

Economic Study of Subsistence Impacts

Final

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Abbreviations

AC Store	Nuiqsut Alaska Commercial Store
AEWC	Alaska Eskimo Whaling Commission
ASRC	Arctic Slope Regional Corporation
CAA	Conflict Avoidance Agreement
CPAI	ConocoPhillips Alaska, Inc.
CPI	Consumer Price Index
GMT1	Greater Mooses Tooth One Development Project
NPR-A	National Petroleum Reserve–Alaska
NSB	North Slope Borough
PFD	Alaska Permanent Fund dividend
ROD	Record of Decision

Technical Summary

The Economic Study of Subsistence Impacts is required per the Record of Decision (ROD) issued by the Bureau of Land Management for the Greater Mooses Tooth One Development Project (GMT1) located in the National Petroleum Reserve-Alaska. The ROD stipulated that ConocoPhillips Alaska, Inc. (CPAI) “undertake a thorough one-time economic study at the beginning of the GMT1 project of the costs that individuals and families incur to continue subsistence activities at desired levels (or would have to incur to participate in subsistence activities if they are not able to afford them).”

This work has been performed for CPAI by Northern Economics, Inc. and three subcontractors: Arctic Slope Regional Corporation (ASRC) Energy Services Alaska, Inc.; Veritas Economic Consulting; and Applied Sociocultural Research (collectively, the project team). The project team proposed an economic model to meet the noted ROD requirements and developed an initial data gap analysis report to identify information needs.

The initial data gap analysis report¹ presented the proposed economic model to determine the monetary value of subsistence resources in the community of Nuiqsut, Alaska, accompanied by a discussion of the theoretical context that influenced the development of the model. The report further identified resources with useful data related to the model inputs, identified those inputs for which no adequate data exist, and provided recommendations for addressing these data gaps.

Various methods for data collection were considered, including a workshop, before a questionnaire-based approach was decided upon. The questionnaire itself was developed based on the data gap analysis to specifically target the information required to fill identified gaps as well as document time spent on subsistence activities and purchases of market goods for consumption. The team administered the questionnaire in November 2017.

An economic model of a mixed subsistence-market economy was developed to produce a quantitative estimate of the impact on Nuiqsut households of potential changes in the availability of subsistence resources, incorporating the household production theory of Becker and information on the subsistence traditions of Nuiqsut. The model evaluates how a household allocates its time and resources to maximize its wellbeing, referred to in economics as utility. The model uses a Cobb-Douglas utility function that is composed of shares of time spent in work, leisure, and several subsistence activities; diet, including various sources of subsistence and market protein; and sharing of various harvested resources. The utility of each activity was identified by utility elicitation items on the questionnaires completed by Nuiqsut residents.

The average cost and productivity of engaging in subsistence activities is determined by a site-choice function in which harvesters choose among sites based on travel cost, travel time, and harvest rate. The approach follows the baseline and counterfactual methodology. The baseline scenario is calibrated to reflect current conditions in Nuiqsut. Baseline conditions are used for comparison purposes in evaluating changes in resource availability potentially resulting from the project. Table TS-1 represents the summary of cost and total harvest of the three major subsistence resources. For information on whales To calculate the average cost of harvest (\$/lb) found in Table TS-1, the village level annual total travel costs of fishing are divided by the annual total village level harvest also presented in Table TS-1 (Brown et al. 2016).

In counterfactual specifications, changes in the availability of subsistence resources cause households to reallocate their harvest site, time, money, and consumption, so that they are as well off as possible

¹ See *Economic Study of Subsistence Impacts: Subsistence Economic Model and Data Gap Analysis* in Appendix C.

given the new conditions. Based on GMT1’s location relative to both Nuiqsut and the resources on which it relies, GMT1 was determined to have the greatest potential effect on caribou. A Baseline model was developed to represent the current seasonal caribou harvest conditions in the Nuiqsut area to estimate total harvests, travel cost, and average cost per pound of edible meat by season.

Table TS-1. Baseline Summary

Resource	Season	Average Cost of Harvest (\$/lb)	Total Harvest (thousands of lb)	Total Travel Cost (\$thousands)
Caribou	Summer	1.73	62.47	107.7
	Fall	1.34	25.49	34.11
	Winter	2.50	34.70	86.72
Fish	Annual	0.94	89.00	83.53

The implications for Nuiqsut households can be identified by specifying offsetting mitigation payments and/or harvest changes. This study considered three potential GMT1 project-specific counterfactual scenarios: traveling 20 miles farther, increasing use of trucks, and use of a hypothetical road to access a new site. The estimated change in costs cost per pound and total costs are shown in Table TS-2.

Table TS-2. Summary of Counterfactual Scenarios

Scenario	Season	Average Cost of Caribou (\$/lb)	Cost Increase (\$/lb)	Change in Total Annual Community Harvest Cost (\$)
20 Miles Farther	Summer	1.89	+0.16	+13,970
	Fall	1.82	+0.48	+12,920
	Winter	3.03	+0.53	+18,390
Increase Trucks	Winter	2.47	-0.03	-905
Hypothetical Road	Winter	1.80	-0.70	-13,490

As estimated by the counterfactual modeling process, potential scenarios could result in annual, community-wide economic effects ranging from a decrease of more than \$13,000 in harvest costs under the hypothetical road scenario to an increase of more than \$45,000 in harvest costs in all three seasons under the scenario in which hunters have to travel farther given the modeling process. Mitigation funding appears to adequately cover the anticipated physical costs and economic effects of each counterfactual scenario.

Note that this modeling does not include other potential impacts such as avoiding an area, cultural effects, or community stress related to potential hunting impacts, such as those noted in the ROD: cherished family time on the land, cooperating, teaching, processing, cooking, consuming, sharing, and celebration. This evaluation is based on changes in site choice and do not consider or attempt to place a value on the cultural aspects surrounding the resources.

1 Introduction

This section introduces the study goals and objectives, the project context, and the outline for remaining sections of the report.

1.1 Study Goals and Objectives

The objective of this Economic Study of Subsistence Impacts is to better understand the economic impacts of development on subsistence uses and activities provide recommendations regarding how these impacts could be mitigated.

1.1.1 Background

The Economic Study of Subsistence Impacts is required per the Record of Decision (ROD) issued by the Bureau of Land Management for the Greater Mooses Tooth One Development Project (GMT1) located in the National Petroleum Reserve-Alaska (NPR-A). The ROD stipulated that ConocoPhillips Alaska, Inc. (CPAI) “undertake a thorough one-time economic study at the beginning of the GMT1 project of the costs that individuals and families incur to continue subsistence activities at desired levels (or would have to incur to participate in subsistence activities if they are not able to afford them).”

The project team proposed an economic model to meet these requirements and conducted a data gap analysis. In June 2017, the team generated the report *Economic Study of Subsistence Impacts: Subsistence Economic Model and Data Gap Analysis*.² The report presented a proposed economic model to determine the monetary value of subsistence resources in the community of Nuiqsut, Alaska. The proposed economic model was accompanied by a discussion of the theoretical context that influenced the development of the model. The data gap analysis encompassed a compilation and assessment of existing documents, data, and resources relevant to potential inputs for the model. The document identified those resources with useful data related to the model inputs, identified those inputs for which no adequate data exist, and provided recommendations for addressing these data gaps.

The report included a discussion of the model development and overall approach, including the theoretical basis for the modeling task and the primary variables and inputs needed for the model. The report then identified each variable and indicated whether the project team was successful in finding adequate data for it in existing data sources. Also included was an identification of any data adequacy issues and/or considerations, including the age, species focus, or geographic focus of the data. The report discussed relevant and substantial qualitative information regarding the role of subsistence harvesting in Iñupiat culture and the perceptions regarding how industrial development on the North Slope has affected subsistence harvesting activities in the region.

The report concluded with a range of recommendations for obtaining data for those variables in the economic model for which no adequate data currently exist. These data were generally related to the monetary costs associated with subsistence-related travel, purchasing and maintaining subsistence-related gear, existing market economy behaviors and spending patterns, and generalized preferences regarding the amount of subsistence foods harvested and shared. In general, the project team recommended a limited public outreach effort that included coordination with local agencies, a focus group with Nuiqsut subsistence harvesters, and key interviews with people knowledgeable about subsistence practices and the monetary costs associated with harvesting activities.

² See Appendix C.

1.1.2 Data Gaps

Based on a preliminary analysis of the available data, the following were identified as areas in which more information was needed:

- Amount of fish and meat procured per household (ultimately expressed in pounds in the model)
- Average cost of procuring fish per household
- Amount of time households spend in subsistence hunting and fishing activities per year
- Household preference for time spent on subsistence activities
- Household preference for time spent on work activities

The project team, following initial discussions with representatives from key community organizations, determined that administering a subsistence questionnaire to Nuiqsut residents would be the preferred mode of addressing the data gaps. Other key issues proposed to be discussed concerning economy and subsistence included the following: market goods used in subsistence activities, wages, household and exogenous income, market goods used for consumption, sharing practices, and how/if regional issues may affect subsistence harvest-related travel activities (e.g., erosion, pollution, and food safety).

1.2 Project Context

Previous research in Nuiqsut and in other communities on the North Slope has suggested that participation in subsistence activities is changing over time, regardless of proximity to energy exploration and development. However, this research also indicated that energy development can have an influence on the localized nature of change. For example, surveys recently conducted with residents, whaling captains, and elders in Nuiqsut have suggested that energy activities are just one of the forces affecting traditional subsistence activities, in addition to other socioeconomic pressures, internal social forces, and global climate change (EDAW 2008; Galginaitis 2014). Additionally, each community has its own unique ties to a specific local landscape. The history of the community of Nuiqsut differs from that of other North Slope communities (e.g. Point Hope), as traditional subsistence activities have an interrupted time depth due to the Nuiqsut area having been occupied, depopulated, and resettled over time. One of three abandoned Iñupiat villages identified by the Alaska Native Claims Settlement Act, it was resettled in 1973 by 27 families who lived and carried out all aspects of daily life in tents until federal agencies had completed construction of housing and other facilities in 1973 and 1974. Nuiqsut was incorporated in 1975 (Kuukpik 2017).

1.2.1 Mitigation Drivers of this Effort

As described in the ROD for the Alpine Satellite Development Plan for the proposed GMT1 project, the objective of this economic study of subsistence impacts is “to better understand the economic impacts of development on subsistence uses and activities and provide recommendations regarding how these impacts could be mitigated.” It is requested in the ROD that CPAI undertake a one-time study to quantify the costs associated with subsistence activities and to quantify how past, current, and reasonably foreseeable future projects may affect the cost of participating in subsistence activities. It is mentioned in the ROD that local residents have stated that costs associated with subsistence activities have increased over recent years because they must travel farther away from oil and gas development in the region to obtain adequate resources.

1.2.2 Relevant Previous Research and Subsistence Modeling Efforts

Researching the interrelationship between traditional subsistence activities and outside economic influences is not particularly new. Writing specifically about subsistence economies, Sahlins made a counter-intuitive argument in 1972 that societies for which hunting and gathering activities were the primary mode of meeting subsistence needs, were not the disenfranchised, afflicted economies described in early Jesuit missionary and ethnographic texts, but instead were the “original affluent society,” with a “kind of material plenty” that may be the envy of other peoples with established agricultural practices and different divisions of labor (Sahlins 1972). Quantifications of time spent participating in subsistence activities were cited by Sahlins and he concludes that those individuals who are part of hunting and gathering societies do not spend the majority of their time actively performing subsistence tasks – perhaps under 3 hours a day.

In 1960, James VanStone explored the seemingly inherent tension between subsistence activities and participation in a wage economy for people living in small, Arctic villages stating pessimistically, “Seldom, it would seem, is it possible for communities to successfully combine wage labor with a subsistence economy in the village.” At the time, VanStone noted that the material culture of Point Hope residents had shifted from homemade materials to mass-produced, manufactured materials that had to be purchased with cash; the cash was earned through village employment and/or the selling of furs and pelts. Regardless of their participation in employment, however, residents made a concerted effort to remain engaged in subsistence activities (VanStone 1960). Another study from the early 1980s, produced by the Alaska Department of Fish and Game, also explored the changes to rural Alaskan communities as a result of influences from the wage economy. The researchers found that the answer was complex and not the same everywhere: in some contexts, traditional hunting economies could be preserved and reinforced by the presence of cash income, while other communities saw radical transformations in traditional patterns and a shift toward industrial-capital infrastructure. In general, those communities that were able to negotiate participation in the wage economy and in subsistence production:

Typically allied into production and consumption networks – an organization strategy creating domestic groups larger than a single household operating as economic units. Within and between members of a domestic unit there was a cooperative pooling of resources and labor for the mutual benefit of the entire unit. Production capital purchased (and nominally owned) by one member was shared in production by other members of the group. High producing households were allied with low producing households, such that subsistence products produced in large quantities by members of one household flowed out to support members of other households. The domestic group represented a pool of labor for productive tasks, which could be drawn upon for subsistence production, commercial fish production, and wage employment.

The researchers also found that subsistence hunters who participated in the wage economy valued the opportunity to take time off and schedule flexibility and that complementary work roles were created by household members; for example, the woman would hold a wage position and the man participated more heavily in subsistence activities (Wolfe et al. 1984).

At the theoretical level, Becker started work that reinterpreted the concepts of “work” and “leisure” to include “productive consumption” and the value of products that take time to produce. The underlying theory was that households were producers as well as consumers, and that there was a mathematical relationship between income earned and that forgone by the use of time and goods to obtain utility (G. S. Becker 1965). By 1986, Gronau explored the various approaches to a “Home Production” model that went past the traditional assumption that consumers should be regarded as welfare maximizers, but instead extends the approach by challenging the assumption that market goods and services are the

direct source of utility and acknowledges that there are a range of outside constraints confronting the household. A survey of the literature found that home production theories recognize the importance of time in the analysis of demand for market goods and services, including the implication for the opportunity cost for time (Gronau 1986).

An economic model presented by Matthew Berman in 1998 provides perhaps the most relevant outline by which the economic study of subsistence can be performed. In his presentation, Berman outlines what he considers a modified household production model that can be used to test hypotheses about subsistence sustainability. He notes that households are known to make tradeoffs between how much time is taken to conduct subsistence activities versus how much time is spent participating in the wage economy, suggesting that a model should include an identification of separate structural relationships for each important household decision. It is argued that the sustainability of the subsistence economy can be simply conceived as a question of ensuring successful harvests of local resources to achieve consumption targets; however, in the Arctic context, two important cultural considerations are important to include: sharing with other households and time spent in direct engagement with the land. The variables for his model, which informed the quantitative economic model used in this study are:

- Consumption of market goods
- Consumption of subsistence goods
- Time spent in activities: subsistence, leisure, family, wage employment
- Total time
- Total cost of market goods used in subsistence activities
- Knowledge: subsistence and wage activities
- Household and community demographic factors (which can influence sharing practices)
- Availability of subsistence resources
- Subsistence production
- Wage rate
- Total household income
- Exogenous income (e.g., permanent dividend fund)
- Price of goods
- Purchases of market goods for consumption
- Purchases of market goods, used as cash inputs for subsistence
- Sharing of goods
- Measurement of “traditionality,” or a preference for traditional activities

The model calculates the utility of the household understanding that the household is constrained by available subsistence production technology, limits on money, and limits on time. Another input is focused on the uncertainty of subsistence production, which is a function of time, capital and operating costs, knowledge, and availability of subsistence resources. The purchases of market goods and services are also added into the model, with the assumption that all purchases may not exceed income (which, in turn, is based on assumptions related to education and other demographics). Limits related to time spent performing subsistence activities, wage labor, family responsibilities, and leisure are also entered into the model. The final piece of the model assumes a certain amount of resource sharing; resources can include market goods, subsistence capital (cash inputs), or subsistence harvests (M. D. Berman 1998).

Other economic models have also been developed that focus on the relationship between subsistence activities and wage labor engagement, including in their considerations that security and well-being are closely tied to subsistence traditions in many traditional communities; they are not a recreational or “lifestyle choice.” The model put forth by Usher begins with the assumption of the household as the basic economic unit and the factors of production include land, labor, and capital. The authors put forth a series of key features of a model that takes into the considerations of village economies with strong subsistence-based ties:

1. The local economy consists of both market and subsistence spheres, and many if not most households are oriented to both of these spheres, not exclusively to one or the other.
2. Income flows to households from both of these spheres in the form of wages, commodity production, and transfers (cash income), and of subsistence (income in kind).
3. The household deploys the factors of production available to it (land, labor, capital) so as to capture these sources of income, in a flexible manner.
4. Household success requires successful integration of market activities, subsistence production, and household reproduction. The model explicitly rejects the assumption that those without paid jobs are “unemployed” and hence make no productive contribution to economic well-being.
5. Individuals maximize their ability to provide for their households not necessarily by having a single skill, occupation, or job, but several. Nor is it appropriate to assume that individuals derive their livelihood from any single sector of the regional economy.
6. There is substantial cooperation and sharing among households, generally along lines of kinship, to optimize these flows of income and to ensure a general distribution of benefits.
7. Most importantly, because there are not two separate economies, people do not choose between living in a “traditional” economy or “modern” economy, nor are they in transition between the two. The modern economy in northern communities is in fact a mixed, subsistence-based economy. (Usher, Duhaime, and Searles 2003)

More recently, Berman employed a rational choice economic approach for modelling participation in subsistence hunting in a mixed subsistence/market economy. The authors also found that direct participation from community experts in subsistence hunting also helped influence the model, providing insight on the environmental conditions, availability of harvest resources, and hunting effort required for various zones within the region. The economic team found that an index of the likelihood of encountering subsistence resources (in this case, caribou) in different areas could be calculated and, as an input, could be used to gain more insight into how community members spent their limited time. They conclude with a strong endorsement of including local knowledge in the development of the economic model (M. Berman et al. 2004). Other research by Kruse et al. also strongly suggests the value of directly engaging local knowledge holders regarding subsistence activities. In their research, they also found that inputs related to tourism, climate change, and oil and gas development were major factors that could influence subsistence activities beyond simple participation in wage economies (J. A. Kruse et al. 2004).

A quantification of subsistence activities for various subregions in Alaska in 2012 was published in 2014. For the Arctic, the researchers noted that 438 pounds of wild food was harvested per person, totaling over 11 million pounds for the region. It was estimated that this harvest accounted for 39 percent of all necessary calories per day. Quantifying the value of the subsistence harvest was noted as an estimate, but the state provided figures assuming a cost of \$4/lb and \$8/lb (Fall 2014). Other recent research efforts in the Arctic have explored the limits of societal adaptation to ecosystem changes (Adger et al.

2009), and the resilience of indigenous communities to changes in the cash economy, oil and gas development, and biological and management changes related to the annual caribou harvest (Martin 2015). One recent article explored the economic effects of a new industrial road on subsistence activities in north-central Alaska. The researchers found that the communities near to the proposed road were more involved in subsistence activities than those comparable communities already accessible by road by a measure of 1.8 to 2.5 times. It was projected through their zero inflated negative binomial models that the financial cost of lost subsistence resources resulting from the road would be between \$6,900 and \$10,500 per household per year with an assumed \$17.64/kg (or \$38.89/lb) “replacement” cost (Guettabi et al. 2016).

As noted in the quantitative modelling literature, the accuracy of any model is highly dependent on the accuracy and validity of the inputs. The communities of the Arctic and their subsistence activities have been the subject of research for decades and quantitative and qualitative data have regularly been published. This includes the literature already cited, but Chance (1987) and Stabler (1990), provide additional early data on the activity patterns of Arctic community residents. Specific to the North Slope, Kruse also published the results of two community surveys that explored wage labor participation, household income, and changes in community demographics and household size. Kruse found that continued participation in the subsistence harvest held other benefits for participants beyond that of nutrition, including benefits to perceived quality of life (John A. Kruse 1991). A study on whaling behavior on the North Slope also aimed to quantify the use of time by subsistence hunters, concluding that there is an inverse relationship between active subsistence harvesting and wage labor time, but also that traditional and economic incentives influence the allocation of time between subsistence activities and wage labor (Kerkvliet and Nebesky 1997).

1.3 Report Outline

This report is organized into the following sections:

- **Section 2, Study Approach:** Technical approach to this study.
- **Section 3, Literature Review:** Findings of the literature review and data gap analysis.
- **Section 4, Location and Economy of Study Area:** Brief overview of Nuiqsut’s geographic and economic contexts.
- **Section 5, Subsistence Questionnaires:** Outreach effort and findings of the subsistence questionnaires.
- **Section 6, Economic Model:** Economic model and example results.
- **Section 7, Mitigation Funding:** Description of existing and future mitigation funding and its adequacy.
- **Section 8, Conclusion:** Summary of baseline costs, counterfactual results, and effectiveness of mitigation measures.
- **Section 9, References:** References cited in this report.
- **Appendix A:** Flyer from June 2017 to provide project information to Nuiqsut residents.
- **Appendix B:** Questionnaire form administered in November 2017.
- **Appendix C:** June 2017 report, *Economic Study of Subsistence Impacts: Subsistence Economic Model and Data Gap Analysis*

2 Study Approach

This section provides an overview of the research methods and analytical techniques used for this study.

2.1 Research Methods

This study employed multiple research methods to achieve adequate input for the economic model, including a literature review, the development of a data gap analysis, characterization of the local geographic and economic context, and data collection by means of questionnaire administration sessions in Nuiqsut.

2.1.1 Literature Review

A literature review was conducted to capture existing information that could inform the study effort. It covered two main bodies of available information: (1) potential sources of economic value of subsistence model inputs and bibliographic information that could be used to identify quantitative data of potential use in informing the model and (2) qualitative data that could provide context for the model. Overall, previously published literature related to the volume of subsistence harvests, the location of subsistence harvests, the annual timing of subsistence harvests, and the income earned and received by Nuiqsut residents was relatively well developed (see Section 3).

2.1.2 Data Gap Analysis

The Data Gap Analysis synthesized information gathered during the literature review related to pertinent economic, subsistence, and demographic studies in Nuiqsut and elsewhere on the North Slope. The Data Gap Analysis described the available literature and existing data collections in an annotated bibliography format, with each source described separately. Each source was discussed in terms of methodology used, emphasis of analysis/topic, potential quantitative model inputs available in the document, major conclusions (when available), and other considerations for its use in the overall economic study of subsistence impacts (see Section 1.1.1 for an overview of the data gap analysis process and Appendix C for the full analysis).

2.1.3 Geographic and Economic Context Characterization

The study developed a brief overview of Nuiqsut's geographic context in relation to other communities and in relation to nearby energy development infrastructure, along with a brief overview of Nuiqsut's economic context in terms of levels of income and sources of income, including wages and dividends (see Section 4). These characterizations provide background for the understanding of spatial relationships between development and subsistence resource sites/travel distances and an order-of-magnitude baseline for local income related data.

