LIST OF APPENDICES:

Appendix A

Consent Form

The Northwest Arctic Borough is mapping important subsistence areas across the Borough communities with the guidance of elders and subsistence hunters, fishers, and gatherers. This research will help us preserve Iñupiaq culture by documenting local and traditional knowledge of subsistence practices by season. We are here to conduct an interview about subsistence. We want you to lead the discussion and indicate what is important to you. Local knowledge will be of equal importance to Western science. This research will help us understand the location of important subsistence areas allowing a database of these areas to be created for use in future permitting.

All information will be strictly confidential, and no information will be made public without your explicit written permission, and the unanimous written permission of the Tribal Governments, City Governments, Northwest Arctic Borough Mayor and the Northwest Arctic Borough Assembly. Per Borough Code 9.25.020 Areawide Standards, the information collected from interviews will be used to protect subsistence areas and in reviewing project proposals for development. All data gathered will belong to the Northwest Arctic Borough and to the participating communities.

Your participation is entirely voluntary, and you may stop the interview at any time. Furthermore, you are free to disclose only whatever information you are comfortable disclosing. Notes and audio recordings of the meeting will be taken and we will draw locations on maps. Your answers will be kept private. Your name will not be used in any reports. The name of the village may be used in reports, however, to identify location. Notes of your responses from this meeting, without your name, will be kept in secure files at the Northwest Arctic Borough, along with audio recordings. To thank you for participating and compensating you for your time, you will be paid $75.

If you have questions, comments, or concerns, you can contact the project coordinator:

Zach Stevenson

Subsistence Mapping Coordinator
Northwest Arctic Borough
Planning Department
163 Lagoon Street/P.O. Box 1110
Kotzebue, Alaska 99752

800-478-İ110 x110 (Toll-free)
907-442-2500 x110 (Direct)
907-442-2930 (Fax)
ZStevenson@nwabor.org
www.nwabor.org

Statement of Consent:

I understand the procedures described above. My questions have been answered to my satisfaction, and I agree to participate in this study. I have been provided a copy of this form.

_____

Signature of Participant & Date

_____

Printed Name

_____

Signature of Person Obtaining Consent & Date

Appendix B

Questionnaire

The following is a replication of the questionnaire used to solicit basic demographic and background information from each of the interviewees.

[Community] Interviewee Background Form

This form is for selecting interviewees and statistical purposes. All names, addresses, and contact information are confidential.

Full Name _____

Date of Birth _____

Sex M / F

Years lived in [Community] _____

Age that you began hunting, fishing, or gathering _____

3. Iñupiaq language (circle all that apply):

Speak some Speak fluently
Write Iñupiaq
Understand some Understand everything or mostly everything

4. How many years have you lived in [Community]? _____ years

E-mail Address _____

Phone Number _____

Address _____

Appendix C
Map Sizes and Scales

Buckland Maps:

Greater Region Map Set: This map set shows the largest area (1:100,000 scale).

1. Iñupiaq Place Names in the Buckland Region-DRAFT MAP; Topographic; Greater Region
2. Buckland Region-DRAFT MAP; Topographic; Greater Region ("Blank")
3. Iñupiaq Place Names in the Buckland Region-DRAFT MAP; Aerial; Greater Region
4. Buckland Region-DRAFT MAP; Aerial; Greater Region ("Blank")
5. Iñupiaq Place Names in the Buckland Region-DRAFT MAP; Navigational Chart; Greater Region
6. Buckland Region-DRAFT MAP; Navigational Chart; Greater Region ("Blank")

Local Detail Area # 1 Map Set: This map set shows the finest detail for the Buckland map series (1:32,000 scale). Aerial and navigation chart base maps are not included in this map set because of severe pixilation occurring at this scale. In addition to pixilation issues, the navigation chart base map was inappropriate for this map set since no marine areas are present in the mapped area.

7. Iñupiaq Place Names in the Buckland Region-DRAFT MAP; Topographic; Local Detail Area # 1
8. Buckland Region-DRAFT MAP; Topographic; Local Detail Area # 1

Local Detail Area #2 Map Set: This map set shows "medium" detail (1:42,000). Aerial base maps are not included in this map set because of severe pixilation occurring at this scale.

9. Iñupiaq Place Names in the Buckland Region-DRAFT MAP; Topographic; Local Detail Area # 2
10. Buckland Region-DRAFT MAP; Topographic; Local Detail Area # 2
11. Iñupiaq Place Names in the Buckland Region-DRAFT MAP; Navigational Chart; Local Detail Area # 2
12. Buckland Region-DRAFT MAP; Subtitle: Navigational Chart; Local Detail Area #2

Deering Maps:

Greater Deering Region Map Set: This map set is the largest area (1:200,000 scale) and includes all extent reference points from the village coordinator at the most practicable scale.

1. Topographic Iñupiaq Place Name Map; Greater Region
2. Aerial Iñupiaq Place Name Map; Greater Region
3. Topographic Index Map; Greater Region
4. Aerial Index Map; Greater Region
5. Topographic Map of the Deering Region-"Blank"
6. Aerial Map of the Deering Region-"Blank"

Medium Deering-Centered Map Set: This map set shows a smaller area, in finer detail (1:65,000 scale), around Deering.

7. Topographic Index Map; Mid-size; Centered
8. Aerial Index Map; Mid-size; Centered
9. Aerial Index Map; Mid-size; Centered; With In-Map Table Key*
10. Topographic Iñupiaq Place Name Map; Mid-size; Centered
11. Aerial Iñupiaq Map; Place Name Mid-size; Centered
12. Topographic Map of the Deering Region-"Blank"
13. Aerial Map of the Deering Region-"Blank"

*This is a trial map. It is the Aerial Index Map with a table key in the map of Iñupiaq place names and description of the data by index number in the map to avoid the need for a separate index table printout. Within-map table keys are only feasible at approximately the 1:65,000 scale and smaller because of the amount of data.

Small Deering-Centered Map Set: This map set shows the smallest area (1:32,000 scale) around Deering.*

14. Topographic Iñupiaq Place Name Map; Local
15. Aerial Iñupiaq Place Name Map; Local**
16. Topographic Map of the Deering Region-"Blank"
17. Aerial Map of the Deering Region-"Blank"**

*The index maps did not appear to be useful at this scale, because the place names were so dispersed. We only prepared Iñupiaq place name maps at this local scale.
**The quality of aerial satellite imagery at this scale is severely diminished for this area. We recommend only using the topographic maps in this set.

Medium East of Deering/Eschscholtz Bay Map Set: This map shows the concentration of place name data east of Deering, near Eschscholtz Bay, in more detail (1:65,000 scale) than the Greater Deering Region map set.

18. Topographic Index Map; Mid-size; East of Deering/Eschscholtz Bay
19. Aerial Index Map; Mid-size; East of Deering/Eschscholtz Bay
20. Topographic Iñupiaq Place Name Map; Mid-size; East of Deering/Eschscholtz Bay
21. Aerial Iñupiaq Place Name Map; Mid-size; East of Deering/Eschscholtz Bay
22. Topographic Map of the Deering Region-"Blank"
23. Aerial Map of the Deering Region-"Blank"

Kivalina Maps:

Kivalina Maps (1:140,000 scale):

1. Iñupiaq Place Names in the Kivalina Region-DRAFT MAP; Topographic
2. Kivalina Region-DRAFT MAP; Topographic ("Blank")

3. Iñupiaq Place Names in the Kivalina Region-DRAFT MAP; Aerial
4. Kivalina Region-DRAFT MAP; Aerial ("Blank")
5. Iñupiaq Place Names in the Kivalina Region-DRAFT MAP; Navigational Chart
6. Kivalina Region-DRAFT MAP; Navigational Chart ("Blank")

Kotzebue Maps:

Kotzebue Maps (1:100,000 scale):

1. Iñupiaq Place Names in the Kotzebue Region-DRAFT MAP; Topographic
2. Kotzebue Region-DRAFT MAP; Topographic ("Blank")
3. Iñupiaq Place Names in the Kotzebue Region-DRAFT MAP; Aerial
4. Kotzebue Region-DRAFT MAP; Aerial ("Blank")
5. Iñupiaq Place Names in the Kotzebue Region-DRAFT MAP; Navigational Chart
6. Kotzebue Region-DRAFT MAP; Navigational Chart ("Blank")

Plus 1 place name and 1 blank topo map at 1:32K

Noatak Maps:

Noatak Maps (1:170,000 scale):

1. Iñupiaq Place Names in the Noatak Region-DRAFT MAP; Topographic
2. Noatak Region-DRAFT MAP; Topographic ("Blank")
3. Iñupiaq Place Names in the Noatak Region-DRAFT MAP; Aerial
4. Noatak Region-DRAFT MAP; Aerial ("Blank")

Noorvik Maps:

Greater Noorvik Region Map Set: This map set is the largest area (1:170,000 scale) and includes all extent reference points from the village coordinator at the most practicable scale.*

1. Topographic Index Map; Greater Region
2. Aerial Index Map; Greater Region
3. Topographic Map of the Noorvik Region-"Blank"
4. Aerial Map of the Noorvik Region-"Blank"

*The Iñupiaq place name maps did not appear to be useful at this scale, because the place names were so concentrated. We only prepared numbered index maps at this regional scale.

Medium Noorvik-Centered Map Set: This map set shows a smaller area, in finer detail (1:65,000 scale), around Noorvik.

5. Topographic Index Map; Mid-size; Centered
6. Aerial Index Map; Mid-size; Centered
7. Topographic Iñupiaq Place Name Map; Mid-size; Centered

8. Aerial Iñupiaq Map; Place Name Mid-size; Centered
9. Topographic Map of the Noorvik Region-"Blank"
10. Aerial Map of the Noorvik Region-"Blank"

Small Noorvik-Centered Map Set: This map set shows the smallest area (1:32,000 scale) around Noorvik.*

11. Topographic Iñupiaq Place Name Map; Local
12. Aerial Iñupiaq Place Name Map; Local**
13. Topographic Map of the Noorvik Region-"Blank"
14. Aerial Map of the Noorvik Region-"Blank"**

*The index maps did not appear to be useful at this scale, because the place names were so dispersed. We only prepared Iñupiaq place name maps at this local scale.
**The quality of aerial satellite imagery at this scale is severely diminished for this area. We recommend only using the topographic maps in this set.

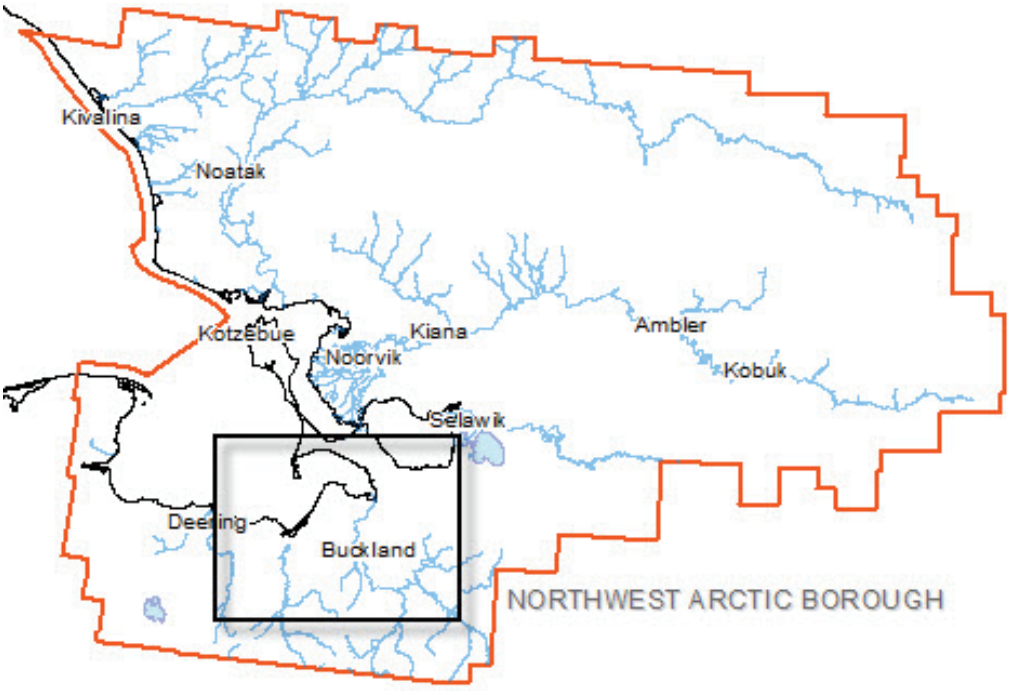
Selawik Maps:

Selawik Maps (1:170,000 scale):

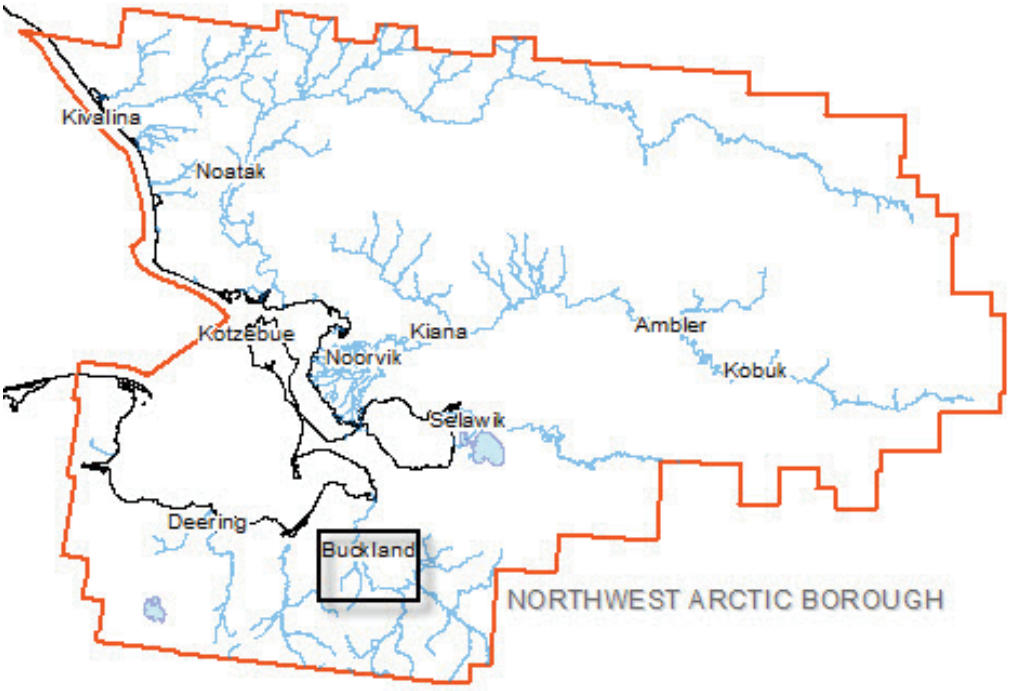
1. Iñupiaq Place Names in the Selawik Region-DRAFT MAP; Topographic
2. Selawik Region-DRAFT MAP; Topographic ("Blank")
3. Iñupiaq Place Names in the Selawik Region-DRAFT MAP; Aerial
4. Selawik Region-DRAFT MAP; Aerial ("Blank")

Site	Scale						
	1:32,000	1:42,000	1:65,000	1:100,000	1:140,000	1:170,000	1:200,000
Buckland	×	×		×			
Deering	×		×				×
Kivalina					×		
Kotzebue	×			×			
Noatak						×	
Noorvik	×		×			×	
Selawik						×	

