples confirmed local reports of seasonal shifts in the seal population's diet and the importance of salmon to the seal population's diet. The cultural importance of seals to the residents of the lake communities was evident in both subsistence surveys and interviews that detailed hunting techniques and traditional practices to manage harvest activities and ensure the continued health of the population. During outreach visits to participating communities, residents expressed concern about future management of the seal population in the lake, and advocated for additional research.

Key words: Harbor seal, *Phoca Vitulina*, Iliamna Lake, local and traditional knowledge, aerial surveys, biosampling, population structure, subsistence household surveys, ethnographic interviews

1. STUDY CHRONOLOGY

This report presents the research results of a North Pacific Research Board (NPRB)-funded project entitled *Integrating local traditional knowledge and subsistence use patterns with aerial surveys to improve scientific and local understanding of the Iliamna Lake seals* (NPRB Project # 1116). Partners in this project include the Alaska Department of Fish and Game (ADF&G) Division of Subsistence, the National Marine Mammal Laboratory (NMML), the University of Alaska Anchorage (UAA), and Bristol Bay Native Association (BBNA). Project # 1116 was conducted over the period from July 1, 2011–June 30, 2013, and was a follow-on study to NPRB Project # 916, which was conducted over the period July 1, 2009–June 30, 2011. Under NPRB Project # 916, UAA researchers successfully worked with the tribal councils of the Iliamna Lake communities of Iliamna, Kokhanok, and Newhalen to conduct marine mammal harvest surveys and research on local traditional knowledge (LTK) of Iliamna Lake seals. During the course of that research for Project # 916, researchers recognized the need for a more formal and structured gathering of LTK about the seals in the lake. To achieve these goals, Project # 1116 included a much expanded and formalized partnership with the Division of Subsistence at ADF&G designed to facilitate the gathering and analysis of LTK and subsistence household surveys. In addition, because survey data and interviews conducted during Project # 916 suggested there might have been some migration or interchange between seals in Iliamna Lake and Bristol Bay via the Kvichak River, a major goal of this research under Project # 1116 has been to determine if the seals inhabiting Iliamna Lake represent a small local population or an outgrowth of the larger Bristol Bay population. To achieve this goal, community partnerships were expanded to include the communities of Igiugig, Levelock, and Pedro Bay (along with longer-term participating communities of Iliamna, Newhalen, and Kokhanok). Igiugig and Levelock are located on the Kvichak River, the only body of water that drains Iliamna Lake into Bristol Bay. As such, seal observations originating from Igiugig and Levelock provide insights into use of the Kvichak River by seals. The Pedro Bay area in the northeastern portion of Iliamna Lake was especially identified as a possible pupping habitat and as important to seals that may be overwintering.

Similarly, aerial survey work conducted under Project # 916 has documented lower seal abundance outside the pupping and molt periods, as well as the first reports of pupping within the lake. Project # 1116 provided additional aerial surveys to better characterize seasonal patterns of abundance, with an increased focus on the pupping period. In addition, the partnership with the Newhalen Tribal Council (NTC) was expanded to include their tribal biologist, Ms. Tatiana Askoak, and an analysis of aerial photographs of seals hauled out collected under a U.S. Fish and Wildlife Service Tribal Wildlife Grant to NTC. These aerial abundance counts were further supplemented with data from Pebble, LTC. Furthermore, in an attempt to identify the species and genetic stock of origin, and to provide information on animal health and condition, the voluntary collection of tissue samples from seals harvested in Iliamna Lake was an important component of this project. The biosampling program was envisioned and developed under Project # 916, but most samples were obtained and analyzed under Project # 1116. This final report synthesizes and integrates data from all previous project reports for both projects # 916 and # 1116.

2. INTRODUCTION

2.1. Project Origins

For generations, the indigenous people who settled the shores of Iliamna Lake and its surrounding tributaries have traditionally harvested freshwater seals from Alaska's largest lake. There are 6 communities found along the shores of Iliamna Lake: Pedro Bay, Kokhanok, Iliamna, Newhalen, and Igiugig (Figure 2-1), and all were participants in this research project. In addition, members of the community of Levelock, located on the Kvichak River between Iliamna Lake and Bristol Bay, also participated in this project (Figure 2-1; Appendix A). Community members of the small community of Pope and Vannoy Landing on Iliamna Lake's southeast shore (hereafter referred to as Pope-Vannoy) also participated in the project. Aside from Pope-Vannoy, these communities each represent a federally recognized tribe that is served by the Bristol Bay Native Association (BBNA), the regional non-profit tribal consortium. The BBNA Natural Resources Department (BBNA NRD) provides support to its member tribes in the areas of subsistence harvest surveys and harvest regulations, tribal environmental programs, subsistence fisheries, marine mammals and migratory bird research and co-management, as well as education and outreach activities to enhance local involvement in natural resource management, including providing technical assistance in understanding resource exploration and potential development implications in the Bristol Bay region.

Over the years, the tribes of the Iliamna Lake region have expressed concern about the lack of available data on the status of the lake's seal population. These concerns are being magnified as mineral exploration and potential development pressures increase within the region. Tribal members have long discussed the need for a program that merges local traditional knowledge (LTK) with Western research protocols to establish a scientific baseline on the seals' population dynamics, and ensure sustainability for traditional harvests and customary uses by Iliamna Lake region residents. Therefore, at the tribes' behest, this project was designed and carried out as a collaborative effort among BBNA, residents of local tribal communities of Newhalen, Kokhanok, and Iliamna, and biologists from UAA and the National Oceanic and Atmospheric Administration (NOAA), researchers from the Alaska Native Harbor Seal Commission (ANHSC), and anthropologists from ADF&G. This project addressed 4 research priorities outlined in the North Pacific Research Board (NPRB) 2011 request for proposals: (2.a) Local and Traditional Knowledge; (2.b) Community Involvement; (1.d.iii) Community adaptability to ecosystem change, market impacts and management regime changes; and (1.c.i) Small or declining marine mammal populations.

2.2. Biological Background

There are 5 lakes in the northern hemisphere where freshwater seal populations can regularly be found: Lake Baikal (~85,000 seals) and Lake Lagoda (~3,000 seals) in Russia; Lake Saimaa (~270 seals) in Finland; Lac de Loups in Quebec, Canada (~120–600 seals); and Iliamna Lake (population uncertain) in Alaska (Everitt and Braham 1980; Rice 1998; Smith et al. 1994, 1996). The seals of Baikal, Lagoda, and Saimaa lakes are all closely related to ringed seals *Pusa hispisa*, while the Lac de Loups seals are recognized as a subspecies of harbor seals *Phoca vitulina* (Smith et al. 1994). At the start of this research project (i.e., the start of Project # 916), it was unclear whether Iliamna Lake seals are harbor seals, spotted seals *Phoca largha*, or a hybrid of both. Similarly, there was limited information on population abundance. ADF&G and the National Marine Fisheries Service (NMFS) had conducted aerial surveys periodically to provide estimates on seal abundance in the Bristol Bay region; however, over the past 2 decades prior to this work commencing, there were only 5 sets of aerial surveys (1 set in 1991, 1 in 1998/1999, 1 in 2003, 1 in 2005, and 1 in 2008 had been conducted, all during the late summer; see section "5.2.vi Abundance of the Seal Population Within Iliamna Lake" in Chapter 5). The 1999 ADF&G survey documented 225 seals in the lake (Small 2001); 235 animals were photographed on haul outs during a survey in the 2008 set flown by NMFS (Withrow and Yano 2010). Since these values do not include the number of animals that are not hauled out

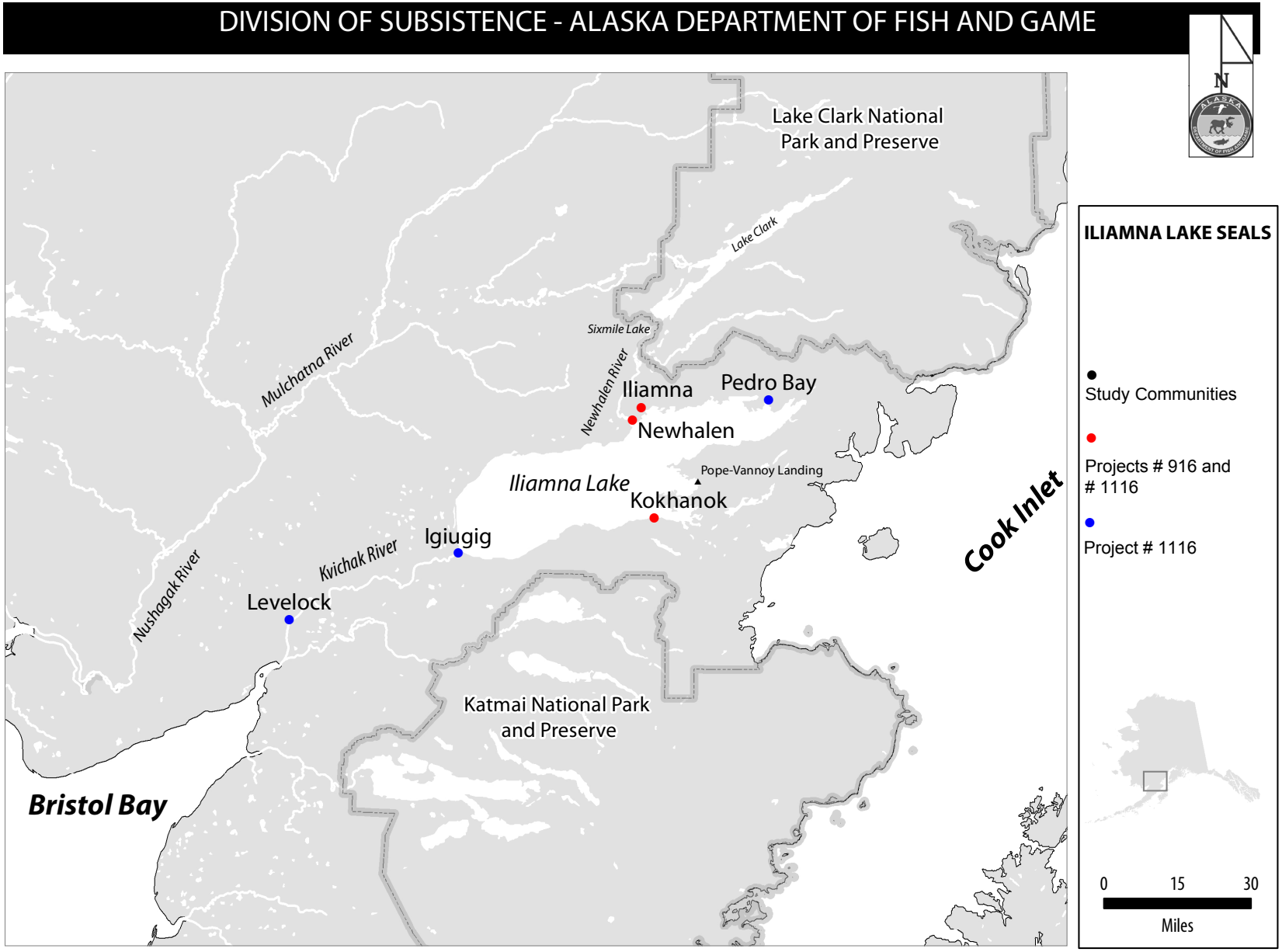


Figure 2-1.–Map of study communities around Iliamna Lake, Alaska.

at the time of the survey, there are likely far more seals in the lake during the late summer molt period. Surveys had also been conducted by contractors working for The Pebble Limited Partnership (PLP, Inc.); those data were not publically available at the start of this research, but have since become available and are included in our reporting of population abundance in Chapter 5.

Prior to the initiation of this research program, little was known about habitat use by Iliamna Lake seals. Residents of Iliamna Lake communities indicated that the seals live in the upper east end of the lake, and this is where they were primarily located during aerial surveys. However, while some local residents reported that the seals do enter Bristol Bay via the Kvichak River, there was no definitive information about whether the entire lake population was resident year-round or whether reproduction occurred in the lake. This type of information, in combination with genetic studies, is essential in order to determine whether the population is closed (i.e., self-sustaining with no movement of animals between Iliamna Lake and the larger Bristol Bay populations of spotted and harbor seals) or occasionally connected to nearby seal populations in Bristol Bay through migration down the Kvichak River.

Understanding the source population and degree of isolation of the Iliamna Lake stock is critical for designing appropriate measures to assure the future of the Iliamna Lake seal population. Harbor seal populations in Bristol Bay are declining slightly (Allen and Angliss 2011), and stock structure in Alaska is currently undergoing a revision that may subdivide the current 3 management stocks into as many as 12 (with no information from Iliamna Lake) (Allen and Angliss 2011; O'Corry-Crowe et al. 2003). Seals are a subsistence resource for several communities on the lake (Fall et al. 2006; Krieg et al. 2009) and the effect of this use on seal populations is determined, in part, by the overall population size. These issues have become even more important with the recent petition to list the seal population in Iliamna Lake as a distinct population segment (DPS) under the federal Endangered Species Act (Center for Biological Diversity 2012). Such a listing is of concern to local communities around the lake, as well as to public and private industry in the region. While the research described in this report was not specifically designed to address questions relative to the petition, this information will likely inform NOAA's decision-making process.

As a traditional subsistence resource for local communities, the seals that inhabit Iliamna Lake are widely shared and consumed (Fall et al. 2006; Krieg et al. 2009). In light of their importance to local communities, it is not surprising that lake residents are concerned about the absence of systematically collected information about the seals in the lake. To gain such information, project researchers collaborated with local residents to gather tissue samples for analysis that might provide information on animal population stock, health, condition, and diet, all of which are critical to understanding how the local seal population might be influenced by changes in the lake ecosystem. Concern regarding the health of the lake ecosystem and its component members stems from global climate change issues as well as increases in human activities in the area associated with mineral exploration and development, including the proposed Pebble Mine (Holen 2009). The information gained from this study is designed to establish a thorough basis as a starting point in understanding this unique population.

Explicitly, the hypotheses that informed this work were:

1. That members of the local communities on Iliamna Lake have important information about the behavior and ecology of the seals within the lake that is not currently known to Western scientists, and that integrating such information with Western scientific techniques will lead to an improved understanding of the seals within Iliamna Lake.

2. That understanding the cultural and traditional practices surrounding the harvest and use of seals in the Iliamna Lake region is critical for maintaining subsistence opportunity as well as for designing appropriate management and co-management plans.

3. That the population of freshwater seals in Iliamna Lake is potentially a uniquely isolated subspecies that is separate from the marine harbor seal population in Bristol Bay.

In this report, the results of the ethnographic and biological research methods are integrated into an interdisciplinary framework that attempts to describe the role of seals within the Iliamna Lake social-ecological system. Since understanding the ethnography and cultural traditions of the participating communities is a critical component of this work, this introduction concludes with a detailed geographic and ethno-historical overview of the Iliamna Lake watershed and the project study communities. Contemporary demographic information on the study communities is also provided so that the reader can better understand the importance of the seals as a resource to local users.

2.3. Ethno-Historical Overview of the Iliamna Lake Watershed

Iliamna Lake is a territory shared between cultures. Kokhanok residents relate that the boundary traditionally was a line formed from Łiq›a Qilantnu, Dena'ina for "fish-are-there creek," or Tommy Creek, which is located just north of Kokhanok on the southern shore of Iliamna Lake, to *Nughil Vetnu*, "flows downstream," or the Newhalen River, which is straight north across the lake from Tommy Creek. The Central Yup'ik territory was from this boundary west and the Dena'ina Athabascan territory lay to the east. A Yup'ik resident of Newhalen related how once she traveled into Dena'ina territory to hunt for beavers. After locating a beaver she shot at it, and the beaver became a log and floated away. The log was still moving though, just like a beaver would, and this experience was enough to keep her from going over in the Dena'ina territory to fish or hunt anymore (Holen et al. 2005).

Iliamna Lake is 60 miles long by 20 miles wide and is the largest lake in Alaska. Surrounding the lake are snowcapped peaks encased in glacial ice flowing down into valleys of low-lying brush and trees. The boreal forest environment, which is dominated by spruce and deciduous trees in the east part of the area, meets the flat lowland tundra that dominates much of Southwestern Alaska to the west. Glacial ice melts and flows through carved granite valleys and through 2 main lakes: Lake Clark, which then flows into the Newhalen River, and Iliamna Lake, and then finally down the Kvichak River, which flows to Bristol Bay (see Figure 2-1). This hydrologic cycle is described in the narrative Łi Ta'a, the Dena'ina story of glacier water as told by Antone Evan during an interview with Priscilla Russel in 1980.

> *Qizhjeh Vena Qizhjeh Vena veq'atl'a ghini tustes ghu łi yan nlan ha t'ent'a Dzeł Ken teh.*
>
> Up at the head of Lake Clark, up in that valley, there are passes in the Alaska Range where there are glaciers.
>
> *Yi ghini idghalzex ch'u k'etnu gguya q'andazdlen ha t'ix łi ta'a nlan ha.*
>
> When the glaciers start melting, all the water flows into the river.
>
> *Ghuh q'andazdlen ch'u Chuqutenghehtnu dahkadilax ha*
>
> And it flows down then it flows into 'by the cache trail river'
>
> *Yehdi ven edilax [Qizhjej Vena Q'atl'a]*
>
> then it forms the lake (Little Lake Clark).
>
> Łi T*a'a ghini*
>
> that glacier water.
>
> *Yi edilax ch'uq'u Qizhjeh Vena ku'u edilax.*
>
> It forms 'people gathered lake' [Lake Clark]
>
> *Yi edilax ch'u Nundaltin Vena kiq'u edilax.*
>
> And then it forms 'extends across lake' [which is known as Six-mile Lake]
>
> *Nughil Vetnu t'ech' ku'u hkadilax.*
>
> And then downstream it flows also to 'current descends river' [Newhalen River]
>
> *Nila Vena ku'u edilax,*

and then that forms ‘islands lake’ [Lake Iliamna]

Ch’u Nilan Vena Q’estsiq’ nishdelax ha q’uyehdi nuti at nik’udelax

And then it flows down to ‘islands outlet stream’ [Kvichak River] and it goes out into the ocean.

Yi ɬi ta’a ghin nuti gheli edilax.

That glacier water [from the head of Lake Clark] travels all the way into the salt water.

Ɬi ta’a ghini minɬni ghini qut’ana nughedeɬ qich’a shughu nidelax da.

That glacial water travels farther than human beings, that water goes farther than people can travel.

Ts’itsatna ghuna dach’ qeyeɬ dghinih.

This is what the ancestors used to say. (Evanoff 2010:36)

Iliamna Lake was originally settled by people of the Ocean Bay Tradition dating from 7,600 to 4,000 years ago. There are 2 major village sites located on Iliamna Lake on the eastern end of the lake: Pedro Bay and Old Iliamna, which are located on the Pile River. Pedro Bay has the longest documented history of occupation of any site in the region, representing occupations by multiple cultures over the past 4,500 years (Reger et al. 2005). The lake at the time of the Ocean Bay culture was larger with water levels 25 feet higher than it currently is (Reger et al. 2005). Artifacts found at the deepest levels of the site are identical to ones found on Kodiak Island, Kachemak Bay, and the Alaska Peninsula (Reger et al. 2005). These cultures were adapted to a maritime subsistence way of life, including the hunting of marine mammals. Two other coastal marine cultures thrived here: the Arctic Small Tool Tradition around 3,000 years ago, and the Norton Culture around 2,500 to 1,500 years ago (Reger et al. 2005).

One of the features of this site that attracted continued occupation is Pedro Mountain. This mountain provides shelter from prevailing westerly winds that travel up Bristol Bay across Iliamna Lake and out into Cook Inlet. This area is one of the only places on Iliamna Lake with this type of natural shelter (Reger et al. 2005). After the disappearance of the Norton Culture from the area, this site remained dormant until around 1750 when Dena’ina moved down onto Iliamna Lake and occupied the site. They remained at the site until Old Iliamna Village was established in 1838 near a Russian post that was itself established earlier in 1821 (Ellanna 1986). At Old Iliamna Village, the Dena’ina became accustomed to Western influence from Russian fur traders and missionaries. Dena’ina people are organized through kinship, and in the past the relative isolation of different bands spread across Southcentral Alaska led to linguistic differences as well. The language consists of 2 linguistic divisions, Upper Inlet and Lower Inlet. There are 3 Lower Inlet dialects: Inland, Iliamna, and Outer Inlet. The Inland Dena’ina dialect is spoken on Lake Clark and at Stony River, the believed origin location of the Dena’ina people. The Iliamna dialect is spoken on Iliamna Lake, and Outer Inlet is spoken on the Kenai Peninsula (Kari and Fall 2003; Kari and Kari 1982; Krauss 1982; Townsend 1981).

The Central Yup’ik population of Iliamna Lake consists of 2 separate groups, the *Aglurmiut*, the more northern group, and the *Kiatagmiut*. The Aglurmiut, whose territory has generally been thought to have included most of the Alaska Peninsula to the southwest as far as Port Moller, occupied territory including the western two-thirds of Iliamna Lake (VanStone 1967). Nushagak River Central Yup’ik refer to themselves as Kiatagmiut. This subgroup of Central Yup’ik speakers occupied the entire Nushagak River and maintained territory including the upper Kvichak River and probably the lower end of Iliamna Lake (VanStone 1984). The diversity of Inter-Yup’ik ethnicity became blurred “with European contact as epidemic diseases, the establishment of schools and missions, and particularly the emergence of the fur trade and an important commercial salmon-fishing industry in Bristol Bay resulted in considerable movement of Eskimos throughout the region, the coalescence of some populations and the dispersal of others” (VanStone 1984). One aspect of this “blurring” of ethnicity is that Yup’ik peoples of the coast and the Nushagak and Kvichak rivers were referred to as Aleut in many narratives. Aleut are people associated with the Aleutian Islands

but this term is commonly used by some Bristol Bay area Yup'ik people to describe themselves. When Hannah Breece (Jacobs 1997), a schoolteacher, traveled across Iliamna Lake from the Dena'ina village of Old Iliamna she encountered a small community of Yup'ik people who lived on the Newhalen River (near present-day Newhalen) and who appeared to have good relations with the majority Dena'ina population to the north and east. The Dena'ina name for Lake Clark, *Qizhjeh Vena*, means "people gathered lake." Many residents of the communities of Iliamna and Newhalen today are the descendants of the people who Breece met at the mouth of the Newhalen River as well as later arrivals of Yup'ik and Dena'ina descent.

2.3.i. The Historical Period

Iliamna Lake is geographically and culturally part of the larger Bristol Bay region. The establishment of the trading post of Aleksandrovski Redoubt in Bristol Bay, at the location that would later become known as Nushagak by Euro-Americans, was "responsible for opening the interior regions of southwestern Alaska to the fur trade" (VanStone 1971). In the Bristol Bay area the Russians penetrated the interior of the Alaska Peninsula from the Nushagak area, using the trading post of Aleksandrovski Redoubt as a staging area. The first Russian exploration of the area was a military exploration in 1791 (Michael 1967). Dmitri Ivanovich Bocharov, a naval officer acting under orders from Alexander Andreevich Baranov, then manager of Shelikov's trading company, explored some of the northern part of the Alaska Peninsula, making efforts to establish friendly relations with the inhabitants in the interest of beginning to trade for furs. According to Lieutenant Zagoskin, it seems possible that Bocharov reached Iliamna Lake (Michael 1967). The rival Russian companies of Shelikov and Lebedev-Lastochkin competed for control over the Cook Inlet area and the latter plundered the Iliamna and Nushagak villages in 1792, where they then established a small trading post (VanStone and Townsend 1970). In 1797, after further mistreatment by the Russians, the Dena'ina massacred the Russians stationed at the post. It was not until 1821 that the Dena'ina permitted the Russians to re-establish a trading post among them (VanStone and Townsend 1970).

The fur trade in Cook Inlet spread from the posts at Kenai inland to Iliamna Lake. Lieutenant Zagoskin's travel journals from the 1840s demonstrate that Russian influence had been penetrating deep into Dena'ina territory (Michael 1967). The fur trade continued in the region throughout the Russian period. In Interior Alaska, the Dena'ina of Stony River traded with the Russians in the Iliamna Lake area (Ellanna 1986). In addition, at one time, according to Kokhanok residents, there was another village on the south shore of Iliamna Lake to the west of Kokhanok. There was trade between this village and Kamashak Bay for sea otter pelts that were sold to the Russians. Trade of traditional goods between the Iliamna Lake area Dena'ina and the Bristol Bay Yup'ik populations continued during the Russian period: "the Dena'ina supplying moose and wolverine skins for seal skins for example, while the Lake Clark, Mulchatna, and Stony River Dena'ina maintained trade with the *Kuskowagamiut* [Yup'ik]" (Osgood 1937). Additionally the Dena'ina even obtained their baidarkas (kayaks) from the Chugach and Koniag Eskimos that were settled by the Russians on the Kenai Peninsula (Townsend 1979).

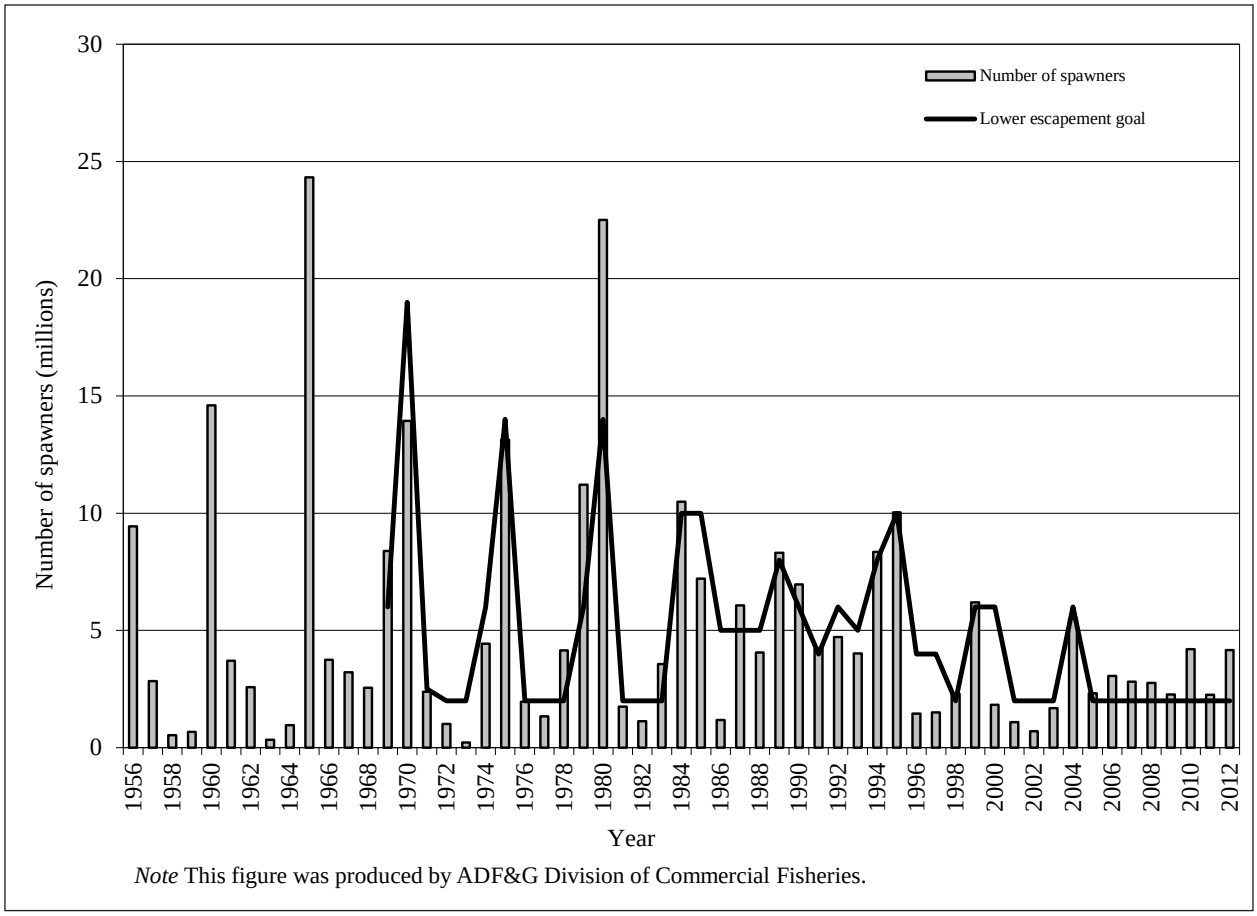
The Iliamna Portage (*Tus Nuch'elyasht*, "pass where we bring things back") is a centuries-old trail approximately 22 miles long, extending from the mouth of the Iliamna River through the mountains, along Chinkelyes Creek to the head of Iliamna Bay. In 1818, Peter Korsakovsky, an early Russian explorer and his party—most likely the first Europeans to use the pass—were guided by Dena'ina over this portage during his trip to assess the fur potential in the Iliamna Lake region (Unrau 1994). The trail became the main route for bringing fur from the interior area near Lake Clark to Cook Inlet. Trade posts passed from the control of the Russian America Company eventually to the Alaska Commercial Company (ACC) after the sale of Alaska to the United States in 1867. The ACC, which ran a post on Iliamna Lake, had a substation at the head of Iliamna Bay during the 1880s and 1890s at a site called AC Point. John W. Clark, for whom Lake Clark is named, ran the Iliamna Post from the 1880s to 1897 (Unrau 1994).

During the early 20th century, commercial salmon fishing in Bristol Bay became an important aspect of life for many residents. "Between 1883 and 1903 ten canneries were constructed at various points on Nushagak Bay. … Large numbers of Eskimos [Yup'ik] were attracted to Nushagak Bay during the fishing seasons, however, and gradually some were able to obtain employment in the canneries in spite of considerable

prejudice against them and their abilities as workers" (VanStone 1971:22). It took a decade before a reasonable number of local Yup'ik people were working in the canneries. The 1894 *Report of the Governor of Alaska* indicates as many as 128 "native" employees were working in the cannery (Alaska Governor 1899).

For the Dena'ina and Yup'ik of the Iliamna Lake area the salmon industry had 2 effects. The first effect was that the fishing industry drew people to Bristol Bay from the lake region to work in cannery jobs. The second was that the fish traps used by the canneries in the early years blocked the river for spawning salmon to return into the Kvichak River system. The use of traps was quickly seen as a problem. In 1890, O.F. Spaulding, Acting Secretary of the Treasury, signed a statement deeming traps or any impediment to anadromous fish as illegal and urged that they should be removed (Unrau 1994). To ensure the health of the salmon run on the Kvichak River, the Bureau of Fisheries investigated the Kvichak River drainage, including Iliamna Lake, in 1906 and again in 1920 and cataloged the streams and predator species, such as Dolly Varden *Salvelinus malma* and lake trout *S. namaycush*. These reports provided data on the effects of the commercial fisheries on the indigenous population in the Kvichak River drainage (Unrau 1994). The investigators visited the villages along the Kvichak River and Iliamna Lake and observed that in both cases residents of the communities had acquired enough salmon for their needs and had a good season. These investigations ensured that the Bristol Bay fishery would continue to be managed in such a way as to allow for the continuity of the large sockeye salmon *Oncorhynchus nerka* runs that continue to this day in the Kvichak River system. This early effort to ensure the health of the Kvichak River sockeye salmon run allowed for the continuity of an important fishery in Bristol Bay over time. Figure 2-2 shows the historical escapement of the sockeye salmon run for the Kvichak River (Morstad and Brazil 2012). As discussed below, lake residents report that seals follow salmon up the Kvichak River and the continued large run of sockeye salmon in the Kvichak River is an important factor in this research regarding migration of seals on the Kvichak River and throughout Iliamna Lake.

In addition to economic opportunities, other factors influenced the regional economy and settlement patterns in the 20th century. A change in resource abundance, or other social or economic factors, caused the movement of communities to new locations as well as the merging of communities. By the late 20th century the commercial fishery had become a way of life for many residents of southwest Alaska and the mainstay of the local economy. While not comparable to the fishery in terms of importance as a food resource, marine mammals, particularly seals and beluga whales, have likely always played a role in the subsistence economy of the Iliamna Lake cultures. As we shall see, marine mammals continue to be an important local subsistence resource for Iliamna Lake communities today.



Note This figure was produced by ADF&G Division of Commercial Fisheries.

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Figure 2-2.–Kvichak River sockeye salmon lower escapement goals (1969–2012) and number of spawners (1956–2012).

2.3.ii. Recent History and Contemporary Communities

Pedro Bay

At the far eastern end of Iliamna Lake, where the irregular shoreline breaks into numerous bays and islands, the water body of Pedro Bay lies beneath the 3,000-foot peaks of the Chigmit Mountains. The village of Pedro Bay sits at the head of a bay of the same name, with the prominent peaks of Pedro Mountain and Knutson Mountain looming to the west and north. The community is physically isolated, sandwiched between these high mountains to the north and rocky islands and lakeshore to the south. Pedro Bay is the only current predominately Dena'ina Athabascan community on Iliamna Lake. As noted above, archaeological evidence indicates Pedro Bay was occupied in the mid-1700s (Townsend 1965), and was subsequently abandoned. In 1906 a man named "Old Pedro" lived at the site, giving it its modern name. Beginning around 1935, families from the nearby villages of Old Iliamna and a younger community, Pile Bay, started abandoning their communities and moving to Pedro Bay. The present population is descended from those settlers. The current population is 27 residents, of which 75% are Alaska Native (Table 2-1). Residents of Pedro Bay

Table 2-1.–Population estimates for study communities: Igiugig, Iliamna, Kokhanok, Levelock, Newhalen, and Pedro Bay, 2010 and 2011.

	2010 Census				Study findings for 2011			
	Total population		Alaska Native population		Total population		Alaska Native population	
Community	Households	Population	People	Percentage of total	Households	Population	People	Percentage of total
Igiugig	16	50	35	70.0%	18	59	53	89.3%
Iliamna	39	109	71	65.1%	25	74	49	66.1%
Kokhanok	52	170	153	90.0%	47	137	126	92.0%
Levelock	27	69	62	89.9%	30	86	81	93.9%
Newhalen	50	190	175	92.1%	45	164	148	90.3%
Pedro Bay	19	42	30	71.4%	16	27	20	75.0%

Sources This study: ADF&G Division of Subsistence household surveys, 2011; 2010 Census: Alaska Department of Labor and Workforce Development, Research and Analysis Section. http://live.laborstats.alaska.gov/cen/dparea.cfm, accessed 1 March, 2013.

have modern telecommunications and regular air service to Anchorage via Iliamna or Port Alsworth. Pedro Bay no longer has a school since enrollment fell below the minimum threshold in 2009.

Kokhanok

The community of Kokhanok surrounds a lagoon on the southeast shore of Iliamna Lake. It has been the home of a predominately Aglurmiut Central Yup'ik population (VanStone 1967). Reindeer herding and commercial fishing became mainstays of the economy in the early 20th century. Reindeer eventually joined the nearby Mulchatna and Alaska Peninsula caribou herds. Commercial fishing remains important for Kokhanok residents, many of whom travel to Bristol Bay in the spring to participate in the Bristol Bay commercial fishery. Transportation in and out of Kokhanok is primarily by air through Iliamna. The gravel runway is located just outside the community to the west. The community has modern telecommunications in the center of the community where there is also a small store and a school. Kokhanok is the second largest study community with an estimated population for 2011 of 137 residents, of which 92% were Alaska Native (Table 2-1). There is also a neighboring settlement of 3 households locally called Pope-Vannoy Landing located just to the east in Intricate Bay. Pope-Vannoy was not designated as an official study community for this project but LTK data were collected from residents of this community.

Iliamna

The community of Iliamna is centrally located on the northern shore of Lake Iliamna, approximately 225 air miles southwest of Anchorage. During the 2011 study year, Iliamna had a population of 74 residents, of which 66% were Alaska Native (Table 2-1). The U.S. Census (2011) showed a higher population of 109 residents, however, some of the people counted in the census may have been seasonal residents of the community since Iliamna hosts a number of hunting and fishing guide lodges on a seasonal basis. Historically (pre-1935), the traditional Dena'ina community of "Old Iliamna" was located at the mouth of the Iliamna River. Villagers relocated the community to its present location on or around 1935, and it is now situated approximately 40 miles from the previous site. Iliamna is currently the regional hub with paved runways and small docking facilities for river barges. There is also a store in Iliamna and during the summer food services are open. Iliamna has also become the staging area for the Pebble Project, a proposed mine to harvest gold, copper, and molybdenum.[1] Iliamna and Newhalen are connected by a paved road that runs to the airport as well. The paved road continues northeast past the airport for some miles and eventually turns to gravel as it continues to the shore of Sixmile Lake.

Newhalen

Positioned at the mouth of the Newhalen River on Iliamna Lake, where strong runs of sockeye salmon return each year, the community of Newhalen has been shaped by the river that bears its name. The location of the traditional village is not far from the current village. In fact some houses border the old village. This predominately Yup'ik village today appears like an extension of neighboring Iliamna, to which it is connected by road, yet Newhalen residents relate a separate and distinct history of themselves as a community. Newhalen is the largest study community with a population of 164 residents, of which 90% identify as Alaska Native (Table 2-1). A census conducted in 1890 listed the community of Newhalen as the Eskimo village of *Noghelingamiut* which translates as "people of Noghelin," with a total of 16 residents at its current location (Porter 1893). Newhalen is an Anglicized version of its original name. Newhalen was established in the 1800s due to its proximity to large fish and game resources and was incorporated as a city in 1971.[2] Newhalen and Iliamna share a post office, a clinic funded by Southcentral Foundation, and a school.

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1. Pebble Limited Partnership. n.d. "Location: Where is the Pebble Deposit?" http://www.pebblepartnership.com/location.html#-section-geography (accessed October 2015).
2. Alaska Department of Commerce, Community, and Economic Development (ADCCED) Division of Community and Regional Affairs, Juneau. n.d. "Alaska Community Database Online: Community Information." https://www.commerce.alaska.gov/dcra/DCRAExternal/community (accessed October 2014).

Igiugig

The residents of Igiugig moved to their current location from the Alagnak River located downriver on the Kvichak River. Residents of Igiugig settled in their current location after migrating through the area while herding reindeer, which were introduced in the area in 1935. Today, a few elders in Igiugig remember working with the reindeer as children as they moved from camp to camp with their parents. The descendants of the residents of the region who moved with the seasons from camp to camp, following a patterned seasonal round, or with their reindeer herds, today are settled in Igiugig at the mouth of the Kvichak River and the outlet of Iliamna Lake. Igiugig today has 2 bunkhouses that are rented to visiting fishers. There are also several lodges located nearby. Igiugig has a gravel runway, store, modern telecommunications, and a school. The 2011 population of Igiugig was an estimated 59 residents, of which 89% are Alaska Native (Table 2-1).

Levelock

Levelock is located in the Bristol Bay area on the west side the Kvichak River near its mouth. As was true of most Bristol Bay communities, the way of life in Levelock was heavily affected by the fur trade and the commercial salmon fishing industry. A village at the site of present-day Levelock existed in the early 1800s.[3] In 1837, the village was heavily depopulated by smallpox. The federal census first listed Levelock in 1890. The village and settlements on the Alagnak River were affected by several other epidemics in the early 1900s. The Alagnak River was more commonly called the "Branch River" by local people. It is a tributary of the Kvichak River, and people from former villages who moved to Levelock later occupied semi-permanent and seasonal camps in the area. Relatives of the residents of Levelock also settled at Igiugig, as mentioned above.

Koggiung Packers began operating the Libby, McNeil, & Libby cannery nearby in 1915. In 1926, the cannery burned, and in 1928 a second cannery began operation. The first school opened in Levelock in 1929. Residents also worked by herding reindeer like their relatives in Igiugig. In 1939, the first post office in Levelock, referred to as "Kvichak," opened. A third cannery started operations around 1950. In 1973, an 8-mile-long road was constructed along the Kvichak River. In 1978, the high school was built. In 1990, a grocery store opened in the village, and a few other commercial businesses began operating; however, the grocery store later closed. There is a gravel runway on the edge of the community. Study findings indicate that the population of Levelock was 86 residents in 2011, of which 94% are Alaska Native (Table 2-1).

2.3.iii. Marine Mammal Use in the Contemporary Communities

All of the study communities described above can be characterized as maintaining subsistence-oriented economies that obtain a large portion of their food from local wild resources. Fish, especially salmon *Oncorhynchus* spp., are a highly important local wild food used by the study communities, as are large land mammals such as moose *Alces alces* and caribou *Rangifer tarandus* (Fall et al. 2006; Holen 2009; Holen et al. 2005; Krieg et al. 2005). While the 1972 federal Marine Mammal Protection Act (MMPA) generally prohibits the harvest of marine mammals in U.S. waters, a 1994 amendment to the MMPA permits the harvest of marine mammals by Alaska Natives for subsistence uses (Marine Mammal Commission 2007), and seals are an important local resource to communities. Subsistence use of freshwater seals by residents of Iliamna, Newhalen, and Kokhanok was documented by ADF&G researchers who conducted subsistence household surveys for the 2005 and 2006 study years (Fall et al. 2006; Krieg et al. 2009). These surveys were supplemented by work conducted by this research team during Project # 916 (Burns et al. 2012, 2011), and whenever methods and data were comparable, the integrated findings are reported here.

3. Alaska Department of Commerce, Community, and Economic Development (ADCCED) Division of Community and Regional Affairs, Juneau. n.d. "Alaska Community Database Online: Community Information." https://www.commerce.alaska.gov/dcra/DCRAExternal/community (accessed October 2014).

3. PROJECT OBJECTIVES

Objective 1—To Gather Important Subsistence Household Surveys and Local Traditional Knowledge About Seals in the Iliamna Lake Area Through Systematic Household Surveys and Key Respondent Interviews

- This was a core objective of Project # 916, and efforts in this area were continued and expanded during the course of Project # 1116. The methods used to conduct subsistence household surveys and interviews with lake residents are outlined, and the survey instruments are provided, in appendices B–D. Information on local participation in the harvests and uses of marine mammals for subsistence, with particular focus on the harvests of seals within Iliamna Lake, and historical accounts of seal hunting in Iliamna Lake, as determined from subsistence household surveys and ethnographic interviews conducted over both projects # 916 and # 1116 are combined. Information on seal hunting seasons, locations, and strategies, as well as on the processing, preservation, use, and sharing of seals for subsistence by local residents is reviewed.

Objective 2 – To Gather Data on the Abundance and Distribution of Seals in the Lake Through Systematic Aerial Surveys

¶ • To document long-term and seasonal trends in seal abundance and haul out locations through aerial survey efforts, 27 aerial surveys were conducted on 25 dates in collaboration with biologist Dr. David Withrow from the National Marine Mammal Laboratory (NMML) under projects # 916 and # 1116. These surveys took place during the summer pupping and molting periods, and during the ice-covered season. One survey in 2011 and one in 2013 were flown late in the evening (~22:00) to extend coverage hours and begin to evaluate whether seals were more abundant at night. Aerial surveys covered all areas known to be used by seals, as well as the river course.

- During the survey and local traditional knowledge interview process, lake residents indicated locations where they saw seals hauled out at different times of the year, as well as areas where seals were observed feeding. Methods used to document local residents' knowledge of seal habitat use are described. Aerial survey results are compared with local knowledge about pupping activities, seasonal movements, feeding areas, and haul out locations, while genetic data are used to contextualize local residents' understanding of the potential for seal migration between Iliamna Lake and Bristol Bay along the Kvichak River.

- Two difficulties with using only aerial surveys to assess population size and status are that the correction factors needed to transform haul out counts to total abundance have not been determined for lake seals, and that seasonal changes in the proportion of the population that hauls out at any given time are unknown. Unfortunately, capture and tagging operations that would allow correction factors to be determined for animals carrying VHF, TDR, or satellite tags were beyond the scope of this project, and so remain to be accomplished. However, local residents are interested in seeing such

tagging work take place in the future, as we identified in community visits; those visits and findings are reported in Chapter 7 regarding "Management and Policy Implications."

Objective 3 – To Work with Hunters to Voluntarily Collect Tissue Samples From Harvested Seals for Health and Genetic Studies

- Subsistence harvest rates in these communities were documented by subsistence harvest surveys (detailed under objective 1), and annual rates are low and variable. Despite this, under projects # 916 and # 1116, researchers trained local residents to serve as biosamplers within their own communities, and obtained tissue samples through the cooperation of local subsistence hunters. Samples from 11 seals were obtained during the 2011–2012 harvest season. Samples were not obtained in the 2012–2013 harvest season because ice conditions were so poor that hunting did not take place during the late winter or early spring.
- Biosamples are particularly important since they provide information critical to determining the stock of origin for seals in the lake. Toward that end, 11 tissue samples were provided (in duplicate) to NMML and Dr. O'Corey-Crowe for genetic analysis, and information from those analyses, as supplemented by other extant samples, are detailed in the results. In those cases where teeth were available (n=5), they were tested for age determination.
- In an attempt to document foraging behavior directly, 8 stomach samples were processed; unfortunately only 3 contained identifiable hard parts. The stable isotope profiles (δ13C and δ15N) of whisker and soft tissue samples from 8 seals were analyzed in an attempt to determine foraging location and guild (freshwater versus saltwater). Unfortunately, this activity was hampered by an absence of data on whisker growth rates, tissue turnover times, or direct measures of the isotopic signature of potential prey resources.

Objective 4 – To Integrate Local and Scientific Knowledge, and Report to Communities

- Over the course of projects # 916 and # 1116, researchers had a robust study design that focused on gathering scientific and local and traditional knowledge about seals in Iliamna Lake. This final report documents the information obtained by both research methods. Throughout the reporting of results we have attempted to integrate research findings and to develop a synthesized understanding of the ecology of seals in Iliamna Lake, and their importance to local communities.
- A second objective of this research was to report all findings to local communities, and to develop pathways of communication. To do so, we delivered information about our project to local residents during community meetings, in response to questions asked by interviewees, and via the Bristol Bay Native Association newsletter. In addition, research findings have been provided in scientific meetings in Alaska and at national conferences. However, there remains considerable confusion within the communities with respect to the petition to list the seals in the lake as a distinct population segment (DPS) under the Endangered Species Act (Center for Biological Diversity 2012), and

community presentations of our research findings frequently featured questions related to potential management decisions. Management and policy implications of our research and community concerns are detailed in Chapter 7 of this report.

4. METHODS

4.1. Social Science Research Methods

The social science component of this research involved household harvest surveys and local traditional knowledge (LTK) interviews and was led by Alaska Department of Fish and Game (ADF&G) Subsistence Resource Specialist James M. Van Lanen. Other participants in the fieldwork included University of Alaska Anchorage (UAA) graduate intern Yoko Kugo, who also later became a graduate intern at ADF&G, and ADF&G college intern Hollie Wynne. Kugo is a graduate student in the anthropology and biology departments at UAA and Wynne is a college student studying wildlife biology in the biology department at UAA. Other participants in the research are listed in Appendix B.

From November 2011 through May 2012 Van Lanen, Kugo, and Wynne made 4 trips to Iliamna Lake to work with local community residents to develop a greater understanding of the seal population in Iliamna Lake and the use of seals as a subsistence resource for local people. Approval for the project was obtained from the local tribal governments in each community prior to data collection. The Bristol Bay Native Association (BBNA) assisted in getting approval from the study communities, and protocols were approved by the UAA Institutional Research Board. Research methods included household marine mammal harvest surveys and LTK interviews. Both the harvest surveys and the LTK interviews included a mapping component.

ADF&G and UAA researchers worked with representatives of study community local governments to select residents to administer the surveys during face-to-face interviews. These local residents were contracted as local research assistants (LRAs). During preliminary meetings with the communities, teachers from the schools in both Newhalen and Levelock expressed an interest in having local high school students participate in the project. This interest was rooted in ongoing efforts by science teachers from the Lake and Peninsula School District to provide students with opportunities to immerse themselves in understanding their own social-ecological systems as a foundation for their studies in science. The tribal governments of Newhalen and Levelock expressed support for collaborating with the schools to complete the project and therefore the LRAs in those communities were high school students working under the direction of local teachers. In these cases the stipends normally paid to individual LRAs for their work were instead donated to the schools to fund future scientific, place-based educational programs administered by the Lake and Peninsula School District (Plate 4-1).

¶ 4.1.i. Systematic Household Surveys

For both the 2010 and 2011 study years, the primary method for collecting harvest information in this project was through a systematic household survey (SHS). In 2010, LRAs were identified by their tribal council or government and trained by UAA researchers in biosampling and survey techniques. The LRAs also compiled current household lists for their communities and conducted the SHSs between May and June 2011. The 2010 survey document is provided in Appendix C. This form, prepared by ADF&G, was used to collect basic demographic information for household members, as well as household participation in marine mammal harvesting and processing activities, use of marine mammals by the household, distribution of the marine mammal harvest, and marine mammal harvests by species. Results from the 2010 survey reflect the reported data provided by surveyed households and are not expanded into community-wide harvest estimates.

The 2011 survey component of the project was similar in scope to the 2010 survey, although additional questions were added. Furthermore, during the 2011 study year, geographic information was collected through a mapping component accompanying each household survey. A copy of the survey form for 2011 is included in Appendix D. The form collected information from households, including basic demographic information for household members, household participation in marine mammal harvesting and processing activities, use of marine mammals by the household, distribution of the marine mammal harvest, marine

Photography by Yoko Kugo, UAA & ADF&G

Plate 4-1.–James Van Lanen (ADF&G) explains the Iliamna Lake seal research project to students at Levelock School.

mammal harvests by species, seasonality, hunt area, sex of animal, household observations on the abundance, health, and behavior of seals inhabiting Iliamna Lake and the Kvichak River, and household assessments comparing the 2011 marine mammal subsistence harvest and use with use levels during previous years. The 2011 household survey design followed ADF&G Division of Subsistence household survey methods used to develop community harvest estimates. Results from the 2011 survey were expanded to derive community harvest estimates. Fractions of animals result from the expansion procedure and are rounded to the nearest tenth in accompanying report tables.

For study year 2011, LRAs were trained to complete the survey component of the project and, in concert with their local governments, LRAs were responsible for compiling current household lists for their communities prior to the survey effort. Fieldwork for the 2011 study year was accomplished by ADF&G and UAA researchers during 3 separate trips to the study communities in January, March, and May 2012.

While the 2010 study year data were collected under Project # 916 and are described in detail in the final report for that project (Burns et al. 2011), information on those surveys is included in this report because findings were aggregated across the 2 years and are synthesized here.

4.1.ii. Subsistence Household Survey Data Entry and Analysis

Prior to analysis, completed subsistence household survey forms underwent several reviews. LRAs were asked to review forms for completeness and legibility prior to submitting them to ADF&G and UAA project coordinators. Responses were coded following standardized conventions used by ADF&G to facilitate data entry. Project coordinators then reviewed the completed forms for logical errors or omissions and resolved any problems with the LRAs. The completed forms were then sent to the ADF&G Division of Subsistence

Information Management section where a double data entry method was used to enter information into a computerized system for data analysis.

Information Management staff within the Division of Subsistence set up database structures within Microsoft SQL Server at ADF&G in Anchorage to hold the survey data. The database structures included rules, constraints, and referential integrity to ensure that data were entered completely and accurately. Daily incremental backups of the database occurred, and transaction logs were backed up hourly. Full backups of the database occurred twice weekly. This ensured that no more than 1 hour of data entry would be lost in the unlikely event of a catastrophic failure. All survey data were entered twice and each set compared in order to minimize data entry errors.

Once data were entered and confirmed, information was processed with the use of Statistical Package for the Social Sciences (SPSS) software, Version 20.[1] Initial processing included the performance of standardized logic checks of the data. Logic checks are often needed in complex data sets where rules, constraints, and referential integrity do not capture all of the possible inconsistencies that may appear. Harvest data collected as numbers of animals, or in gallons or buckets were converted to pounds usable weight using standard factors (Appendix E).

ADF&G staff also used SPSS for analyzing the survey information. Analysis included review of raw data frequencies, cross tabulations, table generation, estimation of population parameters, and calculation of confidence intervals for the estimates. Missing information was addressed on a case-by-case basis according to standardized practices, such as minimal value substitution or using an averaged response for similarly-characterized households. Typically, missing data are an uncommon, randomly-occurring phenomenon in household surveys conducted by the division. In unusual cases where a substantial amount of survey information was missing, the household survey was treated as a "non-response" and not included in community estimates. ADF&G researchers documented all adjustments.

Harvest estimates and responses to all questions were calculated based upon the application of weighted means (Cochran 1977). These calculations are standard methods for extrapolating sampled data. As an example, the formula for harvest expansion is

$$H_i = \overline{h}_i S_i \qquad (1)$$

where:

$\overline{h}_i = \frac{h_i}{n_i}$ (mean harvest per returned survey)

H_i = the total harvest (numbers of resource or pounds) for the community *i*,

$\overline{h}_i$ = the mean harvest per returned survey for the community *i*,

h_i = the total harvest reported in returned surveys,

n_i = the number of returned surveys

S_i = the number of households in a community.

The standard deviation (SD), variance (V), and standard error of the mean were also calculated with the raw, unexpanded data from each community. In this study, the relative precision of the mean is shown in the tables as a confidence limit (CL), expressed as a percentage.

The corrected, final data from the household survey will be added to the Alaska Department of Fish and Game's Division of Subsistence Community Subsistence Information System (CSIS). This publicly-accessible database includes community-level study findings and can be found at http://www.adfg.alaska.gov/sb/CSIS//.

1. Product names are given because they are established standards for the State of Alaska or for scientific completeness; they do not constitute product endorsement.

4.1.iii. Ethnographic Research

Besides the household surveys, the second social science research component included the semi-structured key respondent interviews. Between November 2011 and May 2012, ADF&G and UAA researchers conducted 23 semi-structured, open-ended ethnographic interviews with residents of Newhalen (6), Iliamna (4), Igiugig (3), Levelock (2), Pedro Bay (3), Kokhanok (4) and nearby Pope-Vannoy (1). Ethnographic interview questions are provided in Appendix F, and covered the following topics:

- Historical knowledge and lifetime observations of seals in Iliamna Lake.
- Seasonal movements of seals in Iliamna Lake and the Kvichak River.
- Seal haul outs by location, season, and weather conditions.
- Seal reproduction knowledge.
- Seal feeding behavior and feeding locations.
- Local seal overwintering observations and seal migration concepts.
- Local perceptions of the differences between freshwater seals and saltwater seals.
- History of seal hunting in Iliamna Lake.
- Seasonality and locations of seal hunting.
- Ice and open water seal hunting strategies, and the differences between strategies.
- Subsistence use and sharing of harvested seals by Iliamna Lake communities.

Key respondents were largely selected by local governments or through snowball methods, in which identified participants identify other potential participants to be added to the list. The interviews were recorded, and the audio was transcribed and coded by project staff. In order to obtain additional information on certain topics, follow-up correspondence with some of the respondents occurred using telephone and email. The research team additionally made contact with an active seal hunter from the small community of Pope-Vannoy. While not a study community for Project # 1116, snowball methods informed the research team that the Pope-Vannoy hunter's knowledge of seals within Iliamna Lake was extensive and thus a detailed ethnographic interview was conducted with the hunter as a part of this study. The results of that interview are included throughout this report.

Information about seal reproduction and pupping obtained during the ethnographic portion of this work is limited by the lumping of pups into one general category during the interview process. For instance, the researchers did not narrow down reported pup sightings in respect to the size of the pups observed or whether the pups were observed weaning or moving around. Thus reported observations of pups should be seen simply as general observations of small seals interpreted to be pups by community respondents.

4.1.iv. Mapping and Generation of Integrated Maps

Both the 2011 SHS and traditional knowledge interviews included a mapping component where geographic locations concerning the topics above were mapped by community respondents. During the study year 2011 fieldwork season, researchers recorded the locations of seal harvests by households, seal haul out locations, seal feeding locations, seal pupping locations, and known seasonal movements. The mapping component was open-ended and thus any detailed information about local knowledge of seal behavior provided by respondents was recorded. It is important to emphasize that, unless otherwise stated, the mapped data presented in this report are representative of respondent observations over multiple years, and do not reflect specific locations where seals were sighted in 2011 alone. Thus, areas where seals are seen rarely (such

Table 4-1.–Dates of aerial surveys of Iliamna Lake, NPRB projects # 916 and # 1116, 2009–2013.

Year	Aerial survey source	Aerial survey date
2009	NOAA	5/9, 6/14
2009	NPRB	8/15, 8/20, 8/22
2009	NTC	6/18, 6/21, 6/24, 6/28, 7/7, 7/27, 8/2, 8/16, 8/25, 9/19
2010	NOAA	8/24
2010	NPRB	4/3, 5/28, 7/9, 8/3, 11/3
2011	NOAA	8/13, 8/15
2011	NPRB	4/14, 6/17, 7/15, 11/7
2012	NOAA	8/10
2012	NPRB	4/3, 7/10
2013	NOAA	8/4, 8/7
2013	NPRB	4/4, 6/29, 7/12

Source NOAA National Centers for Environmental Information, Ocean Archive System, most recent published version (file: 123188.2.3.tar.gz). "Aerial Survey Counts of Harbor Seals in Lake Iliamna, Alaska, 1984–2013 (NODC Accession 0123188)," http://www.nodc.noaa.gov/cgi-bin/OAS/prd/accession/download/123188.

Note NOAA (National Oceanic and Atmospheric Administration); NPRB (North Pacific Research Board); NTC (Newhalen Tribal Council).

as at the mouth of the Kvichak River in winter) are not distinguished in maps from areas where seals are seen regularly. However, these discrepancies are noted in comments by LTK respondents included in the text of this report. During the data analysis phase the mapping data obtained from the ethnographic interviews were combined with the mapping data obtained from the systematic household surveys. The maps produced in this report are thus comprehensive in that they represent a compilation of data sets. The polygons representing different classes of seal activity completely encompass all reported areas of activity. For example, polygons labeled as "known pupping locations" on the study maps represent locations where community respondents believe seals pups are born and/or weaned. Similarly, polygons labeled "foraging" areas include all areas where seals were observed feeding.

4.2. Biological Science Research Methods

4.2.i. Systematic Aerial Surveys

Aerial surveys were flown from a twin-engine Piston Commander 680 operating at an altitude of 200–300 m. All surveys were led by Dr. David Withrow, research biologist at the National Marine Mammal Laboratory (NMML), in Seattle, Wash., with additional participation by Dr. Jennifer Burns from UAA, and project LRAs as available. Aerial surveys were authorized under a Marine Mammal Protection Act (MMPA) General Authorization (LOC No. 14590) issued to NMML.

All aerial surveys conducted over the course of this research (Table 4-1) were flown in the mid- to late-afternoon, when the number of seals hauled out was expected to be highest (Bengtson et al. 2007; Mathews

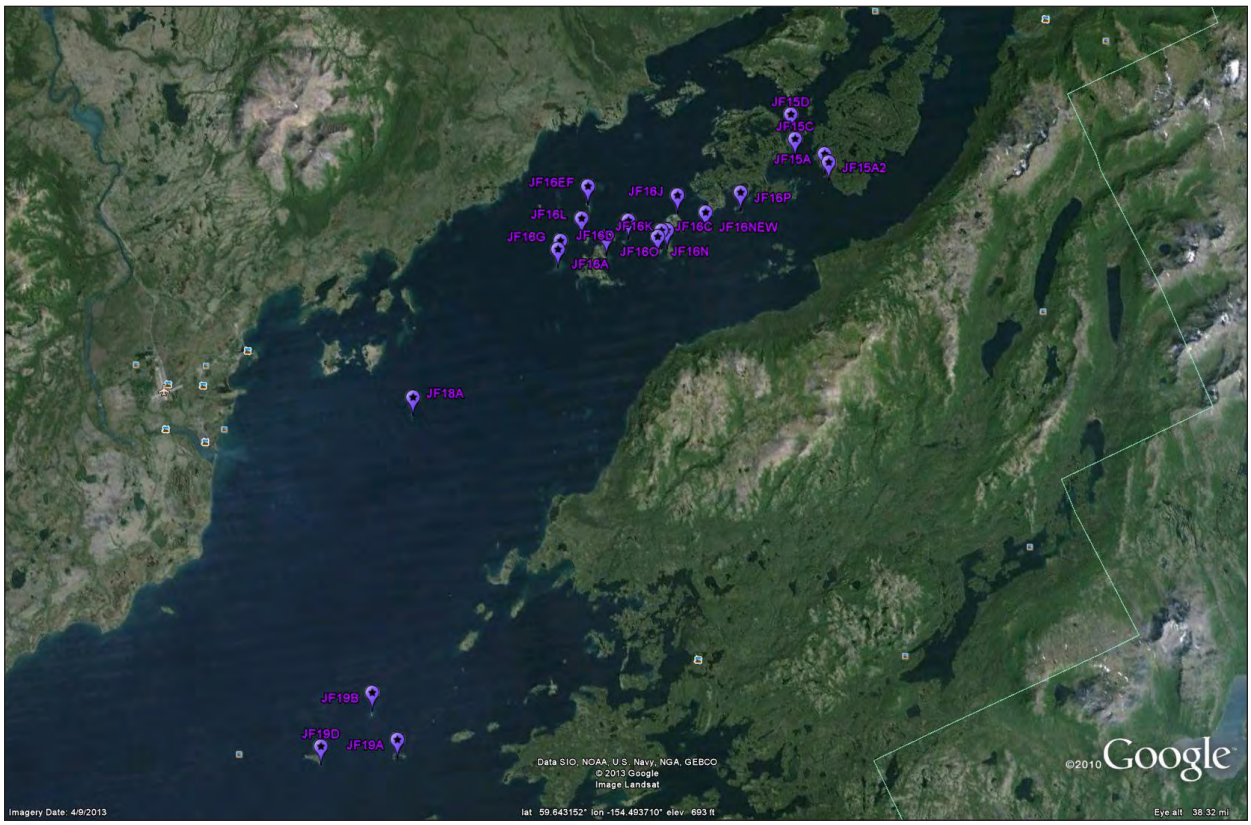

Figure 4-1.–All known harbor seal haul out locations, with site names, that were overflown during each aerial survey in which the lake was free of ice.

and Kelly 1996; Simpkins et al. 2003). On several surveys, haul out locations were overflown more than once to assess changes in number of animals hauled out; the high count was used in the calculation of the total number of seals present. On one occasion, a late-night flight was flown in close association with a daytime survey in order to better assess whether late afternoon was indeed an optimal time. However, there ¶ were not sufficient instances of days on which multiple surveys were flown; therefore it is not possible with extant data to address questions of diel variation in seal abundance more fully.

During each aerial survey, all locations where seals had previously been recorded during aerial surveys (Mathisen and Kline 1992; Small 2001; Withrow and Yano 2010), or where mapping exercises suggested seals were located, were overflown (Figure 4-1). At least once each year following ice breakup, the entire lake coastline and the complete length of the Kvichak River was surveyed. During surveys when the lake was ice-covered, the northwest side of the lake was searched, and all detected areas of open water and leads were overflown to determine if seals were present. Wintertime seal haul out locations identified by village residents in the mapping exercise were also overflown.

In each survey, the flight path was recorded via a global positioning system (GPS) device, and all seals sighted were digitally photographed using a single-lens reflex camera (Nikon N7000) with zoom lens (NIKKOR 80-400mm). Time, date, frame number, latitude, longitude, and altitude were embedded into the images' metadata automatically as each photo was taken. The observer also recorded weather and visibility information as well as site name and polygon name.[2] Images were later analyzed and the number of seals counted using a variety of mapping and photographic programs (Garmin's Mapsource, RoboGEO,

2. The polygons (coastal segments) are used in the NMML's Harbor Seal Population Structure, which is an Oracle database, where marine mammal surveys are recorded.

Figure 4-2.–Aerial survey photo of seal adults and pups hauled out. Seal pups are distinguished from adults based on their small size, pelage color, and proximity to an adult.

GoogleEarth, and Adobe Photoshop). The total number of seals hauled out was recorded for each site. Pups were identified when possible and the number of seals nearby in the water was also tallied. Pups were identified by their smaller size, generally lighter color, and close proximity (< 1 body length; either nursing or laying right next) to a larger seal (Figure 4-2). Pups were no longer recorded beyond about mid-August when many were weaned and the pups had grown so large that they could not reliably be distinguished from other non-adult seals.

Seasonal variation in the abundance of animals hauled out was plotted, and the date of peak abundance modeled. Historical data from earlier surveys were incorporated when available. This included data from
¶ 2005, 2007, and 2008 reported by ABR, Inc.–Environmental Research & Services (2011), and aerial survey photos taken by a biologist working for the Newhalen Tribal Council (NTC) in 2009. Those photos were counted by Ms. Tatiana Askoak and assigned to known haul out sites by Withrow. To assess whether there were trends in seal abundance over time, the peak number of animals observed during the late August molt period was compared across years. However, all count data should be treated cautiously since they are not corrected for differences in time of day, tidal state, day of year, or weather because, generally, these data are not available for the historical data. Additionally, none of the counts were corrected for the proportion of animals in the water at the time of the surveys due to the lack of appropriate correction factors for the freshwater lake habitat (Bengtson et al. 2007; Simpkins et al. 2003). Therefore both inter- and intra-annual comparisons should be treated cautiously.