2.1.4 Nuiqsut Questionnaire Sessions

The team held sessions in which they provided participants with a subsistence questionnaire to help gather sufficient data for the model by addressing identified data gaps. The questionnaire was pre-tested in Anchorage with individuals from or familiar with Nuiqsut before it was administered in Nuiqsut. As Nuiqsut residents participate in a mixed subsistence/wage economy, the questionnaire focused on both economic dimensions (see Section 5).

2.2 Analytical Techniques

This economic study focuses on the development of a model at the beginning of the GMT1 project to determine the costs that individuals and families incur to continue subsistence activities at desired levels (or would have to incur to participate in subsistence activities if they are not able to afford them).

2.2.1 Development of Quantitative Model

The economic model developed for this study evaluates how the household allocates its time and resources to maximize its wellbeing, referred to in economics as utility. The model uses a Cobb-Douglas utility function that is composed of shares of time spent in work, leisure, and several subsistence activities; diet, including various sources of subsistence and market protein; and sharing of various harvested resources. The utility of each activity was identified by utility elicitation items included in the questionnaires completed by Nuiqsut residents, with breakouts provided for caribou, whales, and fish (see Section 6).

2.2.2 Application of the Economic Model

The model was applied in terms of resources, households, household allocation of time and household utility and constraints (see Sections 6.2 through 6.5). The model can be used to quantify impact (and therefore appropriate mitigation) of potential changes in resource availability using a baseline versus counterfactual methodology. This study considered three potential GMT1 project-specific counterfactual scenarios (actual project effects): traveling 20 miles farther, increasing use of trucks, and use of a hypothetical road to access a new site. These scenarios are presented in Section 6.6.

3 Literature Review

This section presents the economic value of subsistence model inputs along with bibliographic information that identifies quantitative data that may be used to inform the model and qualitative data that provide context for the model. Table 1 presents the quantitative data inputs for the economic subsistence model. Overall, previously published literature related to the volume of subsistence harvests, the location of subsistence harvests, the annual timing of subsistence harvests, and the income earned and received by Nuiqsut residents was relatively well developed; in most cases, model inputs could be adequately filled with previously published data or with some simplifying assumptions (e.g., averaging community-wide estimates per the number of identified households). The reviewers found that recently published studies from the Alaska Department of Fish and Game, the North Slope Borough (NSB), and the Bureau of Ocean Energy Management (including those funded by the oil and gas industry) contained the most relevant information. For more detail about the data sources for the economic model, see Section 3 of *Economic Study of Subsistence Impacts: Subsistence Economic Model and Data Gap Analysis*, in Appendix C.

Despite this review task, data gaps remained. The reviewers did not find substantial previously published information regarding the cost of subsistence harvesting gear (e.g., rifles, ammunition, snowmachines), costs associated with subsistence harvest travel, quantifications of existing household market spending on food, or easily quantified preferences for subsistence foods in a typical Nuiqsut diet. In those instances where some quantifying information was found, the data were specific to individual subsistence species (e.g., caribou, bowhead whale). Finally, some excellent research has been conducted in the community of Nuiqsut identifying the cultural relevance of subsistence activities, its role in Iñupiaq culture, and community perceptions regarding how recent industrial developments and weather variabilities have affected subsistence harvesting (e.g. Galginaitis 2014; EDAW 2008; SRBA 2016); however, these reports were generally qualitative in nature and did not include dollar values or other quantifications that could directly form inputs into the model.

3.1 Quantitative Data

Table 1 includes columns that identify the existing source from which data can be used, if available. The letters used to identify the source match the sources listed in Section 9, References. In some cases, data related to the model input could be found in multiple publications. In these cases, the reviewers found a clear trend that one dataset should be considered “primary” and would likely serve as the key piece of information for that input, based either on its recent publication, geographic specificity to the community of Nuiqsut, specific discussion of multiple subsistence resources, or a combination of these elements.

The table also includes a column that identifies issues with the referenced data that may need to be considered before their use in the model. These considerations include, but are not limited to:

- Data are related to a specific subsistence resource (e.g., bowhead whale, caribou, fish)
- Data are generalized across all subsistence resources and aggregated
- Data are over 10 years old
- Data show generalized harvest locations
- Data are at the NSB geographic level and not specific to Nuiqsut
- Data are at the generalized Arctic geographic level and not specific to Nuiqsut
- Data are not at a household level of detail

Finally, Table 1 also includes a color-coded column that provides a qualitative indication as to the adequacy of the data for the economic model. The legend for the colors is as follows:

- Existing data are adequate; no data gap
- Existing data are nearly adequate; minor assumptions may be required for use
- Existing data are not adequate; substantial assumptions may be required for use
- Existing data are not present; data gap exists

Table 1. Model Inputs and Identified Data Gaps

<i>Input Name</i>	<i>Description</i>	<i>Source</i>	<i>Consideration</i>	<i>Data Adequacy</i>
Senior males	Number of senior males household type Hi	[(Brown et al. 2016), p338]; [(U.S. Census Bureau 2017), p1, p3, p4, p6, p19]; [(State of Alaska 2017), p6]; (State of Alaska 2018b), p9-p10]; [(North Slope Borough 2016a), p69, p230]	[(Brown et al. 2016), Data not at household level]; [(U.S. Census Bureau 2017), Data not at household level]; [(State of Alaska 2017a), Data not at household level]; [(North Slope Borough 2016), Data at NSB level, data not at household level]	
Adult males	Number of adult males household type Hi	[(Brown et al. 2016), p338]; [(U.S. Census Bureau 2017), p1, p3, p4, p6, p19]; [(State of Alaska 2017), p6]; [(State of Alaska 2018b), p9-p10]; [(North Slope Borough 2016a), p69, p230]	[(Brown et al. 2016), Data not at household level]; [(U.S. Census Bureau 2017), Data not at household level]; [(State of Alaska 2017a), Data not at household level]; [(North Slope Borough 2016), Data at NSB level, data not at household level]	
Child males	Number of child males household type Hi	[(Brown et al. 2016), p338]; [(U.S. Census Bureau 2017), p1, p3, p4, p6, p19]; [(State of Alaska 2017), p6]; [(State of Alaska 2018b), p9-p10]; [(North Slope Borough 2016a), p69, p230]	[(Brown et al. 2016), Data not at household level]; [(U.S. Census Bureau 2017), Data not at household level]; [(State of Alaska 2017a), Data not at household level]; [(North Slope Borough 2016), Data at NSB level, data not at household level]	
Senior females	Number of senior females household type Hi	[(Brown et al. 2016), p338]; [(U.S. Census Bureau 2017), p1, p3, p4, p6, p19]; [(State of Alaska 2017), p6]; [(State of Alaska 2018b), p9-p10]; [(North Slope Borough 2016a), p69, p230]	[(Brown et al. 2016), Data not at household level]; [(U.S. Census Bureau 2017), Data not at household level]; [(State of Alaska 2017a), Data not at household level]; [(North Slope Borough 2016), Data at NSB level, data not at household level]	
Adult females	Number of adult females household type Hi	[(Brown et al. 2016), p338]; [(U.S. Census Bureau 2017), p1, p3, p4, p6, p19]; [(State of Alaska 2017), p6]; [(State of Alaska 2018b), p9-p10]; [(North Slope Borough 2016a), p69, p230]	[(Brown et al. 2016), Data not at household level]; [(U.S. Census Bureau 2017), Data not at household level]; [(State of Alaska 2017a), Data not at household level]; [(North Slope Borough 2016), Data at NSB level, data not at household level]	

Economic Study of Subsistence Impacts

<i>Input Name</i>	<i>Description</i>	<i>Source</i>	<i>Consideration</i>	<i>Data Adequacy</i>
Child females	Number of child females household type Hi	[(Brown et al. 2016), p338]; [(U.S. Census Bureau 2017), p1, p3, p4, p6, p19]; [(State of Alaska 2017), p6]; [(State of Alaska 2018b), p9-p10]; [(North Slope Borough 2016a), p69, p230]	[(Brown et al. 2016), Data not at household level]; [(U.S. Census Bureau 2017), Data not at household level]; [(State of Alaska 2017a), Data not at household level]; [(North Slope Borough 2016), Data at NSB level, data not at household level]	
Subsistence Meat Productivity ij	Amount of meat per hour at Site j by Household type i	[(SRBA 2010), p240-p337]		
Subsistence Fish Productivity ij	Amount of fish per hour at Site j by Household type i	[(SRBA 2010), p240-p337]; [(Carothers, Cotton, and Moerlein 2013), p13, p24]	[SRBA 2010, calculation by day and CPUE]; [(Carothers, Cotton, and Moerlein 2013), Data at NSB level]	
Subsistence Meat Effort ij	Amount of effort for meat at Site j by Household type i	[(Braem et al. 2011); p64, p65, p77-p81]; [(Brown et al. 2016); p351, p354, p356, p359, p362, p356, p367]; [(SRBA 2016) ³ ; p30, p33, p37, p67, p74]; [(Brower and Hepa 1998), p32]	[(Braem et al. 2011), Data specific to caribou; data over 10 years old]; [(Brown et al. 2016), generalized harvest locations]; [(SRBA 2016), Caribou only]; [(Brower and Hepa 1998), Data not specific to resource type, data over 10 years old]	
Subsistence Fish Effort ij	Amount of effort for fish at Site j by Household type i	[(Brown et al. 2016); p351, p354, p356, p359, p362, p356, p367]; [(Seigle et al. 2016), p15, p22-p23, p25, p29-p30]	[(Brown et al. 2016), generalized harvest locations]; [(Seigle et al. 2016), Specific to Arctic cisco, Data not by household]	
Subsistence Meat Mode ij	Mode of accessing site j by Household type i when going for meat	[(SRBA 2016), p56, p59-p64]; [(SRBA 2010), p240-p337];	[(SRBA 2016), Caribou only]	
Subsistence Fish Mode ij	Mode of accessing site j by Household type i when going for fish	[(SRBA 2010), p240-p337];		
Subsistence Meat Time ij	Average time accessing Site j by Household type i for meat	[(SRBA 2016), p58]; [(SRBA 2010), p240-p337]	[(SRBA 2016), Caribou only]	
Subsistence Fish Time ij	Average time accessing Site j by Household type i for fish	[(SRBA 2010), p240-p337]; [(Seigle et al. 2016), p15, p22-p23, p25, p29-p30]	[(Seigle et al. 2016), Specific to Arctic cisco, Data not by household]	
Subsistence Meat Gear ij	Typical gear at Site j by Household type i for meat	[(SRBA 2010), p240-p337]; [(North Slope Borough 2016b), p76, p92]		
Subsistence Fish Gear ij	Typical gear at Site j by Household type i for fish	[(SRBA 2010), p240-p337]; [(Fall and Utermohle 1995), p393-p398]; [(North Slope Borough 2016b), p76, p92]	[(Fall and Utermohle 1995), Data not by site]	

³ SRBA 2016 is year seven of a multiyear study. SRBA 2016 contains results from previous years and is in a similar format from year to year. For the purposes of simplicity, other SRBA citations in this series are not included in this table, but can be accessed if need be.

Economic Study of Subsistence Impacts

<i>Input Name</i>	<i>Description</i>	<i>Source</i>	<i>Consideration</i>	<i>Data Adequacy</i>
Subsistence Meat Consumption i	Amount of subsistence meat consumed per year by Household type i	[(Braem et al. 2011), p54]; [(Brown et al. 2016), p342-346]; [(Fall 2014), p3]; [(Braund and Kruse 2009), p211, p240]; [(U.S. Bureau of Land Management 2005), p28-p29]; [(CSIS 2017)]; [(Fall and Utermohle 1995), p384-p386, p390-p392]; [(Bacon et al. 2009), p82-p99, p135]	[(Braem et al. 2011), Data specific to caribou]; [(Fall 2014), Generalized to Arctic, subsistence resources aggregated]; [(Braund and Kruse 2009), Over 10 years old]; [(U.S. Bureau of Land Management 2005), Over 10 years old]; [(CSIS 2017), Data over 10 years old, data specific to some species]; [(Fall and Utermohle 1995), Over 10 years old]; [(Bacon et al. 2009), Data over 10 years old]	
Subsistence Fish Consumption i	Amount of subsistence fish consumed per year by Household type i	[(Brown et al. 2016), p342-346]; [(Braund and Kruse 2009), p211, p240]; [(U.S. Bureau of Land Management 2005), p28-p29]; [(CSIS 2017)]; [(Fall and Utermohle 1995), p384-p386, p390-p392]; [(Bacon et al. 2009), p82-p83]	[(Braund and Kruse 2009), Over 10 years old]; [(U.S. Bureau of Land Management 2005), Over 10 years old]; [(CSIS 2017), Data over 10 years old, data specific to some species]; [(Fall and Utermohle 1995), Over 10 years old]; [(Bacon et al. 2009), Data over 10 years old]	
Market Meat Consumption i	Amount of market meat consumed per year by Household type i			
Market Fish Consumption i	Amount of market fish consumed per year by Household type i			
Non-Protein Consumption i	Amount of non-protein consumed per year by Household type i			
Subsistence Meat Shared i	Amount of subsistence meat shared (+/-) per year by Household type i with other households	[(Braem et al. 2011), p54]; [(Brown et al. 2016), p342-346]; [(Braund and Kruse 2009), p249]; [(SRBA 2016), p66]; [(U.S. Bureau of Land Management 2005), p28-p29]; [(CSIS 2017)]; [(Fall and Utermohle 1995), p387]; [(Bacon et al. 2009), p15]	[(Braem et al. 2011), Data specific to caribou]; [(Braund and Kruse 2009), Subsistence resources generalized, data over 10 years old]; [(SRBA 2016), Specific to caribou]; [(U.S. Bureau of Land Management 2005), Over 10 years old]; [(CSIS 2017), Data over 10 years old, data specific to some species]; [(Fall and Utermohle 1995), Over 10 years old]; [(Bacon et al. 2009), Data not specific to any subsistence resource, data at village level, data are over 10 years old]	
Subsistence Fish Shared i	Amount of subsistence fish shared (+/-) per year by Household type i with other households	[(Brown et al. 2016), p342-346]; [(U.S. Bureau of Land Management 2005), p28-p29]; [(CSIS 2017)]; [(Fall and Utermohle 1995), p387]	[(U.S. Bureau of Land Management 2005), Over 10 years old]; [(CSIS 2017), Data over 10 years old, data specific to some species]; [(Fall and Utermohle 1995), Over 10 years old]	

Economic Study of Subsistence Impacts

<i>Input Name</i>	<i>Description</i>	<i>Source</i>	<i>Consideration</i>	<i>Data Adequacy</i>
Wage income	Amount of income from wages per year by Household type i	[(Brown et al. 2016); p331, p369]; (U.S. Census Bureau 2017), p10-p11]; [(State of Alaska 2018b), p1-p2]; [(State of Alaska 2017), p6]; [(North Slope Borough 2010), p16-p19]; [(North Slope Borough 2016a), p106-p111]		
Wage effort	Amount of time spent obtaining wages per year by Household type i	[(Brown et al. 2016); p331, p371]; [(North Slope Borough 2010), p8-p11]; [(Turcotte-Seabury 2011), p133-p137, p143-p144]		
Investment income	Amount of income from investments per year by Household type i	[(Brown et al. 2016); p331, p369]; [(U.S. Census Bureau 2017), p10-p11]; [(North Slope Borough 2010), p15]		
Assistance income	Amount of income from assistance per year by Household type i	[(Brown et al. 2016); p331, p369]; [(U.S. Census Bureau 2017), p10-p11]; [(North Slope Borough 2010), p15]; [(North Slope Borough 2016a), p106-p111]		
Entitlement income	Amount of income from entitlements per year by Household type i	[(Brown et al. 2016); p331, p369]; [(U.S. Census Bureau 2017), p10-p11]; [(North Slope Borough 2010), p15]; [(North Slope Borough 2016b), p94-p95]; [(North Slope Borough 2016a), p104, p106-p111]		
Market meat	Amount spent per year on market meat by Household type i			
Market fish	Amount spent per year on market fish by Household type i			
Market not protein	Amount spent per year on food that is not protein by Household type i			
Subsistence activity spending	Amount of spending on subsistence activities per year by Household type i	[(U.S. Bureau of Land Management 2005), p45]; [(North Slope Borough 2010), p38]	[(U.S. Bureau of Land Management 2005), Data over 10 years old]	
Work time	Amount of time working for wages per year by Household type i	[(Brown et al. 2016); p331, p371]; [(Jack Kruse et al. 2008), p4]; [(North Slope Borough 2016a), p230]	[(Jack Kruse et al. 2008), Over 10 years old, Generalized to NSB]	
Subsistence time	Amount of time spent subsistence hunting/fishing per year by Household type i	[(SRBA 2010), p240-p337]		
Subsistence preparation time	Amount of time spent preparing subsistence food per year by Household type i			

Economic Study of Subsistence Impacts

<i>Input Name</i>	<i>Description</i>	<i>Source</i>	<i>Consideration</i>	<i>Data Adequacy</i>
Subsistence preference	Relative preference for time spent on subsistence activities by Household type i	[(Turcotte-Seabury 2011); p147]; [(Jack Kruse et al. 2008), p11]	[(Turcotte-Seabury 2011), Not specific to Nuiqsut]; [(Jack Kruse et al. 2008), Not specific to Nuiqsut]	
Subsistence maximum	Maximum amount of time desired to spend in subsistence activities per year by Household type i			
Work preference	Relative preference for time spent on work by Household type i	[(Turcotte-Seabury 2011); p137-p138, p146-p147]; [(Jack Kruse et al. 2008), p11]	[(Turcotte-Seabury 2011), Not specific to Nuiqsut]; [(Jack Kruse et al. 2008), Not specific to Nuiqsut]	
Leisure preference	Relative preference for time spent on leisure by Household type i			
Subsistence meat consumption preference	Relative preference for consuming subsistence meat by Household type i	[(Brown et al. 2016), p374, p377]		
Subsistence meat consumption maximum	Maximum amount of subsistence meat consumption per year desired by Household type i	[(Brown et al. 2016), p374, p377]		
Subsistence meat sharing preference	Relative preference for sharing subsistence meat Household type i			
Subsistence meat sharing maximum	Maximum amount of subsistence meat sharing per year desired by Household type i			
Subsistence fish consumption preference	Relative preference for consuming subsistence fish by Household type i	[(Brown et al. 2016), p374, p377]		
Subsistence fish consumption maximum	Maximum amount of subsistence fish consumption per year desired by Household type i	[(Brown et al. 2016), p374, p377]		
Subsistence fish sharing preference	Relative preference for sharing subsistence fish Household type i			
Subsistence fish sharing maximum	Maximum amount of subsistence fish sharing per year desired by Household type i			

3.2 Qualitative Data

The documents and datasets reviewed included a substantial amount of quantitative data that could be used as inputs for the economic model. However, numerous resources reviewed by the team included descriptions regarding the cultural and societal importance of subsistence harvesting for people on the

North Slope generally, and the people of Nuiqsut, in particular. These resources included qualitative information about the spiritual and cultural relevance of subsistence harvesting, the role subsistence harvesting plays in cultural transmission, and how subsistence practices have been changed by recent changes in the region. While the model is quantitative and econometric in nature, information from these documents was used to inform the interpretation of modelling results and provide context for community-wide communication of the research process and results. These qualitative data also provided the project team with additional historical and cultural context as they developed and implemented recommendations to fill the data gaps identified in this section.

For example, Galginaitis (2014) specifically details the spiritual aspects of subsistence whaling among hunters in Nuiqsut, which touches on subsistence hunting on land, as well. EDAW 2008 includes a citation from a published Bureau of Ocean Energy Management report (Minerals Management Service 2002) that specifically notes:

In spite of the rising cash income, these traditions remain as central values and activities for all Iñupiat on the North Slope. Bowhead whale hunting strengthens family and community ties and the sense of a common Iñupiaq heritage, cultural, and way of life. In this way, whale-hunting activities provide strength, purpose, and unity in the face of rapid change.

Fishing studies, including a recent study by Carothers et al (Carothers, Cotton, and Moerlein 2013), also discuss the cultural dimensions related to subsistence harvesting, citing Stairs and Wenzel (1992) in their conclusion that an Inuit becomes a “whole” person by being a conduit between the environment and their community. Carothers found that the act of fishing in Utqiagvik and Nuiqsut provided a forum for cultural transmission during which traditional knowledge about weather, plants and animals, survival skills, Iñupiaq language, and traditional methods of hunting and gathering could be shared with younger generations. The opportunity for younger members of the community to share the fish they caught with members of the community also would instill a sense of accomplishment and pride. A recent survey on health issues in Nuiqsut also noted having access to subsistence foods and teaching the younger generation to hunt and fish were the top concerns for community leaders (North Slope Borough 2013).

The cultural importance of subsistence resource sharing was explored recently by Kofinas et al (2016) in a report that looked at the range of social structures and economic patterns that characterize Arctic communities, the flows of subsistence resources along social networks, and sources of resilience of households and communities to change. The concept of reciprocity is discussed, including the role it plays in keeping households connected and food secure. The report also notes the concept of “balanced reciprocity” within the Iñupiat culture where there is a belief that the animal willingly gave itself to the hunter, and now the hunter must share the animal with others.

In many cases, the discussions of cultural importance and qualitative changes in subsistence activities are included in discussions focused on changes to subsistence practices in recent years, affected by changing demographics, industrial development, climate change, or a combination of other factors. For example, SRBA’s annual reports (e.g., SRBA 2016) on caribou harvesting in Nuiqsut include direct quotes from subsistence hunters focusing on changes in hunt success, frequency, timing, area, and caribou health. These reports also include interviewee perceptions regarding how industrial development in the region has affected the caribou hunt, including impacts from helicopter traffic, airplane traffic, manmade structures, regulations, and seismic activity. The hunters noted regularly throughout this series of reports changes in timing and effort due to a variety of outside factors.

EDAW (2008) specifically surveyed North Slope residents about the perceived impacts to bowhead whaling and other subsistence practices they had seen in recent years resulting from industrial development. The authors found that 59 percent of the surveyed whaling captains responded that oil and gas development had a neutral effect or responded that they “don’t know” about an impact to whaling practices. Galginaitis (2014) provided additional information from Nuiqsut whale hunters,

stating generally that recent hunting activities had been not been seriously adversely affected by oil and gas activities; however, commercial shipping (not oil and gas related) had affected hunts in the late 2000s.