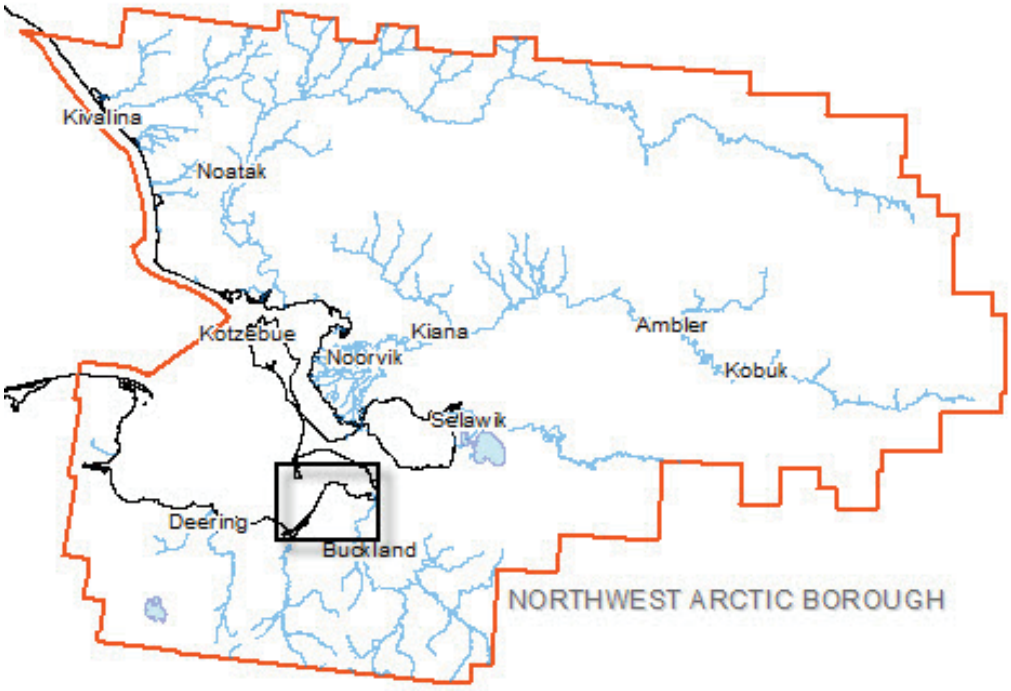
Buckland Greater Region (1:100K):



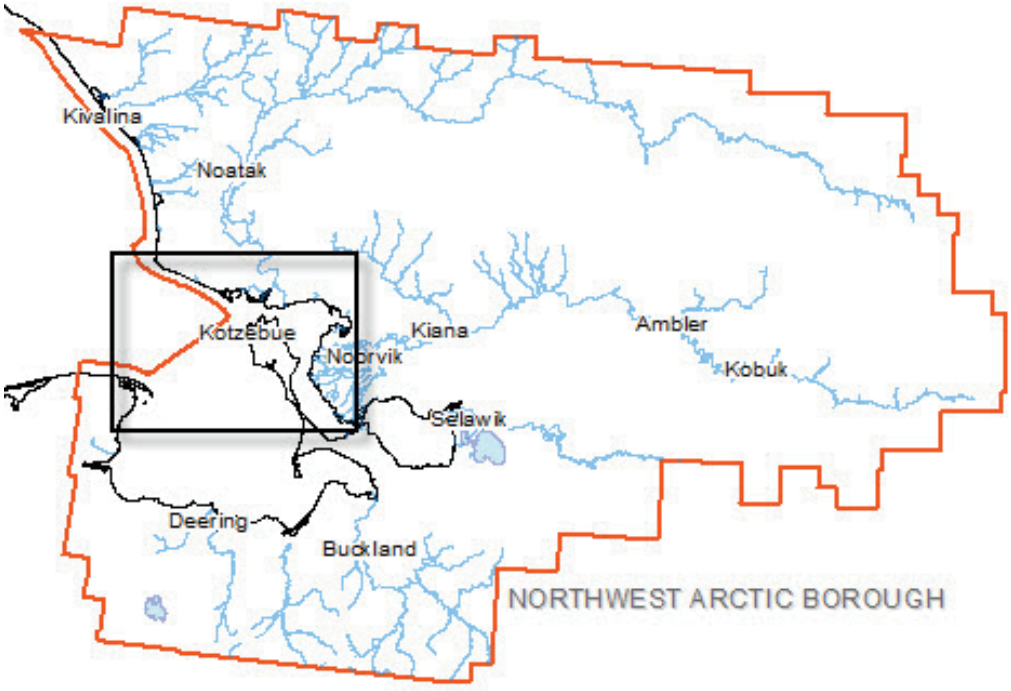
Buckland Local Detail (1:32K):



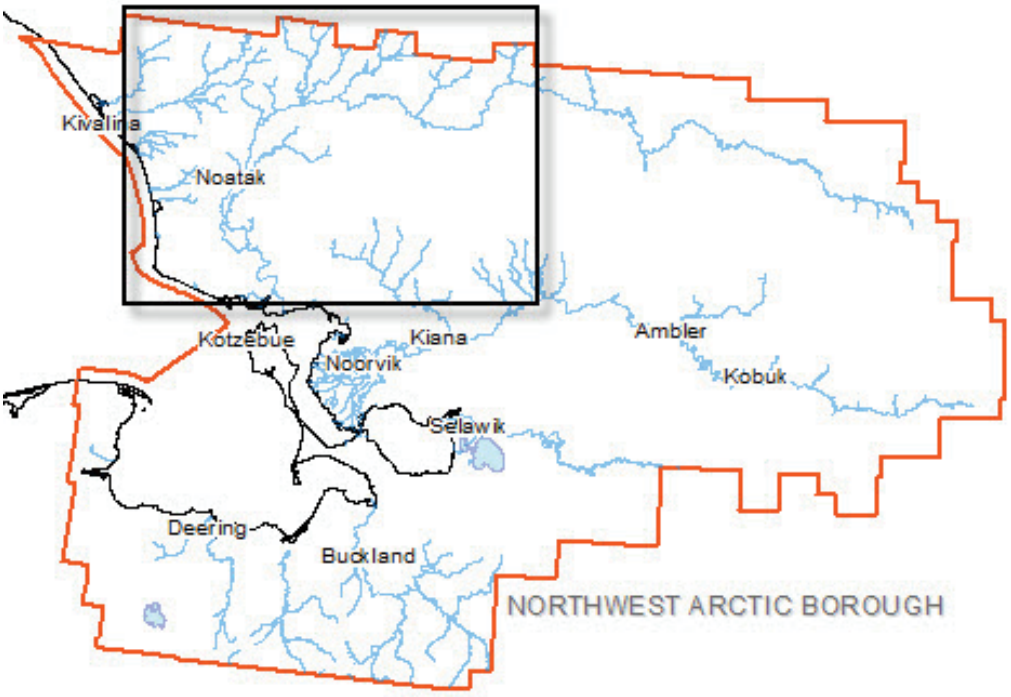
Buckland Local Detail 2 (1:42K):



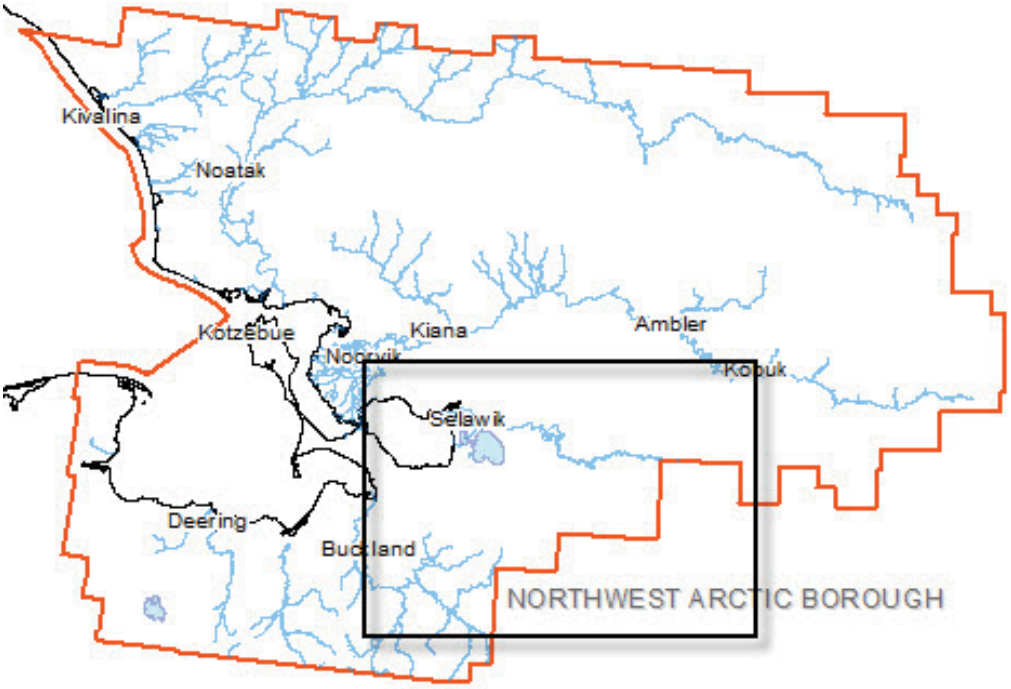
Kotzebue (1:100K):



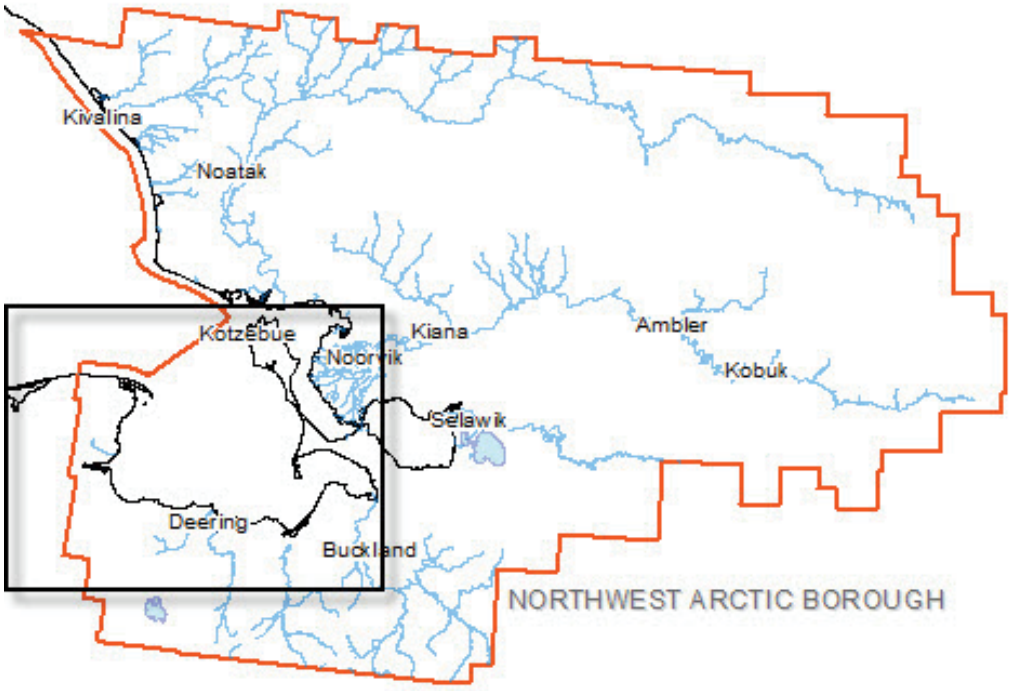
Noatak (1:170K):



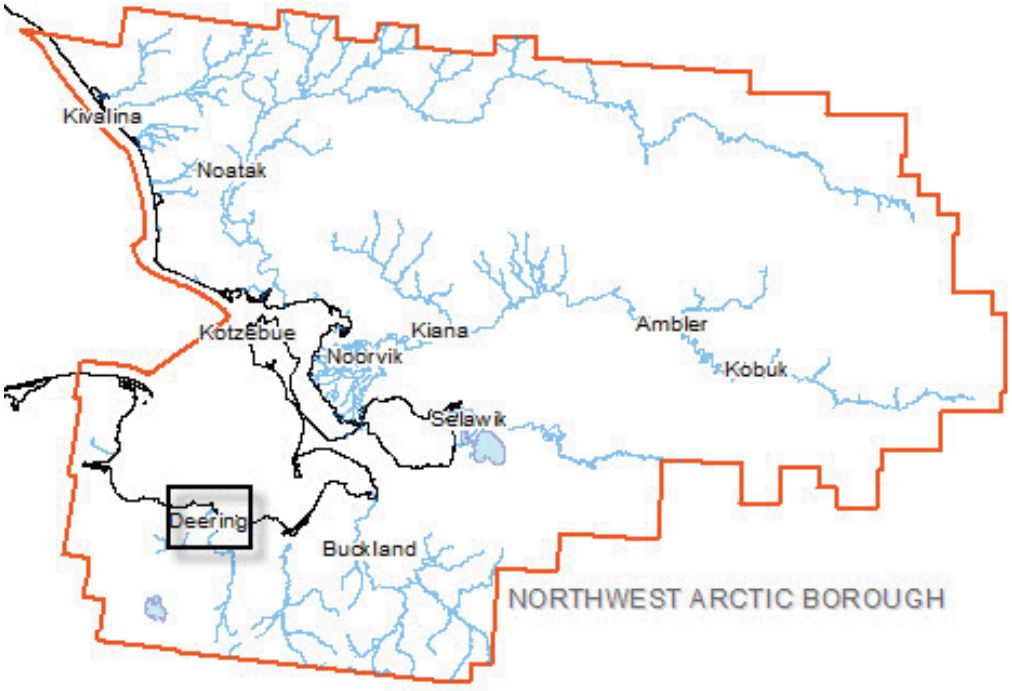
Selawik (1:170K):



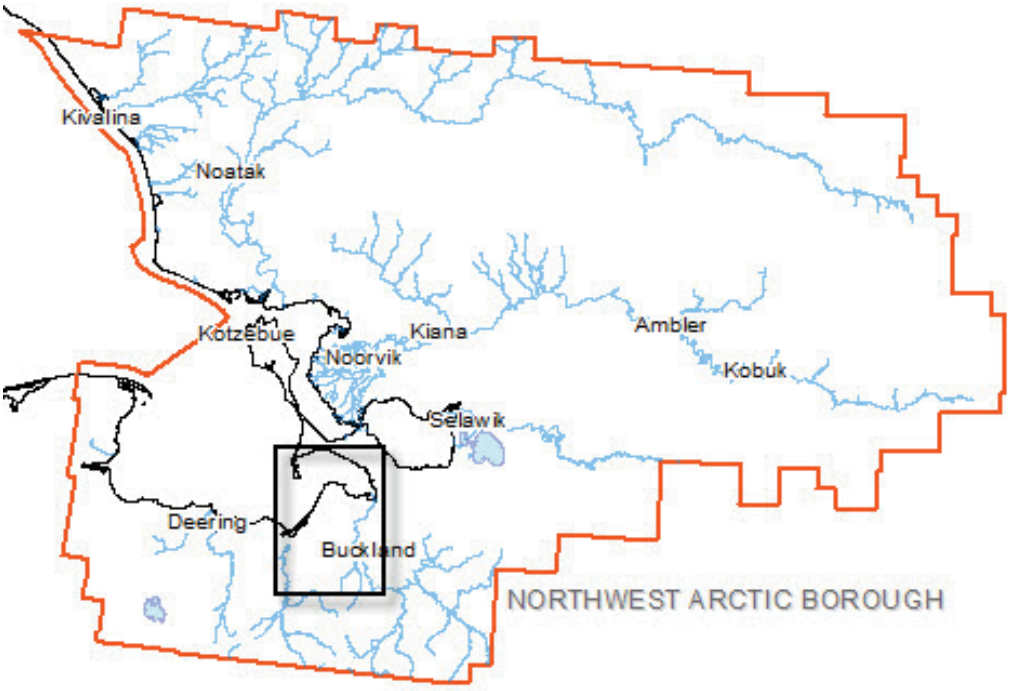
Deering Greater Region (1:200K):