4.2.ii. Collection of Tissue Samples from Harvested Seals

The collection of tissue samples and baseline biosampling data from harvested seals was led by Askoak, biologist for the Newhalen Tribal Council, in collaboration with Burns, from the Department of Biological Sciences at UAA. Biosampling instructions and sampling kits modeled on those developed by the Alaska Native Harbor Seal Commission were provided to each village that agreed to participate in this project (biosampling form and bucket inventory appear in Appendix G). Askoak was trained in sampling procedures by Burns. In some cases, local hunters completed forms and collected samples without Askoak's assistance. Participation in the biosampling program was voluntary, and data and samples were provided on an

Table 4-2.–Basic information on seal samples from Iliamna Lake, Alaska, provided by hunters through the biosampling program.

Field ID	Harvest location	Harvest date	Age, field	Age (years), cementum	Sex (reported/ genetic)	SL (cm)	Blubber thickness (cm)	Stomach	Stomach	Whisker	Kidney	Liver	Heart	Muscle	Blubber	Skin	Fur	Reproductive tract	Notes
PV-IL-AK-2002-01	Near Pedro Bay	5/–/02	Adult		–/–	131		N/A		Y						Y			
PV-IL-AK-2011-01	Near Kokhanok	1/–/11	Adult		F/–			N/A											Pregnant; samples badly decomposed.
PV-IL-AK-2011-02	Iliamna Lake		Adult	5	–/F			Empty (worms)	Y	Y	Y	Y	Y	Y	Y	Y	Y		No biosampling datasheet provided.
PV-IL-AK-2012-01	Near Kokhanok	03/01/12	Fetus		F/F			Empty	Y	Y	Y	Y	Y	Y	Y	Y	Y		Fresh umbilicus still attached; full lanugo; lungs never inflated; thin blubber layer; small amount of stool in lower intestine; brown adipose tissue present.
PV-IL-AK-2012-02	Near Pedro Bay	04/17/12	Adult		M/M			N/A						Y	Y				
PV-IL-AK-2012-03	Near Newhalen	04/19/12	Adult	5	M/M	~165		Otoliths, bones	Y	Y	Y	Y	Y	Y					
PV-IL-AK-2012-04	Near Newhalen	04/19/12	Adult	16	M/M	~183	4.5	Otoliths	Y		Y	Y	Y	Y	Y	Y			
PV-IL-AK-2012-05	Near Pedro Bay	04/19/12	Adult		–/F		5.1	Otoliths, bones (worms)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Scar on flank from earlier shooting.
PV-IL-AK-2012-06	Iliamna Lake	06/14/12	Adult	7	F/F		5.3	Empty	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Pregnant, female (F) fetus, not collected.
PV-IL-AK-2012-07	Iliamna	07/22/12	Adult	6	F/F			Empty (worms)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	
PV-IL-AK-2012-08	Seal Island	07/23/12	Adult		–/F		5.3	Empty	Y	Y					Y	Y	Y		

Note "–" indicates data not available.

opportunistic basis. Samples were frozen in the field and shipped to UAA for processing and analysis. Burns has a MMPA permit for receipt and analysis of biosamples (# 15510), and holds current UAA Institutional Animal Care and Use Committee (IACUC) permits for work with post-mortem tissues such as biosamples.

Once at UAA, samples were thawed and separated for analysis. Not all tissues were available from all harvested seals (Table 4-2); therefore sample size for each analysis varies. Whiskers and fur samples were collected from the head, and air-dried prior to storage and/or analysis. Soft tissue subsamples were collected from the heart, kidney, liver, muscle, skin, and blubber as available, and stored in cryovials at -80°C. Multiple subsamples were collected because the NTC has plans to analyze some of the tissues for contaminants; these samples are currently stored at UAA.

Age Determination

If present, the lower jaw was removed from the skull, and simmered in water for approximately 8 hours until the teeth could be removed. The lower canine or premolar (if canine not present) was sent to Matson's Laboratory, LLC (Bozeman, Mont.), for age determination.

Diet Assessment

Diet was determined based on stomach content analysis for those seals for which stomachs were provided. Stomachs were thawed, rinsed with fresh water to remove all hard parts, and the rinsate processed through a series of sieves (1cm to 1mm grid size). Recovered hard parts were air dried and sent to Pacific Identifications Inc. (Vancouver, British Columbia, Canada), for identification.

As an alternate method for dietary reconstruction, whisker, fur, and all soft tissue samples were analyzed for $\delta^{13}C$ and $\delta^{15}N$ using a Costech ECS 4010 elemental analyzer (Costech Analytical Technologies, Inc., Valencia, Calif.) coupled to a Thermo Scientific Delta V Advantage continuous flow isotope ratio mass spectrometer (Thermo Fisher Scientific, Inc., Bremen, Germany) at the UAA Stable Isotope Laboratory. International reference standards (International Atomic Energy Agency [IAEA], Vienna, Austria) were used to calibrate the instrument and results are presented in delta notation relative to Vienna Pee Dee Belemnite (VPDB) for $\delta^{13}C$ and relative to air for $\delta^{15}N$. Long-term averages of internal laboratory standard analytical results yield an instrumental precision of 0.1 ‰ for $\delta^{13}C$ and 0.2 ‰ for $\delta^{15}N$. To control for the variable lipid content in soft tissue, blubber, muscle, liver, kidney, and heart tissues were lipid extracted using a modification of the method (Bligh and Dyer 1959). Dried homogenized samples were immersed in a 2:1 ratio of chloroform/methanol. Samples were then mixed for 30 seconds using a vortex mixer, left to settle for 30 minutes, centrifuged for 10 minutes at 3,400 rpm, and the supernatant containing solvent and lipids was then removed. The process was repeated until the supernatant was clear and colorless following centrifugation. Samples were re-dried at 50°C for 24 hours to remove any remaining solvent. This method produced the most complete removal of tissue lipids compared to methods using non-polar solvents (Logan and Lutcavage 2008).

In an attempt to reconstruct seasonal changes in diet, whiskers were subsampled at 1cm intervals from the base, and each subsample was analyzed separately. In the absence of species-specific whisker growth rates for the seals within Iliamna Lake, whisker growth was assumed to follow the growth curve previously determined for grey seals (Greaves et al. 2004). Curvilinear growth rates have also been documented by researchers at the University of California Santa Cruz (Beltran et al. 2015). We assumed that whiskers were shed annually (Hirons et al. 2001; Zhao and Schell 2004). Once biosynthesis date was determined, whisker samples from different seals were aligned in time, and the overall seasonal pattern described. Isotopic signatures for potential lacustrine and marine prey items (Table 4-3) were taken from the literature (Denton et al. 2010; Johnson 2011; Kline 2013; Kurle et al. 2011) and compared to values for seal whiskers, and muscle, using the Bayesian Stable Isotope Analysis package in R (SIAR v. 4.2). In this effort, trophic discrimination factors 2.8 for $\delta^{15}N$ and 3.2 for $\delta^{13}C$ were used (Hobson et al. 1996).

Table 4-3.–Stable isotope values for potential prey resources used in dietary reconstruction, seal samples, Iliamna Lake, Alaska.

Diet category	Species	δ15N	δ13C	Sample location	Data source
Marine	Walleye pollock	13.6	-19.9	Bering Sea, summer	Kurle et al. 2011
Marine	Walleye pollock	12.3	-19.1	Bering Sea, winter	Kurle et al. 2011
Marine	Pacific herring	14.5	-19.9	Bering Sea	Kurle et al. 2011
Marine	Eulachon	13.5	-19.4	Bering Sea	Kurle et al. 2011
Marine	Pacific cod	16.2	-17.3	Bering Sea, summer	Kurle et al. 2011
Marine	Arrowtooth flounder	15.2	-19.3	Bering Sea, summer	Kurle et al. 2011
Freshwater	Sockeye smolt	9.1	-26.5	Kvichack River	Kline 2013
Freshwater	Sockeye smolt	9.7	-26	Kvichack River	Kline 2013
Freshwater	Dolly Varden	12.81	-21.01	Iliamna River	Denton et al. 2010
Freshwater	Dolly Varden	13.57	-21.67	Iliamna Lake	Denton et al. 2010
Freshwater	Arctic char	11	-21.74	Iliamna Lake	Denton et al. 2010
Freshwater	Arctic char < 50 mm	8	-18	Iliamna Lake	Denton et al. 2010
Freshwater	Arctic char 50–350 mm	10	-19	Iliamna Lake	Denton et al. 2010
Freshwater	Arctic char > 350 mm	12	-23	Iliamna Lake	Denton et al. 2010
Freshwater	Dolly Varden < 75 mm	10	-25	Pedro Bay Ponds	Denton et al. 2010
Freshwater	Dolly Varden < 75 mm	9	-25	Iliamna Lake	Denton et al. 2010
Freshwater	Dolly Varden > 125 mm	13	-21	Iliamna Lake	Denton et al. 2010
Adult salmon	Sockeye salmon, age 2	11.24	-17.06	Kvichak River	Johnson 2011
Adult salmon	Sockeye salmon, age 2	11.21	-16.85	Ugashik, Bristol Bay	Johnson 2011
Adult salmon	Sockeye salmon, age 2	11.21	-16.91	Egegik, Bristol Bay	Johnson 2011
Adult salmon	Sockeye salmon, age 2	11.42	-16.94	Naknek, Bristol Bay	Johnson 2011

Genetic Analyses

Skin and/or muscle samples from 10 seals were provided to Dr. Greg O'Corey-Crowe for genetic analysis to determine species and likely stock of origin, with duplicate samples archived at NMML in Seattle, Wash. The final analyzed sample included 3 additional samples from archived material. The samples were collected over the period of 1996–2012 (see Table 5-3 for details). Total DNA was successfully isolated from all samples using standard cell lysis-protein digestion methods followed by silica-based DNA extraction and recovery protocols. Tissue lysis and digestion steps were automated using the FastDNA™ kit and the FastPrep™ instrument (Qbiogene, Inc., Carlsbad, Calif.). The concentration and quality of the purified DNA from all samples were estimated by spectrophotometry. Each sample was screened for variation within a 435bp fragment of the mtDNA genome and 11 independent microsatellite loci. The 11 microsatellite loci were used to confirm that 13 individuals composed the dataset. Slightly less loci (n = 9–10) were used in all subsequent analyses (see below). A polymerase chain reaction (PCR)-based method was used for gender determination (Fain and LeMay 1995). For more details on lab techniques see O'Corry-Crowe (2013).

We used mtDNA sequence data (435bp) from over 1,400 harbor seal samples from across the North Pacific, including 1,271 from Alaska waters and 247 samples from spotted seals, to identify the mtDNA lineage of the Iliamna animals to species. We also compared the multi-locus genotypes of the Iliamna seals to genotypes from 684 harbor seals and 202 spotted seals to assign the nuclear profiles of the lake seals to species. This analysis comprised 9 loci that were screened in both species sample sets. To determine the level of mtDNA differentiation between Iliamna and neighboring Bristol Bay seals, a subset of 76 harbor seals from Bristol Bay were used in the mtDNA analysis and 39 seals from Bristol Bay were used in the mtDNA analysis.

4.3. The Integration of Local and Scientific Knowledge

The integration of local and scientific knowledge into a synthesized understanding of the ecology of seals within the lake was achieved by comparing results from the data obtained through interviews, surveys, and samples, and treating both data sets as equally valid and worthy of evaluation. For this reason, results of the different methods are not reported separately, but together, with similarities and differences discussed when they occur. In addition, the results and discussion of the 2 methods are combined into a single section with an overall conclusions chapter following. Successful integration of these results was informed by community review meetings conducted in July 2013. Between July 9–12, 2013, Helen Aderman (BBNA), Burns (UAA), Danielle Stickman (BBNA), Van Lanen (ADF&G), and Withrow (NMML) traveled to Iliamna, Newhalen, Kokhanok, and Igiugig to present preliminary research results to the study communities. Draft aerial survey, bio-tissue sampling, local traditional knowledge, and systematic household survey results were presented and community members were given the opportunity to ask questions and provide comment. Comments received from these meetings have been used to fine tune some of the social science information contained in this report, as well as the interpretation of how the 2 ways of knowing (i.e., Western scientific study and local traditional knowledge) differed. This final report was also sent to communities for their review.

5. INTEGRATED RESULTS AND DISCUSSION

5.1. Subsistence Household Survey and Ethnographic Interview Achievement

For the 2010 study year, subsistence household surveys were successfully completed in Kokhanok and Newhalen. Attempts were made to survey Iliamna, but refusal rates were high; because the sample obtained was too small relative to the size of the community to provide an accurate description of the community's marine mammal harvest and use activities, details from Iliamna for 2010 are not provided here (Table 5-1). Due to slightly different sampling procedures, data for the 2010 study year are presented in this report as they were received (only reported values are given; no estimates were made), as opposed to the 2011 data, which are expanded to account for unsurveyed households to estimate community results.

For the 2011 study year, a total of 181 households were identified in the 6 participating communities. Subsistence household surveys were completed with 150 households (83%) (Table 5-1). Due to the small size of the participating communities, researchers attempted a census sample in each community. The lowest sample achievement rate occurred in Pedro Bay, where 12 of 16 households (75%) were surveyed, and the highest rate occurred in Igiugig, where 94% of the households were surveyed. Refusal rates ranged from 0% in Igiugig to 16% in Iliamna. Additionally, the research team made contact with an active seal hunter from the small community of Pope-Vannoy (3 households) and the results of that inquiry are also included as reported harvests in the 2011 marine mammal harvest estimates presented in this report. Demographic information on the households sampled for the 2010 and 2011 survey years is provided in Table 5-2.

Ethnographic interviews were conducted with a diverse cross-section of Iliamna Lake area residents, including "young adult hunters" (defined in this research as those between the age of 20–39), "middle-aged hunters" (defined as those between the age of 40–59), and "elders" (defined as those over the age of 60). Of the participating respondents, 12 were elders, 7 were middle-aged hunters, and 4 were young adult hunters. The perspectives of both men and women are important in obtaining a thorough understanding of subsistence harvest and use practices. Therefore, gender also played a role in the selection of respondents. Six women were interviewed: 5 elder women and 1 female middle-aged hunter. The remaining 17 respondents were male. Respondents from the participating communities ranged from 27 to 81 years of age. The average age of respondents was 57.

5.2. Integrated Knowledge About the Seals of Iliamna Lake

5.2.i. Origin of Seals

Oral tradition handed down from generation to generation asserts that seals originated in Iliamna Lake long before humans ever inhabited the region. Most respondents from the communities participating in the research for study years 2010 and 2011 believed that seals have always lived in Iliamna Lake. None of the respondents could recall a time when seals were not present in Iliamna Lake, nor did any of the respondents recall being told by previous generations of a time when seals were absent from the lake. "*I never heard the elders say that there was any point [in time] that there were no seals*," said a Newhalen hunter. Another Newhalen hunter said, "*These seals have been here since way before my time, and I think way before my grandparents' time … they were here before we [humans] were.*" Reflecting on what he had heard from elders in the past, an Iliamna elder said, "*There are some stories; seals came from the ocean under the cracks from the ocean floor to the lake, from outside of this area. Legend says that seals came from under the mountains. There is a big crack somewhere.*" Other respondents suggested that the seals became trapped in the lake long ago during an ice age event. A Kokhanok hunter recalled that when he was young elders told him that a very long time ago the seals got stuck in the lake because of permanent ice in the Kvichak River watershed and were forced to stay in the lake permanently. These observations concur with the methods by

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Table 5-1.–Sample achievement, Kokhanok and Newhalen, 2010, and Igiugig, Iliamna, Kokhanok, Levelock, Newhalen, and Pedro Bay, 2011.

	2010		2011					
	Kokhanok	Newhalen	Igiugig	Iliamna	Kokhanok	Levelock	Newhalen	Pedro Bay
Number of dwelling units	–	–	18	25	47	30	45	16
Interview goal	40	26	18	25	47	30	45	16
Households interviewed	40	26	17	21	43	23	34	12
Households failed to contact	7	16	1	0	1	6	5	2
Households declined to be interviewed	0	0	0	4	3	1	6	2
Households moved or nonresident	–	–	1	1	3	0	3	0
Total households attempted to interview	47	43	17	25	46	24	40	14
Refusal rate	0.0%	0.0%	0.0%	16.0%	6.5%	4.2%	15.0%	14.3%
Final estimate of permanent households	–	–	18.0	25.0	47.0	30.0	45.0	16.0
Percentage of total households interviewed	–	–	94.4%	84.0%	91.5%	76.7%	75.6%	75.0%
Interview weighting factor	1.0	1.0	1.1	1.2	1.1	1.3	1.3	1.3
Sampled population	140.0	95.0	56.0	62.0	125.0	66.0	124.0	20.0
Estimated population	–	–	59.3	73.8	136.6	86.1	164.1	26.7

Source ADF&G Division of Subsistence household surveys, 2011 and 2012.

Note "–" indicates insufficient data about community households and that sampling estimates were not calculated.

Table 5-2.–Sample and demographic characteristics, Kokhanok and Newhalen, 2010, and Igiugig, Iliamna, Kokhanok, Levelock, Newhalen, and Pedro Bay, 2011.

¶

	2010		2011					
Characteristics	Kokhanok	Newhalen	Igiugig	Iliamna	Kokhanok	Levelock	Newhalen	Pedro Bay
Sampled households	40	26	17	21	43	23	34	12
Eligible households	–	–	18	25	47	30	45	16
Percentage sampled	–	–	94.4%	84.0%	91.5%	76.7%	75.6%	75.0%
Household size								
Mean	3.5	3.7	3.3	3.0	2.9	2.9	3.6	1.7
Minimum	1	1	1	1	1	1	1	1
Maximum	13	7	9	7	8	6	7	4
Sample population	140.0	95.0	56.0	62.0	125.0	66.0	124.0	20.0
Estimated community population	–	–	59.3	73.8	136.6	86.1	164.1	26.7
Age								
Mean	32.4	29.5	28.6	36.6	33.1	28.9	26.9	48.9
Minimum[a]	1	1	0	0	0	0	0	12
Maximum	85	82	80	79	79	76	74	70
Median	28	24.5	23	38.5	29	24	23.5	51
Length of residency								
Total population								
Mean	21.9	22.1	14.8	24.9	25.5	19.8	21.2	24.2
Minimum[a]	0	0	1	1	1	0	0	3
Maximum	72	73	76	80	76	76	74	57
Heads of household								
Mean	30.8	31.8	25.0	31.7	34.1	31.7	32.4	26.2
Minimum	3	1	1	3	1	1	1	3
Maximum	72	73	76	80	72	76	74	57
Sex								
Estimated male[c]								
Number	69.0	44.0	25.4	39.3	64.5	47.0	83.4	13.3
Percentage	49.3%	46.3%	42.9%	53.2%	47.2%	54.5%	50.8%	50.0%
Estimated female[c]								
Number	69.0	51.0	33.9	34.5	72.1	39.1	80.7	13.3
Percentage	49.3%	53.7%	57.1%	46.8%	52.8%	45.5%	49.2%	50.0%
Alaska Native								
Estimated households[b, c]								
Number	36.0	25.0	16.9	16.7	42.6	26.1	39.7	12.0
Percentage	90.0%	96.2%	94.1%	66.7%	90.7%	87.0%	88.2%	75.0%
Estimated population[c]								
Number	128.0	90.0	52.9	48.8	125.7	80.9	148.2	20.0
Percentage	91.4%	94.7%	89.3%	66.1%	92.0%	93.9%	90.3%	75.0%

Source Bristol Bay Native Association and University of Alaska Anchorage household surveys, 2011.

Note "–" indicates insufficient data about community households and that sampling estimates were not calculated.

a. A minimum age of 0 (zero) is used for infants that are less than 1 year of age.

b. The estimated number of households in which at least one head of household is Alaska Native.

c. For the 2010 study year communities Kokhanok and Newhalen, the data are reported values.

Table 5-3.–Summary of mtDNA haplotype and microsatellite assignment based on testing of seals from Iliamna Lake.

		Collection		mtDNA		Mitochondrial DNA			
								Assignment (Q value)	
Lab ID	Field ID	Date	Location	Haplotype	Species lineage	No. loci screened	No. loci scored	P. larga	P. vitulina
Z5984	AF13937	1996	Iliamna Lake	7	P vit	9	9	0.007	0.993
Z60967	PV98008B/Il	1998	Iliamna Lake	7	P vit	9	9	0.088	0.912
H5760	PV-Il-AK2002-01	2002	Iliamna Lake	–	P vit	9	5	–	–
Z74418	AF70846	2008	Iliamna Lake	7	P vit	9	9	0.006	0.994
H5762	PV-IL-AK2011-02	2011	Iliamna Lake	7	P vit	9	9	0.006	0.994
H5764	PV-IL-AK2012-01	2012	Iliamna Lake	7	P vit	9	8	0.009	0.991
H5765	PV-IL-AK2012-02	2012	Iliamna Lake	7	P vit	9	9	0.011	0.989
H5766	PV-IL-AK2012-03	2012	Iliamna Lake	7	P vit	9	7	0.008	0.992
H5767	PV-IL-AK2012-04	2012	Iliamna Lake	7	P vit	9	9	0.004	0.996
H5769	PV-IL-AK2012-05	2012	Iliamna Lake	7	P vit	9	9	0.004	0.996
H5771	PV-IL-AK2012-06	2012	Iliamna Lake	7	P vit	9	9	0.029	0.971
H5772	PV-IL-AK2012-07	2012	Iliamna Lake	7	P vit	9	8	0.006	0.994
H5774	PV-IL-AK2012-08	2012	Iliamna Lake	–	P vit	9	8	0.004	0.996

Note "–" indicates that the sample was not of sufficient quality for haplotype determination.

Note Nuclear analysis was based on a set of 9 microsatellite loci screened in 684 harbor seals and 202 spotted seals.

which other freshwater seal populations, including the Lake Saimaa ringed seals in Finland and the Lac de Loups harbor seals in Quebec, are thought to have originated (i.e., as a result of glacial and hydrological systems changes during the last ice age approximately 8,000 years ago) (Ranta et al. 1996; Smith and Horonowitsch 1987). Many respondents suggested that whatever their origins in the lake, the seals found their way into the lake as a result of pursuing fish to eat. "*I guess they just follow the salmon up,*" said an Igiugig elder, and a Newhalen hunter said, "*Seals got here by following the fish, thousands of years ago, and they stayed here because of the fish population.*" A Kokhanok hunter said, "*I imagine the seals, at one time, they came from the salt water up here and they just stayed.*" Respondents expressed an interest in future archaeological research that would attempt to establish dating of prehistoric harvest and use of seals by early inhabitants of Iliamna Lake.

Insights into the origin of the seals as provided by genetic analysis confirm these oral traditions. Of the 13 samples obtained from seals in Iliamna Lake, 11 of them provided high-quality sequence data. All these seals possessed mtDNA haplotype P vit-Hap#7 that is characteristic of harbor seals *Phoca vitulina* (Table 5-3). Using multi-locus genotypes based on 9 microsatellite loci that were screened in both spotted *P. largha* (n=202) and North Pacific harbor (n=684) seals, all Iliamna Lake individuals with sufficient data (n=12/13) were assigned to harbor seal with a high degree of confidence (Table 5-3). Bayesian cluster analysis using the program Structure 2.3.4 (Hubisz et al. 2009; Pritchard et al. 2000), under the model of admixture and without any prior information on sampling location, found that the 12 Iliamna Lake seals that were scored at 7 or more loci had very high likelihoods of *P. vitulina* inferred ancestry (Table 5-3). Because the sample size was small, these results must be interpreted with caution. There were high-quality sequence data for just 11 individuals and multi-locus microsatellite data for 12 seals. Nevertheless, the samples were collected from a number of locations and seasons over a 16-year time span, providing a certain amount of confidence that the findings are representative of the population. The consistent assignment of all samples to *P. vitulina* and not *P. largha*, for example, indicate that the Iliamna Lake seals are most likely harbor seals and are unlikely to have spotted seal ancestry. Given regional topography and historical sea level patterns, the only possible site of origin for harbor seals within Iliamna Lake is Bristol Bay.

5.2.ii. Phenotypic Characteristics of Freshwater Versus Saltwater Seals

The consensus of respondents from the study communities, and of researchers analyzing the genetic data, is that the seals residing in Iliamna Lake are some type of harbor seal *P. vitulina*. Still, local knowledge posits that a distinction exists between seals that are uniquely adapted to the Iliamna Lake freshwater habitat and seals that are not. Many community respondents suggested that the fish-abundant, clearwater environment of Iliamna Lake is an ideal habitat for harbor seal settlement. Because of the seals' unique adaptation to the habitat, the seals within Iliamna Lake are said to have different physical characteristics than saltwater seals.

While some respondents did report difficulty in being able to tell the difference between saltwater and freshwater seals by observation of their physical characteristics, other respondents reported that it is often possible to tell the difference between freshwater and saltwater seals by observation. "*Saltwater seals, they look totally different,*" said a Kokhanok hunter. The primary means by which local knowledge makes a distinction between the physical characteristics of saltwater and freshwater seals is by observation of their size and color. With the exception of one Iliamna respondent who reported that saltwater seals are generally larger in size, all key respondents reported that freshwater seals are larger than saltwater seals. "*When I first saw a big seal I couldn't believe how big they get,*" said a Newhalen hunter. While some hunters reported observations of bull seals longer than 10 ft in length in Iliamna Lake, most described the average length of seals found in the lake to range between 6 ft to 8 ft long. A Newhalen hunter said that his 2011 harvest measured 7 ft 4 in long. A Pope-Vannoy hunter that has weighed the seals she has harvested over the years said, "*Most of the seals I have got have been around 120 pounds, but my biggest one I got was last year on the ice and we weighed it and it was about 185 pounds, maybe 190 and that was the biggest seal I have got so far.*"

Estimates of seal length were provided for only 3 of the harvested seals (see Table 4-2), and ranged from 51.5 in to ~72 in. These values are similar to those commonly measured in other regions of Alaska, where the average length for adult harbor seals varies but rarely exceeds 6 ft (Blundell and Pendleton 2008; Burns 2002). Note that while standard morphometric measurements do not take flippers into account in the total length, oral history accounts may include flipper length within the seals' apparent size, and flippers would add approximately 1 ft to the overall appearance (Savarese 2004), bringing both reported and measured length estimates into alignment. While none of the harvested seals were weighed, weights reported in interviews for seals harvested in the lake appear within the range of those expected for seals in Alaska (maximum of 200–250 lb) (Blundell and Pendleton 2008; Burns 2002).

Respondents also reported that freshwater seals are fatter than saltwater seals. For example, a Newhalen hunter said, "*These seals here [Iliamna Lake], their fat is like 5 to 6 in, they're real fat.*" Community respondents said that the reason why the seals within Iliamna Lake are relatively large and are very healthy is because of an abundance of rich food sources available in Iliamna Lake. "*They're [Iliamna Lake seals] eating good. The lake is very rich and the local people take care of the land here, there is not a lot of trash, and the water is very clean,*" said a Newhalen hunter. A Kokhanok hunter said, "*Lake seals are fatter [than saltwater seals] because they have lots of trout to eat year–round,*" and that seals do not have to work as hard for their food. "*They [Iliamna Lake seals] don't have to travel very far. In the salt water, if they [seals] want to go out to the Pribilofs [islands] after pollock [*Theragra chalcogramma*] they have to swim a long ways.*" For this reason, the hunter said that as an adaptation to traveling long distances saltwater seals "*are more streamlined*" in shape than are freshwater seals. Yet a Pedro Bay elder pointed out that the seals within Iliamna Lake often must dive much deeper underwater to feed than do saltwater seals and, because of their ability to go very deep underwater, "*freshwater seals are more limber, down the stomach, probably, because they go deeper for feeding, that is why freshwater seals are limber.*" A Newhalen hunter said that he can also tell the difference between a freshwater and saltwater seal by looking at its teeth. "*Freshwater seal teeth are very white and nice and saltwater seal teeth are more yellowish [in color],*" said the hunter.

Most community respondents also reported that the color of freshwater seals and the texture of their fur are different from saltwater seals. While most respondents described the seals observed in the lake as being a mix of grey and black in color, some respondents reported the existence of unique dark, black-colored seals in Iliamna Lake. An Igiugig hunter said that the seals display a variety of coloring patterns which range

from "*grey and black [grey on black], black and grey [black with grey spots], white and grey, and brown,*" while a Pope-Vannoy hunter said, "*Most of the ones I get have a fair amount of black color to them.*" These reports were contrasted by those of other respondents who asserted that saltwater seals are generally darker in color than freshwater seals. Comments by some respondents provide some clarity to this contradiction. A Kokhanok hunter explained that saltwater seals are generally "*more greyish*" in color than freshwater seals and that freshwater seals generally lean more toward being either very light or very dark in color. Similarly, a Newhalen hunter said that freshwater seals "*are either really dark or really light over here [in Iliamna Lake] and the ones down in Naknek [in the ocean] are in–between.*" The hunter said that seals as dark in color as those found in Iliamna Lake do not exist in salt waters. In addition, most community respondents reported that freshwater seals often have more elaborate color patterns than do saltwater seals: "*Freshwater seal furs have more dark black spots on them and lighter white in between,*" said a Kokhanok hunter. "*Sometimes they are silver and black but when the fur dries out it turns more white*," continued the hunter.

Respondents also reported that the seals within Iliamna Lake often have softer, less coarse fur than do saltwater seals. For this reason the skins of the seals within Iliamna Lake are preferred over the skins from saltwater seals for use for sewing and crafts. Some residents from Iliamna disagreed that there are major differences between seal fur harvested in Iliamna Lake or Bristol Bay. An Iliamna elder said that tanned seal pelt color and softness is affected by the way in which the raw pelt was handled prior to tanning. The elder said that if the oil is not scraped thoroughly from the skin the final product will appear more yellow in color. Similarly, First Nations people local to the Lac de Loups area report that Lac de Loups freshwater seals have softer pelts and a taste that is distinct from saltwater harbor seals.[1]

Across their range, harbor seal pelage patterns are known to vary quite extensively. While in California a larger proportion of the harbor seals are dark with light spots, in Washington the pattern is reversed; and in Alaska the relative proportion of different color morphs varies by location (Kelly 1981; Shaughnessy and Fay 1977; Stutz 1967). These phenotypic differences may reflect genetic drift or represent a balanced polymorphism across an environmental gradient (Kelly 1981; Shaughnessy and Fay 1977; Stutz 1967). In addition, some of these differences might be due to the time of harvest, since spring is a preferred harvest time for lake seals (see section "5.4. Seal Hunting Strategies, Past to Present"), while most saltwater seals are harvested in mid- to late summer. Because harbor seals typically molt in late summer (Daniel et al. 2003; Kelly 1981; Moss 1992), some differences in pelage texture and/or coloration might be due to the status of the hair itself.

Seal hunters from the Iliamna Lake region also report that male and female seals differ in characteristics, such as their size and color. Respondents reported that adult male seals are generally larger than adult female seals. An Iliamna elder said that it is easy to differentiate the sex of a seal by looking at "*their sizes when they are on the reefs.*" Some respondents said that when a seal is in the water, or if its body is obscured, its sex can be determined by the size of its head. A Newhalen hunter said, "*Females have a smaller head, and it's long, but smaller. Males have a real big head [and it is shaped] more like a bulldog.*" Size differences in skulls is known to exist in other pinniped species (Jones and Goswami 2010) with differentiation typically greater in species with higher degrees of sexual size dimorphism. While the degree of sexual size dimorphism is slight in harbor seals (Bigg 1969; Burns 2002; Pitcher 1977), differences in cranio-facial morphology may exist in harbor seals as well. In addition, respondents reported that seals of darker color tend to be males. "*Really dark ones are male,*" said a Pedro Bay elder, and that the largest (and presumably male) seals found in the lake are normally all black in color. For example, a Newhalen hunter said, "*The big ones are pure black, [with] no spots on them.*" Such variation in pelage color pattern by sex has not been reported in the scientific literature for harbor seals.

While some respondents assert that the difference between freshwater and saltwater seals can be ascertained by observation of the physical characteristics described above, others maintain that the difference can only be told by taste. For example, an Igiugig elder said, "*You can't tell the difference on the outside of the seal [whether its freshwater or saltwater], but the taste changes.*" A Levelock elder said, "*Folks know*

1. Department of Fisheries and Oceans Canada. 2015. "Aquatic species, aquatic species at risk: harbor seal Lacs des Loups marine subspecies, description," http://www.dfo-mpo.gc.ca/species-especes/profiles-profils/harbourseal-phoquecommun-eng.html (accessed October 2015).

which ones came down the [Kvichak] river and which ones stayed [in the lake] because they each have a different kind of oil." Still, while most respondents were confident that they could tell the difference between saltwater seals and freshwater seals by the taste of their oil, there was considerable disagreement among respondents as to which of the 2 types of oil is stronger in taste. Many respondents reported that oil from saltwater seals is much stronger in taste than oil from freshwater seals. For example, a Pedro Bay elder said, "*The taste [of freshwater seal oil] is a little more watered down [than that of saltwater seal oil], [it has] a freshwater flavor,*" and an Iliamna elder said, "*[freshwater seal] oil is lighter, stays clear, [keeps] longer, and doesn't taste as fishy [as saltwater seal oil].*" Similarly, a Newhalen hunter said, "*You can taste the difference when you go down to the [Bristol] bay, [saltwater seal oil is] stronger, seems like it burns more, [it's] too strong.*" Yet other respondents reported that oil from freshwater seals is stronger in taste than oil from saltwater seals. For example, a Newhalen hunter said, "*The difference is, these here [Iliamna Lake seals] are tangier than [saltwater seals], they're really strong.*" An elder from Igiugig agreed: "*I guess [seals] from the salt water, that makes them taste a little better than the freshwater [seals], [fresh water] doesn't clean them out like the salt water does.*" Moreover, there was disagreement about differences in the shelf life of seal oil from freshwater seals and seal oil from saltwater seals. Some respondents reported that freshwater seal oil has a much longer shelf life than does oil from saltwater seals while other respondents reported that freshwater seal oil does not keep as long as saltwater seal oil. For example, a Pedro Bay elder said, "*Freshwater seal oil spoils faster, [because it has a] higher oxygen content than saltwater seal oil.*" An Iliamna elder said that strong-tasting oil may have more to do with the length of time the oil has been stored than the oil being sourced from either a seal from Iliamna Lake or Bristol Bay.

Seasonality may play a role in taste distinction. Several respondents reported that the seals within Iliamna Lake do become extremely strong in taste during and after the salmon runs, as a result of their heavy fish consumption, and for this reason many residents avoid consuming seals at this time. A Kokhanok hunter explained that when freshwater seals have been eating salmon they are stronger in taste than saltwater seals ever are, but that saltwater seals remain consistently fishy in taste: "*If you get 'em [seals] in the falltime here [in Iliamna Lake] they're pretty goddamn strong, [because they eat] a lot of salmon. If you get 'em [seals] in the spring in the salt water they're not that strong but they have been into the herring and other stuff in there so they have a taste to 'em.*"

As a result of these reported differences between saltwater seals and freshwater seals, community respondents who consume seal meat and oil voiced different preferences for freshwater and saltwater seals. While a few respondents did report a preference for saltwater seals over freshwater seals, most respondents reported a preference for freshwater seal oil and freshwater seal meat over that of saltwater seals. For example, a Newhalen hunter said, "*Can't beat that freshwater seal. If guys give me saltwater seal I'll take a little bit, but not too much, I prefer this freshwater seal,*" and an Igiugig hunter said, "*I've tasted saltwater seal, and I'm not a big fan of it. I love freshwater seal [meat] and I love freshwater seal oil. It's so much better I think.*" Likewise, a Kokhanok hunter said, "*I think the saltwater seals taste stronger versus the freshwater seals … I prefer a freshwater seal over a saltwater seal.*" Respondents also reported that when Iliamna Lake residents share or trade freshwater seal oil with people from other communities who normally consume saltwater seal oil, those people normally end up preferring freshwater seal oil from Iliamna Lake over saltwater seal oil from Bristol Bay. For example, a Newhalen hunter said, "*The oil [from Iliamna Lake seals] doesn't have that strong taste to it … I found out that even the people in Stuyahok like the oil from here better than the oil from salt water.*" A Pope-Vannoy hunter said: "*My sister goes up north and she brings some of the seal oil that I get with her and she says that up north the people really really like the seal oil from here [Iliamna Lake], they say it's a little bit different … they can notice a difference.*" Residents of the area do display general taste preferences for other resources besides seals. For example, residents also relate how they prefer the taste of locally caught salmon in the lake system to that of fish from the marine environment of Bristol Bay (Fall et al. 2010), and note that they show seasonal preferences for brown bears *Ursus americanus* that are dependent on what the bears are eating (Holen et al. 2005).

5.2.iii. Feeding Behavior of the Seals Within Iliamna Lake

Fish are the primary source of food for the seals within Iliamna Lake. A Newhalen elder said, "*They subsist entirely on fish.*" Salmon are particularly important, especially sockeye salmon *Oncorhynchus nerka*. Chinook salmon *O. tshawytscha*, coho salmon *O. kisutch*, pink salmon *O. gorbuscha*, and chum salmon *O. keta* are also potential sources of food for the seals within Iliamna Lake, and salmon carcasses showing signs of being depredated by seals are commonly found (Hauser et al. 2008). Still, salmon do not make up the entirety of the seal diet; respondents explained that the seals within Iliamna Lake feed on both salmon and nonsalmon fish, even during the summer.

Respondents reported that when salmon are not present in the lake the seals feed primarily on several species of nonsalmon fish such as lake trout *Salvelinus namaycush*, rainbow trout *O. mykiss*, Arctic char *S. alpinus*, Dolly Varden *S. malma*, Arctic grayling *Thymallus arcticus*, and longnose sucker *Catostomus catostomus*. Many other nonsalmon fish present in the lake are potential sources of food for seals. These include rainbow smelt *Osmerus mordax*, pond smelt *Hypomesus olidus*, burbot *Lota lota*, round whitefish *Prosopium cylindraceum*, humpback whitefish *Coregonus pidschian*, pygmy whitefish *P. coulterii*, least cisco *C. sardinellas*, Arctic cisco *C. autumnalis*, northern pike *Esox lucius*, threespine stickleback *Gasterosteus cognatus*, ninespine stickleback *Pungitius pungitius*, slimy sculpin *Cottus cognatus*, coastrange sculpin *C. aleuticus*, Alaska blackfish *Dallia pectoralis*, and Pacific lamprey *Lampetra tridentatata* (Bond and Becker 1963; Hauser et al. 2008). Note that both smelt and least cisco are also sometimes called "freshwater herring" by Iliamna Lake residents (Krieg et al. 2005; Stickman et al. 2003). Residents also report that crushed clam shells are often found inside the guts of harvested seals, and suggest that seals feed on freshwater clams and snails. However, directed foraging on shellfish has not previously been described for harbor seals, and secondary ingestion may account for these observations since several of the freshwater fish that seals potentially prey upon are themselves known to forage on benthic invertebrates.

Eight stomach samples were obtained through the biosampling program, but only 3 of these contained any identifiable hard parts (Table 5-4). Two others contained a variety of unidentified round worms, while the remaining 2 were completely empty. The stomachs that contained identifiable prey parts came from 3 adults (2 male, 1 female), and all were harvested on April 19, 2012. One stomach, from an adult male, was very full of fish bones and otoliths. Most of the otoliths (101) were identified as from the *Oncorhynchus* or *Salvelinus* family; specimens were too small and/or degraded for identification at the species level. A few otoliths (5) were from Arctic grayling, and bones of the threespine stickleback were also recovered. The vertebral columns of the *Oncorhynchus/Salvelinus* specimens were less than 8 cm in length, indicating that the seal was preying on juvenile fish. One stomach from an adult female contained bones from threespine stickleback and *Oncorhynchus/Salvelinus* specimens of similar size. The final stomach from an adult male only included a few bones from *Oncorhynchus/Salvelinus* specimens.

As detailed in the section on seasonal movements ("5.2.vii. Seasonal Variation in Abundance"), the feeding locations of seals fluctuate with the locations of their prey (Figure 5-1). "*They change their locations depending on where fish are,*" said a Pedro Bay elder. Respondents reported that seal activity in Iliamna Lake increases during summer and fall when the salmon enter the lake. As an Iliamna elder said, once the salmon runs begin "*the seals are all over eating salmon.*" Indeed, many respondents expressed a belief that the abundance of salmon in Iliamna Lake is the primary reason for the origin of the population and the continuing presence of seals. For example, when asked about traditional stories of seal origins in the lake an Igiugig elder said, "*I guess they just follow the salmon up, the food they use to survive. All [the seals] have to follow the salmon up and then when the salmon quit spawning, they find the lake trout, and rainbows, and grayling, and whitefish.*" Many respondents pointed out that Iliamna Lake has a consistently abundant escapement of salmon (see Figure 2-2) and because of the abundance of a variety of salmon and nonsalmon fish species it is easy to see why seals have established themselves in Iliamna Lake. As salmon abundance declines, respondents say that seals begin working their way back toward the northeastern portion of the lake for overwintering and for feeding on nonsalmon fish, especially lake trout (Figure 5-2). For example, a Pope-Vannoy hunter said, "*As the lake freezes up they seem to go farther towards the Pedro Bay area*

Table 5-4.–Hard parts identified from stomach contents based on testing of seals from Iliamna Lake.

Field ID	Family	Species	Common name	Element (count)	Classification confidence[a]	Confidence interval[a]	Comments
PV-IL-AK-2012-03	Salmonidae	*Thymallus arcticus*	Arctic grayling	Otoliths (5)	F	ID 100% certain to F	Could also be lake whitefish.
PV-IL-AK-2012-03	Gasterosteidae	*Gasterosteus aculaeatus*	Threespine stickleback	Pelvic spine	F (G/S)	ID 100% certain to F; confident G/S	A few tiny otoliths may be this species.
PV-IL-AK-2012-03	Salmonidae	*Oncorhynchus/Salvelinus* sp.	Salmon/trout	Otoliths (86)	F	ID 100% certain to F	Also vertebrae.
PV-IL-AK-2012-03	Salmonidae	*Oncorhynchus/Salvelinus* sp.	Salmon/trout	Otoliths (15)	(F)	ID tentative to F	These are likely very tiny or very eroded salmonids.
PV-IL-AK-2012-04	Salmonidae	*Oncorhynchus/Salvelinus* sp.	Salmon/trout	Otolith (1)	F	ID 100% certain to F	
PV-IL-AK-2012-05	Salmonidae	*Oncorhynchus/Salvelinus* sp.	Salmon/trout	Vertebrae	F	ID 100% certain to F	
PV-IL-AK-2012-05	Gasterosteidae	*Gasterosteus aculaeatus*	Threespine stickleback	Vertebrae	F (G/S)	ID 100% certain to F; confident G/S	

a. F–family; G–genus; and S–species.

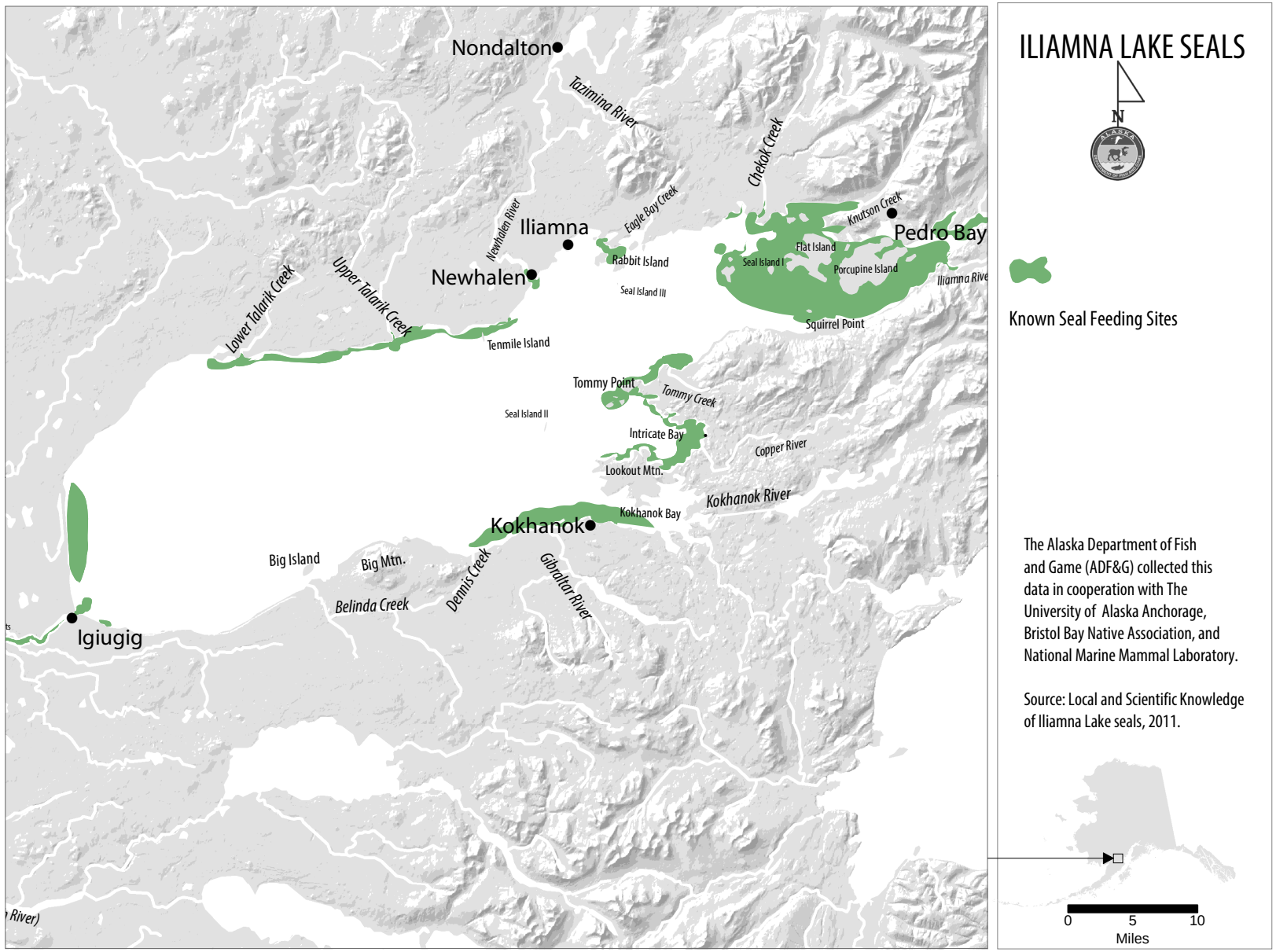


Figure 5-1.–All known seal foraging locations within Iliamna Lake.

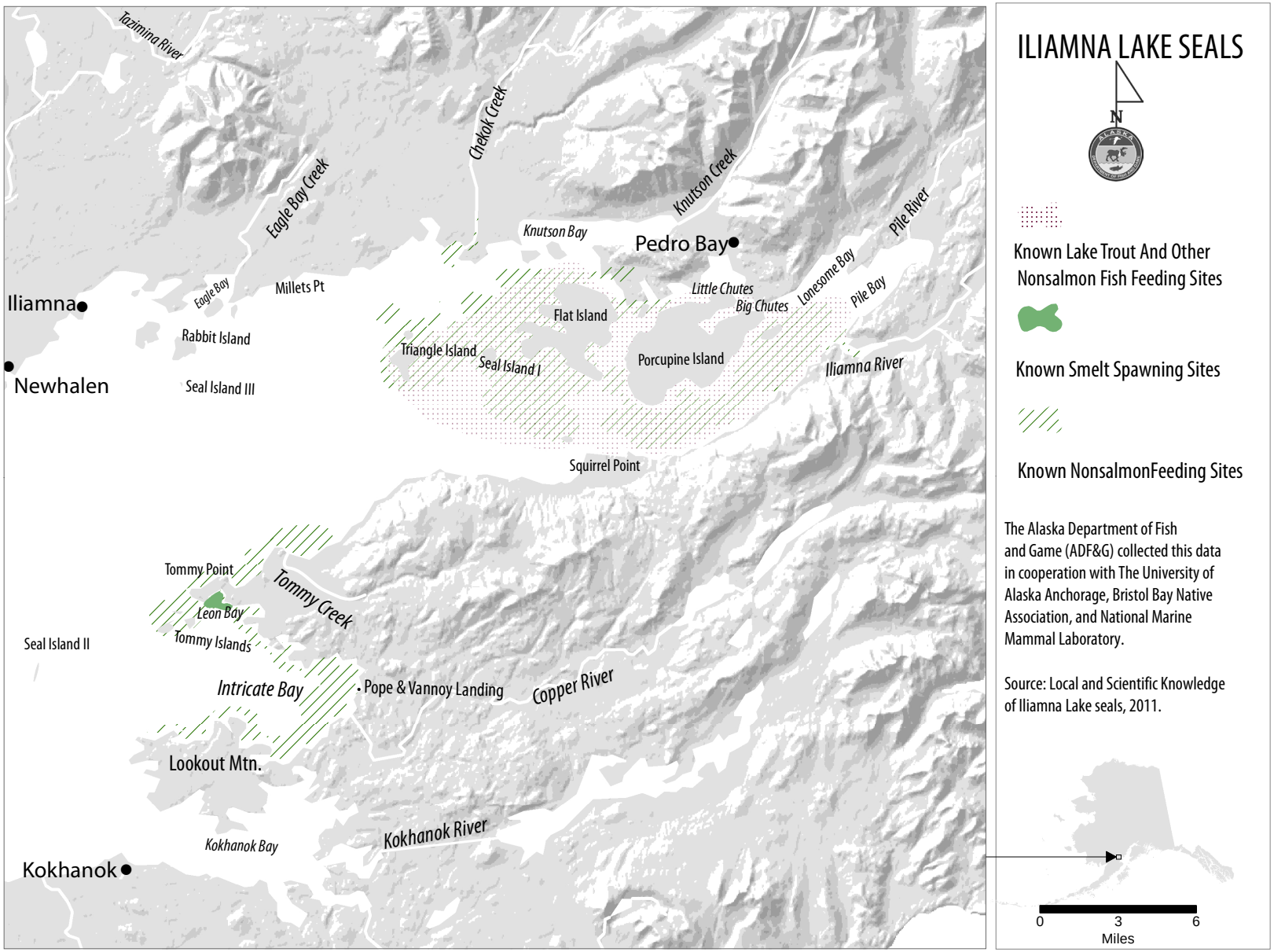


Figure 5-2.–Specific locations where seals forage on prey other than salmon within Iliamna Lake.

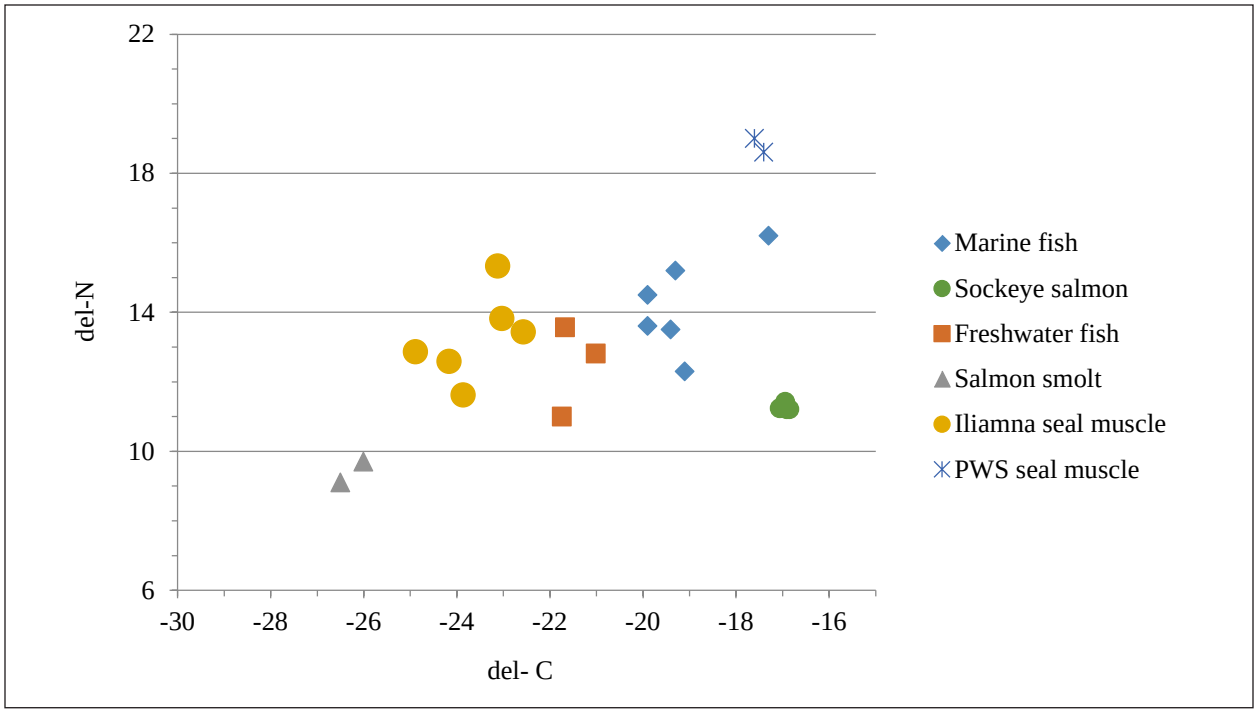


Figure 5-3.–Isotopic values for potential prey species for Iliamna Lake seals, and muscle samples from harbor seals from Iliamna Lake and Prince William Sound, Alaska.

[where the trout are]. Although there is a lot that just stay up there too [during spring, summer, and fall], that's a really common area for them."

Isotopic analysis of seal tissues and whiskers was also used to assess seasonal changes in their diet. In this effort, isotopic values for seal tissues (muscle and whiskers) were compared to literature values for potential marine, anadromous, and freshwater prey resources (Denton et al. 2010; Hobson et al. 1997; Johnson 2011; Kline 2013; Kurle et al. 2011). Marine fish species have higher $\delta^{15}N$ and $\delta^{13}C$ signatures than do freshwater species, with adult salmon falling somewhat between the 2 ends of the spectra, and salmon fry are similar to freshwater fishes (Figure 5-3). Unfortunately, we do not have a library of isotopic values for fish from within Iliamna Lake at different times of the year, and so estimates of the seal diet are likely to be less precise than if such data were available (Kurle et al. 2011).

The isotopic signatures of different tissues are thought to reflect the signature of the source molecules (dietary or endogenous) as well as tissue-specific fractionation processes (discriminate factors) and turnover times (Germain et al. 2012; Newsome et al. 2010). Thus different tissues within the same individual can vary in isotopic signature, with those tissues with faster turnover times reflecting the more recent diet (Germain et al. 2012; Kurle and Worthy 2002; Orr et al. 2009; Todd et al. 2010; Zhao et al. 2006). Less is known about how discrimination factors may vary by tissue or compound source (Bond and Diamond 2011; Newsome et al. 2010). In addition, tissue-specific turnover times are not well known for large mammals, although it is generally thought that metabolically active tissues, such as muscle, integrate diet over the past several months, while more inert tissues, such as whiskers, reflect the diet at the time of tissue synthesis (Germain et al. 2012; Newsome et al. 2010; Orr et al. 2009; Todd et al. 2010; Zhao et al. 2006). These patterns are true for both predator and prey, so that the isotopic signature of the potential prey items for seals within Iliamna Lake may themselves change seasonally to reflect their diet; indeed intraspecific isotopic variation has been detected in many fish due to both diet and size. More specifically, in Iliamna Lake, the isotopic signature of freshwater fish changes in response to their own reliance on salmon-derived nutrients such as eggs and carcasses (Denton et al. 2010; Kline et al. 1998; Kurle et al. 2011; Scheuerell et al. 2007).

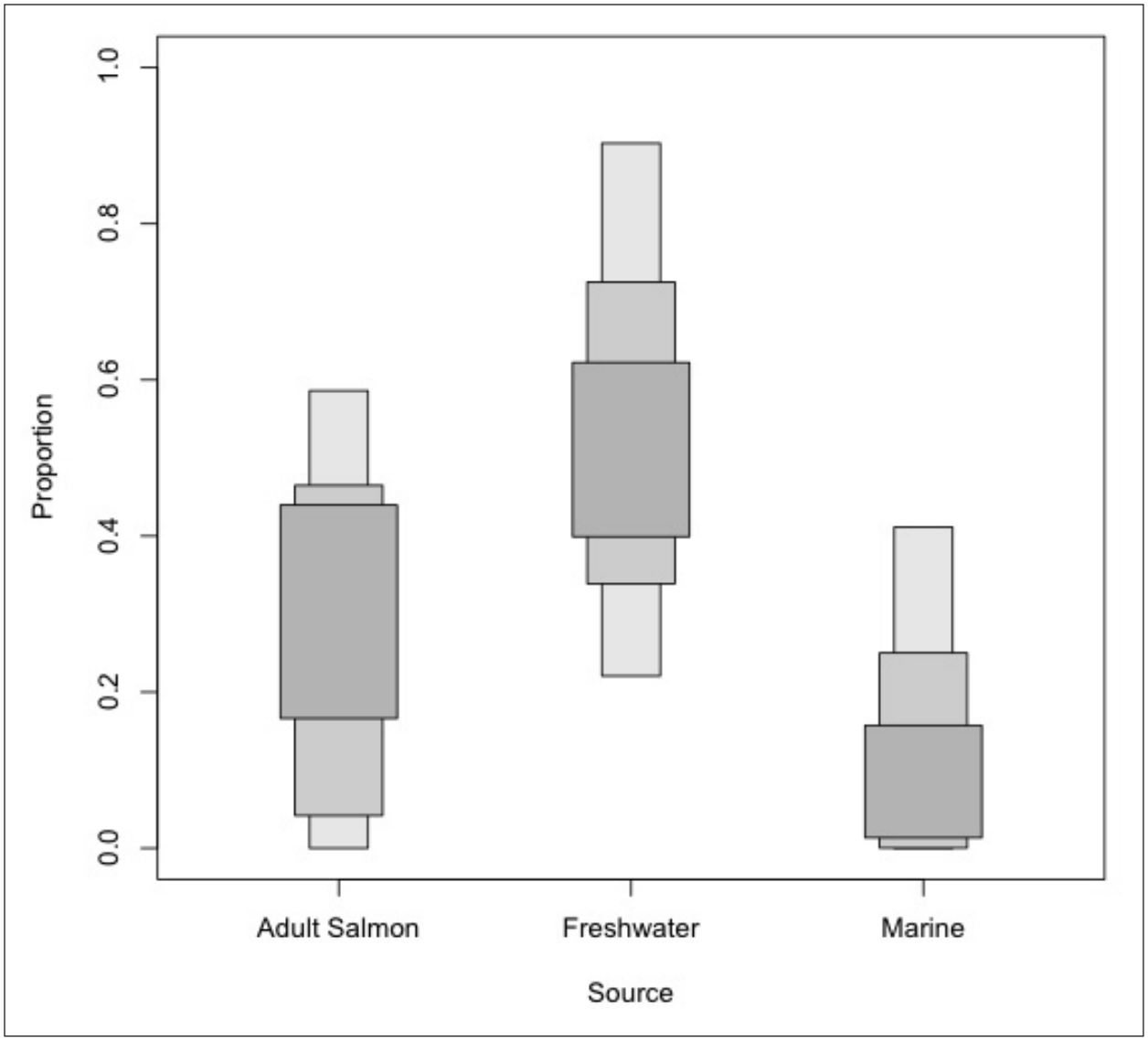


Figure 5-4.–Relative proportion of adult salmon, freshwater, and marine food resources in the diet of harbor seals at the time of harvest, as determined from an analysis of muscle samples.

When the isotopic values for soft tissues (muscle, heart, kidney, liver) for individual seals were compared, we found no difference among tissue types in either $\delta^{15}N$ or $\delta^{13}C$ (paired t-tests, all $p > 0.05$). Therefore, we are presenting only the muscle data from the 7 animals for which they were available. As compared to seals from Prince William Sound (PWS) (Hobson et al. 1997), the isotopic values for muscle from the seals harvested within Iliamna Lake were significantly depleted in both $\delta^{15}N$ and $\delta^{13}C$ (Figure 5-3). In addition, while the PWS seals had $\delta^{15}N$ values more enriched than those for marine fishes from Bristol Bay, as would be expected based on an approximate 3 ppm enrichment in $\delta^{15}N$ up the food chain (Hobson et al. 1997; Newsome et al. 2010), samples from Iliamna had del-N values similar to most marine and freshwater fish, and were only more enriched than salmon smolt. In combination, these findings strongly suggest that seals had been feeding primarily on freshwater fish during the several months prior to harvest (Figure 5-4). There was no significant relationship between date of harvest and $\delta^{15}N$ or $\delta^{13}C$ in these seals, and because the only male samples were 3 of the 4 from April, it is impossible to test whether there are sex-specific differences in diet using these techniques.

Unlike muscle, which continually integrates the diet, isotopic values in whiskers represent the diet at the time the whisker was biosynthesized; isotopic values from close to the base represent a more recent diet than those closer to the tip (Greaves et al. 2004; Hirons et al. 2001; Zhao and Schell 2004), and so there is archive information on the diet for the time over which the whisker was growing. Whiskers were analyzed for 5 seals that were harvested in April, June, and July. Whisker samples from the tanned hide and the fetus were not included. Extrapolating from whisker growth rates measured in grey seals (Greaves et al. 2004), the whiskers from sampled seals captured data for an average of 90 days prior to collection. When aligned in time, there was a clear pattern of decline in both nitrogen and carbon through the winter months, with a suggestion for an increase in mid-summer (Figure 5-5).

Stable isotope mixing models were used to estimate the relative proportion of marine, anadromous, and freshwater fish in the diet of seals in January and May. While hampered by small sample sizes in these 2 months (3 animals apiece), results suggest salmon and freshwater fishes together accounted for the bulk of the diet in both January and May, and that freshwater fishes were a larger fraction of the diet in May than in January (Figure 5-6). While the confidence intervals around the median estimates of diet proportion are large due to small sample size and large variation in the isotopic signature of fishes in each dietary category (see Table 4-3), the findings generally agree with seasonal dietary shifts reported by respondents. The winter (January) dietary signal likely reflects the importance of salmon to the seals' diet through the summer and fall, when nutrients of salmon origin likely contribute to increases in lipid and nutrient reserves. Then, as salmon and other prey are less available, these nutrients, in combination with those contributed by freshwater fishes, are used to sustain whisker growth. Thus the whisker likely reflects a combination of new and endogenous nutrients (Greaves et al. 2004). Alternatively, seals may continue to prey on spawned-out salmon into the winter, since such fish would likely be easy to capture and be of relatively high nutrient quality. By May, the contribution of last-summer's salmon run to the diet of the seals has declined, and the isotopic signature more closely approximates that of the freshwater fishes. The apparent continued contribution of salmon to the May diet could reflect either early salmon returns, or an anadromous signal introduced through the ingestion of freshwater fishes that themselves had preyed heavily on salmon the previous fall, and that still retain that signal. Whether there is an annual oscillation in $\delta^{13}C$ and $\delta^{15}N$ across years cannot be determined from the collected whiskers; however, we will be examining the strontium ($^{87}Sr/^{86}Sr$) and oxygen ($\delta^{18}O$) isotope signature across teeth annuli to see if the pattern suggested in whiskers persists across multiple years. While limited, the data strongly support the view of local residents about the importance of both salmon and nonsalmon fish prey resources to the seals of Iliamna Lake.

Respondents described the feeding behavior of the seals within Iliamna Lake to be very aggressive. A Pedro Bay elder described watching a group of seals "corral" a school of trout under water by swirling around them to block their escape. Respondents described seals raiding salmon setnets so aggressively that the seals themselves end up getting caught in the nets. While both bears and seals are known to damage nets when trying to obtain salmon from them, "*Seals leave smaller holes in nets. Bears leave big holes in nets, so you can tell when the seals are around town and it's not just a bear. Seals eat the salmon bellies and leave the rest*," said an Iliamna elder. During fieldwork at fish camps in 2007, Davin Holen and Theodore M. Krieg, with the Alaska Department of Fish and Game (ADF&G) Division of Subsistence, observed seals near fish nets and had to spend time working with a fisher to untangle a young seal from a setnet near Newhalen. Even after being untangled the seal continued to hang around the net (Fall et al. 2010). Observations of harbor seals targeting fish in nets are frequent in coastal waters throughout the harbor seals' range, and harbor seals are known to follow salmon upriver in California, Washington, and Oregon (Brown and Mate 1983; Harvey et al. 1995; Orr et al. 2004).