SRBA (2009) synthesized interviews with 215 active harvesters across the North Slope, including harvesters in Nuiqsut, regarding their perceptions of how oil and gas development had affected subsistence harvests. The team found that impacts related to caribou and bowhead displacement were of the most concern, with Nuiqsut residents stating that caribou were more affected than whales or other marine mammals. Nuiqsut residents, overall, stated that the impacts they mostly frequently experienced were difficulty hunting, displacement of wildlife, and disruption of wildlife. Pipelines and the presence of facilities and vehicles were two of the most mentioned activities associated with impacts for Nuiqsut residents. Benefits from increased activity included corporate dividend benefits, employment benefits, and subsistence mitigation benefits.

4 Location and Economy of Study Area

This section provides a brief overview of Nuiqsut’s geographic context in relation to other communities and in relation to nearby energy development infrastructure. Also presented is a brief overview of Nuiqsut’s economic context in terms of levels of income and sources of income, including wages, corporate income dividends, and Permanent Fund dividends (PFDs).

4.1 Nuiqsut Geographic Overview

Nuiqsut is located approximately 620 air miles north of Anchorage, 152 miles southeast of Utqiagvik (formerly Barrow⁴), 65 miles northeast of Umiat, 60 miles west of Deadhorse, and 17 miles south of the shores of the Beaufort Sea (Figure 1).

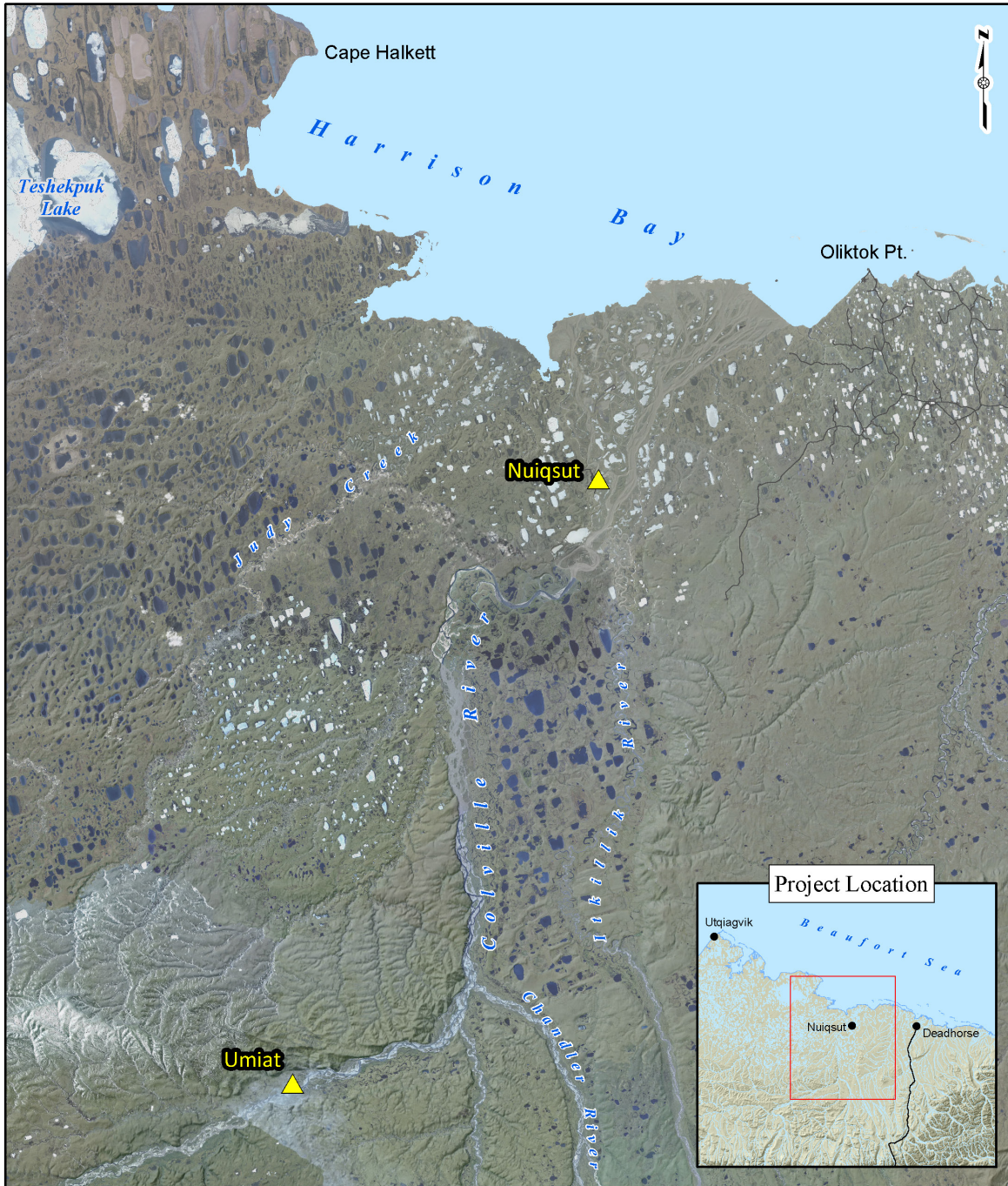
Nuiqsut is situated in the Colville River Delta, on the west bank of the Nechelik Channel approximately 7 miles from the main Alpine facility and 12 miles from the GMT1 drillsite. The City is located within the NPR-A and the NSB—encompassing 9.2 square miles of land. Figure 2 shows the location of Nuiqsut in relation to nearby development infrastructure.

The name Nuiqsut recalls prehistoric and historic camps and settlements occupied by numerous families on the main channel of the Colville River that had been used traditionally as an area for hunting, fishing, trapping, and trading. In the 1940s, most residents moved to Utqiagvik when the Bureau of Indian Affairs mandated school attendance for children. However, former residents continued to use the Colville River area for subsistence purposes. After the passage of the Alaska Native Claims Settlement Act, the area was resettled by 27 families in 1973 (EDAW 2008).

Nuiqsut has grown considerably since its resettlement. Today, Nuiqsut hosts an airport, a pre-kindergarten through grade 12 school, community center, power plant, wastewater treatment center, clinic, post office, hotel, and grocery store. The population in 2017 was 482 residents, up from 470 in 2016 (State of Alaska 2018a). Most homes in Nuiqsut are heated with natural gas provided by the Alpine oilfield and an NSB gas pipeline. Emergency services are provided by the NSB and the local governance is comprised of the City of Nuiqsut, Native Village of Nuiqsut, and the NSB. Nuiqsut is also a member community to both regional and local Alaska Native corporations. Both the Arctic Slope Regional Corporation (ASRC) and Kuukpik Corporation (village corporation) work toward enhancing Iñupiaq cultural and economic freedoms (Brown et al. 2016). It should be noted that a significant portion of the Alpine development, including GMT1 and CD5, resides on Alaska Native corporation land (surface owned by Kuukpik Corporation and subsurface owned by ASRC). This plays an important role in corporation dividend payments affecting the income and wages of Nuiqsut residents, as will be discussed below.

⁴ The community reverted to its original name, Utqiagvik, in 2016, which is the name consistently used in this report.

Figure 1. Project Overview



ConocoPhillips

PROJECT OVERVIEW
Economic Study of Subsistence Impacts

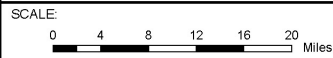
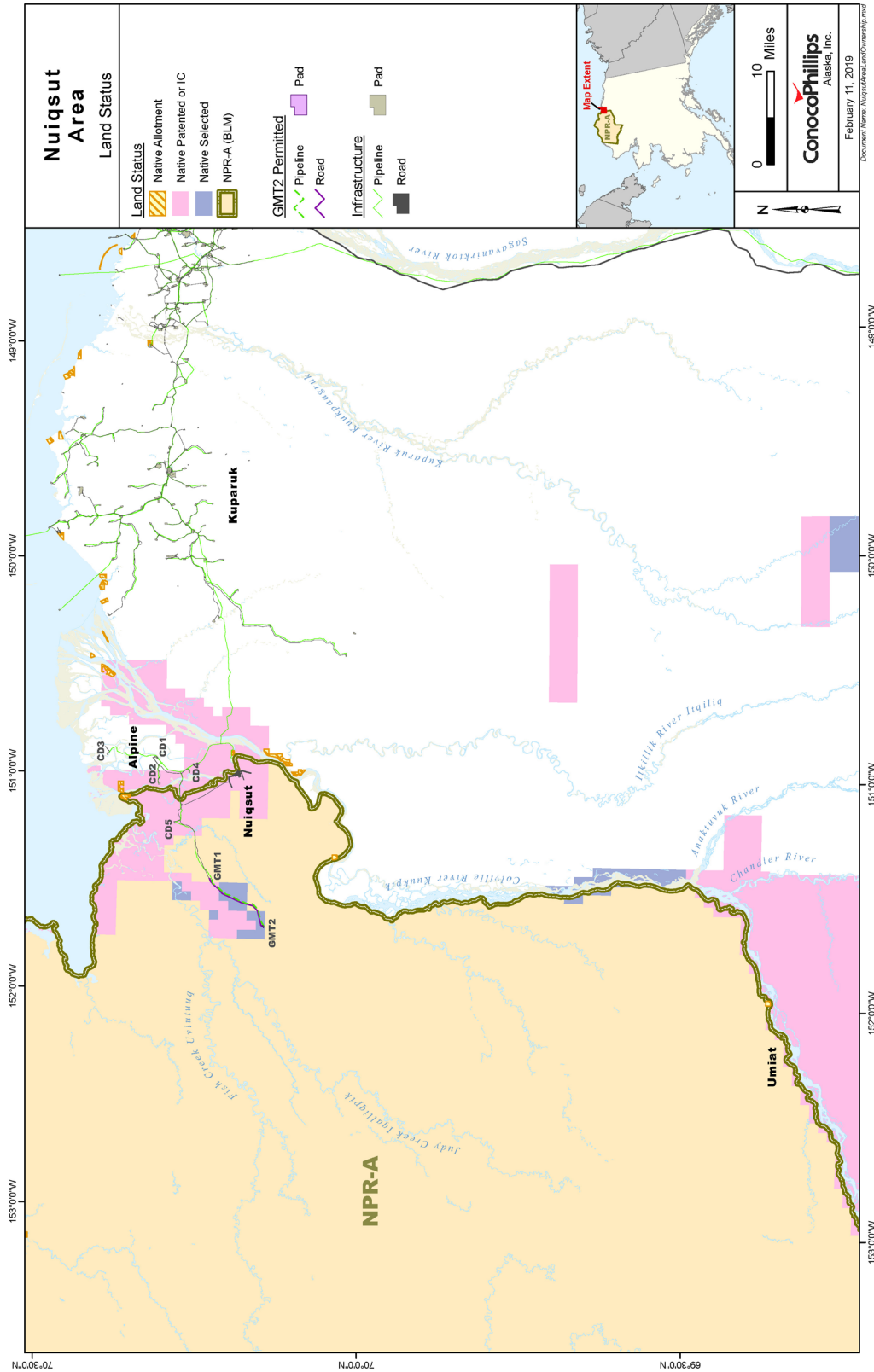


FIGURE:

NAD83, State Plane Zone 4

AES-RTS: 18-033-001.mxd, 03/19/18

Figure 2. Nuiqsut and Nearby Infrastructure



4.2 Nuiqsut Economic Overview

Nuiqsut’s economy comprises both cash-based and subsistence components, with the “typical” Nuiqsut resident likely to define his or her lifestyle more in terms of subsistence activities and the annual subsistence cycle rather than in terms of employment for wages or consumer goods (EDAW 2008). The relationship among wage labor, income, and participation in subsistence is a very complex subject. In short, wage labor and income are not related to participation in subsistence activities in a simple way.

Like many other North Slope communities, the development of oil and gas has had both direct and indirect influences on Nuiqsut’s economy due to increased services offered by the NSB as a result of taxation on oil and gas facilities. The effects on Nuiqsut are more direct than most given the city’s proximity to both onshore and offshore oil development activities (see Figure 2). Nuiqsut’s proximity to development on land owned by the Kuukpik Corporation is especially notable. The revenues received by the regional and village corporations and subsequent dividend payments to shareholders are not equally distributed to all residents, not all of whom are shareholders, resulting in a differential distribution of resources.

This chapter focuses on the economy of Nuiqsut by providing the necessary contextual information on these topics, including household income and the three main sources of income (wages, corporation dividends, and PFDs).

4.2.1 Income

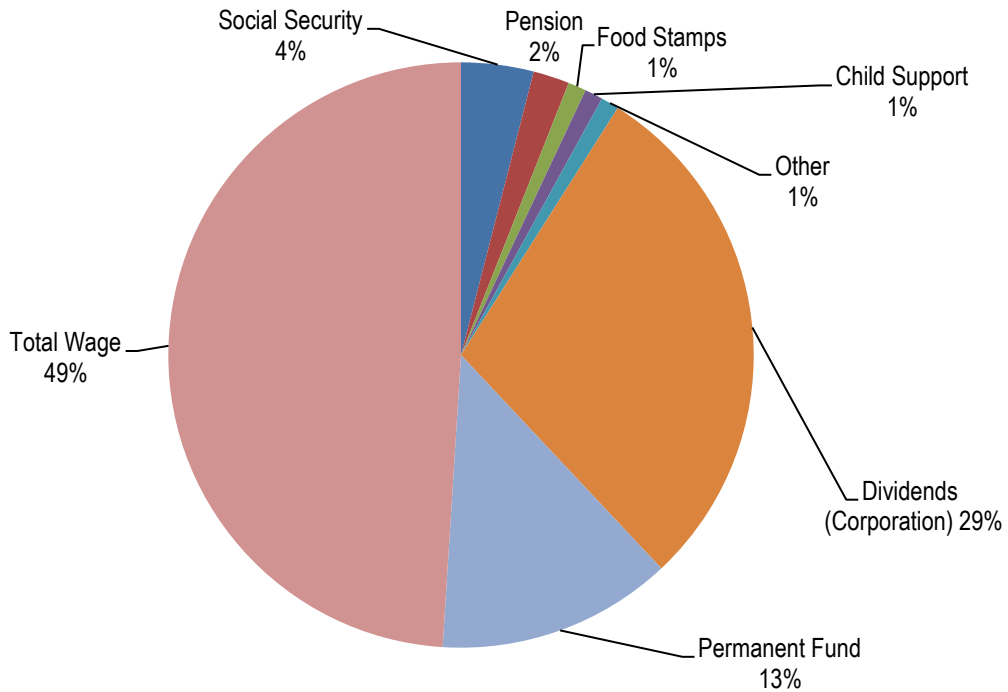
Based on household surveys conducted for the 2013–2017 American Community Survey 5-year estimate, the per capita income in Nuiqsut was estimated to be \$22,481 and the median household income was estimated to be \$82,813 (U.S. Census Bureau 2019). This is a decrease from the 2016 5-year estimate, which estimated the per capita income to be \$24,312 and the median household income at \$84,464. The per capita and median household incomes have also decreased when compared to those reported in the year 2010 (\$22,981 and \$86,042, respectively). Nuiqsut’s decrease in income is likely the result of a decline in oil prices that started in the summer of 2014. In 2017, Nuiqsut ranked 117th of 314 Alaskan communities with per capita income data that year, and 31st out of 276 Alaskan communities with median household income data that year.

Based on the information available for corporate dividends and state of Alaska PFD, the NSB estimated that “a Nuiqsut household comprised of four persons, each enrolled in ASRC with 100 shares each, eligible for the Alaska PFD and two members enrolled in the Kuukpik Corporation with 100 shares each could generate \$48,800 to \$64,800 from 2014 dividends” (North Slope Borough 2016b).

4.2.2 Sources of Income

According to the NSB Economic and Census Profile, the three most important sources of income for Iñupiat residents on the North Slope are wage work (57 percent of total income), corporation dividend income (20 percent of total income), and permanent fund monies from the State of Alaska (12 percent of total income). These three sources account for 90 percent of Iñupiat household income (North Slope Borough 2016a). For Nuiqsut, wages comprise 49 percent of total income, followed by corporation dividend income (29 percent) and the PFD (13 percent) (North Slope Borough 2016a). Figure 3 is a breakdown of all sources of income for Nuiqsut.

Figure 3. Nuiqsut Sources of Household Income

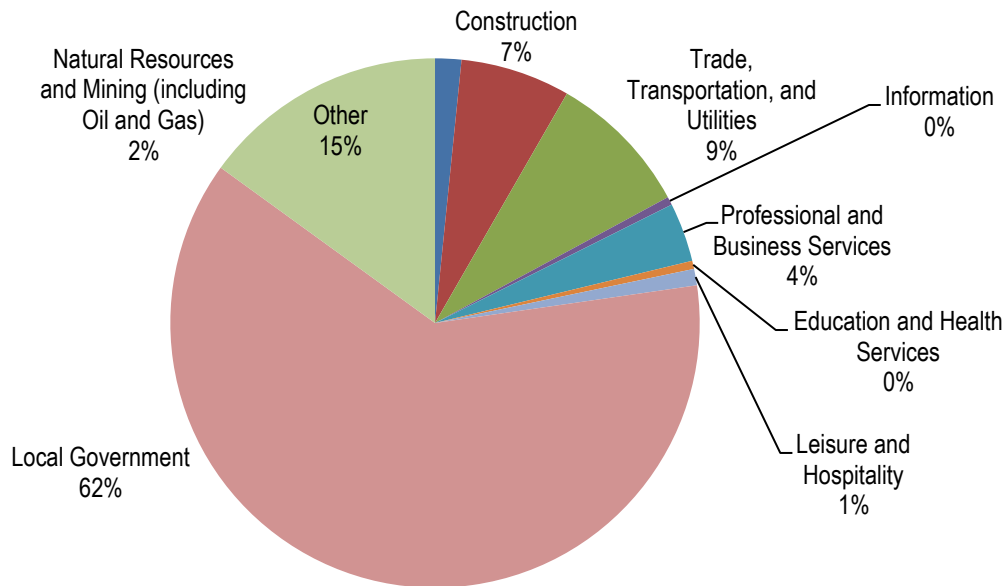


Source: (North Slope Borough 2016a)

4.2.2.1 Wage Income

In 2016, the majority of Nuiqsut’s workforce was employed by local government (Figure 4). Trade, transportation, and utilities and construction represented the next single-largest industries, accounting for 8.8 percent and 6.7 percent of jobs in Nuiqsut, respectively. The top three occupations reported in Nuiqsut in 2016 were clerks (bookkeeping, accounting, and auditing), truck drivers (heavy and tractor-trailer), and teacher assistants, janitors and cleaners (not maids or housekeeping cleaners), and general maintenance and repair workers (Table 2) (State of Alaska 2018a). It should also be noted that trapping and craft-making also provide some income, and subsistence harvest is a foundational aspect of the local economy. However, these data are not included by the U.S. Census or Alaska Department of Labor.

Figure 4. Local Employment by Industry



Source: (State of Alaska 2018b)

Table 2. Top Occupations, 2016

Occupation	Number of Workers
Bookkeeping, Accounting, and Auditing Clerks	25
Heavy and Tractor-Trailer Truck Drivers	10
Maintenance and Repair Workers, General	9
Teacher Assistants	9
Janitors and Cleaners, Except Maid and Housekeeping Cleaners	9

Source: (State of Alaska 2018b)

Note: Occupation data represent resident workers only

Nuiqsut’s proximity to development in the Colville River delta has increased the number of Nuiqsut residents being employed by the petroleum industry, with a limited number of current Nuiqsut residents seeking employment in the oil and gas industry. For example, CPAI funds a subsistence oversight panel that employed 12 ASRC shareholders and/or Nuiqsut residents in the 2015–2016 season and 16 ASRC shareholders and/or Nuiqsut residents in the 2016–2017 season. Approximately 21 ASRC shareholders and/or Nuiqsut residents were contracted by CPAI during the ice road season of 2015–2016, while approximately 37 ASRC shareholders and/or Nuiqsut residents were employed during the 2016–2017 GMT-1 construction season. Overall, however, the pattern was and continues to be that such employment is generally in lower-level positions and is temporary in the sense that it does not lead to a career (EDAW 2008).

4.2.2.2 Corporate Income Dividends

Nuiqsut’s village corporation, Kuukpik Corporation, was established in 1973 and owns the surface rights to land in the vicinity of Nuiqsut, including portions of the Alpine oilfield. Kuukpik Corporation receives

revenues for the use of its land and its subsidiaries also provide oil support services. Kuukpik has over 250 enrolled shareholders who receive dividends (U.S. Bureau of Land Management 2014).

According to the 2010 NSB census, 97.9 percent of Nuiqsut residents who participated in the survey were ASRC shareholders while 68.5 percent were Kuukpik Corporation shareholders (Shepro et al. 2011). Kuukpik Corporation issues quarterly dividends to shareholders of \$30 to \$50 per share. Less than half of all shareholders have 100 shares. The Nuiqsut Comprehensive Plan states that two issues of contention for Nuiqsut residents are that corporation dividends are given to some shareholders who no longer live in Nuiqsut; and that those born after December 18, 1971 can only acquire shares through inheritance or gift (North Slope Borough 2016b).

ASRC, the Alaska Native regional corporation, not only has several oil services contracts with operators in the North Slope oilfields, but also has a royalty interest in the Colville River Unit and GMT Unit (U.S. Bureau of Land Management 2014). Most Nuiqsut residents are ASRC shareholders (97.9 percent in 2010) (Shepro et al. 2011). Dividends are distributed quarterly. In 2018, ASRC dividends were approximately \$7,000 per 100 shares for the whole year (Arctic Slope Regional Corporation 2019).

4.2.2.3 Permanent Fund Dividends

The Alaska Permanent Fund is a “sovereign wealth fund for the State of Alaska” (Berman and Reamey 2016). It was created as a mechanism to save a portion of nonrenewable oil revenues for future public needs. The PFD program was enacted in 1980 by the Alaska Legislature to generate political support for conservative management of the fund. Through the PFD program, equal annual payments have been provided to Alaska residents, regardless of need (Berman and Reamey 2016).

In 2014, 391 Nuiqsut residents qualified for the Alaska PFD. The PFD accounts for 13 percent of the income of Nuiqsut residents (North Slope Borough 2016a). Dividend payouts for State of Alaska residents for the past 6 years are shown in Table 3.

Table 3. Alaska Permanent Fund Dividend Payouts 2013–2018

Year	Amount (\$)
2013	900
2014	1,884
2015	2,072
2016	1,022
2017	1,100
2018	1,600

Source: (State of Alaska 2018a)

Recent research by ISER has indicated that PFD payments have helped reduce poverty in rural Alaska. Without this dividend, more than one in five rural Alaskans would be below the poverty threshold (Berman and Reamey 2016). However, recent PFD payments have not increased as fast as inflation and therefore represent a smaller percentage of per capita income than they did in the 1990s (Berman and Reamey 2016). This plays an important role in the overall income of Nuiqsut household income, as the PFD comprises such a large percentage of total household income (North Slope Borough 2016a).