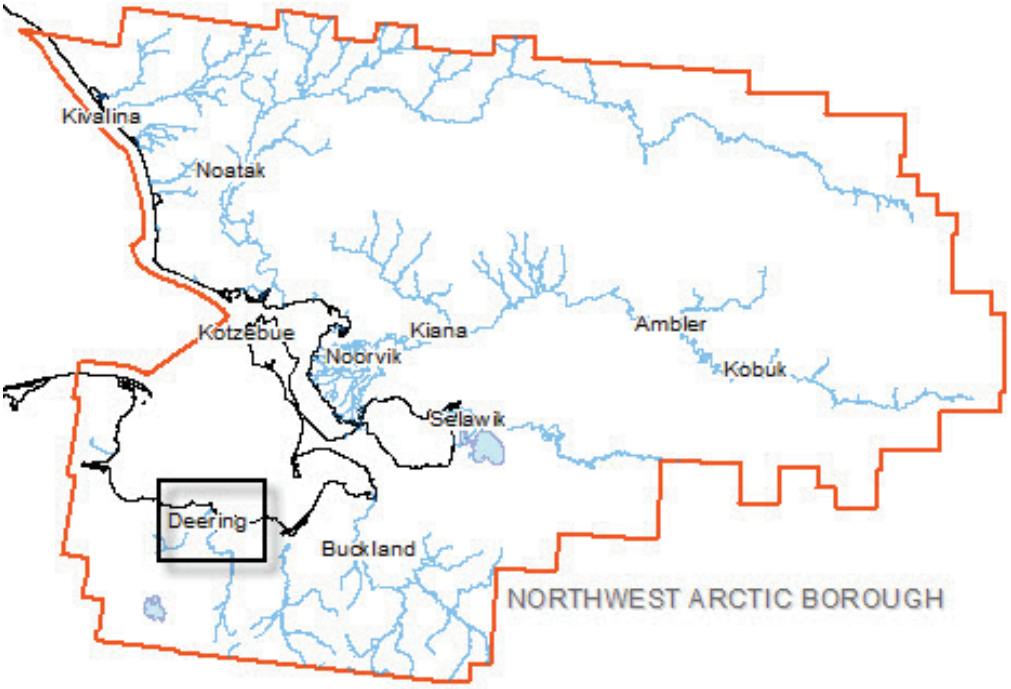
Deering Local (1:32K):



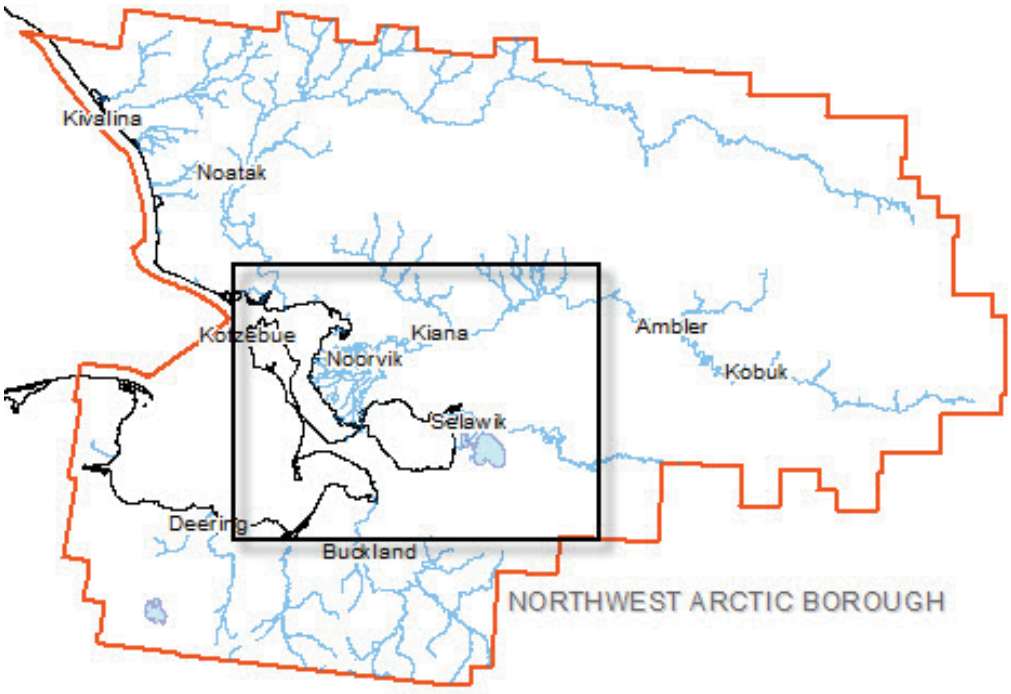
Deering Mid-Size East of Deering Eschscholtz Bay (1:65K):



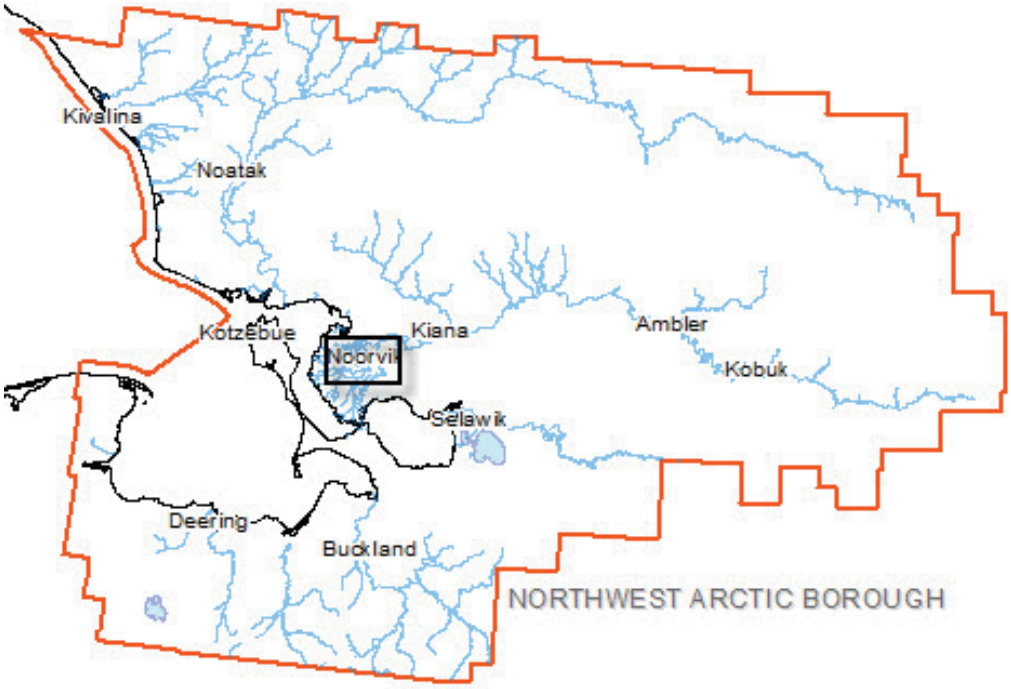
Deering Mid-Sized Centered (1:65K):



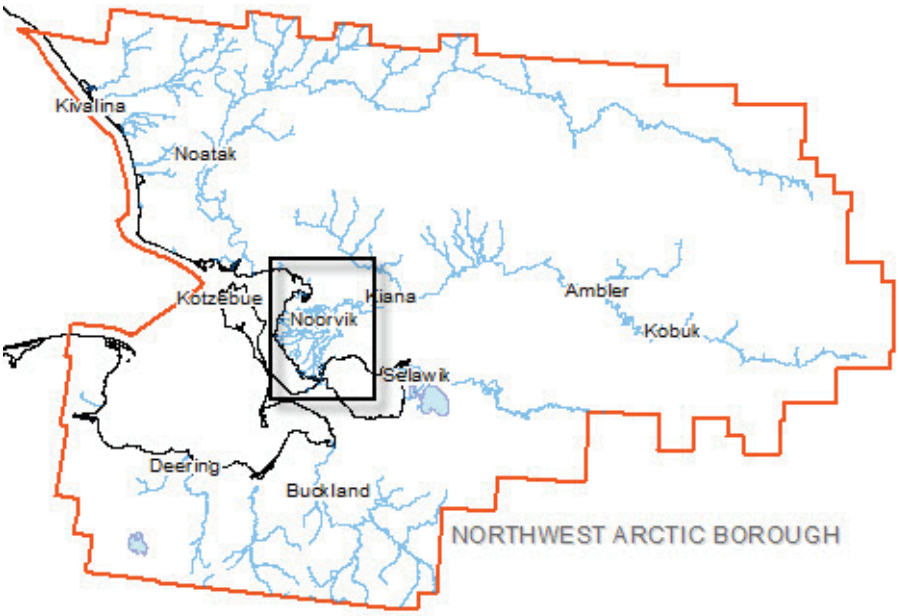
Noorvik Greater Region (1:170K):



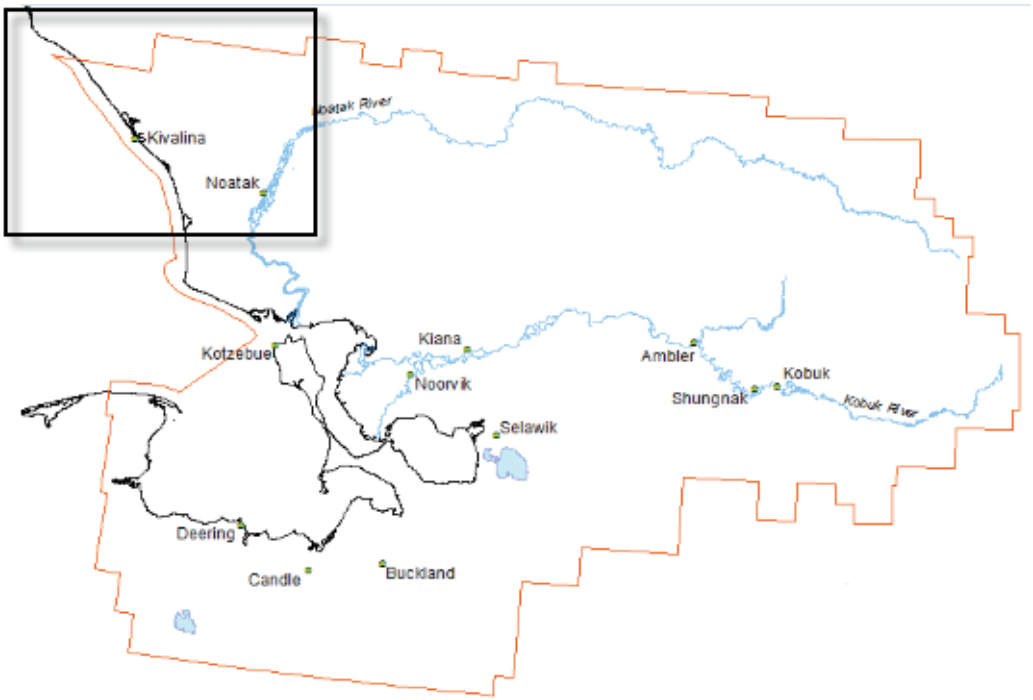
Noorvik Local (1:32K):



Noorvik Mid-sized centered (1:65K):



Kivalina (1:140K):



Appendix D:
Interviewer's Data Recording Sheet

Location: _____ Interviewee: _____ Mylar® ID:_____

Map ID	Type[a]	Season	Months	Ice[b]	Species	Notes

[a] Point, line, or polygon

[b] E.g., "before/after freeze-up/break-up" if applicable

Appendix E

Methodology for Analyzing Sufficiency and Representativeness of Study Sample

"Sufficiency of data" refers to how complete the data are expected to be after a given number of interviews.

"Representativeness" refers to how well the demographic makeup of the interviewees reflects the demographic makeup of the population of subsistence practitioners in the study area as a whole.

Analysis of Demographic Representativeness

This analysis was intended to determine how representative our sample of interviewees in each of our sites was and to determine which age/gender classes may have been underrepresented. These results (along with the analysis of completeness) were used to guide the recruitment of underrepresented classes in the following round of interviews. The demographics of the sampled interviewees in each community should be a representative cross-section of the subsistence practitioners (hunters, fishers, and/or gatherers) in the community as a whole. For example, if the male elders make up 8% of the subsistence practitioners in Kivalina, then 8% our Kivalina sample should similarly be male elders (i.e., should not differ significantly from 8%). However, as we do not have reliable data about the demographic makeup of *just* subsistence users in each community, this analysis approximates the numbers of subsistence practitioners from an estimate based on the demographic makeup of the community as a whole, which was then adjusted by input from the communities about the demographics composition of the subsistence practitioners. The village-level demographic data come from the 2010 US Census (US Census, 2010). For the purpose of this analysis, the data are stratified by gender and by age-category as follows: young adults (18-34), middle-aged adults (35-64), and elders (65 and above). The joint distributions of these categories (e.g., number of females age 18-34, etc.) were not available, so they were estimated from the marginal values (described below).

Approximating the joint distribution of gender and age class
Age and gender data for each site were obtained from the census data, and proportions of each category were calculated. For the purpose of this analysis, only adults (age ≥18) were considered. Because data are not stratified by both age and gender, proportions of each class were estimated from the marginal values. For example, in Buckland, the Census data are as follows:

Adult Males: (≥18):	132
Adult Females:	104
Age 18-34:	121 (includes males and females)
Age 35-64:	98
Age 65+:	17

From these data, we estimate the cells in the following contingency table:

Table E-1(a). Contingency table for age and gender classes in Buckland, AK

	18-34	35-64	65+	Total
Male	?	?	?	132
Female	?	?	?	104
Total	121	98	17	236

The proportion of each cell is estimated by multiplying the proportions of the marginal values of each row and column as a proportion of the total as in Table E-1(b) below.

Table E-1(b). Estimating cell values from marginal values

	18-34	35-64	65+	Total
Male	28.7%	23.2%	4.0%	55.9% (=132/236)
Female	22.6%	18.3%	3.2%	44.1% (=104/236)
Total	51.3% (=121/236)	41.5% (=98/236)	7.2% (=17/236)	100%

Adjusting the data to represent only regular subsistence practitioners

Table E-1(b) represents proportions of the entire village. However, we are interested in the proportions of each age and gender class for subsistence practitioners only. To estimate these values, we first asked our traditional knowledge specialist, village coordinators, and knowledgeable subsistence practitioners to estimate the percentage of each age-gender class that were active subsistence practitioners. For example, we asked: "Of all males age 18 – 34, what percentage are regular hunters, fishers, and/or gatherers?" We asked similar questions for each age and gender class. For elders (age 65 and older), we asked specifically "…what percentage were regular hunters, fishers, and/or gatherers *when they were most active*?" Finally, because Kotzebue has a wider array of available jobs than the surrounding villages, we asked them to estimate Kotzebue and the other villages separately. The mean values (n = 16) are reported in tables E-2(a) and E-2(b) below.

Table E-2(a). Estimated proportions of regular subsistence practitioners in Kotzebue

	18-34	35-64	65+
Male	29%	45%	70%
Female	17%	28%	59%

Table E-2(b). Estimated proportions of regular subsistence practitioners in Northwest Arctic Borough villages (excluding Kotzebue)

	18-34	35-64	65+
Male	51%	70%	93%
Female	41%	57%	84%

Note that in tables E-2(a) and E-2(b) the values in each cell represent proportions of each total subgroup. In other words in Table E-2(a), the first cell—for males age 18-34—indicates that 29% of all males age 18-34 are regular subsistence practitioners—*not that 29% of all subsistence practitioners are males age 18-34*.

Ultimately, we do wish to estimate the percentage of all subsistence practitioners in each age and gender class. In order to do this, we multiply the proportion of each age and gender class by the proportion of that age/gender class made up of regular subsistence practitioners. Using the Buckland data in Table E-1(b) to estimate, the updated values are given in table E-3 below.

Table E-3. Estimating relative proportions of regular subsistence practitioners in Buckland (not normalized = Table E-1(b) * Table E-2(b))

	18-34	35-64	65+	Total
Male	0.146 (51% of 28.7%)	0.162 (70% of 23.2%)	0.037 (93% of 4.0%)	*0.345*
Female	0.093 (41% of 22.6%)	0.104 (57% of 18.3%)	0.027 (84% of 3.2%)	*0.224*
Total	*0.239*	*0.266*	*0.064*	*0.569*

Finally, although the relative proportions are correct in Table E-3, to express them as a percentage, the total must sum to 1 (or 100%). To do this, we normalize all of the data by dividing each cell by the total (0.569). The final adjusted table is presented as E-4(a) below.

Table E-4(a). Estimated proportions of regular subsistence practitioners in Buckland

	18-34	35-64	65+	Total
Male	25.7%	28.5%	6.5%	60.7%
Female	16.3%	18.3%	4.7%	39.3%
Total	42.0%	46.8%	11.2%	100%

Table E-4(a) presents the final adjusted data for Buckland. Of all regular subsistence practitioners currently living in Buckland, these numbers estimate the percentage of those practitioners belonging to each age/gender class. Tables E-4(b) – (g) show similarly adjusted data for each of the communities.