Many respondents said that, compared to their fearful behavior during hunting season, seals become much more courageous around people when they are feeding on salmon. Additionally, several respondents said that the physical size of the seals grows every year following the salmon runs. For example, an Iliamna elder said: "*Springtime they are spooky as can be, you can hardly get close to 'em, even just in passing. You'll see just this movement into the water before you can get there. In the falltime they're just laying out there like, 'Who cares?' They can't even move because they're so fat!*" The elder continued: "*The physical size of the seals from the spring to the fall varies a lot because of the salmon. They grow up to large size very fast*

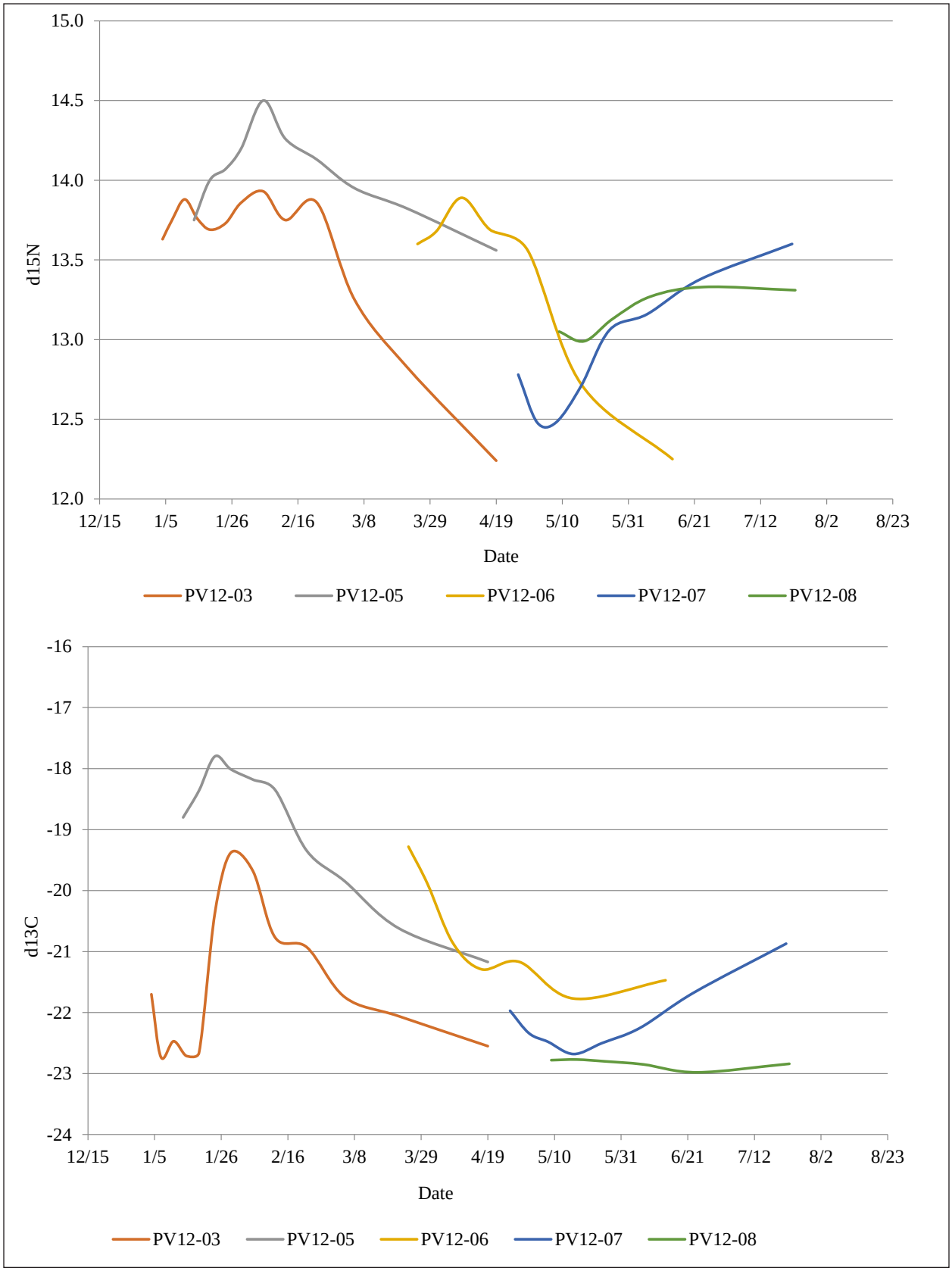


Figure 5-5.–Changes in whisker isotope signature over time.

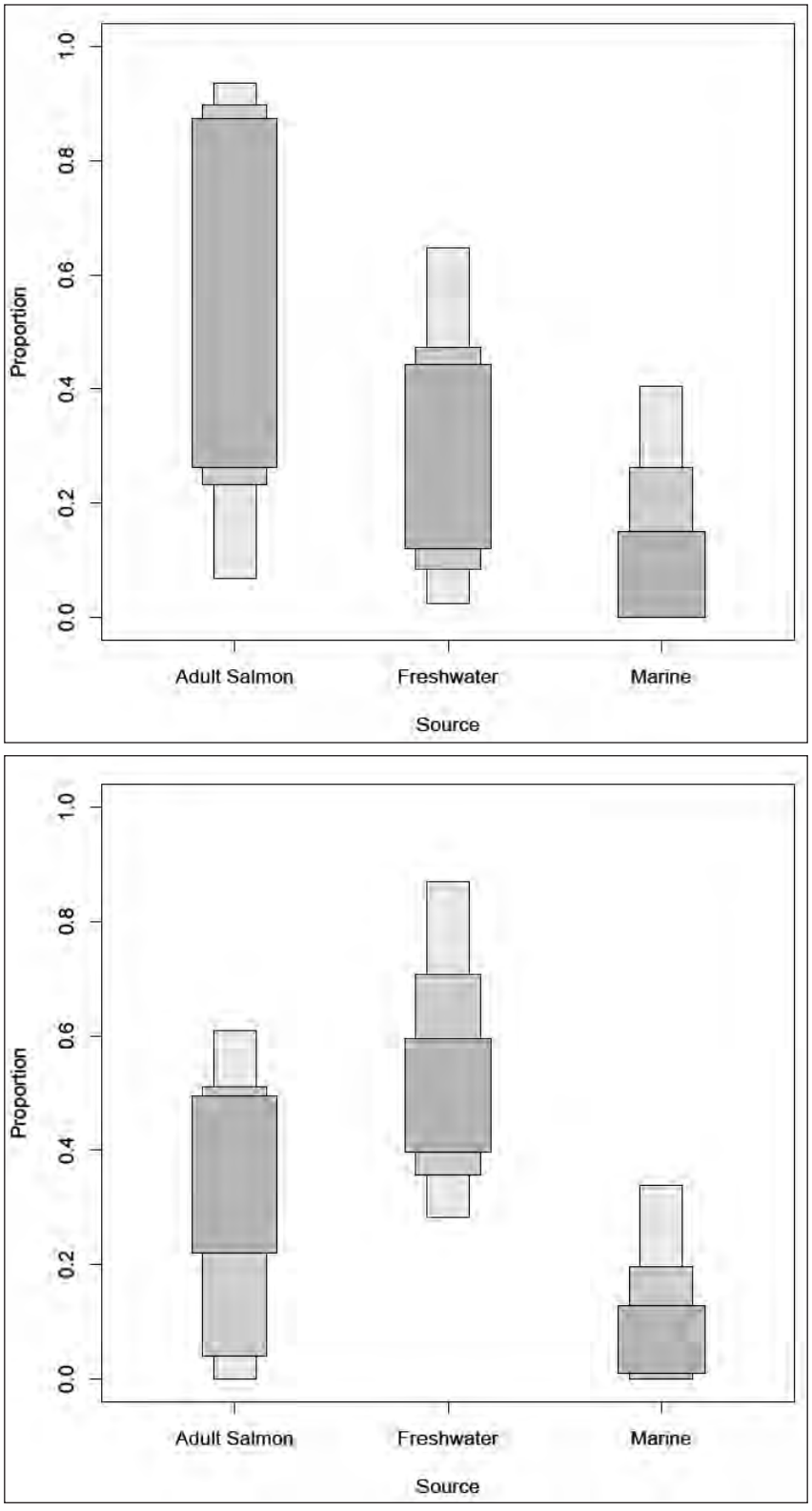


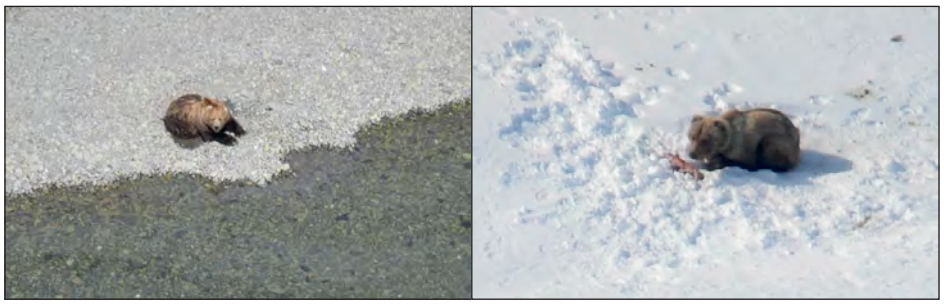
Figure 5-6.–Relative proportion of adult salmon, freshwater, and marine food resources in the diet of harbor seals in January (top) and May (bottom), as determined from temporally aligned whisker samples.

from pups, and then you get them sucking down some salmon and they're going to really pooch out! Some of these things, they are huge, 'cause they just gorge themselves on salmon." Observations of variation in animal condition across the season fit with literature reports. In general, phocid seals are at peak condition (fatness) in the spring prior to the pupping season, and at a nadir in condition following the reproductive and molt periods (Rosen and Renouf 1997, 1998). Late summer foraging activities on seasonally abundant food resources can allow rapid gains in mass and body condition, and seals that feed on lipid-rich food resources will gain mass more quickly (Trumble et al. 2003; Womble 2012). The large influx of energy-dense salmon resources starting in mid-summer in Iliamna Lake suggests that the seals would rapidly and likely reach peak condition toward the end of the salmon season.

5.2.iv. Predation on the Seals Within Iliamna Lake

Not only did respondents discuss their observations of seal feeding behavior in the lake, they also reported that the seals within Iliamna Lake are preyed on by wolves *Canis lupus* and wolverines *Gulo gulo* inhabiting the watershed. Respondents reported observations of wolves and wolverines preying on seals and the presence of seal-kill sites on the lake ice resulting from these predation activities. Respondents reported that wolves and wolverines have been observed following pressure cracks on the ice in search of hauled out seals. Respondents said that once a wolf or wolverine locates seals hauled out on the ice they will stalk the seals at the haul out location. A Pope-Vannoy hunter and 2 different Kokhanok hunters reported recent observations of seal-kill sites near open water in the Tommy Point area. A Kokhanok hunter explained that when a group of seals hauled out on the ice becomes startled they will all rush to the hole and try to jump back in the water but that the seals get tangled up and several of them usually get "stalled" and that this is how predators can successfully obtain a seal trapped on the ice. An Iliamna elder reported that during the winter of 2010–2011 a wolf pack killed seals in an area near Pedro Bay. The elder said that the wolves had only recently "*learned the pressure cracks*" and that as far as he knew wolves preying on seals is "*a new behavior.*" A Kokhanok hunter reported that he recently had observed a wolverine traveling alongside the windward side of a pressure crack near Tommy Point. The respondent believed that wolverines were seal hunting. The respondent also said that, due to this seal stalking behavior, wolverines have been occasionally harvested opportunistically by local hunters while seal hunting.

The risk of predation is also thought to influence site selection when seals choose to haul out. Respondents reported numerous island and sandbar locations where seals can be seen hauled out in the summer months, but respondents did not report observing seals ever being hauled out on the shoreline of the lake. "*You'll see them cruising around in front of the streams and rivers on the shoreline there but I've never seen a seal actually on the beach on any shoreline other than one of the islands,*" said an Iliamna respondent. The respondent suggested one reason for this is due to the threat of predation on the main shoreline. "*They're smart. They're on these islands for a very good reason. There's not going to be bears or wolves,*" said the respondent.



Photography by David Withrow, NOAA

Plate 5-1.–Brown bear on seal haulout JH16HI on June 29, 2013, and brown bear eating a large fish on the lake ice on April 3, 2012.

Table 5-5.–The proportion of households that used marine mammals that noticed a change in the condition of marine mammals, study communities, 2011.

Community	Sampled households	Do not use	Use	Households observing condition of marine mammals: Change Number	Change Percentage	No change Number	No change Percentage	Unknown Number	Unknown Percentage
All communities	**150**	**81**	**69**	**4**	**5.8%**	**65**	**94.2%**	**1**	**1.4%**
Igiugig	17	8	9	0	0.0%	9	100.0%	0	0.0%
Iliamna	21	12	9	1	11.1%	8	88.9%	0	0.0%
Kokhanok	43	27	16	0	0.0%	15	93.8%	1	6.3%
Levelock	23	11	12	0	0.0%	12	100.0%	0	0.0%
Newhalen	34	12	22	3	13.6%	19	86.4%	0	0.0%
Pedro Bay	12	11	1	0	0.0%	1	100.0%	0	0.0%

Source ADF&G Division of Subsistence household surveys, 2012.
Note Survey respondents were asked about the condition of marine mammals in general; regardless, there was no discussion about changed conditions of any species other than seals in Iliamna Lake.

While no direct predation on harbor seals was observed during the course of this research, a brown bear was sighted on site JF16HI on June 29, 2013 (Plate 5-1). This site is considered one of the top 3 sites where seals consistently haul out in large numbers and during this survey, large numbers of seals were expected during the observation since it was pupping season. Seals were seen in the nearby waters, but no seals were hauled out while the bear was present. Twice, bears have been sighted near seal haul out sites in the early spring when the lake was still frozen (Plate 5-1). Indeed, bears, coyotes *Canis latrans*, and foxes *Vulpes* spp. are all known predators of seals in other areas of their range (Moss 1992)[2], and predation risk is hypothesized as the underlying cause for the seals' use of offshore islands and sandbars as haul out locations rather than coastal shorelines (Savarese 2004; da Silva and Terhune 1988). Within Alaska, harbor seals frequently utilize glacier ice as haul out substrate within fjords in PWS, Kenai Fjords National Park, and Glacier Bay (Blundell et al. 2011; Lowry et al. 2001; Mathews and Pendleton 2006). In addition, icebergs accumulate within Vitus Lake at the terminus of the Bering Glacier, and seals travel up the relatively short Seal River to haul out on the ice, rather than along the Gulf of Alaska coastline. Since there are few fish within Vitus Lake, this haul out behavior is largely attributed to an avoidance of predation risk (Savarese and Burns 2010).

5.2.v. Health of the Seal Population Within Iliamna Lake

Iliamna Lake residents believe that the current population of seals in the lake is both healthy and stable. Respondent observations portray a seal population that is biologically healthy and free of disease, sores, or other signs of malady. When local residents were asked if they had observed changes in the health of marine mammals in the Iliamna Lake area, 94% of the households surveyed that use marine mammals reported that they had not noticed any type of change in condition (Table 5-5). "*I've never seen a seal that looked or acted sickly before*," said a Pope-Vannoy hunter.

Tissues obtained from the biosampling program did not appear to be diseased, and none of the biosampling sheets from the harvested seals included any indication that the seals were unhealthy. Indeed, 2 of the 5 adult females harvested were noted as pregnant at the time of collection (PV-IL-AK-2011-01 harvested in January, and PV-IL-AK-2012-06 harvested in June), and the 3 seals for which blubber thickness measurements were included on the sampling datasheets all had a very thick blubber layer (>4.5 cm; see Table 4-2). Samples have been archived for contaminant analysis, and project partners at the Newhalen Tribal Council (NTC) are developing a sample analysis plan (such analyses were not planned as part of this study).

2. Gearin, P., M. Johnson, J. Calambokidis, and G. Steiger. 1990. "Coyote (*Canis latrans*) predation and scavenging on harbor seal (*Phoca vitulina*) pups," (unpublished manuscript) Cascadia Research Collective: Olympia, WA.

5.2.vi. Abundance of the Seal Population Within Iliamna Lake

Relative to population abundance, residents likewise believe the population to be healthy. For example, a Newhalen hunter commented that there are "*more than enough seals*" in the lake and an Iliamna elder said that Iliamna Lake contains a "*fairly stable [seal] population, no more than a couple of hundred seals, but they're healthy … I don't think there have ever been over about 200 seals. We have counted between 125–150.*" Overall, when households were asked how many seals they believe reside in Iliamna Lake, survey respondents suggested that the seal population in Iliamna Lake is between 200–500 individual animals; residents of Igiugig, Pedro Bay, and Iliamna reported the lowest average estimates while residents of Levelock, Newhalen, and Kokhanok reported the highest estimates. The average number of seals believed to inhabit the lake reported by all sampled households was 329 ± 29 seals, with estimates generally higher in communities from the northeastern end of the lake (Figure 5-7).

When asked about trends in the abundance of seals within Iliamna Lake, several respondents reported that the seal population has increased over time. "*Seal populations are increasing in the lake. The population has become larger year after year,*" said a Kokhanok hunter. An Iliamna elder said, "*I think there are more seals today. There was a time when there were less than there are now.*" A Newhalen hunter reported that he had been observing increasingly larger groups of seals hauled out along pressure cracks on the lake ice. The hunter had observed groups of 30 or more seals and said that this was an increase from his past observations. The hunter believed that the seal population in the lake had been increasing over the last 40 years. Similarly, a Kokhanok hunter said that "*there was a time in the '60s when there wasn't very many [seals in Iliamna Lake], but they rebounded.*"

Some respondents said that the seal population has increased because of the abundance of fish in Iliamna Lake on which the seals feed. For example, a Newhalen hunter said, "*The [seal] population is coming up, not declining. I think it has something to do with the [commercial salmon] fishery.*" An elder from Igiugig instead suggested that the observed increase could be the result of seal hunting pressure from local residents decreasing over the last several decades, allowing the population to grow. A Kokhanok hunter suggested that the reported increase in seal populations may also be due to changes in perspectives due to modern air travel allowing for residents to see the seals from the air over a large expanse instead of from land or water. Because residents often fly between Kokhanok and Iliamna today "*they [seals] tend to be noticed more,*" said the respondent.

Respondents also pointed out that weather conditions affect the size of the seal population in Iliamna Lake. An Iliamna elder suggested that recent increases in the seal population might be the result of climate warming trends observed in the area. "*We have shorter and warmer winters [now, so] more and more [seals] survive,*" said the elder. The elder went on to explain that the winter of 2011–2012 was much colder than the previous several winters and that the cold conditions and resulting very thick lake ice may be one reason why seals were seldom seen during the winter of 2011–2012. An elder from Pedro Bay said that during very cold winters, seals have a more difficult time surviving in the lake. The elder had observed the effects of a cold winter on seals firsthand: "*I remember one really cold year I finally shot one [in March] … The seal was very skinny, no fat at all on it, so I think it had a hard year. It was thick ice for a long time.*" The elder suggested that during cold winters seals are not able to find enough fish to eat. The elder said that finding a skinny seal with no fat on it is a very rare occurrence in Iliamna Lake and that normally the seals have an abundance of fat, even in winter.

¶ Aerial surveys of harbor seals in Lake Iliamna have been conducted sporadically over the past 40 years (Mathisen and Kline 1992; Small 2001; Withrow and Yano 2010).[3] Until this project began in 2009, surveys were concentrated during the August molt period—this was presumed to be the time of greatest abundance or likelihood of the highest proportion of animals hauled out (see section "5.2.vii. Seasonal Variation in Abundance" for seasonal patterns). A comparison of the peak unadjusted number of seals observed hauled out during August surveys suggests that the local perception of stable population abundance is correct

3. NOAA National Centers for Environmental Information, Ocean Archive System, most recent published version (file: 123188.2.3.tar.gz). "Aerial Survey Counts of Harbor Seals in Lake Iliamna, Alaska, 1984–2013 (NODC Accession 0123188)." http://www.nodc.noaa.gov/cgi-bin/OAS/prd/accession/download/123188

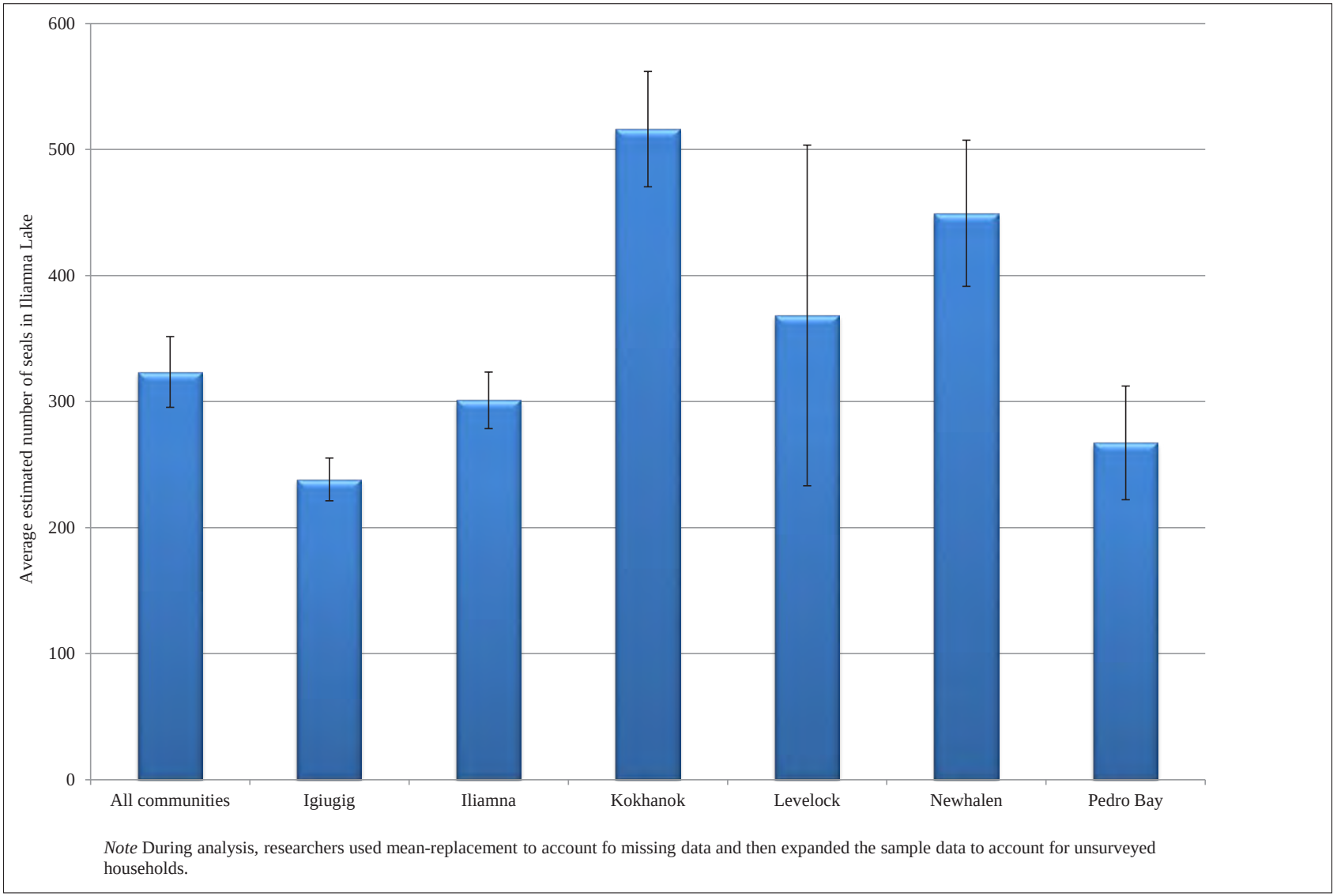


Figure 5-7.–Average number of seals that community residents estimate live in Iliamna Lake, study communities, 2011.

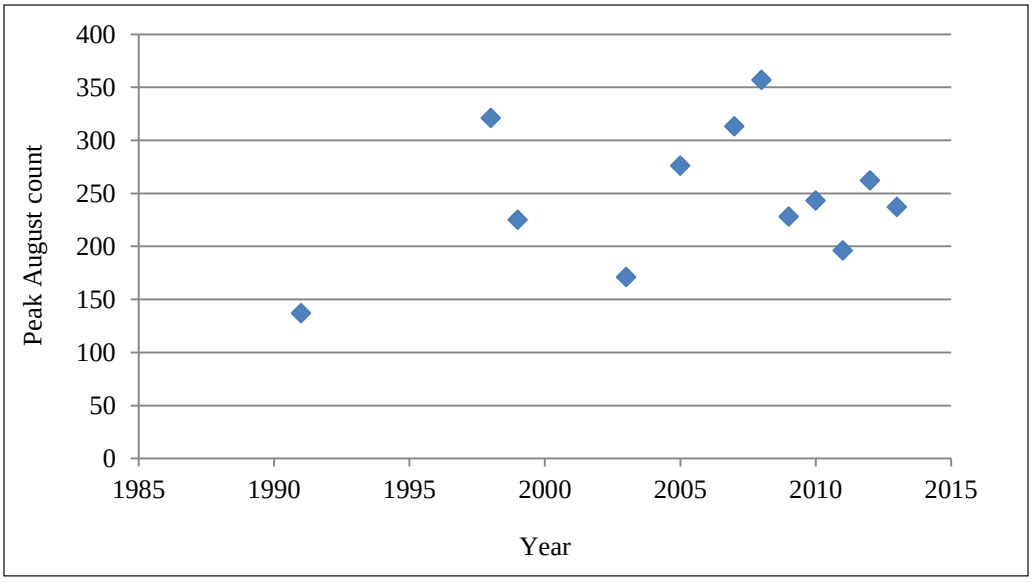


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Figure 5-8.–Maximum number of harbor seals observed hauled out during aerial surveys conducted in August 1991–2013.

(Figure 5-8). However, this conclusion should be treated cautiously since none of the counts have been corrected for factors known to influence the proportion of the population that was hauled out at the time of the survey—factors such as weather or day of year. In other locations and conditions, the fraction of the population observed hauled out can vary from less than one-third to close to 100% (Bengtson et al. 2007; Boveng et al. 2003; Simpkins et al. 2003). In addition, some of the surveys conducted prior to Project # 916 may not have included all known haul out locations. Still, the similarity between the local residents' estimates of between 200–300 seals, and the peak number of seals seen during aerial surveys, is remarkable. We made a big effort to inform village governments, elders, and hunters about the results of each aerial survey over the lake. It remains unclear if our results had any influence in their seal estimates.

5.2.vii. Seasonal Variation in Abundance

When survey respondents were asked for the 2011 study year if they had observed variations in the Iliamna Lake seal population during the course of a normal year, 43% of households said that population levels vary seasonally, 30% said that there is no variation in the seal population over the year, and 27% were unsure (Table 5-6). However, the perception of seasonal change varied, with communities to the northeastern end of the lake perceiving more seasonal variation than those in the southwest end (Table 5-6). Information obtained from ethnographic interviews portrays a local perspective where observed seasonal variation in the seal population results more so from seals being less active and more difficult to observe during the winter months rather than resulting from seals' leaving the lake during the winter months. Moreover, local people are more active in the summer months and less active in the winter months, which likely also contributes to seasonal variation in locally reported seal observations.

Household survey respondents were also asked what months of the year they normally observe seals in Iliamna Lake, the Kvichak River, or both.[4] By far the majority of seal observations were reported to occur between the months of March and September with increasing seal observations beginning in the spring, peaking during late summer, and largely declining in the winter months (Figure 5-9).

4. Note that researchers conclude that it is probable that the seal observations reported by Levelock respondents occurred exclusively in the Kvichak River due to the community's location.

Table 5-6.–The proportion of households that used marine mammals that observed seasonal variations in seal populations during the year, study communities, 2011.

Community	Sampled households	Did not respond (missing)	Total households	Households observing variations in seal populations during the year: Yes Number	Yes Percentage	No Number	No Percentage	Unknown Number	Unknown Percentage
All communities	**151**	**1**	**150**	**64**	**42.7%**	**45**	**30.0%**	**41**	**27.3%**
Igiugig	17	0	17	5	29.4%	6	35.3%	6	35.3%
Iliamna	21	0	21	11	52.4%	6	28.6%	4	19.0%
Kokhanok	43	1	42	28	66.7%	10	23.8%	4	9.5%
Levelock	23	0	23	2	8.7%	5	21.7%	16	69.6%
Newhalen	34	0	34	12	35.3%	16	47.1%	6	17.6%
Pedro Bay	12	0	12	6	50.0%	2	16.7%	4	33.3%

Source ADF&G Division of Subsistence household surveys, 2012.

¶ Seasonal shifts in the abundance of seals observed hauled out in the lake have also been documented by aerial surveys conducted under funding for projects # 916 and # 1116 (2009–2013 surveys), by The Pebble Limited Partnership (PLP) (2005 and 2007 surveys), NTC (2009 survey), and others (Mathisen and Kline 1992; Small 2001; Withrow and Yano 2010)[5] (Figure 5-10). While surveys conducted during August produced the highest number of seals sighted, seals have been observed in all months in which surveys have been conducted except March and December, which have each been surveyed once (Figure 5-10). Counts are much lower March–May, and September–November, and no surveys have been flown from January–February due to weather and daylight limitations. Given that these 2 metrics (households observing seals versus abundance of seals hauled out) are very different, the seasonal pattern is remarkably consistent, with the highest counts noted in mid-summer (June and July for households, August for surveys). Seals have a "need" to haul out in late June and July (pupping) and August (molting). The observed peaks tend to support this pattern. This haul out pattern is the expected pattern for harbor seals throughout their range, whether in fresh water or salt water. The lower numbers observed outside of the pupping and molting periods do not necessarily represent lower numbers of seals in the lake.

5.2.viii. Diel- and Weather-Induced Variation in Seal Abundance

Household survey respondents were asked what time of the day seals are normally observed hauled out at Iliamna Lake. Households reported that seals are most frequently observed hauled out during the afternoon (48%) (Table 5-7). Key respondents interviewed for the ethnographic component of the study explained that, no matter what the season, seals favor sunshine for hauling out and that they are more prone to come out on sunny days when the strength of the sun is high, normally in the afternoons and evenings. An Iliamna elder explained that whether seals haul out or not "*depends on the amount of light and wind*" and said that the most likely time to see seals hauled out is "*during the warmest times of the day.*" A Kokhanok hunter said, "*Seals are hauled out when it is a nice, calm, sunny day, that's what matters most, not the time or the month. If it's cloudy or bad weather they don't come out. Afternoon you might see more seals because they are sunning,*" and an Igiugig elder said, "*When the sun comes out, and it's nice and warm, then they'll come out on all those pressure cracks that's out there.*" Respondents consistently said that, regardless of the season, afternoon was the most likely time for warm temperatures on the lake. Respondents explained that it is much more common for seals to haul out on ice, on a sandbar, or on an island when weather conditions are calm as opposed to when conditions are windy and stormy. For example, a Newhalen hunter said, "*They'll [seals will] be under ice if it's windy out, they don't like to come out.*" Interview respondents from

5. NOAA National Centers for Environmental Information, Ocean Archive System, most recent published version (file: 123188.2.3.tar.gz). "Aerial Survey Counts of Harbor Seals in Lake Iliamna, Alaska, 1984–2013 (NODC Accession 0123188)." http://www.nodc.noaa.gov/cgi-bin/OAS/prd/accession/download/123188

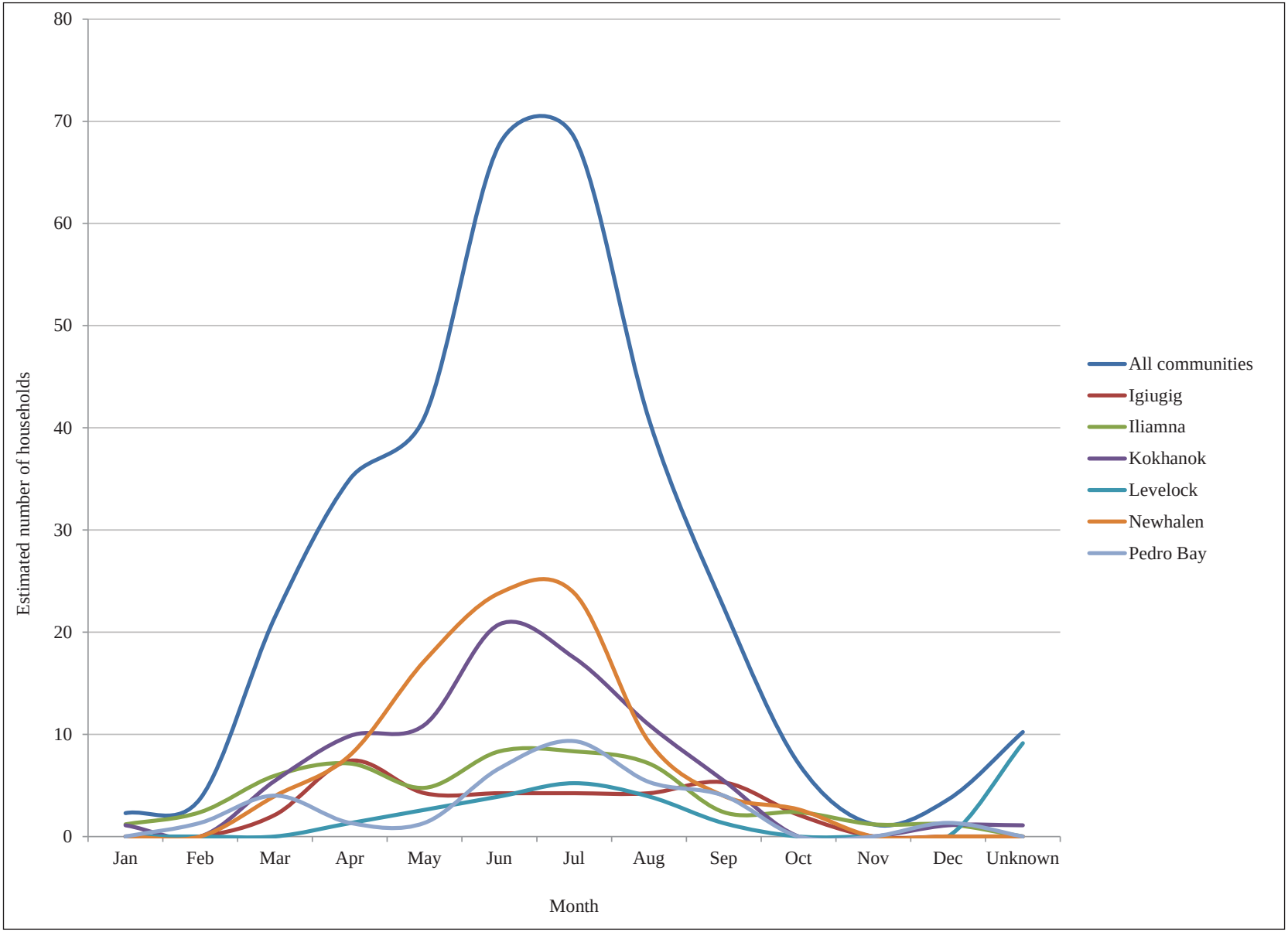

Figure 5-9.–Estimated number of households observing seals in Iliamna Lake, the Kvichak River, or both, by month, study communities, 2011.

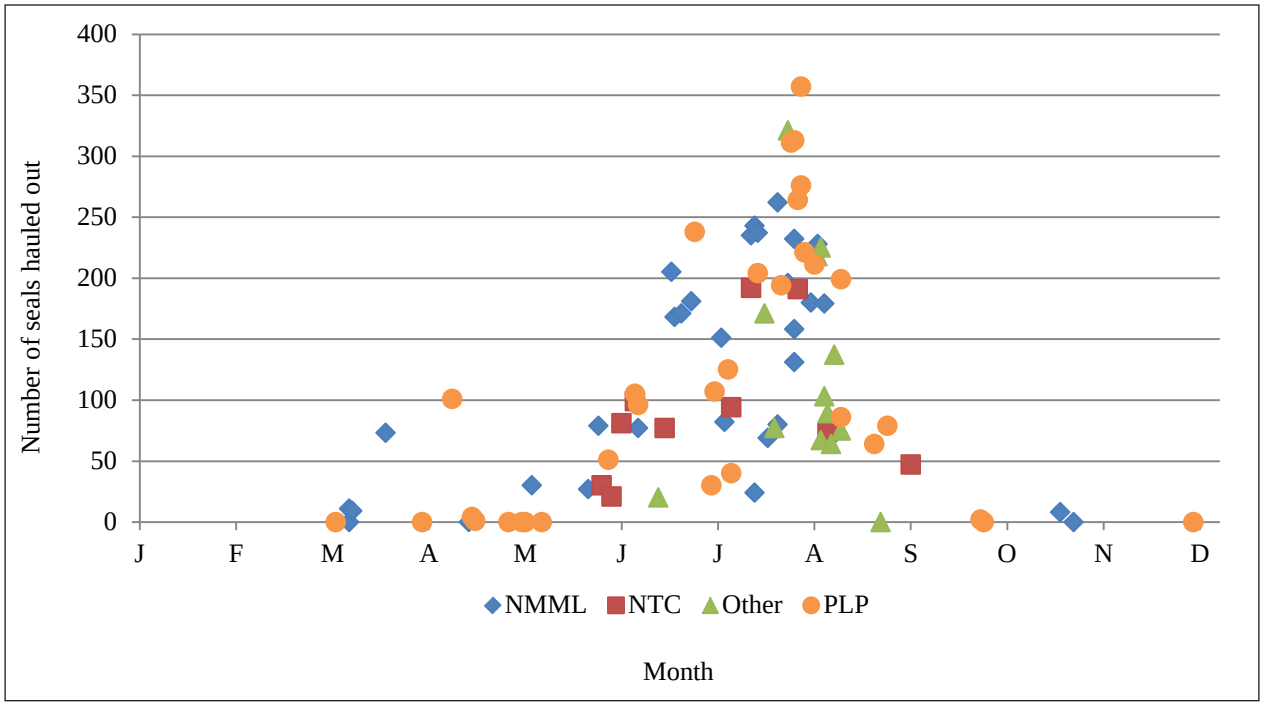

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Figure 5-10.–Number of seals hauled out during all aerial surveys, 1984–2013.

Table 5-7.–The proportion of households that observed seals hauled out at different times of the day, study communities, 2011

Community	Sampled households	Did not respond (missing)	Total households[a]	Households observing seals hauled out							
				Morning		Afternoon		Evening		Unknown	
				Number	Percentage	Number	Percentage	Number	Percentage	Number	Percentage
All communities	**151**	**4**	**170**	**22**	**12.9%**	**81**	**47.6%**	**25**	**14.7%**	**42**	**24.7%**
Igiugig	17	0	18	1	5.6%	9	50.0%	2	11.1%	6	33.3%
Iliamna	21	1	23	2	8.7%	15	65.2%	4	17.4%	2	8.7%
Kokhanok	43	2	42	8	19.0%	24	57.1%	3	7.1%	7	16.7%
Levelock	23	1	23	1	4.3%	6	26.1%	1	4.3%	15	65.2%
Newhalen	34	0	44	7	15.9%	17	38.6%	9	20.5%	11	25.0%
Pedro Bay	12	0	19	3	15.8%	10	52.6%	6	31.6%	0	0.0%

Source ADF&G Division of Subsistence household surveys, 2012.

a. Households may respond to more than one category. As a result, the number of households responding ("total households") may exceed the number of households that were sampled.

Levelock and Igiugig, located on the Kvichak River, also reported that seals most often haul out during the afternoon along the Kvichak River and near Bristol Bay. Levelock respondents said that ocean tides also affect when seals haul out in the Levelock area. Levelock respondents said that seals are often seen hauled out during low tide.

These observations of seal behavior for hauling out fit with behavioral patterns that have been documented in other regions. In general, harbor seals are more likely to be hauled out in the afternoon and less likely to be visible on cold or rainy days (Bengtson et al. 2007; Boveng et al. 2003; Frost et al. 1999; Savarese 2004; Simpkins et al. 2003). One other factor that is frequently cited as influencing seal haul out patterns, the tidal state, is not an operative factor in Iliamna Lake. However, lake levels do vary seasonally (Lenarz 1966), and several of the preferred haul out sites are very low-lying. As such, water height may influence haul out location selection or preference. However, as yet, there has not been sufficient survey or tagging effort dedicated to determining the factors that influence the probability of harbor seals hauling out within Iliamna Lake. It is the absence of such correction factors that prevents extrapolation of the number of seals hauled out during any given survey to an estimate of the abundance of seals within the lake.

5.2.ix. Reproductive Behavior

When asked about whether seals in the lake were reproductively active, most respondents from the study communities reported observing seal pups in Iliamna Lake. Even those who did not still said they believed that both breeding and pupping occurs in the lake. "*I'm pretty sure they breed here*," said a Kokhanok hunter. Some respondents said that they had observed small seals, or "yearlings," but had never seen very small pups in the lake. Respondents reported that seal pupping in Iliamna Lake is mostly concentrated at the islands in northeastern portion of lake including: the islands near the mouth of the Chekok Creek, Porcupine Island and the surrounding smaller islands, the islands between Triangle and Flat islands, Knutson Bay, Seal islands I, II, and III, and the islands around Tommy Point (Figure 5-11). A Kokhanok respondent reported that a seal pup was once found caught in a subsistence setnet near the mouth of the Gibraltar River. Another Kokhanok respondent reported once finding a sick baby seal on a beach near Kokhanok. Respondents from Igiugig and Levelock reported occasionally observing seal pups in the Kvichak River (Figure 5-12). It is unknown if the pups observed in the Kvichak River originated in Iliamna Lake or Bristol Bay. When asked about the habitat where seal pups are most likely to be seen, an Iliamna elder said that pups are most often seen on beaches that are flat, protected from the weather, and that have good exposure to the sun. "*Where they have a long beach that faces east, where it is warmer, seals are more likely to have pups*," said the elder. When seal pups are seen by respondents they are usually with their mothers on an island beach or a sandbar. The Iliamna elder explained that seal pups will sometimes stay on the beach alone while their mothers go hunting, but that when the seals travel in groups the pups will travel with the group. The elder also said that male seals are normally not present during pupping. Segregation by sex and age is known to occur within harbor seal populations in other areas, particularly during the breeding season, when adult males defend underwater breeding territories and females with young pups segregate themselves from other age classes (Hayes et al. 2006; Moss 1992; Thompson et al. 1989; Van Parijs et al. 1997).

Observations about seal pups are largely in agreement with aerial survey data. During such surveys, seal pups have only been observed on a few low-lying islands and sand spits in the eastern side of the lake (see Figure 5-13), and pups were never observed in the Kvichak River. However, differences in seal pup location based on aerial surveys and residents' observations and local knowledge are likely due to differences in method. Seal pups identified in aerial surveys must be: 1) hauled out; 2) within 1 body-length of an adult seal; and 3) substantially smaller than the adult seal. Thus, pups documented in aerial surveys are only those that are still nursing, and likely less than 1 month old (Burns et al. 2005; Schulz and Bowen 2004). Residents were not asked to distinguish nursing pups from weaned or young independent animals, and when they did so (such as in the above quote), the 2 methods were in better agreement.

This difference in categorization of young or small animals is further reflected in answers to questions of when seal pups are sighted. Household survey respondent observation of seal pups ranged from February to September but the majority of pup observations were reported to occur between the months of April and

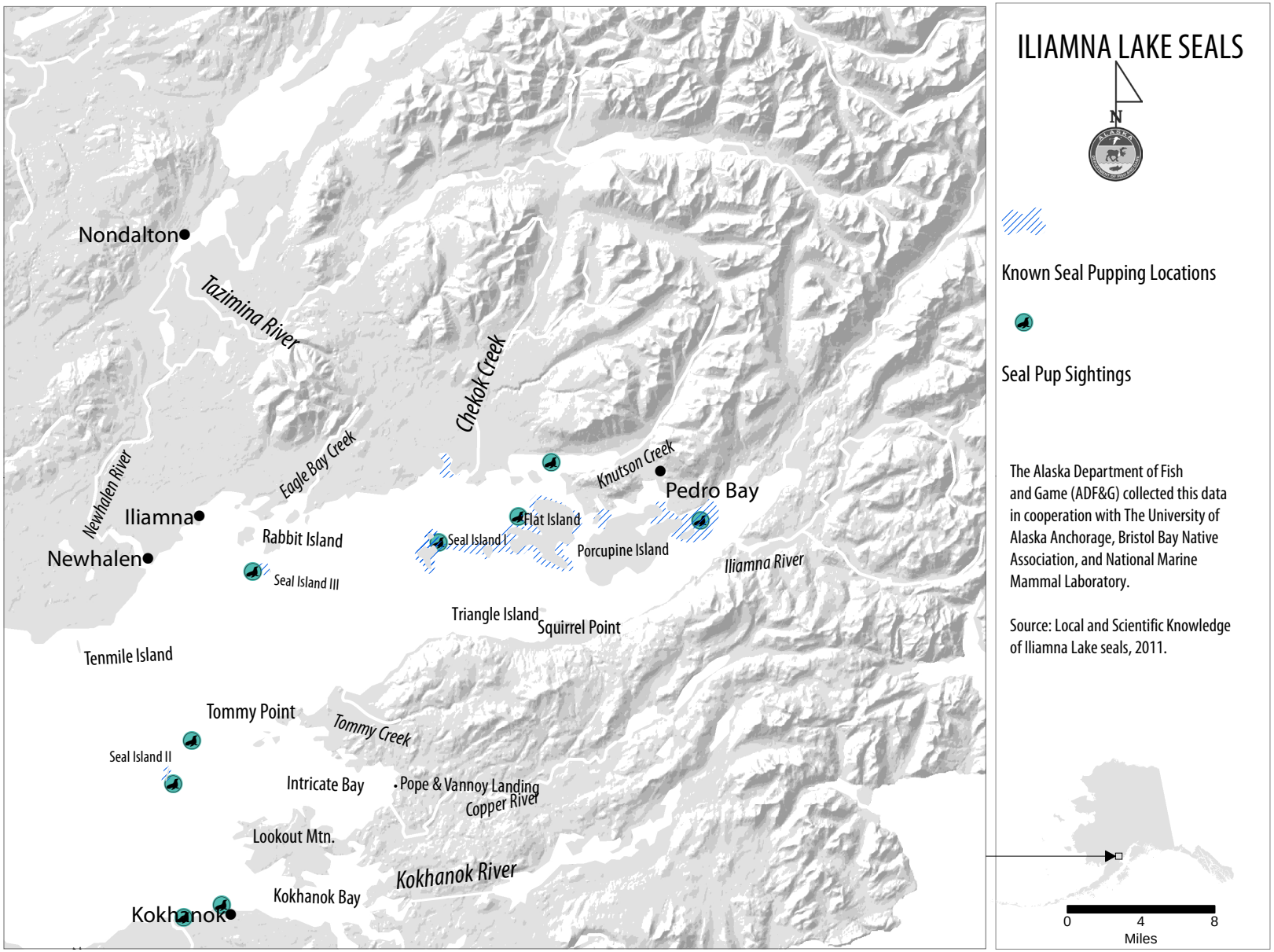


Figure 5-11.–Locations where pupping activity and seal pups have been sighted by residents at the northeast end of Iliamna Lake.

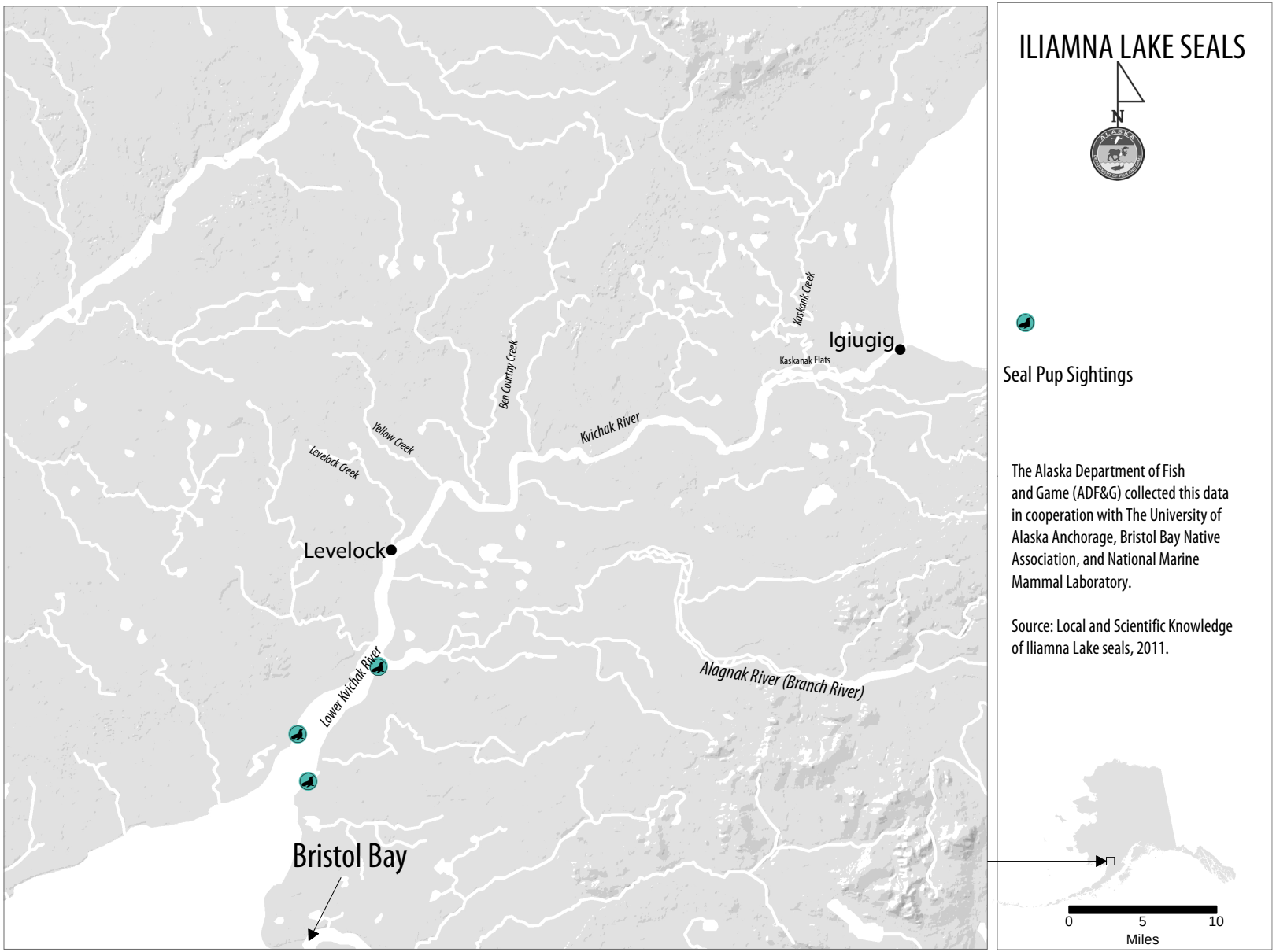


Figure 5-12.–Locations where seal pups have been sighted by residents along the Kvichak River.

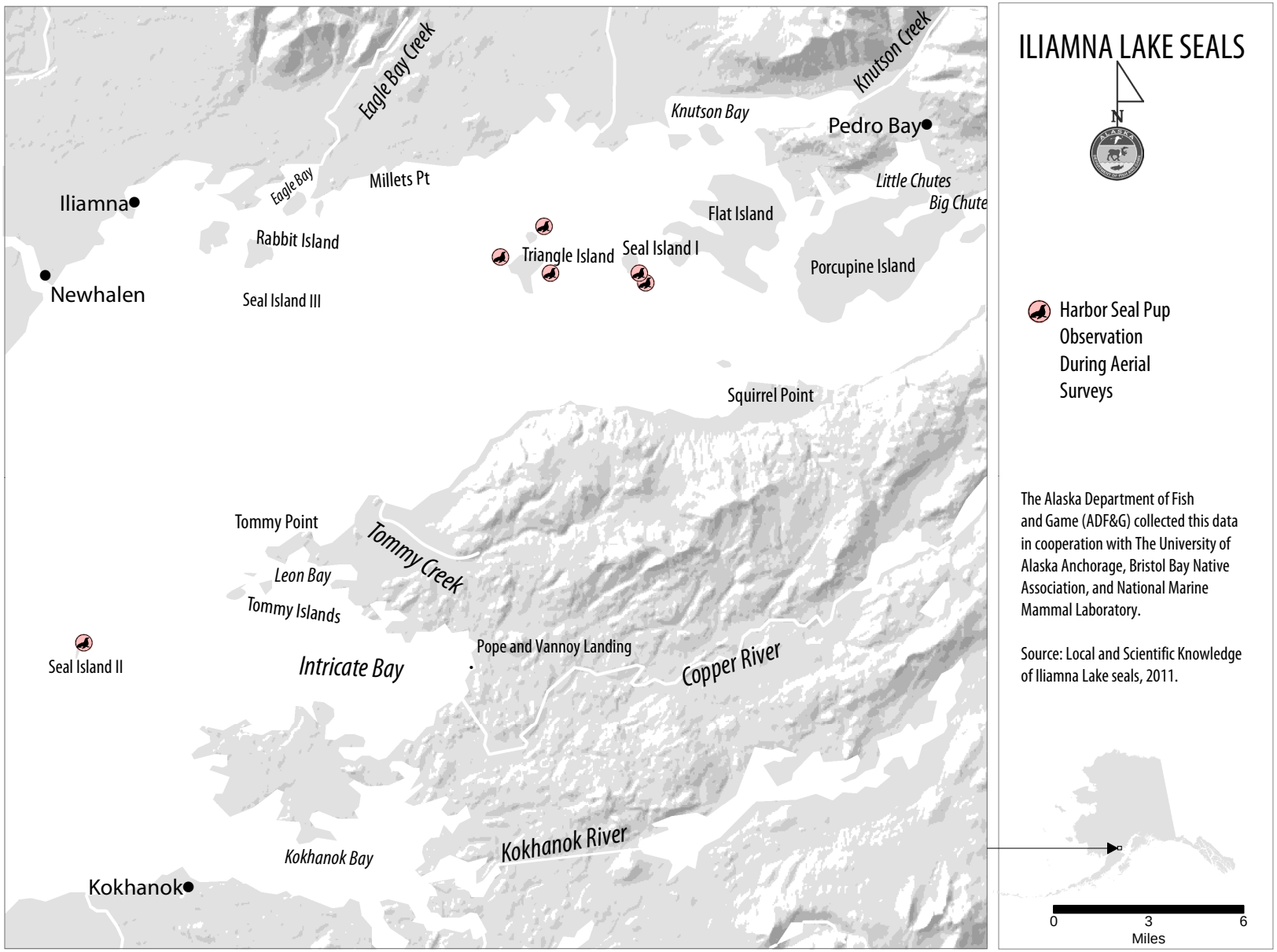


Figure 5-13.–Locations where seal pups have been sighted during aerial surveys in June, July, or August.

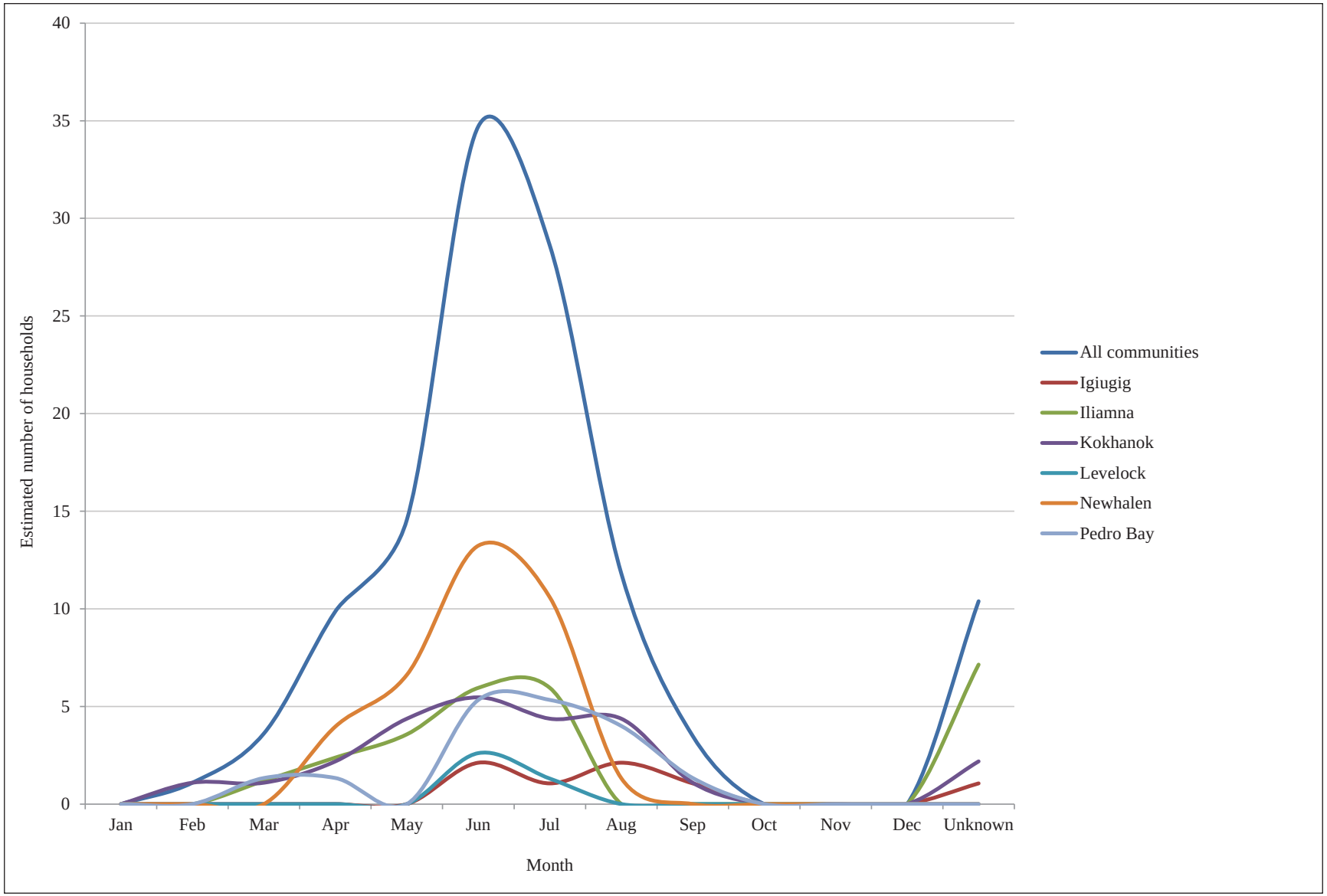
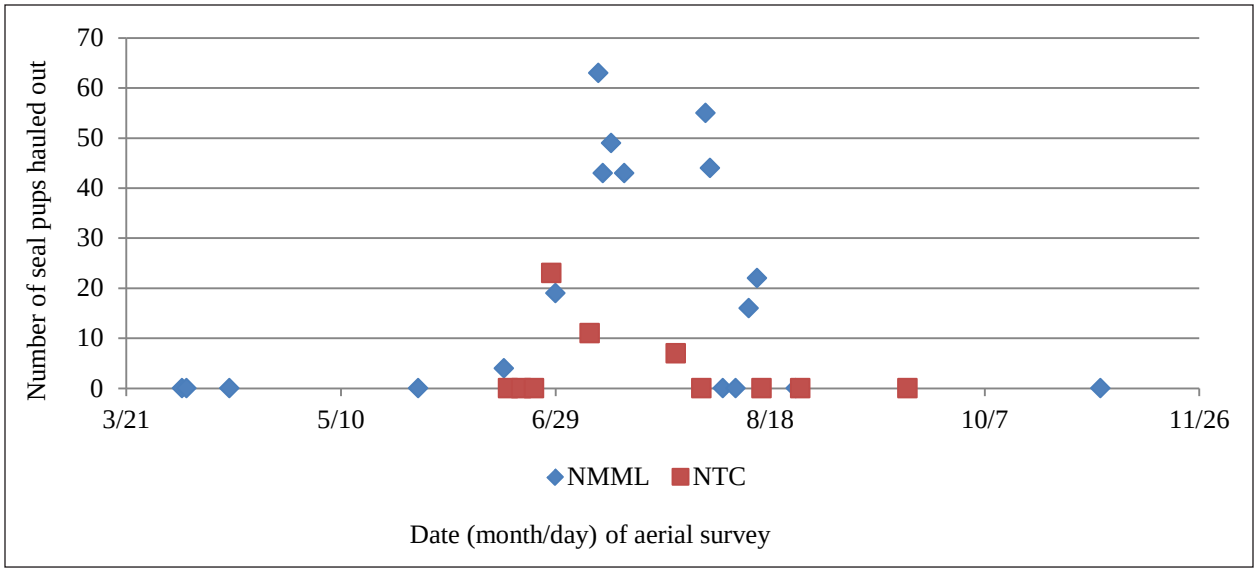
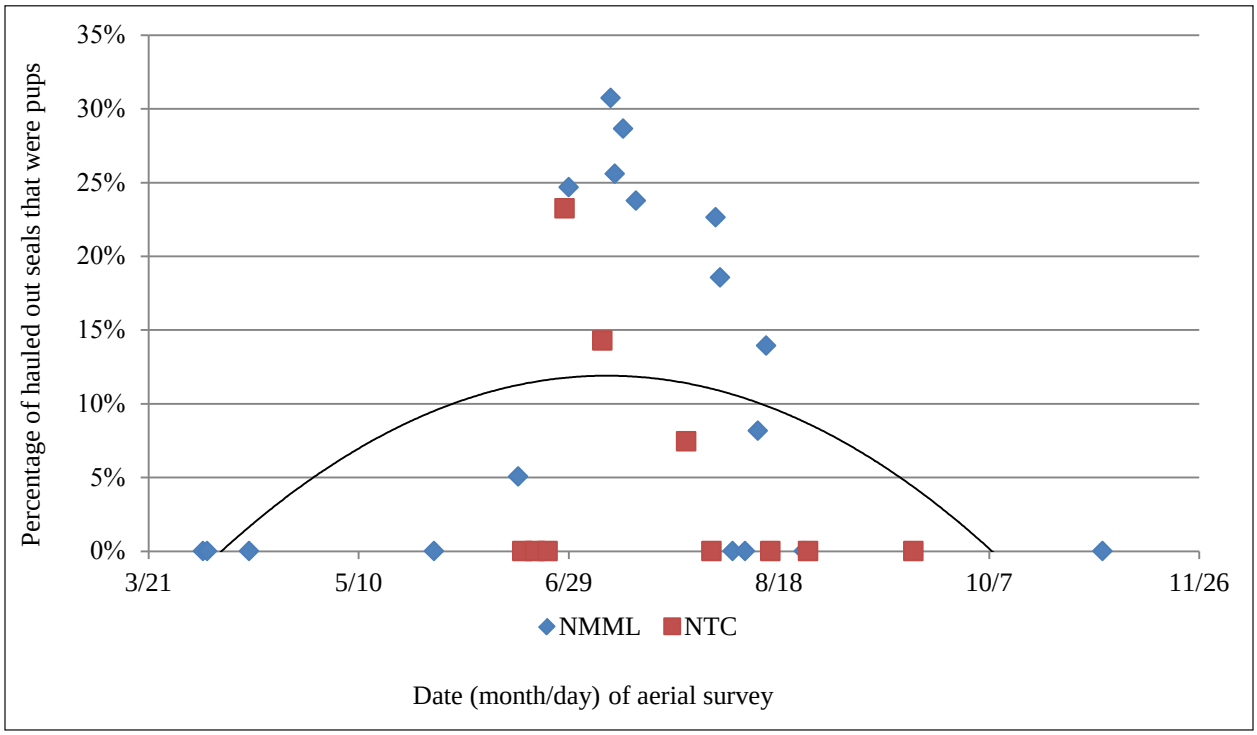


Figure 5-14.–Estimated number of households that observed seal pups in Iliamna Lake, by month, study communities, 2011.





¶

Figure 5-15.–(Top) Total number of seal pups and (bottom) proportion of seal pups out of total seals observed hauled out during aerial surveys conducted with NPRB and NTC funding, 2009–2013.

Photography by Ron Aaberg, Pedro Bay

Plate 5-2.–An Iliamna Lake seal pup hauled out on the beach of a small unnamed island near Triangle Island during an aerial survey conducted late June 2009.

August with increasing pup observations beginning in the spring, peaking during early summer, and largely declining to zero by the beginning of October (Figure 5-14). Some ethnographic interview respondents suggested that seal pups are normally born on the lake ice during March and April. Other respondents said that Iliamna Lake seal pups are born during the first half of June. "*People say they see newborn seals when they seagull egg hunt in June*," said a Pope-Vannoy hunter. Respondents from Levelock reported seeing seal pups in the Kvichak River during April and May.

¶ Aerial surveys conducted as part of North Pacific Research Board (NPRB) projects # 916 and # 1116 for 2009–2013 documented seal pups during the months of June, July, and August, with the first pups seen on June 17, and the last pups observed August 15. In 2009, the NTC flew additional surveys during the summer months (June 18–September 19, 2009), and during these surveys staff observed seal pups as early as June 28, but did not observe pups following the July 27 aerial survey (Figure 5-15). During the period from June–August, seal pups as a proportion of the total number of seals hauled for NPRB-funded surveys ranged from 0%–31%, with a peak proportion on July 9; for NTC surveys, the proportion ranged from 0%–23%, with a peak proportion on June 28 (Figure 5-15).