5 Subsistence Questionnaires

This section presents a summary of the subsistence questionnaires administered to the volunteer Nuiqsut residents during November 9–13, 2017, including the results of primary quantitative data collection, community feedback, and steps taken to respond to community input on the economic survey.

5.1 Methods

This section discusses project introduction, study design and field preparation, questionnaire pre-testing, questionnaire structure and content, community engagement, and the questionnaire administration process.

5.1.1 Project Introduction

Two project team members planned to accompany CPAI staff to Nuiqsut for a community meeting in June 2017. The purpose of the trip was to offer a project introduction/summary overview of the study and to discuss the upcoming workshop (later changed to questionnaire administration sessions) with community members. The formal presentation was to include a discussion of the research, its purpose, what community members could expect, and a general timeline. The intent was not only to introduce the project to community members, but also to stimulate interest in participation.

The community meeting at which the formal presentation was to occur was canceled due to a memorial service in the community. While in Nuiqsut, however, project team members were able to make brief presentations about the project to the Nuiqsut City Council during their regularly scheduled meeting and to a few Kuukpik Subsistence Oversight Panel members during an informal lunch meeting. The Kuukpik Subsistence Oversight Panel members present at the meeting specifically suggested that a community-wide survey may be a better option than the planned workshop to get data from a greater number of residents.

Additionally, the project team members were able to visit public facilities and offices throughout Nuiqsut and distribute the project flyer (see Appendix A) and comment cards to numerous entities. The project team visited the following offices: ASRC, Native Village of Nuiqsut, NSB, the Nuiqsut Alaska Commercial (AC) Store, post office, police station, Kuukpik Hotel, and other public posting boards around the village. When possible, the project team introduced the project one-on-one with Nuiqsut residents and provided extra copies of the flyer and comment cards for additional distribution. Overall, reception to the project and workshop/questionnaire seemed positive. The project team also documented prices of meat and other food staples (i.e., dairy and bread) at the AC Store.

CPAI rescheduled their community meeting for June 20, 2017. Information regarding this study was handed out at that meeting.

5.1.2 Study Design and Field Preparation

Although originally conceived as a workshop, through feedback received during community discussions, the study design was ultimately changed to a questionnaire. This type of field survey technique would allow more residents to participate but would still allow the researchers to ask the questions needed to fill the data gaps. The project team coordinated efforts to develop and design a survey instrument that would meet the needs expressed of the research method. The subsistence questionnaire was developed from the results of the Economic Study of Subsistence Impacts-Data Gap Analysis with the goal of

gathering the information necessary for development of the economic model and to address “Red Flag” items identified in the analysis report.

A pre-test of the preliminary questionnaire instrument was organized by AES Alaska and administered on October 17, 2017 at the ASRC office building in Anchorage, Alaska. The purpose of the pre-test was to collect comments and suggestions from people familiar with the area⁵ to make sure that the questions asked were culturally appropriate and sensitive, to make sure that the questionnaire was user-friendly, and to test the length of time it took to complete the questionnaire. Input from the pre-test was incorporated into the questionnaire.

5.1.3 Questionnaire Structure and Content

Each questionnaire was designed to take approximately 90 minutes to finish. Consent forms were created for each participant to sign before taking the questionnaire. The research team also planned to give each participant a stipend (either a cash payout or gift card to the AC Store) once they finished the questionnaire in its entirety. AES Alaska team members administered the questionnaire in person in Nuiqsut during the second week of November 2017 and were available to assist participants and walk them through the entire questionnaire.

The questionnaire consisted of nine questions. The **first four questions** addressed subsistence harvesting of caribou, fish, whales, and one other subsistence resource of the participant’s choosing. For each resource (excluding whale), participants were provided a map to indicate where they harvested each resource. For each site identified on the map, they were asked the following questions:

- Number of trips to each site over the past 12 months
- Length of time it takes to reach this site
- Length of time they stayed at the site
- How much of each resource brought home
- How much of the resource is shared with other households

Participants could answer the above questions for up to four specific locales. Participants were also encouraged to answer the above questions for another resource(s) of their choosing, a resource that was of importance to them or their household. Geese and seals were the most numerous “other resource” listed, followed by moose, berries, furbearers (wolf, wolverine, fox), duck, and bear.

Figure 5 shows the subsistence use destinations and place names commonly discussed by participants during the interviews.

⁵ Four individuals from Nuiqsut and one individual from Wainwright participated in the pre-test.

For whaling, participants were asked the following:

- Length of time it takes to get to Cross Island
- How long they stay at Cross Island
- Whether they participate in whaling at a location other than Cross Island (with their Nuiqsut crew)
- Whether they participate in whaling with a crew from another village
- The length of time for the whale to arrive in Nuiqsut after it is caught
- Whether the whale is processed at Cross Island or Nuiqsut
- How long it takes to process the whale

Several respondents answered the question “How long does it take to process a whale?” by describing a process drawn out over several months. One respondent explained it by drawing a sketch of a whale divided in three parts. The center section is the “Captain’s share” and is divided immediately. The “other crews” section encompasses the body and head forward of the mid-section. This is harvested immediately and also stored for use during the year. The remainder he labeled “Christmas and Thanksgiving,” the portion destined for community distribution during holiday periods.

The timing of the questionnaire administration may have influenced participant responses. The project team was in Nuiqsut just a couple of weeks before Thanksgiving; therefore, many people were talking about the upcoming preparation of the whale to get it ready for the community Thanksgiving feast. This round of preparations was fresh in everyone’s mind, perhaps more so than if the project team had been in town during a different part of the year.

Question 5 focused on how participants use their time and how they would prefer to use their time. Each participant was provided with a table listing specific activities, including:

- Sleeping
- Working at a job for wages
- Working inside the household not earning a wage
- Preparation and maintenance for subsistence activities
- Harvesting, preparing for harvesting, and processing:
 - Fishing
 - Caribou
 - Seal
 - Whaling
 - Other subsistence resources
- Other activities including social activities

Participants were asked to complete the table for both their *actual* time spent and *preferred* time spent for both themselves individually and their household as a whole. Many participants had difficulty estimating both “actual” and “preferred” percentages for activities of their larger household—several explained they didn’t feel comfortable speaking for other members of their family. Additionally, many participants labored over finding appropriate methods to measure their time spent in subsistence activities, as subsistence trips vary widely from day trips, to overnights, to longer expeditions. On these trips multiple resources are often taken, so it is hard to estimate percentages of time for each subsistence activity.

Other participants expressed frustration at trying to visualize a “preferred” way to spend their time. For example, one participant stated that he had a large household consisting of three adults and three children. If he changed how he spent his time in any one category, it would change the time spent in any other category and change the way his household lived their lives together.

Another participant identified herself as the head of her household of six. She stated that her household acts as single unit, with her directing activities. She acknowledged satisfaction with the level or intensity of subsistence they were doing, therefore the “actual” and “preferred” time for the household were the same.

Question 6 was divided into two parts, both of which focused on the time and aspects of life. The first part of **Question 6** asked participants to prioritize aspects of their lives by spreading out 100 points between the following: food, time, purchasing power, and social activities. The more important the aspect of life, the more points it would receive.

The second part of **Question 6** asked participants to distribute 100 points between four categories based on their importance compared to each other. The categories were: subsistence activities, leisure time, working inside the household, and working for wages.

For both parts of **Question 6**, participants were provided with a visual aid to assist in distributing the 100 points. They were given 10 blocks, each block representative of 10 points. The visual aid was beneficial to some participants, although not everyone used them.

Question 7 asked participants if they ever purchased meat from the store, how frequently it was purchased, what type of meat they purchased, and how much it typically cost. Of the 35 participants, only 3 answered that they never purchased meat at the store. Most answered that they purchased meat between once a year, monthly, weekly, or several times a week. Many participants purchase meat in the AC Store as “boxes,” measuring at least 10 or more pounds each, with some known as “variety packs.” As a result, only a few had an idea how much meat cost per pound, and cost per type of meat.

Question 8 asked if any people in their household also lived at another residence outside of Nuiqsut. Thirteen participants had at least one member of their household who also resided outside of Nuiqsut for part of the year. Utqiagvik was the most frequent other residence mentioned.

The last question (**Question 9**) asked about each participant’s household. After asking how many people live in their household, participants were asked to answer the following for each household member over the age of 18:

- Gender and age
- If they worked outside the home for wages
 - Hours per week
 - How much they earned
- If they hunted/fished last year
 - What species
- If they spent time preparing, maintaining, or repairing harvesting/fishing materials or gear in the last year.

5.1.4 Community Engagement

Project team members arrived in Nuiqsut on November 9, 2017 to administer the questionnaires. To inform residents of the opportunity to participate in the subsistence study through the questionnaires, project team members posted flyers around town, specifically at the Kuukpik Hotel, the AC Store, ASRC

office, community center, and Native Village offices. November 9 was also the day of the community-wide Science Fair at the school. The project team had a table at the fair and distributed flyers to interested individuals, introduced people to the project, and scheduled questionnaire session for later in the week.

5.1.5 Questionnaire Administration Process

Questionnaires were administered at open tables at the Kuukpik Hotel from November 9 through November 13, 2017. Some residents called ahead to schedule a time to complete the questionnaire, while others were served on a walk-in basis. The project team tried to accommodate participants as best they could, although at times some had to be turned away or asked to come back later due to a long wait time or if it was too late in the day to complete the questionnaire.

The questionnaire was open to any Nuiqsut resident over the age of 18 who participated (or who lived in a household that participated) in subsistence activities in any capacity for the past 12 months. The questionnaire took approximately 45 minutes to 1 hour to complete for most participants; although the range of time was between 20 minutes for the shortest and over 2 hours for the longest. The project team went over each question individually with participants while they input their answers.

Over the course of five days, the research team administered the questionnaire to 35 people. Each participant completed his/her own questionnaire. Project team members entered the answers into the questionnaire sheet for two individuals, both of whom were elders and did not want to write out their own answers, so project team members transcribed their answers onto the paper for them.

Overall, the reaction by the community to the questionnaire was positive. Participants seemed genuinely excited to participate in the study. They provided positive feedback that the project team had opened the process to a broader range of participants. Several participants expressed frustration that previous research in the community had focused on only a few families and that others were left out of research, despite also participating in subsistence harvesting and having their own stories to share. The current survey sample included appreciable numbers of female residents and younger residents. However, several older hunters were incredulous over younger residents' participation and offered derogatory comments over their inexperience or "laziness," indicating a high amount of status attached to participation in the subsistence economy.⁶ Despite a few negative comments, the overall feedback from the community was positive.

5.2 Fieldwork Summary

The following information summarizes demographic and other information collected about the study participants.

5.2.1 Demographics

The 35 residents who completed the questionnaire were a representative cross-section of the community by gender: 46 percent of respondents were female, compared to 48 percent as reported by the 2010 census of Nuiqsut residents (U.S. Census Bureau 2017). Additionally, of the 35 participants,

⁶ The project team observed a unique "status hierarchy" in the community, not strictly based on values of financial wealth and conspicuous consumption, but on increased participation, success, and knowledge in subsistence resources and activities. Certain families who are currently active, generationally active, and successful in whaling and subsistence have earned community-wide status as leaders in this field. The project team believes the comments about inexperienced or younger participants came from (high status) subsistence traditionalists trying to differentiate themselves from those who had lower status as hunters.

54 percent were under the age of 40. Female participants ranged in age from 19 to 65, while males ranged in age from 21 to 61. The age group with the most representation was 18–29, followed closely by 50–59.

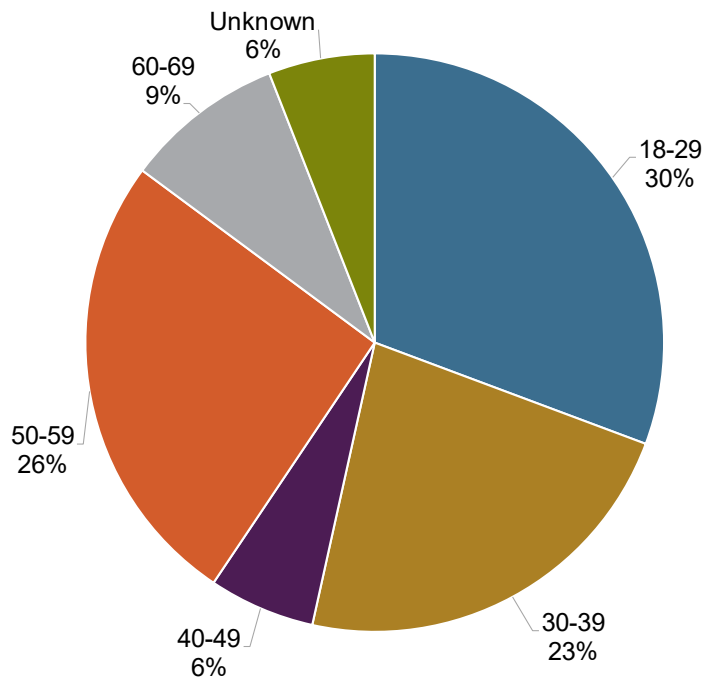
Table 4 summarizes the age range and gender of the participants.

Table 4. Demographics of Study Participants

Age Range	Male	Female	Total
18-29	4	7	11
30-39	6	2	8
40-49	2	-	2
50-59	6	3	9
60-69	1	2	3
Unknown	-	2	2
Total	19	16	35

Source: Northern Economics, Inc. Project Team

Figure 6. Age Range of Study Participants



Source: Northern Economics, Inc. Project Team

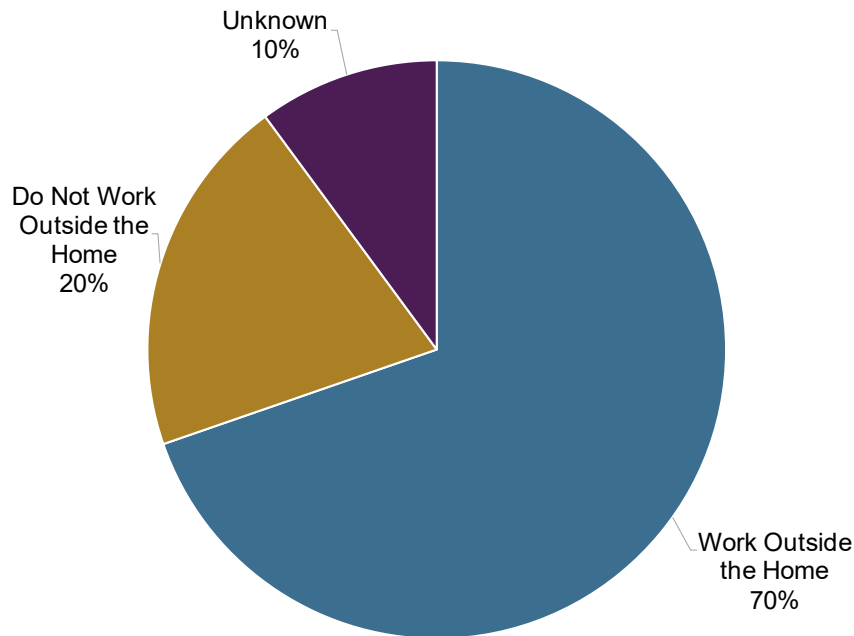
5.2.2 Employment

When asked whether they had worked outside the home for income in the past 12 months, 70 percent of participants said that they had, compared with 75 percent employed in the 2010 census (U.S. Census Bureau 2017). This included full-time, part-time, and seasonal employment. Working for wages is dependent on when jobs are available, as many of the jobs in the community are only available

seasonally. For example, ice road construction offers seasonal employment to many residents, but is only for a few weeks each year. Since jobs aren't always available, many families barter by using subsistence goods instead of cash. One respondent stated that his family currently is not working, but they fish, and their fish is their cash. They sell or barter for money and for the goods that they need.

Participants' ability to participate in various subsistence activities is often limited by lack of, or lack of access to, cash. Several participants expressed frustration or shame when they were unable to hunt for a particular resource due to the lack of a working boat or all-terrain vehicle. They were also more reliant on other families to share their resources with them.

Figure 7. Employment Status of Study Participants



Source: Northern Economics, Inc. Project Team

5.2.3 Community Sharing

Sharing of resources of all types is widespread in the community. Although numbers vary depending on resource, most shared at least 40 percent of everything with other households. One respondent stated that most of the caribou that he hunts goes to his mom, an elder in the community. She then decides which households and other elders with whom he shares the caribou. She also decides how much of the caribou to keep and how much to share. The participant said he gives the caribou shares to whomever she tells him to give it to.

Another participant stated that he shares his resources with elders or people who do not have a boat or motor. The amount he shares is dependent on what is going on in the community. If it is near a holiday, a community feast, or potluck, then he will share a greater percentage of his resources to help the community with its needs.

An elder noted that she does not subsistence hunt anymore, but her son who lives in her household does. He is not able to go caribou hunting frequently and when he did go this year, he did not have a

successful hunt. The elder did not seem too concerned because she knew others in the community would share their caribou with them.

When describing the importance of resource sharing in the community, one participant put it this way: “going to [the] store is so expensive, that’s why I live a subsistence way of life. I help to get a share of food and share with relatives living in different community. Sharing is our way of life.”

6 Economic Model

As noted earlier, Nuiqsut is a small Iñupiat community located within the central Arctic coastal plain of the North Slope of Alaska. Specifically, the community is on the Nechelik Channel of the lower Colville (Kuukpik) River, about 35 river miles from the headlands at the Beaufort Sea. The people inhabiting the lower Colville River have had a subsistence-based economy following the seasonal movement of food resources for millennia. Today, the 482 residents of Nuiqsut have a mixed subsistence-market economy. They live in a compact village laid out as a grid with utilities and schools. Rather than following resources, they reside permanently in the village and use modern modes of transportation including motor boats and snowmachines to access resources (Kuukpik Corporation 2017).

The exploration, development, and transportation of oil may affect the availability of subsistence resources and, through them, the Iñupiat way of life. This chapter describes the economic model used to characterize the economic effect that oil exploration and transportation activities may have on Nuiqsut residents.

6.1 Theoretical Framework and Development of the Model

The impact on Nuiqsut households of potential changes in the availability of subsistence resources is projected using an economic model of a mixed subsistence-market economy. This model incorporates the household production theory of Becker and information on the subsistence traditions of Nuiqsut (M. Berman et al. 2004; Gary S. Becker 1976).

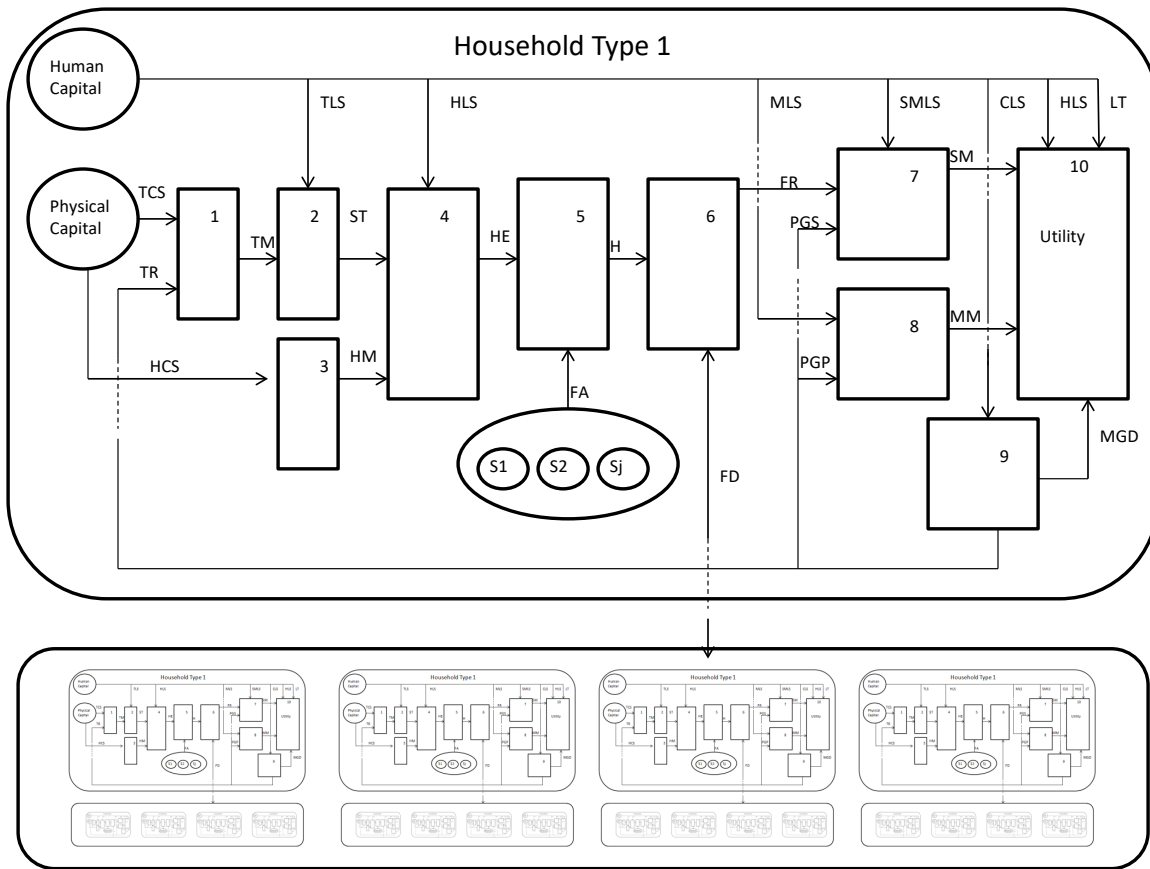
The economic analysis of this subsistence-market economy centers on the household, its relationship to the land, to the market economy, and to other households in the community. The economic model evaluates how the household allocates its time and resources to maximize its wellbeing, referred to in economics as utility. The model uses a Cobb-Douglas utility function that is composed of shares of time spent in work, leisure, and several subsistence activities; diet, including various sources of subsistence and market protein; and sharing of various harvested resources. The utility of each activity was identified by utility elicitation items on the questionnaires completed by Nuiqsut residents.

Constraints ensure time, money, and self-consumption versus sharing budgets are not exceeded. The average cost and productivity of engaging in subsistence activities is determined by a site-choice function in which harvesters choose among sites based on travel cost, travel time, and harvest rate. The approach follows the baseline and counterfactual methodology. The baseline model links resource cost and availability, subsistence protein harvesting activities, wages and work activities, protein consumption, and sharing utility in a manner that is consistent with elicited utilities for representative households and post optimization reproduces observed outcomes (harvest, income, sharing) at the village level.