Table E-4(b). Estimated proportions of regular subsistence practitioners in Deering

	18-34	35-64	65+	Total
Male	15.4%	34.3	9.7%	59.4%
Female	10.3%	23.1	7.3%	40.7%
Total	25.7%	57.4%	17.0%	100.1%[1]

Table E-4(c). Estimated proportions of regular subsistence practitioners in Kivalina

	18-34	35-64	65+	Total
Male	20.3%	25.1%	6.9%	52.1%
Female	18.1%	22.6%	6.9%	47.6%
Total	38.4%	47.7%	13.8%	99.7%

Table E-4(d). Estimated proportions of regular subsistence practitioners in Kotzebue

	18-34	35-64	65+	Total
Male	18.1%	33.3%	10.2%	61.6%
Female	10.2%	20.0%	8.3%	38.5%
Total	28.3%	53.3%	18.5%	100.1%

Table E-4(e). Estimated proportions of regular subsistence practitioners in Noatak

	18-34	35-64	65+	Total
Male	18.2%	29.9%	8.8%	56.9%
Female	13.5%	22.3%	7.3%	43.1%
Total	31.7%	52.2%	16.1%	100.0%

Table E-4(f). Estimated proportions of regular subsistence practitioners in Noorvik

	18-34	35-64	65+	Total
Male	19.0%	32.9%	9.5%	61.4%
Female	11.9%	20.6%	6.7%	39.2%
Total	30.9%	53.5%	16.2%	100.6%

Table E-4(g). Estimated proportions of regular subsistence practitioners in Selawik

	18-34	35-64	65+	Total
Male	22.8%	28.4%	5.8%	57.0%
Female	16.9%	21.3%	4.8%	43.0%
Total	39.7%	49.7%	10.6%	100.0%

We analyzed our data for each site independently using the G-goodness-of-fit test, in which our sample data are the "observed" frequencies, and tables E-4(a) – (g) indicated the "expected" proportions. Summary tables for our sample are provided below as Tables E-5(a) – (g). In each cell, the count of each age/gender class in our sample is given, followed by the percentage of the total sample in parentheses for the sake of direct comparison with Tables E-4(a) – (g).

Table E-5(a). Summary of sample data for Buckland, as of summer 2013

	18-34	35-64	65+	Total
Male	4 (23.5%)	12 (70.6%)	0 (0%)	16
Female	1 (5.9%)	0 (0%)	0 (0%)	1
Total	5	12	0	17

[1] Note: Totals may not sum to 100% due to rounding error.

Table E-5(b). Summary of sample data for Deering, as of summer 2013

	18-34	35-64	65+	Total
Male	2 (25%)	4 (50%)	2 (25%)	8
Female	0 (0%)	0 (0%)	0 (0%)	0
Total	2	4	2	8

Table E-5(c). Summary of sample data for Kivalina, as of summer 2013

	18-34	35-64	65+	Total
Male	4 (33.3%)	5 (41.7%)	2 (16.7%)	11
Female	1 (8.3%)	0 (0%)	0 (0%)	1
Total	5	5	2	12

Table E-5(d). Summary of sample data for Kotzebue, as of Jan 2014

	18-34	35-64	65+	Total
Male	4 (10.5%)	12 (31.6%)	9 (23.7%)	25
Female	4 (10.5%)	8 (21.1%)	1 (2.6%)	13
Total	8	20	10	38

Table E-5(e). Summary of sample data for Noatak, as of summer 2013

	18-34	35-64	65+	Total
Male	0 (0%)	9 (60.0%)	3 (20.0%)	12
Female	0 (0%)	2 (13.3%)	1 (6.7%)	3
Total	0	11	4	15

Table E-5(f). Summary of sample data for Noorvik, as of summer 2013

	18-34	35-64	65+	Total
Male	0 (0%)	8 (38.1%)	2 (9.5%)	10
Female	2 (9.5%)	8 (38.1%)	1 (4.8%)	11
Total	2	16	3	21

Table E-5(g). Summary of sample data for Selawik, as of summer 2013

	18-34	35-64	65+	Total
Male	1 (4%)	12 (48%)	6 (24%)	19
Female	0 (0%)	5 (20%)	1 (4%)	6
Total	1	17	7	25

Results—

For each cell of each table, the *p* values of the G-goodness-of-fit statistics are provided in Tables E-6(a) – (f) below. Proportions that are significantly different ($p \leq 0.05$) from the expected values (*see* Tables E-4(a) – (f)) are indicated with asterisks to denote the age/gender class is underrepresented.

Table 6a. Buckland: *p* values for the G-goodness-of-fit test

	18 – 34	35 – 64	65+
Male	0.43	>0.99	0.50
Female	0.08	0.03*	0.58

Table 6b. Deering: *p* values for the G-goodness-of-fit test

	18 – 34	35 – 64	65+
Male	0.55	0.80	0.91
Female	0.27	0.10	0.65

Table 6c. Kivalina: *p* values for the G-goodness-of-fit test

	18 – 34	35 – 64	65+
Male	0.72	0.92	0.91
Female	0.16	0.05*	0.56

Table 6d. Kotzebue: *p* values for the G-goodness-of-fit test

	18 – 34	35 – 64	65+
Male	0.07	0.78	>0.99
Female	0.09	0.42	0.46

Table 6e. Noatak: *p* values for the G-goodness-of-fit test

	18 – 34	35 – 64	65+
Male	0.03*	>0.99	0.95
Female	0.04*	0.29	0.45

Table 6f. Noorvik: *p* values for the G-goodness-of-fit test

	18 – 34	35 – 64	65+
Male	0.005**	0.80	0.63
Female	0.27	0.94	0.74

Table 6g. Selawik: *p* values for the G-goodness-of-fit test

	18 – 34	35 – 64	65+
Male	0.006**	0.99	>0.99
Female	0.001**	0.55	0.44

For each significantly underrepresented age/gender class in each village, the minimum number of additional interviewees necessary, such that the proportions would not significantly differ from the expected values was calculated. The minimally necessary data were:

Buckland:	1 female 35-64
Kivalina:	1 female 35-64
Kotzebue:	None
Noatak:	1 male 18-34 and 1 female 18-34
Noorvik:	2 males 18-34
Selawik:	3 males 18-34 and 4 females 18-34

Analysis of Data Sufficiency

This analysis was similarly conducted after the first round of interviews had been completed. It was intended to determine how complete our sample of interviewees in each of our sites was. These results, along with the analysis of representativeness, were used to determine the number of additional interviews to be conducted.

One of the primary objectives of the subsistence mapping project was to document those lands that are used for subsistence practices. In principal, we would hope to document all such lands used for subsistence. However, the only way to be certain that all such lands are indeed documented would be a complete census of all subsistence practitioners. However, because many different people use the same lands for the same purposes, there is considerable overlap of information. As such, there are generally diminishing returns on the amount of new information provided by each additional interviewee. Therefore, a good approximation to the total land use may be captured from only a subset of the population in each community. This analysis quantifies the amount of new data that might be expected from each additional interview.

Methods:

The methods for this part of the project are currently pending review for publication in a peer-reviewed scientific journal. In the meantime, the methods are available at both of the following URLs, which will be updated as the review process continues.
http://www.nwabor.org/pdfs/subsistence_mapping_project_methods_Appendix_E.pdf
http://www.phillips-research.com/pdfs/subsistence_mapping_project_methods_Appendix_E.pdf

Appendix F

Source Code for Calculating Lifetime Subsistence Estimates

```
#=====================================================================#
#                                                                     #
#  Lifetime Subsistence Estimates                                     #
#  This script assumes input files "IntervieweeData" a .csv file in   #
#  which each entry is an individual interviewee, and fields include  #
#  "Age", "AgeRange" (with values "young", "mid" and "senior" for age #
#  ranges [18, 34], [35, 64], and [65, maxAge] repsectively), "Sex"   #
# ("male" or "female") and "totalArea" (indicating the total area of  #
#  the union of all of that individual's search areas)                #
#                                                                     #
#  @author: Damian Satterthwaite-Phillips <damiansp@gmail.com>        #
#  @version: 04 Feb 2015                                              #
#                                                                     #
#=====================================================================#


# Load data
dat <- read.csv('Path_to_IntervieweeData.csv')

# Reorder age range so that ordering is: young, mid, senior
dat$AgeRange <- factor(dat$AgeRange, levels(dat$AgeRange)[c(3, 1, 2)])

# Code to test a range of exponential transforms to find the optimal
# value
# @param x: the vector of untransformed data
# @param expRange: a vector of length two, indicating the minimum and
#                  maximum values of exponents to test
# @param res: resolution--e.g., distance between different exponents to
#             test
# @param graph: if TRUE, graphical output is provided
# @return: a list of best.exponent--the optimal exponent found, within
#          the range provided, and to the nearest resolution provided;
#          p.value--the p value of the Shapiro-Wilk Test for the
#          transformed data (x^best.exponent)
bestExpTrans <- function(x, expRange=c(-1, 1), res=0.01, graph=T) {
    # Keep track of best p values for Shapiro-Wilk Test and the
    # exponents associated with them (NOTE: for this test, a higher p
    # value indicates greater normality)
    ps <- c()
    exps <- seq(expRange[1], expRange[2], res)
    # 0 exponent is undefined, so remove if in vals:
    if (0.0 %in% exps) {
       index0 <- which(exps == 0.0)
       exps <- exps[-index0]
    }

    # Loop through all exponent values and append p value to ps
    for (i in 1:length(exps)) {
       ps <- c(ps, shapiro.test(x^exps[i])$p.value)
    }

    bestP <- max(ps)[1]
    bestExp <- exps[which(ps == bestP)]
```

```
    if (graph == T) {
       plot(ps ~ exps, type='l')
       abline(v=exps[which(ps == bestP)], col=2)
    }

    return (list(best.exponent=bestExp, p.value=bestP))
}

# Transform variables
bestExpTrans(dat$totalArea)
dat$areaT <- dat$totalArea^0.10  # optimal for our data; p = 0.65
                                 # change exponent values as required
bestExpTrans(dat$nPoly)
dat$nPolyT <- dat$nPoly^-0.04    # p = 0.15

bestExpTrans(dat$nSpec)
dat$nSpecT <- dat$nSpec^0.31     # p = 0.77

bestExpTrans(dat$Age)
dat$ageT <- dat$Age^0.68         # p = 0.04

attach(dat)


# Model the total search area with age, log(age), age range, sex, and
# their interactions as predictors
ageCatMod <- lm( areaT ~ log(ageT) + log(ageT):Sex + AgeRange +
                 AgeRange:Sex, data = dat )
summary(ageCatMod)
ageCatMod <- step(ageCatMod, direction='both')
summary(ageCatMod) # p = 2.18e-10     rsq. = 0.28
par(mfrow=c(2,2))

# Note that this model has very good diagnostics. In particular,
# variance is constant, and residuals are normally distributed.  These
# are important assumptions to meet when reversing the transformation
# to estimate variance at age 89
plot(ageCatMod)
shapiro.test(resid(ageCatMod)) # p = 0.92


# Use model to estimate total search area at age 89

# For a given data point, project their expected lifetime search area
# @param err: the error or residual value of the data point relative to
#             the model (ageCatMod)
# @parm mid: dummy variable: 1 if the person is middle-aged, 0
#            otherwise
# @parm senior: dummy variable: 1 if the person is a senior, 0
#               otherwise
# @parm male: dummy variable: 1 if the person is a male, 0 otherwise
# The function uses the model fit from our data; change accordingly
ageAdj <- function(err, mid, senior, male) {
   ( coef(ageCatMod)[1] + coef(ageCatMod)[2]*(log(89^0.68)) +
     coef(ageCatMod)[3]*mid + coef(ageCatMod)[4]*senior +
     coef(ageCatMod)[5]*log(89^0.68)*male + err )^10
```

```
}

resids <- resid(ageCatMod)
# Create vectors for each of the dummy variables
mid.v <- 1*(AgeRange[!is.na(Age)] == 'mid')
senior.v <- 1*(AgeRange[!is.na(Age)] == 'senior')
male.v <- 1*(Sex[!is.na(Age)] == 'male')

# Estimate total search areas at age 89
adjAreas <- ageAdj(resids, mid.v, senior.v, male.v)

# Plot
boxplot( adjAreas ~ AgeRange[!is.na(Age)],
         main='Predicted Total Search Area Over a Lifetime',
         ylab=expression('Area ' (km^2)), cex.lab=0.8 )

# Now obtain bootstrap estimates of different quantiles from the
# projected data
# Number of iterations to bootstrap
n <- 500000

# Number of each age group in the actual sample
nYoung <- 39
nMid <- 91
nSenior <- 30

# Initialize vectors of length n to store quantile estimates for each
# age group
yQ <- mQ <- sQ <- numeric(n)

# Set desired quantile to test
Q <- 0.7
lifetimeArea <- adjAreas

# Bootstrap, and write quantile estimates to yQ, mQ, and sQ
for (i in 1:n) {
   # Output progress
   if (i %% 100 == 0) {
      cat(round(100*(i/n), 2), '% complete\n', sep='')
   }

   youngAreas <- sample( lifetimeArea[AgeRange == 'young'], size=nYoung,
                         replace=T )
   midAreas <- sample( lifetimeArea[AgeRange == 'mid'], size=nMid,
                       replace=T )
   seniorAreas <- sample( lifetimeArea[AgeRange == 'senior'],
                          size=nSenior, replace=T )

   yQ[i] <- quantile(youngAreas, Q)
   mQ[i] <- quantile(midAreas, Q, na.rm=T)
   sQ[i] <- quantile(seniorAreas, Q)
}

# Display the distributions of the quantile estimates for each age
# group
par(mfrow=c(3, 1))
par(mar=c(2, 4, 2, 1))
```

```
hist( yQ, xlim=c(0.9*min(yQ, mQ, sQ), 1.1*max(yQ, mQ, sQ)),
      main=paste( 'Young Adult ', Q*100,
                  'th Percentile (500000 bootstraps)', sep='' ))
abline( v=quantile(yQ, probs=c(0.01, 0.05, 0.95, 0.99)), col=2,
        lty=c(2,1,1,2) )
legend('topright', lty=1:2, col=2, legend=c('95% CI', '99% CI'))

hist( mQ, xlim=c(0.9*min(yQ, mQ, sQ), 1.1*max(yQ, mQ, sQ)),
      main=paste('Middle Aged Adult ', Q*100,
      'th Percentile (500000 bootstraps)', sep='') )
abline( v=quantile(mQ, probs=c(0.01, 0.05, 0.95, 0.99)), col=2,
        lty=c(2,1,1,2) )

hist( sQ, xlim=c(0.9*min(yQ, mQ, sQ), 1.1*max(yQ, mQ, sQ)),
      main=paste( 'Senior ', Q*100, 'th Percentile (500000 bootstraps)',
                  sep='' ))
abline( v=quantile(sQ, probs=c(0.01, 0.05, 0.95, 0.99)), col=2,
        lty=c(2,1,1,2) )


# For higher quantiles, and especially max values (e.g., the 100th
# percentile) bootstrap estimates are limited in their inference,
# because they can never estimate a value greater than the maximum
# observed value.  To overcome this limitation, we use a kernel density
# estimate of the distribution of lifetime search areas, which assigns
# a non-zero probability to ages above the maximum observed
youngDensity <- density(lifetimeArea[AgeRange == 'young'])
midLifetimeArea <- lifetimeArea[AgeRange == 'mid']
midLifetimeArea <- midLifetimeArea[!is.na(midLifetimeArea)]
midDensity <- density(midLifetimeArea)
seniorDensity <- density(lifetimeArea[AgeRange == 'senior'])

# In earlier versions of R, the MASS library must be installed before
# the truehist function can be called.  To do this, uncomment and run
# the following line:
# library(MASS)
truehist( lifetimeArea[AgeRange == 'young'],
          xlim=c(0, 1.1*max(lifetimeArea)) )
lines(youngDensity)
truehist( lifetimeArea[AgeRange == 'mid'], xlim=c(0,
          1.1*max(lifetimeArea)) )
lines(midDensity)
truehist( lifetimeArea[AgeRange == 'senior'], xlim=c(0,
          1.1*max(lifetimeArea)) )
lines(seniorDensity)


yQ <- mQ <- sQ <- numeric(n)

# Set Q to 1 (max)
Q <- 1

# Bootstrap, sampling from kernel density estimates, and write quantile
# estimates to yQ, mQ, and sQ
for (i in 1:n) {
   # Output progress
   if (i %% 100 == 0) {
```

```
      cat(round(100*(i/n), 2), '% complete\n', sep='')
    }

    youngAreas <- sample( youngDensity$x, size=nYoung, replace=T,
                          prob=youngDensity$y/sum(youngDensity$y) )
    midAreas <- sample( midDensity$x, size=nYoung, replace=T,
                        prob=midDensity$y/sum(midDensity$y) )
    seniorAreas <- sample( youngDensity$x, size=nYoung, replace=T,
                          prob=seniorDensity$y/sum(seniorDensity$y) )

    yQ[i] <- quantile(youngAreas, Q)
    mQ[i] <- quantile(midAreas, Q, na.rm=T)
    sQ[i] <- quantile(seniorAreas, Q)
}

# Plot distributions
hist( yQ, xlim=c(0.9*min(yQ, mQ, sQ), 1.1*max(yQ, mQ, sQ)),
      main=paste('Young Adult ', Q*100,
      'th Percentile (500000 bootstraps)', sep='') )
abline( v=quantile(yQ, probs=c(0.01, 0.05, 0.95, 0.99)), col=2,
        lty=c(2,1,1,2) )
legend('topright', lty=1:2, col=2, legend=c('95% CI', '99% CI'))

hist( mQ, xlim=c(0.9*min(yQ, mQ, sQ), 1.1*max(yQ, mQ, sQ)),
      main=paste('Middle Aged Adult ', Q*100,
      'th Percentile (500000 bootstraps)', sep='') )
abline( v=quantile(mQ, probs=c(0.01, 0.05, 0.95, 0.99)), col=2,
        lty=c(2,1,1,2) )

hist( sQ, xlim=c(0.9*min(yQ, mQ, sQ), 1.1*max(yQ, mQ, sQ)),
      main=paste('Senior ', Q*100, 'th Percentile (500000 bootstraps)',
      sep='') )
abline( v=quantile(sQ, probs=c(0.01, 0.05, 0.95, 0.99)), col=2,
        lty=c(2,1,1,2) )

detach(dat)   # clear dat from memory


#=====================END OF SCRIPT=================#
```