These dates span the range of when pupping is thought to occur in Bristol Bay (Jemison et al. 2006; Jemison and Kelly 2001). In combination, results of both interviews and aerial surveys suggest that harbor seals are pupping within Iliamna Lake, with pups likely born in June and July and weaned by the end of August. When compared to the timing of pupping for other regions of Alaska, the Iliamna Lake pupping season appears to be delayed about 3 weeks (Frost et al. 2006; Temte et al. 1991). However, the distribution of pup birth dates within the Bristol Bay harbor seal population is less understood than in many other regions of Alaska, and, when compared to Bristol Bay seals only, the timing of pupping in Iliamna Lake does not appear to be substantially delayed.

Respondents described the seal pups seen in the lake to be approximately 18 in long when first born and to range in color from pure white, to brown-tan, pure black, white with grey spots, grey with white spots, black with grey spots, grey with black spots, and sometimes with tinges of silver (Plate 5-2). "*I've seen*

them [seal pups] all the way from white to black in color," said an Iliamna elder. Another Iliamna elder said that seal pups found in the lake are "*typically mostly white, or mostly white-grey with dark spots. A lot of them are very light colored.*" An Igiugig hunter said, "*We've seen some [seal pups] that were not completely black but really dark, with a little bit of grey in them, grey and white, white and silver.*" Other respondents reported that they had never seen a white seal pup and that seal pups found in the lake are usually all black. Others reported that seal pups are normally brown or "*brownish-tan.*" Igiugig and Levelock respondents who reported seeing seal pups in the Kvichak River said that the pups were grey and speckled with greyish spots. An Igiugig elder said that the color of seal pups evolves as the pups age: "*Well when they're first born, they're all white and then the spots will come up after that.*"

Harbor seal pups are generally born with an adult-like pelage that appears light and/or silvery, particularly when wet. However, throughout the harbor seal range, there is a small proportion of pups that do not shed their lanugo in utero, and so are born with a coat of long, white fur (Bowen et al. 2001; Cottrell et al. 2006; Oftedal et al. 1991). In addition, harbor seal pups grow quickly during the lactation period, but typically show little gain in mass through the rest of their first year. As a result, year-old harbor seals are frequently no larger than newly weaned pups (Burns et al. 2005; Clark et al. 2007). However, their fur is very different in appearance. Because the seals have weathered a year at sea, the fur is frequently coarse and brown in coloration, with spots that are difficult to distinguish until the seals complete their first molt at approximately 15 months of age (Moss 1992; Thompson and Rothery 1987).

While traditional conservation practices (see section "5.4.vii. Conservation Measures") discourage harvesting pregnant or lactating females, hunters from both Kokhanok and Pedro Bay reported occurrences of harvesting female seals with unborn pups inside the mother. Some respondents also recalled a July 1998 incident when an injured seal pup was found on a beach near Iliamna. The seal pup had a gash on its head, likely from getting hit by a boat. This pup ended up being taken to the Alaska SeaLife Center in Seward for recovery and was released back into Iliamna Lake the following fall. As indicated earlier, 2 of the seals for which biosamples were available were pregnant: 1 was harvested in January, and the other in mid-June. In addition, a near-full term fetus was recovered from the shore near Kokhanok in early March 2012. The fetus's lanugo coat was intact, and the lungs had never inflated, suggesting a pre-term stillbirth; genetic analysis indicated that the pup was a harbor seal (see Table 4-2).

¶ 5.2.x. Seasonal Variation in Seal Locations and Behavior

This section provides a general overview of the locations where seals are found throughout Iliamna Lake, as documented through interviews and aerial surveys. Respondents from the study communities reported seals being observed in locations all over Iliamna Lake and within the Kvichak River. However, respondents also reported that seals are predominantly found in the northeast end of the lake and are seen much less in the southwest end of the lake. For example, an Iliamna respondent who has flown the air routes between Iliamna, Kokhanok, and Igiugig almost daily for 40 years said, "*Very, very seldom do you ever see them [seals] anywhere past [southwest] a direct line between Kokhanok and Newhalen.*" This fits with observations made during aerial surveys, since seals were never sighted hauled out in the southwest end of the lake. Understanding of seal behavior and distribution in the lake is much improved by incorporating the local knowledge of both haul out and feeding locations to complement aerial survey data.

In gathering results on seal habitat use and distribution, the survey team discovered that, while respondents continually mentioned "Seal Island" as an important location, the actual location referred to differed by survey community. Indeed, there are 3 separate locations known as "Seal Island" within Iliamna Lake, and when discussed in this report these locations will be referred to as *Seal Island I*, *Seal Island II*, and *Seal Island III* (Figure 5-16). **Seal Island I** is known as a traditional seal hunting location for the Dena'ina people who referred to it as *Hnighejuzhi*, which translates to "clumped" or "tied together" (Evanoff 2010). This meaning is in reference to Dena'ina observations of many seals hauled out together at this location (Karen Evanoff, Cultural Anthropologist, National Park Service, Lake Clark National Park and Preserve, April 2013, personal communication). This location is labeled "Seal Island" on U.S. Geological Survey maps, and is located between Triangle Island and Flat Island. **Seal Island II** is 2 connected sandbars, rather than

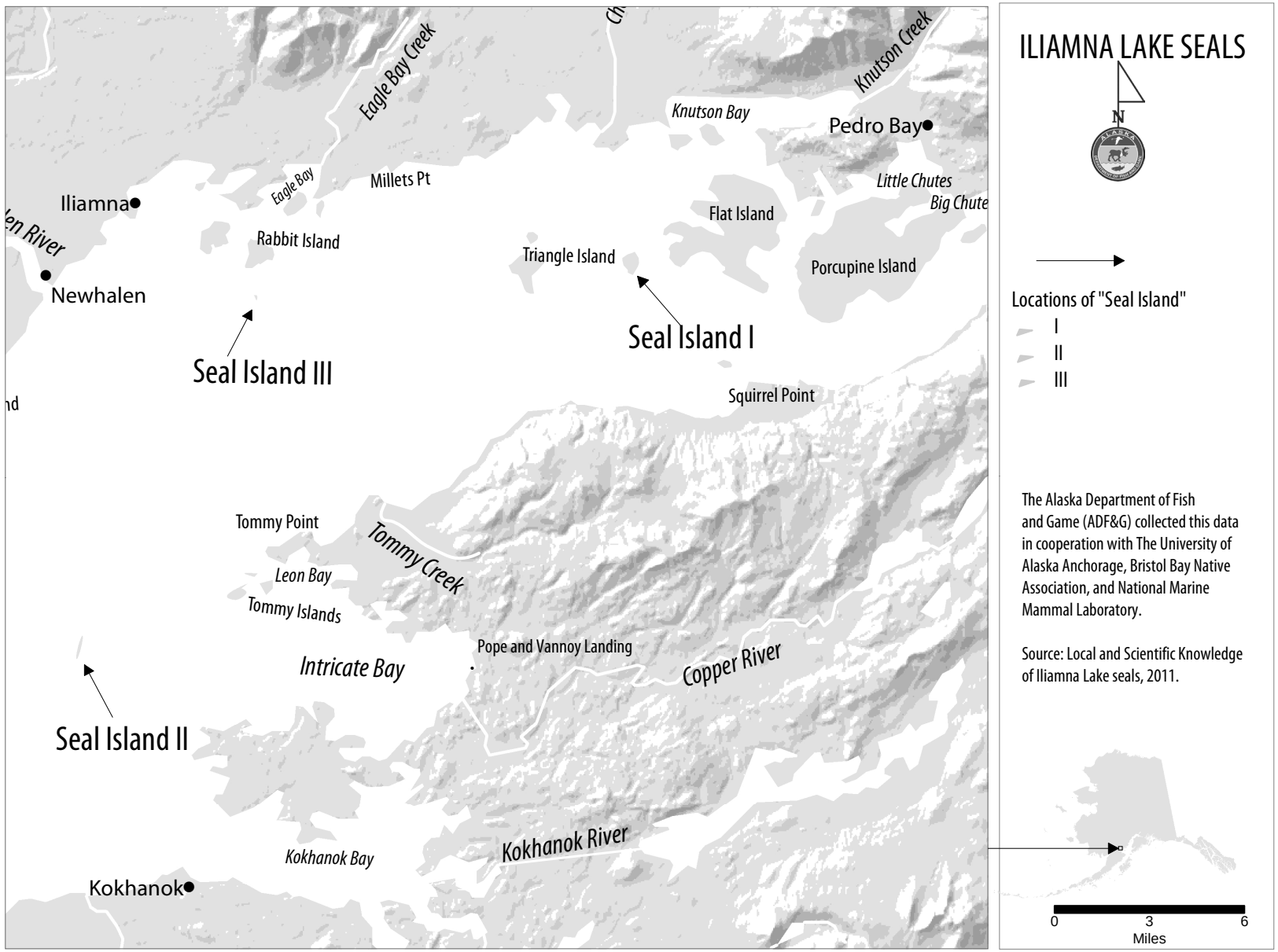


Figure 5-16.–The location of the 3 different "Seal Islands" documented through ethnographic interviews, 2011.

an island, and, as such, is a geographical feature that is constantly changing in relation to water conditions. It is located approximately 8 miles north and slightly west of the community of Kokhanok and 6.5 miles southwest of Tommy Point. A respondent from Iliamna, a local pilot who frequently flies over Iliamna Lake, explained that there are 2 main geographic features present at the location labeled on report maps as "Seal Island II": a long, skinny sandbar that local pilots call "*the seal spit,*" and a larger island-type sandbar that the local residents call "*Seal Island,*" which is located just north of the "*seal spit.*" **Seal Island III** is a rock outcropping referred to as "*Seal Island*" by residents of the community of Iliamna, who frequently observe seals hauled out at this location. Seal Island III is also sometimes called "*Flat Rock*" by Iliamna residents. It is located approximately 6 miles east of the community of Newhalen and approximately 1 mile south of Rabbit Island. Relative to the aerial survey locations (see Figure 5-16), Seal Island I is site JF16EF (N59.74930, W154.43800), Seal Island II is site JF19B (N59.55880, W154.85500), and Seal Island III is site JF18A (N59.68846, W154.69342).

Of the 3 separate locations known locally as "Seal Island," Seal Island II was most frequently discussed by study respondents. "*Those [the two parts of Seal Island II] are the 2 main places that you'll see any masses of [seals],*" said the Iliamna respondent. Indeed, many respondents explained that seals can be consistently seen hauled out on the sandbars of Seal Island II, or in the water adjacent to the sandbars, whenever there is open water. However, respondents also explained that these sandbars have a tendency to disappear and reappear as a result of weather events, thus affecting the presence of seals there. For example, an Iliamna respondent explained that "*the seal spit changes its shape substantially as the east and west wind hits it and there are times when the water washes it completely out … and, then, the wind changes directions and it will build all that gravel right back up.*" Respondents explained that when the wind moves in a westerly direction one can count on there being seals on these sandbars. An Igiugig hunter explained:

> *When it blows West wind, this place [Seal Island II] will pile up with seals. There'll be so many there that you can't count them as you're passing by on an airplane. I don't know if they all just kind of flock to there or what but … that little island out of Kokhanok [Seal Island II] you see them most out of there.*

Respondents explained that seals use this prominent location for hauling out whenever weather conditions make it available to them. "*You'll see seals on [Seal Island II] clear till freeze-up,*" said an Iliamna elder.

In addition, residents identified 3 distinct periods of the year when seal locations, movements, and behavior were distinct: spring (late-March–May), summer and fall (June–November), and winter (December–mid-March). The primary seasonal factors influencing seal behavior were the presence or absence of lake ice, the occurrence of salmon runs into and out of Iliamna Lake, and regional variation in ice conditions during winter. The following section will describe local knowledge of seasonal seal movements and behaviors in detail, and is based on household survey results, verbal descriptions, and mapped information provided by respondents from the study communities. Results are contrasted with observations from the aerial surveys.

Springtime and Ice Breakup (March to June)

According to respondents from the study communities, prominent pressure cracks in the lake ice normally begin emerging sometime in March followed by the winter ice on Iliamna Lake beginning to break up by early- to mid-May. The occurrence of pressure cracks and open water locations during times when ice is present in Iliamna Lake varies annually and the locations, size, length, and shape of these features also vary from year to year. In addition, break-up timing is also weather-, temperature-, and location-dependent. For example, respondents explained that the winter of 2011–2012 was very cold and as a result very thick lake ice formed. An Iliamna respondent explained:

> *Right now [March 2012], this is one of the coldest winters we have had for a long time, so the ice depth is going to be really deep. If we get a really mellow low-pressure system, where we get a lot of east wind blowing, the ice just sits there and just kinda rots in place but if we get some really heavy winds in the spring it'll break up little holes and then it really starts chewing it up fast. [This year it] could even be as late as June for breakup.*

Photography by David Withrow, NOAA

Plate 5-3.–Nine seals hauled out along a break in the spring ice in Iliamna Lake, as viewed from an aerial survey in April 2013.

Alternately, a Newhalen hunter explained that a warmer winter could initiate the break-up process as early as late March. An Iliamna elder said that the cold winter of 2011–2012 represented an exception to local observations of winters becoming warmer and shorter in recent years.

As the air temperatures begin to rise in early spring (mid-March to April), and the ice begins to break up, seals begin to appear hauled out on the lake ice (Plate 5-3). Respondents explained that following a long winter of residing under the ice, the seals are eager for an opportunity to haul out and will thus emerge on the ice as soon as the first pressure cracks open, which is usually in March. A Levelock elder explained that at their first chance in the springtime the seals will haul out and "*start basking in the sun.*" Some respondents reported that more seals can be seen on the lake during early spring than any other time of the year. According to an Iliamna elder:

> *This time of the year [mid-March], there are little open water places. Up by Pedro Bay they call it 'the Chutes' and over in the Chekok [Creek mouth] area there are typically areas of water that open up pretty early. There is usually a huge pressure crack that runs between Tommy Point and Iliamna and that's where you usually start seeing the first seals popping up. Or between Tenmile Island and Kokhanok line there is usually another big pressure crack. When these pressure cracks starts opening up, just enough for a tiny little hole along the pressure crack, you'll see 1 or 2 or 3 seals on top of the ice there." Another Iliamna elder said, "in the springtime you see more [seals] on the ice. If it's a real nice day there's pods of them all over Chekok out there, afternoon when the sun gets up nice and warm.*

Respondents also indicate that it is at this time of year that some seals begin traveling as extensively as possible, especially in a southwesterly direction, in search of pressure cracks to haul out on. A Pedro Bay hunter said that the seals are somewhat lethargic, "*tame*," and easy to hunt at this time due to low energy from surviving a long winter.

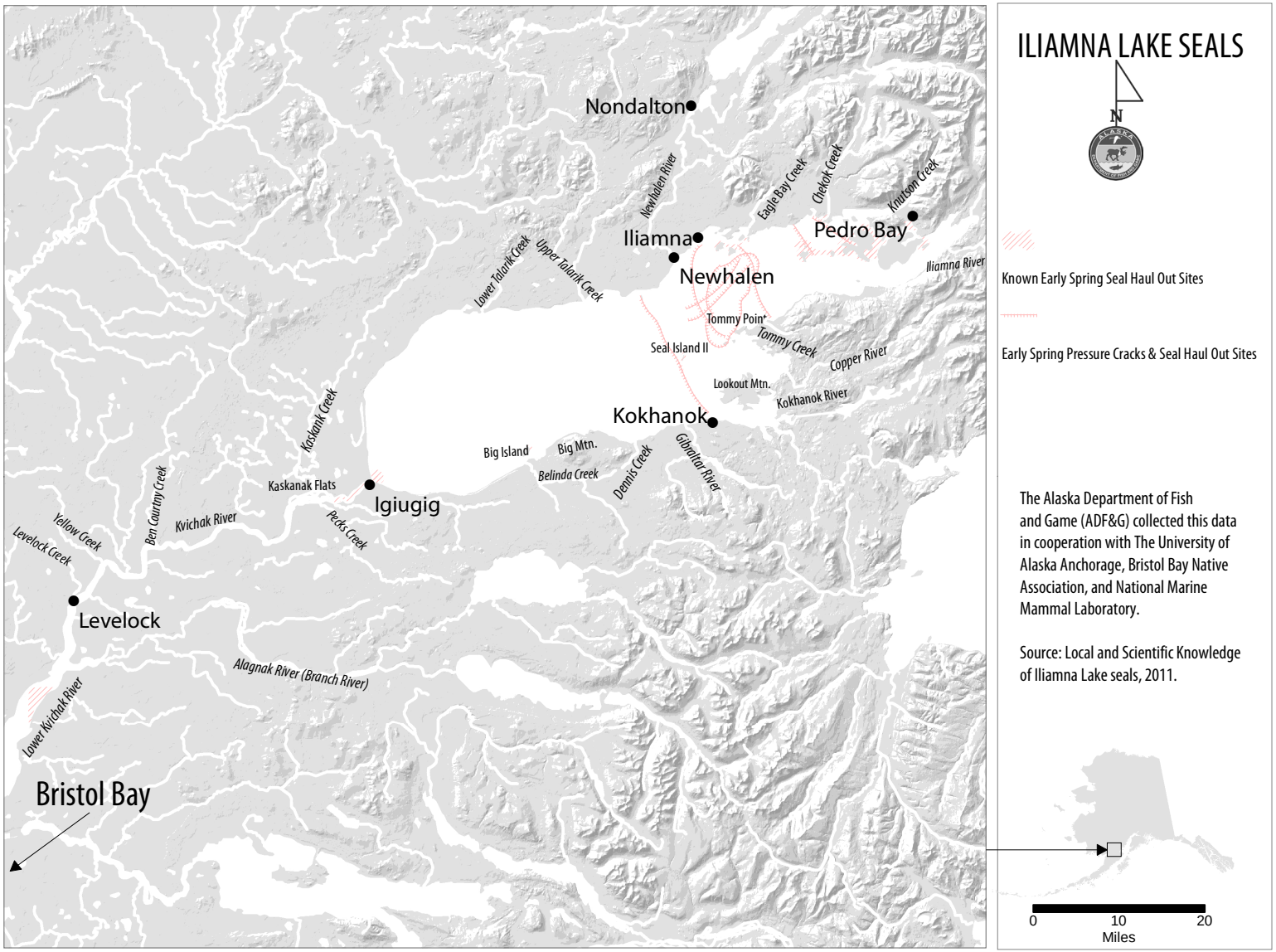


Figure 5-17.–Known early spring haul out locations and associated pressure crack locations observed by local residents as occurring on a regular basis in Iliamna Lake.

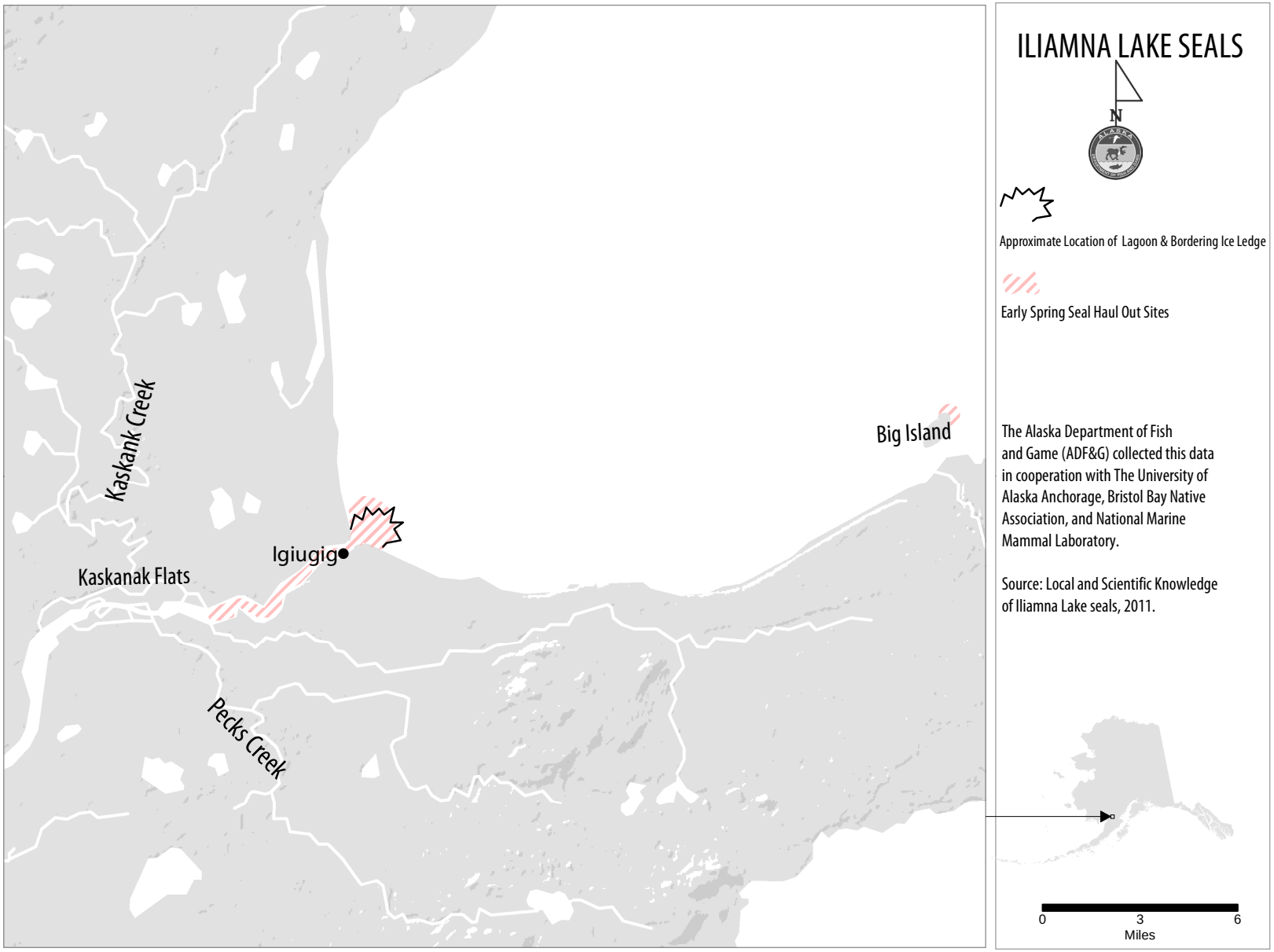


Figure 5-18.–A close-up view of the "lagoon" that forms at the headwaters of the Kvichak River.

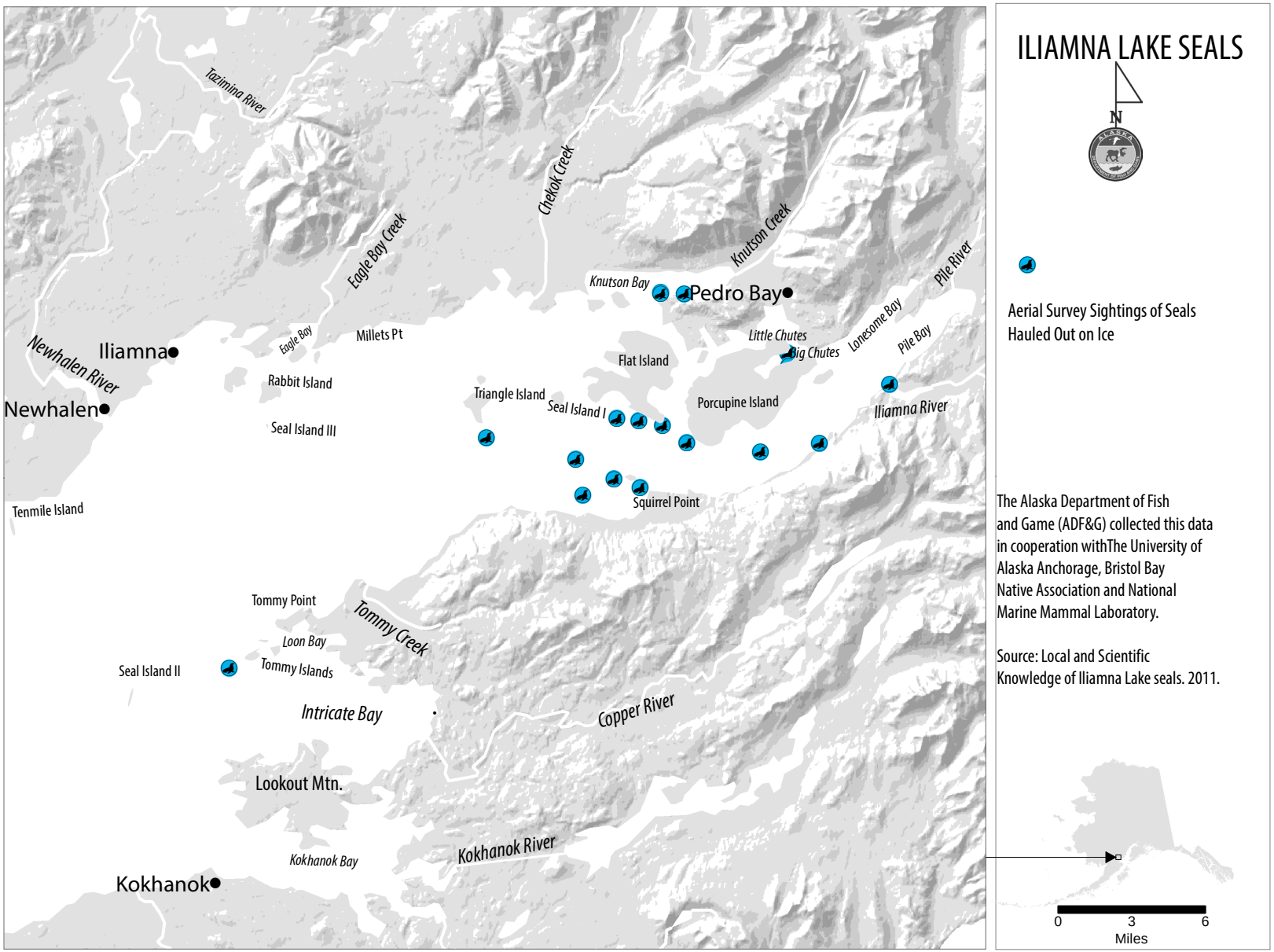


Figure 5-19.–Locations where seals were observed hauled out during aerial surveys conducted when the lake was covered by ice.

As the month of May approaches and air temperatures continue to increase the ice breakup intensifies and more and more seals become visibly abundant in the northeastern portion of the lake. An Iliamna elder explained: "*When it starts turning warm here you'll see seals all over the place. They haul out in 20–30 to a bunch.*" Respondents explained that, as the lake transitions to becoming completely ice-free, seals begin to consistently haul out on islands and sandbars between Kokhanok and Newhalen, such as Seal Island II and Tommy Point. Respondents reported that large groups of seals also haul out in the north end of the lake where they normally overwinter, near the many islands in the vicinity of Pedro Bay (Figure 5-17).[6]

Farther southwest, seals are less abundant. Igiugig and Levelock respondents report occasionally seeing seals in the southwestern end of the lake, and inside the Kvichak River, but these sightings do not occur in every year and are dependent on the presence of open water. Igiugig respondents refer to an area of open water outside the headwaters of the Kvichak River as "*the lagoon*" and reported that an "*ice ledge*" forms above the open water of "*the lagoon*" by early January and lasts up until May (Figure 5-18). Respondents from both Levelock and Igiugig reported that seals are sometimes in "*the lagoon*" during early spring, both in the open water season and when hauled out on the ice. Respondents also reported occasionally observing seals hauled out on the northern tip of Big Island in the spring. For example, an Igiugig elder said, "*Every once in a while we'll get some stragglers down near Igiugig … Sometimes we'll see them [seals] out on the ice here.*" The elder said that the appearance of seals around Igiugig when most of the lake is still covered in ice is an "*occasional*" occurrence that does not happen on a consistent annual basis: "*Just a few, very few [seals are seen at the headwaters of the Kvichak River during spring]. The only place you get a whole bunch is way up [north] on them islands.*" For example, while the elder said that he has observed around 30 seals at a time on the ice along the pressure cracks in the north end of the lake, he explained that he has only seen 1–3 seals at any one time near Igiugig on the "*ice ledge*" or in "*the lagoon.*" Furthermore when seals do appear along the ice at Igiugig they usually appear from the "*later part of March to early May, when it [the ice] starts to break up.*" At that point, seals may also be seen hauled out on spring ice near Igiugig and on sandbars inside the Kvichak River (both at the headwaters, and in the lower reaches). According to a Levelock elder, during springtime the seals haul out on "*any sandbars you see along the [Kvichak] river*" and begin "*basking in the sun.*" It is unknown to Levelock respondents whether the seals observed in the lower Kvichak River originate from Iliamna Lake or from Bristol Bay.

One possible reason for the reported presence of seals near the entrance to the Kvichak River during spring is the opportunity for seals to feed on sockeye salmon smolt exiting the lake during mid- to late May for their migration to salt water via the Kvichak River (Crawford 2001). Additionally, rainbow smelt are known to migrate up the Kvichak River beginning in early spring (Krieg et al. 2005). The presence of large schools of smelt in the upper reaches of the Kvichak River at this time may also attract seals to the area. However, an Iliamna elder also indicated that during spring seals are known to amass in and around Leon Bay (outside Kokhanok) to feed on spawning smelt.

¶ Local observations of the locations where seals are sighted during spring coincide with aerial survey data. For example, many of the locations where local respondents reported observing seals hauled out on ice coincide with the general proximity of locations where aerial surveys have recorded seals hauled out on ice (Figure 5-19). On April 14, 2011 and April 3, 2012, an aerial survey of the first 10 miles of the Kvichak River from the lake was conducted. Some open water was seen until Kaskanak Flats, but the rest of the river appeared frozen. No seals were sighted.

Summer (June to Mid-September)

While the seals are primarily found in the northeastern end of the lake during spring, respondents explained that, beginning in mid- to late June, when the lake is completely ice-free, greater numbers of seals are known to migrate down the lake to intercept salmon entering the lake at the headwaters of the Kvichak River. An Iliamna elder said that seals can be expected in the Igiugig area "*as the salmon come in, anywhere from late June to the first week or so of July.*" Respondents explained that salmon entering the lake move

6. All seal haul out sites and locations included in this report were mapped by respondents as approximate locations representative of local observations over multiple years. Seals are known to haul out anywhere along the length of these pressure cracks. Pressure ridges and cracks are shown in approximate locations, as mapped by local respondents.

quickly and that around July 1 most of the seals have moved back up the lake to the mouths of rivers and streams to feed on salmon entering rivers and streams (Figure 5-20). Once salmon have dispersed in the lake, respondents report that seals are seen abundantly over widespread areas of the lake feeding on salmon. For example, an Iliamna respondent said:

> *They [seals] follow the fish. As soon as the salmon come in the lake they're everywhere. They really spread fast. It only takes a couple of days for the salmon to travel and they start congregating at the mouths of every one of these streams, and there are a lot of middle-of-the-lake spawners and beach spawners and stream spawners.*

An Igiugig elder said, "*I've actually even see them down at the creeks here [creeks emptying into the lake near Upper Talarik Creek], I even shot 'em up on the lake there, right inside the lake there*." Kokhanok respondents reported seeing seals along the lakeshore near Big Mountain in the summertime. Respondents also reported that seals will travel some distance up rivers and creeks to follow the fish. For example, a Newhalen hunter said, "*They go way up the rivers [that drain into Iliamna Lake] hunting for those salmon and trout.*" River and creek mouths are utilized not only by salmon, but also by species such as rainbow trout, Dolly Varden, and Arctic grayling; respondents consistently reported these to be the primary feeding locations for the seals within Iliamna Lake.

However, while seals may congregate near the mouths and inside of the lake's many tributary rivers and creeks, they can also be found in bays and islands in the northeastern portion of the lake (Figure 5-21). Indeed, some respondents reported that the Intricate Bay area north of Kokhanok is known as an important seal haul out area because it is protected from adverse weather conditions. A Kokhanok hunter said that in years past many bull seals would be seen hauled out on the reefs and rocks at Intricate Bay but that they are no longer seen: "*It used to be any spring you could go up there and see between 5 and 20 [bull seals] hauled up on the rocks or the reefs, but now you don't. If you see 1 you're lucky.*" The respondents said that these sightings represented an obvious separation of male seals from female seals and that during summer male seals would stay in Intricate Bay while the female seals "*would be around Tommy Point or [Seal Island II]*." The respondent was unsure why this change had occurred.

In addition, some seals remain in the southwestern end of the lake throughout summer. A Levelock elder who used to drive a barge up the Kvichak River to Iliamna Lake communities reported that during summer it is not uncommon to see seals in the waters all along the lakeshore outside of Igiugig, and Igiugig respondents reported that sometimes during July or August seals are seen hauled out on a "*small strip of a sandy beach*" near Igiugig. In addition, respondents from Igiugig and Levelock reported that seals could be observed in the Kvichak River feeding on salmon or hauled out on sandbars inside the Kvichak River, near the mouth of Yellow Creek, and near the mouth of the Kvichak River at Bristol Bay (Figure 5-22; Figure 5-23). A Levelock elder reported that when seals are seen in the Kvichak River it is almost always when the salmon are running. The elder said that during this time it is possible to see seals hauled out on "*any sandbars you see along the river.*" The elder said that near the mouth of Yellow Creek there "*is a sandbar [on the Kvichak] … where they like to haul out.*" The elder reported that seals are known to feed at the mouth of and around one-quarter mile upriver of Yellow Creek. "*A lot of times I spot 'em there, there's fish in there, that's what they're after,*" said the elder. Indeed, when household survey respondents were asked what months of the year they normally observed seals in the Kvichak River, the data indicated that seal observations began in the spring, peaked during mid-summer, and with the exception of observations by Levelock residents, declined to zero in the winter months (Figure 5-24). Respondents were uncertain if all or any of the seals seen in the Kvichak River were Iliamna Lake freshwater seals, or saltwater seals from Bristol Bay.

Seal haul out locations reported by local residents are largely in agreement with the data from aerial surveys: most seals are sighted hauled out on the sand spits and islands in the northeast portion of the lake (Figure 5-25). Seal use of river and creek mouths as foraging areas are not documented by aerial surveys due to methodological issues, in that the surveys only record animals hauled out, not those in the water. This may explain why no seals were photo-documented as hauled out in the Kvichak River or at the southwest end of the lake during the 4 complete and one partial aerial surveys flown over the Kvichak River.[7] Indeed, during

7. Complete surveys were flown July 25, 2008; August 15, 2009; July 9, 2010; and August 4, 2013 and a partial survey was flown

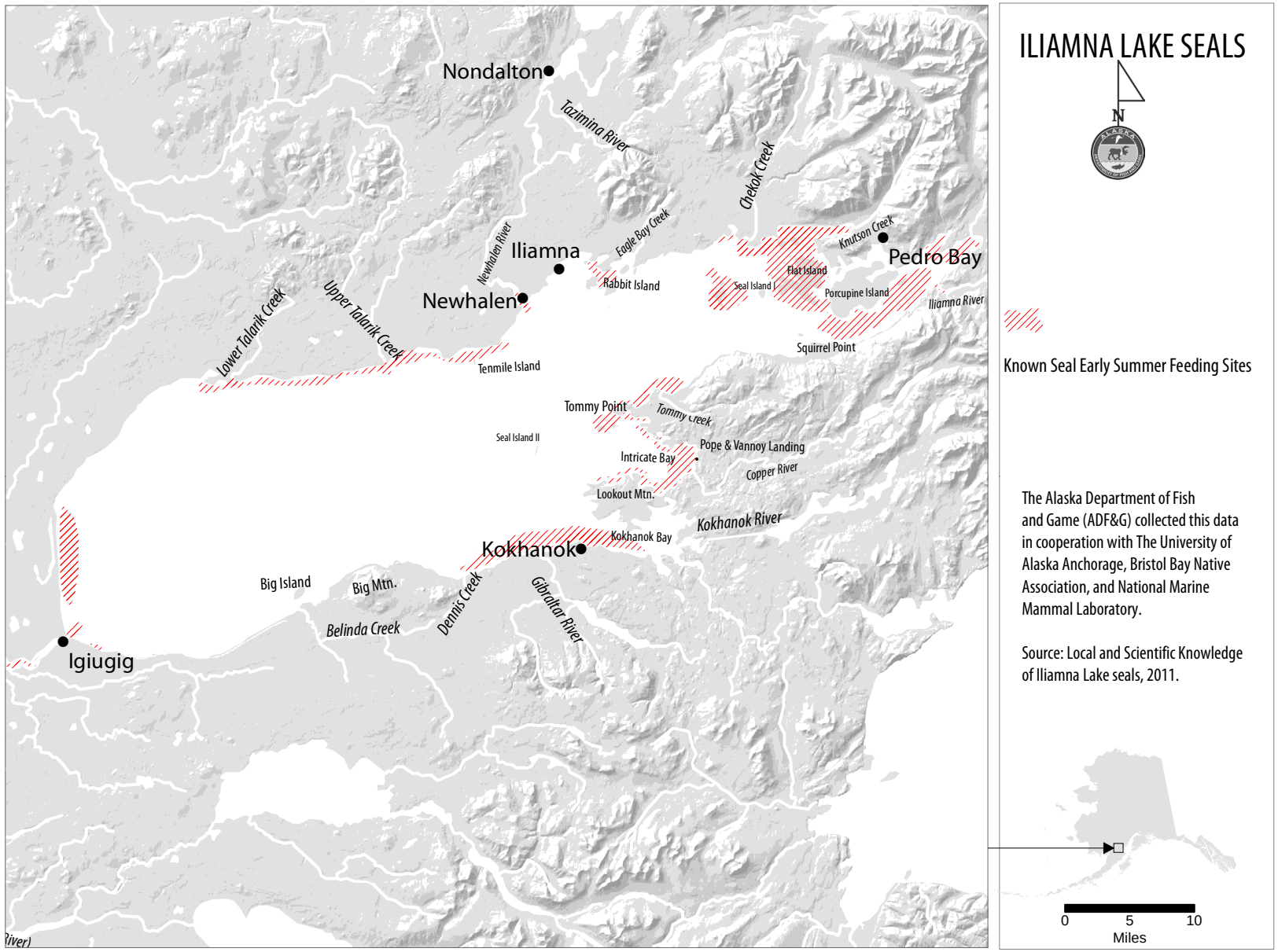


Figure 5-20.–Locations where seals are seen feeding based on local observations during summer months when the lake is free of ice.

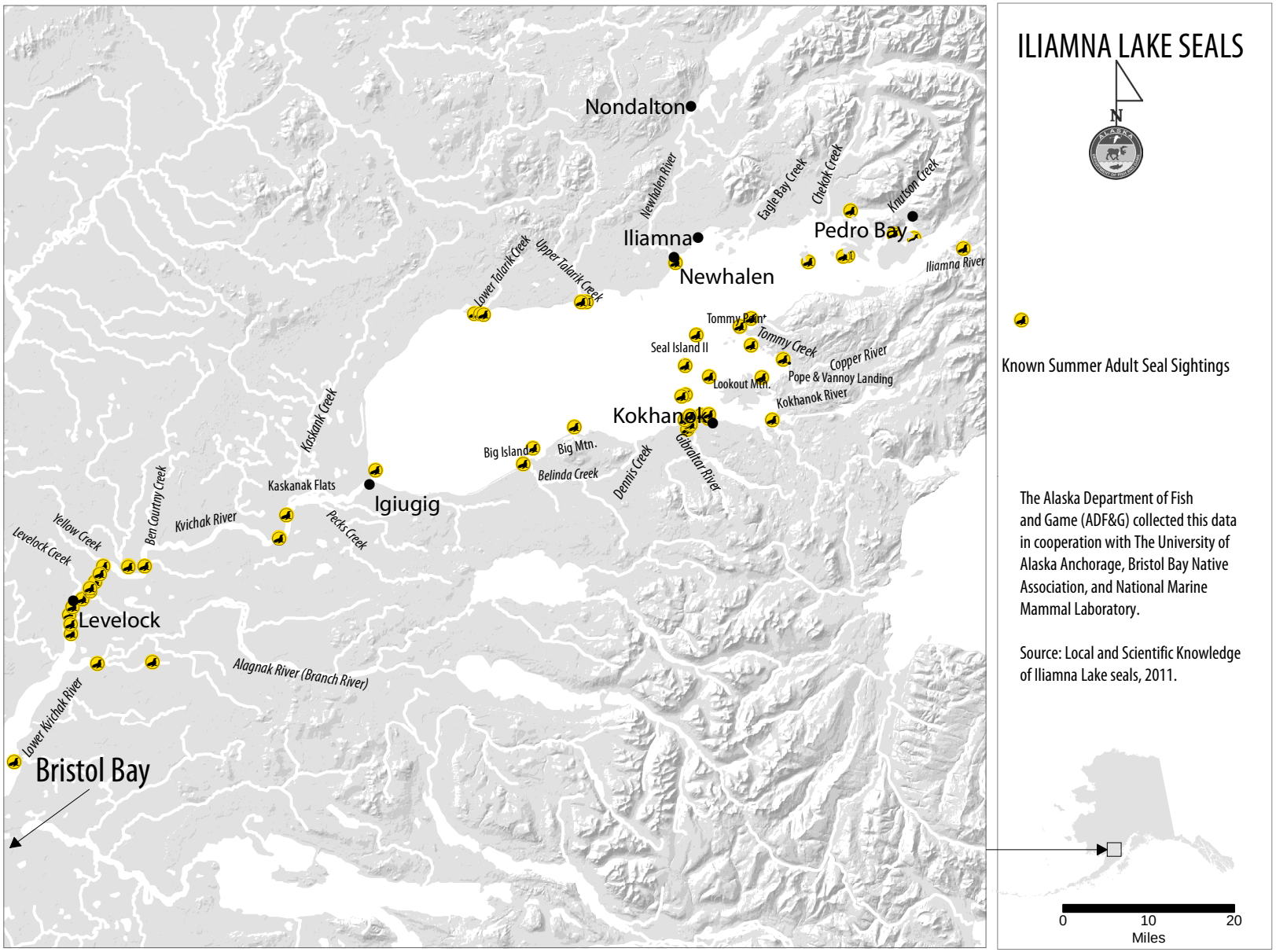


Figure 5-21.–Locations where seals are seen hauled out based on local observations during summer months when the lake is free of ice.

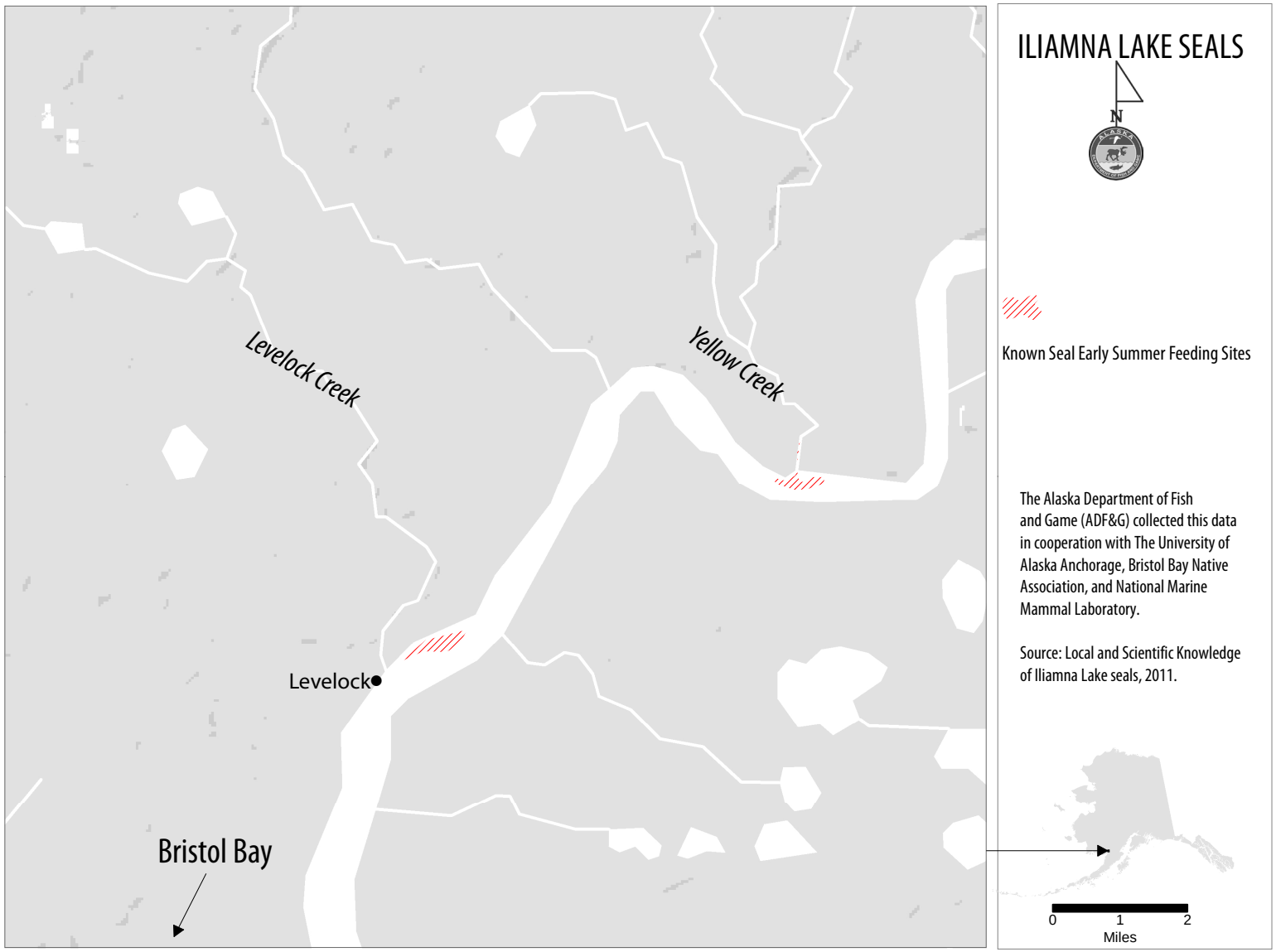


Figure 5-22.–Locations where seals are seen feeding in the Kvichak River based on local observations during summer months when the lake is free of ice.

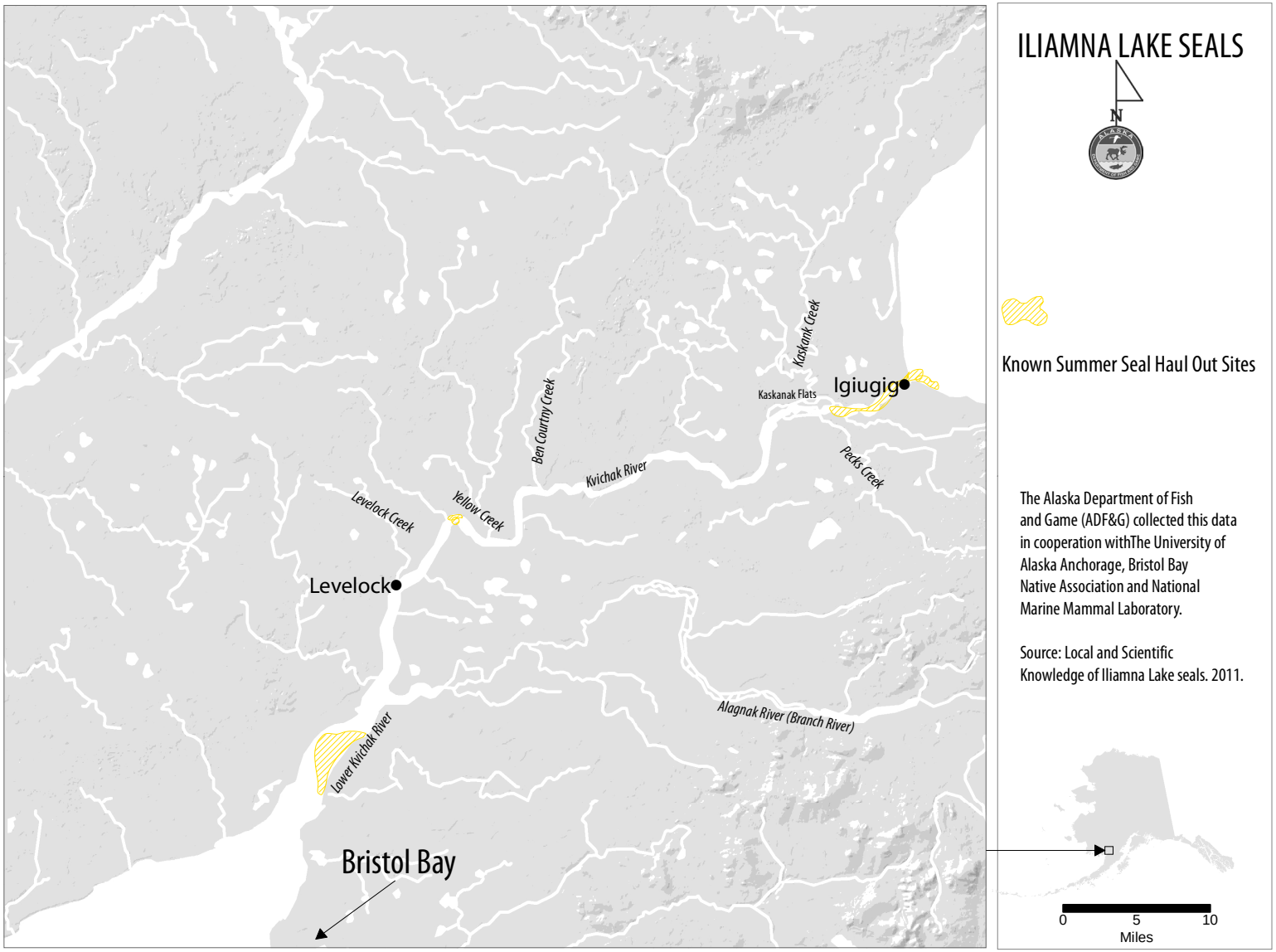


Figure 5-23.–Locations where seals are seen hauled out in the Kvichak River based on local observations during summer months when the lake is free of ice.

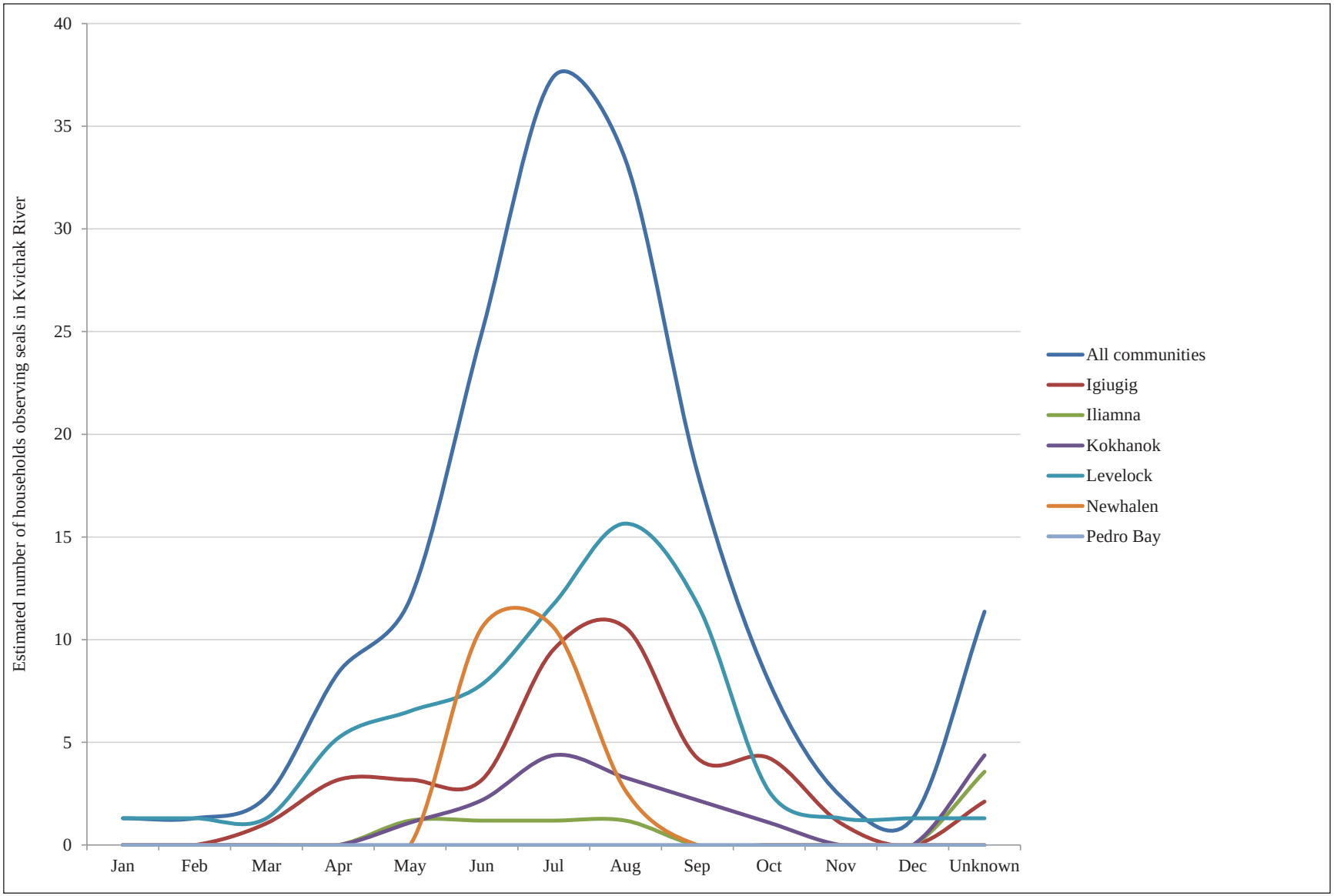


Figure 5-24.–Estimated number of households observing seals in the Kvichak River, by month, each study community and all communities combined, 2011.

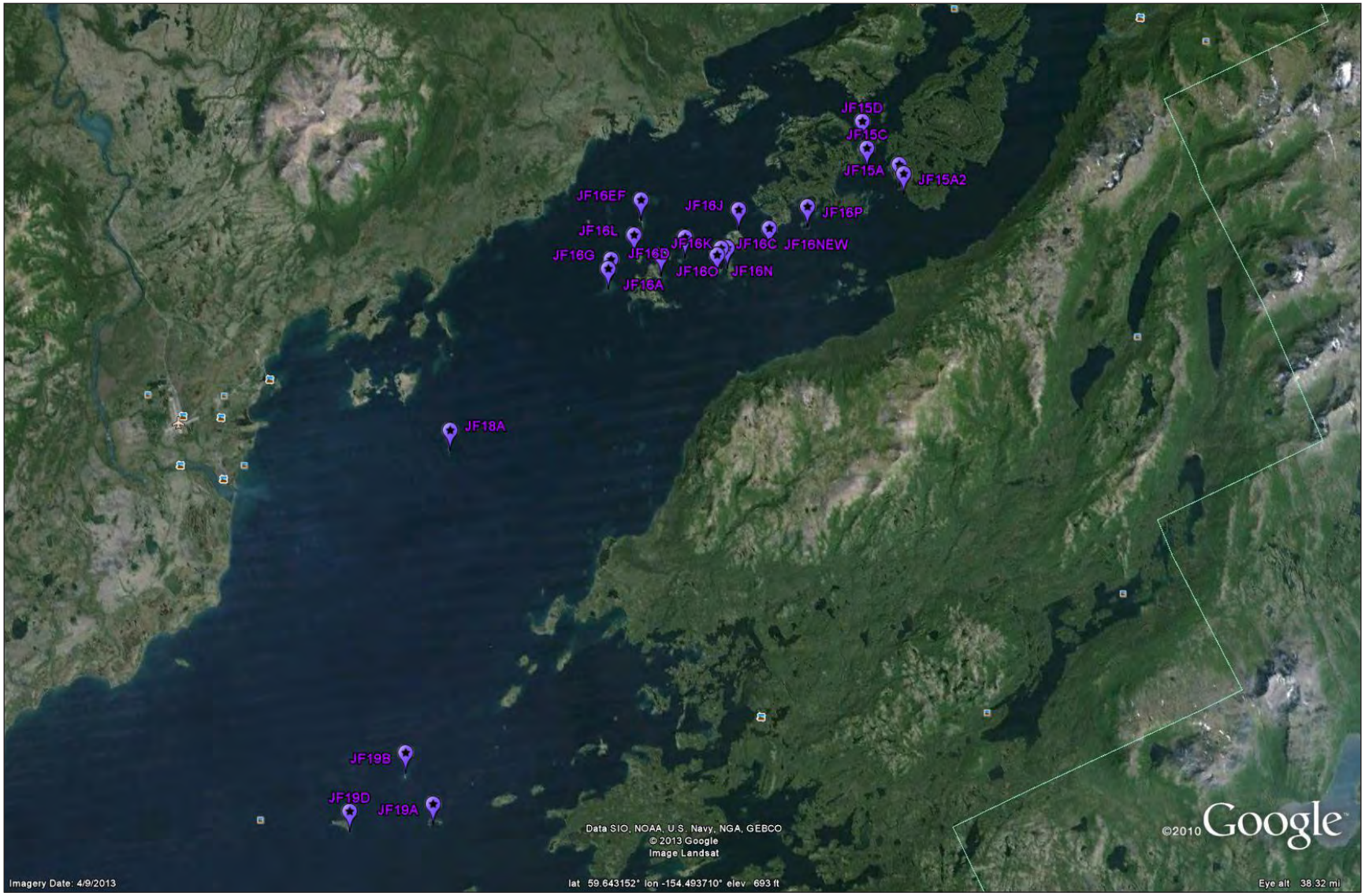


Figure 5-25.–Locations where seals are seen hauled out in Iliamna Lake during aerial surveys flown when the lake is free of ice.

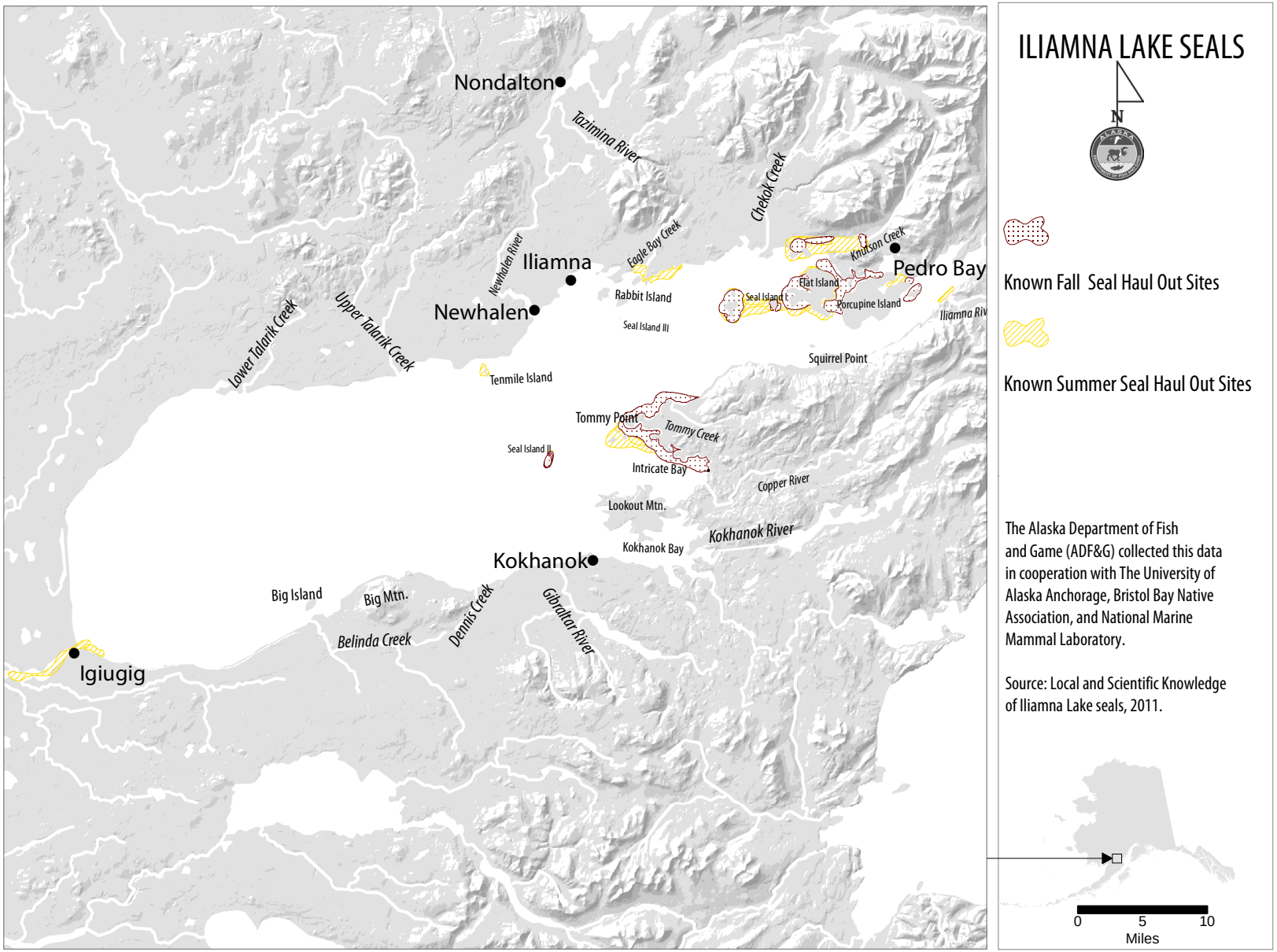


Figure 5-26.–Locations where seals are seen hauled out in Iliamna Lake based on local observations during summer and fall.

one of those surveys, a local pilot said he recently saw 2–3 seals around Kaskanak Flats—not in the main channel but in one of the offshoots. The area was searched, but surveyors did not locate the seals.

Fall (Mid-September to December)

Throughout summer and into fall and early winter seals continue to haul out on sandbars, spits, and the beaches and rocks of islands used during the summer months (Figure 5-26). In addition, as the season shifts to fall, the mouths of rivers and creeks within Iliamna Lake remain active with seals feeding as spawning salmon continue amassing in those locations. "*In the falltime this whole lake is just full of salmon so wherever there is any major spawning grounds you'll find them [seals] especially the mouths of creeks,*" said a Kokhanok hunter. Respondents also consistently discussed Knutson Bay as a major falltime spawning area for sockeye salmon and thus an area where seals feed abundantly. "*Knutson Bay gets an incredible amount of salmon,*" said an Iliamna elder. The elder said that spawning salmon will sit along the beaches in Knutson Bay and the seals will prey on them there (Figure 5-26).

Similarly, Newhalen respondents often discussed the presence of seals in the Newhalen River, and reported that seals can be found in the Newhalen River feeding on fish into September and October and that they continue to feed on fish up until right before freeze-up. During salmon season, seals are known to take salmon from Newhalen residents' setnets and seals have even been caught in setnets when trying to take fish from them (Fall et al. 2010). A Newhalen hunter said, "*Fall usually we are just getting the red salmon, spawned out salmon, at that time and that's when you see the big seals, that's when we usually see them, when we don't normally [hunt] them cause they've been eating fish.*" As described by local residents, the heavy reliance of seals on salmon is reflected in the taste of the seal meat, and local hunters report that it develops a strong fishy taste at the time, which is undesirable. While both Igiugig and Levelock respondents reported that seals are often seen feeding on salmon in the Kvichak River during late summer and into fall (Figure 5-27), Levelock residents said that seals are otherwise rarely seen near Levelock.

Lake Freeze-Up and Wintertime (December to March)

Respondents explained that precise freeze-up and breakup times for Iliamna Lake are subject to change every year, with freeze-up generally occurring between late December and early January. An Iliamna respondent said, "*Typically the lake freezes over by the end of the year. We've kept track of it for many, many years and typically by December 31st the lake is completely sealed over.*" However, certain locations of the lake may not freeze and instead maintain open water throughout the winter, and respondents explained that the shallower southwest portion of the lake freezes prior to the deeper northeast portion. An Iliamna elder said, "*From Iliamna up is the last section to freeze, the north end is the deeper end and the lake freezes from south to north.*" Within the lake, the deepest measured depths are located in Pile Bay (greater than 300 m) (Anderson 1969), and satellite imagery taken by the University of Alaska Geographic Information Network of Alaska[8] indicates that Knutson Bay, Pedro Bay, and Pile Bay are the last areas of Iliamna Lake to freeze, which normally occurs around early January. These areas are recognized by local residents as the last to freeze, if they freeze at all, during winter: "*The main part of Lake Iliamna from Pile Bay down to Squirrel Point, in the first 10 miles of the lake [from the east] is where the really deep water is,*" said an Iliamna respondent, and a Pope-Vannoy hunter said, "*Up from Tommy Point to the Pedro Bay area it takes the ice a long time to freeze in the winter.*"

An Igiugig hunter explained that freeze-up occurs in a process where the ice surges and retreats in sheets and this will occur several times before the lake is completely covered in ice. Still, respondents explained that it is common for the entire lake to freeze over in mid-winter, leaving no open water for the seals to use for hauling out on ice or for breathing holes. For example, the winter of 2011–2012 (when this research was conducted) was said to be abnormally cold. "*This winter, there were very few pressure cracks, very cold. It didn't open up,*" said an Iliamna elder. In addition, respondents explained that freeze-up can occur so rapidly that seals can sometimes become trapped on top of the ice with no access to water. In contrast, an Iliamna elder said that there are areas of the lake that never freeze and that seals always have access to

August 13, 2011.