In counterfactual specifications, changes in the availability of subsistence resources cause households to reallocate their harvest site, time, money, and consumption, so that they are as well off as possible given the new conditions. Given a reduction in subsistence resource availability, this necessarily results in lower utilities. The implications for Nuiqsut households can be identified by specifying offsetting monetary payments and/or harvest changes that restore utility to the Baseline value.

The flows of activities required to produce meals in a mixed subsistence-market household are shown in Figure 8. These activities are incorporated in the economic model. Each rectangle represents processes that transform inputs into outputs of value to the household.

Figure 8. Model of Nuiqsut Household Preferences (Variable Labels Defined in the Table Below)



Working down the diagram, the household combines the services of transportation (boats and snowmachines) with material inputs (e.g., fuel) to provide transport from the community to the harvest site and back. On site, the crew⁷ combines the services of self-provided gear (e.g., rifles) with material inputs (e.g., ammunition) to harvest resources (e.g., caribou). The success of the harvest in this example depends on the skills of the hunter(s), the adequacy of harvest gear, and the productivity of the environment (i.e., the availability, accessibility, and behavior of caribou), but these same types of factors are applicable to any subsistence pursuit.

Table 5 presents the model variables found in the figure above. Values for these variables are computed in the economic model at the household and community levels. More detail about the data sources for the economic model is found in Section 3 of *Economic Study of Subsistence Impacts: Subsistence Economic Model and Data Gap Analysis*, in Appendix C.

The data collection process initially looked at multiple subsistence resources. Based on GMT1’s location relative to both Nuiqsut and the resources on which it relies, GMT1 was determined to have the greatest potential effect on caribou and there the analysis focused on caribou. However, the following section, Section 6.2, discusses the information collected for other resources.

⁷ The term “crew,” usually associated with whaling, is used here to mean the group of individuals engaged in harvesting of any subsistence resource.

Table 5. Variables in the Economic Model of Nuiqsut Household Preferences

Symbol	Description	Relationship within the Model Architecture	Unit of Measure
CLS	The household's time spent working for wages in the market economy	The employment and wages received (not shown) in the commercial sector (9)	\$/yr
FA	The availability of subsistence resources at a site	The natural productivity of the environment	lb
FD	The share of the harvest shared with other households or received from them	A gift to other households or input to the production of subsistence-based meals (7)	lb/yr
FR	The share of the harvest retained by the harvesting household	An input to the production of subsistence-based meals (7)	lb/yr
H	The harvest of subsistence resources at a site	The result of applying effort to the environment (5)	lb/trip
HCS	Harvest gear capital services	An input to the production of harvest effort (4)	\$/yr
HE	The effort spent on-site to harvest subsistence resources	The combined application of harvest labor, capital and materials (4)	hr/trip
HLS	The household's time spent in an effort to secure subsistence resources	The on-site harvest of resources (4) and the personal enjoyment of subsistence activities (10)	hr/yr
HM	The combined harvest gear capital services and materials used to harvest subsistence resources	The combined inputs to the production of harvest effort (4)	\$/yr
LT	The household's time spent in leisure/personal activities	Directly contributes to household utility (10)	hr/yr
MGD	Other market purchases	Items purchased by the household (except those covered above) that contribute to household welfare (10)	\$/yr
MLS	The household's time spent to prepare and clean up from meals prepared primarily with market foods	The preparation of at home meals (8)	hr/yr
MM	Market-based meals	The result of the preparation of a market-based meal (8)	\$/yr
PGP	The purchased ingredients used in market-based meals	An input to the production of market-based meals (7)	\$/yr
PGS	The purchased ingredients used in subsistence-based meals	An input to the production of subsistence-based meals (7)	\$/yr
SM	Subsistence-based meals	The result of the preparation of a subsistence-based meal (7)	\$/yr
SMLS	The household's time spent to prepare and clean up from meals prepared primarily with subsistence foods	The preparation of at home meals (7)	hr/yr
ST	The trip made to a site	Places the subsistence hunter on site (4)	\$/yr
TCS	The capital services provided by self-owned transport resources	An input to the production (1) of transport services	\$/yr
TLS	The household's time spent to transport self to a subsistence site	The self-transport to a subsistence site (2)	hr/yr
TM	The combined transport capital services and materials used to transport to a site	The production of transport services (ST)	\$/yr
TR	The purchased material resources used to transport to a site	An input to the production (1) of transport services	\$/yr

6.2 Resources

Technology and transportation, especially modern transport modes, allow even relatively heavily subsistence-dependent groups to remain in permanent, year-round communities, rather than following the seasonal movements of food sources as their ancestors did, instead traveling to those resources.⁸ Transport equipment is treated as being self-provided by the fisher/hunter. Data gathered from the questionnaire and the 2017 CSIS Nuiqsut Community Harvest (Alaska Department of Fish and Game 2018) plus some additional supplementary research from the 2014 Alaska Fuel Price Report (Alaska Department of Commerce Community and Economic Development 2014), the Personal Transportation in Rural Alaska (Schwörer and Phillip 2013), the 2016 Snowmobile Fuel Mileage Data report (Swanson 2016), and prices recorded from the most recent research trip taken by AES to Nuiqsut were gathered to calculate the travel cost for each trip.

Sharing of subsistence resources is a central feature and one of the most important values of the Iñupiat culture and people. Because of the inherent risks of fishing and hunting—there will be times for all subsistence harvesters when they come home empty handed and must rely on others for their subsistence. Even though the methods of subsistence harvesting may be different than how they were done traditionally, the meaning behind subsistence and why it is done has remained the same. For the subsistence simulation model, harvest is specified to be shared across all Nuiqsut households.

The Iñupiat hunt and gather fish, wildlife, and vegetation species for subsistence, however, all communities do not pursue all species. Brown et al. (2016) found that Nuiqsut residents harvested some 54 unique resources in 2014: 23 fish, 7 wildlife, and 4 marine mammal species, 14 bird species, including adult animals and eggs, and 6 varieties of vegetation. The Nuiqsut harvest in 2014 was 372,000 pounds, almost 900 pounds per capita (Brown et al. 2016). Wildlife (terrestrial and marine mammals) account for about three-quarters of the subsistence harvest, fish is one-third of the wildlife share. Birds and eggs and vegetation resources are a minimal component of the Nuiqsut diet.

The arctic and least Cisco account for almost half of the fish harvest, with the broad category of whitefish another 41 percent. Among marine mammals, the bowhead whale accounts for 88 percent of the marine mammal harvest with seal making up the remainder. The subsistence harvest and use of bowhead whale is of central cultural and social significance to the residents of the North Slope, with a tradition that extends thousands of years into the past (Brower 1998). Bowhead whales are the most culturally significant resource because the hunt is communal, and the harvest is largely distributed throughout the community, emphasizing sharing and not retention.

Harvest by food categories are incorporated in the economic model. Birds, eggs, vegetation and seal are not in the model because of their small share of subsistence resources. The resources specifically included in the model include caribou and fish; a section below discusses whales, but due to the uncertainty and challenge of modeling whaling impacts, as well as the unlikelihood of impacts of GMT1 on whaling activities, whaling costs are not modeled.

6.2.1 Caribou

Caribou hunting is an extremely important resource to the subsistence lifestyle of the Nuiqsut people. Caribou are the most common large land mammal harvested and are relied upon by the Nuiqsut people as a major food source comprising 30 percent of the annual Nuiqsut subsistence harvest. Hunters potentially target caribou from four herds with overlapping ranges: the Western Arctic herd (WAH), the

⁸ That is not to say that seasonal or shorter resource related relocations from fixed communities do not still occur on the North Slope if in altered forms, as substantial numbers of residents of some communities still do spend varying amounts of time in whaling or fish camps.

Porcupine herd (PCH), the Central Arctic herd (CAH), and the Teshekpuk Lake herd (TLH). The Teshekpuk Lake and Central Arctic herds are their primary focus (ADF&G 2016). Nuiqsut hunters harvested 774 caribou (averaging about 136 pounds per caribou) in 2014 totaling 105,193 edible pounds with most coming from the Teshekpuk Lake herd (Brown et al. 2016).

Hunting caribou on the North Slope is a dynamic activity as weather and travel conditions, herd availability, and meat quality vary by season. The spring migration to the northern summering grounds for these herds begins in early March with the pregnant females, barren cows, and some yearlings leading the way followed by bulls and the remaining juveniles. Hunting activity peaks between June and September when hunters utilize boats in ice-free waterways to travel longer distances seeking caribou along with fish, birds, and seals. During this period, caribou build their fat stores in preparation for the upcoming rutting period, fall migration, and winter months. During the summer, all caribou are good to eat and availability is at its highest.

The fall migration to the southern wintering grounds may begin anytime from late August to mid-October. The boating season typically ends in September, and caribou harvests decline. Hunters are limited to hunting in a 10- to 15-mile radius of Nuiqsut using the more costly travel mode, the ATV. The rut is the annual caribou mating period in lasting approximately two weeks in mid-October when cow caribou come into estrus. In early October caribou bulls begin the rutting phase causing hormonal changes giving their meat a strong odor and flavor. At that time subsistence hunters shift from taking bulls, especially large bulls, to cows or small bulls. Although there is no closed season on bull caribou, it is considered poor practice to harvest a large bull during the rut and it is considered offensive and disrespectful to offer local people meat from a rutty bull caribou.

As fall tends toward winter, snow accumulates and snow machines become the most utilized mode of transportation. These allow residents to travel long distances in pursuit of wolves and wolverines as well as wintering caribou as needed to supplement their summer harvest. Due to harsh conditions brought on by the arctic winter, fewer people participate in caribou hunting this time of year.

Qualitative and quantitative data from SRB&A research and interviews with prominent Nuiqsut hunters provided the baseline trip data. Data gathered from the questionnaire along with additional supplementary research from the 2014 Alaska Fuel Price Report (Alaska Department of Commerce Community and Economic Development 2014), the Personal Transportation in Rural Alaska (Schwörer and Phillip 2013), the 2016 Snowmobile Fuel Mileage Data report (Swanson 2016), and prices recorded from the most recent research trip taken by AES to Nuiqsut were gathered to calculate the travel cost for each trip.

Table 6. Travel Method to Caribou Use Areas

Travel Method	Percentage of Caribou Use Areas (%)						
	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7
Boat	74	80	74	80	74	77	70
Snowmachine	22	9	16	12	8	10	15
ATV	4	9	9	9	17	11	14
Truck	2	2	0	0	1	1	1
Total	100	100	100	100	100	100	100

Note: Values may not add to 100 due to rounding.

Table 7. Estimated Seasonal Travel Method to Caribou Use Areas

Travel Method	Percentage of Caribou Use Areas (%)		
	Summer	Fall	Winter
Boat	95	75	0
Snowmachine	0	0	69
ATV	5	25	13
Truck	0	0	19

Note: Values may not add to 100 due to rounding.

Table 8. Travel Cost per Mile by Mode

Mode	Cost (\$) per Mile
Truck	0.30
ATV	1.24
Snow Machine	0.88
Boat	0.91

Table 9. Annual Caribou Harvest by Area

Caribou Hunting Area	Percentage
Nigliq Channel	18
East Channel Colville	12
Other Colville Delta	1
Fish Creek	4
Coastal West	1
Coastal East	1
Itkillik River	5
Ocean Point	13
Sentinel Hill	7
Colville River South	6
West of Nuiqsut	28
Other	3
Total	100

Note: Value do not add to 100 due to rounding.

This data was used to develop econometric models. Separate models were developed for Summer, Fall, and Winter/Spring due to differences in travel costs, availability and quality of caribou across seasons. Model data requirements include travel costs, harvest rates, and percent of trips for each site. Site visitation frequency and vehicle choice were identified using existing qualitative and quantitative information found in the SRB&A reports including seasonal subsistence effort, site productivity, and seasonal vehicle choice.

Places identified as subsistence areas for caribou are shown in Figure 9.

Summer models were based on the information in Table 10.

Table 10. Summer Models

Summer Sites and Modes	Per Trip Harvest Rate (lb)	Per Trip Travel Cost (\$)	Trip Percentage (%)
Puviqsuq Boat	10.88	43.11	7
Nigliq woods Boat	5.44	39.53	20
Nigliq woods ATV	5.44	45.51	0
Qakimak Boat	27.20	56.26	18
Nuiqsapiaq Boat	34.00	77.72	13
Qitik Boat	40.80	102.44	5
Qitik ATV	40.80	110.54	5
Sentinel Hill (Umiuraq) Boat	66.64	165.27	31
Judy Creek Boat	44.88	157.80	0
Fish Creek Boat	44.88	157.80	0

The econometric model for Summer is shown below.

Conditional (fixed-effects) logistic regression	Number of obs	=	1000
	LR chi2(2)	=	41.61
	Prob > chi2	=	0.0000
Log likelihood = -209.45563	Pseudo R2	=	0.0903

Sitechoice	Coefficient	Standard Error	z	P> z	95% Conf. Interval
harvestrate	.0937001	.0162467	5.77	0.000	.061857 .1255431
travelcost	-.035211	.0065859	-5.35	0.000	-.0481191 -.0223029

In Baseline simulations, hunters harvest 62.04 thousand pounds of edible caribou meat in the summer. This estimate is based on the annual aggregate harvest provided by ADF&G 2016. They spend \$107.7 thousand for an average cost of \$1.737 per pound.

Fall models were based on the information in Table 11.

Table 11. Fall Models

Fall Sites and Modes	Per Trip Harvest Rate (lb)	Per Trip Travel Cost (\$)	Trip Percentage (%)
Puviqsuq Boat	21.76	43.11	20
Nigliq woods Boat	17.68	39.53	15
Nigliq woods ATV	17.68	45.51	20
Qakimak Boat	36.72	56.26	18
Nuiqsapiaq Boat	47.60	77.72	13
Qitik Boat	57.12	102.44	5
Qitik ATV	57.12	110.54	5
Sentinel Hill (Umiuraq) Boat	72.08	165.27	31
Judy Creek Boat	63.92	157.80	0
Fish Creek Boat	63.92	157.80	0

The econometric model for fall is shown below.

Conditional (fixed-effects) logistic regression	Number of obs	=	1000
	LR chi2(2)	=	42.01
	Prob > chi2	=	0.0000
Log likelihood = -209.25341	Pseudo R2	=	0.0912

Sitechoice	Coefficient	Standard Error	z	P> z	95% Conf. Interval	
harvestrate	.0034727	.0188835	0.18	0.854	-.0335382	.0404836
travelcost	-.0165033	.0095238	-1.73	0.083	-.0351695	.002163
canuseATV	.5069255	.260756	1.94	0.052	-.0041468	1.017998
isPuviqusuq	.3784954	.2918063	1.30	0.195	-.1934344	.9504252
isSentinel~l	.8334961	.6020789	1.38	0.166	-.3465569	2.013549

In Baseline simulations, hunters harvest 25.49 thousand pounds of edible caribou meat in the summer. This estimate is based on the annual aggregate harvest provided by ADF&G 2016. They spend \$34.11 thousand for an average cost of \$1.338 per pound.

Winter models were based on the information in Table 12.

Table 12. Winter Models

Winter Sites and Modes	Per Trip Harvest Rate (lb)	Travel Cost (\$)	Trip Percent (%)
Puviqusuq ATV	20.40	51.51	6
Nigliq woods ATV	10.88	45.51	0
Qakimak ATV	34.00	68.14	0
Nuiqsapiaq ATV	47.60	95.54	0
Qitik ATV	61.20	110.54	0
Sentinel Hill (Umiuraq) ATV	68.00	215.57	6
Judy Creek ATV	27.20	64.77	0
Fish Creek ATV	27.20	64.77	0
Puviqusuq Truck	20.40	25.15	0
Nigliq woods Truck	10.88	21.98	0
Qakimak Truck	34.00	34.24	0
Nuiqsapiaq Truck	47.60	44.70	0
Qitik Truck	61.20	64.85	0
Sentinel Hill (Umiuraq) Truck	68.00	112.00	0
Judy Creek Truck	27.20	31.82	13
Fish Creek Truck	27.20	31.82	6
Puviqusuq Snowmachine	20.40	41.44	6
Nigliq woods Snowmachine	10.88	36.52	13
Qakimak Snowmachine	34.00	55.18	6
Nuiqsapiaq Snowmachine	47.60	76.11	6
Qitik Snowmachine	61.20	106.15	0
Sentinel Hill (Umiuraq) Snowmachine	68.00	175.98	6
Judy Creek Snowmachine	27.20	52.18	19
Fish Creek Snowmachine	27.20	52.18	13

Winter models yielded unsatisfactory results and therefore could not be used to model and analyze baseline and counterfactual scenarios. We suspect that the variable nature of quality, availability, and accessibility make winter caribou hunting a more complex activity than in summer and fall and that the data we have do not adequately characterize it. The average harvest rate and travel cost coefficients for fall and summer were used for the winter coefficients. The travel cost coefficient is $-.02585715$, and the harvest rate coefficient is $.0485864$.

In Baseline simulations, hunters harvest 34.7 thousand pounds of edible caribou meat in the winter. This estimate is based on the annual aggregate harvest provided by ADF&G 2016. They spend \$86.72 thousand for an average cost of \$2.499 per pound.

6.2.2 Whales

This short, separate section is provided because while whales are an important component of Nuiqsut's overall subsistence activity, whaling as an activity cannot be modeled in the same way as caribou hunting or fishing. The reasons for this are briefly discussed, and a possible alternative approach to an economic evaluation of Cross Island subsistence whaling is suggested. Given the small likelihood that actions envisioned by ConocoPhillips at GMT1 would affect Cross Island whaling, further elaboration did not seem justified.

On the North Slope, communities of Point Hope, Point Lay, Wainwright, and Utqiagvik whale in the spring. Utqiagvik and Wainwright also whale in the fall (when quota is available), while Nuiqsut and Kaktovik only whale in the fall. For Nuiqsut, each fall from three to seven crews travel in boats 5–8 hours (about 98 miles), depending on weather and water conditions, from Nuiqsut to Cross Island to hunt whales. The Nuiqsut quota, set by the Alaska Eskimo Whaling Commission (AEWC) as a part of the overall quota set by the International Whaling Commission is at present four strikes. The AEWC also sets the means and methods allowed. “[T]raditional weapons means a harpoon with line attached, darting gun, shoulder gun, lance or any other weapon approved by the AEWC as such a weapon in order to improve the efficiency of the bowhead whale harvest” (EDAW 2008).

Information conveyed in this section is based on data from a longitudinal study of Cross Island whaling (2001 to present) and other published sources. Whaling differs from all other subsistence activities in that it is organized on a community basis, rather than an individual or small-group basis. All subsistence resources are shared to some extent, but the results of subsistence whaling have explicit rules for intra-community sharing, as well as less formalized practices of for extra-community sharing. Nuiqsut was given a quota of one strike in 1982, increased to the current quota of four in 1995. Since 2001, Nuiqsut's largest whale harvest was in 2014, when they landed five whales (their full quota plus one strike not used by another community and transferred to Nuiqsut), for an estimated harvest of 148,086 pounds (about 30,000 pounds per whale) and accounting for nearly 40 percent of harvested subsistence resources for that year (Suydam et al. 2015; Richardson, W. John, and Katherine H. Kim 2015). Much of the fifth whale was shared with other communities, especially the one from which the fifth strike was transferred. 1994 was the most recent year when Nuiqsut did not land a whale and 2005 was the most recent year when Nuiqsut landed only one whale.

Information from the ongoing Cross Island study (2001-2018 as of this report) was used to generate the characteristics of the “average” Cross Island subsistence whaling season. This is of course an artificial concept but is useful for the discussion to follow. Per season, Nuiqsut whalers have landed 3.4 whales with a combined length of 127 feet (average 39 feet), struck and lost 0.2 whales, with five crews using 10 boats, a total workforce of 31 people, over a season of 25 days. It should be noted that there has been a trend over this period for the length of the season to decrease and for the number of crews, boats, and people to increase, although the most recent season was an exception. “Level of effort” has been measured in a number of ways, but for purposes of this report will be represented by length of

season and number of people and by the total number of miles traveled by boat. On average, during the “average” whaling season Cross Island whalers have traveled 3,010 miles while searching for whales and another 3,944 miles in support activities (traveling between Nuiqsut and Cross Island and various logistical trips for supplies). This does not account for travel before the season to stage supplies or otherwise support whaling activity.

A discussion of the economics or cost of whaling is fundamentally different from that of most other subsistence activities, and for this report specifically for caribou and fish. Caribou and fish are harvested by individuals or small groups, during a relatively large number of individually planned (and mostly single day) trips, and within a relatively extended “opportunity period” of time. Whaling occurs during essentially one communally planned trip lasting two to four weeks, remote from the village, during a period that is relatively fixed. Whereas for caribou and fish the participants in each trip are mostly expected to share in both the costs and results of the harvest, with whaling the captain of each crew is expected to bear the majority of the costs (traditionally ALL costs) and sharing with the entire community (and beyond) is mandated. Bodenhorn 1990 and 2000, and Kishigami 2013 and 2019 speak to these points, although their main interests are elsewhere. Kishigami 2013 does also provide what is now a somewhat dated (in terms of values) estimate of whaling expenses for Barrow, Alaska. The categories are still useful for thinking about the Cross Island case.

However, the Cross Island hunt presents some additional complications. Cross Island is 90+ miles from Nuiqsut, and while most other communities can conduct subsistence whaling with day trips from their villages, Nuiqsut whalers essentially camp (in cabins) on Cross Island for the duration of the season. Each captain has the responsibility of supporting his crew while they are on Cross Island. Most Nuiqsut captains, although they use multiple boats, own only their “number one” boat and thus do not have the full capital expense of multiple boats – but a captain is still usually responsible for the expenses of running the boat and repairs that may be needed after the season. Since the mid-1980s Nuiqsut whalers have had an agreement with the oil and gas industry, in its current form called the Conflict Avoidance Agreement (CAA). Since this is an agreement between industry and private parties (the whalers, as represented by the Alaska Eskimo Whaling Commission), how the agreement works, the costs associated with the agreement, and who pays for what expenses, is not transparent. As part of the agreement, or as a working annex to it, Nuiqsut whalers receive logistical support while at Cross Island, which includes:

- VHF radios and EPIRBs for all boats used for whaling
- A communications center with Inupiaq-speaking operators based at Deadhorse or Endicott for the duration of the whaling season
- Temporary infrastructure on Cross Island during the whaling season – generator(s) to provide electricity for the cabins on Cross Island, large tanks of potable water, tanker trucks with gas (for the boats) and diesel fuel (to heat most of the cabins), supplies to box up the butchered whale for shipment (large boxes, plastic liners, plastic bags, strapping material for the boxes, portable lighting plants to assist butchering at night
- Support for the winch on Cross Island used to haul up whales for butchering
- A loader, used primarily to assist in butchering, but also to move boats and other materials as needed
- Assistance in transporting the butchered whale to Nuiqsut – by barge to West Dock/Deadhorse and then usually by air to Nuiqsut
- In recent years, a provision of the CAA has required the continuation of the Cross Island project data gathering effort, which provides an honorarium to the whalers (about \$1100 worth of store-bought food for each crew) for their participation
- A large barge for the mobilization and demobilization of the temporary Cross Island infrastructure

In addition, all whaling crews usually receive assistance from one or more village entities (Kuukpiik Corporation and/or the City of Nuiqsut) in the form of gas for the trip to Cross Island, oil, and perhaps spark plugs. Also, since 2004 the IRS has allowed whaling captains to deduct up to \$10,000 a year of whaling expenses on their federal tax returns (Internal Revenue Service 2019).