Appendix G
Data Release Consent Form and Mayor's Cover Letter

NORTHWEST ARCTIC BOROUGH

Ambler Buckland Candle Deering Kiana Kivalina Kobuk
Kotzebue Noatak Noorvik Selawik Shungnak

September 19, 2014

Dear Noorvik Participant in the Subsistence Mapping Project:

I am pleased to report that significant progress has been made on the subsistence mapping project that incorporates information you provided during interviews over the last year. The project team has produced initial draft maps of subsistence use for inclusion in an atlas that will be published next May. Before finalizing these maps, we would like your consent-to include information from your interviews. Please take a moment to complete the enclosed form and return it to me in the enclosed stamped envelope.

As promised, we won't be producing "treasure maps," and your specific ·search areas will not be identified. Instead, the maps will consolidate information into general maps. I've enclosed a sample map with this letter to give you an idea of what the maps will look like.

Information from the project will help the Borough protect subsistence uses and resources during reviews of development projects and during planning efforts. The project will also provide our children, grandchildren, and future generations with important information about subsistence.

After receiving consent from the subsistence users interviewed for this ·project, we will bring the draft atlas to the village advisory groups and to city and tribal councils for their final review. After their input, the Assembly and I will be asked for final approval before releasing the map atlas.

In closing, I wish to thank you for your participation in this important project. I look forward to hearing back from you. Please send me the completed form by September 26, 2014.

Sincerely,

Reggie Joule
Mayor

P.O. Box 1110 · Kotzebue, Alaska 99752 · (907) 442-2500 · Fax (907) 442-2930 · www.nwabor.org

Northwest Arctic Borough Subsistence Mapping Project
Consent Form

Subsistence User Interviews

This form asks for your input on the three items listed below. Please complete the entire form and return it to me in by September 26, 2014. A self-addressed and postage paid envelope is provided.

1) **Use of Subsistence Information in Map Atlas:** I agree to the use of information that I provided about subsistence search areas in the map atlas being prepared for the subsistence mapping project. I understand the maps will show only general use areas and my specific search areas will not be depicted on the maps. Before being published, the atlas will be approved by the community advisory groups established for this project, by the cities and tribes, by Northwest Arctic Borough Mayor Joule, and by the Borough Assembly.

_____	_____	_____
Signature of Person Interviewed	Printed Name of Interviewee	Date Signed

2) **Acknowledgement:** The map atlas will include a section acknowledging people who have participated in the project. Please check one of the boxes below.

___ Please add my name to the acknowledgements section of the map atlas.

___ Do not add my name to th3e acknowledgements section of the atlas.

3) **Future Use of Information:** As indicated in the consent form I previously signed, the Borough will have access to the entire project database for use during planning efforts and during reviews of development projects.

In the event there is a need to use information from this project by others in addition to the Borough, I agree that information I provided may be included in a limited database if the following criteria are met.

- My information will be aggregated with that of others interviewed (my specific information will not be accessible in the limited database).
- The affected city and tribe will provide written approval before access to the database is provided.

_____	_____	_____
Signature of Person Interviewed	Printed Name of Interviewee	Date Signed

Appendix H

Process Followed to Arrive at Density Scores on Analysis Maps in Chapter 4

The step-by-step process we used to quantify marine multi species (including human subsistence harvesters) to determine important areas for species and ecosystem IEAs for the maps in chapter 4 is explained below.

Step 1: Small and Large Study Areas Delineated

At the outset of our analytical process, two study areas were delineated for the southern Chukchi Sea and Kotzebue Sound area, with the smaller study area being the eastern portion of the larger study area. We examined the two different spatial scales, because we suspected the patterns of relative importance might be different at the two scales.

The large analysis study area was delineated by the following set of boundaries: starting with the northern maritime boundary of the Northwest Arctic Borough from the coast out to three nautical miles and working in a counterclockwise direction from there, the boundary heads in a straight line northwest to 68°30'00"N 169°W; south along 169°W to 66°N; northeast in a straight line to the northern extent (three nautical miles offshore) of the southwestern maritime boundary of the Northwest Arctic Borough off the Seward Peninsula; following the Northwest Arctic Borough maritime boundary to shore; and along the coastline of the Northwest Arctic Borough back to the starting point. The analysis maps ultimately included in chapter 4 are of this large area.

The smaller analysis study area was a subset of the larger study area. The area was delineated by all of the area in the large study area east of the straight line from the point that is the northern extent (three nautical miles offshore) of the southwestern maritime boundary of the Northwest Arctic Borough to the point that is the western extent of the northern maritime boundary of the Northwest Arctic Borough. Because the results between the smaller and larger study area had qualitatively similar patterns, only the results of the large study area are presented in the atlas.

Step 2: IEA Density Proxy Assigned to Individual Species and Area Attributes

To identify multi species marine IEAs, we created an IEA density proxy for each individual species. For each species, IEAs were identified for reproduction, rearing, feeding, migration, or general health of a given species. Each type of IEA was given a density score of 1 (important areas for reproduction, rearing, feeding, migration, or general health of a given species). We calculated the IEA density proxy as the summation of the individual types. For example, an area that was important for reproduction and feeding received an IEA density proxy score of 2, whereas an area that was only important for feeding would receive an IEA density proxy score of 1.

Areas where information on reproduction, rearing, feeding, migration was not available but were known to be high density (concentration or high-concentration areas) were assumed to be IEAs as well, with concentration areas receiving a density score of 1 and high-concentration areas receiving a density score of 2. This scoring method enabled us to combine different types of information (density with key life cycle areas) about a species to create one IEA density proxy.

In some cases, information was available that allowed us to extrapolate the density of a species or attribute across the region. In these cases, we used density as the IEA density proxy. Areas of high density received a high-IEA density proxy score while areas with a low-density proxy received a lower score.

Step 3: Analysis Structure for Multi-Species IEAs and Ecosystem IEAs Established

An analysis structure was established to identify Multi Species IEAs and Ecosystem IEAs within each season. Most species in the Arctic have a seasonal distribution and abundance cycle. The analyses we conducted were repeated for each season as well as for a composite of all seasons, as follows:

1. Winter: December, January, February
2. Spring: March, April, May
3. Summer: June, July, August
4. Fall: September, October, November
5. Year-Round: information combined across all seasons

The level of ecological complexity (single species IEA, multi species IEA, and ecosystem IEA) affects the identification of IEAs. An area that is critical for one species, say beluga whales, may not be the same place where productivity and habitat lead to numerous other species converging in an area. An analysis at only one level of ecological complexity will miss patterns of abundance at other levels of ecological complexity. To account for this, we structured our analysis to find evidence of IEAs at three levels of ecological complexity:

1. Single Species
2. Multiple Species (subsistence harvesters, marine mammals, seabirds, fish, zooplankton, benthos, primary production, sea ice)
3. Ecosystem

Information for each species was mapped to identify IEAs for that species. The mapped areas include information about reproduction, rearing, feeding, migration, the general health of a given species, and density, which are all evidence of important areas for a species. Likewise, information for individual species was combined and mapped to provide evidence of multi species IEAs. Similarly, the information for multi species IEAs was combined to identify ecosystem IEAs.

Step 4: Groupings of Multiple Species Established for IEA Identification

We identified multi species groupings by examining the major features of the ecosystem that are described in the literature. The specific groupings were identified through review of the scientific literature, discussions with Arctic researchers, and examination of available data sets; and correspond to prior work in the region that compartmentalizes components of the ecosystem (NPRB 2006). The following provides a brief overview of each multi species grouping and why it was included. More detailed overviews of each grouping are provided in subsequent sections of the atlas.

Subsistence Harvesters: Arctic peoples' subsistence way of life is an essential part of having healthy Arctic ecosystems, and we consider subsistence harvesting to constitute a part of the ecosystem. Hunters use large areas over which they search for subsistence resources, as the location of subsistence resources can vary on an hourly, daily, and seasonal basis (Kassam and Wainwright Traditional Council 2001, Kawerak 2013). For terms of the analysis, we treated each type of subsistence activity as a "species," and considered combined subsistence as a "multi species" grouping.

Marine Mammals: Many species of marine mammals utilize the southern Chukchi Sea and Kotzebue Sound area, including bowhead, beluga and gray whales; porpoise; walrus; bearded, ringed, spotted, and ribbon seals; and polar bears.(Angliss and Outlaw 2008, Smith 2010) Marine mammals are an important taxonomic group in the Arctic. Most marine mammal species are near the top of the food web and are important subsistence resources (ACIA 2004).

Seabirds and Waterfowl: Audubon Alaska has identified several Important Bird Areas in the southern Chukchi Sea region (Smith et al. 2012). Birds are important foragers in Arctic marine ecosystems (Smith 2010, Smith et al. 2012, Gall et al. 2013) and a subsistence resource (Kassam and Wainwright Traditional Council 2001). Birds are also good indicator species for environmental changes in an ecosystem (Springer et al. 1984, Gall et al. 2013).

Fish: Fish fill a central role in the food web in almost every marine ecosystem (Lalli and Parsons 1997). Small fish are forage for larger fish and marine mammals, and larger fish can be important predators (Enticknap et al. 2011). In Arctic marine ecosystems, fish, especially Arctic cod, are an important link between the plankton and higher trophic levels such as birds and marine mammals (ACIA 2004). Subsistence fishers harvest a number of different fish species, including salmon, cod, trout, sheefish, and whitefish (Georgette and Shiedt 2005, Whiting 2006, Magdanz et al. 2010).

Benthic Species (Benthos): A diverse group of animals live on and in the mud and sand of the sea floor, which is commonly referred to as the benthos. The benthos of the southern Chukchi Sea region is rich in comparison to other areas of the world (Grebmeier et al. 2006a, Grebmeier 2012). The seafloor community is fueled by a rain of organic material made up of dead and dying plankton and other animal remnants or waste. Much of the energy of Arctic marine ecosystems moves through the benthos, which provides rich foraging grounds for benthic feeding marine mammals and sea ducks (Grebmeier et al. 2006b).

Primary Production: In marine ecosystems algae utilize the sun's energy through photosynthesis to grow. Almost all the primary production in Arctic marine ecosystems comes from microscopic algae that grow floating in the water (phytoplankton) or attached to sea ice (ACIA 2004). Primary production is the foundation of life in marine ecosystems, and large blooms of algae are consumed by zooplankton, clams, and many other animals.

Sea Ice: While sea ice is not a living part of the ecosystem, it is a key component of structuring Arctic ecosystems (ACIA 2005), which is why it is included in the analyses. Sea ice is habitat for algae, microscopic animals, fish, and marine mammals. Open water areas, known as polynyas, can be pockets of productivity in the ecosystem, areas where marine mammals can swim and forage, and important migration corridors for seabirds and marine mammals (Laidre et al. 2008, Moore and Huntington 2008). Landfast ice is important habitat for denning seals through the winter and spring (Kelly et al. 2010), and provides an extension of land for subsistence hunters (Kassam and Wainwright Traditional Council 2001). In summer, areas of longer lingering ice can be an important platform for walruses and seals to rest on (Kassam and Wainwright Traditional Council 2001, Jay et al. 2012).

Step 5: Hierarchical Analytical Values Outlined

We used a hierarchical process for identifying IEAs. As highlighted earlier, IEAs for each species were identified through a synthesis of existing information wherever adequate information was available. The multi species groupings established in *Step 4* were used to combine IEA information from different species (following the process outlined in *Step 6*) within each multi species grouping to identify multi species IEAs. For example, beluga whale IEA information was combined with available IEA information for all other marine mammal species in the region to identify marine mammal multi species IEAs. Subsequently the different multi species IEA information was then combined to identify ecosystem IEAs.

In some cases, such as for primary production and seafloor biomass, there was not available information on individual species, but there was information available as a metric of the multi species grouping. For example, integrated water column chlorophyll-*a* is a proxy of primary production that is a measure of the

many different species of phytoplankton in the water column. In these cases we used the metric as an indicator of IEAs for that multi species grouping.

As explained above, this analysis was conducted five times: once for each season and once for information combined across all seasons (Year-Round).

Step 6: IEA Information Combined

At the individual species level, delineating IEAs is relatively straightforward. However combining information from different sources is necessary to identify multi species IEAs and ecosystem IEAs. This requires combining information potentially collected with different methods and measurements. The following is an overview of the steps used in the analyses to combine information.

To combine the information, a fixed 5x5 kilometer grid was created across the large and small study areas.

The following process was used for combining different species IEA information in a given season to identify multi species IEAs in that season:

1. The average IEA density proxy value in each grid cell was calculated for a species in a season.
2. The grid cell IEA density proxy values were converted to positive standard deviates.
3. Steps 1-2 were repeated for the other species in that multi species grouping for that season.
4. All species' positive standard deviates in each grid cell were summed for that ecological feature in that season.
5. The summed value in each grid cell was divided by the square root of the number of species in a multi species grouping.

The following steps were used to combine the multi species IEAs in a given season to identify ecosystem IEAs in that season.

1. Within each grid cell the values of the different multi species IEAs (results of step 5. above) for a season were summed.
2. The summed value in each grid cell was divided by the square root of the number of multi species categories.

We elaborate on each of these steps in the following paragraphs:

Calculating the Average IEA Density Proxy Values in Each Grid Cell

The fixed grid cells were overlaid on each IEA density proxy map, and the average density value in each grid cell (5 X 5 km) was calculated. If a grid cell was fully covered by a density value of 1, the average value of that grid cell was 1. If three quarters of that grid cell were covered by a density value of 1 and the rest of the grid cell had an IEA density proxy value of 0, the average density value of that grid cell was 0.75.

Converting Grid Cell Density Values to Positive Standard Deviates

The calculated grid cell density values resulted in 868 and 2,427 measures of density across the small and large study areas respectively. The measures have a mean (average) and a standard deviation for each study area. The standard deviation measures the amount of dispersion in the data away from the mean. Small dispersions result in a small standard deviation, while large dispersions result in a large standard deviation.

The mean and standard deviation can be used to determine how far above or below average each density value is from the mean relative to the dispersion of the data. This is referred to as a standard deviate. It is calculated with the following formula:

$$z_{ij} = \frac{x_{ij} - \overline{x}_i}{\sigma_i}$$

Where (z_{ij}) is the standard deviate of grid cell j for the ith species, (x_{ij}) is the density value for grid cell j for the ith species, and ($\overline{x}_i$) and (σ_i) are the mean and standard deviation respectively of the calculated grid cell density values for the ith species.