8. For information about the University of Alaska Geographic Information Network of Alaska see: www.gina.alaska.edu.

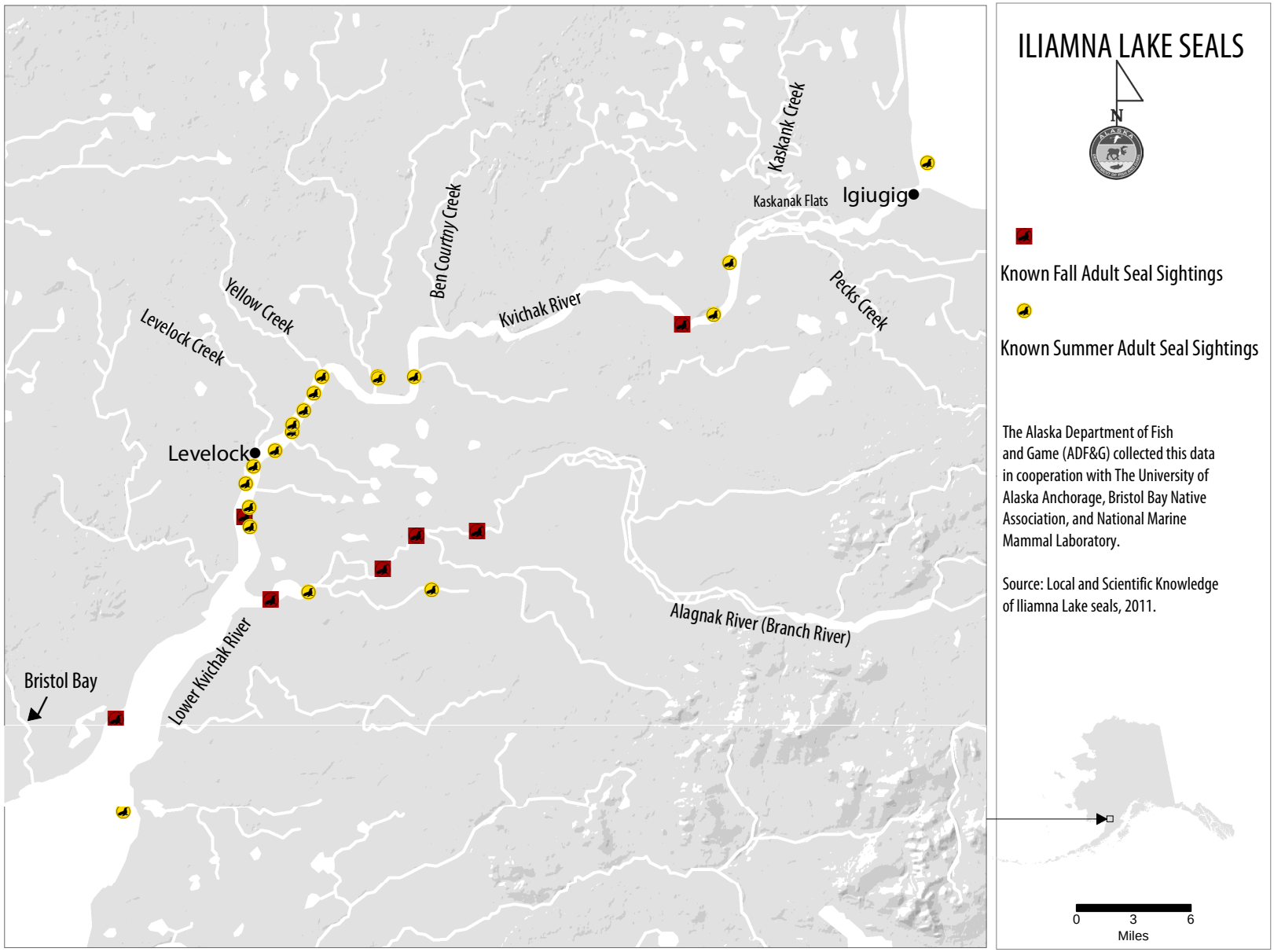


Figure 5-27.–Locations where seals are seen feeding or hauled out in the Kvichak River based on local observations during summer and fall.

some amount of open water year-round.

As the lake freezes over at the onset of winter, seals are seen hauled out much less frequently. However, respondents from the study communities reported that seals always overwinter in Iliamna Lake and many respondents suggested that if people spent more time on the lake ice and in the island areas in the middle of winter they would probably see more seals. For example, a Newhalen elder said, "*People usually see most of their seals in the summer because that's when people are out on the lake, not because there are no seals in the lake during winter.*" Although seals are seldom seen in mid-winter, respondents from the study communities reported that the seals within Iliamna Lake haul out year-round and that seals will end up anywhere in the lake where open water remains or where pressure cracks form. "*It all depends on the pressure cracks,*" said an Igiugig hunter. A Pope-Vannoy hunter said, "*If it opens up anywhere on the lake during winter the seals will come out,*" and a Newhalen hunter said, "*In winter they go wherever there is open water or pressure cracks.*"

Interviews and mapping exercises indicated that mid-winter haul out locations were clustered around the islands and inlets in the northeastern portion of the lake, as well as along the associated pressure ridges; winter sightings near the Kvichak River are rare (Figure 5-28). Respondents explained that these areas are favored over more open areas with vast expanses of ice because during winter small pressure cracks sometimes form in the ice between the small islands and above shallow reefs and sandbars associated with islands. More specifically, the majority of respondents made reference to the Pedro Bay–Porcupine Island–Pile Bay area as the primary overwintering grounds (Figure 5-28). Respondents explained that this area of the lake is ideal seal wintering habitat because of its combination of island systems, shallow reefs, and very deep waters, which take much longer to freeze, thus providing open water for longer periods of time before freeze-up. For example, a Pope-Vannoy hunter said, "*The area where they hang out in the winter the most is the deepest part of the lake and the last part to freeze.*" A Kokhanok elder said, "*In the wintertime they all hibernate up towards Pedro Bay. They got more open water up there, where they like to stay.*" The elder said that it is not uncommon to observe seals hauled out on the ice next to open water at these locations during the winter months. "*I think that islands would be the most common places where they [seals] would be, as it is very deep water around [the islands], as compared to the lake shoreline, which is gradient,*" explained a Pope-Vannoy hunter. An elder from Iliamna explained that the deep waters surrounding Porcupine Island are known to be seal overwintering locations. "*It is deep water all the way around … [Porcupine Island] … . There are seals all the way around that island,*" said the elder. Specifically, "*the Chutes*" area, a narrow passage along the edge of Porcupine Island between Pile Bay and Pedro Bay, is considered to be a wintering location for seals because of the area's tendency to maintain patches of open water during winter. However, while the northeast portion of the lake is believed to be the primary overwintering habitat for the seals within Iliamna Lake, respondents do report that seals can haul out during winter at any place where open water exists. For instance, a Pope-Vannoy hunter said: "*Whenever there is water I usually see them.*"

During the course of this research, 5 surveys were flown while the lake was ice-covered, and in all cases seals were only sighted along cracks and small areas of open water in the northeastern section of the lake (Figure 5-28), which agrees with the general pattern of habitat use discussed by local residents.

Local knowledge contends that during winter seals within Iliamna Lake feed on various species of nonsalmon fish such as lake trout, rainbow trout, Arctic char, Dolly Varden, burbot, Arctic grayling, freshwater smelt, round whitefish, humpback whitefish, least cisco, northern pike, longnose sucker, threespine stickleback, slimy sculpin, Alaska blackfish, Pacific lamprey, and probably salmon smolt. Respondents explained that the deep waters in the Pedro Bay area and the many islands in the northeast portion of the lake, where most seals are known to overwinter, are areas that are known as prime lake trout habitat (Figure 5-29). Several respondents reported that overwintering seals feed primarily on lake trout in these deep-water bays and around islands in proximity to Pedro Bay. "*There are schools of big trout around those islands [near Pedro Bay] and the seals feed there all winter,*" said an Iliamna elder. An Igiugig respondent said that lake trout populations in the area had declined and suggested this may have occurred as a result of excessive seal predation. Conversely, a Pope-Vannoy hunter questioned if seals within Iliamna Lake feed at all during winter, after discovering no traces of food inside the intestines of 2 different seals she harvested on the ice:

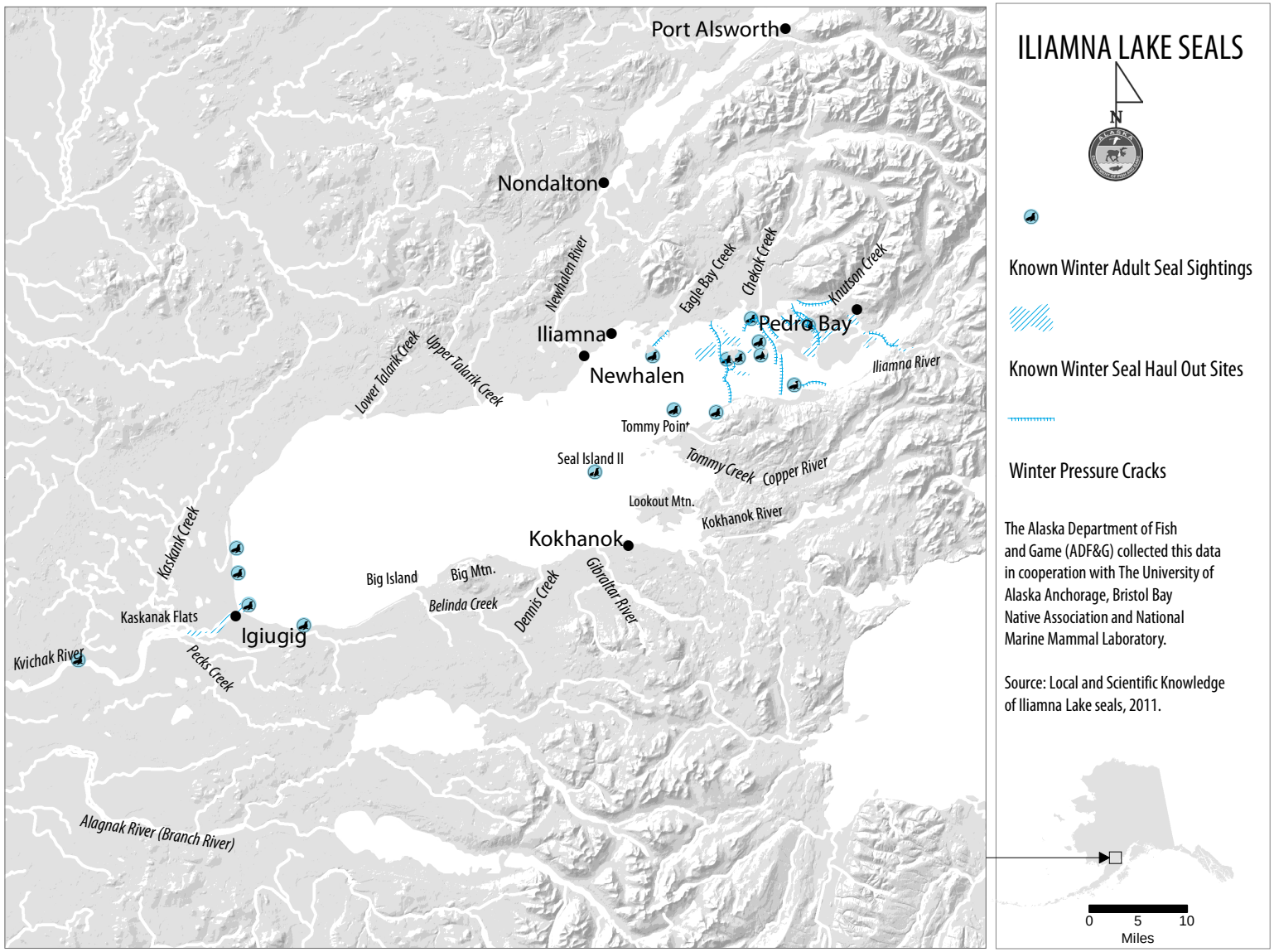


Figure 5-28.–Known wintertime harbor seal haulout locations in Iliamna Lake and locations where residents believe the seal population within Iliamna Lake concentrate for overwintering.

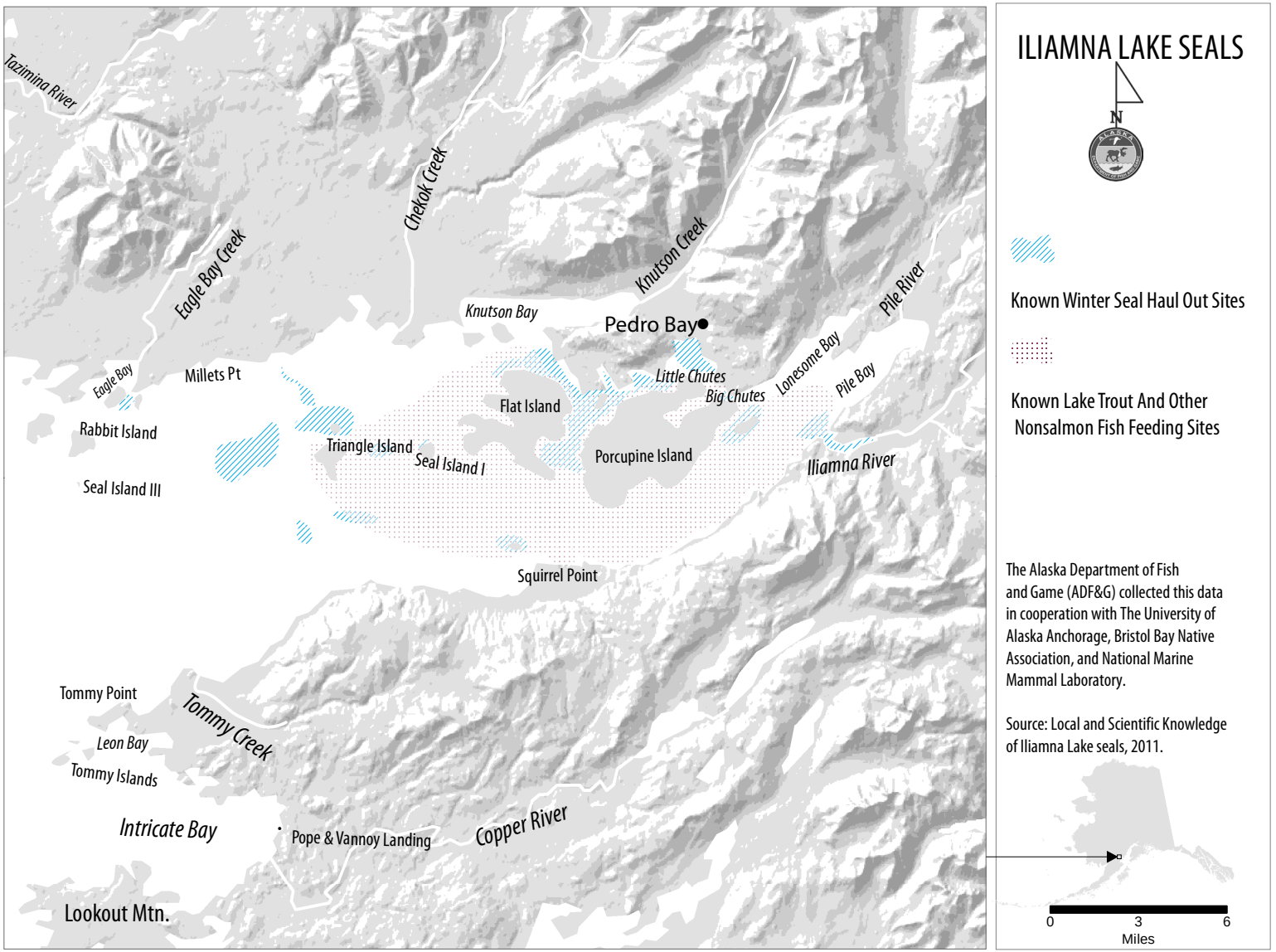


Figure 5-29.–An expanded view of wintertime seal haulout locations in the Pedro Bay area and locations where local residents believe the seal population within Iliamna Lake concentrates for overwintering.

Something I wonder about is whether [the seals] go into sort of a hibernation mode under the ice. I ended up digging into the seal's guts, for the intestines (which can be sewn into clothing and crafts) the last 2 years. Neither of them had one drop of food in the stomach or intestines. I'm sure they could find fish under there if they wanted.

Harbor seals do not hibernate, and so maintain relatively constant basal metabolic rates throughout the year (Ashwell-Erickson and Elsner 1981; Renouf and Noseworthy 1991; Rosen and Renouf 1998). Should intake rates decline during winter, they can compensate by catabolizing lipid reserves accumulated during the preceding summer and fall (Trumble et al. 2003). However, complete abstinence is not possible for more than a very short period. The low frequency with which hunters observed food remains in the stomachs of harvested seals is not surprising, since many studies have found low fill rates in the majority of sampled seals (Lowry et al. 1988; Lowry and Frost 1981; Pitcher 1980).

5.2.xi. Overwintering Strategies

Local traditional knowledge maintains that seals have always overwintered in Iliamna Lake. Elders told of their grandparents and great-grandparents hunting seals during winter. An Iliamna elder said that based upon stories he had heard from his grandparents he was positive that seals have been overwintering in Iliamna Lake "*at least since the 1800s.*" When asked about the history of the seals overwintering in the lake, an Igiugig elder said, "*As long as I could remember they've been [overwintering]. The elders always talk about it, always see them.*" Speaking of her memories of local seal hunters as a young girl in the 1920s, that Iliamna elder said, "*I always remember ice hunters on the lake in winter*," while another said, "*They have always overwintered in the lake.*" A historical account written by prospector Lemuel L. Bonham dated March 10, 1901, describes seals overwintering in Iliamna Lake: "[Iliamna Lake] has many islands in the upper half. Among these islands are plenty of hair seal [harbor seal]. Perhaps the only place on earth where seals are found in freshwater … The seals live under the ice, and have places at the islands where they come at frequent intervals to breathe–a small hole in the ice" (Branson 2007).

An Iliamna elder said, "*I think in the winter they are in the upper quarter of the lake.*" Respondents explained that the locations where the ice is thinnest are also the locations where pressure cracks tend to form the earliest in the season. For this reason, seals are known to concentrate at these locations during winter where water flow patterns maintain openings in the ice that seals can use to exit the water and haul out onto the ice. "*They naturally stay where they can [get] the most [air] and then [that area eventually] gets the big pressure cracks where they can come out as soon as the sun warms the ice up a bit,*" said a Pope-Vannoy hunter.

Alternatively, seals are known to create their own small winter breathing holes in sections of thinner ice. Respondents reported that, early in the winter, seals will bore out a hole in the surface of the ice and then maintain that hole throughout the winter. Respondents suggested that seals create these holes with their nose, or by "*chewing*" the ice. For example, a Pope-Vannoy hunter said, "*I think that the seals go from one pocket of air to another as needed … As long as the ice is thin they just keep breaking it to get air,*" and an Iliamna elder said: "*We see holes on the ice. There are some places where you see the holes seals chew and where they keep holes open on the lake in winter.*" "*I heard about in the old time, when the ice first freezes over, the ice is very thin and the seals find an air hole. They [seals] eat ice to make air holes,*" said a Pedro Bay elder. A respondent reported a prominent location where he had observed air holes approximately one-half mile south of Triangle Island (see Figure 5-16). The elder went on to explain that volcanic activity in the Iliamna Lake/Katmai region may assist seals in their efforts: "*There is also a phenomena here where there are old volcanic vents [which release] methane gas that bubbles up to the surface and a lot of times [this creates] enough turbulence for the ice not to freeze as thick, so the seals will find those spots and keep them open.*" Maintaining such holes may be critical, given a Kokhanok hunter made reference to incidences where seals have become stuck on the winter ice and, unable to access the water, have frozen to death.

Nonetheless, local knowledge also asserts that access to open areas, leads, and seal-maintained breathing holes are not necessary for seals to survive in the lake over winter. Respondents assert that the primary

means by which seals survive in Iliamna Lake throughout the winter is through a reliance on air gaps that form between the shore-fast ice layer and the surfaces of both the lake and dry ground. Local knowledge asserts that as Iliamna Lake's many tributary rivers and streams freeze at the onset of winter and water flow into the lake is reduced, the lake level eventually lowers enough along the shoreline to expose beaches, reefs, and sandbars that allow seals dry ground on which to haul out on that is beneath an ice layer. A Pedro Bay elder described his knowledge of the process by which this unique winter seal habitat is formed in Iliamna Lake:

> *In the fall the lake level is always dropping and when the ice freezes over they [the seals] hang out by the islands down there [around Porcupine Island and near the Chutes] … . When the lake starts dropping the ice makes [an air pocket because the waterline drops below the ice cover] and there is air all around them reefs and I've heard them breathing in there … the lake will drop probably 4–5 feet during the winter.*

Similarly, an Iliamna elder said that "*after the lake freezes, the water is less, the rivers slow down, so the water drops but the ice stays the same and there is a pocket of air, that's where seals go.*" Additionally, a Pope-Vannoy hunter said, "*Even though there is all that ice, the ice never freezes completely flat. Underneath it's pocked where they can get their air under the ice.*"

Respondents suggested that because of the air gap underneath the ice, Iliamna Lake seals do not need to haul out in the open during winter to survive, and for this reason they are seen less frequently on the surface. "*This time of the year [January] you don't see seals anywhere … there's an air layer between the water and the frozen-over lake that they can get air from,*" said an Iliamna respondent. A Pedro Bay elder also explained this: "*They mostly stay right by the islands so they must, after a while, have quite a bit of air. Along the reefs, along the islands, it just makes kind of a shelf there … it is probably enough where they could, after a while [as the water level drops] crawl out on the beach under the ice.*" An Iliamna elder described the first time he became aware that seals could haul out on the shore underneath the ice:

> *I didn't believe it the first time, [when] my father told me that … [but] one time I was on the water, just on the ice, stopped on the one side of the island [a small island off the western shore of Flat Island]. I could hear the seal coming up and blowing air. I could hear them under the ice. It had to be true! There must be an air pocket there, and they can lie on the beach there, a safe place, [where] nothing can get to them.*

A Pope-Vannoy hunter also reported observations of seals inhabiting air pockets under the ice:

> *We do hear seals under the ice off of the small islands [southwest of Triangle Island] in the winter. When the water level goes down later in the winter there are big hollow air spaces under the ice around these islands and the seals sometimes are in these areas. They will snort and make noises when we are up above them on the ice. The same is true for the pressure cracks that run between the islands. We have heard them swimming and snorting along those also.*

Thus local knowledge asserts that the formation of the air gaps along shorelines and underneath pressure cracks provide a habitat for seals to live throughout the winter underneath a completely frozen Iliamna Lake.

Another means by which local knowledge suggests seals overwinter in the lake is the possible existence of underwater caves that lead to dry rock caverns where the seals can haul out. A Kokhanok hunter said that oral tradition from a story from long ago, passed down from generation to generation by Yup'ik residents of Iliamna Lake, describes a cave system where seals are believed to overwinter. Local residents believe this cave system still exists and could be used as an underground seal haul out (rookery) area. An Iliamna respondent suggested that an existing cave near the lake shore [near Schoolhouse Lake] provides "*evidence of what the water and waves could do in the Porcupine Island area*" (Figure 5-30). The respondent continued:

> *I am convinced that there has to be an underground rookery or cave that [the seals] go into during winter. Up in the Porcupine Island area there is a lot of really deep water*

and it is probably the most logical area where there would be an underground rookery of some sort. You compare that to the lower end of the lake and it is all really flat, gravelly beach and there is really no place that you could get an underground rookery in that area. But in the upper lake it is all really rocky country, I think more conducive to cave type [features].

The respondent suggested that "*the Chutes*" area on the northeast side of Porcupine Island is the most plausible location for an underground seal rookery in Iliamna Lake. That seals do need to haul out at times during the winter, whether above or below the ice, is recognized by local residents. For example, an Iliamna respondent said, "*They can hold their breath for a long time but I would think you can't swim for six months, I would think you'd have to take a break sometimes.*"

Figure 5-31 displays a matrix of seal overwintering habitat in the northeastern portion of Iliamna Lake mapped by community respondents, including deep-water locations that tend to be the last areas of the lake to freeze, shallow reef locations where air gaps underneath the ice possibly form, locations where pressure cracks are known to form during winter, and seal breathing holes observed by respondents during winter.

Most of the behaviors attributed to harbor seals by local respondents echo those seen in harbor seal populations elsewhere. For example, harbor seals in Gulf of Saint Lawrence and Arctic Canada and Svalbard, Norway, rely on water currents and tides to maintain openings that are used by seals when waters are ice-covered (Mansfield 1967; Prestrud and Gjertz 1990; Smith and Horonowitsch 1987). And while no prior descriptions of harbor seals maintaining breathing holes with teeth exist in literature, such behavior is commonly observed in closely related ringed seals, as well as in other populations of freshwater seals (Ponganis et al. 1997; Smith et al. 1991; Stewart et al. 2006; Stirling 1977). Regardless, harbor seals lack the long claws and haulage grip of more northerly distributed phocids, as well as the strong teeth and large gape of species such as Weddell seals, which are known to maintain holes in the ice by chewing (Kooyman 1969). That the seals in Iliamna Lake use subnivian caverns as haul out locations has been suggested as a strategy in other distinct freshwater seal populations, including the population of harbor seals *P. vitulina mellonae* found in freshwater lakes in northern Quebec, Canada; the 2 species of freshwater ringed seals found in the Baltic region of Finland *P. hispida saimensis* and Russia *P. hispida ladogensis*; and the species of ringed seals *P. sibirica* found in Lake Baikal, Russia (ECOS 2007; Metsahallitus 2009; Smith and Horonowitsch 1987; Stewart et al. 2006). However, documented proof of such use by ringed seals and harbor seals is largely absent. Subnivian caverns offer protection from weather and predators, and use of this habitat would be highly adaptive.

5.2.xii. Migration Between Bristol Bay and Iliamna Lake

Whether it is through the existence of caves, air gaps that form between the ice and the shore, by the seals' creation of breathing holes in the ice, or by their ability to use small pockets of air trapped on the undersurface of the ice, local knowledge asserts that the seals within Iliamna Lake have always maintained an ability to overwinter in the lake. As a Newhalen hunter said, "*Seals don't need to migrate from the lake. They got everything they need here.*" However, local knowledge also portrays an active seal population in the Kvichak River, and the potential for interchange with the saltwater seal population in Bristol Bay. Still, respondents were uncertain about whether the seals seen in the river are generally seals from Bristol Bay, from Iliamna Lake, or are representative of populations that overwinter in both fresh water and salt water. Several respondents suggested that the seals found today in Iliamna Lake at one point traveled to the lake via the Kvichak River, eventually establishing a more permanent population in the lake. A Kokhanok hunter said, "*I imagine the seals, at one time, they came from the salt water up here and they just stayed.*" Moreover, respondent reports of beluga whales being observed in the Kvichak River near Igiugig are also testament to the ability of marine mammals to travel the length of the river. And while local knowledge asserts that at least some portion of the seal population inhabiting Iliamna Lake overwinters in the lake, the major question is to what extent the current population in the lake is permanent and non-migratory.

Some respondents from the study communities located in the northeastern portion of the lake, such as

Figure 5-30.–Habitat features identified by respondents to be used by seals overwintering in Iliamna Lake: (top left) air gaps that form between the lake ice and shorelines due to ice surging along the shore and lake levels dropping; (top right) air gaps that form along islands in a similar process; (bottom left) air gaps that form under pressure ridges; and (bottom right) cave features such as the arch near Schoolhouse Lake on Iliamna Lake.

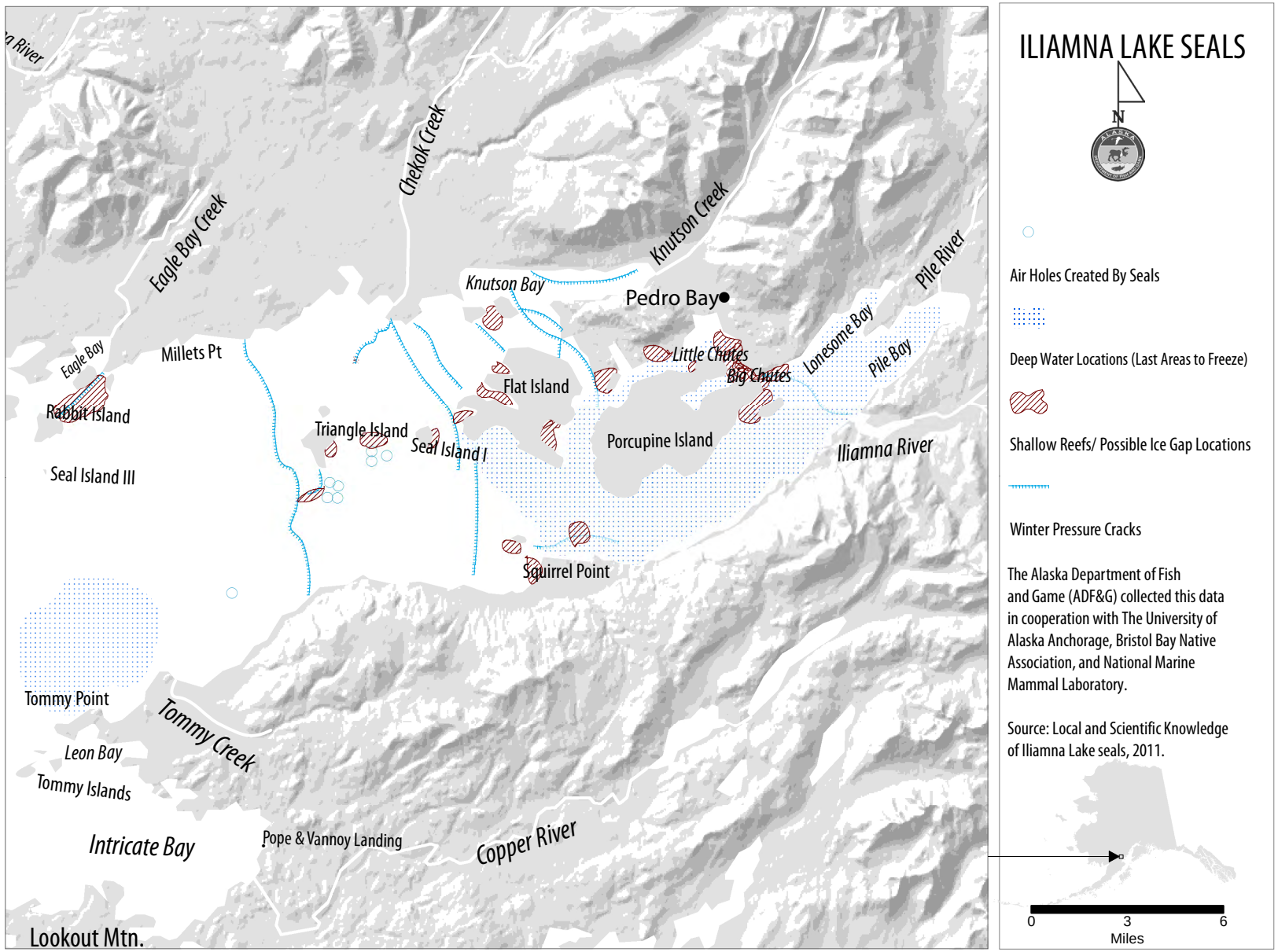


Figure 5-31.–Locations of prominent features used by seals to survive overwintering in Iliamna Lake.

Newhalen and Kokhanok, voiced a belief that the seals found in Iliamna Lake are representative of a permanent, non-migratory, resident population. Some of these respondents suggest that the seals observed in the Kvichak River originate entirely from the salt water of Bristol Bay and do not enter the lake. For example, when asked if the seals observed in the Kvichak River are freshwater or saltwater seals, a Kokhanok hunter who had harvested seals in the Kvichak River said, "*The seals that I have got on the Kvichak were saltwater seals.*" A Newhalen hunter said, "*They [lake seals] don't migrate. They stay here. I fish in Bristol Bay. Every time I go down the Kvichak [River] I see some [saltwater] seals but they don't go as far [upriver] as Igiugig. Once here [in Iliamna Lake] they stay in here.*" Similarly, some Igiugig respondents believed that saltwater seals following the salmon runs do travel the length of the Kvichak River but that those seals do not enter the lake. Other respondents assert that some of the seals observed in the river do originate from Iliamna Lake but only travel in the Kvichak River temporarily to feed on migrating salmon as they enter the lake. For example, a Newhalen hunter said, "*The lake seals are permanent, the lake is their home but they do drift around, they go into the Kvichak but come back.*"

In contrast, both Igiugig and Levelock elders expressed a view that the seals that inhabit Iliamna Lake year-round are representative of a more consistently transient population. "*They [Iliamna Lake seals] go back and forth [from fresh water to salt water and vice versa] in summers, I think,*" said a Levelock elder. One of the most revealing accounts of the potentially transient nature of the seals within Iliamna Lake are the observations by Igiugig residents of seals hauled out on the ice near the open water at the entrance to the Kvichak River. These winter and early spring sightings suggest that seals do travel long distances and that the seals that make the journey to the Igiugig area travel there, either from the far end of the lake or from the river, to wait for either the lake or the river to break up so that they can continue their journey either up the lake or down the river. When an Igiugig elder was asked if the seals he has observed hauled out on ice near Igiugig during early spring originated from the north end of the lake or from the river, the elder said:

> *I think they [seals] do come up from the river. But also, sometimes before the river goes out [breaks up], there is ice down there [on the river], some of them [seals] come down from up on the lake [to Igiugig]. They just come down [from the north end of the lake] and go down the river. I guess they are traveling. That's how they show up here. Some of them want to go back down [to Bristol Bay] I guess. They just go down the river. Some of them want to come up, and they go up into the lake. It is the same seals I think. When they want to go back down they go down and when they want to go up they come up and they go into the lake. That's what I see. I see them come up the river [to Igiugig] and they keep going [into the lake]. Some of them like to stay up there [at the north end of the lake] and they stay up there.*

A geographic point of interest by which the extent of Iliamna Lake seal mobility can be further explored is the Kaskanak Flats area of the Kvichak River, known locally as "*the flats.*" Located approximately 4 miles downriver from Igiugig and 42 miles upriver from Levelock, the Kaskanak Flats make the up the wide, braided area of the Kvichak River drainage near the mouth of the Kaskanak River and the mouth of Pecks Creek. Seals are known to pursue salmon in the Kaskanak Flats. "*They [seals] go to Kaskanak River to feed on king salmon [Chinook salmon],*" said a Newhalen hunter. A Levelock elder explained that the Kaskanak Flats are the furthest extent where high tides bring salt water up the Kvichak River from Bristol Bay and several respondents discussed the Kaskanak Flats as a separation point between distinct freshwater and saltwater seal populations. These respondents were divided into 2 camps: one that believes that the seals within Iliamna Lake do not travel all the way to the Kaskanak Flats and that the seals that feed on salmon there are saltwater seals, which return to Bristol Bay, and another that believes that the flats location is the limit of the freshwater seal populations' summer feeding migration down the Kvichak River. A Levelock elder expressed confidence that saltwater seals from Bristol Bay travel at least as far up the Kvichak River as Kaskanak Flats to feed on salmon while a Newhalen hunter asserted that the seals observed "*on the Kvichak, at the flats are ocean seals, not freshwater seals, they [freshwater seals] will not go down that far.*" However, a Levelock hunter reported harvesting a seal, which the hunter believed was a freshwater seal originating from the lake, on the Kvichak River in 2010. For this reason the hunter believes that the seals within Iliamna Lake do travel down the Kvichak River.

Some respondents asserted that freshwater seals (and trout) from the lake will migrate to the flats area to feed but will go no farther downriver and instead return to the lake. For example, a Newhalen hunter said: "*I think they go down for the king salmon haul. They go to the flats, that's it. Then they come back up. It's the same thing with our trout, they do the same migration. They go halfway [down the river], to the flats, and then come back up. They never leave this area.*" The Newhalen hunter also said that lake seals will travel to the Kaskanak Flats area to feed on whitefishes.

Thus respondents expressed 2 distinct possibilities for seal movements to the Kaskanak Flats area of the Kvichak River. However, in both of these possibilities the Kaskanak Flats area is viewed as a nexus where 2 biologically distinct populations remain detached. Figure 5-32 outlines the Kaskanak Flats area, displays the local delineation of the maximum extent of salt water in the Kvichak River at high tide, and shows the approximate locations of seals harvested in the Kvichak River by local hunters during 2011. Still another possibility is that a more transient group of seals aggregates at the Kaskanak Flats during summer to feed on salmon, with some seals traveling upriver to Iliamna Lake and others traveling back downriver to Bristol Bay. This view, where the seals observed in the Kvichak River are representative of a mixed freshwater/saltwater population, was expressed by one elder from Kokhanok and also by an elder from Igiugig, both of whom have long-term experience observing local seal behavior. And while most respondents from Iliamna, Newhalen, Kokhanok, and Pedro Bay displayed an opposing view—that the seals within Iliamna Lake are a distinct freshwater population—Levelock respondents, situated at a geographic position at the river's end, remained unsure. A Levelock elder said that it is "*too hard to tell*" whether seals seen in the Kvichak River are saltwater seals, migrating freshwater seals, or both. The elder said that seal migrations in the Kvichak River are "*a mystery*" to residents of Levelock. When asked if he could tell the difference between a saltwater seal and a freshwater seal another Levelock elder said, "*A seal is a seal to me.*"

The genetic analyses conducted on the samples from harvested seals can also be used to shed light onto the degree to which the seals within Iliamna Lake may be reproductively isolated from those in Bristol Bay. From the perspective of genetic diversity, the presence of only a single mitochondrial DNA (mtDNA) haplotype among 11 Iliamna area seals collected in 5 different years across a 16-year period appears to be an unusually low level of mtDNA diversity for such a sampling regime for this species elsewhere in Alaska (Table 5-3). Relative to the question of migration and gene flow, the single haplotype (P vit-Hap#7) observed in Iliamna area samples occurred at a frequency of 21% in the eastern Bristol Bay sample (n=16/76) and a similar frequency across the entire bay (22%, n=24/109). If immigration and reproductive mixing from the Bristol Bay population into a resident Iliamna Lake population was ongoing there is a near 80% likelihood that mtDNA haplotypes other than Hap#7 would be introduced. The rate of such immigration would, of course, determine the frequency of such haplotypes in the lake population and thus also in a sample of this population. That none of these other haplotypes have been recorded as yet in Iliamna Lake seals suggests that immigration, if it occurs, is not substantial.

In addition, as a group, the Iliamna Lake seals were substantially genetically differentiated from neighboring Bristol Bay harbor seals for both mtDNA and microsatellite markers (Table 5-8). Analyses of genetic differentiation and homogeneity tests (n=50,000 permutations) conducted in Arlequin 3.01 (Excoffier et al. 2005) revealed high levels of heterogeneity for both frequency-based (F_{st} mtDNA = 0.261, $P < 0.0001$; Fst microsat = 0.161, $P < 0.0001$) and distance-based (Φ_{st} mtDNA = 0.191, $P < 0.001$; R_{st} microsat = 0.364, $P < 0.0001$) statistics (Table 5-8). This level of differentiation was adjudged to be highly significant under a hypothesis-testing framework at $\alpha=0.001$.

In combination, initial findings suggest that the population of seals in Iliamna Lake is differentiated from the nearest harbor seal population in Bristol Bay with restricted male- and female-mediated dispersal between the 2. However, sample size was small and so these results must be interpreted with caution. There was high-quality sequence data for just 11 individuals and multi-locus microsatellite data for 12 seals, and kinship among samples tested remains unknown. In addition, population size and breeding patterns are known to influence the genetic makeup of the population. If the Iliamna Lake population has a naturally small effective population size, a relatively rapid rate of genetic drift may enhance genetic differentiation with other populations, even in the face of continued gene flow. Thus strong conclusions

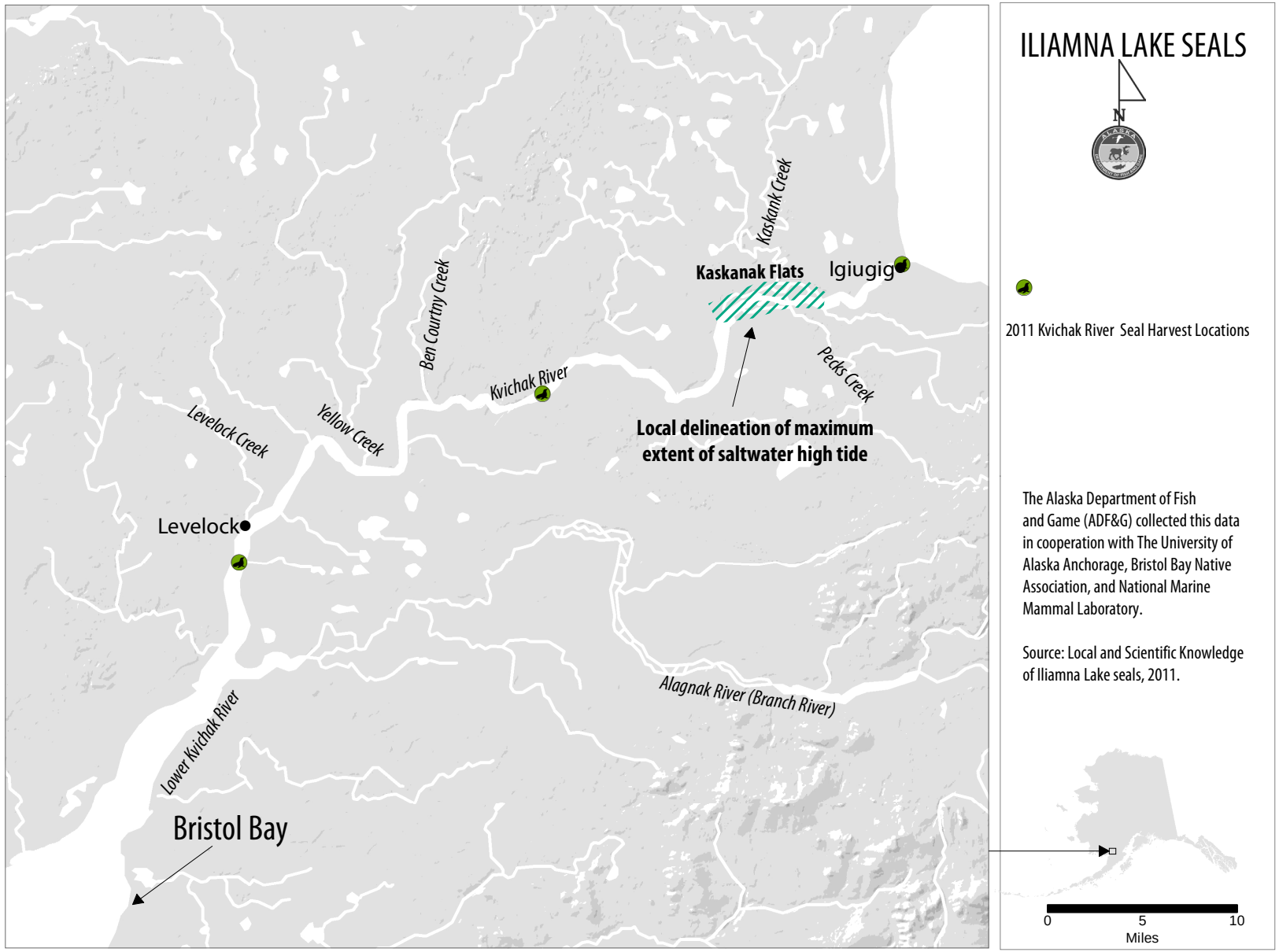


Figure 5-32.–Location of the Kaskanak Flats area of the Kvichak River.

Table 5-8.–Genetic differentiation between harbor seals in Iliamna Lake and eastern Bristol Bay.

	mtDNA		Microsatellites	
	Eastern Bristol Bay	Iliamna Lake	Eastern Bristol Bay	Iliamna Lake
	n=76	n=11	n=39	n=13
Eastern Bristol Bay		ϕst= 0.191**		Rst= 0.364***
Iliamna Lake	Fst = 0.261***		Fst = 0.165***	

Note n=number of seals sampled; Fst indicates frequncy-based statistics; Rst and ϕst indicate distance-based statistics.

*Note ** P < 0.001; *** P < 0.0001.*

Note Homogeneity tests were based on 50,000 permutations of the original data.

about population distinctness must await more formal analyses where observed diversity is statistically compared to distributions of expected diversity in other regions based on similar sampling regimes, as well as tests on heterozygosity and allelic diversity in nuclear DNA (nDNA) diversity.

5.3. Subsistence Use Patterns

5.3.i. Local and Historical Accounts of Past Seal Hunting

Local knowledge asserts that seals have been hunted in Iliamna Lake for a long time: "*As long as people have been here [inhabiting the Iliamna Lake area], people went out with the skin boats, they hunted them [seals]. During winters, they walked on the ice to hunt seals,*" said an Iliamna elder. Historical documentation confirms local historical knowledge from at least the 19th century. The earliest historical documentation of seal hunting in Iliamna Lake occurred 192 years ago when the Russian explorer Petr Korsakovskiy recorded the harvest of a seal from Iliamna Lake on September 8, 1819: "…we said farewell to the Indians and set out on the return journey to Lake Iliamna [from Lake Clark and Sixmile Lake] … . Toward evening we came upon our baydarkas (kayaks), got into them, and set out along the [Newhalen River] to the lake. Patyukov killed a harbor seal. We went ashore, pitched our tent, and settled down for the night" (Korsakovskiy and Vasilev 1988).

Later, in 1900, the prospector Lemuel E. Bonham, who briefly resided at Old Iliamna, a traditional Dena'ina Athabascan village located 6 miles up the Iliamna River from Iliamna Lake, recorded Dena'ina harvest and use of the seals within Iliamna Lake and said, "The Natives went hunting them [Iliamna Lake seals] this winter and killed twelve. They gave us some. It is very good, but tastes a little fishy" (Branson 2007). According to Townsend (1965), "In 1906, the Old Iliamna Dena'ina hunted seals at blow holes with harpoons during the winter" near Pile Bay. A Dena'ina Athabascan elder, Walter Johnson, a former Pedro Bay resident, reported hunting seals in Iliamna Lake throughout his life. A favorite hunting location of Johnson's was near Lonesome Bay at a location referred to in the Dena'ina language as *Vighutiztin*, which translates to "trail goes along it" (Johnson 2004).

Many respondents recalled their parents, grandparents, and great-grandparents hunting seals in the lake. "*I've always known seals to be in the lake, always. I remember the old people talking about their hunts,*" recalled an Igiugig elder. An Iliamna elder said that his family has been hunting seals in Iliamna Lake for more than 100 years: "*My grandpa came in the 1800s and as far I know there was seals since then.*" Another Iliamna elder recalled active seal hunting by community members dating back at least since the 1940s, and said that seal hunting had always occurred on the ice during winter. Many respondents from the study communities recalled stories shared by their grandparents and parents about elders hunting seals in the lake from the late 19th century and early 20th century. Elders recollected their experiences hunting seals on the lake during the first half of the 20th century and on. Some of them said that local residents no longer hunt for seals as actively as the previous generations did. "*Nobody hardly hunt [seals] no more now,*" said an Igiugig elder.

Elders reported that prior to the use of motorboats much of the seal hunting that occurred in the northeastern portion of the lake was done in the winter on the ice. An Iliamna elder said: "*We know where the pressure cracks are. So we just walk and make sure we are downwind from them [seals], and just walk to where the pressure cracks are going to open up … and you can get to a high point on the lake so people can look and people just walked up and had a little sled they towed, and some a kind of camouflage, white canvas, or clothes to help camouflage them.*" Bonham's account of 1900 also suggests that it was traditional for seal hunters to hunt seals in Iliamna Lake during winter once the lake was covered by ice. During this time seals were hunted with toggled harpoons:

> They [Dena'ina Athabascans from Old Iliamna Village] hunt them [Iliamna Lake seals] only when the lake is frozen over, and the weather very cold. The seals live under the ice, and have places at the islands where they come at frequent intervals to breathe – a small hole in the ice. The Native finds these holes – they cut a hole in the ice about a foot across, and two or three feet from the hole where the seal comes to breathe. The Indian sits by this hole he has cut in the ice with a spear. So arranged that when it is plunged into the seal the end is detached to which is fastened a strong rope. When the seal comes to breathe the Native sees him through this he had cut in the ice and throws the spear into him. (Branson 2007)

It was formerly difficult for Levelock hunters to travel to Iliamna Lake to hunt seals. Levelock elders explained that seal hunting on the Kvichak River was normally more of an opportunistic pursuit. A Levelock elder explained:

> *We get them [seals] if we see 'em, but we never depended on them. We do put away what we catch for the winter, usually about 2–3 [seals per family]. Going up to Igiugig [in a boat on the Kvichak River] and 'Look out here, there's a seal!' and then we'd stick with it 'til we get it. I grew up in the time when you hunt what you need for food, there were not many stores. You see a seal, that's 'game.' And mom would take care of the skin and make something out of it.*

The elder said that historically Levelock hunters we far more dependent upon moose and caribou than they were on seals and that no one from the community ever hunted in Iliamna Lake because it was too far away. Regarding the use of marine mammals for subsistence, another Levelock elder explained that Levelock residents are traditionally much more beluga whale hunters than they are seal hunters. Historically, Levelock hunters only occasionally harvested seals in the Kvichak River because they were never abundantly seen. "*Most of them [seals] were in Pedro Bay, in them [pressure] cracks,*" said a Levelock elder. An Igiugig elder who was born and raised in Levelock said that he began seal hunting more actively when his family relocated to Igiugig during the 1960s. "*After we moved up here [from Levelock to Igiugig] that's when I really started hunting [seals in] the lake because I used to just hunt the Kvichak [River].*"

5.3.ii. Contemporary Subsistence Hunting and Use of Marine Mammals

Harvest, Use, and Sharing: All Communities Combined

The goal of the harvest survey was to understand the entire harvest of marine mammals by the study communities so as to be able to place the harvest of freshwater seals in the context of the overall marine mammal harvests. Therefore, information on all marine mammal harvests, and not just harvest of freshwater seals, is presented in this section. The surveys included questions about the harvest of freshwater and saltwater harbor seals, other phocids, Steller sea lions, fur seals, walrus, sea otters, whales (unspecified), and beluga whales (Appendix H). However, no pinnipeds other than freshwater or saltwater harbor seals, or whales other than beluga, were reported to have been taken by hunters from Iliamna Lake study communities in either 2010 or 2011.

Seals composed the entire marine mammal harvest reported by households from the study communities of Newhalen and Kokhanok during the 2010 study year (Table 5-9). Household harvest surveys recorded

3 individual seal harvests in 2010 for the 2 study communities combined, of which 1 was recorded by households as a "saltwater seal" and 2 were recorded as "freshwater seals." "Saltwater seals" were harvested by study community residents at Bristol Bay and in the Kvichak River. The freshwater seals were used by 62% of households in the study communities, while saltwater seals were used by 23% of the households in the study communities. Freshwater seals made up the majority (67%) of the total weight of the marine mammals harvested by Newhalen and Kokhanok households in 2010, and they provided a little more than double the usable weight per household than saltwater seals (Table 5-9).

In 2011, analysis of household harvest surveys produced an estimate of 29 individual seal harvests in 2011 for the 7 study communities combined, of which 5 were "saltwater seals" and 24 were "freshwater seals" (Figure 5-33). In addition to these estimated seal harvests, hunters from the study communities harvested an estimated 7 beluga whales during 2011, with Igiugig hunters harvesting an estimated 2 beluga whales and Levelock hunters harvesting an estimated 5 (Figure 5-33).

Because beluga whales are so much larger than seals, beluga whale harvests by Levelock and Igiugig hunters made up 79% of the total estimated marine mammal harvest weight (7,734 lb, or 42 lb per household) by all study communities (Figure 5-34; Table 5-10). The remaining 21% of the estimated total harvest weight consisted of seals; freshwater seals made up the majority of the remaining harvest (84% of the seal harvest; 18% total weight), and saltwater seals made up 16% of the seal harvest and 3% of the overall harvest weight (Figure 5-34).

Hunters from the communities of Newhalen and Kokhanok harvested the majority (59%) of the freshwater seals; but, excluding the Pope-Vannoy settlement (which harvested an average of 37 lb per household), residents of Igiugig had the highest mean per household estimated harvest (13 lb per household) (Table 5-11). Saltwater seals were harvested by hunters from Kokhanok, Levelock, and Newhalen (Table 5-12). Beluga whales were harvested by the communities of Igiugig and Levelock (Table 5-13).

As with harvest rates, there was also variation among study communities in the rates of use of marine mammals. These differences largely reflect the specific geography and economics of the study communities. For instance, beluga whales inhabit Bristol Bay and the Kvichak River but not Iliamna Lake and thus are more available to residents of Levelock and Igiugig for harvest, which increased the level of use of beluga whales at Igiugig and Levelock in comparison to other communities (Table 5-13). Freshwater seals are available to hunters residing in Iliamna Lake communities but not necessarily to hunters from Levelock (located 46 miles downriver from the lake) (Table 5-11). Because of Levelock's geographic proximity to Bristol Bay, Levelock hunters normally hunt only saltwater seals, while Kokhanok and Newhalen residents who participate in the Bristol Bay commercial fisheries have the opportunity to harvest saltwater seals while traveling to and from Bristol Bay and while commercial fishing in the salt water (Table 5-12). Overall, in 2011, marine mammals were used by 53% of households in the study communities, with 44% of households using freshwater seals, 17% of households using beluga whales, and 13% of households using saltwater seals (tables 5-10 through 5-13).

Clearly, the products obtained from seals harvested in Iliamna Lake are widely shared with other Iliamna Lake communities and are often shared with relatives from communities outside the area as well. In fact, most of the hunters interviewed for this study reported that they give other households the majority of the seal meat and fat from the seals they harvest. For example, a Kokhanok hunter said that he normally gives away around 90% of the yielded fat and meat from each seal he harvests, and an Iliamna elder said, "*When we get one [a seal], meat and hide, we give most of it away.*" A Newhalen hunter explained that his family normally only harvests 1 seal per year and distributes the yield from that seal around the community: "*We just take 1 [seal] to share with everybody, fat and oil.*" Both the 2010 and 2011 household survey results revealed substantial sharing of harvested marine mammals among the study communities by hunters. In 2011, for the study communities combined, 47% of households received marine mammals and 26% of households gave marine mammals away (Table 5-10). In Igiugig, where there was the most estimated sharing, 71% of households received marine mammals, and, in Newhalen, 68% of households received marine mammals (Table 5-10).

Table 5-9.–Reported harvest of marine mammals, Newhalen and Kokhanok, 2010.

	Percentage of households					Harvest weight (lb)			Harvest amount			95% confidence
Resource	Use	Attempt	Harvest	Receive	Give	Total	Mean per household	Mean per capita	Total	Unit	Mean per household	limit (±) harvest
Marine mammals	**62.1%**	**18.2%**	**4.5%**	**60.6%**	**24.2%**	**168.0**	**2.5**	**0.7**	**3.0**	**ind**	**0.05**	**0.0%**
Seal	62.1%	18.2%	4.5%	60.6%	24.2%	168.0	2.5	0.7	3.0	ind	0.05	0.0%
Fur seal	3.0%	3.0%	0.0%	3.0%	1.5%	0.0	0.0	0.0	0.0	ind	0.0	0.0%
Harbor seal	62.1%	16.7%	4.5%	60.6%	22.7%	168.0	2.5	0.7	3.0	ind	0.05	0.0%
Harbor seal (freshwater)	62.1%	16.7%	3.0%	60.6%	21.2%	112.0	1.7	0.5	2.0	ind	0.03	0.0%
Harbor seal (saltwater)	22.7%	1.5%	1.5%	22.7%	10.6%	56.0	0.8	0.2	1.0	ind	0.02	0.0%
Steller sea lion	1.5%	1.5%	0.0%	1.5%	1.5%	0.0	0.0	0.0	0.0	ind	0.0	0.0%
Walrus	3.0%	1.5%	0.0%	3.0%	1.5%	0.0	0.0	0.0	0.0	ind	0.0	0.0%
Whale	15.2%	1.5%	0.0%	15.2%	4.5%	0.0	0.0	0.0	0.0	ind	0.0	0.0%
Beluga	15.2%	1.5%	0.0%	15.2%	4.5%	0.0	0.0	0.0	0.0	ind	0.0	0.0%

Source Bristol Bay Native Association and University of Alaska Anchorage household surveys, 2011.

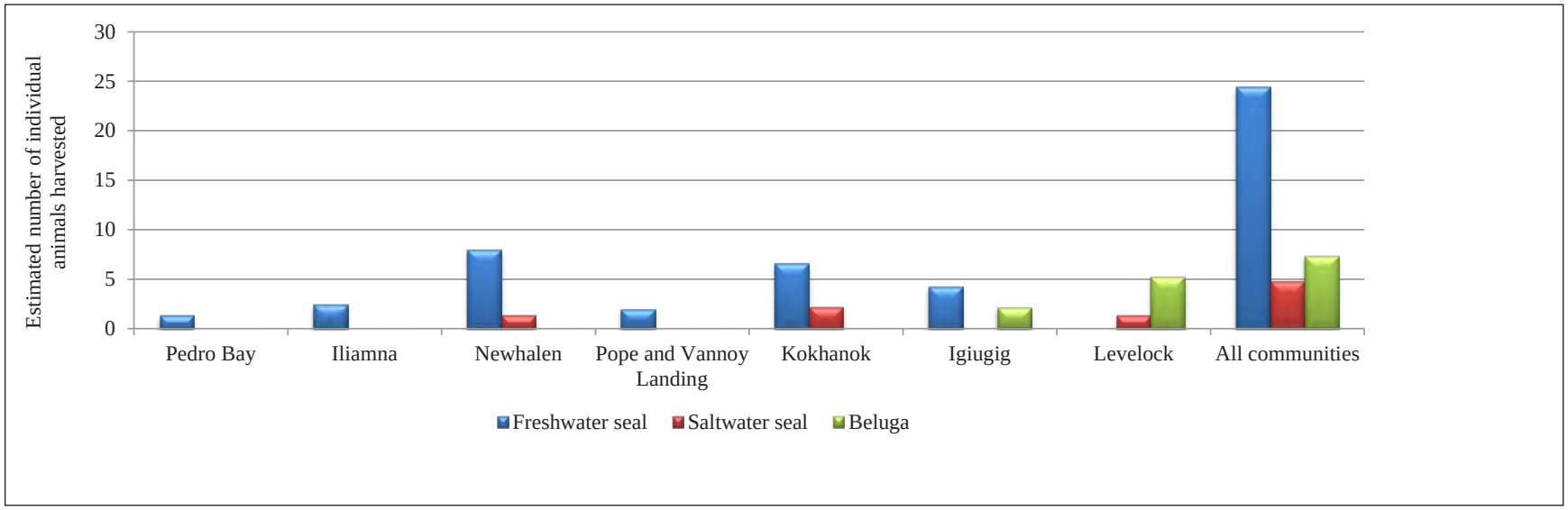


Figure 5-33.–Estimated number of individual animals harvested by species, study communities, 2011.

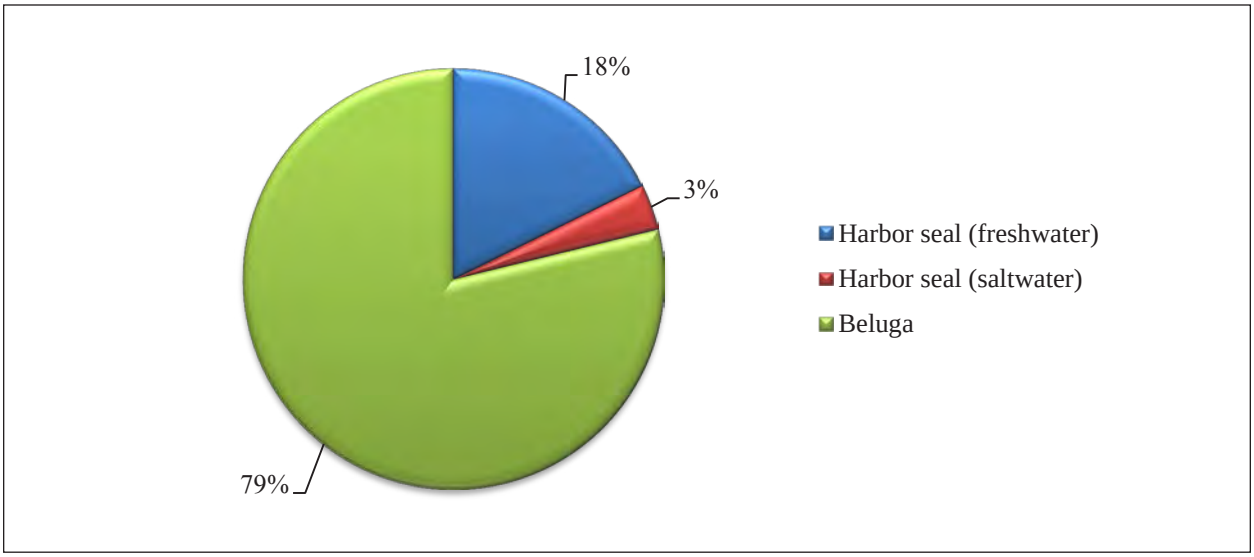


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Figure 5-34.–Composition of estimated harvest weight, study communities combined, 2011.

Seal products are traditional foods highly relished by elders and much of the seal distribution goes to elders in the communities who have retired from hunting activities. "*I give a lot of it [a seal] away to people who really want it. Especially the elders, they really prize seal oil,*" explained a Pope-Vannoy hunter when describing what she does with the meat and fat from seals she harvests in Iliamna Lake. Similarly, another Kokhanok hunter said, "*I bring the whole seal back to the village, cut it up, hand out the meat, everybody, elders first and then whoever wants it.*" Another Kokhanok hunter, describing how he goes about distributing meat and fat from seals he harvests, said, "*I'll go to certain houses; I'll start with the elders and then other people that I know who like seal meat.*"

Iliamna Lake residents also share seal meat and fat at community potlucks, celebrations, and holidays. A hunter's first seal harvest is an event worthy of celebration for many community members. For the first harvest the hunter must give all of the harvest away in order to demonstrate that he can provide for the community first. An Iliamna elder told about sharing the yield from his grandson's first seal harvest:

> *This summer my grandson, 15 years old, got his first seal. I am very proud and happy! We give all of it away to relatives: to his god-father, god-mother, and older people … just give it all away, that is our custom.… Here, young man just gives it all away … we have a dinner, and then he [the hunter] tells about the hunt.*

A hunter from Newhalen with relatives in New Stuyahok, located on the Nushagak River 83 miles northwest of Iliamna Lake, told about sharing seal fat with people there: "*A lot of people where I'm originally from, New Stuyahok, they really like seal oil. I send a lot of seal fat over there.*" The hunter said he also sometimes trades seal meat for caribou dry meat and Chinook salmon (known as "king salmon") with people in New Stuyahok. Newhalen respondents also reported sharing seal meat and fat with relatives in the community of Nondalton, located 18 miles north of Iliamna Lake. Other respondents from the study communities reported sharing products from seals harvested within Iliamna Lake with relatives and friends in Bristol Bay communities and also in Anchorage.

5.3.iii. Variation within Individual Communities

In addition to variation among lake communities in their harvest and use patterns, there are also differences within communities in how different marine mammal species are obtained and used. These differences are discussed below, with an emphasis on patterns within rather than between communities.

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Table 5-10.–Estimated harvests and uses of marine mammals for all species combined, study communities, 2011.