Assigning values to these cost elements, in the absence of access to the underlying financial records would yield approximate values at best. Determining who pays those costs would also be difficult, but it is clear that in the end some entity pays (or provides in-kind) for all services or costs associated with Cross Island whaling, and that the total is relatively large. If the estimate of 30,000 pounds per landed whale is correct, with an average of 3.4 whales landed at Cross Island a year, about 102,000 pounds of whale are harvested at Cross Island each season. Preliminary analysis of the data available on recovered/usable weight of whales butchered on Cross Island seems to indicate that a lower number may be appropriate, in a range of an average recovered weight of between 20,000 and 24,000 pounds per whale (or 68,000 to 81,600 pounds per season). Be that as it may, only a very approximate cost per pound of whale harvested at Cross Island could be computed based on a guess of total costs incurred for the hunt and total edible pounds recovered from the hunt. Clearly the information available and the character of the hunt does not allow these elements of the whale hunt to be modeled in the same way as for caribou and fish, and the GMT1 development is unlikely to affect Cross Island subsistence whaling in any event. This discussion has been provided mainly to indicate a possible approach to an economic evaluation of Cross Island subsistence whaling, the difficulties to consider, and a short discussion of why it could not be incorporated into the same sort of model as caribou and fish.

6.2.3 Fish

Fishing is a year-round activity in which almost 80 percent of Nuiqsut households participate. Fish is an important resource throughout the summer and winter months. As of 2014 fish represented approximately 22 percent of total subsistence harvests, accounting for an estimated 88,995 lb harvested. The majority of fish are harvested using four methods: gill nets, set nets, rod and reel (open water), and hooking/jigging (through the ice). During summer months Nuiqsut residents rely on boats for transportation to fishing sites, while in the winter months snowmachines are the primary form of transportation (Alaska Department of Natural Resources 2018).

Nuiqsut residents focus their fishing efforts in the Nigliq channel on the Nigliq River delta, the upper Nigliq River nearest Nuiqsut, Anakik (a site along the Nigliq River), Uyagagviq (near Nuiqsut), and some freshwater lakes. Known locations for fishing are shown in Figure 10.

The average travel time to fishing areas is about 30 minutes, and the most common length of trips are day trips. “Every family has their own section of river for fishing; can be very competitive if people are too close to other families' sections” (Nuiqsut Household Questionnaire).

The major species harvested in these areas include: whitefish (arctic cisco, least cisco, humpback whitefish), arctic grayling, dolly varden, rainbow smelt, arctic char, northern pike, burbot, lake trout, and salmon (Alaska Department of Natural Resources 2018). Success of each trip varies widely. There are reports of trips catching as few as one fish or as many as 300. Based on the most recent survey, an average of all fishing methods and time of year is about 50 fish harvested per trip. Like most resources, sharing with friends and family is a large part of the harvest process. Approximately 50 percent of harvest is recorded as being given away.

Based on this information, the site choice model for fishing is specified to consist of motorized single day trips to the Nigliq channel, the Nigliq River delta, the upper Nigliq River, Anakik, and Uyagagviq as characterized by Table 13.

Figure 10. Subsistence Areas for Fish Used in the Model

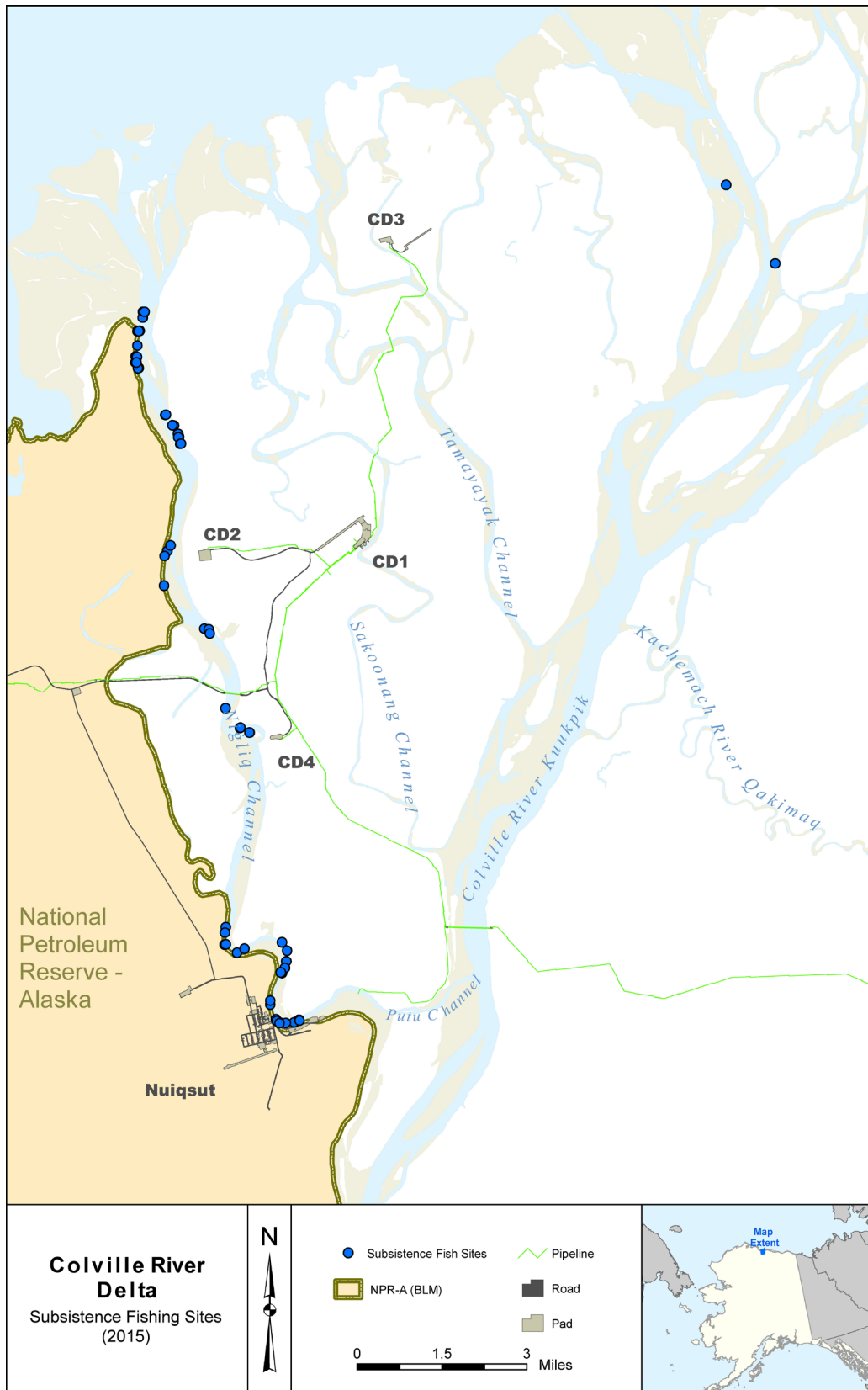


Table 13 represents a breakdown of an average household’s annual fishing activity. The total annual household travel cost associated with fishing activities is calculated using a weighted average of trips taken to each site. The total annual travel cost by household is then multiplied by the number of households who participate to represent the village level total travel costs of fishing. To calculate the average cost of harvest (\$/lb) found in Table TS-1, the village level annual total travel costs of fishing are divided by the annual total village level harvest also presented in Table TS-1 (Brown et al. 2016).

Table 13. Fishing Specification

Site	Per Trip Travel Cost (\$)	Per Trip Travel Time (hours)	Harvest Rates (fish per person-day)	Total Trips (per person-year)
Nigliq channel	10.72	0.75	50	28
Nigliq River delta	14.22	1.00	75	15
Upper Nigliq River	3.87	0.25	25	41
Anakik	14.22	1.00	75	15
Uyagagviq	3.87	0.25	25	41

6.3 Households

Nuiqsut is a micro economy with the key economic sectors found in all modern economies: household, private, and public. This economy is located in a unique environmental setting. The economic model provides an abstraction of this economy with a focus on the household sector and how it interfaces with the environment. Nuiqsut households number approximately 105 with an average of 4 persons per household (U.S. Census Bureau 2018).

Households may consist of a single family or some other grouping of people. In economics, households are typically regarded as the ultimate consumptive unit. It is frequently the convention to treat the household as a unified utility-maximizing entity and that is what is done here.

Currency is needed to purchase the inputs to subsistence activities and for other goods and services. This demand is met largely by the household providing labor services to employers. Further, government (federal, state, and local) provides a variety of services and employment opportunities for Nuiqsut residents.

Employment by sector is summarized in Table 14. Most of these jobs appear to provide services to the community’s residents. Export-related jobs such as commercial fishing, tourism, art, petroleum products exploration and extraction are very limited.

Table 14. Employment by Sector, Nuiqsut, Alaska: 2014 (US Census)

Sector	Employment Full Time Equivalents	Households Primary Employment
Local government, including tribal	106.1	74.3
Services	36.7	28.1
Transportation	8.2	8.0
Mining	10.2	8.0
Federal government	4.1	4.0
Construction	4.1	4.0
Retail trade	8.2	8.0
Agriculture, forestry, and fisheries	4.1	4.0
State government	4.1	4.0
Manufacturing	2.0	2.0
Total	171.4	100.0

Income from employment and all other sources is shown in Table 15. The number of labor hours represented by this income is that income divided by the appropriate wage. ResourceEcon et al. (2011) estimated the 2010 average wage rate for all Alaskans as \$22.94 thus the total hours supplied to the market economy is 332,270.

Table 15. Income from All Sources, Nuiqsut, Alaska: 2014 (US Census)

Source	Number of Households	Total (\$)	Per Household Receiving (\$)
Local government, including tribal Services	74.3	4,465,482	
Transportation	28.1	1,807,479	
Mining	8.0	514,083	
Federal government	8.0	489,236	
Construction	4.0	118,528	
Retail trade	4.0	104,008	
Agriculture, forestry, and fisheries	8.0	66,968	
State government	4.0	27,780	
Manufacturing	4.0	23,150	
Total	100.3	7,622,270	
<i>Other Income:</i>			
Native Corporation dividend	95.0	2,999,760	31,576
Alaska Permanent Fund dividend	89.4	652,514	7,299
Social Security	16.8	200,244	11,919
Meeting honoraria	13.0	192,086	14,776
Pension/retirement	9.3	160,734	17,283
Other		70,868	
Total		4,359,482	
<i>Retirement Income:</i>			
Social Security	16.8	200,244	11,919
Pension/retirement	9.3	160,734	17,283
Total		360,978	

Non-labor income provides a significant share of the total income of Nuiqsut. The State of Alaska receives tax payments and royalties related to the extraction and transport of oil from the North Slope. This income is deposited into the Alaska Permanent Fund, which pays an annual dividend to Alaskans. The size of the dividend varies with the size of the fund, which in turn is determined by payments from the petroleum industry and the interest earned on the fund's assets. In 2015 the dividend payout was \$2,072 to each citizen. This income source can, however, be quite variable depending on the economics of the oil industry.

Spending on consumer goods includes those on durable goods (e.g., motor vehicles and parts, furnishings and durable household equipment, recreational goods and vehicles); nondurable goods (e.g., food and beverages, clothing and footwear, gasoline and other energy goods); and services (e.g., housing and utilities, health care, transportation services, recreation services, food services and accommodations, financial services and insurance). At the national level saving, represents a small and variable share of income. Thus savings/dissaving are assumed to be zero in the simulation model.

6.4 Household Allocation of Time

Nuiqsut households are specified to allocate their time across leisure (including sleep), subsistence activities related to whale, seal, fish, and caribou (among other subsistence pursuits), and working for

wages. The total amount of time available is the 8,760 hours in a year multiplied by number of adults in the household. Time shares are constrained to equal one and time spent in each activity is the share of time multiplied by time available for the household.

6.5 Household Utility and Constraints

In the model, households are specified to maximize their utility or well-being subject to applicable constraints. The model specifies that household utility arises from allocations of time, sharing of harvest, and consumption of subsistence and market protein. Individuals are constrained to have 8,760 hours annually to allocate to its subsistence, market, and leisure activities. Household expenditures are constrained to be less than or equal to income. Harvested protein is either consumed or shared.

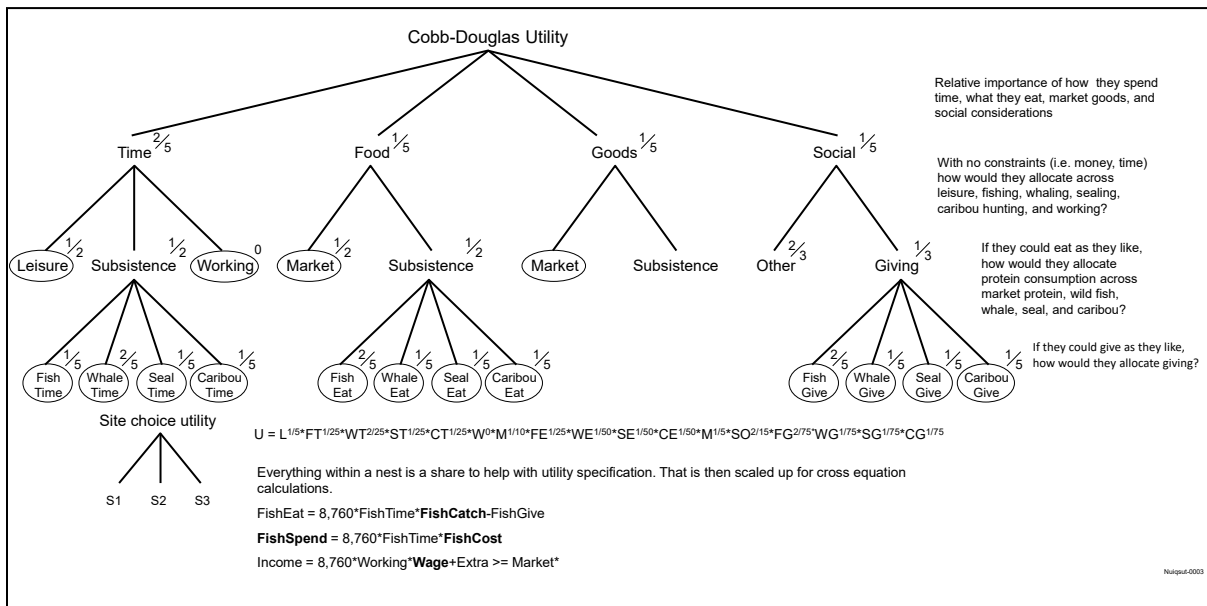
A very popular functional form for a utility function is:

$$U = x^a y^b, x, y > 0.$$

Figure 11 illustrates how the structure of the model incorporates this utility function into the analysis. The first level of the model separates the household’s utility into the relative importance that it places on four specific components:

- How the household spends its time
- The food the household has available to eat
- The goods available to the household,
- The household’s engagement in social activities.

Figure 11. Model of Nuiqsut Household Preferences



Source: Project Team

The exponents on each category represent the relative importance that an individual household places on each category. In the figure, the example household places the same relative importance on the food it has available to eat, the goods it has available, and its engagement in social activities, and it places twice as much relative importance on how its members are able to spend their time.

Within the category of time, the next level of the nest shows that the model accounts for the importance that the household places on leisure activities, subsistence activities, and working. For the subsistence activities, the model further divides the importance of these activities across time spent fishing, whaling, hunting seals, and hunting caribou. Finally, for each of these activities, the model identifies the sites where the household can harvest each species and contains information on each site that affect how likely a household is to choose it such as the travel cost to get to the site and the harvest rate at the site. Using this structure, the model is able to evaluate how changes in site conditions affect the household's utility. For example, if harvest rates decrease at a site, the model can evaluate how that affects the household's overall utility through its effect on the success of an individual trip.

To develop the importance that the household places on each component in the utility function, the model uses responses that surveyed households provided to the questionnaire administered to Nuiqsut residents. The questionnaire used the technique of utility elicitation to identify the relative shares that households place on each component of the utility function. Utility elicitation is the process of collecting information on a person's utility (Keeney and Raiffa 1976; Chajewska, Koller, and Parr 2000; Chajewska et al. 2013). Utility elicitation collects information on people's or household's preferences over a set of goods and/or services to determine their utility function. In making decisions about different goods or services, people do not always agree on their preferences because the goods or services have different attributes. It is therefore useful to elicit a utility function for each person, which can be a data intensive process. To streamline this process, attributes with similar functions can be grouped to identify utility preferences across clusters of goods and services. This information can be used to develop decision trees similar to the figure above which can be used to predict a person's or household's utility.

Data from the survey were used to develop the relative importance that different households placed on each component of the utility function. To develop the importance weighting, the analysis used a four-step process.

- First, respondent answers to Survey Question 6a were examined. This question asked respondents to consider the importance of four aspects of life: food, time, goods, and social activities. Respondents were asked to divide 100 points between the four aspects, with the activities they spend more time doing receiving more points.
- Second, responses were then grouped across households that gave the same or similar point distribution to each of the four aspects of life. The results of this process produced fourteen subgroupings.
- Third, responses to Survey Question 6b were reviewed. This question asked respondents to distribute 100 points between four other categories: subsistence activities, leisure time, working inside the household (for no wage), and working outside the household (for wage). The respondent is asked to consider their household as a whole and distribute the points according to the importance of each category.
- Finally, answers to these questions were examined in relation to the subcategories created from Question 6a. Each response to Question 6a was taken and matched with the corresponding respondent response to question 6b. This produced the set of household preferences used for the model.

6.6 Specific Caribou Counterfactual Model Results

The economic model was developed using the theoretical framework outlined in Section 6.1, the cost of caribou hunting by season and mode on a per pound basis (Section 6.2), and composition, time allocation, and utility functions and constraints of households (Sections 6.3–6.5). The analysis uses the

model to analyze counterfactual scenarios, focusing on caribou as it is the subsistence resource that received the most comments and that is potentially most impacted by COP’s operations. The scenarios below are hypothetical situations used to demonstrate the economic effects of common scenarios.

Given the importance of caribou and the potential for impacts to caribou harvest a set of possible scenarios representing changes to caribou hunting conditions are evaluated. The implications of changes in resource availability are evaluated using the baseline versus counterfactual methodology. This approach is flexible in that it can be applied to evaluate many changes within the context of the economic model. Applying it requires specifying both baseline and counterfactual conditions. Baseline conditions are specified as described previously. The three evaluated scenarios are described below.⁹

These scenarios focus on implications for caribou hunting considering that hunters may travel farther or that hunters may increase use of gravel and ice roads.

Scenarios of hunters traveling farther:

- Scenario 1: Caribou hunters travel 20 miles farther during fall and winter hunting (ATVs and snow machines) to harvest the same amount of caribou meat (i.e., other resources such as fish do not replace caribou meat).
- Scenario 2: Caribou hunters travel 20 miles farther during summer hunting using boats to harvest the same amount of caribou meat (i.e., other resources such as fish do not replace caribou meat).

Scenarios of hunters increasing use of gravel and ice roads for hunting activities:

- Scenario 3: Hunters drive trucks on a hypothetical road to transport snowmachines approximately 60 miles west of Nuiqsut to access areas that previously could only be reached during the winter on long snow machine rides. Estimate increase in winter harvest rates at the western site by 15 percent through increased access.

Table 16 summarizes the economic effects of each counterfactual scenario. Detail on each is in the following sections.

Table 16. Summary of Counterfactual Scenarios

Scenario	Season	Average Cost of Caribou (\$/lb)	Cost Increase (\$/lb)	Change in Total Harvest Cost (\$)
20 Miles Farther	Summer	1.89	+0.16	+13,970
	Fall	1.82	+0.48	+12,920
	Winter	3.03	+0.53	+18,390
Increase Trucks	Winter	2.47	-0.03	-905
Hypothetical Road	Winter	1.80	-0.70	-13,490

6.6.1 Counterfactual Scenario “20 Miles Farther”

Under the summer counterfactual scenario “20 Miles Farther” conditions, hunters travel 20 miles farther to each site. This leads to a change in how trips are distributed across sites. Under this scenario the

⁹ An additional scenario in which hunters could employ a combination of truck and snowmachine to reach the furthest snowmachine-accessible region to the west of Nuiqsut and south of Teshekpuk Lake was evaluated. As specified, this site was over 100 miles away with a harvest rate that was 15 percent higher than the existing site with the highest harvest rate. This site has a higher per pound cost than all of the existing sites and does not change use and cost outcomes.

average cost of one pound of caribou harvested is \$1.89. This is an increase of \$0.16 per pound. With this cost increase the total harvest can be maintained while incurred costs are increased by \$13.97 thousand.

Under the fall counterfactual scenario “20 Miles Farther” conditions, hunters travel 20 miles farther to each site. This leads to a change in how trips are distributed across sites. Under this scenario the average cost of one pound of caribou harvested is \$1.82. This is an increase of \$0.48 per pound. With this cost increase the total harvest can be maintained while incurred costs are increased by \$12.92 thousand.

Under the winter counterfactual scenario “20 Miles Farther” conditions, hunters travel 20 miles farther to each site. This leads to a change in how trips are distributed across sites. Under this scenario the average cost of one pound of caribou harvested is \$3.03. This is an increase of \$0.53 per pound. With this cost increase the total harvest can be maintained while incurred costs are increased by \$18.39 thousand.

6.6.2 Counterfactual Scenario “Increase Trucks”

Under the winter counterfactual scenario “Increase Trucks” conditions, hunters use roads to access the study area farther west during the winter and can increase harvests by 15 percent at these sites by using trucks. This leads to a change in how trips are distributed across sites. Under this scenario the average cost of one pound of caribou harvested is \$2.47. This is a decrease of \$.026 per pound. With this cost decrease the total harvest can be maintained while incurred costs are reduced by \$905.10.