A standard deviate close to zero means the value is close to the average. A large negative standard deviate means the value is well below average, while a large positive standard deviate means the value is well above average. Grid cell density values were converted to standard deviates to provide a systematic way to compare information about different species.

As we are specifically interested in areas that are above average, we set all negative standard deviates to zero. Most species are found in particular habitats and not found everywhere (MacArthur 1958). We did not want the lack of a particular species in an area to count against that area just because the area was not habitat for that species. For example, walrus prefer to forage on clams, but gray whales in the southern Chukchi Sea region prefer to feed on small crustaceans called amphipods that live on the seafloor (ADFG 2008). We did not want the fact that walrus do not feed on amphipods to count against the areas where gray whales forage. To avoid a penalty for an area without a particular species, the analysis only included positive standard deviates.

Combining Positive Standard Deviates

For a multi species grouping in a season, the positive standard deviates from each of the species IEA layers were summed within each grid cell. In other words, for the marine mammals grouping in spring for grid cell #378, each of the positive standard deviates for bearded seal, ringed seal, spotted seal, bowhead whale, beluga whale, gray whale, and polar bear in grid cell #378 were added together, which was also done for the other grid cells as well. In this case, the grid cells with high combined positive standard deviates are the areas that have multiple marine mammal IEAs and are therefore a marine mammal multi species IEA.

Addressing No Data Areas

Efforts to combine data across many aspects of the ecosystem will inevitably run into portions of the study area where there is a data gap for one or more species or in the ecosystem. This is especially true in the southern Chukchi Sea and Kotzebue Sound region, where there are numerous data gaps. This atlas brings together disparate and often very old data sets to identify patterns for, marine mammals and other species, but there are many cases where there are known data gaps. Additionally, many data gaps are unknown or poorly delineated, and in these cases, areas of missing data are effectively counted as zeroes in these analyses.

For a species or multi species grouping with a known data gap, we calculated the positive standard deviate based on the grid cells for which data was available. Using a subset of grid cells to calculate standard deviates has a negligible effect on the values of those standard deviates so long as there are a large numbers of grid cells (as there are in both of our study areas). When normalizing we accounted for data gaps by dividing the values in each grid cell by the number of layers for which there was data for that grid cell (including IEA density proxy values of zero).

Year-Round Analysis

The IEA analyses were carried out for each season and for a composite of all four seasons. The year-round analysis integrated the information available for each species across the four seasons. For each species the information on IEAs for all seasons was combined. To calculate the IEA density proxy for each species in the year-round analysis, we mapped all IEAs without consideration of season. If a spot on the map was an IEA for a species in fall, but not during any other season it would be considered an IEA area in the year-round analysis (IEA density proxy of 1). If a spot on the map was an IEA for spawning for a species in one season and rearing for that same species in another season that area on the map would receive an IEA density proxy of 2 for that species.

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Appendix I

Additional Information on Existing and Potential Development in the Northwest Arctic Borough

More information about existing and potential development areas in the Northwest Arctic Borough can be found at the below links.

The Bureau of Land Management (BLM) provides numerous resources, including:

Data on Resource Management classes:

- http://www.blm.gov/pgdata/etc/medialib/blm/ak/fdo/ksp.Par.27883.File.dat/2_1_vrm_b.pdf
- http://www.blm.gov/pgdata/etc/medialib/blm/ak/fdo/ksp.Par.11597.File.dat/2_2_vrm_c.pdf
- www.blm.gov/pgdata/etc/medialib/blm/ak/fdo/ksp.Par.5951.File.dat/2_3_vrm_d.pdf

Locatable and Known Mineral Areas:

- http://www.blm.gov/pgdata/etc/medialib/blm/ak/fdo/ksp.Par.16389.File.dat/2_11_minerals_locate_c.pdf
- http://www.blm.gov/pgdata/etc/medialib/blm/ak/fdo/ksp.Par.96892.File.dat/2_12_minerals_locate_d.pdf
- http://www.blm.gov/pgdata/etc/medialib/blm/ak/fdo/ksp.Par.99231.File.dat/3_29_minerals_locate.pdf

Zoning for Fluid Mineral Leasing:

- http://www.blm.gov/pgdata/etc/medialib/blm/ak/fdo/ksp.Par.98706.File.dat/2_6_minerals_fluid_b.pdf
- http://www.blm.gov/pgdata/etc/medialib/blm/ak/fdo/ksp.Par.96129.File.dat/2_7_minerals_fluid_c.pdf
- http://www.blm.gov/pgdata/etc/medialib/blm/ak/fdo/ksp.Par.94168.File.dat/2_8_minerals_fluid_d.pdf

Locations of Known Oil and Gas Basins:

- http://www.blm.gov/pgdata/etc/medialib/blm/ak/fdo/ksp.Par.40037.File.dat/3_27_oilgas_basins.pdf

Zoning for Solid Mineral Exploration/Prospecting:

- http://www.blm.gov/pgdata/etc/medialib/blm/ak/fdo/ksp.Par.99125.File.dat/2_9_minerals_solid_c.pdf
- http://www.blm.gov/pgdata/etc/medialib/blm/ak/fdo/ksp.Par.20670.File.dat/2_10_minerals_solid_d.pdf

Locations of Known Coal Resources:

- http://www.blm.gov/pgdata/etc/medialib/blm/ak/fdo/ksp.Par.34528.File.dat/3_28_coal.pdf

Lease Status on BLM Lands:

- http://www.blm.gov/pgdata/etc/medialib/blm/ak/fdo/ksp.Par.52569.File.dat/3_26_mineral_leasing.pdf

Locations of Placer Mining Applications:

- http://www.blm.gov/pgdata/etc/medialib/blm/ak/fdo/ksp.Par.71920.File.dat/3_30_minerals_apma.pdf

The Alaska Department of Natural Resources provides a record of all existing mining claims in the state:

- http://dnr.alaska.gov/MapAK/mapper?url=General%20User&uid=mining&reqtype=LINK&gsid=CC2A8B5C01345DA5B2C52E83D1A99BEA.tomcat-91

Current information on the status of the Ambler Road (one of the "Roads to Resources," a network of roads proposed to link mineral resources to urban centers around Alaska and to ports or other transportation sites), can be found at: http://www.ambleraccess.org/projects/ambler/index.html

Appendix J

Bilingual Listing of Subsistence Species in the Study

The following is a list of species harvested for subsistence in the Northwest Arctic Borough, Alaska, as documented in the present research project. This table is modeled after U.S. Fish and Wildlife Service (2011, App. H); supplemental data for plant species and Iñupiaq names are from Jones (1983).

Taxonomic Group	Subgroup	Common Name	Species	Iñupiaq Name(s)[a]
Birds, Fish, Mammals & Invertebrates				
Birds				
	Gaviiformes (Loons[b])	Pacific loon	*Gavia pacifica*	*Malġi*
		Red-throated loon	*G. stellata*	*Qaqsrauq*
		Yellow-billed loon	*G. adamsii*	*Tuutlik*
		Common loon	*G. immer*	*Taatchiŋiq*
	Anseriformes (Waterfowl)	Swan	*Cygnus columbianus, C. buccinator*	*Qugruk*
		Greater white-fronted goose, Specklebelly goose	*Anser albifrons*	*Kigiyuk*
		Snow goose	*Chen caerulescens*	*Kaŋuq*
		Emperor goose, Grey goose	*C. canagica*	*Liġliqpak, Liġliq*
		Brant	*Branta bernicla*	*Niġliqnaq*
		Canada goose	*B. canadensis*	*Iqsraġutilik*
		Cackling goose	*B. hutchinsii*	
		Canvasback	*Aythya valisineria*	
		Greater scaup, Bluebill	*A. marila*	*Qaqlutuuq*
		Teal	*Anas crecca, A. discors*	*Qaiŋiq*
		Mallard	*A. platyrhynchos*	*Ivugasrugruk*
		Northern pintail, "Pigeontail"	*A. acuta*	*Ivugaq, Kurugak*

	Northern shoveler, "Spoonbill"	*A. clypeata*	*Aluutaq*
	Wigeon	*A. americana, A. penelope*	*Ugiihiq*
	Eider	*Polysticta stelleri, Somateria fischeri, S. mollissima, S. spectabilis*	*Igniqauqtuq, Qavaasuk, Mitiq, Amauligruaq, Qiŋalik*
	Long-tailed duck, Old squaw duck	*Clangula hyemalis*	*Aahaaliq*
	Scoter, "Black ducks"	*Melanitta nigra, M. perspicillata, M. fusca*	*Uviñauyuk, Tuunġaaġruk, Killalik*
Galliformes (Game fowl)	Ptarmigan	*Lagopus lagopus, L. mutus*	*Aqargiq, Niqsaaqtuŋiq*
Gruiformes (Cranes)	Sandhill crane	*Grus canadensis*	*Tatirgaq*
Charadriiformes (Gulls and shorebirds)	Wilson's snipe	*Gallinago delicata*	*Kuukukiaq*
	Seagull[b]	*Larus* spp. *Rissa tridactyla, Rhodostethia rosea, Xema sabini, Pagophila eburnea*	*Nasiŋaruaġruk, Nauyatchiaq, Qiġitiġiaq, Nauyasugruk, Aqargigiaq*
	Murre[b]	*Uria aalge, U. lomvia*	*Akpaliq, Akpaluuraq*
	Puffin[b]	*Fratercula*	*Qilaŋak*
		corniculata, F. cirrhata	
	Tern	*Sterna paradisaea, S. aleutica*	*Mitqutailaq*
Stigiformes (Owls)	Great horned owl	*Bubo virginianus*	*Nukisaġaq*
	Snowy owl	*Nyctea scandiaca*	*Ukpik*

Fish

Clupeidae	Pacific herring	*Clupea pallasii*	*Uqsruqtuuq*
Esocidae	Northern pike	*Esox lucius*	*Siulik*

Gadidae	Arctic cod, Blue cod	*Boreogadus saida*	*Qaluaq*
	Saffron cod Tom cod	*Eleginus gracilis*	*Uugaq*
	Burbot, Mudshark, Link cod	*Lota lota*	*Tittaaliq*
Osmeridae	Smelt	*Hypomesus olidus, Osmerus mordax*	*Iłhuaġniq*
Pleuronectidae	Flounder	*Pleuronectes quadrituberculatus, P. stellatus*	*Ipqaqnailiaq, Nataaġnaq*
Salmonidae	Arctic char, Dolly Varden, ("trout"), "Rainbow trout," Lake trout	*Salvelinus alpinus, S. malma, S. namaycush*	*Qalukpik, Aqalukpik*
	Arctic grayling	*Thymallus arcticus*	*Sulukpaugaq*
	Bering cisco	*Coregonus laurettae*	*Tipuk*
	Least cisco	*C. sardinella*	*Qalusraaq, Aŋuutituuq, Qalutchiaq*
	Broad whitefish	*C. nasus*	*Qausriluk, Siyyuilaq*
	Humpback whitefish	*C. pidschian*	*Qaalġiq, Ikkuiyiq*
	Round whitefish	*Prosopium cylindraceum*	*Quptik*
	Chum salmon, "Dog salmon"	*Oncorhynchus keta,*	*Qalugruaq*
	Coho salmon, "Silver salmon"	*O. kisutch*	*Qalugruaq*
	Pink salmon, "Humpback salmon"	*O. gorbuscha*	*Amaqtuq*
	Chinook salmon, King salmon	*O. tshawytscha*	*Qaluaqpuk, Iqalusugruk*
	Sockeye salmon, "Red salmon"	*O. nerka*	*Qalugruaq*
	Sheefish	*Stenodus nelma*	*Sii*

	Umbridae	Alaska blackfish	*Dallia pectoralis*	*Iluiqiñiq*
Marine Mammals	*Pinnipedia* (Seals and Walrus)	Bearded seal	*Erignathus barbatus*	*Ugruk*
		Spotted seal	*Phoca largha*	*Qasigiaq, Qasrigiaq*
		Ringed seal	*Pusa hispida* [*Phoca hispida*]	*Natchiq*
		Harbor seal[c]	*Phoca vitulina*	*Qasigiaq, Qasrigiaq*
		Ribbon seal, "Striped seal"	*Histriophoca fasciata*	
		Walrus	*Odobensus rosmarus*	*Aiviq*
	Cetacea (Whales)	Beluga	*Delphinapterus leucas*	*Sisuaq*
		Bowhead whale	*Balena mysticetus*	*Aġvik*[1]
		Minke whale	*Balaenoptera acutorostrata*	
		Grey whale	*Eschrichtius robustus*	*Aġvigluaq*
	Ursidae (Bears)	Polar bear[2]	*Ursus maritimus*	*Nanuq*
Terrestrial mammals[3]		Grizzly bear, Brown bear	*U. arctos*	*Akłaq*
		Black bear	*U. americanos*	*Iyyaġriq*
	Mustelidae (Weasels)	Marten	*Martes americana*	*Qapvaitchiaq*
		Weasel	*Mustela erminea, M. nivalis*	*Tiġiaq*
		Mink	*M. vison*	*Tiġiaqpak*
		Wolverine	*Gulo gulo*	*Qapvik*
		River otter	*Lontra canadensis*	*Pamiuqtuuq*

[1] *Aġvik* also has the generic meaning of simply "whale," but, for at least some speakers, bowhead whale is the default sense.

[2] In the subsistence maps, polar bears are included in the large game terrestrial species; in the IEA maps they are included with marine mammals. (Polar bears are protected under the federal Marine Mammal Protection Act.)

[3] Species considered as "large game" include all of the cervids (caribou, reindeer, moose) and bovids (muskox and dall sheep), and ursids (black, brown, and, sometimes, polar bears).

	Canidae (Canines)	Wolf	*Canis lupus*	*Amaġuq*
		Arctic fox	*Alopex lagopus*	*Qusraaq*
		Red fox, "cross fox"[d]	*Vulpes vulpes*	*Kayuqtuq, Qianġaq*
	Felidae (Cats)	Lynx	*Lynx canadensis*	*Nuutuuyiq*
	Cervidae (Deer family)	Moose	*Alces alces*	*Tinniikaq*
		Caribou, Reindeer	*Rangifer tarandus*	*Tuttu*
				Qunŋiq
	Bovidae (Cow family)	Muskox	*Ovibos moschatus*	*Umiŋmak*
		Dall sheep	*Ovis dalli*	*Ipñiaq*
	Rodentia (Rodents)	Arctic ground squirrel	*Spermophilus parryii*	*Siksrik*
		Muskrat	*Ondatra zibethicus*	*Kigvaluk*
		Beaver	*Castor canadensis*	*Paluqtaq*
		Porcupine	*Erethizon dorsatum*	*Iluqutaq*
		Marmot	*Marmota broweri*	*Siksrikpak*
	Lagomorpha (Rabbits and hares)	Tundra/Arctic hare	*Lepus othus*	*Ukallisugruk*
		Snowshoe hare	*L. americanus*	*Ukalliq, ukalliatchiaq*
Invertebrates	Clams, snails, mussels	(Various)	? spp.	*Kigirauraq, Uviļu, Uviļuq*
	Urchin	?	? spp.	?
	Crabs	King crab, etc.	*Lithodes* spp., *Paralithodes* spp.,	*Putyugiaq*

Plants

Gymnosperms	*Pinales* (Conifers)	Juniper berry	*Juniperus communis*	*Tulukkam asriaq*
		Pine resin	Various pines	*Kutchuq*
Monocots	*Asparagales*	Wild chive, wild onion	*Allium schoenoprasum*	*Paatitaaq*
	Poales (Grasses)	Tall cottongrass, "Grassroot"	*Eriophorum angustifolium*	*Pikniq, Pitniq*
Core Eudicots	*Caryophyllales*	Beach greens[e]	*Honckenya peploides*	*Atchaaqłuk*
		Wild rhubarb	*Polygonum alaskanum*	*Qusrimmaq, Qusimmaq*
		Sourdock	*Rumex arcticus*	*Quaġaq*
	Saxifragales	Currant	*Ribes triste*	*Niviŋŋaqutaq*
Asterids	*Apiales*	Wild Celery	*Angelica lucida*	*Ikuusuk*
		Sea lovage, "Beach greens"[e]	*Ligusticum scoticum*	*Tukkaayuk*
	Asterales	Stinkweed	*Artemisia tilesii*	*Sargiq, Sargiġruaq*
	Ericales	Bearberry	*Arctostaphylos uva-ursi*	*Tinnik*
		Crowberry, "Blackberry"	*Empetrum nigrum*	*Paunġaq*
		Eskimo tea, Labradore tea, Tundra tea	*Rhododendron tomentosum* [*Ledum palustre*], *R. subarcticum* [*L. decumbens*]	*Tilaaqiuq*
		Cranberry	*Vaccinium vitis-idaea, V. oxycoccus*	*Kikmiññaq, Qunmun sanmiruq, Qunmun asriaq*
		Blueberry	*V. uliginosum*	*Asriavik*
Rosids	*Fabales*	Eskimo potato	*Hedysarum alpinum*	*Masru, Masu*[f]
	Malpighiales	Cottonwood (leaves)	*Populus balsamifera*	*Nimiuk, Ninŋuq*
		Willow (leaves)	*Salix* spp.	*Sura*[g]
	Myrtales	Fireweed	*Epilobium angustifolium, E.*	*Pamiuqtaq, Pautnuq,*

			latifolium	*Quppiqutaq*
	Rosales	Rose (rosehips)	*Rosa acicularis*	*Igruŋnaq*
		Raspberry, "Strawberry"	*Rubus arcticus, R. idaeus*	*Aqpiŋñaq, Ivgum asriaq, Tuunġaum asriaq*
		Salmonberry	*Rubus chamaemorus*	*Aqpik*
(Various)		Wood, driftwood	Various	*Qiruk*

[a] Some dialectical variation occurs throughout the Borough.