	Percentage of households					Harvest weight (lb)			Harvest amount			95% confidence limit (±) harvest
Community	Use	Attempt	Harvest	Receive	Give	Total	Mean per household	Mean per capita	Total	Unit	Mean per household	
All communities	**53.3%**	**23.3%**	**12.3%**	**46.9%**	**26.2%**	**7,734.1**	**42.0**	**14.1**	**36.6**	**ind**	**0.2**	**43.5%**
Igiugig	82.4%	47.1%	23.5%	70.6%	52.9%	1,996.9	110.9	33.7	6.4	ind	0.4	45.3%
Iliamna	42.9%	23.8%	9.5%	42.9%	23.8%	133.3	5.3	1.8	2.4	ind	0.1	57.5%
Kokhanok	51.2%	16.3%	9.3%	44.2%	25.6%	489.7	10.4	3.6	8.7	ind	0.2	33.7%
Levelock	47.8%	17.4%	8.7%	39.1%	30.4%	4,408.7	147.0	51.2	6.5	ind	0.2	77.3%
Newhalen	70.6%	26.5%	14.7%	67.6%	20.6%	518.8	11.5	3.2	9.3	ind	0.2	45.1%
Pedro Bay	8.3%	16.7%	8.3%	0.0%	8.3%	74.7	4.7	2.8	1.3	ind	0.1	110.0%
Pope and Vannoy Landing	33.3%	33.3%	33.3%	0.0%	33.3%	112.0	37.3	37.3	2.0	ind	0.7	0.0%

Source ADF&G Division of Subsistence household surveys, 2012.

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Table 5-11.–Estimated harvests and uses of freshwater seals, study communities, 2011.

	Percentage of households					Harvest weight (lb)			Harvest amount			95% confidence limit (±) harvest
Community	Use	Attempt	Harvest	Receive	Give	Total	Mean per household	Mean per capita	Total	Unit	Mean per household	
All communities	**43.5%**	**20.5%**	**10.1%**	**36.8%**	**21.4%**	**1,369.1**	**7.4**	**2.5**	**24.4**	**ind**	**0.1**	**19.8%**
Igiugig	82.4%	47.1%	23.5%	64.7%	47.1%	237.2	13.2	4.0	4.2	ind	0.2	22.5%
Iliamna	38.1%	23.8%	9.5%	33.3%	23.8%	133.3	5.3	1.8	2.4	ind	0.1	57.5%
Kokhanok	48.8%	16.3%	9.3%	39.5%	25.6%	367.3	7.8	2.7	6.6	ind	0.1	30.1%
Levelock	4.3%	4.3%	0.0%	4.3%	4.3%	0.0	0.0	0.0	0.0	ind	0.0	0.0%
Newhalen	64.7%	23.5%	11.8%	61.8%	20.6%	444.7	9.9	2.7	7.9	ind	0.2	50.9%
Pedro Bay	8.3%	16.7%	8.3%	0.0%	8.3%	74.7	4.7	2.8	1.3	ind	0.1	110.0%
Pope and Vannoy Landing	33.3%	33.3%	33.3%	0.0%	33.3%	112.0	37.3	37.3	2.0	ind	0.7	0.0%

Source ADF&G Division of Subsistence household surveys, 2012.

Table 5-12.–Estimated harvests and uses of saltwater seals, study communities, 2011.

Community	Percentage of households					Harvest weight (lb)			Harvest amount			95% confidence limit (±) harvest
	Use	Attempt	Harvest	Receive	Give	Total	Mean per household	Mean per capita	Total	Unit	Mean per household	
All communities	**13.0%**	**2.7%**	**2.0%**	**11.7%**	**4.0%**	**269.6**	**1.5**	**0.5**	**4.8**	**ind**	**0.03**	**45.6%**
Igiugig	5.9%	0.0%	0.0%	5.9%	5.9%	0.0	0.0	0.0	0.0	ind	0.0	0.0%
Iliamna	14.3%	4.8%	0.0%	14.3%	0.0%	0.0	0.0	0.0	0.0	ind	0.0	0.0%
Kokhanok	4.7%	2.3%	2.3%	2.3%	2.3%	122.4	2.6	0.9	2.2	ind	0.05	58.9%
Levelock	30.4%	4.3%	4.3%	26.1%	17.4%	73.0	2.4	0.8	1.3	ind	0.04	100.2%
Newhalen	17.6%	2.9%	2.9%	17.6%	0.0%	74.1	1.6	0.5	1.3	ind	0.03	100.6%
Pedro Bay	0.0%	0.0%	0.0%	0.0%	0.0%	0.0	0.0	0.0	0.0	ind	0.0	0.0%
Pope and Vannoy Landing	0.0%	0.0%	0.0%	0.0%	0.0%	0.0	0.0	0.0	0.0	ind	0.0	0.0%

Source ADF&G Division of Subsistence household surveys, 2012.

Table 5-13.–Estimated harvests and uses of beluga whales, study communities, 2011.

Community	Percentage of households					Harvest weight (lb)			Harvest amount			95% confidence limit (±) harvest
	Use	Attempt	Harvest	Receive	Give	Total	Mean per household	Mean per capita	Total	Unit	Mean per household	
All communities	**16.9%**	**4.0%**	**2.0%**	**14.9%**	**5.9%**	**6,095.4**	**33.1**	**11.1**	**7.3**	**ind**	**0.04**	**54.6%**
Igiugig	58.8%	11.8%	5.9%	52.9%	23.5%	1,759.8	97.8	29.7	2.1	ind	0.1	50.0%
Iliamna	4.8%	0.0%	0.0%	4.8%	0.0%	0.0	0.0	0.0	0.0	ind	0.0	0.0%
Kokhanok	0.0%	0.0%	0.0%	0.0%	0.0%	0.0	0.0	0.0	0.0	ind	0.0	0.0%
Levelock	26.1%	13.0%	8.7%	17.4%	17.4%	4,335.7	144.5	50.4	5.2	ind	0.2	78.1%
Newhalen	20.6%	2.9%	0.0%	20.6%	2.9%	0.0	0.0	0.0	0.0	ind	0.0	0.0%
Pedro Bay	0.0%	0.0%	0.0%	0.0%	0.0%	0.0	0.0	0.0	0.0	ind	0.0	0.0%
Pope and Vannoy Landing	0.0%	0.0%	0.0%	0.0%	0.0%	0.0	0.0	0.0	0.0	ind	0.0	0.0%

Source ADF&G Division of Subsistence household surveys, 2012.

Pedro Bay

Ethnographic results from the community of Pedro Bay depict an annual community seal harvest of 1–2 seals. "*We try to get 2 seals every year,*" said a Pedro Bay hunter. In 2011, according to subsistence survey results, hunters from Pedro Bay households (17%) hunted for marine mammals, but an estimated 1 freshwater seal was harvested, therefore making up 100% of the total marine mammal usable harvest weight (Table 5-14). The harvested seal was used only by the household of the successful hunter, but the hunter did report sharing the seal harvest with households located outside of the community. While formerly a core seal hunting community, respondents reported that most of the Pedro Bay residents who actively hunted seals in the past have moved away from the community or are now deceased. As a result, active seal hunting by residents of Pedro Bay during the 21st century has been limited. A Pedro Bay elder said that Newhalen is a much more active seal hunting community today than is Pedro Bay.

Pope-Vannoy

Ethnographic results from the community of Pope-Vannoy depict active annual seal hunting effort by 1 household. Harvest survey results indicate that in 2011, a single hunter reported hunting for and harvesting 2 freshwater seals (Table 5-15). These seals provided an estimated 112 lb of usable harvest weight. No other marine mammals were hunted or used within the community.

Kokhanok

Ethnographic results from the community of Kokhanok depict active annual freshwater seal hunting in Iliamna Lake and typical community-wide harvests of 8–10 seals annually. Individual hunters from Kokhanok said there are some years when they do not successfully harvest any seals.

In 2010, hunters from 18% of Kokhanok households reported attempting to harvest marine mammals, but hunters reported harvesting only 1 saltwater seal in 2010 (Table 5-16). In contrast, the hunters from an estimated 16% of Kokhanok households that attempted to harvest marine mammals in 2011 were much more successful: the households harvested an estimated 9 seals in 2011 (7 of which were freshwater seals and 2 of which were saltwater seals) (Table 5-16). While saltwater seals made up 100% of the estimated 56 lb of marine mammals harvested in 2010 by Kokhanok hunters, in 2011, freshwater seals made up the majority (75%, or 367 lb usable weight) of the marine mammal harvest.

Sharing of marine mammal resources is clearly important to the Kokhanok community. In 2010, saltwater seals were used by 23% of the households, and freshwater seals were received and used by 58% of the households. Presumably the freshwater seal resources used were shared by other local communities since no harvests were reported by local hunters. Similarly, in 2011, all of Kokhanok harvesting households shared seals with other households, and 51% of Kokhanok households used seals and 42% of households received seals from other households. Additionally, even in the absence of local hunting success, Kokhanok households used beluga whales (8% in 2010, 5% in 2011), walrus (5% in 2010), fur seals (5% in 2010), and Steller sea lions (3% in 2010), all of which were received from other communities. Overall, Kokhanok respondents reported that subsistence seal hunting is important to the community, but not as important to the community as subsistence moose and caribou hunting.

Newhalen

Ethnographic results from the community of Newhalen depict active annual seal hunting and community harvests of 5–8 seals annually; however, only 2 freshwater seals were harvested in 2010, as reported on the subsistence surveys (Table 5-17). In contrast, the number of households attempting to hunt increased from 19% in 2010 to 27% in 2011, and harvest rates also increased with Newhalen hunters harvesting an estimated 9 seals in 2011 (8 of which were freshwater seals and 1 of which was a saltwater seal). Freshwater seals made up 100% in 2010 and the majority in 2011 of the total estimated usable weight of marine mammals harvested by Newhalen households.

Newhalen hunters reported that when a seal is harvested it is normally shared throughout the community.

Table 5-14.–Estimated harvests and uses of marine mammals, Pedro Bay, 2011.

	Percentage of households					Harvest weight (lb)			Harvest amount			95% confidence limit (±) harvest
Resource	Use	Attempt	Harvest	Receive	Give	Total	Mean per household	Mean per capita	Total	Unit	Mean per household	
Marine mammals	**8.3%**	**16.7%**	**8.3%**	**0.0%**	**8.3%**	**74.7**	**4.7**	**2.8**	**1.3**	**ind**	**0.1**	**110.0%**
Seal	8.3%	16.7%	8.3%	0.0%	8.3%	74.7	4.7	2.8	1.3	ind	0.1	110.0%
Fur seal	0.0%	0.0%	0.0%	0.0%	0.0%	0.0	0.0	0.0	0.0	ind	0.0	0.0%
Harbor seal	8.3%	16.7%	8.3%	0.0%	8.3%	74.7	4.7	2.8	1.3	ind	0.1	110.0%
Harbor seal (freshwater)	8.3%	16.7%	8.3%	0.0%	8.3%	74.7	4.7	2.8	1.3	ind	0.1	110.0%
Harbor seal (saltwater)	0.0%	0.0%	0.0%	0.0%	0.0%	0.0	0.0	0.0	0.0	ind	0.0	0.0%
Steller sea lion	0.0%	0.0%	0.0%	0.0%	0.0%	0.0	0.0	0.0	0.0	ind	0.0	0.0%
Walrus	0.0%	0.0%	0.0%	0.0%	0.0%	0.0	0.0	0.0	0.0	ind	0.0	0.0%
Whale	0.0%	0.0%	0.0%	0.0%	0.0%	0.0	0.0	0.0	0.0	ind	0.0	0.0%
Beluga	0.0%	0.0%	0.0%	0.0%	0.0%	0.0	0.0	0.0	0.0	ind	0.0	0.0%

Source ADF&G Division of Subsistence household surveys, 2012.

Table 5-15.–Reported harvests and uses of marine mammals, Pope and Vannoy Landing, 2011.

	Percentage of households					Harvest weight (lb)			Harvest amount			95% confidence limit (±) harvest
Resource	Use	Attempt	Harvest	Receive	Give	Total	Mean household	Mean per capita	Total	Unit	Mean per household	
Marine mammals	**33.3%**	**33.3%**	**33.3%**	**0.0%**	**33.3%**	**112.0**	**37.3**	**37.3**	**2.0**	**ind**	**0.7**	**0.0%**
Seal	33.3%	33.3%	33.3%	0.0%	33.3%	112.0	37.3	37.3	2.0	ind	0.7	0.0%
Fur seal	0.0%	0.0%	0.0%	0.0%	0.0%	0.0	0.0	0.0	0.0	ind	0.0	0.0%
Harbor seal	33.3%	33.3%	33.3%	0.0%	33.3%	112.0	37.3	37.3	2.0	ind	0.7	0.0%
Harbor seal (freshwater)	33.3%	33.3%	33.3%	0.0%	33.3%	112.0	37.3	37.3	2.0	ind	0.7	0.0%
Harbor seal (saltwater)	0.0%	0.0%	0.0%	0.0%	0.0%	0.0	0.0	0.0	0.0	ind	0.0	0.0%
Steller sea lion	0.0%	0.0%	0.0%	0.0%	0.0%	0.0	0.0	0.0	0.0	ind	0.0	0.0%
Walrus	0.0%	0.0%	0.0%	0.0%	0.0%	0.0	0.0	0.0	0.0	ind	0.0	0.0%
Whale	0.0%	0.0%	0.0%	0.0%	0.0%	0.0	0.0	0.0	0.0	ind	0.0	0.0%
Beluga	0.0%	0.0%	0.0%	0.0%	0.0%	0.0	0.0	0.0	0.0	ind	0.0	0.0%

Source ADF&G Division of Subsistence household surveys, 2013.

Note Data for Pope and Vannoy Landing come from a single, ad hoc survey that was administered in July 2013. Because this community is small, the sample size is small, and the community was not systematically or randomly sampled, no estimates were made. These data are reported data, but they are believed to represent a complete and accurate accounting of the 2011 seal harvest in Pope and Vannoy Landing.

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Table 5-16.–Reported harvests and uses of marine mammals, Kokhanok, 2010, and estimated harvests and uses of marine mammals, Kokhanok, 2011.

	Percentage of households					Harvest weight (lb)			Harvest amount			95% confidence limit (±) harvest
Resource	Use	Attempt	Harvest	Receive	Give	Total	Mean per household	Mean per capita	Total	Unit	Mean per household	
2010												
Marine mammals	**57.5%**	**17.5%**	**2.5%**	**57.5%**	**20.0%**	**56.0**	**1.4**	**0.4**	**1.0**	**ind**	**0.03**	**0.0%**
Seal	57.5%	17.5%	2.5%	57.5%	20.0%	56.0	1.4	0.4	1.0	ind	0.03	0.0%
Fur seal	5.0%	5.0%	0.0%	5.0%	2.5%	0.0	0.0	0.0	0.0	ind	0.0	0.0%
Harbor seal	57.5%	15.0%	2.5%	57.5%	17.5%	56.0	1.4	0.4	1.0	ind	0.03	0.0%
Harbor seal (freshwater)	57.5%	15.0%	0.0%	57.5%	17.5%	0.0	0.0	0.0	0.0	ind	0.0	0.0%
Harbor seal (saltwater)	22.5%	2.5%	2.5%	22.5%	10.0%	56.0	1.4	0.4	1.0	ind	0.03	0.0%
Steller sea lion	2.5%	2.5%	0.0%	2.5%	2.5%	0.0	0.0	0.0	0.0	ind	0.0	0.0%
Walrus	5.0%	2.5%	0.0%	5.0%	2.5%	0.0	0.0	0.0	0.0	ind	0.0	0.0%
Whale	7.5%	2.5%	0.0%	7.5%	5.0%	0.0	0.0	0.0	0.0	ind	0.0	0.0%
Beluga	7.5%	2.5%	0.0%	7.5%	5.0%	0.0	0.0	0.0	0.0	ind	0.0	0.0%
2011												
Marine mammals	**51.2%**	**16.3%**	**9.3%**	**44.2%**	**25.6%**	**489.7**	**10.4**	**3.6**	**8.7**	**ind**	**0.2**	**33.7%**
Seal	51.2%	16.3%	9.3%	41.9%	25.6%	489.7	10.4	3.6	8.7	ind	0.2	33.7%
Fur seal	0.0%	0.0%	0.0%	0.0%	0.0%	0.0	0.0	0.0	0.0	ind	0.0	0.0%
Harbor seal	51.2%	16.3%	9.3%	41.9%	25.6%	489.7	10.4	3.6	8.7	ind	0.2	33.7%
Harbor seal (freshwater)	48.8%	16.3%	9.3%	39.5%	25.6%	367.3	7.8	2.7	6.6	ind	0.1	30.1%
Harbor seal (saltwater)	4.7%	2.3%	2.3%	2.3%	2.3%	122.4	2.6	0.9	2.2	ind	0.0	58.9%
Steller sea lion	0.0%	0.0%	0.0%	0.0%	0.0%	0.0	0.0	0.0	0.0	ind	0.0	0.0%
Walrus	0.0%	0.0%	0.0%	0.0%	0.0%	0.0	0.0	0.0	0.0	ind	0.0	0.0%
Whale	4.7%	0.0%	0.0%	4.7%	0.0%	0.0	0.0	0.0	0.0	ind	0.0	0.0%
Beluga	4.7%	0.0%	0.0%	4.7%	0.0%	0.0	0.0	0.0	0.0	ind	0.0	0.0%

Source For 2010, Bristol Bay Native Association and University of Alaska Anchorage household surveys, 2011; for 2011,ADF&G Division of Subsistence household surveys, 2012.

Note Data for 2010 are reported and data for 2011 are estimated.

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Table 5-17.–Reported harvests and uses of marine mammals, Newhalen, 2010, and estimated harvests and uses of marine mammals, Newhalen, 2011.

	Percentage of households					Harvest weight (lb)			Harvest amount			95% confidence limit (±) harvest
Resource	Use	Attempt	Harvest	Receive	Give	Total	Mean per household	Mean per capita	Total	Unit	Mean per household	
2010												
Marine mammals	**69.2%**	**19.2%**	**7.7%**	**65.4%**	**30.8%**	**112.0**	**4.3**	**1.2**	**2.0**	**ind**	**0.08**	**0.0%**
Seal	69.2%	19.2%	7.7%	65.4%	30.8%	112.0	4.3	1.2	2.0	ind	0.1	0.0%
Fur seal	0.0%	0.0%	0.0%	0.0%	0.0%	0.0	0.0	0.0	0.0	ind	0.0	0.0%
Harbor seal	69.2%	19.2%	7.7%	65.4%	30.8%	112.0	4.3	1.2	2.0	ind	0.08	0.0%
Harbor seal (freshwater)	69.2%	19.2%	7.7%	65.4%	26.9%	112.0	4.3	1.2	2.0	ind	0.08	0.0%
Harbor seal (saltwater)	23.1%	0.0%	0.0%	23.1%	11.5%	0.0	0.0	0.0	0.0	ind	0.0	0.0%
Steller sea lion	0.0%	0.0%	0.0%	0.0%	0.0%	0.0	0.0	0.0	0.0	ind	0.0	0.0%
Walrus	0.0%	0.0%	0.0%	0.0%	0.0%	0.0	0.0	0.0	0.0	ind	0.0	0.0%
Whale	26.9%	0.0%	0.0%	26.9%	3.8%	0.0	0.0	0.0	0.0	ind	0.0	0.0%
Beluga	26.9%	0.0%	0.0%	26.9%	3.8%	0.0	0.0	0.0	0.0	ind	0.0	0.0%
2011												
Marine mammals	**70.6%**	**26.5%**	**14.7%**	**67.6%**	**20.6%**	**518.8**	**11.5**	**3.2**	**9.3**	**ind**	**0.2**	**45.1%**
Seal	70.6%	23.5%	14.7%	67.6%	20.6%	518.8	11.5	3.2	9.3	ind	0.2	45.1%
Fur seal	0.0%	0.0%	0.0%	0.0%	0.0%	0.0	0.0	0.0	0.0	ind	0.0	0.0%
Harbor seal	70.6%	23.5%	14.7%	67.6%	20.6%	518.8	11.5	3.2	9.3	ind	0.2	45.1%
Harbor seal (freshwater)	64.7%	23.5%	11.8%	61.8%	20.6%	444.7	9.9	2.7	7.9	ind	0.2	50.9%
Harbor seal (saltwater)	17.6%	2.9%	2.9%	17.6%	0.0%	74.1	1.6	0.5	1.3	ind	0.0	100.6%
Steller sea lion	0.0%	0.0%	0.0%	0.0%	0.0%	0.0	0.0	0.0	0.0	ind	0.0	0.0%
Walrus	2.9%	0.0%	0.0%	2.9%	0.0%	0.0	0.0	0.0	0.0	ind	0.0	0.0%
Whale	20.6%	2.9%	0.0%	20.6%	2.9%	0.0	0.0	0.0	0.0	ind	0.0	0.0%
Beluga	20.6%	2.9%	0.0%	20.6%	2.9%	0.0	0.0	0.0	0.0	ind	0.0	0.0%

Source For 2010, Bristol Bay Native Association and University of Alaska Anchorage, household surveys, 2011; for 2011, ADF&G Division of Subsistence household surveys, 2012.

Note Data for 2010 are reported and data for 2011 are estimated.

"*We just take 1 [seal] to share with everybody, fat and oil*," said a Newhalen hunter. Newhalen hunters reported that seal hunting is primarily motivated by requests from elders for seal meat and oil. All of the Newhalen hunters who reported harvesting seals reported sharing seals with other households. In Newhalen, greater than 65% of households used and received seals in both 2010 and 2011 (Table 5-17). In addition, 27% of Newhalen households used beluga whales that they received in 2010.

Elders from Newhalen who are no longer able to hunt reported that seal hunting and harvests had declined in the community from previous periods, but that when seals are harvested they always receive a share of the harvest. Nevertheless, some Newhalen respondents suggested that community dependence on seals for subsistence use has increased in recent years as a result of declines in the abundance of local moose and caribou populations and a concomitant decline in the community's harvests of those animals. A Newhalen hunter said that as a result of large land mammal declines in the region "*we have become more dependent upon the fishery and the seals.*"

Iliamna

Ethnographic results from the community of Iliamna depict community harvests of 1–2 seals annually. According to the subsistence survey, in 2011, hunters from an estimated 24% of Iliamna households attempted to harvest marine mammals (Table 5-18). Iliamna hunters harvested an estimated 2 seals in 2011. Freshwater seals made up 100% of the total marine mammal harvest in terms of usable weight (133 lb). All of the harvesting households in Iliamna shared seal resources with other households. In Iliamna, 38% of households used seals and 38% of households received seals from other households. Saltwater seals were received and used by 14% of Iliamna households but was not harvested by hunters from the community. Additionally, 5% of Iliamna households used beluga whale resources received from other communities. Sea otters were used by 5% of Iliamna households; most likely sea otters were used for their fur.

Iliamna respondents explained that seals are only harvested by the community when needed. For example, an Iliamna elder said, "*If our seal [supply] gets down then I go out and go get one. I don't get one every year,*" and another Iliamna elder said, "*Only if we need it, do we get a seal. Otherwise, we leave them alone.*" Another Iliamna elder said that "*there never has been tons of really hard seal hunting pressure*" by Iliamna hunters. The elder explained that "*there is a fairly constant [level of hunting pressure in the springtime] when they [hunters] can still travel on the ice*" but that "*there is not even a half-dozen guys [from Iliamna] that go out each spring for maybe a few days at a time.*" The elder said that Newhalen and Kokhanok are the 2 most active seal hunting communities at Iliamna Lake.

Igiugig

Ethnographic results from the community of Igiugig depict high levels of marine mammal use by the community and active annual marine mammal hunting by some community members. Household survey results estimate 47% of Igiugig households attempted to harvest marine mammals in 2011 (Table 5-19). Igiugig hunters harvested an estimated 4 seals in 2011, all of which were identified as freshwater seals. All of the Igiugig harvesting households shared seal resources with other households. In Igiugig, 82% of households used seals and 65% of households received seals from other households. Saltwater seals were received and used by 6% of Igiugig households but not harvested by hunters from the community. Additionally, 12% of Igiugig households attempted to harvest beluga whales and 6% of Igiugig households successfully harvested beluga whales. Igiugig hunters harvested an estimated 2 beluga whales in 2011 and 58% of Igiugig households used beluga whales (53% of Igiugig households received beluga whales). Igiugig households also used bowhead whales (18%) and walrus (6%). Freshwater seals made up 12% of the total marine mammal harvest in terms of usable weight harvested by Igiugig households. The remaining 88% of the total marine mammal harvest weight can be attributed to the harvest of 2 beluga whales by the community. There are many kinship ties between Igiugig, Levelock, and other coastal communities along the northern coast of Alaska, which likely account for the use of bearded seals, ringed seals, and bowhead whales by this community.

Table 5-18.–Estimated harvests and uses of marine mammals, Iliamna, 2011.

	Percentage of households					Harvest weight (lb)			Harvest amount			95% confidence limit (±) harvest
Resource	Use	Attempt	Harvest	Receive	Give	Total	Mean per household	Mean per capita	Total	Unit	Mean per household	
Marine mammals	**42.9%**	**23.8%**	**9.5%**	**42.9%**	**23.8%**	**133.3**	**5.3**	**1.8**	**2.4**	**ind**	**0.1**	**57.5%**
Seal	38.1%	23.8%	9.5%	38.1%	23.8%	133.3	5.3	1.8	2.4	ind	0.1	57.5%
Fur seal	0.0%	0.0%	0.0%	0.0%	0.0%	0.0	0.0	0.0	0.0	ind	0.0	0.0%
Harbor seal	38.1%	23.8%	9.5%	38.1%	23.8%	133.3	5.3	1.8	2.4	ind	0.1	57.5%
Harbor seal (freshwater)	38.1%	23.8%	9.5%	33.3%	23.8%	133.3	5.3	1.8	2.4	ind	0.1	57.5%
Harbor seal (saltwater)	14.3%	4.8%	0.0%	14.3%	0.0%	0.0	0.0	0.0	0.0	ind	0.0	0.0%
Sea otter	4.8%	4.8%	0.0%	4.8%	4.8%	0.0	0.0	0.0	0.0	ind	0.0	0.0%
Steller sea lion	0.0%	0.0%	0.0%	0.0%	0.0%	0.0	0.0	0.0	0.0	ind	0.0	0.0%
Walrus	0.0%	0.0%	0.0%	0.0%	0.0%	0.0	0.0	0.0	0.0	ind	0.0	0.0%
Whale	4.8%	0.0%	0.0%	4.8%	0.0%	0.0	0.0	0.0	0.0	ind	0.0	0.0%
Beluga	4.8%	0.0%	0.0%	4.8%	0.0%	0.0	0.0	0.0	0.0	ind	0.0	0.0%

Source ADF&G Division of Subsistence household surveys, 2012.

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Table 5-19.–Estimated harvests and uses of marine mammals, Igiugig, 2011.

	Percentage of households					Harvest weight (lb)			Harvest amount			95% confidence limit (±) harvest
Resource	Use	Attempt	Harvest	Receive	Give	Total	Mean per household	Mean per capita	Total	Unit	Mean per household	
Marine mammals	**82.4%**	**47.1%**	**23.5%**	**70.6%**	**52.9%**	**1,996.9**	**110.9**	**33.7**	**6.4**	**ind**	**0.4**	**45.3%**
Seal	82.4%	47.1%	23.5%	64.7%	47.1%	237.2	13.2	4.0	4.2	ind	0.2	22.5%
Beard seal	5.9%	0.0%	0.0%	5.9%	0.0%	0.0	0.0	0.0	0.0	ind	0.0	0.0%
Fur seal	0.0%	0.0%	0.0%	0.0%	0.0%	0.0	0.0	0.0	0.0	ind	0.0	0.0%
Harbor seal	82.4%	47.1%	23.5%	64.7%	47.1%	237.2	13.2	4.0	4.2	ind	0.2	22.5%
Harbor seal (freshwater)	82.4%	47.1%	23.5%	64.7%	47.1%	237.2	13.2	4.0	4.2	ind	0.2	22.5%
Harbor seal (saltwater)	5.9%	0.0%	0.0%	5.9%	5.9%	0.0	0.0	0.0	0.0	ind	0.0	0.0%
Ringed seal	5.9%	0.0%	0.0%	5.9%	0.0%	0.0	0.0	0.0	0.0	ind	0.0	0.0%
Steller sea lion	0.0%	0.0%	0.0%	0.0%	0.0%	0.0	0.0	0.0	0.0	ind	0.0	0.0%
Walrus	5.9%	0.0%	0.0%	5.9%	0.0%	0.0	0.0	0.0	0.0	ind	0.0	0.0%
Whale	58.8%	11.8%	5.9%	52.9%	23.5%	1,759.8	97.8	29.7	2.1	ind	0.1	50.0%
Beluga	58.8%	11.8%	5.9%	52.9%	23.5%	1,759.8	97.8	29.7	2.1	ind	0.1	50.0%
Bowhead	17.6%	0.0%	0.0%	17.6%	0.0%	0.0	0.0	0.0	0.0	ind	0.0	0.0%

Source ADF&G Division of Subsistence household surveys, 2012.

Levelock

Ethnographic results from the community of Levelock depict active annual beluga whale hunting effort and less active annual seal hunting effort by some households in the community. In 2011, hunters from 17% of Levelock households attempted to harvest marine mammals (Table 5-20). Levelock hunters harvested an estimated 1 seal in 2011, which was reported as being a saltwater seal. The seal harvest was shared with other households; 30% of households used seals and 26% of households received seals from other households. Freshwater seals were received and used by 4% of Levelock households but were not harvested by hunters from the community. Additionally, 13% of Levelock households attempted to harvest beluga whales and 9% of Levelock households successfully harvested beluga whales. Levelock hunters harvested an estimated 5 beluga whales in 2011 and 26% of Levelock households used beluga whales. In Levelock, 4% of households used gray whales received from outside the community. Seals made up only 2% of the total harvest weight (4,409 lb) of marine mammals harvested by Levelock households. The remaining 98% of the total weight of marine mammals harvested by Levelock hunters can be attributed to the harvest of 5 beluga whales.

Levelock respondents reported that the community's seal harvests are fewer today than they were during the 20th century. Levelock respondents also said that any seals harvested by the community today originate in Bristol Bay. Levelock respondents reported that the seal oil used by their households today is often given to the community by more active seal hunters from different Bristol Bay communities where residents have kinship ties, such as Togiak. Moreover, Levelock respondents reported that seal hunting by community residents is only opportunistic and that beluga whales are the only marine mammal intentionally hunted by Levelock hunters. "*A lot of oil we get is from beluga. There are still some beluga hunters here. My brother, every year he goes out and gets a beluga. Then we go down to his house and have a feast*," said a Levelock elder.

5.3.iv. Community Participation

Reported participation in seal hunting activities, seal harvests, and uses for all of the study communities may reflect lower levels of participation, harvest, and use than in the past since many respondents reported that active seal hunting has decreased within the lake communities. "*They hunted more in the past than they do now,*" said an Igiugig elder. Some respondents suggested that a decline in seal hunting activity is a result of the newer generations not having as much of an interest in using seals for food as did the older generations. For example, an Igiugig hunter said, "*The older people started passing away, and less people [were] going out [seal hunting] because they had nobody [elders] to hunt for.*" Respondents also explained that even though active annual seal hunting does occur, there are normally only a select few individuals in each community who hunt seals. For example, a Kokhanok hunter said that "*up until the mid- to late 1960s participation in hunting was probably 100% [of individual male hunters in a given community], now in the 2000s, it's probably about 20%*." Many hunters interviewed in this study said that providing seals to elders is a primary reason why they hunt seals today. Several hunters reported that the greater portion of a harvested seal is often not kept by the hunter but is instead distributed to elders.

Even though the number of active seal hunters in each community is reported by community members to have declined, and despite reports by some respondents that harvests are low, other respondents suggested that the use of modern technology, such as snowmachines and high-powered boat motors used for transport during hunting, has led to greater ecological effects on the seal population. An Iliamna elder suggested that seal harvests could be greater today than during the 20th century because "*now, there are more [seals] harvested, because [people have] faster boats. And some people are not following the old tradition. The older tradition, we only take when we need.*"

In order to provide a more complete picture of community participation in marine mammal subsistence activities, the household survey also gauged community participation in the processing of harvested marine mammals in 2010 and 2011. With the exception of Kokhanok in 2010, and Igiugig and Pedro Bay in 2011, more households from the study communities participated in processing harvested marine mammals than participated in hunting marine mammals (Figure 5-35). This displays a community effort to participate in

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Table 5-20.–Estimated harvests and uses of marine mammals, Levelock, 2011.

	Percentage of households					Harvest weight (lb)			Harvest amount			95% confidence limit (±) harvest
Resource	Use	Attempt	Harvest	Receive	Give	Total	Mean per household	Mean per capita	Total	Unit	Mean per household	
Marine mammals	**47.8%**	**17.4%**	**8.7%**	**39.1%**	**30.4%**	**4,408.7**	**147.0**	**51.2**	**6.5**	**ind**	**0.2**	**77.3%**
Seal	30.4%	8.7%	4.3%	26.1%	17.4%	73.0	2.4	0.8	1.3	ind	0.0	100.2%
Fur seal	0.0%	0.0%	0.0%	0.0%	0.0%	0.0	0.0	0.0	0.0	ind	0.0	0.0%
Harbor seal	30.4%	8.7%	4.3%	26.1%	17.4%	73.0	2.4	0.8	1.3	ind	0.0	100.2%
Harbor seal (freshwater)	4.3%	4.3%	0.0%	4.3%	4.3%	0.0	0.0	0.0	0.0	ind	0.0	0.0%
Harbor seal (saltwater)	30.4%	4.3%	4.3%	26.1%	17.4%	73.0	2.4	0.8	1.3	ind	0.0	100.2%
Steller sea lion	0.0%	0.0%	0.0%	0.0%	0.0%	0.0	0.0	0.0	0.0	ind	0.0	0.0%
Walrus	0.0%	0.0%	0.0%	0.0%	0.0%	0.0	0.0	0.0	0.0	ind	0.0	0.0%
Whale	30.4%	13.0%	8.7%	21.7%	21.7%	4,335.7	144.5	50.4	5.2	ind	0.2	78.1%
Beluga	26.1%	13.0%	8.7%	17.4%	17.4%	4,335.7	144.5	50.4	5.2	ind	0.2	78.1%
Gray whale	4.3%	0.0%	0.0%	4.3%	4.3%	0.0	0.0	0.0	0.0	ind	0.0	0.0%

Source ADF&G Division of Subsistence household surveys, 2012.

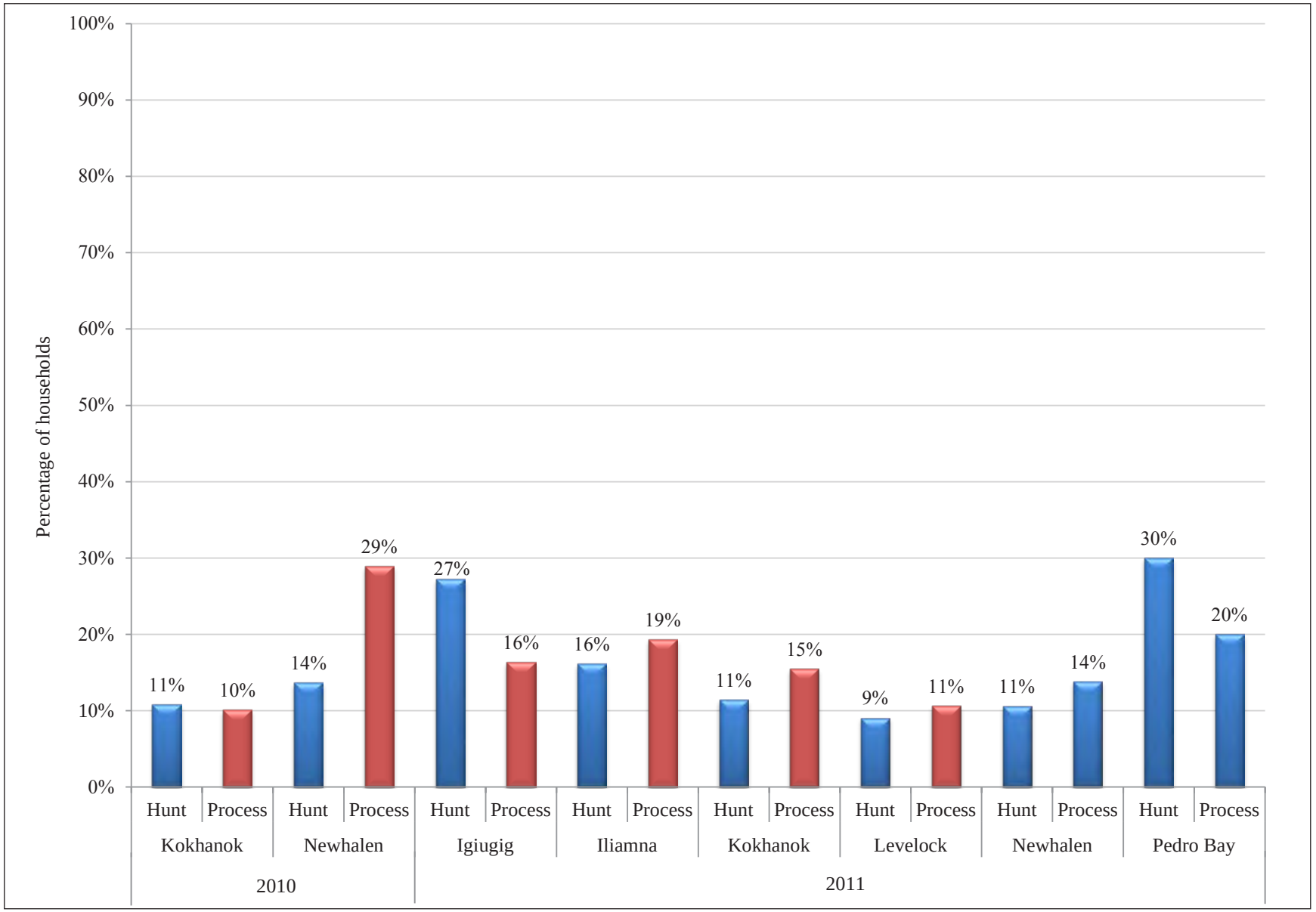

Figure 5-35.–The percentage of households participating in both marine mammal hunting and processing activities, study communities, 2011.

¶ *Table 5-21.–Changes in marine mammal use compared to the past year, study communities, 2010 and 2011.*

Community	Sampled households	Valid responses[a]	Households reporting use: Less use Number	Less use Percentage	Same use Number	Same use Percentage	More use Number	More use Percentage
2010								
Kokhanok	40	20	8	40%	9	45%	3	15%
Newhalen	26	17	4	24%	13	76%	0	0%
2011								
Igiugig	17	14	3	21%	5	36%	6	43%
Iliamna	21	10	6	60%	2	20%	2	20%
Kokhanok	42	23	14	61%	8	35%	2	9%
Levelock	23	12	1	8%	11	92%	0	0%
Newhalen	35	27	10	37%	16	59%	0	0%
Pedro Bay	12	3	1	33%	1	33%	1	33%

Source For 2010, Bristol Bay Native Association and University of Alaska Anchorage household surveys, 2011; for 2012, ADF&G Division of Subsistence household surveys, 2011.

a. Valid responses include only households that used resources and responded to the question about use.

marine mammal subsistence activities that goes beyond the efforts of individual hunters.

¶ 5.3.v. Changes in Marine Mammal Use and Sharing

In both 2010 and 2011, the household harvest survey asked residents of the study communities to compare their household's use and sharing of marine mammals with previous years. Of the surveyed households that used marine mammal resources, 40% of Kokhanok households and 24% of Newhalen households said that their use of marine mammal resources in 2010 was *less* when compared to recent years (Table 5-21). By 2011, most households in Kokhanok said that they used *less* marine mammal resources as compared to recent years, while 59% of households in Newhalen reported that their use had *remained the same*. In contrast, in 2011 more Igiugig households said they used *more* marine mammals in 2011 when compared to recent years than said they used the *same* or *less*, while residents from Iliamna reported that they used *less* (60% of responding households). For the majority of the households in Levelock, marine mammal use *remained the same* in 2011 as it had been in recent years. Responses were split among the Pedro Bay respondents with 1 household each stating use was *less*, the *same*, and *more*.

When Kokhanok and Newhalen households that reported using less marine mammals in 2010 than in previous years were asked why they used less marine mammals, one-half of the households with valid responses (4 in Kokhanok, 2 in Newhalen) reported that *reduced sharing* was the primary cause of their households' declined marine mammal use (Table 5-22). Other households cited *personal reasons* for a decline in marine mammal use (4 in Kokhanok, 1 in Newhalen). These reasons were echoed by the survey in 2011, which included more communities.

Thirteen households from all 6 communities that reported using less marine mammals in 2011 than in previous years attributed the decline to *reduced sharing*; no other reason was cited by more households (Table 5-23). The second highest number of responses (9 households) attributed *personal reasons* (such as health and being present to harvest) as the cause for less use. Another 5 households said that *harvesting difficulties* caused less use of marine mammals, 4 households said that *employment interference* with marine mammal hunting activities led to a decline in use, and 1 household reported less marine mammal use in 2011 because hunting is *economically prohibitive*.

Table 5-22.–Reasons for less household uses of marine mammal resources compared to the past year, Kokhanok and Newhalen, 2010.

Community	Valid responses[a]	Households reporting **less** use	Unfavorable weather		Employment interfered		Too much competition		Regulatory restrictions	
			Number	Percentage	Number	Percentage	Number	Percentage	Number	Percentage
Kokhanok	20	8	0	0%	0	0%	0	0%	0	0%
Newhalen	17	4	0	0%	0	0%	0	0%	0	0%

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Table 5-22.–Continued.

Community	Valid responses[a]	Households reporting **less** use	Sharing reduced		Difficult to harvest		Personal reasons interfered		Fuel, equipment, or both too espensive	
			Number	Percentage	Number	Percentage	Number	Percentage	Number	Percentage
Kokhanok	20	8	4	50%	0	0%	4	50%	0	0%
Newhalen	17	4	2	50%	1	25%	1	25%	0	0%

Source Bristol Bay Native Association and University of Alaska Anchorage household surveys, 2011.

a. Valid responses include only households that used resource and responsed to the question about use.

Table 5-23.–Reasons for less household uses of marine mammal resources compared to the past year, study communities, 2011.

Community	Valid responses[a]	Households reporting **less** use	Unfavorable weather		Employment interfered		Too much competition		Regulatory restrictions	
			Number	Percentage	Number	Percentage	Number	Percentage	Number	Percentage
Igiugig	17	3	0	0%	0	0%	0	0%	0	0%
Iliamna	16	6	0	0%	1	17%	0	0%	0	0%
Kokhanok	39	14	0	0%	3	21%	0	0%	0	0%
Levelock	23	1	0	0%	0	0%	0	0%	0	0%
Newhalen	34	10	0	0%	0	0%	0	0%	0	0%
Pedro Bay	12	1	0	0%	0	0%	0	0%	0	0%

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Table 5-23.–Continued.

Community	Valid responses[a]	Households reporting **less** use	Sharing reduced		Difficult to harvest		Personal reasons interfered		Fuel, equipment, or both too expensive	
			Number	Percentage	Number	Percentage	Number	Percentage	Number	Percentage
Igiugig	17	3	1	33%	0	0%	2	67%	0	0%
Iliamna	16	6	0	0%	2	33%	2	33%	0	0%
Kokhanok	39	14	7	50%	2	14%	2	14%	0	0%
Levelock	23	1	1	100%	0	0%	0	0%	0	0%
Newhalen	34	10	4	40%	0	0%	3	30%	1	10%
Pedro Bay	12	1	0	0%	1	100%	0	0%	0	0%

Source ADF&G Division of Subsistence household surveys, 2011.

a. Valid responses include only households that used resource and responsed to the question about use.

In 2010, there were 3 Kokhanok households that reported *more* use of marine mammals, and 1 household each cited *increased sharing* and *favorable personal reasons* as a reason for the increase in use (Table 5-24). This was also the reason for increased use reported by 4 households (3 from Igiugig and 1 from Kokhanok) in 2011, while 5 households (Igiugig 2, Iliamna 2, and Pedro Bay 1) reported seals being *easy to harvest*, and 2 households (1 each from Igiugig and Kokhanok 1) cited *personal reasons* as the primary causes of their households' increased marine mammal use (Table 5-25).

Note that reasons not selected by respondents, whether explaining less or more use, included factors from weather, competition, and regulations. Some ethnographic interview respondents, particularly those who were elders, reported that sharing of marine mammal harvests in the community had declined when compared to past years. Correspondingly, many of the elders interviewed during this research reported that seal hunting activities in their communities had declined over the years and that as a result their households no longer received normal amounts of seal meat and oil from other hunting households in their communities.

¶ 5.3.vi. Seal Harvests in Iliamna Lake, 1982–2011

The historical seal harvests by Igiugig, Iliamna, Kokhanok, Levelock, Newhalen, and Pedro Bay from 1982–2011 are shown in Table 5-26. These data show that seal harvests by the study communities have fluctuated through time. Newhalen seal harvests during 1983, 1991, and 2004 were particularly high when compared to 2010 and 2011 harvests (14, 23, and 18 seals harvested compared to 2 and 8 seals harvested). Harvests for Levelock in 1988 likely occurred in marine waters or the Kvichak River. Most of the harvest estimates for the other communities likely occurred in Iliamna Lake or the Kvichak River.

Slight differences in the methods by which the marine mammal harvest and use data for 2011 were obtained as compared to earlier surveys, including the 2010 surveys, make it difficult to accurately identify trends in seal harvests by the communities. However, there is a high level of confidence that the 2011 harvest and use data presented in this report accurately quantify contemporary marine mammal harvests and use levels for the study communities. Continued and consistent harvest monitoring will be required in the future in order to identify trends.

5.4. Seal Hunting Strategies, Past to Present

As described above, in 1900 the prospector Bonham documented the traditional Dena'ina practice of harpooning the seals within Iliamna Lake at their breathing holes on the lake ice (Branson 2007). Likewise, elder respondents during this research reported that prior to the adoption of firearms and modern transportation, Iliamna Lake hunters used still hunting methods to harvest seals on the ice that included harpoons. For this tactic the hunter moved slowly to the breathing hole or ice fissure and waited, sometimes hours, while staying as still as possible. Elders reported that pursuing seals hauled out on the ice near pressure cracks using spot and stalk methods was also a traditional practice. In contrast to the still hunting method, in order to spot and stalk seals the hunter monitored a larger area to find seals and stalked them, moving slowly, often on his or her stomach, to where the seals were located.

Elder respondents said that seal hunters would either travel by dog team or walk on the lake ice to locations with pressure cracks, wait for seals to appear, and then attempt to harvest one. "*There was a guy from Newhalen, he would walk out there on springtime ice and wait for a day before he could get one [a seal],*" said a Kokhanok elder. Elders explained that seal hunting on the ice was the dominant strategy used by pre-modern hunters because it was the most efficient means of harvesting a seal. This is because, prior to the availability of motorboats, travel on the ice required less effort than travel on the water by paddled watercraft, and also because it is easier to spot and stalk seals along pressure cracks in the ice than it is to hunt them from a non-motorized boat in open water.

Prior to the adoption of using boat motors, some seal hunters did hunt seals when Iliamna Lake was not ice-covered by traveling by canoe or kayak. Some elder respondents recalled their grandparents and parents traveling by canoe to hunt seals in the lake with harpoons. For example, an Igiugig elder said: "*My dad*

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Table 5-24.–Reasons for more household uses of marine mammal resources compared to the past year, Kokhanok and Newhalen, 2010.

Community	Valid responses[a]	Households reporting **more** use	No reason stated		Favorable weather		Employment conducive		Less competition		Regulations conducive	
			Number	Percentage	Number	Percentage	Number	Percentage	Number	Percentage	Number	Percentage
Kokhanok	20	3	1	33%	0	0%	0	0%	0	0%	0	0%
Newhalen	17	0	0	0%	0	0%	0	0%	0	0%	0	0%

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Table 5-24.–Continued.

Community	Valid responses[a]	Households reporting **more** use	Sharing increased		Easy to harvest		Personal reasons conducive		Fuel, equipment, or both affordable	
			Number	Percentage	Number	Percentage	Number	Percentage	Number	Percentage
Kokhanok	20	3	1	33%	0	0%	1	33%	0	0%
Newhalen	17	0	0	0%	0	0%	0	0%	0	0%

Source ADF&G Division of Subsistence household surveys, 2011.

a. Valid responses include only households that used resource and responsed to the question about use.

Table 5-25.–Reasons for more household uses of marine mammal resources compared to the past year, study communities, 2011.

Community	Valid responses[a]	Households reporting **more** use	No reason stated		Favorable weather		Employment conducive		Less competition		Regulations conducive	
			Number	Percentage	Number	Percentage	Number	Percentage	Number	Percentage	Number	Percentage
Igiugig	17	6	0	0%	0	0%	0	0%	0	0%	0	0%
Iliamna	16	2	0	0%	0	0%	0	0%	0	0%	0	0%
Kokhanok	39	2	0	0%	0	0%	0	0%	0	0%	0	0%
Levelock	23	0	0	0%	0	0%	0	0%	0	0%	0	0%
Newhalen	34	0	0	0%	0	0%	0	0%	0	0%	0	0%
Pedro Bay	12	1	0	0%	0	0%	0	0%	0	0%	0	0%

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Table 5-25.–Continued.

Community	Valid responses[a]	Households reporting **more** use	Sharing increased		Easy to harvest		Personal reasons conducive		Fuel, equipment, or both affordable	
			Number	Percentage	Number	Percentage	Number	Percentage	Number	Percentage
Igiugig	17	6	3	50%	2	33%	1	17%	0	0%
Iliamna	16	2	0	0%	2	100%	0	0%	0	0%
Kokhanok	39	2	1	50%	0	0%	1	50%	0	0%
Levelock	23	0	0	0%	0	0%	0	0%	0	0%
Newhalen	34	0	0	0%	0	0%	0	0%	0	0%
Pedro Bay	12	1	0	0%	1	100%	0	0%	0	0%

Source ADF&G Division of Subsistence household surveys, 2011.

a. Valid responses include only households that used resource and responsed to the question about use.

Table 5-26.–Historical estimated and reported harvests of freshwater harbor seals, study communities, 1982, 1983, 1988, 1991, 1992, 1996, 2004, 2005, 2010, and 2011.

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Year	Community	Estimated harvest	Unit	95% confidence limit (±) harvest
1982	Pedro Bay	0.0	ind	
1983	Igiugig	4.0	ind	150.0%
1983	Iliamna	5.0	ind	100.0%
1983	Kokhanok	0.0	ind	
1983	Newhalen	14.0	ind	107.0%
1988	Levelock	16.0	ind	43.0%
1991	Iliamna	10.0	ind	80.0%
1991	Newhalen	23.0	ind	30.0%
1992	Igiugig	2.0	ind	
1992	Kokhanok	11.0	ind	
1992	Levelock	0.0	ind	
1996	Pedro Bay	0.0	ind	
2004	Iliamna	8.5	ind	20.0%
2004	Newhalen	17.9	ind	8.0%
2004	Pedro Bay	0	ind	
2005	Igiugig	5.4	ind	29.4%
2005	Kokhanok	4.8	ind	6.9%
2005	Levelock	0.0	ind	
2010	Kokhanok	0.0	ind	
2010	Newhalen	2.0	ind	
2011	Igiugig	4.2	ind	22.5%
2011	Iliamna	2.4	ind	57.5%
2011	Kokhanok	6.6	ind	30.1%
2011	Levelock	0.0	ind	
2011	Newhalen	7.9	ind	50.9%
2011	Pedro Bay	1.3	ind	110.0%

Sources 1982, 1983, 1988, 1991, 1992, and 1996 data: ADF&G Division of Subsistence Community Profile Database, 2001, Version 3.12; 2004 data: Fall et al. (2006); 2005 data: Holen et al. (2009); 2010 data: Bristol Bay Native Association and University of Alaska Anchorage household surveys, 2011; and 2011 data: ADF&G Division of Subsistence household surveys, 2012.
Note Data prior to 1992 may include the harvests of seals in marine waters.

usually used canoe. You covered it up with seal skin or sometimes brown bear skin, too ….. My dad used to make canoe." Another Igiugig elder said:

> *I always heard stories about them, when they had to use harpoons and canoes and kayaks. And they chase them into a harbor that catches [traps] them … . You can chase them [seals] into a harbor with canoes made with big animal skins like big seal and bear. Then they used a harpoon or bow and arrow. But people don't hunt like that anymore.*

An Igiugig elder said that, later on, people covered their canoes with painted canvas instead of skins. The elder explained that when motorboats were eventually adopted by Iliamna Lake residents they became the primary mode of transport for seal hunting on the open water. However, the traditional method of hunting seals on the ice by dog team continued as the primary winter method because snowmachines and all-terrain vehicles (ATVs) were not yet available. "*Wintertime—dog team, summertime—in skiff,*" said the elder. Similarly, an Iliamna elder said, "*Right now if you wanted to go get a seal you need a snowmachine or a 4-wheeler and back them days [circa 1950] it was either with a boat or a dog team.*" The elder explained that, prior to the use of motorboats, traveling on the ice in search of seals was the most efficient method but that once motorboats were acquired hunting seals on the water became easier than managing a dog team on the ice. However, the hunters' preference for hunting seals after the lake was ice-covered was later revived with the adoption of snowmachines and ATVs for hunting transport.

Although each hunter has his or her own seasonal preferences, in modern times, motorboats, snowmachines, and ATVs share equal importance for seal hunting transport. An Igiugig hunter explained that today hunters target seals in Iliamna Lake "*by boat in the summer and snowmachine or 4-wheeler in the winter.*" Airplanes are another type of modern transport that has been used for seal hunting. While he no longer does so, a Pedro Bay elder said that he used to search for seals by air and, once hauled out seals were located, would land on the ice at a distance and stalk the seals. The elder said that he had harvested several seals by this method in the past. While one Igiugig elder reported that he continues to carry a harpoon in his boat in case it becomes useful for retrieving a seal, he said that today seals are hunted with small-caliber rifles, such as .22, .22-250, .243, and .270, and even sometimes with 12-gauge shotguns. An Iliamna elder explained that harvesting a seal in the lake requires knowledge of seal behavior and a good hunting strategy for the conditions at the time. "*Hunting strategies are based on what you know about seal behavior … I know where seals will be at a certain time of the day,*" said the elder.

Traditional cosmological views about attitude, luck, and proper treatment of seals also play a role in hunting success. A Kokhanok hunter explained that he was taught by his father not to talk about seals or tell anyone else that you are going hunting for them. "*You don't 'go hunting' for seals, you just 'go look around' because they'll hear you through the water,*" said the hunter. The hunter said that he was also taught other important traditional rules a seal hunter must follow in order to ensure hunting success in the future. The hunter said: "*When hunting seals, if we shot one, we had to give it a drink of fresh water. You shoot a seal, you give it a drink of water.*" Likewise, an Iliamna elder reported that it was traditional practice to spit water into a seal's mouth after it was killed. The elder said that some Iliamna Lake seal hunters continue this practice today. Seal hunters from Iliamna Lake also sometimes leave an offering, such as a cracker or some coffee grounds, on an island or on the ice after killing a seal. "*Sometimes even if you did not see a seal you would still leave something,*" said a Kokhanok hunter. Coastal Yup'ik Alaska Natives are also known to provide both food offerings for seals when they wish to harvest one and to provide a drink of fresh water to the seal following its death (Fienup-Riordan 1983, 2007; Fienup-Riordan et al. 2000). Food offerings are viewed as an act of reciprocation between the hunter and the seal and providing a drink of fresh water to the seal following its death is done in order to initiate a cycle of rebirth for the seal (Fienup-Riordan 1983; Fienup-Riordan et al. 2000).

5.4.i. Hunting Locations in Iliamna Lake

Specific seal hunting locations used by hunters from the study communities are distinct but also often overlap. Hunters from Iliamna, Kokhanok, Pedro Bay, and Newhalen generally only hunt seals in the

northeastern portion of the lake. The seal hunting area for these communities extends no farther southwest than Dennis Creek. The seal hunting search areas during 2011 mapped by hunters from Iliamna, Kokhanok, Pedro Bay, and Newhalen are shown in Figure 5-36, while specific seal hunting areas for Igiugig and Levelock are shown in Figure 5-37 and Figure 5-38.

Iliamna hunters travel a distance anywhere from 7 miles to 38 miles roundtrip to hunt seals. Specific seal hunting locations for Iliamna hunters include the waters around Rabbit Island, Eagle Bay, Triangle Island, Flat Island, Knutson Bay, the mouth of the Chekok Creek, Seal Island I, Seal Island III, and Porcupine Island (Figure 5-36). An Iliamna elder reported that his family has hunted seals in the bays around Porcupine Island for more than 100 years. "*There are seals all the way around that island*," said the elder. Iliamna hunters reported that Seal Island I, Seal Island III, Rabbit Island, and Knutson Bay are hunted opportunistically while fishing for spawned-out salmon in the fall.

Specific seal hunting locations for Kokhanok hunters include the waters around Triangle Island, Seal Island I, Seal Island II, Flat Island, Tommy Point, Tommy Islands, Tommy Creek area, Leon Bay, the mouth of the Gibraltar River, and Knutson Bay. Kokhanok residents hunt the area of an ice pressure crack formation extending from Eagle Bay Island in the north to Tommy Point in the south and to Triangle Island in the east during early spring. Seal Island II, located slightly less than 10 miles from Kokhanok, is hunted only by boat in the summer and fall. Kokhanok hunters reported that they normally travel at least 20–30 miles roundtrip by skiff to hunt seals from Kokhanok, and between 20–60 miles roundtrip when hunting by snowmachine.

Specific seal hunting locations for Newhalen hunters include the waters west of Porcupine Island, the waters surrounding Flat Island, Triangle Island, Seal Island I, Rabbit Island, Eagle Bay, Eagle Bay Island, Tommy Point, Tommy Islands, Squirrel Point, Knutson Bay, and Seal Island II. Newhalen residents hunt the area of an ice pressure crack formation extending from Millets Point in the north to Squirrel Point in the south during spring. In contrast, specific seal hunting locations for Pedro Bay hunters are surrounding islands and nearby inlets in vicinity to the community and include the waters of and ice pressure cracks forming around Pedro Bay, Porcupine Island, the Little Chutes and Big Chutes nearby Pedro Bay, and Lonesome Bay.

Hunters from Igiugig and Levelock hunt seals in the northeastern portion of the lake but extend their seal hunting areas to include waters directly in the vicinity of Igiugig, at the extreme southwestern end of the lake, and inside the Kvichak River. The specific seal hunting locations for Igiugig hunters include the mouth of the Kvichak River, inside the Kvichak River, Seal Island I, Seal Island II, and the waters surrounding Flat Island, Knutson Bay, and around the mouth of the Newhalen River (Figure 5-37; Figure 5-38). Similarly, while Levelock hunters generally hunt seals in the lower half of the Kvichak River and into Bristol Bay, they occasionally travel to the northeastern portion of Iliamna Lake to hunt seals. Specific seal hunting locations for Levelock hunters include Bristol Bay, Kvichak River, Yellow Creek, Alagnak River, the nearby Seal Island I, Seal Island II, Flat Island, Tommy Point, and Bristol Bay (Figure 5-37; Figure 5-38). A Levelock elder said that "*a lot of times you'll find them [seals] in the creeks [tributaries of the Kvichak River]. They [seals] know there's fish in there.*" Another Levelock elder explained that Levelock hunters prefer to hunt for seals in Bristol Bay instead of the lake because Bristol Bay is much closer for them.

5.4.ii. Seal Hunting Seasons

It is possible to harvest a seal during any month of the year on Iliamna Lake, but seal hunting seasons depend upon both the environmental conditions of the lake and the preferences of the hunter. For the majority of hunters interviewed (who are mostly residents of the upper lake communities) traditional seal hunting season is spring. However, some households also commonly hunt seals starting in August, after salmon fishing season. Few households hunt seals during the winter months, although some winter hunting does occur (Figure 5-39).

Spring is largely considered the best time for seal hunting because during spring months the lake remains frozen but the weather has become warm enough to open up pressure cracks in the ice for the seals to haul out alongside. Because it is considered easier to harvest a seal and easier to travel on solid ice than in a boat, in which one must negotiate constantly changing water conditions, most hunters prefer traveling on the ice

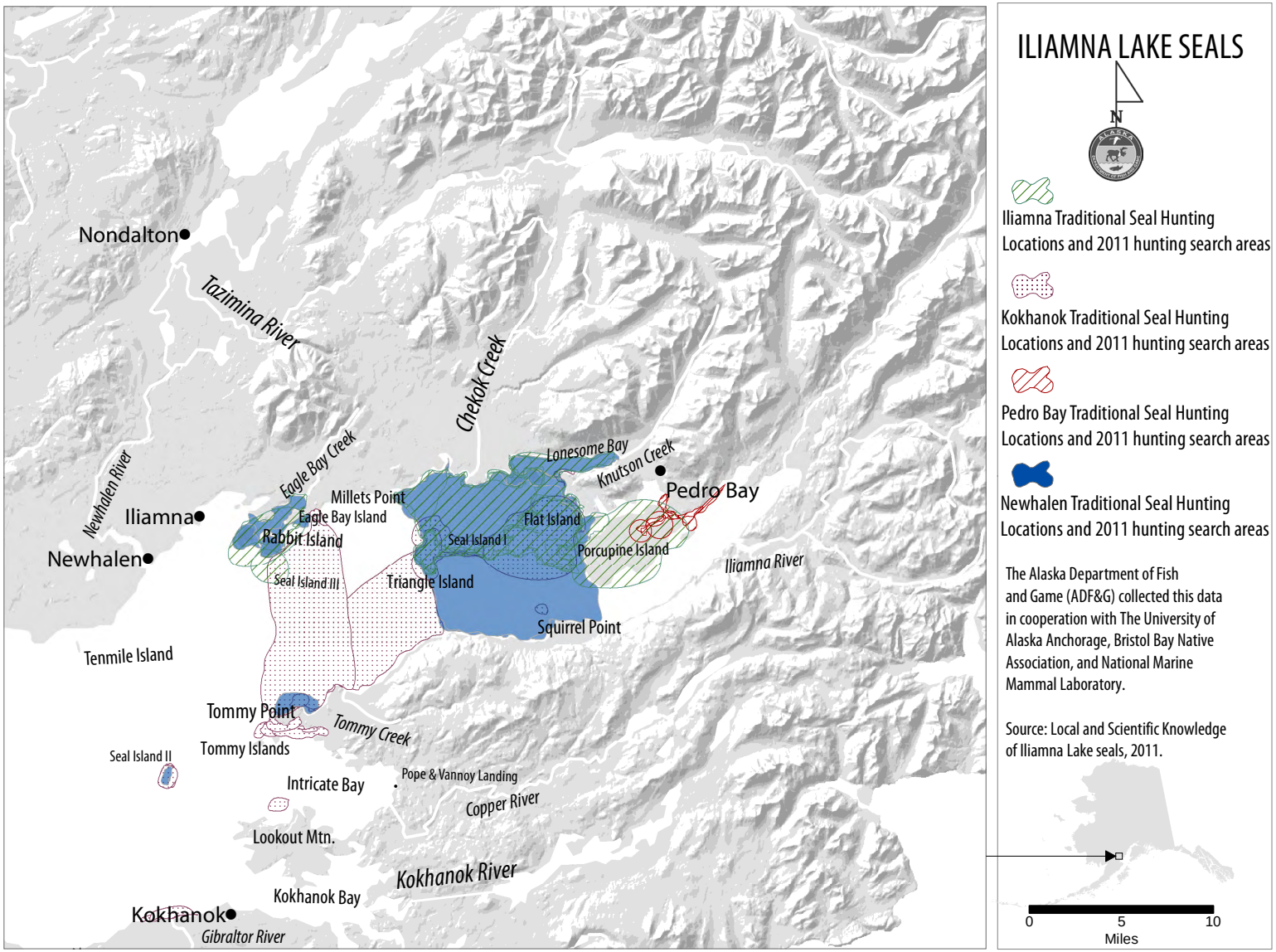

Figure 5-36.–Traditional seal hunting locations for the communities of Kokhanok, Pedro Bay, and Newhalen, as identified in ethnographic interviews for 2011.