6.6.3 Counterfactual Scenario “Hypothetical Road”

Under the winter counterfactual scenario “Hypothetical Road” conditions, hunters drive trucks on a hypothetical road to transport snowmachines approximately 60 miles west of Nuiqsut to access a new site with a 15 percent higher harvest rate than the site with the highest harvest rate in the baseline scenario which previously could only be reached during the fall and winter on long snowmachine rides. This leads to a change in how trips are distributed across sites. Under this scenario the average cost of one pound of caribou harvested is \$1.80. This is a decrease of \$0.70 per pound. With this cost decrease the total harvest can be maintained while incurred costs are reduced by \$13.49 thousand.

7 Mitigation Funding

As noted in Section 1.1, in accordance with stipulations in the ROD issued by the Bureau of Land Management for GMT1, CPAI has undertaken this thorough one-time economic study at the beginning of the GMT1 project of the costs that individuals and families incur to continue subsistence activities at desired levels (or would have to incur to participate in subsistence activities if they are not able to afford them). The previous sections of the document have addressed this requirement.

The ROD also stipulates that “the [one-time economic] study will include an overview of the impacts to subsistence activities related to past and current future projects and will account for the increase in cost of living. The study will also describe the adequacy of existing subsistence mitigation funds to address identified impacts.” This section addresses these requirements.

7.1 Overview of Mitigation

The increasing presence of development activities in and around Nuiqsut may disrupt the economic organization of the community through changes in subsistence activities and participation in the cash economy. If subsistence activities or resources are disrupted to the extent that overall harvests of subsistence resources decline, then residents may begin to rely more heavily on wage employment and participate less in traditional subsistence activities, which could have both direct and indirect consequences (U.S. Bureau of Land Management 2018).

Under the NPR-A Impact Mitigation Grant Program, the State uses its share of NPR-A revenues to grant funds to communities in or near the NPR-A, including Nuiqsut, to pay for projects that address residual impacts of oil and gas development in the NPR-A. To date, the state has awarded over \$180 million in funding for such projects. This amount is anticipated to increase substantially going forward as production of federal oil comes online. Activities that are eligible to receive NPR-A grant funding from the state are limited to three categories: (1) planning; (2) construction, maintenance, and operation of essential public facilities; and (3) other necessary public services provided by a municipality. Many subsistence projects are funded as “planning” or as “other necessary public services.” Fund levels change every year because they are based on lease sales and production royalties. Priority is given to those communities most directly or severely impacted by oil and gas development, which has historically meant those communities located within the NPR-A, including Nuiqsut (U.S. Bureau of Land Management 2018).

As part of the North Slope Borough’s permit for CPAI’s development of CD4, CPAI established a fund to mitigate subsistence impacts on local residents. The fund was managed by the NSB with assistance from representatives of the City of Nuiqsut, the Native Village of Nuiqsut, and the Kuukpik Corporation. The NSB CD4 permit required annual payments of \$50,000 for 10 years, and the last payment was made in 2013 (ConocoPhillips Alaska Inc. 2014; cited in U.S. Bureau of Land Management 2018). In 2008, CPAI agreed to make annual payments to a mitigation fund administered by a joint committee of the City of Nuiqsut, the Native Village of Nuiqsut, and Kuukpik Corporation of \$50,000 (adjusted for inflation) per year per Alpine satellite pad in the NPR-A and for the Nigliq Channel bridge (ConocoPhillips Alaska Inc. 2014; cited in U.S. Bureau of Land Management 2018). These funds are distributed in the form of fuel vouchers and household payments. In 2019, with the start of the construction of GMT2, the base mitigation payment is \$200,000 per year (before inflation adjustment). ConocoPhillips estimates that from 2017 to 2050, Kuukpik Subsistence Mitigation payments (including payments for CD5) will total \$10.5 million (ConocoPhillips Alaska Inc. 2016; cited in U.S. Bureau of Land Management 2018).

Other existing mitigation payments include an annual contribution from Caelus to the City of Nuiqsut of \$50,000 and an annual ENI payment to the NSB (for Nuiqsut) for \$50,000. In both cases, the mitigation committee determines how these mitigation funds will be used. Most recently, the City of Nuiqsut has been dividing received mitigation payments by household and issuing payments to those households. For fiscal year 2017, the City of Nuiqsut received \$275,000 in mitigation funds, or approximately 13 percent of its total budget (U.S. Bureau of Land Management 2018). In 2018, the City of Nuiqsut received over \$300,000 in mitigation payments including CPAI, Caelus, and ENI contributions. Industry also provides financial support for the Nuiqsut whaling captains to support the annual hunt at Cross Island.

While not directly related to mitigation programs, Nuiqsut residents (and residents of other NSB communities) benefit from the property taxes CPAI pays to the NSB, which are used by the borough to finance schools, public services, training programs, planning, and wildlife management (U.S. Bureau of Land Management 2018). Further, both Kuukpik Corporation and ASRC shareholders, including those living in Nuiqsut, stand to benefit economically from local development on lands for which they have surface and/or subsurface rights, including GMT1, and these earnings could result in continued or larger dividends paid to shareholders.

7.2 Increases in Cost of Living

Increases in the cost of living, often measured in terms of the Consumer Price Index (CPI), have the potential to decrease the relative effectiveness (or “buying power”) of mitigation funding that is not adjusted for such increases.

Alaska inflation has averaged 1.75 percent annually over the last decade, as measured by the CPI in Anchorage (Alaska Department of Labor and Workforce Development 2019). The CPI does not reflect relative differences in the cost of living, however, and due to geographic location, environment, and logistics and fuel costs, many rural locations on the North Slope face higher costs of goods. As referenced in Fried (2017), the military has a cost of living index that places Utqiagvik at 148, relative to 128 for Anchorage. This suggests that goods incur an additional cost of more than 15 percent due to transportation to Utqiagvik, and potentially more to Nuiqsut and other locations.

Increases in the cost of goods, both market goods for consumption as well as market goods for use in subsistence activities, can erode the effectiveness of mitigation funding, unless that funding is inflated to account for that gradual increase over time. The annual mitigation payments by CPAI are adjusted for inflation; however, it is unknown if payments paid by other operators include this adjustment.

7.3 Mitigation Funding to Address Identified Impacts

With the 2015 ROD permitting the GMT1 Project, the BLM required CPAI to contribute \$8 million to BLM to establish a GMT1 compensatory mitigation fund to offset identified impacts. As established by the measure, CPAI contributed \$1 million within 60 days of the ROD being issued for the development and implementation of a landscape-level Regional Mitigation Strategy for the Northeastern NPR-A Region. Two additional contributions totaling \$7 million were contributed to the fund itself (\$3.5 million within 30 days after installation of first gravel and \$3.5 million within 30 days of completion of road, pad, and pipeline). The Nuiqsut Trilateral Committee on GMT1 compensatory mitigation funds finalized an implementation plan for the first \$3.5 million in early 2017 and CPAI contributed the first installment in February 2017 and final payment in August 2018. Because the mitigation actions established by the Nuiqsut Trilateral Committee on GMT1 funds have not yet been put in place, it is

not possible to evaluate their effectiveness at mitigating impacts at this time (U.S. Bureau of Land Management 2018).

As estimated by the counterfactual modeling process, potential scenarios could result in economic effects ranging from a decrease of more than \$13,000 in harvest costs under the hypothetical road scenario to an increase of more than \$45,000 in harvest costs in all three seasons under the scenario in which hunters have to travel farther given the modeling process. Mitigation funding appears to adequately cover the anticipated physical costs and economic effects of each counterfactual scenario. Note that this modeling does not include other potential impacts such as avoiding an area, cultural effects, or community stress related to potential hunting impacts, such as those noted in the ROD: cherished family time on the land, cooperating, teaching, processing, cooking, consuming, sharing, and celebration.

8 Conclusion

Based on GMT1’s location relative to both Nuiqsut and the resources on which it relies, GMT1 was determined to have the greatest potential effect on caribou. The study developed a baseline model to represent the current seasonal caribou harvest conditions in the Nuiqsut area. Table 17 shows the baseline total harvests, travel cost, and average cost per pound of edible meat by season.

Table 17. Summary of Baseline Caribou Costs

Scenario	Season	Average Cost of Caribou (\$/lb)	Total Harvest (thousands of lb)	Total Travel Cost (\$ thousands)
Baseline	Summer	\$1.73	62.47	\$107.7
	Fall	\$1.34	25.49	\$34.11
	Winter	\$2.50	34.7	\$86.72

The implications for Nuiqsut households can be identified by specifying offsetting mitigation payments and/or harvest changes. The study considered three potential GMT1 project-specific counterfactual scenarios: traveling 20 miles farther, increasing use of trucks, and use of a hypothetical road to access a new site. Table 18 shows the estimated changes in costs per pound and total harvest cost.

Table 18. Summary of Counterfactual Scenarios

Scenario	Season	Average Cost of Caribou (\$/lb)	Cost Increase (\$/lb)	Change in Total Harvest Cost (\$)
20 Miles Farther	Summer	1.89	+0.16	+13,970
	Fall	1.82	+0.48	+12,920
	Winter	3.03	+0.53	+18,390
Increase Trucks	Winter	2.47	-0.03	-905
Hypothetical Road	Winter	1.80	-0.70	-13,490

As estimated by the counterfactual modeling process, potential scenarios could result in economic effects ranging from a decrease of more than \$13,000 in harvest costs under the hypothetical road scenario to an increase of more than \$45,000 in harvest costs in all three seasons under the scenario in which hunters have to travel farther given the modeling process. Mitigation funding appears to adequately cover the anticipated physical costs and economic effects of each counterfactual scenario. Note that this modeling does not include other potential impacts such as avoiding an area, cultural effects, or community stress related to potential hunting impacts, such as those noted in the ROD: cherished family time on the land, cooperating, teaching, processing, cooking, consuming, sharing, and celebration.

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Appendix A: June 2017 Flyer to Provide Project Information to Nuiqsut Residents

The flyer on the following page was used in June 2017 to provide information about the project to Nuiqsut residents.

Nuiqsut Economic Study of Subsistence Impacts

Get Involved: Be Part of the Study

The BLM Record of Decision for the Greater Mooses Tooth 1 Development Project requires a study to better understand the economic impacts of development on subsistence uses and activities. This study will help inform future project designs and decisions on the direct and cumulative impacts of oil and gas development on subsistence activities. As part of the study, social scientists are developing an economic model of subsistence harvesting in Nuiqsut and we will be hosting a workshop this fall to get your input.



Why study the economics of subsistence?

While economic considerations are only a limited part of the value of subsistence, an economic model of subsistence will help gain a better understanding of the value of subsistence resources to Nuiqsut households, how much money families spend, and how much time community residents spend harvesting and preparing resources for personal use, sharing, and trading. With this understanding, other model inputs can be adjusted (like household income, or travel time). This information can be used to quantify economic impacts associated with oil and gas development and evaluate the effectiveness of mitigation programs.

Why is my involvement important?

The involvement of all kinds of subsistence harvesters and hunters is an important part of the study. **In order for the team to understand the economic importance of subsistence resources, we need to hear from those people most involved in fishing, caribou hunting, whaling, and other harvesting activities.** Each type of activity requires a different set of tools, takes place at a different time and space, and involves households in different ways. Participation of all kinds of subsistence harvesters will allow the team to better understand the whole subsistence economy.

Thank you for your help!

Please take a few minutes to fill out a contact card and let a member of our team know that you would like to be part of the upcoming workshop or interviews. Your information will directly help our understanding of the subsistence economy and potential cumulative impacts.



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Appendix B: Subsistence Questionnaire

The following pages contain the questionnaire packet administered in November 2017, along with the consent form each participant signed and the maps the team provided for participants to locate sites.

Nuiqsut Questionnaire

November 2017

Question 1 **Caribou**

Considering the last 12 months, if you or members of your household harvested **caribou**, please identify the following for each site where they harvested caribou. Please identify each site on the map provided by placing the number on the map that corresponds to the number of the site location listed in the table below (for example, if you write Ocean Point next to Site Location 1 in the table below, you would place a 1 on the map next to Ocean Point).

Site	1.	2.	3.	4.	5.
Number of trips members of your household took to this site last year					
How long does it take to get to this site?					
How long do members of your household stay at this site on a typical trip? (number of days)					
How many caribou do members of your household harvest on a typical trip?					
How much of your harvest do members of your household typically give away to members of other households? (please provide in a percentage)	%	%	%	%	%

Notes/Comments:

Question 2 **Whales**

Considering the last 12 months, if you or members of your household participated in **whaling** please answer the following questions.

Question	Answer
How long does it take you to get to Cross Island?	
When you travel there for whaling, how many days do you typically stay there?	
Do you or your households ever whale for a Nuiqsut crew from a location other than Cross Island? Please list where.	
Do you or your household ever whale as part of a crew from another village? Please list which villages.	
If you answered yes to the question above, how often do you join a whaling crew from another village (e.g., once or twice in the past, once every five years, every couple of years, every year).	
How many days after the whale is caught does it take for it to arrive in Nuiqsut?	
Is the whale typically processed on Cross Island or in Nuiqsut?	
How long does processing usually take?	

Notes/Comments:

Question 3 **Fish**

Considering the last 12 months, if members of your household, including you, harvested **fish** this year, please identify the following for each site where they harvested fish. Please identify each site on the map provided by placing the number on the map that corresponds to the number of the site location listed in the table below (for example, if you write Nanuk next to Site Location 1 in the table below, you would place a 1 on the map next to Nanuk).

Site Location:	1.	2.	3.	4.	5.
Number of trips members of your household took to this site last year					
How long does it take to get to this site?					
How long do members of your household stay at this site on a typical trip? (number of days)					
How many fish do members of your household keep on a typical trip?					
How much of your harvest do members of your household typically give away to members of other households? (please provide in a percentage)	%	%	%	%	%

Notes/Comments:

Question 4 **Most Important other Resources**

Considering the last 12 months, if you or members of your household harvested **other resources**, please identify the following for each site where they harvested. Please identify each site on the map provided by placing the number on the map that corresponds to the number of the site location listed in the table below (for example, if you write Ocean Point next to Site Location 1 in the table below, you would place a 1 on the map next to Ocean Point).

Site Location:	1.	2.	3.	4.	5.
Resource harvested at this site					
Number of trips members of your household took to this site last year					
How long does it take to get to this site?					
How long do members of your household stay at this site on a typical trip? (number of days)					
How much of this resource (in pounds, gallons, number of animals, etc.) do members of your household harvest on a typical trip?					
How much of your harvest do members of your household typically give away to members of other households? (please provide in a percentage)	%	%	%	%	%

Notes/Comments:

Question 5 Time Use—Current and Preferred

Instructions

The table immediately below shows the portion of a year used doing an activity. For example, spending eight hours a day sleeping uses up 33 percent (one-third) of the year, while going Caribou hunting on day-trips for 20 days per year uses up 2 percent of your time in a year.

Daily Activities such as Sleeping, Housework, Other Activities	Percent of Year	Day Long Activities (Fishing or Hunting)	Percent of Year	Overnight or Multi-Day Activities (Fishing, Hunting, Whaling)	Percent of Year
2 Hours per Day	8%	5 Days per year	1%	5 Days per year	1%
4 Hours per Day	17%	10 Days per Year	1%	10 Days per Year	3%
6 Hours per Day	25%	20 Days per Year	2%	20 Days per Year	5%
8 Hours per Day	33%	50 Days per Year	6%	50 Days per Year	14%
10 Hours per Day	42%	100 Days per Year	11%	100 Days per Year	27%
12 Hours per Day	50%	200 Days per Year	23%	200 Days per Year	55%

Using the table above, we'd like to ask you how much time you spend doing these activities versus how much time you'd *prefer* to spend doing these activities. For example, the individual shown below would like to spend less time sleeping and working and more time sealing and harvesting other subsistence resources. *The table for you to fill out continues on the next page.*

Household Member	Sleeping	Working at a job for wages	Working inside the household not earning a wage	Preparation and Maintenance for Subsistence Activities	Harvesting, Preparing for Harvesting, and Processing					Other Activities including social activities	Total to 100%
					Fishing	Caribou	Seal	Whaling	Other Subsistence Resources		
You- <i>Actual</i>	40%	25%	17%	2%	2%	2%	0%	1%	0%	9%	100%
You- <i>Preferred</i>	31%	17%	8%	2%	6%	6%	5%	3%	5%	17%	100%

Question 5 Entry Table

Please enter your information for Question 5 here. Start with how you spend your time and then enter how you'd *like* to spend your time.

Household Member	Sleeping	Working at a job for wages	Working inside the household not earning a wage	Preparation and Maintenance for Subsistence Activities	Harvesting, Preparing for Harvesting, and Processing					Other Activities including social activities	Total to 100%
					Fishing	Caribou	Seal	Whaling	Other Subsistence Resources		
You- <i>Actual</i>	%	%	%	%	%	%	%	%	%	%	100%
You- <i>Preferred</i>	%	%	%	%	%	%	%	%	%	%	100%
Your Household- <i>Actual</i>	%	%	%	%	%	%	%	%	%	%	100%
Your Household- <i>Preferred</i>	%	%	%	%	%	%	%	%	%	%	100%

Notes/Comments:

Question 6 Time and Aspects of Life

Question 6a. Aspects of Life

There are aspects of life that are important to each of us. Aspects can include how we spend our time, what we have to eat, our ability to buy physical items, or our ability to participate in social, cultural, and religious activities. We often must prioritize these aspects in our daily lives and make tradeoffs between them. Consider that you have 100 points to spread between these four parts of your life based on their importance compared to each other with more important aspects receiving more points. How would you distribute these points to show the importance of these aspects? Please use the graph below and distribute 100 points between the four aspects.



= 100

Question 6, Time and Aspects of Life (contd.)

Question 6b. Distribution of Household Time

Think about the four activities listed below: subsistence activities, leisure time for social activities, working inside the home, and working outside the home. For your household, please distribute 100 points between the four categories using the graph below based on their importance compared to each other.



= 100

Question 7 Meat Purchases

Do you, or does anyone in your household, ever purchase meat at the store or purchase meat from outside the community? Yes _____ No _____

No – Go to Question 8

Yes – Please complete the following table

Question	Beef/ Pork	Chicken	Fish	Other Meat		
				_____	_____	_____
7a. In the last year, did you buy each of the following at the store? (Please fill in yes or no for each item. If you respond yes for Other, please identify what other types of meat you purchase)						
7b. For the meat you do purchase, how often do you purchase it? Please enter one of the following in the cell for the type of meat you do purchase: a. two or more times a week b. once per week c. once per month d. every other month e. every three to six months f. once a year						
7c. For the meat you do purchase, how many pounds do you typically purchase at a time (Please provide your answer in the nearest amount of pounds)						
7d. For the meat you do purchase, how much does it typically cost? (Please provide your answer in the nearest cost per pound)						

Notes/Comments:

Question 8 **Residency**

Do any of the people that live in your household also reside at another location outside of Nuiqsut for some part of the year?

Yes _____ No _____

If Yes, please complete the following table for each member of your household including you.

Household Members <i>Over Age 18</i>	In what other community or communities does this family member reside?	What percentage of the year does this household member live in the location outside of Nuiqsut?
1		
2		
3		
4		
5		

Notes/Comments:

Question 9 About Your Household

How many people, including you, live in your household (by household we mean the people that live in the physical structure where you live)? _____

Please complete the following table for each member of your household **over the age of 18** including you.

Household Member:	1. You	2.	3.	4.	5.
Gender/Age	/	/	/	/	/
Did this member work outside the house in the last year to earn income? (Y/N)					
If this member works outside the house, how many hours a week does the member work? (Hours per week)					
How much does this member earn an hour working outside the house? (\$)					
Did this household member harvest animals and/or fish last year? (Y/N)					
If they harvested animals last year, what species did they harvest: whale, caribou, seal, other? (If other, please identify the species.)					
How many calendar days did this household member spend harvesting last year?					
How many calendar days did this household member spend fishing last year?					
How many calendar days did this household member spend preparing, maintaining, or repairing harvesting or fishing materials and/or gear last year?					

Notes/Comments:

Question 10 **Additional comments?**

Is there anything we didn't ask that you feel should have been addressed?

Thank you for your help!

Figure 12. Consent Form

Consent Form
Participation in the Nuiqsut Economic Study of Subsistence Impacts

Description of the research and your participation

You are invited to participate in a research study conducted by social scientists working with ConocoPhillips Alaska, Inc. The purpose of this research is to gain a better understanding of the economic impacts of development on subsistence uses and activities. As part of this study, social scientists are developing an economic model of subsistence harvesting in Nuiqsut.

We would like to interview knowledgeable subsistence harvesters about the costs that individuals and families incur to continue subsistence activities at desired levels. We will ask questions about the money and time you spend on obtaining resources and how the costs of various goods (i.e., fuel, snow machines, and ammunition) affect you.

Risks and Benefits

This study was established by the Record of Decision for the Alpine Satellite Development Plan for the Proposed Greater Mooses Tooth One Development Project. This study will help inform future project designs and decisions on the direct and cumulative impacts of oil and gas development on subsistence activities. Any information you can provide will likely benefit our understanding of the subsistence economy and potential cumulative impacts. As with all studies of this nature, there is no guarantee of how the information will be used in the future.

Compensation

Each participant who completes the entire questionnaire will be provided a small monetary compensation.

Protection of confidentiality

Your name will not be used in our study, unless you expressly make that request. If individual harvest information is shared with researchers, it will not be included in the report.

Voluntary participation

Your participation in this research study is voluntary. You may choose not to participate and you may withdraw your consent to participate at any time. You will not be penalized in any way should you decide not to participate or to withdraw from this study.

Contact information

If you have any questions or concerns about this study or if any problems arise, please contact Jonathan King at Northern Economics, Inc. at 907-947-7039, jonathan.king@norecon.com.