[b] Seagull, murre, and puffin eggs, though not the birds themselves, were harvested. Eggs of all kinds are referred to as *mannik* (sg/dual), *mannit* (pl.) in Iñupiaq.

[c] The harbor seal (*Phoca vitulina*) is not normally found in the Chukchi Sea. This may have been an anomaly, or a misidentification (note that the Iñupiaq term *qas(r)igiaq* can refer to both the harbor seal and the spotted seal (*P. largha*).

[d] "Cross fox" refers to a silver color morph of the red fox.

[e] "Beach greens" was more commonly used to refer to sea lovage (*Ligusticum scoticum*; Iñup. *tuukaayuk*) than to *Honckenya peploides* (*atchaaqluk*).

[f] *Mas(r)u* refers to the root only, *mas(r)uqutaq* to the entire plant.

[g] *Sura* refers to the leaf buds only; the tree/shrub is referred to as *uqpik, uqpisugruk,* or *kanunniq*.

Appendix K

Comprehensive Summary of Subsistence Mapping Project Activities 2009-2015

2009 – 2011 Oceana advisor Caleb Pungowiyi approaches Borough with project idea. Coastal Impact Assistance (CIAP) and Oak Foundation funding secured, agreements with the Alaska Department of Fish and Game (ADF&G) Division of Subsistence, Oceana and Project Evaluator Glenn Gray signed, Project Coordinator Zach Stevenson hired, and project team assembled.

Spring 2011 Traditional Knowledge Specialist John Goodwin, Social Anthropologist Dr. Brandon Chapman, and Village Coordinators Lee Ballot, Sr., Alvin Ashby, Raymond Lee, Jr. hired; project team meets for the first time in Kotzebue and project evaluation and monitoring plan adopted.

Summer 2011 Project staff and researchers meet with tribal councils, cities, and NANA Resource Offices to solicit nominations for advisory group members. Advisory group members also recruited using VHF radio announcements, announcement on KOTZ Radio 720 AM, and flyers posted in each of the seven participating communities.

Fall 2011 Local advisory groups assembled; Zach Stevenson, Dr. Brandon Chapman, and Oceana staff work out base map regions and scales; first Subsistence Mapping Conference held in Kotzebue in November.

Winter 2011 Local advisory group members reviewed and approved by tribes, cities, Northwest Arctic Borough Mayor Martha Siikauraq Whiting and appointed. Jim Magdamz of the Alaska Department of Fish and Game Division of Subsistence completes an agreement with the Northwest Arctic Borough for "Improving Subsistence Information to Implement Federal Plans." The agreement included two phases:

- Compiling and circulating an electronic database of literature related to subsistence hunting and fishing in Northwest Alaska. Status: Completed.
- Administering household subsistence surveys in one Northwest community to gather new subsistence harvest information. Status: Completed. See: Nicole M. Braem, James, S. Magdanz, David S. Koster, and Patricia Fox. Technical Paper No. 389. Subsistence Harvests in Northwest Alaska: Selawik, 2010-2011. Nome: Alaska Department of Fish and Game Division of Subsistence, 2013. Print and Web. <http://www.adfg.alaska.gov/techpap/TP389.pdf>.

The literature collection itself is too large to circulate via e-mail, approximately 6 Gb and 2,000 individual PDF files. The Northwest Arctic Borough has edited summaries of the collection, created using the bibliography program EndNote. The collection includes all the technical papers published by the ADF&G Division of Subsistence and by the Alaska MMS-OCS program (now BOEMRE). It also includes approximately 1,500 journal articles, conference papers, books, and reports related to subsistence in Northwest Alaska that ADF&G collected during their research. The collection includes literature related to:

- Northwest Alaska subsistence activities, such Georgette and Shiedt (2005)
- Whitefish: Traditional ecological knowledge and subsistence fishing in the Kotzebue Sound Region, Alaska.
- Northwest Alaska subsistence species, including some reports from other areas that cover species found locally, such as Underwood (2000) Abundance, length, composition, and migration of spawning inconnu in the Selawik River, Alaska.
- Archeological and historical subjects such as Anderson (1988) Onion Portage: The archeology of a stratified site from the Kobuk River, Northwestern Alaska.
- Economic topics, such as Kruse (1991) Alaska Inupiat subsistence and wage employment patterns: understanding individual choice.
- Food safety topics, such as Kuhnlein and Chan (2000) Environment and contaminants in traditional food systems of northern indigenous peoples.
- Food security topics, such as Ford (2009) Vulnerability of Iñuit food systems to food insecurity as a consequence of climate change: a case study from Igloolik, Nunavut.
- Theoretical literature from ecology, economics, sociology, and other disciplines that may (or may not) be relevant to subsistence in northwest Alaska such as

Axelrod (1984) The Evolution of Cooperation, Henrich (2004) Foundations of human sociality: Economic experiments and ethnographic evidence from fifteen small-scale societies, Ostrom (2009) A General Framework for Analyzing Sustainability of Social-Ecological Systems, and Sahlins (1972) Stone age economics.

The full collection is available on the Northwest Arctic Borough server as more than 2,000 individual PDF files. The easiest way to work with the literature collection is in the EndNote program. However, not everyone uses Endnote, so ADF&G printed the collection as PDF files. The collection is strong in subsistence topics, and less complete in biological topics. Additionally many papers have been added the collection, and some duplication is evident.

Magdanz notes a few deserve special recognition: Linda Ellanna, former deputy director of the Division of Subsistence; Richard Stern, former regional supervisor for the Division of Subsistence; Susan Georgette (now with the Selawik Refuge); Alex Whiting, with the Native Village of Kotzebue; and Denali Whiting, who scanned many older papers with support from Bureau of Land Management and the Native Village of Kotzebue.

The ADF&G Division of Subsistence completes a written review of literature relevant to subsistence hunting, fishing, and gathering in northwest Alaska. The document assesses gaps in the subsistence literature, and discusses priorities for future studies of subsistence in Northwest Alaska.

Spring 2012	Advisory groups meet and begin work to identify local hunters, fishers, and gatherers to Interview and review study methods; Northwest Arctic Borough Assembly approves Oceana contract.
Summer-Fall 2012	Advisory groups meet; second Subsistence Mapping Conference held in Kotzebue in October. Oceana prepares a technical paper *Local and Traditional Knowledge and "Western" Science Principles and Implementation Strategy* (October 2012).
Winter 2012	Advisory groups meet; Iñupiaq place name mapping requested by tribal elders gets underway.
Spring 2013	Dr. Damian Satterthwaite-Phillips replaces Dr. Chapman as the project's social scientist and refines methods for gathering and analyzing data; study participants recruited in villages; Lance Kramer takes over from John Goodwin as traditional knowledge specialist; Oceana approves mapping methodology; scientific review panel approves data gathering and analysis methods. Lee Ballot, Sr. leaves the project team.
Summer 2013	Dr. Satterthwaite-Phillips interviews study participants in seven villages.
Fall-Winter 2013	Interim analysis of data conducted to determine representativeness and completeness of study sample. Buckland test sample conducted to verify methods.
Spring-Summer 2014	Additional village participants interviewed to expand sample. Youth education and outreach activities conducted in the project's seven participating communities. All interviews are completed. All maps documenting traditional knowledge and scientific knowledge of subsistence use and important ecological areas (IEAs) completed and reviewed by advisory groups in each of the seven participating communities. Both the subsistence use maps and IEA maps were also reviewed at the October 2014 workshop in Kotzebue. Additionally the IEA maps were reviewed by Advisory Groups per the second round of advisory group meetings. Analysis of participants' subsistence patterns by age, gender, and location performed.

Two hundred and thirty one interviews were conducted to document traditional knowledge of subsistence use by season in each of the seven participating communities. Interviewees provided with an informed consent document explaining how the information would be used, by whom, for what purpose, and compensation. The traditional knowledge shared during the interviews was documented using plastic transparent sheets, topographic and aerial base maps developed in partnership with participating communities, colored markers, a digital audio recorder, and species recording sheets.

The hand-drawn maps were digitized using a Nova 36e Vidar scanner, HP Designjet T1100 ps 44 in PS3 plotter, and CopySystems software. The digital files were compressed to reduce file size and stored on a password protected cloud database on a password protected computer. Data collected from the subsistence interviews was entered into an Excel database. The database contains more than 5,000 records and includes information on more than 150 species. The database can be searched by species, taxa (groups of species), season, location, and the age or gender of the interviewee.

Composite summary and site-specific GIS maps were made using the database. The data is shown as "heat maps" where darker colors indicate higher intensity subsistence use. Heat maps are an effective decision support tool that allow for the protection of traditional knowledge while enabling the viewer to understand resource use patterns. Addressing quality control, the GIS maps were statistically analyzed to confirm the data is representative and complete for each community. The maps were checked with Advisory Groups in each of the seven communities. Minor edits and editions were made as needed.

The subsistence interviews and review of the maps were completed in November 2013. The traditional knowledge documented during the interviews remains confidential until authorized for release per the Northwest Arctic Borough's Protocols for Protecting Traditional Knowledge. *See* Summary of Protocols to Protect Local Traditional Knowledge, prepared by Zach Stevenson. January 29, 2013. 1 page. This document is available on request. Prepared an article providing an overview an update on the Northwest Arctic Borough Subsistence mapping Project for the Northwest Arctic Borough quarterly newsletter.

The approved atlas will be featured on a web portal and made available in print and digital (CD-ROM) format. Additionally, documentation of important ecological areas (IEAs) was conducted with advisory groups. The digitizing of IEAs was completed on April 28, 2014. The draft IEA maps were reviewed by advisory group members at the round two meetings and the October 2014 IEA workshop.

Presented an overview and update of the Northwest Arctic Borough Subsistence Mapping Project at the NAB Science Steering Committee Meeting in Kotzebue. Attendees included Tribal representatives, representatives from state and federal agencies, researchers, representatives from Alaska Native Corporations, and representatives from the oil industry.

Provided an overview and update on the Northwest Arctic Borough Subsistence Mapping Project to the Northwest Arctic Borough Assembly, Northwest Arctic Borough Science Steering Committee and the Pew Charitable Trusts.

Delivered an overview and update on the Northwest Arctic Borough Subsistence Mapping Project at the Northwest Arctic Borough Meeting for Community Representatives in Kotzebue, Alaska focused on recruiting participants for the Northwest Arctic Borough Marine Debris Clean Up Initiative funded through a separate grant by CIAP.

At the invitation of the National Science Foundation (NSF), the project team delivered an overview of the Northwest Arctic Borough Subsistence Mapping Project for the $20 million NSF Belmont Forum call for proposals.

Participated in a workshop entitled "Community-Based Monitoring: Observing Alaska's Coasts and Oceans" hosted by the Alaska Ocean Observing System and Sea Grant in Anchorage, Alaska. Participated in a panel addressing qualitative and quantitative indicators and evaluating programs. Provided an overview of the research methods in the Northwest Arctic Borough Subsistence Mapping Project. Attendees included state and federal agency representatives, Tribal representatives, and researchers.

Fall-Winter 2014

Jaime Lambert hired as Program Officer for the Northwest Arctic Borough Subsistence Mapping Project, replacing Ellenore Sunii Jackson. The Northwest Arctic Borough receives a $100,000.00 donation from ConocoPhillips Alaska. This donation supported the development of a subsistence photo contest, subsistence youth education activities, climate change related film, and captains license training for local hunters. Interview data digitized and initial maps prepared; Oceana finishes marine and coastal literature review, analysis, and maps; project sponsors photo contest; Sarah Betcher completes film *Effects of Weather and Climate on Subsistence Communities* (gathering information used for "Voices" sections in chapter 2); project funds U.S. Coast Guard "six-pack" license training for 10 Borough residents; 2-day expert workshop held in Kotzebue in October.

The workshop participants included project staff, partners, and 18 locally appointed hunters, fishers, and gatherers representing the 7 coastal communities involved in the Northwest Arctic Borough Subsistence Mapping Project advisory groups and interviews. The goal of the workshop was to review draft maps reflecting scientific information documenting IEAs (where animals feed, migrate, breed, and raise young) for communities involved in the project. The workshop objectives included confirming whether the draft IEA maps were correct and making corrections and/or edits to the draft maps as needed.

Workshop presentations and actions included the following:

- Presentation on Scientific IEA Analysis Methods from Chris Krenz (Oceana).
- Presentation and Discussion of Combined Subsistence Use Maps Showing Scientific and Traditional Knowledge information from Damian Satterthwaite-Phillips (PhillipsResearch and Analytics).
- Presentation and Discussion of Combined Marine Mammal Maps from Chris Krenz (Oceana).
- Overview of Salmon and Trout Maps from Brianne Mecum (Oceana).
- Review of Salmon and Trout Maps: Group mapping was led by Raymond Lee, Jr. (NAB), Alvin Ashby, Sr. (NAB), Lance Kramer (NAB) and Damian Satterthwaite-Phillips (Phillips Research and Analytics). Data recording was conducted by Chris Krenz (Oceana), Brianne Mecum (Oceana), Damian Satterthwaite-Phillips (Philips Research and Analytics), and Glenn Gray (Glenn Gray and Associates). Assistance was provided by Zach Stevenson (NAB).
- Overview of Sheefish, Tomcod, and Whitefish Maps from Brianne Mecum (Oceana).
- Review Sheefish, Tomcod, and Whitefish Maps: Group mapping was led by Raymond Lee, Jr. (NAB), Alvin Ashby, Sr (NAB), and Lance Kramer (NAB), and Damian Satterthwaite-Phillips (Phillips Research and Analytics). Data recording was conducted by Chris Krenz (Oceana), Brianne Mecum (Oceana), Damian Satterthwaite Phillips (Philips Research and Analytics), and Glenn Gray (Glenn Gray and Associates). Assistance was provided by Zach Stevenson (NAB).
- Overview of Sea Ice Maps by Chris Krenz (Oceana).
- Review Sea Ice Maps: Group mapping was led by Raymond Lee, Jr. (NAB), Alvin Ashby, Sr. (NAB), Lance Kramer (NAB), and Damian Satterthwaite-Phillips (Philips Research and Analytics). Data recording was conducted by Chris Krenz (Oceana), Brianne Mecum (Oceana), Damian Satterthwaite Phillips (Phillips Research and Analytics), and Glenn Gray (Glenn Gray and Associates). Assistance was provided by Zach Stevenson (NAB).

A youth activity was conducted by Lance Kramer (NAB) involving participation of more than 50 Kotzebue high school students. The youth activity addressed the importance of subsistence mapping to preserving lands, promoting healthy lifestyles, and fostering Iñupiaq values such as sharing and respect for the land. The youth activity also provided an overview of the process used to make the maps.