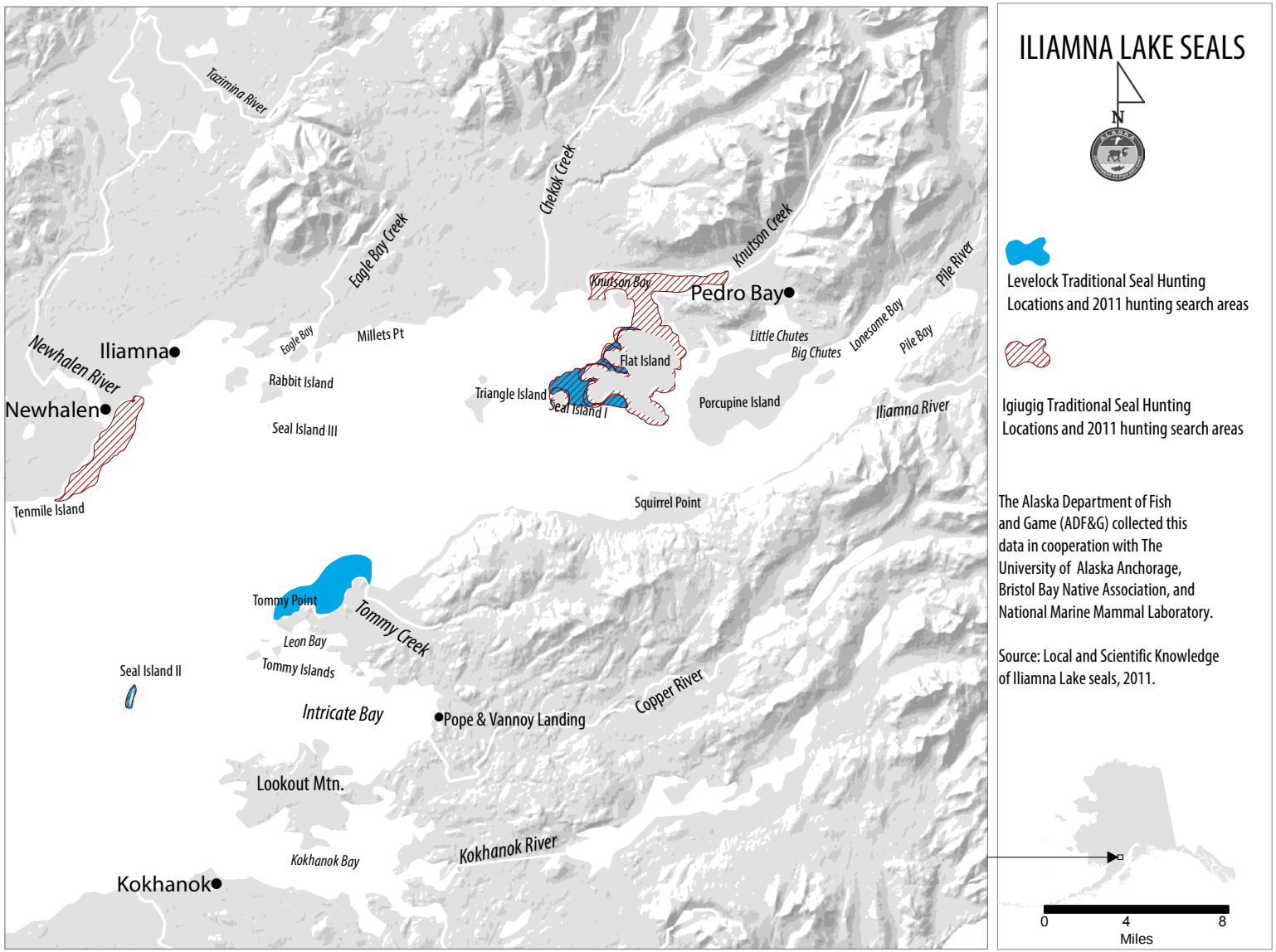

Figure 5-37.–Traditional seal hunting locations in Iliamna Lake for the communities of Levelock and Igiugig, as identified in ethnographic interviews for 2011.

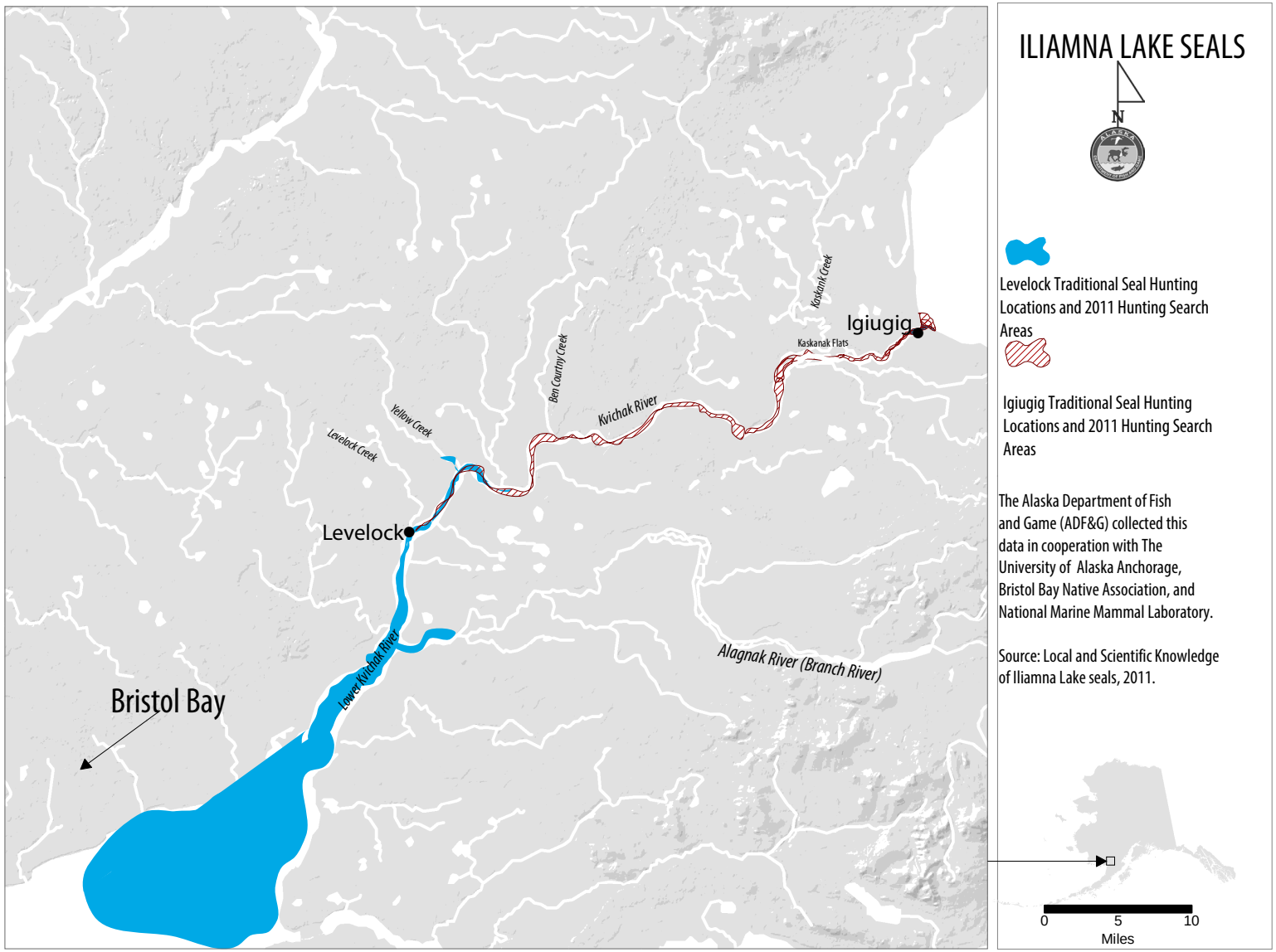

Figure 5-38.–Traditional seal hunting locations in the Kvichak River for the communities of Levelock and Igiugig, as identified in ethnographic interviews for 2011.

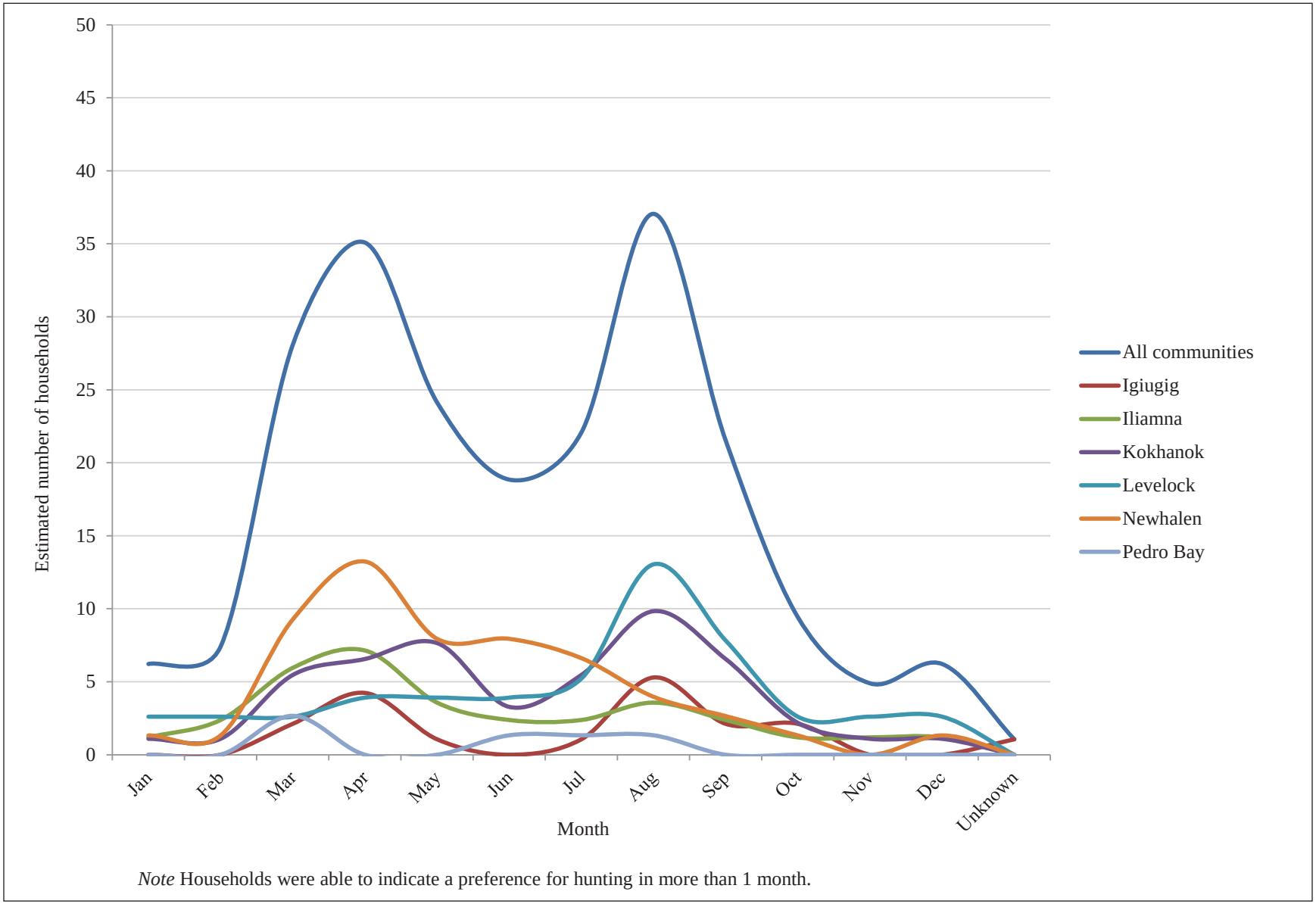

Figure 5-39.–Estimated number of households preferring to hunt seals in a given month, study communities, 2011.

with a snowmachine or ATV compared to hunting by boat on the open water. While some hunters reported seal hunting as soon as the first major pressure cracks open up in the ice, which can be as early as the second week of March, other hunters reported that they normally begin hunting in April when more pressure cracks are open and there is a better chance that seals will be visible. A Kokhanok hunter reported a preference to begin hunting as early as possible in order to take advantage of a time when the hunting pressure on the lake is lower than later in spring when Newhalen hunters begin hunting:

> *Right now [March] is when I like to go, when the pressure cracks are still fairly closed, because once they start opening up more, the other side of the lake they [Newhalen hunters] are out every day and they [seals] get spooky, so it's hard to get 'em.*

Conversely, an Iliamna elder explained that he always waits until April to hunt seals because "*it's got to be warm enough for the pressure cracks to start opening up so the seals are on top of the ice and available*." Some hunters reported hunting seals on the ice into May but that as the ice begins to break up the hunting can become more dangerous. If hunters have not harvested a seal by breakup some will begin hunting by skiff around June on the open water. An Iliamna elder explained that if he does hunt seals during June he does not do so during the first 2 weeks of the month because the mothers are still pupping during early June. Still, most hunters prefer to hunt on the ice and mostly refrain from hunting when the ice gets too thin for safe travel. Many hunters also prefer to hunt seals in the lake in spring because seals are generally considered to taste better at this time. An Iliamna elder explained that during winter the seals eat freshwater fish, such as trout, and that the consumption of those fish does affect the taste of their flesh and oil, as does a diet of salmon.

While some summertime hunting does occur, as noted earlier, Iliamna Lake hunters generally avoid hunting seals in summer because seals become very fishy in taste during this season as a result of heavy feeding on salmon, particularly during July and August. For example, a Newhalen elder said, "*When they [seals] start eating salmon they taste fishy. It's best time to get it [seals] in springtime, May month, before they start eating too much fish.*" Another Newhalen elder explained that, as a result of seals eating large amounts of salmon, seal meat in later summer becomes very strong in taste, similar to the taste of bears that eat salmon. "*Nobody hunts seals summertime, springtime only. Certain time we hunt certain animal, during certain month. Like black bear when they are eating blueberries, falltime. [Summer] it's not time [to harvest a seal]. They don't waste a good seal for nothing*," said the elder. Newhalen hunters also explained that during summer community members are very busy with catching their own salmon for subsistence and thus for this reason do not bother with hunting seals at this time.

After the salmon runs have passed, seal hunting becomes an important activity for some hunters during the fall months. "*If I don't get one in the springtime I go in October,*" said a Newhalen hunter. Likewise, a Pedro Bay elder said, "*We always get one [a seal] in the fall, best time to hunt seals is in the late fall and October,*" and a Pope-Vannoy hunter said he preferred to hunt seals during "*late fall, [because] that's when they're first starting to get thick and you're more apt to see them.*" A Newhalen hunter said that it was traditional for his family to hunt in both spring and fall. "*We do an early spring hunt before the pups are born, we get one [seal] there, and one in the fall.*"

Hunters who attempt to harvest seals on the Kvichak River are especially active in fall. An Igiugig elder explained that even though seals caught in the fall taste more like salmon than the ones caught in the spring he often hunts seals in the Kvichak River during fall because seals appear more often in the river at this time and it is closer to home. "*Falltime, then we hunt the river and don't have to go way up there [north end of the lake] because they [seals] are traveling on the [Kvichak] river and that's where they catch them,*" said the elder. Seal hunting by Levelock hunters also often occurs in fall. Levelock hunters explained that this is because falltime is when seals are the most abundant in the Kvichak River. Levelock hunters said that they normally hunt seals during the short time between the commercial fishing season and the moose hunting season. A Levelock hunter said that he also always hunts seals opportunistically while traveling by boat during the fall moose hunting season, especially during September.

Following freeze-up, few Iliamna Lake hunters attempt to hunt seals during mid-winter. Hunters explained that it is possible to hunt seals during winter but that it is very difficult to find seals or open water during winter. "*You got to be really lucky to find a seal in mid-winter,*" said a Newhalen hunter. An Iliamna elder said that while seal hunting during mid-winter was not done every year, traditionally it was done during times when pressure cracks opened up and community members needed a seal for food. A Pedro Bay elder reported harvesting a seal at a pressure crack during winter near Pedro Bay once. The elder said that he harvested the seal in February or January, but could not recall the exact month. Most Iliamna Lake hunters wait until spring for the ice to open up more consistently before they begin hunting seals.

Exact hunting locations within the upper portion of the lake change with the seasons; during winter and spring when the lake is frozen seals are hunted at pressure cracks, which are formed in locations where seals are not found when there is open water. For example, Figure 5-40 and Figure 5-41 show search areas by season for the different communities. While most respondents said they refrain from hunting seals during the salmon run because of the strong fishy taste of seals harvested then, Igiugig respondents reported that they actively hunt seals during the summer months. An Igiugig elder said that "*[We] hunt where most of the fish are located, so it would be next to streams and around the islands and bays.*" This explains the pursuit of seals near the mouth of the Newhalen River during summer. Regarding the northeastern portion of the lake, an Igiugig elder said, "*There was always good hunting up there, [at the] upper end of the lake where all them islands are*" but that in recent years he had not traveled long distances to hunt seals and instead had been hunting "*just here on the [Kvichak river], I haven't hunted back up on the lake for about 5 years now.*"

5.4.iii. Open Water and Island Hunting Strategies

Most Iliamna Lake seal hunters hunt seals both on the ice and by motorboat on the open water. While many hunters prefer hunting seals on the ice, some seal hunters prefer to hunt only by boat. Pedro Bay respondents reported that hunters from their community hunt only by boat and never on the ice because persistent open water and thin ice in the Pedro Bay area during winter makes it too difficult to travel on the ice. Hunters from other communities also voiced a preference for hunting seals by boat. These hunters cited ease of travel, ease of access, easier stalking, and easier shooting when boat hunting compared to hunting on the ice. For example, a Pope-Vannoy hunter said:

> *You probably have more of a chance to get a seal with a boat. You don't have to be quite as sneaky. When the seal is just sitting out on the ice they have a pretty good view and they are, I think, more leery of things coming close to them, whereas if just their little head is sticking out they maybe feel a bit safer.*

Hunters who avoid hunting seals in open water do so because lake conditions are often unpredictable and dangerous as a result of bad weather, making for inefficient and cumbersome hunting trips. A Kokhanok hunter who prefers hunting seals on the ice and normally avoids hunting seals by boat explained:

> *Mainly it is weather. The lake is more dangerous than the ocean in bad weather. The lake is very, very choppy and the waves are not uniform like the ocean, all of the islands create different disturbances and the white caps are crisscross and closer together making for difficult boating conditions. It can't be windy for boat hunting.*

In order to avoid dangerous lake conditions, and to have the best chance of harvesting a seal in open water conditions, Iliamna Lake seal hunters limit their boat hunting activities to days when the weather is calm and the waters are generally flat.

The basic strategy employed by seal hunters traveling by boat is to search for seals along the shores of islands, shallow-water reefs, and sandbars. Seals can be found hauled out in these places, and on beaches and rocks. When pursuing this strategy Iliamna Lake seal hunters will either hunt from their boats or they will disembark from them and stalk seals on an island by foot. It is considered optimal to find seals that are hauled out rather than in the water because they are easier to shoot and easier to retrieve on land. An Iliamna elder explained that, when there is open water, the best strategy for locating hauled out seals is to arrive

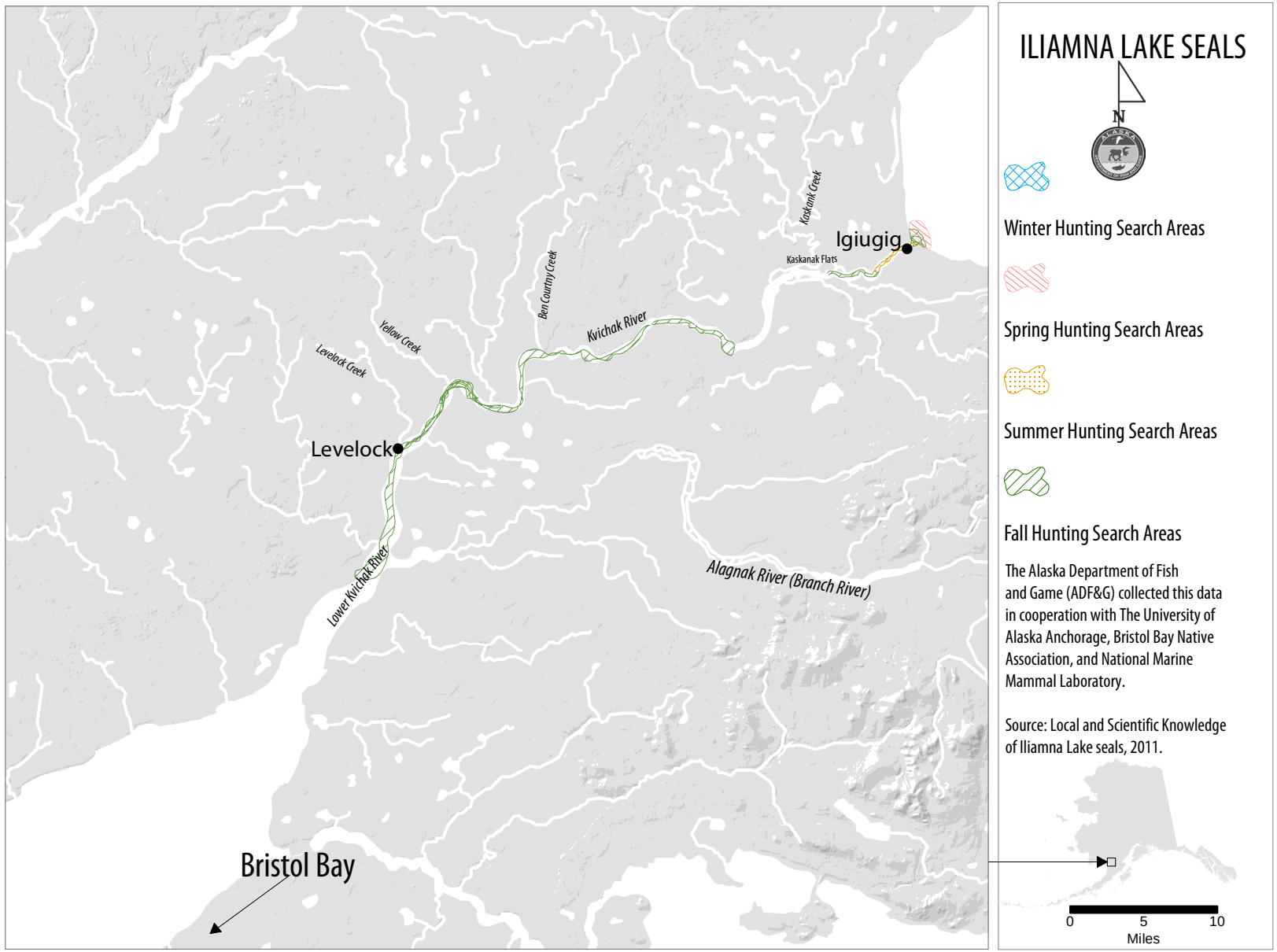

Figure 5-40.–Traditional hunting areas in the Kvichak River, separated by season, study communities combined.

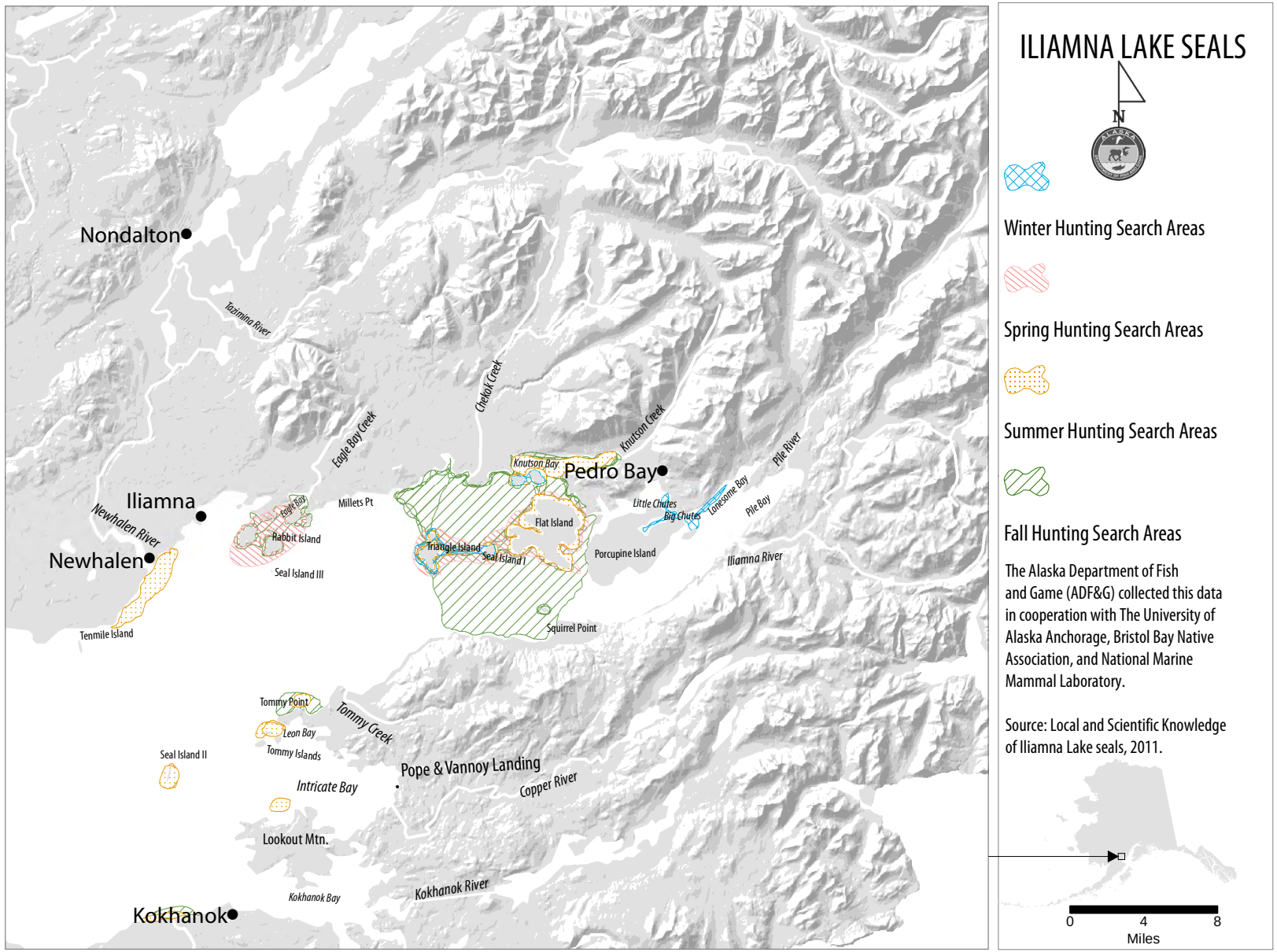

Figure 5-41.–Traditional hunting areas in Iliamna Lake, separated by season, study communities combined.

at a haul out location very early in the morning before any seals have hauled out. Because seals generally only haul out in the sun or during midday, the hunter can then wait in silence for seals to haul out. "*Look for them on the reefs, hauled out, and [you] need to know how to wait for them*," said the elder. Sometimes hunters wait on the land within shooting distance of a known haul out location and other times they will wait in their boats for a seal to appear. A Newhalen hunter reported that when he finds seals hauled out on an island he can usually drive right up to the seals and shoot one because they "*normally freeze in place*," allowing for an easy shot. In contrast, an Iliamna elder said that he prefers to shoot a seal when it is lying on shore with its eyes closed because if a seal sees the hunter it will dart into the water. A Pope-Vannoy hunter said, "*When you come with a boat they'll hop off the gravel bar and just sort of swim around*," and thus a seal will be easily shot in the water.

While locating a hauled out seal is optimal, Iliamna Lake seal hunters also try to locate seals in the water along reefs, sandbars, and in shallow bays. For instance, an Igiugig elder said, "*We'll go to any of the islands and just wait. We'll just wait and see if anything pops up*," and a Kokhanok hunter said, "*We just go to [Seal] island. They'll [seals] swim around the island*." Most respondents said that seals in the water are very alert and will thus disappear quickly if they become aware of human hunters traveling in a boat. An Iliamna elder explained that when the water first opens up seals are wary, but that during fall after the seals have been feeding heavily on salmon they are more lethargic and much easier to harvest:

> *Springtime they are spooky as can be, you can hardly get close to 'em, even just in passing. You'll see just this movement into the water before you can get there. In the falltime they're just laying out there like 'who cares?'… . They can't even move because they're so fat.*

Seals will normally dive when they become aware of human presence but eventually they must come back up for air. A Pope-Vannoy hunter explained that when a seal comes back up for air it will be shot: "*Usually if I see a seal and it's in an area where the water is shallow enough I'll just slowly coast to where I've seen it and stop the motor and just wait for it to come up for air again. Then I'll use a gun to shoot it.*" Likewise, a Newhalen hunter said: "*When you see them go down, you go slow, then you turn your engine off, and then they usually pop up within 50–80 yards of the skiff and then you have a pretty good shot.*"

Respondents explained that the most critical rule for an open water seal hunter to follow is to not shoot a seal in deep water where the seal can quickly sink and thus become irretrievable. "*You might see them [seals] in deep water and you could kill them but you can't get them because the water is too deep*," said a Pedro Bay elder. For this reason, Iliamna Lake seal hunters only hunt seals in shallow waters of less than 20 feet in depth. An Igiugig elder said that if a seal is located it depends upon the depth of the water whether or not the seal will be shot: "*We'll decide, if it's in shallow water then we'll shoot, because [in deep water] they sink right away."* Some hunters said that if a seal is found in deep water they will follow it until it is in shallow water and shoot it there. A Levelock hunter said he actually tries to chase seals into shallow water before harvesting them. Mainly, however, Iliamna Lake seal hunters deliberately search for seals in specific locations known for shallow water. An Iliamna elder explained that local hunters have rich knowledge of which islands and reefs are optimal for finding seals in shallow water:

> *We have to know which islands have shallow water, where reefs are, because when we shoot the seals they sink quickly in the fresh water. You need to know where the reefs are, and where shallow water is. When you kill a seal it won't sink very far and you won't lose the seal.*

Once a seal is located in shallow water the hunter must then focus on shot placement. Respondents explained that it is critical that seals are shot directly in the head, otherwise the seal may be wounded and still be able to get away. "*You get 1 shot. Rarely do you get 2 shots. Wait all day for 1 shot and it must be in the head or it's [the seal] going to waste*," said a Kokhanok hunter. Another Kokhanok hunter said that the shot "*need[s] to hit them right behind the eyeball or in the eye. [If the shot is good] they usually float, but if you don't hit them right then they kind of twitch and then they'll dive.*" A Newhalen hunter said, "*You need to hit a spot about the size of a cork, so you can't miss. If you miss [they will dive and] you won't see them again*

after that." Another Kokhanok hunter said that because of the high risk of wounding and then losing a seal he only hunts seals hauled out on the land and only shoots from land. "*I never shoot from the boat. It rocks too much. I'll just go directly to the island,*" said the hunter.

Once a hunter has shot and killed a seal the seal must be retrieved. Respondents reported that a properly shot seal will normally float for several minutes before it sinks underwater. Thus the hunters must move swiftly to retrieve the seal before it begins to sink. "*You got to go over there real quick and before it sinks you pull it up into the skiff,*" said a Newhalen hunter. Sometimes a seal can be retrieved by hand but usually hunters hook the seal with a line and haul the seal into the boat. To retrieve harvested seals from the water, Iliamna Lake seal hunters use either a large treble hook attached to a rod and reel with heavy fishing line, a pole with a snare attached to it, or a harpoon. An Iliamna elder described his use of a rod and reel with fishing line and a treble hook to retrieve seals from the water: "*I have a weighted 3-prong hook, so if they do go down more than few feet, I can hook it with a line and pull it up to the beach and put it on the boat. I like to hook it on the fins because if you try to hook it on the body, there is so much fat and the hook just slides off.*" The elder said that hooking a seal in the mouth will also secure the seal but that the mouth is a very small target and is difficult to hook.

Hunters reported that a properly shot seal can sometimes float up to up to 5 minutes or more before it sinks. Local knowledge asserts that the more air inside a seal's lungs at the time they are shot the longer they will float. To help facilitate as long of a floating time as possible, and thus ensure the best chance of retrieval, Iliamna Lake seal hunters try to match shot timing with the seal's breathing patterns. A Kokhanok hunter explained: "*Usually we shoot them right when they pop out of the water so they got air in their lungs and they won't sink very well.*" Similarly, an Iliamna elder said, "*When we hunt a seal in the water we shoot the seal after they breathe, the new air stays in their lungs and they'll stay afloat for 5 minutes or more.*" The elder also suggested that the more fat a seal has on it the longer it will stay afloat. This is due to the fact that seal blubber is less dense than fresh water, and a seal with air in its lungs and a thick blubber layer is positively buoyant (Biuw et al. 2003). If a seal does sink it is still retrievable providing it is not in deep water. Hunters reported that seals underneath shallow water can be hooked and pulled into the boat. A Kokhanok hunter said that if a shot seal sinks under shallow water and cannot be hooked it will eventually float back to the surface. "*If they sink in 20 feet or less of water the gasses will build up and they'll pop back up after about an hour or so,*" said the hunter. In this case the hunter must wait patiently for the seal to reappear so it can be retrieved. In other cases, when a seal is shot in shallow water close to the shore, hunters can just wait for the tide to wash the seal directly onto the beach

Respondents also said that, when compared to coastal seal hunters, Iliamna Lake seal hunters need to be extra diligent about conducting speedy seal recoveries because seals sink faster in fresh water than they do in salt water. Hunters said that salt water helps lengthen flotation and that coastal seal hunters normally have the liberty of shooting seals in much deeper water than is feasible in fresh water. A Pedro Bay elder who had learned to hunt seals on the ocean, and then later began to hunt seals in Iliamna Lake, said, "*Fresh water treats seals differently here. We learned right away: don't shoot them in deep water, always in shallow water.*" A Kokhanok hunter explained that, although shot seals float longer in salt water, once a saltwater seal does sink it is impossible to recover in the brackish waters of Bristol Bay, whereas the clarity of the fresh water in Iliamna Lake allows a good chance of underwater recovery. "*If you're hunting down in Bristol Bay area the water is so muddy, you can't see them once they sink. In the lake you can see them,*" said the hunter. Still, local knowledge asserts that freshwater seals, which sink in more than 20 feet of water, are usually not retrievable. "*If you're in more than 20 feet of water you aren't going to retrieve it,*" said a Kokhanok hunter. This observation reflects the lower density of fresh water compared to sea water, and the effect of pressure on the volume of air in the seal's lungs. A seal that is positively buoyant in salt water may well be negatively buoyant in fresh water; and as the seal sinks, lung volume shrinks, further reducing the buoyant forces (Biuw et al. 2003; Williams et al. 2000).

Depending on the size of the seal, getting a harvested seal into a boat can present a challenge to hunters. Some respondents talked about the difficulty of getting large seals in their boats. Some hunters reported attaching a line to large seals and towing them by boat to a place where they can be butchered. A Newhalen

hunter said that if a seal looks too large to get into a boat he will not shoot the seal. A female hunter from Pope-Vannoy, who often hunts seals alone, told of her troubles getting retrieved seals into her boat:

> *Actually, it's pretty hard pulling out a seal that's bigger than me. One time I couldn't get it into the boat. It was a little too heavy so I just towed it into shore. You just have to keep tugging and pulling and then if you get part of it in you can maneuver the rest of it. One time I had one sink in about 12 feet of water and I had to attach a snare to an oar and I just spent the longest time just trying to get it just right and it took about an hour before I got it. Because, besides getting the oar in I had to get my arm all the way into the water over the side of the boat so I could get down close enough to where I could get the snare around it. That was the hardest time I ever had, on that occasion, to get one up from the bottom.*

While hunters work their hardest to retrieve the seals they shoot, wounding loss of seals in Iliamna Lake does occur and Iliamna Lake hunters have developed strategies to mitigate instances of wounding loss whenever possible. As discussed above, the most important strategy Iliamna Lake hunters employ is proper shot placement and following a strict rule to only shoot seals in acceptably shallow water. "*I don't shoot it out in the deep*," said a Newhalen hunter. A Pedro Bay elder said that a negative experience of losing a seal shot in deep water made him pay more attention to water depth before making the decision to shoot a seal:

> *Once we shot a seal in deep water in the lake. We stopped the motor and waited for it to come up, but when we got there the seal was already 20 feet down and we were losing it. We felt bad about it so we changed our hunting, don't shoot one in deep water anymore.*

The elder said that he also made it a point to never shoot seals in the water from long distances. A Kokhanok hunter explained that elders had always passed on knowledge about assuring the successful retrieval of seals to younger hunters. The hunter said that "*a long time ago they were patient, they waited before they shot. The elders made them wait until they were 20 feet away to make sure you got them.*" The hunter expressed concern that younger hunters today are not being patient and are not following these traditional teachings.

Other hunters discussed the importance of having in-depth knowledge of water conditions and water depths in the lake, especially the intricacies of the many island systems, reefs, and sandbars of Iliamna Lake. For example, both Seal Island II and Tommy Point are popular seal hunting areas, but hunters must know where to find waters of proper depth for seal hunting in these locations. A Kokhanok hunter explained:

> *If you catch it [a seal] on the west side of the island [Seal Island II], it's deep water, if you catch it on the east side of the island its shallow water. So that's where we shoot them on the east side. So what we want to do is come in from the west, because of the depth of the water, because if it sinks you'll be able to retrieve it with a hook and line. But for Tommy Point you want to look for seals on the south side because it is shallower there.*

Respondents reported a few other struck-and-lost mitigation strategies. For instance, an Igiugig elder continues to carry a harpoon in his boat and discussed the fact that the ancient practice of harpooning a seal usually always led to successful retention of the seal because the harpoon point remained attached to a line from the instant the seal was struck. The elder said that today after shooting a seal he tries to immediately harpoon it. "*You can shoot them and then harpoon them*," said the elder. An Iliamna elder said that he normally prefers to avoid any chance of wounding and losing a seal by not hunting from a boat and by only shooting hauled out seals from the land:

> *I shoot them from the land. Once in the great while, shoot from the boat, but it is too easy to lose the seals, because they get into the deep water. We won't be able to get them. I am very careful about making sure I shoot from the land while they are sleeping or resting so that they either die in shallow water, or on the rocks, or gravel bars.*

5.4.iv. Ice and Pressure Crack Hunting Strategies

Many Iliamna Lake seal hunters hunt seals on the ice. Beginning in early spring, when the lake remains

frozen and the pressure cracks have started to open up, hunters will travel the ice by snowmachine or ATV in search of seals. Several hunters reported a preference for hunting seals on the ice versus seal hunting on the open water. Some of the hunters who prefer hunting on the ice versus open water said that when they are in a boat they only hunt seals opportunistically, attempting to harvest a seal only if they see one, but that when they go out on the ice they are intentionally hunting for seals. Some hunters prefer hunting on the ice but if they are not successful in the spring they will continue to intentionally hunt on the open water as the weather warms up. "*If I don't have no luck, I just wait till the ice goes out [and hunt by boat],*" said a Newhalen hunter.

The reasons these hunters cited a preference for hunting seals on the ice include ease of transport and access, easier hunting, easier retrieval, and safety. Hunters said that the advent of snowmachines and ATVs for lake ice travel allowed for the most efficient and direct means of traveling on the lake ice for seal hunting. These hunters said that prior to the adoption of ATVs and snowmachines travel on the ice by foot or dog team was tedious and thus during those times boat travel was preferred. However, this was no longer the case for hunters who own a snowmachine or ATV. Moreover, some hunters voiced an opinion that ice hunting is safer than boat hunting because Iliamna Lake waters often present precarious travel conditions for watercraft. "*We'd rather go by snowmachine because it's safer at that time,*" said an Igiugig hunter.

Some hunters reported that seals are much harder to kill on the ice than in the water because they are more aware of their surroundings and can see much farther than when they are in the water. These hunters said that stalking a seal on the ice is very difficult, and that it requires a hunter to move slowly and patiently over the ice on foot for long distances, and that ice hunting requires that a hunter take a long-distance shot at a seal in order to avoid startling the group. These hunters said they preferred hunting by boat because a hunter can get closer to the seals and shoot a seal at a more comfortable distance on the open water than on the ice. However, some hunters who prefer ice hunting disagreed and reported that it is easier to harvest a seal on the ice than in the water. For example, an Iliamna elder said: "*They like to sit there in the sun. You'll see 20–30 of them outside a pressure crack. That's when we like to hunt them when they're out on the ice. Then you can get them easy.*"

Although some hunters voiced an opinion that hunting by boat is more dangerous than hunting on the ice, most hunters interviewed felt that seal hunting on the ice is very dangerous. The main reason these hunters consider ice hunting dangerous is because the formation of pressure cracks in the lake ice during spring does not only mean that seals will begin appearing on the ice, it also means that the lake is beginning its annual break-up phase. As the spring ice hunting season progresses the ice becomes weaker and pressure cracks increase in number and size (respondents referred to the weakening ice as "*honeycomb ice*"). For these reasons, Iliamna Lake seal hunters are very wary of deteriorating ice conditions on the lake during the spring hunting season. Hunters have witnessed the ice breaking apart under the weight of a snowmachine and at least one Iliamna Lake seal hunter has fallen through the ice. A Newhalen hunter said that in 2007 his hunting partner fell all the way through the ice while riding on a snowmachine. The respondent said that at first he considered tying a rope to his snowmachine and swimming out in the water to retrieve his partner. This was unnecessary, however, because, as some Iliamna Lake seal hunters do in the case of an emergency, the respondent was carrying a handheld VHF radio and was able to call in a helicopter rescue from the Iliamna airport. Because of these dangerous hunting conditions Iliamna Lake seal hunters try to abide by a rule to always hunt with at least one partner. "*It's dangerous, you don't want to be on that ice by yourself,*" said a Newhalen hunter. Another Newhalen hunter said, "*We don't go out alone. We always go with somebody. [If you don't] you might not return.*"

Because of these safety issues the first step a seal hunter must take before hunting on the ice is making an evaluation of the thickness and stability of the ice. Many hunters prefer using ATVs for ice travel but some prefer snowmachines. A Newhalen hunter who hunts seals on the ice with an ATV said that he does not hunt seals until he knows that the "*ice is thick enough for a Honda.*" Because ATVs weigh more than snowmachines, ATV use requires thicker ice. After evaluating the thickness of the ice the hunter then decides whether to use a snowmachine or an ATV for hunting transport. A Newhalen hunter explained:

> *First it depends on the condition of the ice. We go out and check the ice first to see if it's still thick and will it be able to hold us up and then we decide on either snowmachine, which has more ladder space and less weight, or a Honda, which has more weight than a snowmachine.*

Not only does seal hunting on the ice require specific ice conditions, weather conditions also affect the viability of an ice hunt for seals. Hunters from the study communities reported that sunny and calm weather affords the best chance of seals emerging from pressure cracks to haul out on the ice. For example, a Pope-Vannoy hunter said, "*I just pick a nice, sunny, warm day. Although I have seen them out without the sun too, they just seem to like to come out in the sun. They'll just lounge around with their flippers up when they come out on the ice.*" Another Kokhanok hunter said that when the weather is overcast he does not bother hunting at all because the seals do not tend to haul out. The hunter reported that during overcast conditions it is "*too hard to find them.*" Hunters reported that the more powerful the sun the better the chance of finding seals on the ice. Hunters said that because the sun is strongest in afternoon it is usually the best time to hunt seals. For this reason a Pope-Vannoy hunter explained that she normally begins seal hunting on the ice during "*early afternoon, so the sun has time to get a little bit of power to it. In the morning it can still be a little bit cold so if you wait till afternoon it's better [because there is greater chance of finding seals].*" These observations fit with the optimal times to count harbor seals since warm, sunny afternoons are the time when the largest fraction of the population is hauled out (Bengtson et al. 2007; Simpkins et al. 2003).

Once hunters feel that the lake ice is thick enough for snowmachine or ATV travel, and that the weather conditions are acceptable, they will set out in search of seals hauled out alongside open pressure cracks. Some hunters will travel to high bluffs on the lakeshore or on islands in order to obtain an expanded view of the lake. Hunters use binoculars to scan the ice for seals. An Igiugig elder explained how he traveled from Igiugig to the northeast end of the lake to hunt seals on the ice:

> *I used to leave in the morning on a snowmachine … I leave here in morning when it's daybreak and I'll get up maybe 30 or 40 miles up on the lake and then I'll stop on an island and start getting my binoculars out and start watching and then if I don't see anything I'll move to another island where the pressure cracks are a little bigger and I'll watch again and then I'll follow the pressure cracks until I find a bunch of seals. And then I'll sneak up to them and see if I could get them.*

Hunters must approach hauled out seals carefully in order to avoid startling the seals. Hunters reported that seals are easily startled by noise from an ATV or snowmachine motor. A Kokhanok hunter said that hunters with 4-stroke motor snowmachines have an advantage because these motors are less noisy than a 2-stroke motor. "*It gets you closer,*" said the hunter. Either way, a successful ice hunt often requires a carefully planned stalk by the hunter. "*You have to park far away and then get close to them,*" explained a Newhalen hunter. A Pope-Vannoy hunter reported crawling on the ice for over 1 mile in order to avoid startling a seal and thus successfully harvest it. It is also possible for seal hunters to employ a still hunting strategy where the hunter waits at a location where seals are known to appear. An Iliamna elder explained: "*You go to one of those places where they haul out and you sit and wait and when they haul out you shoot them. Or if they're on the ice when you go out there you have to crawl up on them some way.*"

Stalking requires calm and calculated movements. "*When we hunt on the ice, you got to make sure, you can't do a lot of movement and stuff like that. They have very good vision,*" explained an Igiugig hunter. "*They got good eyesight, for a mile …, yeah, they'll see you from a mile away easy,*" said an Igiugig elder. A Kokhanok hunter recalled a time when he could not even stalk to within 400 yards of hauled out seals before they startled and jumped back in the hole. An Igiugig hunter explained that not only do seals have excellent vision, they also have good hearing, and thus successful ice hunting requires patient and thoughtful stalking: "*We know they can hear us and we try to minimize them seeing us move. Like last year, we shot from an island onto the ice, about 250 yards, and we were moving just a little too much and they started to go into the hole and I had caught mine just before it went in.*" In order to avoid their movements being sensed by hauled out seals, Iliamna Lake seal hunters try to use terrain features for cover while stalking and shooting. "*Shooting from an island bluff is easiest because you're out of their field of view,*"

Photography by Jim Tilly, Pope-Vannoy Landing

Plate 5-4.–Pope and Vannoy Landing hunter Marlene Tilly with a seal harvested in April 2012 at Intricate Bay, Iliamna Lake.

said an Igiugig hunter. A Kokhanok hunter explained that he often uses the ice on the high side of a pressure crack for cover: "*If the pressure cracks are high I'll use that to my advantage. I jump on the other side of the pressure crack and run along it and then when I get close to them [seals] I'll get off [the snowmachine] and I'll start sneaking up to them by foot, just to get as close as you can.*"

Some Iliamna Lake seal hunters also wear white clothing while seal hunting on the ice in order to camouflage their movements (Plate 5-4). An Igiugig elder said that the seals "*watch all the time when you're out on the ice, they spot you a long ways away and dive down, you got to have white clothes on to sneak up close enough to shoot it.*" A Pope-Vannoy hunter told a story about a successful stalk while wearing white attire:

> *I had to sneak out on the ice. I was wearing lots of white clothing and there was about 20 of them on the ice and I just concentrated on one particular one that seemed to be the one doing most of the observation and when it got really nervous that's when I laid down on the ice and put a little bit of snow where the barrel of my gun could rest and then I just had the perfect shot.*

Hunters also explained that when a group of seals hauled out on the ice near a pressure crack becomes startled all at once a bottleneck can develop as the seals scramble chaotically to escape into the water. This bottleneck provides a good opportunity for a hunter to take a shot because some of the seals will be stuck outside the pressure crack with no chance of escape. A Kokhanok hunter reported that wolves are also very successful at seal hunting when their predatory movements cause such a bottleneck.

Because of the difficulty of approaching seals at close distances, successful hunting often requires long-distance marksmanship. Some hunters reported stalking and shooting seals at distances as close as 100

yards. A Newhalen hunter said that he would not shoot a seal on the ice unless he could stalk to within 150 yards of the seal. Other hunters reported shooting longer distances. A Kokhanok hunter reported that when using a high-caliber rifle he will take a shot at a seal from between 300–500 yards away. No matter the distance, successful seal hunting on the ice requires excellent marksmanship because if a seal is not hit directly in the head, and thus killed instantly, it will often quickly escape into adjacent open water. For example, an Igiugig elder said, "*You gotta make sure you shoot good and make sure you shoot to kill so you don't lose it,*" and a Kokhanok hunter said, "*If you don't hit them right in the head and you don't kill them right away and if they're right next to the pressure crack they'll roll in there. I lost a couple like that before.*"

Hunters reported that seals are sometimes struck and lost while ice hunting. Some hunters reported that there is a greater chance of losing a struck seal on the ice than there is while hunting on the open water. A Pedro Bay elder said, "*They are always pointed towards the hole and they're never far from it,*" and an Iliamna elder said "*If you don't hit the seal in the head and stop it cold it's sitting right next to an open hole and one little hop and it's in the water.*" Hunters reported that, in contrast to retrieving a struck seal in open water conditions, retrieving a shot seal that has escaped into a hole in the ice is very difficult. "*It's not hard to lose them in a pressure crack because it's so deep out there and the pressure crack is only [so] wide and if they go 2 feet that ways [under the ice to one side] you can't get them,*" explained a Kokhanok hunter. Another Kokhanok hunter concurred, but said that in some cases it is possible to retrieve a struck seal that has dived into a pressure crack:

> *If you don't head shoot them you are going to hit them in the body and then they're going to get in the water and die and then a lot of time you can't get them out of the water, they'll get down and swim away and just die. But a couple of times I've shot them and you looked in the pressure crack after the blood went away and you could see them and you could get a hook and hook them.*

A Pedro Bay elder said that losing seals that he had shot in this manner had been one reason why he has retired from seal hunting: "*You have to kill them right away, one shot or they'll get away. That's part of the reason I quit hunting them. It's too big of a waste. Lots get away.*"

Some hunters reported that when a seal is successfully killed and retrieved from an ice pressure crack location on Iliamna Lake they must wait some time before they return to the same location to hunt because the seals will avoid hauling out at that location after a harvest has taken place there. "*Once you get a seal there [at a specific hole] they know, they smell the blood. They just don't come back there,*" explained a Newhalen hunter. For this reason the hunter said that each year he finds new pressure cracks to hunt at. The hunter also said that, because the population of seals on Iliamna Lake is small, all of the seals tend to become cautious for a time after a seal harvest has occurred and thus tend not to haul out on the ice as frequently. For this reason, the hunter reported that in order to have the best chance he refrains from hunting for a few days after another hunter has harvested a seal. "*If somebody caught one I just wait a couple of days,*" said the hunter.

5.4.v. Opportunistic Hunting Within Iliamna Lake

Iliamna Lake residents were asked whether seal hunting is normally approached as a pre-planned, *specific* activity, as an *opportunistic* activity, or *both*. Most respondents from the study communities (48%) reported that seal hunting is both a specific and an opportunistic activity for them (Table 5-27). A minority of households reported that seal hunting is only approached specifically (19%), while 33% of households reported that seal hunting is only approached opportunistically.

Specific, pre-planned seal hunting mostly occurs during the spring months when Iliamna Lake seal hunters hunt for seals on the lake ice. Random, opportunistic seal hunting occurs when community members are traveling the lake with boats during the open water months or when traveling by snowmachine across the lake in the winter. Community respondents reported that opportunistic seal hunting occurs while ice fishing, berry picking, moose hunting, fishing, egg gathering, getting firewood, traveling from point A to B, or simply going for a boat ride (a detailed list of all activities, broken down by community, is provided in Appendix

Table 5-27.–The proportion of responding households that described seal hunting activities as opportunistic, targeted, or both, study communities, 2011.

Community	Sampled households	Did not respond (missing)	Total households	Households describing seal hunting as: Opportunistic Number	Opportunistic Percentage	Specific Number	Specific Percentage	Both Number	Both Percentage
All communities	**151**	**88**	**63**	**21**	**33.3%**	**12**	**19.0%**	**30**	**47.6%**
Igiugig	17	8	9	5	55.6%	1	11.1%	3	33.3%
Iliamna	21	16	5	1	20.0%	2	40.0%	2	40.0%
Kokhanok	43	26	17	4	23.5%	3	17.6%	10	58.8%
Levelock	23	11	12	7	58.3%	2	16.7%	3	25.0%
Newhalen	34	17	17	4	23.5%	3	17.6%	10	58.8%
Pedro Bay	12	9	3	0	0.0%	1	33.3%	2	66.7%

Source ADF&G Division of Subsistence household surveys, 2012.

I). For instance, Kokhanok respondents reported that seals are sometimes harvested opportunistically while gathering seagull eggs on islands and sandbars from late May through early June and Newhalen and Pedro Bay hunters reported sometimes opportunistically harvesting seals during fall while fishing for spawned-out salmon in Knutson Bay. A Newhalen hunter discussed opportunistic seal hunting while gathering firewood and said "*getting wood, same time if I see a seal, if I like it, I'll kill it.*"

Another reason seal hunting occurs opportunistically is because the high cost of fuel often prohibits hunters from only pursuing 1 subsistence resource or 1 motorized travel activity at a time. In order to use fuel as efficiently as possible hunters are often prepared to pursue any type of subsistence resource that becomes available to them while traveling. Additionally, efficiency of effort is an important consideration, because seals seen in the open water are often difficult to find again once they dive, thus even if a seal is observed it may not be pursued. This can especially be true for seal hunting in the Kvichak River, where opportunistic seal hunting is the norm and intentional seal hunting is rarely pursued. For example, a Levelock elder said, "*We never go out of our way to go get them [seals]. Sometimes we see them and just let them go. It's real hard to get them down here [lower Kvichak River].*"

The locations where opportunistic hunting occurs (Figure 5-42)—delineated by Knutson Bay on the north, Triangle Island on the west, Squirrel Point to the south, and Porcupine Island on the east—are not markedly different from the pre-planned seal hunting areas mapped by community respondents in Figure 5-40 and Figure 5-41. However, it is notable that opportunistic seal hunting in the Tommy Point and Lookout Mountain areas extends further to the east and further into open water than do the pre-planned hunting areas mapped in Figure 5-36 and Figure 5-37. This reflects extensive boat travel by local residents in those areas of the lake for activities other than seal hunting.

5.4.vi. Harvest Selection Considerations

Some Iliamna Lake seal hunters selectively harvest seals with particular physical characteristics. These hunters target seals of preferable color, body size, and sex. Hunters who expressed a color preference said that they normally attempt to harvest seals light or white in color. Most of the hunters who expressed a preference for light-colored seals said that the larger, older seals tend to be the lightest in color, and thus they attempt to harvest the largest seals. These hunters also prefer the largest seals because they yield larger-sized skins. For these hunters obtaining a desirable seal pelt is an important consideration when selecting a seal to harvest. Other hunters said they do not necessarily prioritize pelt quality when selecting a seal to harvest but that when given the choice they will also choose to harvest seals lightest in color. For example, a Pope-Vannoy hunter said, "*Usually color does not matter too much but if they're out on the ice where I can see their full color I try to get a really light-colored one.*" Some of the hunters who target lightly colored seals said that the pelts of younger seals are not fully developed and thus tend to be darker in color. Some

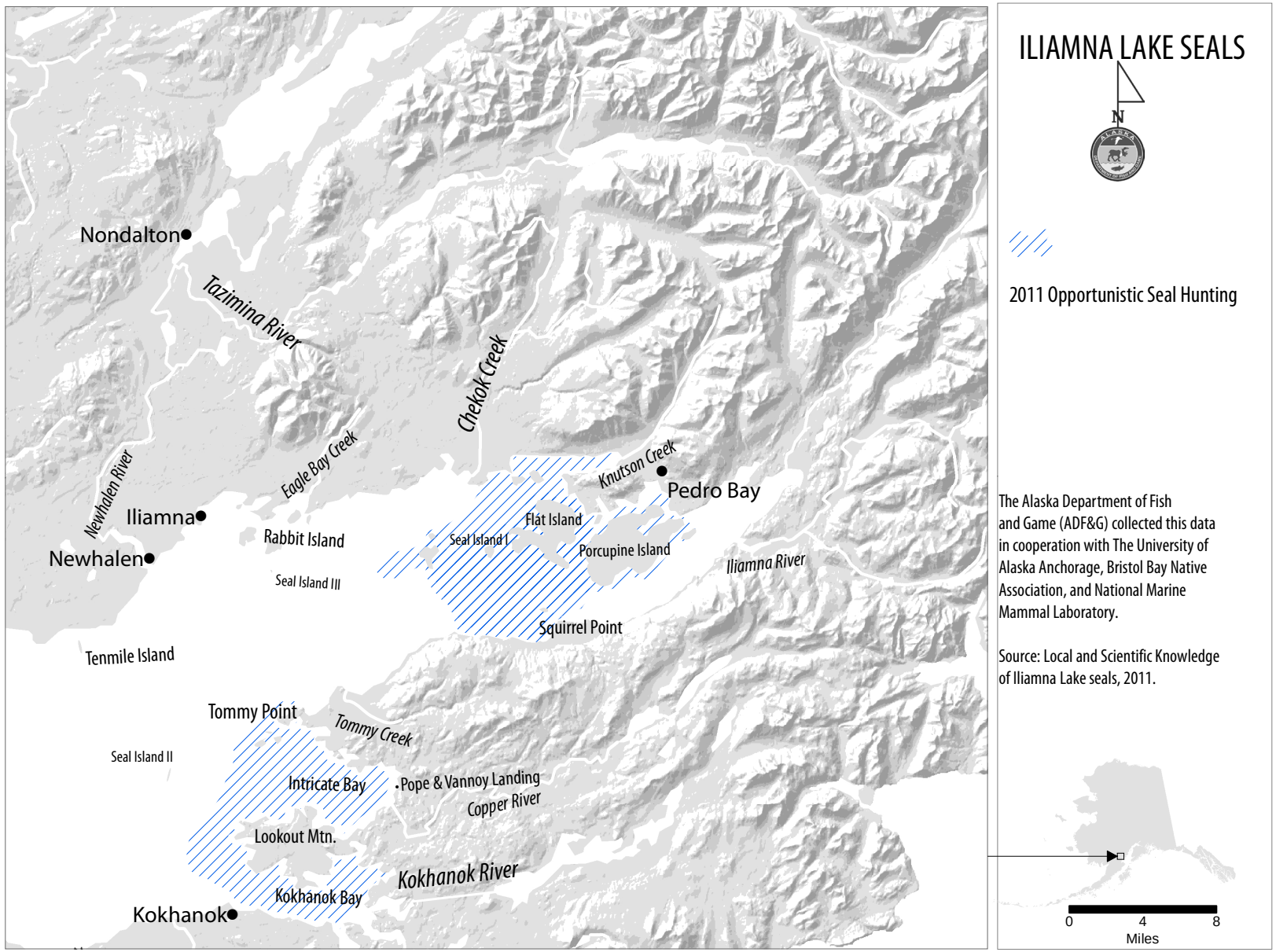

Figure 5-42.–Locations where opportunistic seal hunting is practiced by community residents in the northeast portion of Iliamna Lake.

of these hunters also said that younger seals are not as healthy and fat as older, larger seals; all-in-all, older, larger seals are a preferable resource.

While some hunters prefer harvesting large seals mainly because of their light color and bigger skins, many hunters also target large seals because they yield greater amounts of fat for seal oil. "*I try to go for big seals. Even if they're in the water you can see by the size of their head if they're a big seal or not and I just try not to go for anything small,*" said a Pope-Vannoy hunter. However, many other hunters reported that they avoid harvesting large seals because they are difficult to transport and process, and because their meat is less desirable than that of younger seals. For example, a Newhalen hunter said that older seals are "*too big, you can't get them out of the water and you can't haul them to the beach,*" and an Iliamna elder said the he has never targeted large seals because transporting and processing them is "*a hassle.*" Regarding food preferences and meat quality, a Newhalen hunter explained that large seals are not selected for harvest because their meat is not preferable: "*The old folks say the meat is tougher so just leave the big ones alone.*" Similarly, an Igiugig elder said that she prefers the meat from younger seals: "*Small ones, I like, not big ones, [the meat is] softer.*"

Some hunters reported that traditional conservation methods also dictate that older male seals are not targeted for harvest. These hunters said that during the spring hunting season female seals are not targeted because they are either pregnant or are caring for pups at the time; instead, male seals are targeted. Some hunters said that effective conservation also implies that older male seals are not targeted because of their contribution to successful breeding. For example, an Iliamna elder said, "*The older bulls, older males, big bulls, we don't want to kill them because they will not be able to reproduce as well.*" The elder suggested that it is not necessary to select large seals specifically for their preferable pelts or fat content and explained that seals of approximately 3 years in age tend to yield the ideal combination of lightly colored fur, good fat, and high-quality meat: "*I like to look for 3-year-old seals, lighter colored ones. I don't like to shoot the older adults. The 3-years-old ones are fatter, and we have to be careful not to shoot females.*" Similarly a Newhalen hunter said that he avoids hunting female seals and large male seals and instead targets mid-sized male seals: "*about 5 footers, 6 footers,*" said the hunter.

While several hunters expressed the above-listed preferences for physical characteristics of targeted seals, other hunters said that because seal hunting can be challenging they generally try to harvest whatever seal becomes available. A Kokhanok hunter explained that when hunting seals in the open water it is very difficult to target a specific type of seal, for its size or for its sex, because a hunter cannot see the seal's body in the water before the hunter shoots. Similarly, an Igiugig elder who hunts seals in the Kvichak River explained that because seals are infrequently seen in the Kvichak River he will attempt to harvest any seal he finds there, regardless of physical characteristics. "*It doesn't make any difference, whatever I can see on the [Kvichak] river, I get,*" said the elder. The elder said that it is easier to select a seal for certain physical characteristics when hunting seals hauled out on the ice than it is to do so when hunting seals in the Kvichak River.

5.4.vii. Conservation Measures

For most hunters, hunting activity is balanced with a desire to maintain a viable seal population in the lake. Community respondents consistently discussed the existence of a traditional seal conservation ethic among Iliamna Lake hunters. Elders explained that while overhunting had occurred during certain times in the past the occurrence was rare. During times when concerns about the conservation of the seals arose, knowledgeable elders in the communities would attempt to redirect hunting patterns. A Kokhanok hunter said, "*When we were younger if we got more than a couple seals we got bawled out. They [elders] said, 'No more than 2 or 3 per village out of the lake per year.' If you wanted a lot of seals you went to the coast. The way I understood it, it was like having money in the bank.*" A Newhalen elder explained that seal hunters in the region "*have always hunted with the next generations in mind, only taking what they need*" and suggested that, because of this, the seal population in the lake has increased, rather than decreased. Respondents said that certain measures have been used by the communities to avoid negative effects from overhunting and to protect and conserve the seals. A Kokhanok hunter explained that these local methods

have been effective because the seals are still living in the lake in large numbers and have not declined. "*You don't live here for thousands of years by being dumb*," said the hunter.

Respondents reported that these community-driven seal conservation mechanisms continue to be practiced by Iliamna Lake hunters today. The prominent conservation mechanism employed by resident hunters is adherence to a rule to only harvest what the community needs and to thus produce no waste. Sharing networks within the communities facilitate the distribution of harvested seal parts among the community and respondents reported that seal harvests are limited to ensuring that households that use seals have it available. Respondents reported recognition that seals are a limited resource and explained that, once the households have seal oil for the winter, hunting will normally be discontinued until the following spring. A Kokhanok hunter explained that if a hunter harvests a seal and shares it with other households then usually the people from those households that received seal resources will not hunt that year. Every household in an Iliamna Lake community does not harvest a seal each year and elders encourage younger hunters not to harvest seals unless they are needed by the community. "*We see seals all the time and we just leave them alone. We only take them when we need them*," said an Iliamna elder

Another conservation measure employed by seal hunters is careful selection of the seal to be harvested prior to executing the kill. Hunters reported that they are careful not to harvest females with pups or potentially pregnant females during the springtime (yet note that 2 of the seals from which biosamples were provided were pregnant at the time of harvest). For example, a Newhalen hunter said, "*If they have pups we leave them alone*," and, speaking of hunting during the spring season, a Pedro Bay elder said that spring is a "*certain time of the year we don't want to get them [female seals], [they are] with calves now [late May]*." Similarly, a Newhalen hunter said, "*I take the old people's advice: 'take only 1 seal a year and try not to shoot the females.' One a year. Just enough for seal oil and to share the meat too, if people want the meat or fat.*" Some hunters reported that they also avoid harvesting older, larger-sized male seals because of their importance to seal reproduction. For example, a Newhalen hunter said, "*The old folks say the meat is tougher so just leave the big ones alone. They're the dominant males. They provide the pups. So we don't hunt them*," and an Iliamna elder said, "*The older bulls, older males, big bulls, we don't want to kill them because they [the seal population] will not be able to reproduce as well.*"

All in all, community respondents placed a large emphasis on the importance of both monitoring and protecting the population of seals in Iliamna Lake for the future. "*We don't just kill them. We are trying to keep them under surveillance*," said a Newhalen hunter. The hunter also said that, for the seals' protection, community members normally try not to talk much about the seals to outsiders due to a concern that if other people knew about the seals they would also try to hunt them or harm them. "*These are our resources so that's why we try to keep it to ourselves*," said the hunter. Because of resource development proposals and other affected resources in the region, some community members are concerned about the future of the seals in Iliamna Lake. An Iliamna elder made reference to the negative effects experienced by the freshwater seal population in Lake Baikal, Russia, and voiced a desire that the seals within Iliamna Lake be protected in the future. The elder said, "*I do not want to see the seals in Iliamna [Lake] become destroyed like they have in Lake Baikal. I'd like to see them stick around, those seals.*" This respondent is making reference to the fact that during the 20th century the population of freshwater seals *P. sibirica* inhabiting Lake Baikal in Russia was heavily affected by commercial hunting that, in combination with reductions in prey availability and habitat degradation, led to a large population decline. However, since conservation concerns were recognized, harvest restrictions, in combination with efforts to improve water quality within Lake Baikal, have allowed the population to stabilize.[9]

Other respondents expressed concerns that overhunting of the seals could occur in the future. A Kokhanok hunter said that seal harvests by younger generations of hunters with high-powered motorboats and snowmachines might be increasing. The hunter said that "*the younger folks are not always adhering to it [the hunting rules taught by elders]*." Moreover other respondents pointed out that community dependence on seals for subsistence has increased in recent years as a result of declines in the moose and caribou

9. Pastukhov, V. D. n.d. "Lake Baikal Seals – NERPA," Baikal Web World. http://www.bww.irk.ru/baikalseals/baikalseals_01.html (accessed October 2015).

populations in the region. A Newhalen hunter, who is also a commercial fisherman, pointed out that the future of the Iliamna Lake and Bristol Bay salmon fishery is now uncertain due to increasing effects by commercial fishing activities, including ocean fishing bycatch of salmon, and possible mining development activities in the region. "*If salmon decline then we need to worry about the seals getting hunted more,*" said the hunter.