The workshop was funded, in part, through contributions from the Oak Foundation and ConocoPhillips, which provided an opportunity to support the collaborative documentation of local traditional knowledge and scientific research. The information collected in the workshop was used to update and edit the IEA maps included in the project atlas.

Completed the process of requesting permission from the 231 people interviewed in Selawik, Noorvik, Kivalina, Noatak, Buckland, Deering, and Kotzebue to use their data reflecting traditional knowledge in the Northwest Arctic Borough Subsistence Mapping Project atlas.

The interviewees were provided with a letter describing the purpose of the Northwest Arctic Borough Subsistence Mapping Project, how their information would be used, the purpose for using their information, the process for providing honorariums, and the risks of providing information. Additionally the letter asked:

- Do we have your permission to use your subsistence information in the map atlas (yes/no)?
- Do you want to be acknowledged in the atlas for your involvement in the project

(yes/no)?
- Do we have your permission for future use of your information with the written approval of the Northwest Arctic Borough, Tribal Council, and City (yes/no)?

The letter included a consent form for recording responses to these questions. The letter was signed by Northwest Arctic Borough Mayor Reggie Joule or Planning Director Noah Naylor.

A contest was launched to encourage the completion of the consent forms. Names were entered in raffle for stove oil and airline tickets for each for completed consent form, regardless of whether the interviewee chose to keep their information private or share their information. Completed consent forms have been saved to a secure cloud server database and the results are described below.

Project staff along with village-based short-term hire personnel worked with the Tribal Councils, Cities, and NANA Resource Technicians to have interviewees complete and then collect the consent forms. Tally Results – Of the 231 people interviewed in the 7 participating communities:

- 95% percent of the consent forms were completed.
- 95% percent provided permission to use their subsistence information in the atlas.
- 85% want to be acknowledged in the atlas for their involvement in the project.
- 95% gave permission for future use of their information with the written approval of the Northwest Arctic Borough, Tribal Council, and City.

Results from all of the completed consent forms were scanned and saved to a secure password-protected cloud server database.

The Northwest Arctic Borough launched a subsistence photo contest. Staff circulated a contest flyer in participating communities and on Facebook which specified:

- Contest Prizes – First Prize: Drum of stove oil, Second Prize: 2 Bering Air coupons, and Third prize: 2 Bering Air coupons.
- Contest Entry – There was no limit on the number of entries. The photograph was required to be a taken by the person submitting the entry. Entries required the name of the photographer, address, phone number, email address, and a description of the photo. All entries were required to be submitted on Facebook.
- Purpose – The purpose of the Subsistence Mapping Photo Contest was to show the importance of the subsistence way of life to the people of the Borough and provide a record of the Iñupiaq way of life for children and future generations.
- Subject – Photos submissions were required to show a subsistence activity (e.g., preparation for a subsistence activity, participating in the activity, or preparation and use of the resource once harvested).
- Requirements – Photos were required to be in digital format. All photos were required to be 20 megabytes or smaller, in JPEG or JPG format, and at least 1,600 pixels wide or 1,600 pixels tall.
- Judging – The Subsistence Mapping Project Team would judge all entries received by the deadline of 5:00 pm January 11, 2015.
- Releases – Upon request, each entrant was required to provide (within 7 calendar days of receipt of the Borough's request) a signed release from all persons in the photograph.
- Use of Photos – Any photograph submitted could be used in the atlas produced for the Subsistence Mapping Project.

The Northwest Arctic Borough Subsistence Mapping Photo Contest was funded through a contribution from ConocoPhillips, which provided an opportunity to support the collaborative documentation of local traditional knowledge and scientific research. The highest quality photos were provided to a graphic designer assigned to the project for potential inclusion in the project atlas narrative. The photos illustrate an authentic depiction of subsistence hunting, fishing, and gathering practices in the region provided by Borough residents.

Presented an overview of the Northwest Arctic Borough Subsistence Mapping Project at a panel discussion addressing statewide subsistence mapping initiatives during "Week of the Arctic" in Kotzebue. The event focused on emerging Arctic policy issues and was convened by the Institute of the North, a non-profit organization based in Anchorage,

Alaska. Panelists included Zach Stevenson representing the Northwest Arctic Borough along with representatives from NANA, the Alaska Department of Fish and Game Division of Subsistence, and Aleut International Association.

Overview and update on the Northwest Arctic Borough Subsistence Mapping Project delivered to the Northwest Arctic Borough Assembly.

Delivered a presentation providing an overview and status update on the Northwest Arctic Borough Subsistence Mapping Project at the 2014 Alaska Forum on the Environment in Anchorage. Attendees included tribal managers from throughout the state; municipal officials; representatives from the U.S. Environmental Protection Agency (EPA) funded Tribal Indian Environmental General Assistance Program (IGAP), agency natural resource managers, scientists, and other stakeholders. The Alaska Forum on the Environment is the largest annual meeting of Tribal environmental professionals in Alaska.

Attended the 2014 Alaska Marine Science Symposium (Anchorage, AK) and met with agency representatives and researchers and provided an overview and update of the Northwest Arctic Borough Subsistence Mapping Project.

The Alaska Marine Science Symposium is the largest annual meeting of scientists, state and agency officials, industry, funders, and elected officials in the state focused on marine science and related policy issues. Meetings were held with key stakeholders to provide an overview of the Northwest Arctic Borough Subsistence Mapping Project including:

- Dr. Chris Krenz, Arctic Project Manager Oceana
- Dr. John W. Farrell, Director U.S. Arctic Research Commission, and Dr. Cheryl Rosa, Deputy Director at U.S. Arctic Research Commission
- Dr. John Bengston, Director of the National Marine Mammal Laboratory, Alaska Fisheries Science Center
- Jim Adams, Policy Director Audubon Alaska, and Melanie Smith, Alaska Science Director, Audubon Alaska
- Lisa Pekich, President ConocoPhillips Alaska, Caryn Rea, Senior Staff Biologist ConocoPhillips Alaska and Rusty Creed Brown, Community Relations Representative ConocoPhillips Alaska
- Carolina Behe, Traditional Knowledge/Science Advisor Iñuit Circumpolar Council Alaska
- Maeva Gauthier, Marine Ecologist and Outreach coordinator Coastal and Ocean Resources (Vancouver, BC)
- Dr. Amy Merten, Chief, Spatial Data Branch/Assessment and Restoration Division NOAA's Office of Response and Restoration (Seattle, WA) and Zach Winters-Staszak, Spatial Data Branch NOAA Office of Response and Restoration (Seattle, WA)
- Sylvia A. Kreel, Alaska Coastal Impact Assistance Program, Project Coordinator Department of Natural Resources/Office of Project Management and Permitting
- Dr. Henry Huntington Senior Officer, International Arctic, The Pew Charitable Trusts and Marilyn Heiman, Director, U.S. Arctic, The Pew Charitable Trusts
- Glenn Seaman, Biologist with Expertise Studying Beluga Whales in Buckland
- Darren Stewart, ShoreZone Coordinator at the Alaska Chapter of the Nature Conservancy
- Sarah Bowden, U.S. Interagency Arctic Research Policy Committee (IARPC) Terrestrial Ecosystems Implementation Team (TEIT)

The Northwest Arctic Borough requests proposals for editing services and graphic design Services related to the production of the subsistence mapping project atlas. After receiving and reviewing multiple proposals, Liz Dodd dba IDTC was selected to provide editing services and Strategies 360 was selected to provide graphic design services.

Alvin Ashby, Sr. leaves the project team. Elizabeth Ferguson joins the project team and serves as Program Officer.

Spring 2015 Atlas editor and graphic design team hired; village subsistence histories drafted; first complete atlas draft prepared; project sponsors student subsistence essay contest. Completed the checking of Iñupiaq place names. This information has been shared with the Regional Elders Council and NANA. With support from NANA, the regional place name maps are being updated to reflect the correct spelling and location of the Inñupiaq place names. The maps are to be used for youth education and emergency response

purposes. Prepared substantive written comments addressing Shell Exploration and Production Company/Goodhope Bay Alaska Online Public Notice - Project Name: LAS 30103 reflecting information gathered from existing and publicly available information. To further promote community engagement, and responding to a request from tribal elders, the project team conducted youth activities. The focus of the youth activities was to share local traditional knowledge of hunting, fishing, and gathering with youth and teach students how to pass these skills on to the next generation. In 2015, the Borough sponsored 25 youth activities including:

- *Noatak*: Ice fishing and bird hunting, with the harvest given to local elders.
- *Kivalina*: Seal hunting, shared with the community, fur sewing, beluga knife and ulu making, and whaling.
- *Buckland*: Wolf skinning, atikluk sewing, niksik carving, and ice fishing.
- *Deering*: Ice fishing,
- *Noorvik*: Niksik carving and fur sewing.
- *Selawik*: Mouton sewing, beaver trapping, ivory carving, and ice fishing.
- *Kotzebue*: Niksik carving, ice fishing, wood hauling (for local elders), birch bark basket making, atikluk sewing, caribou fur tufting, making dancing mittens and gloves with fur, and traditional beading.

The Northwest Arctic Borough received a $500,000.00 donation for the Subsistence Mapping Project from Shell. The youth activities were made possible through the donation from Shell.

Summer 2015

Borough stakeholders review atlas draft; major revision prepared. Draft atlas shared with Northwest Arctic Borough Assembly, tribes, and cities for review and comments. Agreement signed with Axiom Data science to develop a web portal for disseminating results of the Northwest Arctic Borough Subsistence Mapping Project.

Additionally, the Borough held a youth subsistence essay contest. The purpose of the contest was to encourage youth to write about the importance of the subsistence way of life and promote youth leadership through participation in government. Twenty-one students submitted essays and seven were selected as finalists. The finalists conducted community service projects. Additionally, the winning essay writers were selected for a trip to Washington, D.C. and Philadelphia in June 2015. The purpose of the trip was to show the students the connections between their traditional way of life and decisions being made by our country's highest decision makers and how to influence those decisions. The trip included youth advocacy training at the Center for Native American Youth and the National Congress of American Indians where the students learned how laws are created and how they can share their ideas in the legislative process. The students also met with senior staff from federal agencies that are active in the Arctic including the United States Congress, Bureau of Ocean and Energy Management, United States Department of the Interior, officials from the White House, Senator Lisa Murkowski, and Senator Dan Sullivan. The youth subsistence essay contest and youth travel was made possible through donations from ConocoPhillips Alaska and Shell.

Fall 2015-Winter 2016

President Obama visits Kotzebue in early September to draw national attention to the issue of climate change. Online GIS database of mapped study data presented to Northwest Arctic Borough Lands Committee for review; writers' and stakeholders' feedback incorporated into second major atlas revision; final edits checked and atlas sent to printer.

	Chronological Listing of Project Publications, Presentations, and Media Coverage
2011	Northwest Arctic Borough. "Conference Report: Northwest Arctic Borough Subsistence Mapping Project Conference – Uniting both traditional and western science to strengthen our way of life." Northwest Arctic Borough. National Park Service Northwest Arctic Heritage Center, Kotzebue, Alaska. 2-4 November 2011. Print and Web. www.nwabor.org/forms/subsistencemapconfreport.pdf> Stevenson, Zach. "Subsistence mapping project strengthens traditional knowledge for future generations." The Arctic Sounder, 7 February 2011: Print and Web. www.thearcticsounder.com/article/1106subsistence_mapping_project_strengthens.
2012	Chapman, Brandon M. and Goodwin, John. "Perspectives of an Iñupiaq Elder: Continuity and Change Above the Arctic Circle." Cultural Survival Quarterly 36-3 Defending Life First (September 2012). Print and Web. www.culturalsurvival.org/publications/cultural-survival-quarterly/perspectives-inupiaq-elder-continuity-and-change-above Coastal Response Research Center and National Oceanic and Atmospheric Administration. "Northwest Arctic Borough Oil Spill Workshop: Natural Resource Damage Assessment (NRDA) and Environmental Response Management Application (ERMA)". National Park Service Northwest Arctic Heritage Center. Kotzebue, Alaska. 22-23 May 2012. Print and Web. https://crrc.unh.edu/sites/crrc.unh.edu/files/media/docs/Workshops/nwab_12/NWAB_workshop_report_appendices.pdf Heimbuch, Hannah. "Subsistence mapping project brings expert to the Arctic." The Arctic Sounder 2 March 2012: Print and Web. http://www.thearcticsounder.com/article/1209subsistence_mapping_project_brings_expert_to_the_Arctic. Stevenson, Zach. "Subsistence Mapping in the Northwest Arctic Borough Presented at the 46th Annual Alaska Surveying and Mapping Conference." Hilton, Anchorage, Alaska. 13-17 February 2012. United States Arctic Research Commission "Report on the Goals and Objectives for Arctic Research 2011 – 2012." This biennial report recommends key goals and objectives to the President and to Congress. February 28, 2012. Cooperative Research Indigenous Use Project, Page 13. Web. <www.arctic.gov/publications/goals/usarc_goals_2011-12.pdf>
2013	Alaska Department of Natural Resources. "Improving Subsistence Information to Implement Federal Plans." Coastal Impact Assistance Program Surge Newsletter Volume 1, Issue 1, August 2013: Print and Web. <http://dnr.alaska.gov/commis/CIAP/PDF%20Files%205.23.14/ciap%20Surge%20newsletter%20Vol%201%20Issue%201%20August%202013.pdf> Brendan P. Kelly, White House Office of Science and Technology Policy, John P. Clement, United States Department of the Interior, and John L. Bengston, National Oceanic and Atmospheric Administration. "Managing for the Future in a Rapidly Changing Arctic: Report to the President." United States Department of the Interior: Interagency Working Group on the Coordination of Domestic Energy Development and Permitting in Alaska. April 3, 2013. Chapter 4.2: Promising Approaches. Page 41. Print and web. www.afsc.noaa.gov/publications/misc_pdf/iamreport.pdf Northwest Arctic Borough. "Improving Local Participation in Research in Northwest Alaska: Final Workshop Summary and Workgroup Recommendations." Sponsored by the University of Alaska Fairbanks Chukchi Campus and the Northwest Arctic Borough. Funded by the National Science Foundation. University of Alaska Fairbanks Chukchi Campus. Kotzebue, Alaska. 2-4 April 2013. Print and Web. www.uaf.edu/files/chukchi/Northwest-Alaska-Research-Workshop-Summary---Final---12-26-13-2.pdf
2014	Committee on Responding to Oil Spills in the U.S. Arctic Marine Environment, Ocean Studies Board, Polar Research Board, Division on Earth and Life Studies, Marine Board, Transportation Research Board, and the National Research Council. "Responding to Oil Spills in the U.S. Arctic Marine Environment." Washington: National Research Council

	of the National Academies, 2014. Print. "The Kobuk River Valley: At a Loss for Herds (Part 2: Viewer Discretion Advised)." Local News. NBC. KTUU Channel 2, Anchorage. 16 October. 2014. Television and Web. www.ktuu.com/news/news/the-kobuk-river-valley-part-2-viewer-discretion-is-advised /29167732 Stevenson, Zach. "Overview of the Northwest Arctic Borough Subsistence Mapping Project, presented at the 2014 Alaska Forum on the Environment." Dena'ina Civic and Convention Center, Anchorage, Alaska. 3-7 February 2014.
2015	Rogers, Jillian. "Youth leaders bring strong voices to D.C." The Arctic Sounder, 3 July 2015: Print and Web. www.thearcticsounder.com/article/1527youth_leaders_bring_strong_ voices_to_dc Rogers, Jillian. "Subsistence mapping project nears completion." Alaska Dispatch News 16 March 2015: Web. www.adn.com/article/20150316/subsistence-mapping-project-nears-completion Stevenson, Zach. "Uniting Indigenous and Western Science through Subsistence Mapping in the Northwest Arctic Borough." Institute of the North Top of the World Telegraph 22 February 2015: Web. www.institutenorth.org/programs/past-programs-and-initiatives/top-of- the-world-telegraph/op-ed-archive/science-environment-climate-change/uniting-indigenous-and-western-science-through-subsistence-mapping-in-the-n/ Stevenson, Zach. "Northwest Arctic Borough Subsistence Mapping Project Newsletter." January 2015. Web. www.slideshare.net/ZachStevenson/nwab-subsistence-mapping-project-newsletter-january-2015-43343268