5.4.viii. Cost Considerations

The high cost of fuel for boat motors, snowmachines, and ATVs for transport is often a consideration for Iliamna Lake seal hunters. Some elders commented that in earlier times obtaining fuel was not required for seal hunting because hunters traveled by kayaks and dog teams. The availability of motorized transport made hunting easier and less time-consuming but it also created a new dependency on the cash required to purchase both the machinery and the fuel required to operate it. Some hunters reported that recent increases in fuel costs have led to a decline in seal hunting activities by Iliamna Lake hunters. For example, a Newhalen hunter said, "*Before the [fuel] prices started zooming up there was a lot more boats out [seal hunting].*" An Igiugig elder explained that Igiugig seal hunters are especially affected by high fuel costs because of their distant location from the most productive seal hunting grounds in the northeastern end of the lake.

Some hunters explained that even though the cost of hunting has increased they will continue to hunt seals on the lake as long as they can afford the fuel they need. For example, an Igiugig hunter explained that he will hunt seals every year regardless of the costs of fuel: "*…nowadays, it [the decision to hunt seals] has a lot to do with the fuel. But, we like it [having seals as a subsistence food] too much to not go.*" Likewise a Newhalen hunter said that his family never views the decision to hunt seals in terms of a dollar cost/benefit ratio but instead views seal hunting as a necessary activity for maintaining the traditional and customary use of seals. "*We want the seal, because we grew up with it,*" said the hunter. An Iliamna elder explained that as an adaption to high fuel costs some seal hunting families have begun cooperating more with one and other by sharing equipment and fuel costs while seal hunting. "*We sometimes team up with other families [for seal hunting] and share,*" said the elder.

Some hunters discussed the fuel costs associated with the distances they must travel from their communities to hunt seals. Newhalen and Iliamna hunters reported that traveling to the islands where seals are found and returning to the community requires anywhere from 10–20 gallons of fuel at $6 per gallon and thus $60–$120 per seal hunting trip. Kokhanok hunters reported requiring less fuel for seal hunting (about 5 gallons of gas roundtrip per hunt). Newhalen hunters must travel an average of 7 miles to hunt seals and Kokhanok hunters must travel an average of 15 miles to hunt seals. By contrast, fuel costs are substantially higher for Igiugig hunters traveling to the northeastern portion of the lake to hunt seals because they must travel approximately 48 miles to reach the hunting grounds.

5.5 Subsistence Uses of Seal Resources

The seals within Iliamna Lake are an important customary and traditional subsistence resource for residents of Iliamna Lake communities. Seals inhabiting the lake are hunted for their oil, fat, organs, meat, and skins. A Newhalen elder explained: "*We harvest seals to eat, for fat, for our nutrition values, for our meals. We use the seal oil during the wintertime for whatever we eat, like fish. We eat the meat. We dry it, like dry meat. They are very tasty and a good nutrition food.*" Many respondents from the study communities explained that seal products make an essential contribution to local food security because store-bought alternatives are often unaffordable. Additionally, some respondents reported a greater nutritional reliance on seals as a result of declined community subsistence moose and caribou harvests.

After a seal is harvested it must then be processed for consumption. Processing often begins in the field but whole seals are often transported back to a community and processed at home (Plate 5-5). Hunters who process harvested seals in the field do so because some seals are too large to transport and also because they prefer not to bring entrails and other unused parts home. Hunters who transport entire seals home for processing do so because they find it easier to do the best job possible in a more controlled environment.

For example, a Pope-Vannoy hunter explained that she normally hangs seals up to process them, both for ease of processing and because it is very important to her that the seal hide is not damaged. "*I like to have [the seal] raised [off the ground] so I don't have to stoop over as much to skin it. It takes quite a while to skin one if you want to do a really good job on it. The less fat on the hide the less work later for scraping, and the better product.*"

Hunters from the study communities reported that the seals within Iliamna Lake normally have a fat layer 2 in to 4 in thick. Once a seal has been skinned the meat is separated from the fat and these parts are shared with the hunter's family and the broader community. A Kokhanok hunter briefly described his activities after returning to the community with a freshly harvested seal:

> *I'll separate the meat from the fat, because a lot of people just want fat, and I'll run around and ask what they want and I'll cut it all up into chunks, separate the bones and stuff so they could just throw it in a pot and cook it … I'll go to certain houses, I'll start with the elders and then other people that I know who like seal meat.*

Seal fat and the oil it produces is the most sought-after subsistence resource obtained from seals for Iliamna Lake residents. Fat from harvested seals is normally distributed throughout the communities. "*Everyone in the village gets a slab of [seal] fat each year,*" said an Iliamna elder. Seal fat is rendered into oil that is used as a condiment at most daily meals. "*I use the fat. I render it down to make seal oil. A seal will have so much on them. They are more fat, I think, than meat. So we just render it down and I give a lot of it away to people who really want it,*" explained a Pope-Vannoy hunter. Dried moose meat, dried caribou meat, dried salmon, and fish eggs are all dipped in seal oil before consumption. As discussed above, oil from older seals, or seals that have been feeding on salmon, is often considered too strong and for this reason hunters are selective about choosing when to harvest a seal and what seal to harvest when doing so. Some Iliamna Lake residents hunt seals primarily to obtain their fat and have little interest in consuming seal meat.

Photography by Rebecca Mike, Kokhanok

Plate 5-5.–A Kokhanok hunter taking a seal home for processing.

Proper production of seal oil requires that a seal's fat is completely separated from its skin and meat during processing (Plate 5-6). It is also very important that a seal's fat is washed clean of any blood. "*You skin it off, then you skin the fat off, with as little of blood and meat as possible,*" explained a Kokhanok hunter. Similarly, a Newhalen hunter explained that the taste and purity of the oil depends upon the processor's diligence in taking care of the fat:

> *[The taste of seal oil] depends how you treat the fat when you cut them up. If I get my freshwater seal, I skin them out there and I cut the fat off and when we come home I take all the blood on the fat, take all that old blood off and then you slice up the fat and put it in jars. If their blood is on there [the fat] it makes the taste stronger.*

Photography by Rebecca Mike, Kokhanok

Plate 5-6.–A Kokhanok resident uses an uluaq to separate fat from the skin of a seal harvested in Iliamna Lake. The pieces of fat are placed in a bowl. The fat will be cleaned of blood, cut into smaller pieces, and placed in jars for rendering.

After the fat is cleaned of meat and blood it is cut into small pieces and placed in glass jars. No further processing is required because over the course of 1–3 weeks the fat naturally renders itself into oil. A Newhalen hunter explained: "*We let it render itself … it tends to come out itself. We just wait till it's done.*" Likewise, an Iliamna elder said, "*I just chop it up and put it in mason jars and let it sit. It renders itself pretty fast.*" The elder also explained that the rendering time is dependent upon how thick the seal fat is cut. Respondents said that proper rendering also requires that the jars containing the seal fat are placed in a cool, dark location. For instance, another Iliamna elder explained his practice of producing seal oil: "*We put it in the container, a quart-size canning jar, and cut the fat in pieces, cut it in strips and chunks and put them in the canning jars. Then we keep them in a cool, dark place and oil renders out of it that way and it stays clear.*" A Kokhanok hunter said that his mother always fries the pieces of seal fat briefly in order to get the rendering process going faster before putting the fat in the jars. Iliamna Lake residents can normally expect to obtain approximately 20 quart-size jars of finished seal oil from each seal harvested. Following the rendering process seal oil is stored in a freezer so it will not spoil.

The meat from harvested seals is not as broadly consumed throughout the communities as is the oil. Some hunters do not hunt seals for their meat at all but instead hunt them only for their fat or for their skins. "*I don't care for the meat very much, [seal hunting,] it's just mainly for the fat and the hide*," said an Iliamna elder. If a particular hunter or the hunter's direct family does not want the meat from a harvested seal then it is usually given to other households who desire it. Elders in the communities generally consume more seal meat than do younger people and seal meat is often distributed to elders. "*The older people like to eat*

it [the meat] and I like to eat it myself, the older people really love it and they rarely get it, so we always give it to them," said an Igiugig hunter. Because seal meat is viewed as traditional food it is also often served at community events. "*At a family dinner, or a birthday, usually the seal meat comes out,*" said a Newhalen hunter. Respondents also reported that seal meat is often given to family members living in other communities outside the region.

Similar to seal oil, the meat from seals harvested during summer salmon runs is not preferred because it "*tastes like fish*" and some respondents said that seal meat always has a strong, fishy taste and that they thus prefer seal oil because it is much more mild in flavor than seal meat. Because of some people's dislike of seal meat, if the meat is not given away, it is sometimes fed to dogs. Iliamna Lake residents who consume seal meat either cook it or make it into dry meat. Cooking consist of boiling, baking, and roasting. Seal pot roast is a favorite Iliamna Lake dish. "*Boiling is our favorite. Cut squares, and boil them, eat with potatoes,*" said a Pedro Bay hunter. A Newhalen hunter described his process for cooking seal ribs: "*If you cook seal ribs, boil it, barbeque sauce and put it in the oven. It's better than beef, I tell you.*" If not made into dry meat, seal meat that is kept and not immediately consumed is stored in the freezer. Prior to the availability of freezers seal meat had to be dried for preservation. To make dry meat the seal meat is cut into thin strips and then hung outside to dry. Some residents smoke the drying meat and others just allow it to dry in the air. "*Let it age, let the sun do its job,*" explained a Newhalen hunter. Respondents reported that in good weather seal meat takes about 1 week to dry thoroughly. Sometimes seal meat is hung to partially dry, or made into half-dried meat, and then it is cooked.

Seal skins are highly valued by Iliamna Lake residents. When a seal is harvested the skin is almost always kept. Some hunters specifically hunt for skins and others hunt specifically for food. Either way, hunters explained that nothing from a seal is ever wasted and that skins, meat, or fat that is not kept by the hunter is always distributed throughout the communities. Seal skins are a traditional fabric used by Iliamna Lake residents for making clothing, parkas, hats, boots, pants, and gloves. An Iliamna elder recalled a family history of utilizing the skins of the seals within Iliamna Lake: "*I don't think we've ever let a seal skin go to waste. We always use them. My mom, that's how she made our clothes when we were growing up. She made coats, and mukluks, and mitts with them for us kids.*" Today seal skins continue to be used for sewing by many women from the study communities. A Pedro Bay elder reported that once, during the month of March, he harvested a female seal that carried an unborn pup. The elder skinned the unborn pup and tanned the skin. He said that the pup skin turned out very nice and had "*curly white fur,*" which likely reflects that the fetus was still in lanugo.

Prior to using a seal skin for sewing, it must first be processed and tanned. First, the underside of the skin must be scraped clean of all its fat. Following scraping, the skin must be stretched in order to loosen its fibers in preparation for tanning. Seal skins were traditionally stretched by being tied with rawhide cord or rope to a rectangular rack made of wooden poles. Today most seal skins are stretched by being nailed to a piece of plywood. "*Before, we used to do it on a rack … nowadays you can go to any hardware store and get a 4 foot by 8 foot plywood and then stretch the whole thing,*" explained a Newhalen hunter. After the skin has been scraped, stretched, and dried it is ready to be softened by tanning. Softening a skin requires the use of a tanning agent, which permanently loosens the skin's fibers and keeps them soft. Traditionally, Iliamna Lake residents accomplished this by rubbing the seal's brain into the skin. Sometimes the seal brains were mixed with urine, seal entrails, or a mixture of both. Following an application of the brain mixture the skin was stretched and worked. The process might be repeated a few times before the skin was successfully tanned. Several respondents recalled their grandparents and parents tanning seals skins in this way. For example, an Iliamna elder said:

> *We used to tan using urine and brain and all of that, very smelly process … . Mix it until it fragmented and bubbled, and you rub it into the hide and fold it. Do that several times and hang the hide up to dry. It was a long time ago … we saw it … I am skimming the whole process … a lot of scraping and stretching a hide, but you have to be careful to not stretch too much because the skin gets thin. I only watched it when I was a kid. My*

grandmother did that and I was the one to carry the smelly tanning solution. Urine is from people, the brain can come from any animal.

Another Iliamna elder said that the tanning process is made easier by first smoking the raw hide in a smokehouse because the smoke loosens up the fibers, allowing the applications of brains to be more potent. A Newhalen elder also recalled her mother tanning seal skins harvested from Iliamna Lake. The elder said that as a method to stretch a seal skin's fibers her mother would give her a seal skin and have her use it as a sled to slide around on in the snow: "*She just make me, wintertime, just get in a seal skin and slide down with it really good, slide down with it! I didn't know I was tanning it for her! Gee I tell you, I used to have fun! Run with the seal skin, go back up on the hill, and go down all day long. It breaks up everything. I was helping her tan it but I didn't know it.*" This is likely the freeze-tan method known to have been utilized by Yup'ik and Nunamiut Eskimos, and the Northern Cree. The forces of expansion placed on a frozen hide are greater than those that can be applied when attempting to stretch a wet hide. Sliding around on the snow with the hide would help break open the fibers on a frozen skin (Fienup-Riordan 2007; Nelson et al. 1982; Vaillancourt 1977). The elder also recalled her adult family members holding a scraped seal hide long-ways while having children bounce up and down on it a as means of stretching the skin for tanning: "*They don't know they're tanning it. I don't know I'm tanning it for my mom. I thought that was the most fun thing you could have!*" Similarly, bouncing and jumping on a raw skin by Yup'ik and Inupiat Eskimo children is a documented skin stretching technique known to aid in the tanning process, and today is a recreational game referred to as the "Eskimo blanket toss" (Fienup-Riordan 2007).

Respondents from the study communities recalled seal skins being tanned in the traditional manner described above through the 1960s. A Kokhanok hunter said that during the 1970s people began sending their seal skins into commercial tanneries and discontinued self-tanning. A Newhalen hunter said that his family sometimes softens seal skins themselves using a commercial tanning agent. Today most Iliamna Lake residents mail their scraped, stretched, and dried seal skins to commercial tanneries in Shishmaref, Anchorage, Idaho, and California. A medium- to large-sized seal skin costs approximately $85 to tan.

Seal organs and guts are a traditional food and sewing resource used in the past by Iliamna Lake residents. These parts are used less today. Elders recalled seal intestines formerly being used to make traditional Yup'ik raincoats. "*A long time ago these [viscera] were used to make kuspuk,*" said an Igiugig elder. A Pedro Bay elder recalled that seal flippers were formerly buried, allowed to ferment, and then eaten, but said this is no longer done. Today seal organs and viscera continue to be used as food by some Iliamna Lake families. These parts are especially relished by elders. Seal livers are consumed and seal intestines are sometimes added to seal meat pot roasts. Intestines are also used as a casing for sausage made of seal fat. However, some families do not consume seal organs or viscera. "*I take the meat and the fat. I throw the guts in the water,*" said a Newhalen hunter. Sometimes the organs and viscera are boiled for use as dog food.

Some respondents described traditional practices of showing respect to seals by properly disposing of their unused parts. Yup'ik tradition dictates that seal bones are taken care of properly in order for the spirit of the seal to return to offer itself to the hunter again (Fienup-Riordan 1994; John and Fienup-Riordan 2003). In order to show proper respect and ensure the return of a seal, Yup'ik people traditionally discarded seal bones in a body of water (Andrew 2008; John and Fienup-Riordan 2003). Similarly, some respondents from Kokhanok and Newhalen said that it is important that any unused parts of a seal are returned to the water. However, an Igiugig elder said that she was taught by her elders to place any unused parts of a seal on the land. "*If you take an animal from the water like seal and beluga, you leave them [the bones] on land. But if like, caribou and moose, you put the bones in the water. That's our old Native way, our tradition,*" said the elder. A Newhalen elder explained that there are also rules for the proper storage of seal meat and oil. The elder said that "*no plastic storage*" is allowed for any seal meat or oil. The elder said that not only will storage in plastic spoil the seal oil it will also "*anger the animals; animals have feelings, they know.*" An Iliamna elder explained that treating seals with respect ensures that more seals will be provided to the hunter in the future. The elder said that when he harvests a seal he always expresses spiritual gratitude. "*What I do is [when a seal is harvested] I thank God for this place, for what the earth has given to me, and the seal that has given itself to me. I give thanks for that,*" said the elder.

6. CONCLUSIONS

This project was designed to gather and synthesize information about the biology and ecology of the seals within Iliamna Lake, Alaska, through a combination of aerial surveys, biological sampling of harvested seals, and surveys and interviews with the residents of 6 communities (Pedro Bay, Kokhanok, Newhalen, Iliamna, Igiugig, and Levelock) along the shores of the lake and the Kvichak River. The research team included academic and federal biologists, anthropologists, staff from the Bristol Bay Native Association, and local community members and students. The team worked well together, and idea exchanges throughout improved survey instruments, aerial survey plans, and biosampling success, and facilitated information exchange with participating communities as well. Research efforts were supplemented with data obtained under North Pacific Research Board Project # 916, additional aerial surveys flown by the National Oceanic and Atmospheric Administration and the Newhalen Tribal Council, and archived tissue samples that were available for genetic analysis.

Findings from all research modalities were integrated into project findings and this final report. Combining local and traditional knowledge of Iliamna Lake seals with data gathered from biological research techniques produced a more detailed and in-depth understanding of the seals' ecology and behavior than would have been possible from either modality alone. In addition, while the 2 ways of knowing rely on very different approaches, the conclusions reached separately were in remarkable agreement, once each method's underlying limitations and potential biases were understood.

For example, while there was close agreement on the abundance of seals in the lake during midsummer based on both aerial surveys and interviews, traditional ecological knowledge provided more nuanced and detailed insights about the seasonal movements and behaviors of the seals within the lake than would have been possible from aerial surveys alone. This was particularly true with respect to seal movements throughout the seasons, and the seals' use of the Kvichak River. Moreover, resident descriptions of seal foraging locations and activities provided insight that aerial surveys could not, due to the focus of surveying locations where seals are hauled out. Analysis of tissue samples from harvested seals confirmed local reports that lake seals include both marine and freshwater fish in their diet, and that midwinter diets include freshwater fish. Similarly, while aerial surveys were able to provide a better picture of the precise timing of pupping within the lake, local accounts indicate that seals have been pupping in the lake for many more years than that documented by survey efforts. Indeed, ethnographic results provided a better historical understanding of seal abundance in the lake than could otherwise have been possible, due to the relatively limited and sporadic survey history.

Another area where ethnographic data provided particular insight was with respect to the strategies used by seals to survive in the lake throughout the winter. While use of cracks, leads, and polynyas had been documented previously, many interviewees reported that seals utilize subnivian spaces as haul outs during the time when the lake is snow- and ice-covered. While this strategy has not been documented for harbor seals in Alaska, it is one that might account for the very low abundance of seals observed during wintertime aerial surveys.

In contrast, insight into the stock of origin and degree of potential isolation of the Iliamna Lake seals provided by genetic analyses refines the local understanding of population isolation, which differed among lake communities. For example, the ethnographic results indicate that there is a mix of perceptions and knowledge regarding the permanence and migratory behavior of the seals within Iliamna Lake, with residents from communities along the Kvichak River more supportive of the view that seals travel between the lake and Bristol Bay, and residents from communities from the northeastern side of the lake were more likely to believe that the seals are permanent lake residents. Still, most respondents were adamant that a distinct population of freshwater seals, which does not migrate, exists in Iliamna Lake, and all respondents voiced a high level of confidence that Iliamna Lake is home to a distinct year-round population of seals. Genetic samples generally support the ethnographic results, in that they firmly support the view that the lake seals are harbor seals from the Bristol Bay region. Further, they provide greater insight into the

potential for isolation, but must be interpreted cautiously given the small sample size. Additional analyses are ongoing. Similarly, while many residents believe that seals have remained in the lake for a long enough period of time to have developed some distinct morphological traits as a result of adaptation to the Iliamna Lake environment, such as unique body size and shape, pelt color, and taste of meat and oil, insights from studies of harbor seals in other regions suggest that the traits so identified are more likely to reflect normal phenotypic plasticity and individual variation, and so may not be reflective of population distinctness.

Ethnographic information obtained from this research does make it clear that marine mammals, and particularly seals harvested in Iliamna Lake, remain an important traditional and customary subsistence resource for the study communities. Because of the importance of the seals within Iliamna Lake as a local subsistence resource, Iliamna Lake residents and respondents highlighted the fact that local hunters practice seal hunting in a calculated manner, are always careful not to overharvest seals, and employ hunting strategies that minimize the potential for waste. Respondents described a conservation ethic and explained that it has always been traditional cultural practice that when seals are harvested in Iliamna Lake they are harvested for the purpose of sharing throughout the communities, not simply for consumption at the individual household level. During outreach visits to participating communities, residents expressed concern about future management of the seal population in the lake, and advocated for additional research. In particular, community members called for future research that can provide definitive answers to the question of active migration. Several respondents called for the use of a scientific method to monitor seal movements. "*They need to tag the seals. If they had them tagged you would know where they went,*" said a Levelock elder. Similarly, a Newhalen hunter said that in order to determine seal migration behavior "*a radio collar-type study is absolutely necessary.*"

7. MANAGEMENT AND POLICY IMPLICATIONS

Over the past 4 years, in collaboration with the local residents, and village and tribal councils in the Iliamna Lake region, we have gathered scientific and local knowledge about the seals that inhabit Alaska's largest lake. Aerial surveys have documented the abundance and locations of seals hauled out during periods when the lake is open water and when ice-covered, while interviews with community residents have captured traditional knowledge about seal behavior and their importance within the local cultures. Over time, we have developed collaborations with local hunters, and have documented harvest patterns both through household surveys and the collection of biosamples, which have further aided in our understanding of the lake's seal population. Early presentations of the data gathered through these research efforts were used as the scientific underpinning of the petition to list Iliamna Lake seals under the federal Endangered Species Act (ESA) that was submitted by the Center for Biological Diversity to the Secretary of Commerce on November 19, 2012 (Center for Biological Diversity 2012). The petition and the potential resulting consequences for local use of the seal resource are of concern to many of the local residents and councils in the Iliamna Lake area. Unfortunately, neither this research team, nor the local communities, were contacted in advance of the petition's submittal, and so a large portion of this team's time when in communities presenting research results for review was dedicated to a discussion of the potential management outcomes should the petition to list the seals be moved forward by the National Marine Fisheries Service (NMFS).

We further recognize that this final report, and all documents and publications that result from this work, are likely to be closely reviewed by both the Biological Review Team that has been convened by NMFS to consider the petition, as well as by other concerned entities, including the participating communities. In recognition of the diverse groups that will be reviewing this report, and the various purposes that our data will be asked to serve, we have retained substantial detail in the presentation of project findings, rather than more concisely summarizing our findings.

In response to local concerns about the potential effects of pending management action, and in recognition of the outstanding need for additional information about the status of the Iliamna Lake seal population, this project will continue extant efforts in 3 areas: 1) aerial surveys to document seasonal patterns of abundance and location of seal haul out areas; 2) collection and analysis of tissue samples provided by participating hunters; and 3) developing a robust framework of education and information flow between local residents and groups involved in the management and protection of the seal population. As part of this third goal, we will also work with local residents to develop a research plan that involves more extensive analysis of tissue samples, and that leads toward a capture and tagging program (to be developed with other funding mechanisms) that will directly monitor seal movements in, and possibly out of, the lake. Such an effort might include seal capture and tagging operations conducted by a team consisting of federal, state, and university personnel, and with the assistance and advice from local residents. This type of program would support the development of spatially and temporally correct correction factors that could be used to transform haul out counts to total abundance, and so address the question of if, and how, seal population numbers have changed over time. Meaningful collaboration and coordination in research and management decisions is a core tenet of co-management programs (Marine Mammal Commission 2007), is a stated policy of the U.S. Department of Commerce[1], and a goal that remains central to this research team.

1. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Alaska Regional Office. n.d. "Co-management of Marine Mammals in Alaska." https://alaskafisheries.noaa.gov/pr/comanagement (accessed October 2015).

8. OUTREACH

During January 2012, Alaska Department of Fish and Game (ADF&G) and University of Alaska Anchorage (UAA) worked cooperatively with science teachers and students from the Lake and Peninsula School District at the Newhalen and Levelock schools to conduct systematic household surveys. In this process local students became familiar with the objectives and methods of the project and participated alongside researchers in administering the systematic household surveys. For their contribution to the project the schools received some of the payment allocated to local research assistants. These moneys will be used to fund additional science- and place-based education projects for the students. Researchers also made educational presentations about this project to classrooms at the Newhalen, Levelock, and Kokhanok schools in order to further raise awareness and interest in the project by local students.

On May 16, 2013, Dr. Jennifer Burns presented research findings to the Bristol Bay Marine Mammal Council at their meeting in Dillingham, Alaska, and provided copies of the presentation to the council. The petition to list the seals as a distinct population segment (DPS) was announced the day before this meeting, and at the meeting Dr. Barbara Mahoney and Dr. Burns provided information on the process and timeline for submitting public comments to the council and to the Bristol Bay Native Association (BBNA).

In 2013, ADF&G, National Marine Mammal Laboratory, and UAA researchers, as well as BBNA staff, traveled to the participating communities of Kokhanok (June 13), Igiugig (June 14), Iliamna (2 presentations on June 11), Newhalen (June 12), and Pedro Bay (July 2013) where we presented the preliminary findings from our research. We provided copies of the presentations to community members, and responded to questions and comments provided to the research team. All comments on research findings were considered when preparing this final report. At these meetings we also provided feedback to communities with respect to the review process that was ongoing by the National Oceanic and Atmospheric Administration as it related to the petition to list the seals in Iliamna Lake as a DPS.

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APPENDIX A–LETTERS OF SUPPORT FOR THE RESEARCH FROM PARTICIPATING COMMUNITIES

Levelock Village Council
P.O. Box 70
Levelock, Alaska 99625

North Pacific Research Board
1007 W 3rd Avenue, Suite 100
Anchorage, AK 99501

December 7, 2010

Dear North Pacific Research Board,

The Levelock Village Council supports NPRB Research Project #916 titled, "Iliamna Lake Freshwater Seal Study: Characterizing Local Use Patterns, Local Traditional Knowledge, and Seal Population Ecology" and is thankful that our neighboring communities of Iliamna, Kokhanok and Newhalen have been working cooperatively with the Bristol Bay Native Association and the University of Alaska, Anchorage to conduct baseline research on the seal habitat and ecology of Iliamna Lake. We would like to express our support to continue collaboration on this project by expanding it through the 2012 NPRB Request for Proposals.

The currently funded research show that seal abundance fluctuates seasonally and corresponds with salmon migration into Iliamna Lake in the summer months. The new proposal seeks to expand our project to increase the number of aerial surveys documenting seal distribution throughout the lake and expanding the current LTK and subsistence harvest research to include communities closer to the Kvichak River.

Levelock is located on the shore of the Kvichak River and looks forward to being included if the research is expanded. These combined efforts will provide data to support a better understanding of seal use of Iliamna Lake and how local people depend upon them for subsistence.

The Levelock Village Council encourages expanding research partnerships to enhance the project's efficiency and make sure that all fields are well supported through this proposal. Our Tribe and community looks forward to working on this research if it is expanded through funding made available by the North Pacific Research Board. Please accept our support of the proposal titled "Integrating local traditional knowledge and subsistence use patterns with aerial surveys to improve scientific and local understanding of the Iliamna Lake seals."

Sincerely,

Greg Andrew
President

IGIUGIG VILLAGE COUNCIL
P.O. Box 4008
Igiugig, AK 99613
Phone: (907)533-3211 or Fax: (907)533-8217 www.igiugig.com email: igiugig@bristolbay.com

North Pacific Research Board
1007 W 3rd Avenue, Suite 100
Anchorage, AK 99501

November 30, 2010

Dear North Pacific Research Board,

The Igiugig Village Council supports NPRB Research Project #916 titled, "Iliamna Lake Freshwater Seal Study: Characterizing Local Use Patterns, Local Traditional Knowledge, and Seal Population Ecology" and is thankful that our neighboring communities of Iliamna, Kokhanok and Newhalen have been working cooperatively with the Bristol Bay Native Association and the University of Alaska, Anchorage to conduct baseline research on the seal habitat and ecology of Iliamna Lake. We would like to express our support to continue collaboration on this project by expanding it through the 2012 NPRB Request for Proposals.

The currently funded research show that seal abundance fluctuates seasonally and corresponds with salmon migration into Iliamna Lake in the summer months. This proposal seeks to expand our project to increase the number of aerial surveys documenting seal distribution throughout the lake and expanding the current LTK and subsistence harvest research to include communities closer to the Kvichak River.

Igiugig is located on the southern end of Iliamna Lake as it flows into the Kvichak River and looks forward to being included if the research is expanded. These combined efforts will provide data to support a better understanding of seal use of Iliamna Lake and how local people depend upon them for subsistence.

The Igiugig Village Council encourages expanding research partnerships to enhance the project's efficiency and make sure that all fields are well supported through this proposal. Our Tribe and community looks forward to working on this research if it is expanded through funding made available by the North Pacific Research Board. Please accept our support of the proposal titled "Integrating local traditional knowledge and subsistence use patterns with aerial surveys to improve scientific and local understanding of the Iliamna Lake seals."

Sincerely,

AlexAnna Salmon

AlexAnna Salmon
President

Newhalen Tribal Council
P.O. Box 207
Newhalen, Alaska 99606

North Pacific Research Board
1007 W 3rd Avenue, Suite 100
Anchorage, AK 99501

November 30, 2010

Dear North Pacific Research Board,

Over the Newhalen Tribal Council began collaborating with the Bristol Bay Native Association and the University of Alaska, Anchorage through streamlining two projects that are researching seals in Iliamna Lake. Our tribal council was awarded funding through the USFWS Tribal Wildlife Grant program and now works closely with BBNA and UAA on the NPRB-funded project titled, "Iliamna Lake Freshwater Seal Study: Characterizing Local Use Patterns, Local Traditional Knowledge, and Seal Population Ecology."

We would like to continue working together by expanding this project through the 2012 NPRB Request for Proposals. This letter expresses support of a new proposal titled, "Integrating local traditional knowledge and Subsistence use patterns with aerial surveys to improve scientific and local understanding of the Iliamna Lake seals."

Through continuation of funding to BBNA and UAA, we hope communities on Iliamna Lake will gain greater insight to the ecology and behavior of the seals that we traditionally harvest from Iliamna Lake. The currently funded research show that seal abundance fluctuates seasonally and corresponds with salmon migration into Iliamna Lake in the summer months.

This proposal seeks to expand our project to increase the number of aerial surveys documenting seal distribution throughout the lake and expanding the current LTK and subsistence harvest research to include communities closer to the Kvichak River. These efforts will provide data to support a better understanding of seal use of Iliamna Lake and how local people depend upon them for subsistence.

The Newhalen Tribal Council encourages expanding research partnerships to enhance both projects' efficiency and make sure that all fields are well supported through this proposal. Maximizing partnerships will foster enhanced scientific knowledge of the seals populating and using Iliamna Lake.

Thank you for considering our support of the proposal titled, "Integrating local traditional knowledge and subsistence use patterns with aerial surveys to improve scientific and local understanding of the Iliamna Lake seals" and we look forward to continuing our research, through funding made available by the North Pacific Research Board.

Sincerely,

Raymond Wassillie
President

Kokhanok Village Council
P.O. Box 1007
Kokhanok, Alaska 99606

North Pacific Research Board
1007 W 3rd Avenue, Suite 100
Anchorage, AK 99501

November 30, 2010

Dear North Pacific Research Board,

The Kokhanok Village Council has enjoyed working cooperatively with the Bristol Bay Native Association and the University of Alaska, Anchorage on the NPRB-funded project titled, "Iliamna Lake Freshwater Seal Study: Characterizing Local Use Patterns, Local Traditional Knowledge, and Seal Population Ecology." We would like to continue collaboration on this project by expanding it through the 2012 NPRB Request for Proposals. This letter expresses support of a new proposal titled, "Integrating local traditional knowledge and subsistence use patterns with aerial surveys to improve scientific and local understanding of the Iliamna Lake seals."

Through continuation of funding to BBNA and UAA, we hope communities on Iliamna Lake will gain greater insight to the ecology and behavior of the seals that we traditionally harvest from Iliamna Lake. The currently funded research show that seal abundance fluctuates seasonally and corresponds with salmon migration into Iliamna Lake in the summer months.

This proposal seeks to expand our project to increase the number of aerial surveys documenting seal distribution throughout the lake and expanding the current LTK and subsistence harvest research to include communities closer to the Kvichak River. These efforts will provide data to support a better understanding of seal use of Iliamna Lake and how local people depend upon them for subsistence.

The Kokhanok Village Council encourages expanding research partnerships to enhance our project's efficiency and make sure that all fields are well supported through this proposal. The inclusion of the ADFG Division of Subsistence is necessary to ensure that the LTK and subsistence harvest data collected is analyzed and incorporated into management accordingly. Partnership with NOAA's National Marine Mammal Laboratory is also supported and appreciated by our organization. Maximizing partnerships will foster enhanced scientific knowledge of the seals populating and using Iliamna Lake.

Thank you for considering our support of the proposal titled, "Integrating local traditional knowledge and subsistence use patterns with aerial surveys to improve scientific and local understanding of the Iliamna Lake seals" and we look forward to continuing our research, through funding made available by the North Pacific Research Board.

Sincerely,

John Nelson Jr.

John Nelson, Jr.
President

Iliamna Village Council
P.O. Box 286
Iliamna, Alaska 99606

North Pacific Research Board
1007 W 3rd Avenue, Suite 100
Anchorage, AK 99501

November 30, 2010

Dear North Pacific Research Board,

The Iliamna Village Council has enjoyed working cooperatively with the Bristol Bay Native Association and the University of Alaska, Anchorage on the NPRB-funded project titled, "Iliamna Lake Freshwater Seal Study: Characterizing Local Use Patterns, Local Traditional Knowledge, and Seal Population Ecology." We would like to continue collaboration on this project by expanding it through the 2012 NPRB Request for Proposals. This letter expresses support of a new proposal titled, "Integrating local traditional knowledge and subsistence use patterns with aerial surveys to improve scientific and local understanding of the Iliamna Lake seals."

Through continuation of funding to BBNA and UAA, we hope communities on Iliamna Lake will gain greater insight to the ecology and behavior of the seals that we traditionally harvest from Iliamna Lake. The currently funded research show that seal abundance fluctuates seasonally and corresponds with salmon migration into Iliamna Lake in the summer months.

This proposal seeks to expand our project to increase the number of aerial surveys documenting seal distribution throughout the lake and expanding the current LTK and subsistence harvest research to include communities closer to the Kvichak River. These efforts will provide data to support a better understanding of seal use of Iliamna Lake and how local people depend upon them for subsistence.

The Iliamna Village Council encourages expanding research partnerships to enhance our project's efficiency and make sure that all fields are well supported through this proposal. The inclusion of the ADFG Division of Subsistence is necessary to ensure that the LTK and subsistence harvest data collected is analyzed and incorporated into management accordingly. Partnership with NOAA's National Marine Mammal Laboratory is also supported and appreciated by our organization. Maximizing partnerships will foster enhanced scientific knowledge of the seals populating and using Iliamna Lake.

Thank you for considering our support of the proposal titled, "Integrating local traditional knowledge and subsistence use patterns with aerial surveys to improve scientific and local understanding of the Iliamna Lake seals" and we look forward to continuing our research, through funding made available by the North Pacific Research Board.

Sincerely,

Harvey Anelon
President

Pedro Bay Village Council

P.O. Box 47020
Pedro Bay, AK 99647

March 6, 2012

North Pacific Research Board
1007 W. 3rd Avenue, Suite 100
Anchorage, AK 99501

Dear North Pacific Research Board:

The Pedro Bay Village Council supports NPRB Research Project # 916 titled, "Iliamna Lake Freshwater Seal Study: Characterizing Local Use Patterns, Local Traditional Knowledge, and Seal Population Ecology" and will be part of the Iliamna Tribal research team of our neighboring communities of Igiugig, Iliamna, Kokhanok, Levelock, and Newhalen who will continue working collaboratively with the Bristol Bay Native Association, the Alaska Department of Fish & Game, Subsistence Division, and the University of Alaska, Anchorage to conduct baseline research on the Iliamna Lake seal habitat and seal ecology. We would like to express our support to continue collaboration of this project by expanding it through to the 2012 NPRB request for proposals which was submitted December 2011.

The currently funded research show that seal abundance fluctuates seasonally and corresponds with salmon migration into Iliamna Lake in the summer months. This proposal seeks to expand our project to increase the number of aerial surveys documenting seal distribution throughout the lake and expanding the current LTK and subsistence harvest research to include communities closer to the Kvichak River. These combined efforts will provide data to support a better understanding of seal use of Iliamna Lake and how local tribal members depend on seals for traditional subsistence seal harvests.

Pedro Bay is located at the east end of Iliamna Lake, 176 air miles southwest of Anchorage, and looks forward to being included in the expanded research project. These combined efforts will provide data to support a better understanding of seal use of Iliamna Lake and how local people depend upon them for subsistence.

The Pedro Bay Village Council encourages expanding research partnerships to enhance the project's efficiency and make sure that all fields are well supported through this proposal. Our Tribe and community looks forward to working on this research if it is expanded through funding made available by the North Pacific Research Board. Please accept our support of the proposal titled "Integrating local traditional knowledge and subsistence use patterns with aerial surveys to improve scientific and local understanding of the Iliamna Lake seals."

Sincerely,

Keith Jensen
President

Bristol Bay Marine Mammal Council
P.O. Box 310
Dillingham, AK 99576

Resolution 10-02

A RESOLUTION SUPPORTING BBNA'S APPLICATION TO CONTINUE FUNDING OF THE LAKE ILIAMNA FRESHWATER SEALS RESEARH PROJECT THROUGH THE NORTH PACIFIC RESEARCH BOARD'S 2012 REQUEST FOR PROPOSALS.

WHEREAS, an isolated population of seals reside in the upper east end of Lake Iliamna, near the villages of Iliamna, Newhalen, Pedro Bay and Kokhanok. The residents of these communities on Lake Iliamna have engaged in customary and traditional ways of harvesting and sharing (subsistence) of these seals for generations

WHEREAS, the Bristol Bay Marine Mammal Council adopted Resolution 08-03 "A RESOLUTION SUPPORTING A PROPOSAL TO CONDUCT BASELINE RESEARCH ON THE UNIQUE AND ISOLATED POPULATION OF SEALS RESIDING IN LAKE ILIAMNA" on October 30, 2008. Resolution 08-03 supported the research proposal which resulted in the funding of the "Iliamna Lake Freshwater Seal Study: Characterizing Local Use Patterns, Local Traditional Knowledge, and Seal Population Ecology" which provides funding to the BBNA Natural Resources Department and the University of Alaska, Anchorage to work with the Kokhanok and Iliamna Village Council(s) to conduct the above titled research project.

WHEREAS, the Bristol Bay Marine Mammal Council adopted Resolution 10-01 "A RESOLUTION SUPPORTING COLLABORATION BETWEEN BBNA AND NEWHALEN TRIBAL COUNCIL, TO COORDINATE RESEARCH PLANS AND ACTIVITIES BETWEEN THE BBNA/UAA ILIAMNA SEALS RESEARCH PROJECT AND THE NEWHALEN TRIBAL COUNCIL'S ILIAMNA SEALS RESEARCH PROJECT on May 7, 2010.

WHEREAS, the Bristol Bay Marine Mammal Council supports collaboration between the BBNA Natural Resources Department and their partnering research agencies and would like to see continuation of the Lake Iliamna Freshwater seal research project.

NOW, THEREFORE, BE IT RESOLVED THAT the Bristol Bay Marine Mammal Council supports BBNA's application to continue funding through the North Pacific Research Board's 2012 Request for Proposals which will lead to greater opportunities for local education, employment and research as well as future funding to conduct much needed research to ensure sustainability of freshwater seals of Lake Iliamna.

Adopted by a duly called quorum of the Bristol Bay Marine Mammal Council on this 15 day of Nov., 2010.

Myra J. Olsen, Chairman, BBMMC

Frank Tagusak Vice Chair

Moses Toyukak, Sr., Secretary, BBMMC

APPENDIX B–ALL PROJECT STAFF FOR THE SOCIAL SCIENCE COMPONENT OF THIS RESEARCH

This table lists those individuals who were involved in project management, field research, data entry, data analysis, map production, and report writing.

Task	Name	Organization
Project design and management	Davin Holen	ADF&G Division of Subsistence
	James Van Lanen	ADF&G Division of Subsistence
Data management lead	David Koster	ADF&G Division of Subsistence
Field research lead	James Van Lanen	ADF&G Division of Subsistence
Research analyst	Garrett Zimpelman	ADF&G Division of Subsistence
Data entry	Hollie Wynne, Yoko Kugo	ADF&G Division of Subsistence / University of Alaska, Anchorage
Cartography	Bronwyn Jones	ADF&G Division of Subsistence
	Davin Holen	ADF&G Division of Subsistence
Field research staff	James Van Lanen	ADF&G Division of Subsistence
	Hollie Wynne	ADF&G Division of Subsistence
	Yoko Kugo	University of Alaska, Anchorage Department of Biology & Anthropology
	Tatiana Askoak	Newhalen Tribal Council
	Chastity Anelon	Iliamna Bristol Bay Native Association
	Alexanna Salmon	Igiugig Tribal Council
	Bill Cornell	Newhalen Lake and Penninsula School District
	Richard Bierer	Levelock Lake and Penninsula School District
	Renae Zackar	Kokhanok
	Paul Hobson Jr.	Kokhanok
	Louise Seeganna	Pedro Bay
	Greg Trefon	Newhalen
	McKayla Anelon	Newhalen
	Shanell Wassillie	Newhalen
	Matthew Anelon	Newhalen
	Eau Apokedak	Levelock
	Eric Tallekpalek	Levelock

APPENDIX C–2010 HOUSEHOLD SURVEY FORM

HARBOR SEAL SUBSISTENCE SURVEY

KOKHANOK, ALASKA

January to December, 2009

This survey is used to estimate subsistence harvests and to describe community subsistence economies. We will publish a summary report, and send it to all households in your community. We share the community information with the Alaska Department of Fish and Game, the U.S. Fish and Wildlife Service and the National Park Service. We work with the Federal Regional Advisory Councils and with local Fish and Game Advisory Committees to better manage subsistence, and to implement federal and state subsistence priorities.

We will NOT identify your household. We will NOT use this information for enforcement. Participation in this survey is voluntary. Even if you agree to be surveyed, you may stop at any time.

HOUSEHOLD ID:		
COMMUNITY ID:	KOKHANOK	198
RESPONDENT ID:		
INTERVIEWER:		
INTERVIEW DATE:		
START TIME:		
STOP TIME:		
DATA CODED BY:		
DATA ENTERED BY:		
SUPERVISOR:		

COOPERATING ORGANIZATIONS

BRISTOL BAY
NATIVE ASSOCIATION
P.O. BOX 310
DILLINGHAM, AK 99576

907-842-5932

DIVISION OF SUBSISTENCE
ALASKA DEPT OF FISH & GAME
333 RASPBERRY ROAD
ANCHORAGE, AK 99518

907-267-2353

UNIVERSITY OF ALASKA
ANCHORAGE
3211 PROVIDENCE DRIVE
ANCHORAGE, AK 99508

907-786-5932

HOUSEHOLD MEMBERS

HOUSEHOLD ID

Between JANUARY and DECEMBER, 2009…
…who lived in your household?

ID#	IS THIS PERSON ANSWERING QUESTIONS *ON THIS SURVEY?* *(circle)*	MALE OR FEMALE? *(circle)*	ALASKA NATIVE? *(circle)*	IN WHAT YEAR WAS THIS PERSON BORN? *(year)*	HOW LONG HAS THIS PERSON LIVED IN Kokhanok *(years)*	IN 2009, DID THIS PERSON PARTICIPATE IN HUNTING MARINE MAMMALS? *(circle)*	IN 2009, DID THIS PERSON HELP PROCESS MARINE MAMMALS? *(circle)*
HEAD 1	Y N	M F	Y N				
01							
Enter spouse or partner next. If household has a SINGLE HEAD, leave HEAD 2 blank.							
HEAD 2	Y N	M F	Y N				
02							
Enter children (oldest to youngest), grandchildren, grandparents, brothers, sisters, or anyone else living full-time in this household.							
03	Y N	M F	Y N		YRS	Y N	Y N
04	Y N	M F	Y N		YRS	Y N	Y N
05	Y N	M F	Y N		YRS	Y N	Y N
06	Y N	M F	Y N		YRS	Y N	Y N
07	Y N	M F	Y N		YRS	Y N	Y N
08	Y N	M F	Y N		YRS	Y N	Y N
09	Y N	M F	Y N		YRS	Y N	Y N
10	Y N	M F	Y N		YRS	Y N	Y N
11	Y N	M F	Y N		YRS	Y N	Y N
12	Y N	M F	Y N		YRS	Y N	Y N
13	Y N	M F	Y N		YRS	Y N	Y N
14	Y N	M F	Y N		YRS	Y N	Y N
15	Y N	M F	Y N		YRS	Y N	Y N

PERMANENT HH MEMBERS: 01 **KOKHANOK: 198**

HARVESTS: MARINE MAMMALS

HOUSEHOLD ID

Do members of your household USUALLY hunt for MARINE MAMMALS for subsistence?..... Y N

Between JANUARY and DECEMBER, 2009…
…Did members of your household USE or TRY TO HARVEST marine mammals?..... Y N

IF NO, go to the next harvest page.
If YES, continue on this page…

Please estimate how many marine mammals ALL MEMBERS OF YOUR HOUSEHOLD HARVEST for subsistence use this year. INCLUDE marine mammals you gave away, ate fresh, fed to dogs, lost to spoilage, or got by helping others. If hunting with others, report ONLY YOUR SHARE of the catch.

	IN 2009 DID MEMBERS OF YOUR HH…					IN 2009, HOW MANY _____ DID MEMBERS OF YOUR HOUSEHOLD HARVEST?													
	USE?	TRY TO HARVEST?	RECEIVE?	GIVE AWAY?	SEX	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER	UNKNOWN	UNITS	WERE LESS, SAME, OR MORE _____ AVAILABLE IN 2009, THAN IN RECENT YEARS?
	(circle)				(enter number by sex and month of take)														(ind)	(circle)
HARBOR SEAL (freshwater)	Y N	Y N	Y N	Y N	M														IND	L S M ?
300806020					F															
300806021					?															
300806022					M															
300806029					F															
HARBOR SEAL (saltwater)	Y N	Y N	Y N	Y N	?															
300806040					M														IND	L S M ?
300806041					F															
300806042					?															
300806049					M															
FUR SEAL	Y N	Y N	Y N	Y N	F															
300804000					?														IND	L S M ?
STELLER SEA LION	Y N	Y N	Y N	Y N																
301200000																			IND	L S M ?
301200001					M															
301200002					F															
301200009					?															
BELUGA WHALE	Y N	Y N	Y N	Y N																
301602000																			IND	L S M ?
WALRUS	Y N	Y N	Y N	Y N																
301400000																			IND	L S M ?
	Y N	Y N	Y N	Y N																
																			IND	L S M ?
																				"?" means "I don't know"

MARINE MAMMALS

Between JANUARY and DECEMBER, 2009…
…Did your household use LESS, SAME, or MORE marine mammals as in recent years?..... X L S M

X = DO NOT USE

If the SAME or DO NOT USE, skip the next question.

If different (LESS or MORE), how and why was your use different?

In 2009, did you notice any changes in the condition of the marine mammals that your household harvested, processed, or used for subsistence? X N Y

If Yes, please describe the changes in condition you observed

X = DID NOT USE

Between JANUARY and DECEMBER, 2009…
…WHERE did members of your household HUNT FOR marine mammals?
…WHERE did members of your household HARVEST marine mammals?

On MAP, mark all harvest locations for page subject.
Circle all search areas on MAP

MARINE MAMMALS: 12 **KOKHANOK: 198**

COMMENTS HOUSEHOLD ID

DO YOU HAVE ANY QUESTIONS, COMMENTS, OR CONCERNS?

INTERVIEW SUMMARY:

BE SURE TO FILL IN THE STOP TIME ON THE FIRST PAGE!!!!

COMMENTS: 30 **KOKHANOK: 198**

APPENDIX D–2011 HOUSEHOLD SURVEY FORM

HARBOR SEAL SUBSISTENCE SURVEY

KOKHANOK, ALASKA

January to December, 2011

This survey is used to estimate subsistence harvests and to describe community subsistence economies. We will publish a summary report, and send it to all households in your community. We share the community information with the Alaska Department of Fish and Game, the U.S. Fish and Wildlife Service and the National Park Service. We work with the Federal Regional Advisory Councils and with local Fish and Game Advisory Committees to better manage subsistence, and to implement federal and state subsistence priorities.

We will NOT identify your household. We will NOT use this information for enforcement. Participation in this survey is voluntary. Even if you agree to be surveyed, you may stop at any time.

HOUSEHOLD ID:		
COMMUNITY ID:	KOKHANOK	198
RESPONDENT ID:		
INTERVIEWER:		
INTERVIEW DATE:		
START TIME:		
STOP TIME:		
DATA CODED BY:		
DATA ENTERED BY:		
SUPERVISOR:		

COOPERATING ORGANIZATIONS

NATIONAL MARINE MAMMAL LABORATORY
NOAA

BRISTOL BAY
NATIVE ASSOCIATION
P.O. BOX 310
DILLINGHAM, AK 99576
907-842-5932

DIVISION OF SUBSISTENCE
ALASKA DEPT OF FISH & GAME
333 RASPBERRY ROAD
ANCHORAGE, AK 99518
907-267-2353

UNIVERSITY OF ALASKA
ANCHORAGE
3211 PROVIDENCE DRIVE
ANCHORAGE, AK 99508
907-786-5932

HOUSEHOLD MEMBERS

HOUSEHOLD ID

Between JANUARY and DECEMBER, 2011...
...who lived in your household?

ID#	IS THIS PERSON ANSWERING QUESTIONS *ON THIS SURVEY?* *(circle)*	MALE OR FEMALE? *(circle)*	ALASKA NATIVE? *(circle)*	IN WHAT YEAR WAS THIS PERSON BORN? *(year)*	HOW LONG HAS THIS PERSON LIVED IN Kokhanok *(years)*	IN 2011, DID THIS PERSON PARTICIPATE IN HUNTING MARINE MAMMALS? *(circle)*	IN 2011, DID THIS PERSON HELP PROCESS MARINE MAMMALS? *(circle)*
HEAD 1	Y N	M F	Y N				
01							
Enter spouse or partner next. If household has a SINGLE HEAD, leave HEAD 2 blank.							
HEAD 2	Y N	M F	Y N				
02							
Enter children (oldest to youngest), grandchildren, grandparents, brothers, sisters, or anyone else living full-time in this household.							
03	Y N	M F	Y N		YRS	Y N	Y N
04	Y N	M F	Y N		YRS	Y N	Y N
05	Y N	M F	Y N		YRS	Y N	Y N
06	Y N	M F	Y N		YRS	Y N	Y N
07	Y N	M F	Y N		YRS	Y N	Y N
08	Y N	M F	Y N		YRS	Y N	Y N
09	Y N	M F	Y N		YRS	Y N	Y N
10	Y N	M F	Y N		YRS	Y N	Y N
11	Y N	M F	Y N		YRS	Y N	Y N
12	Y N	M F	Y N		YRS	Y N	Y N
13	Y N	M F	Y N		YRS	Y N	Y N
14	Y N	M F	Y N		YRS	Y N	Y N
15	Y N	M F	Y N		YRS	Y N	Y N

PERMANENT HH MEMBERS: 01 **KOKHANOK: 198**

HARVESTS: MARINE MAMMALS

HOUSEHOLD ID

Do members of your household USUALLY hunt for MARINE MAMMALS for subsistence? ..... Y N

Between JANUARY and DECEMBER, 2011...
...Did members of your household USE or TRY TO HARVEST marine mammals? ..... Y N

IF NO, go to the next harvest page.

If YES, continue on this page...

Please estimate how many marine mammals ALL MEMBERS OF YOUR HOUSEHOLD HARVEST for subsistence use this year. INCLUDE marine mammals you gave away, ate fresh, fed to dogs, lost to spoilage, or got by helping others. If hunting with others, report ONLY YOUR SHARE of the catch.

	IN 2011 DID MEMBERS OF YOUR HH...					IN 2011, HOW MANY _____ DID MEMBERS OF YOUR HOUSEHOLD HARVEST?													WERE LESS, SAME, OR MORE _____ AVAILABLE IN 2011, THAN IN RECENT YEARS?
	USE?	TRY TO HARVEST?	RECEIVE?	GIVE AWAY?	SEX	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER	UNKNOWN	UNITS	
	(circle)					*(enter number by sex and month of take)*													*(ind)*	*(circle)*
HARBOR SEAL (freshwater)	Y N	Y N	Y N	Y N	M														IND	L S M ?
300806020					F															
300806021					?															
300806022					M															
300806029					F															
HARBOR SEAL (saltwater)	Y N	Y N	Y N	Y N	?														IND	L S M ?
300806040					M															
300806041					F															
300806042					?															
300806049					M															
FUR SEAL	Y N	Y N	Y N	Y N	F														IND	L S M ?
300804000					?															
STELLER SEA LION	Y N	Y N	Y N	Y N															IND	L S M ?
301200000																				
301200001					M															
301200002					F															
301200009					?															
BELUGA WHALE	Y N	Y N	Y N	Y N															IND	L S M ?
301602000																				
WALRUS	Y N	Y N	Y N	Y N															IND	L S M ?
301400000																				
	Y N	Y N	Y N	Y N															IND	L S M ?
																				" ? " means "I don't know"

MARINE MAMMALS

Between JANUARY and DECEMBER, 2011...
...Did your household use LESS, SAME, or MORE marine mammals as in recent years? ..... X L S M

X = DO NOT USE

If the SAME or DO NOT USE, skip the next question.

If different (LESS or MORE), how and why was your use different?

In 2011, did you notice any changes in the condition of the marine mammals that your household harvested, processed, or used for subsistence? X N Y

If Yes, please describe the changes in condition you observed

X = DID NOT USE

Between JANUARY and DECEMBER, 2011...
...WHERE did members of your household HUNT FOR marine mammals?
...WHERE did members of your household HARVEST marine mammals?

On MAP, mark all harvest locations for page subject.
Circle all search areas on MAP

MARINE MAMMALS: 12 **KOKHANOK: 198**

HARVESTS: MARINE MAMMALS

HOUSEHOLD ID

How many seals do you think there are in Iliamna Lake?

Are there variations in the number of seals in Iliamna Lake during the year? Y N

What months do you notice more seals in Iliamna Lake/Kvichak River?

JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER	UNKNOWN

What time of day do you observe seals hauled out? Morning Afternoon Evening

Have you observed pups in Iliamna Lake, and if so which months? Y N

JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER	UNKNOWN

Have you observed seals in the Kvichak River, and if so which months? Y N

JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER	UNKNOWN

Are the seals permanent in the lake or do you think they migrate?

Permanent
Migrate

Comments:

Hunting

Do you or have you hunted seals in Iliamna Lake or the Kvichak River? Y N
If yes continue

What are the preferred months of the year to hunt?

JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER	UNKNOWN

Why do you prefer hunting in this months?

Can you mark on the map for me where you prefer to hunt. *Mark with a polygon the hunting area.*

Does opportunistic hunting occur, or do you make specific trips to hunt or both?

Opportunistic
Specific
Both

If you hunt opportunistically can you mark on a map the area you usually harvest seals? *Mark with a polygon the hunting area.*

If you hunt opportunistically what activity are you usually doing when you harvest seals?

MARINE MAMMALS: 12 **KOKHANOK: 198**

COMMENTS

HOUSEHOLD ID

DO YOU HAVE ANY QUESTIONS, COMMENTS, OR CONCERNS?

INTERVIEW SUMMARY:

BE SURE TO FILL IN THE STOP TIME ON THE FIRST PAGE!!!!

COMMENTS: 30

KOKHANOK: 198

APPENDIX E–CONVERSION FACTORS

¶ The following table presents the conversion factors used in determining how many pounds were harvested for each reported individual animal harvested.

Resource name	Reported units (individual)	Conversion factor in pounds (lb)
Fur seal, male	1	15
Fur seal, female	1	15
Fur seal, unknown sex	1	15
Harbor seal (freshwater), male	1	56
Harbor seal (freshwater), female	1	56
Harbor seal (freshwater), unknown sex	1	56
Harbor seal (saltwater), male	1	56
Harbor seal (saltwater), female	1	56
Harbor seal (saltwater), unknown sex	1	56
Steller sea lion, male	1	200
Steller sea lion, female	1	200
Steller sea lion, unknown sex	1	200
Walrus, male	1	560
Walrus, female	1	560
Walrus, unknown sex	1	560
Beluga whale, male	1	831
Beluga whale, female	1	831
Beluga whale, unknown sex	1	831

APPENDIX F–LOCAL TRADITIONAL KNOWLEDGE (LTK) INTERVIEW GUIDE, 2011

LAKE ILIAMNA SEALS ETHNOGRAPHIC PROJECT

INTERVIEW PROTOCOL

Interviewer – This is a general list of questions. The interview can be as open-ended as you wish. The major questions that should be asked are marked with an asterisk. The rest depend on how the interview is going? Feel free to reword the questions. These interviews can be taped or you can just take notes, depending on how comfortable you and the interviewee feel with each method.

We are going to discuss the harvest and use of seals in your area. Your answers to these questions are anonymous. If we use any quotes citing your name we will ask your permission first.

DEMOGRAPHICS

*Date
*Researcher
*Name
*Age
*Parents Residence when Born
*Current Residence
*Years in Community

HUNTING HISTORY, EXPEREINCES, AND CONSERVATION STRATEGIES

(Use Map 1)

*How old were you when you first started hunting seals in the Lake and who taught you?
*What do you do to make sure your hunt is successful? How do you hunt? (Transport and access?) (How do you avoid/cope with wounding loss?)
*Do you try for certain types of seals? Male, female, big/old, little/young, saltwater/freshwater? If so, why?
*How are seals used? What parts? How are they processed?
*How long have seals been hunted in the Lake?
*Was there a time when there were no seals in the Lake?
*When were seals first known to overwinter in the Lake?
*Where do you hunt? (current hunting site) *Mark on map.*
*Has your hunting areas changed over the years? If so, when? *Mark on map.*
*What is the best time of year to hunt and does location change with the seasons?
Has the cost of fuel changed how often you hunt, where you go to hunt or what transportation method you use when hunting? How?
Is there anything else you would like to tell us about hunting strategies, traditional practices and customs, or your hunting experiences?

FRESHWATER SEAL HABITAT, ECOLOGY, AND HEALTH

(Use Map 2)

*Where do you usually see seals these days and has this changed? *Mark on map.*
*Are there more, less, or the same number of seals now as in the past?
*Do you think the harvest rate of seals is healthy? Has the rate of harvest changed over time?
*Do the seals leave Lake Iliamna and go to the salt water in Bristol Bay? If so,when?

*Do you know of any traditional stories that describe how the seals came to Lake Iliamna and where they came from?
*Can you describe any differences between freshwater and saltwater seals? (size, health, feed)
*What do the seals eat and where do they feed? (Winter and spring)
*Does their location change with the seasons? Do seal locations change as a result of lake conditions, weather, break-up, or freeze-up? (When is break-up/freeze-up on the lake?)
*Where do the seals haul-out on land and at what time? *Mark on map.* Why?
*Where do seals haul out on ice and at what time? *Mark on map.* Why?
*When (season) do you see the most seals hauled out? Why?
*Is this different now than in the past? If so, where did seals used to haul-out? *Mark on map.*
*Where do the seals give birth to their pups (on ice or on land)? *Mark on map.*
What color are the pups? Have you ever seen white pups?
Is this different today than in the past? If so, where did the seals used to have their pups? *Mark on map.* Why?
Was there a time when no pups were born in the Lake?
Are the seals healthy? Fat, good skins, few abnormal growths, etc.
Is there anything else that you want to tell us about the seals in Lake Iliamna?

APPENDIX G–BIOSAMPLING BUCKET CONTENTS

1. 200 lb spring scale (Hanson model 8920)
2. 1 length rope for using to hang seal/scale
3. Clipboard w/ sample guidelines
4. 2 biosampling manuals
5. Datasheets in protective cover
6. Bag of size large latex gloves
7. Blue knife
8. Small ziplock bag with
    a. 2 sharpies
    b. 2 pencils
    c. Thin rope
    d. Extra sample labels
    e. Cloth measuring tape
    f. Sewing gauge for measuring blubber thickness (mfg. Prym)
    g. Small red knife
9. Biosampling kit (for samples from 1 seal)
    a. Whirlpak bag with sample labels
    b. 1 large garbage bag
    c. 2 very large ziplock bags
    d. 3 gallon ziplock bags
    e. 9 quart ziplock bags
    f. Rope for tying stomach shut
    g. Label for outside of large bag

APPENDIX H–MARINE MAMMALS USED BY ILIAMNA LAKE COMMUNITY MEMBERS, AS DETERMINED THROUGH HOUSEHOLD SURVEYS

Common name	Scientific name
Marine Mammals	
Bearded seal	*Erignathus barbatus*
Beluga whale	*Delphinapterus leucas*
Bowhead whale	*Balaena mysticetus*
Gray whale	*Eschrichtius robustus*
Harbor seal (freshwater)	*Phoca vitulina*
Harbor seal (saltwater)	*Phoca vitulina*
Ringed seal	*Pusa hispida*
Sea otter	*Enhydra lutris kenyoni*
Walrus	*Odobenus rosmarus divergens*

APPENDIX I–USUAL ACTIVITIES WHEN HUNTING SEALS OPPORTUNISTICALLY, BY COMMUNITY

Community	Activity
Igiugig	TAKE TURNS, WATCHING RIVER.
	WHEN THE SEALS ARE SEEN IN THE RIVER.
	FISHING AND BOATING.
	HUNTING OTHER ANIMALS OUT FOR A BOAT RIDE.
	OUT SNOW MACHINE.
Iliamna	ICE FISHING
	ICE FISHING.
Kokhanok	TRAVELING ACROSS LAKE.
	SEAGULL EGG PICKING
	TAVELING ON ICE.
	EGG HUNTING OR FISHING IN SUMMER.
	HUNTING FOR MOOSE OR FISHING.
	SEAGULL EGG HUNTING AND BERRY PICKING.
	GOING FOR RIDE, LOOKING.
	TRAVELING.
Levelock	LOOKING, BOATING, CAMPING TO KOKHANOK. FISHING.
	MOOSE HUNTING OR BOATING
	GOING TO IGIUGIG ON BOAT.
	OUT RIDING AROUND.
	DRIVING BY BOAT.
	SEES SEALS WHILE TRAVELING, ALL YEAR ROUND.
	NEVER REALLY LOOKS - OUT RUNNING AROUND - IF THEY POP UP HE'LL GO AFTER THEM. WORD OF MOUTH - HUNTS WHERE HE HEARS ONE IS AROUND.
Newhalen	FISHING.
	MESSING AROUND, BEING MISCHIEF. OUT WITH FRIENDS FOR FUN.
	RIDING ON SKIFF.
	RIDING AROUND WITH SKIFF.
	FISHING OR BOAT RIDING.
	JUST OUT DRIVING AROUND "BOATING"
	FISHING
	FISHING, SEA GULL EGG HUNTING.
	PICKING EGGS AND ON A PICNIC.
	BOAT RIDING, SEA GULL EGG HUNTING.
	GETTING FALL FISH. WHEN TRAVELING TO BRISTOL BAY FOR COMMERCIAL FISHING HE OBSERVED SEALS ON KVICHAK RIVER, BUT DON'T HUNT IN RIVER
Pedro Bay	CAMPING OUT, BOATING.

Source ADF&G Division of Subsistence household surveys, 2012.