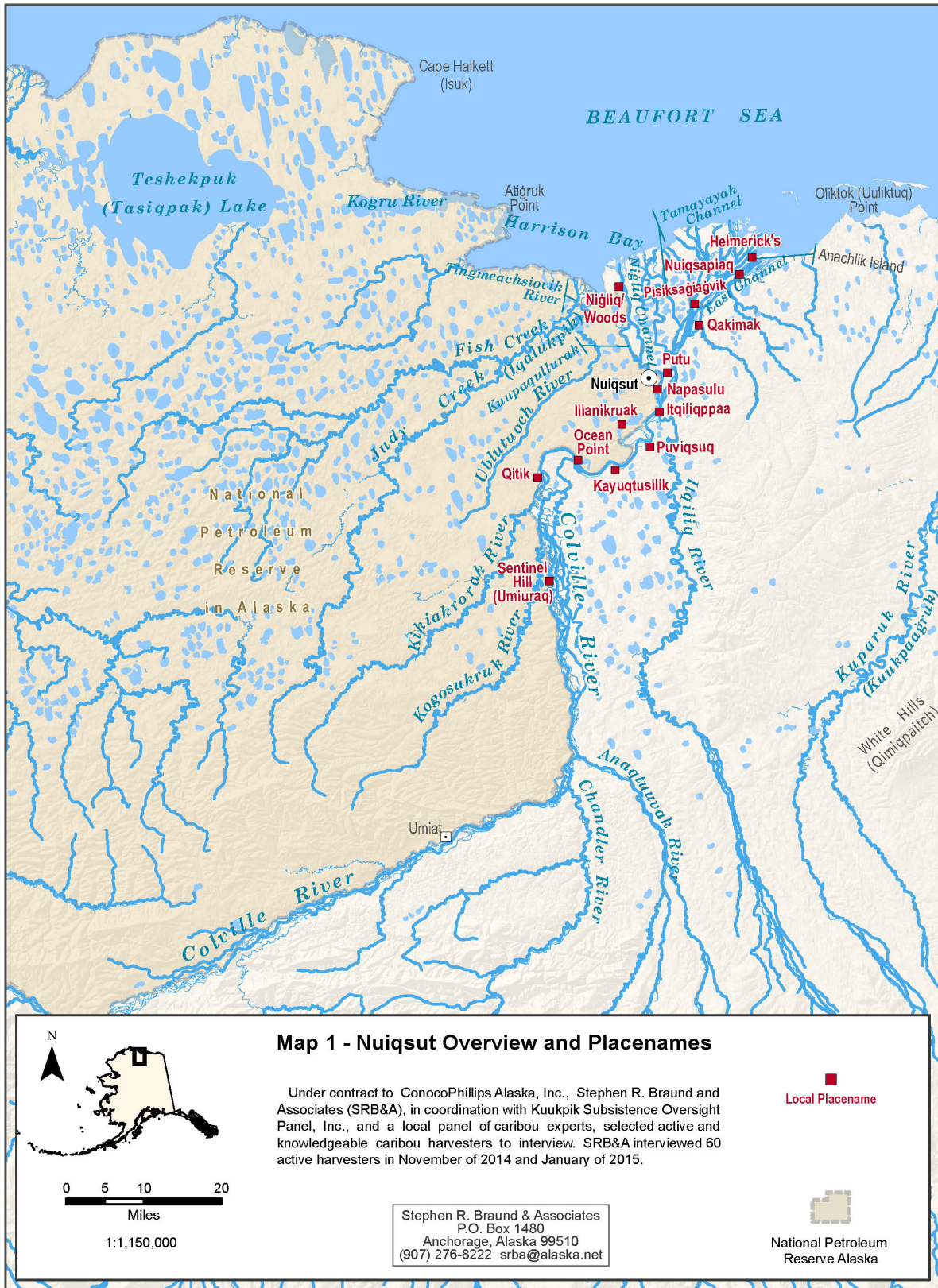
Consent

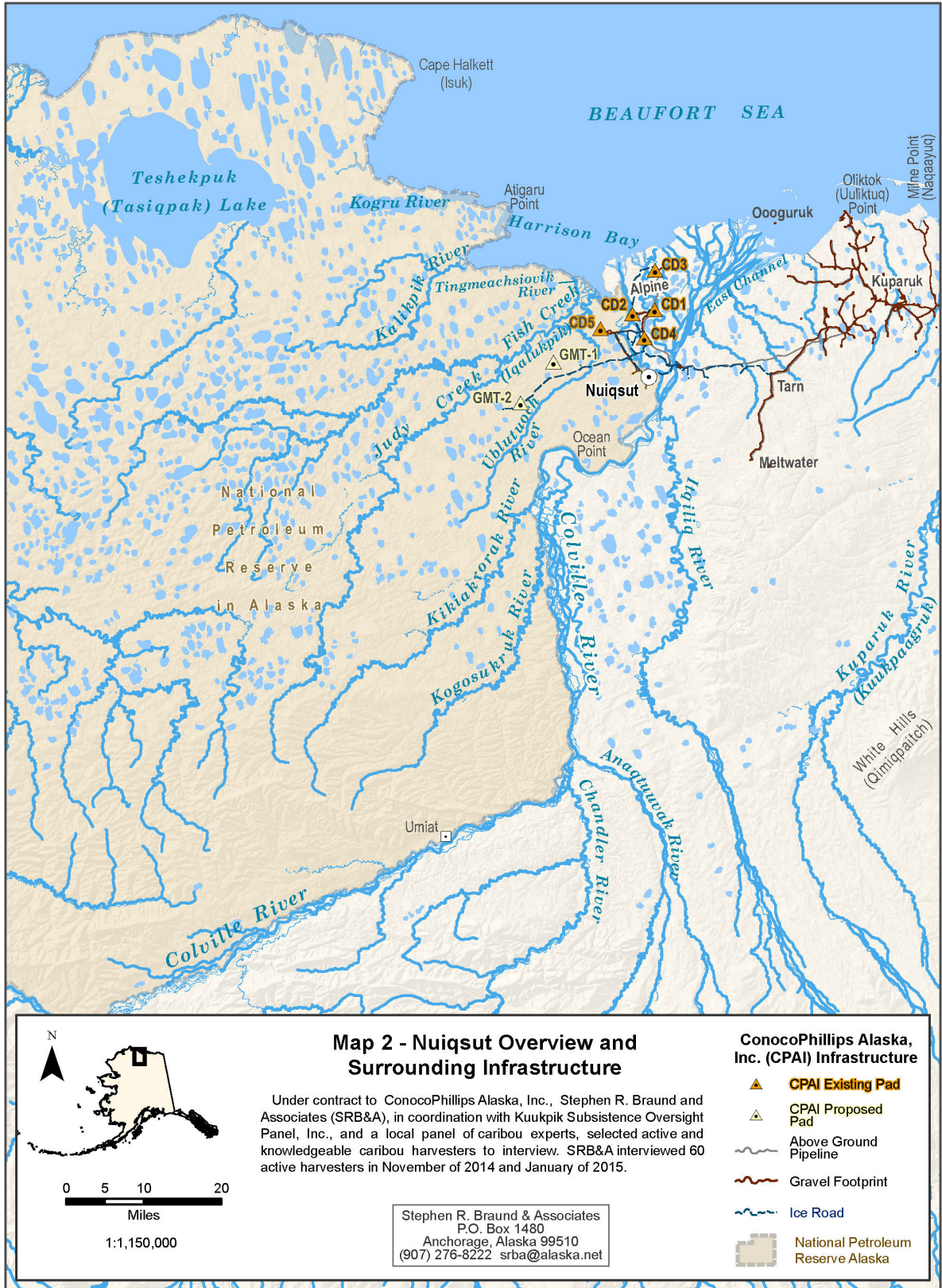
I have read this consent form and have been given the opportunity to ask questions. I give my consent to participate in this study.

Participant's signature _____ Date: _____

Participant's name (printed) _____

The following are maps of the study area created by Stephen R. Braund and Associates under contract to CPAI and used during the subsistence questionnaire administration for this study.





Appendix C: Economic Study of Subsistence Impacts: Subsistence Economic Model and Data Gap Analysis

Economic Study of Subsistence Impacts: Subsistence Economic Model and Data Gap Analysis

Final

Prepared for

ConocoPhillips Alaska, Inc.

June 2017

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a subsidiary of Arctic Slope Regional Corporation

VERITAS
Economic Consulting

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Abbreviations

ASRC	Arctic Slope Regional Corporation
CPAI	ConocoPhillips Alaska, Inc.
GMT1	Greater Mooses Tooth One Development Project
KSOP	Kuukpikmiut Subsistence Oversight Panel, Inc.
NPR-A	National Petroleum Reserve—Alaska
NSB	North Slope Borough
ROD	Record of Decision

1 Introduction

This report provides a proposed economic model to determine the monetary value of subsistence resources in the community of Nuiqsut, located in the North Slope Borough (NSB), Alaska. The proposed economic model is accompanied by a discussion of the theoretical context that influenced the development of this model, as well as an analysis of existing documents, data, and resources that have been reviewed for inputs for the model. This document identifies those resources with useful data related to the model inputs, identifies those inputs for which no adequate data exist, and provides recommendations for the closure of these data gaps. The recommendations include a focus group and targeted interviews with key subsistence harvesters in the community of Nuiqsut.

Section 2 of this document presents a project background and an introduction to the community of Nuiqsut, including a discussion of its demographics, economy, and primary subsistence resources. This section also includes a discussion regarding previous attempts to quantify the economic value of subsistence resources and some of the literature surrounding the quantitative analysis of subsistence economies and market economies with substantial subsistence harvesting engagement.

Section 3 includes a discussion of the model development and overall approach, including the theoretical basis for the modelling task. This section also includes a discussion of the model itself, including a discussion of the primary variables and inputs needed for the model.

Section 4 identifies each variable and whether the project team was successful in finding adequate data for these variables in existing data sources. Each data source is identified, along with the relevant page numbers of the document. Also included is an identification of any data adequacy issues and/or considerations, including the age, species focus, or geographic focus of the data. This section also includes a discussion of those resources that included relevant and substantial qualitative information regarding the role of subsistence harvesting in Iñupiat culture and the perceptions regarding how industrial development on the North Slope has affected subsistence harvesting activities in the region.

Finally, **Section 5** provides a range of recommendations for obtaining data for those variables in the economic model for which no adequate data currently exist. These data are generally related to the monetary costs associated with subsistence-related travel, purchasing and maintaining subsistence-related gear, existing market economy behaviors and spending patterns, and generalized preferences regarding the amount of subsistence foods harvested and shared. In general, the project team recommends a limited public outreach effort that includes coordination with local agencies, a focus group with Nuiqsut subsistence harvesters, and key interviews with people knowledgeable about subsistence practices and the monetary costs associated with harvesting activities.

2 Project Background

This study is required per the Record of Decision (ROD) issued by the BLM for the Greater Mooses Tooth One Development Project (GMT1) located in the National Petroleum Reserve – Alaska (NPR-A). The ROD requires ConocoPhillips Alaska, Inc. (CPAI) to:

“Undertake a thorough one-time economic study at the beginning of the GMT1 project of the costs that individuals and families incur to continue subsistence activities at desired levels (or would have to incur to participate in subsistence activities if they are not able to afford them.) The study will include an overview of the increased impacts to subsistence activities related to past and current future projects, and will account for the increase in cost of living. The study will also describe the adequacy of existing subsistence mitigation funds to address identified impacts” (U.S. Bureau of Land Management 2015).

Previous project experience in Nuiqsut suggests that participation in subsistence activities is changing over time, regardless of the level of oil and gas activity. Surveys recently conducted by Northern Economics Inc. (NEI) research team members with Nuiqsut residents, elders, and whaling captains, have suggested that industry activities are just one of the forces affecting traditional subsistence activities, in addition to other socioeconomic pressures, internal social forces, and global climate change (EDAW 2008; Galginaitis 2014). Traditional subsistence activities in the community of Nuiqsut have a larger historical variation when compared to other communities (e.g., Point Hope) due to the area having been occupied, depopulated (and used seasonally), and permanently resettled over time. This understanding is important in determining the economic costs associated with participating in subsistence activities and how potential changes in the environment may affect subsistence behavior.

Subsistence strategies are not static and resource development may affect access to places and resources vital to subsistence activities or may affect the location of subsistence resources and the success of the subsistence harvest. Resource development may also affect subsistence by impacting the freedom of movement used to pursue subsistence resources. NEI will develop an economic model of subsistence harvesting that attempts to quantify the economic value of subsistence activities and takes this variability over time into account. This model takes into consideration travel costs, gear costs, and overall preferences regarding the amount of subsistence foods in the diet, among other inputs. The model will consider earned income, transfer income, assistance income, and other sources of income that households use to pay for subsistence harvesting activities. The final model will include a range of inputs that can be updated to reflect changes in the cost of living, income trends, changes in subsistence area access, cultural preferences, and harvest rates.

The NEI team would like to note that this economic valuation of subsistence resources, while informed by recent literature, is limited in providing an accurate estimate of the true value of subsistence to the community of Nuiqsut. Modeling the economic value of subsistence has been widely acknowledged to be at best, a partial evaluation of the value of subsistence activities, and perhaps leaves out the most important or valuable aspects of these activities.

2.1 Nuiqsut

The study and model are a BLM requirement issued in the GMT-1 ROD. Nuiqsut is the community closest to GMT-1 and therefore will be the focus of this economic study of subsistence.

Nuiqsut is located approximately 620 air miles north of Anchorage, 152 miles southeast of Utqiagvik (formerly Barrow), 60 miles west of Deadhorse, and 17 miles south of the shores of the Beaufort Sea. Nuiqsut is situated in the Colville River Delta, on the west bank of the Nechelik Channel approximately 7 miles from the main Alpine facility and 12 miles from the GMT1 drillsite. The City is located within

the National Petroleum Reserve—Alaska (NPRA) and the NSB—encompassing 9.2 square miles of land. The name Nuiqsut recalls prehistoric and historic camps and settlements occupied by many families on the main channel of the Colville River that had been used traditionally as an area for hunting, fishing, trapping, and trading. In the 1940s, most residents moved to Utqiagvik when the Bureau of Indian Affairs mandated school attendance for children. However, former residents continued to use the Colville River area for subsistence purposes, and after the passage of the Alaska Native Claims Settlement Act, the area was resettled by 27 families (EDAW 2008) in 1973.

Nuiqsut’s economy comprises both cash-based and subsistence components, with the “typical” Nuiqsut resident likely to define his or her lifestyle more in terms of subsistence activities and the annual subsistence cycle than in terms of employment for wages or consumer goods (EDAW 2008). However, wage labor and income are not related to participation in subsistence activities in a simple way.

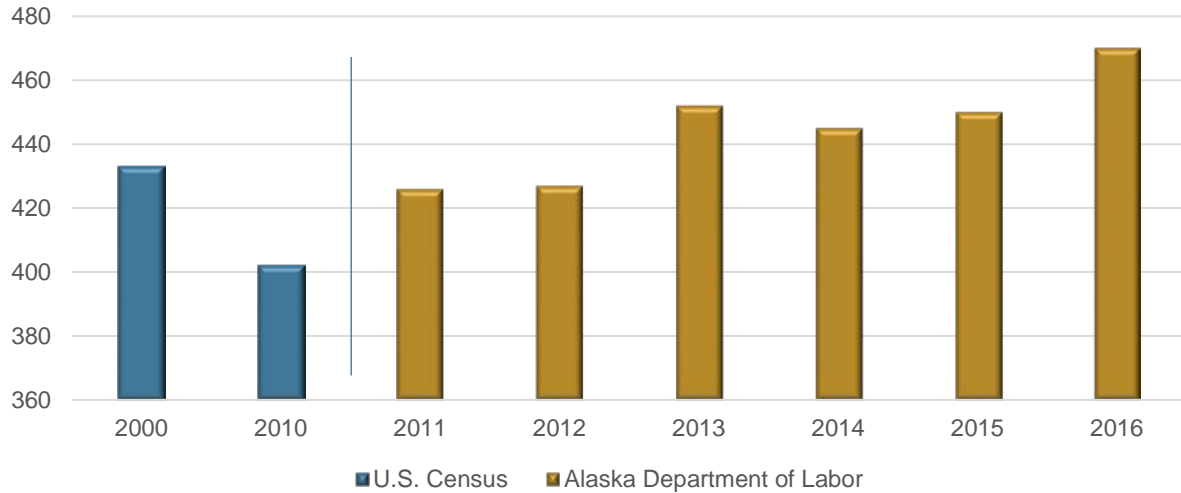
Nuiqsut has grown considerably since its resettlement in 1973. Today, Nuiqsut hosts an airport, a pre-kindergarten through grade 12 school, community center, power plant, wastewater treatment center, clinic, post office, hotel, and grocery store. Most homes in Nuiqsut are heated with natural gas provided by the Alpine oilfield and a NSB gas pipeline. Emergency services are provided by the NSB and a local governance is comprised of the City of Nuiqsut, Native Village of Nuiqsut, and the NSB. Nuiqsut is also a member community to both regional and local native corporations. Arctic Slope Regional Corporation and Kuukpik Corporation work toward enhancing Iñupiaq cultural and economic freedoms (Brown et al. 2016). It should be noted that a significant portion of the Alpine development including GMT1 and CD5, resides on native corporation land (surfaced owned by Kuukpik Corporation and subsurface owned by Arctic Slope Regional Corporation [ASRC].)

2.1.1 Demographics

The population in Nuiqsut decreased approximately seven percent from 433 to 402 residents between 2000 and 2010 (Figure 1). In 2010, the City of Nuiqsut ranked 138th largest of 352 communities in Alaska with recorded populations that year. By 2015, the City had an estimated population of 450, which ranked 128th out of 348 communities with recorded populations. Since 2010, Alaska Department of Labor estimates indicated steady growth through 2016, during which the estimated population was 470 residents.

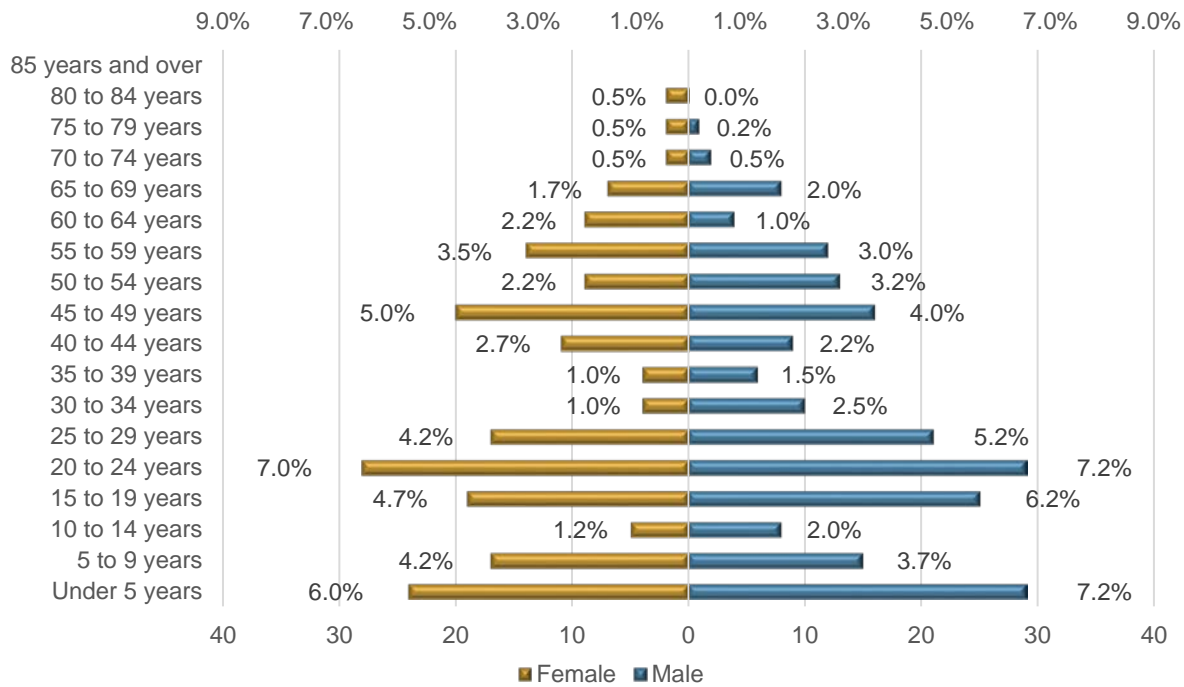
The population of Nuiqsut in 2010 was split almost evenly, with 52 percent of the population reported as male and 48 percent reported as female (Figure 2). A little over a quarter of the population is between the ages of 15 and 24 years old—with nearly half of Nuiqsut’s population 24 years old or younger. In 2015, the American Community Survey reported the median age was 24—54th out of 324 Alaskan communities with median age data—and slightly lower than 25.2 as reported in the 2010 Census (U.S. Census Bureau 2017).

Figure 1. Nuiqsut Population, 2000-2016



Source: U.S. Census Bureau 2017, State of Alaska 2017

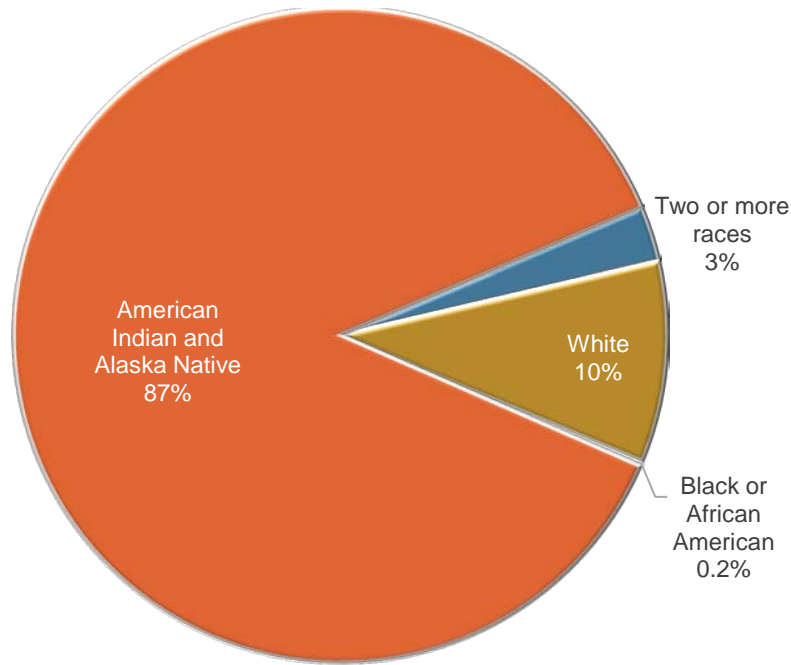
Figure 2. Nuiqsut Population Distribution, by Age and Sex, 2010



Source: U.S. Census Bureau 2017

The majority of the population in Nuiqsut is Iñupiaq Eskimo. In 2010, 87 percent of Nuiqsut residents identified themselves as American Indian or Alaska Native, while 10 percent identified themselves as White, 0.2 percent as Black or African American, and 3 percent identified with two or more races (Figure 3).

Figure 3. Nuiqsut Racial Composition, 2010



Source: U.S. Census Bureau 2017

Between 2000 and 2010, the average household size in Nuiqsut remained fairly consistent, with 3.93 people reported in 2000 and 3.47 in 2010 (U.S. Census Bureau, 2017a). Over that same time period, the number of households in Nuiqsut increased from 126 (110 occupied) to 136 (114 occupied). Of the 136 total housing units surveyed in 2010, 44.9 percent were owner-occupied, 39 percent were rented, and 16.2 percent were vacant or used only seasonally. Since 2010, Nuiqsut added 11 more single-family housing units.

2.1.2 Current Economy

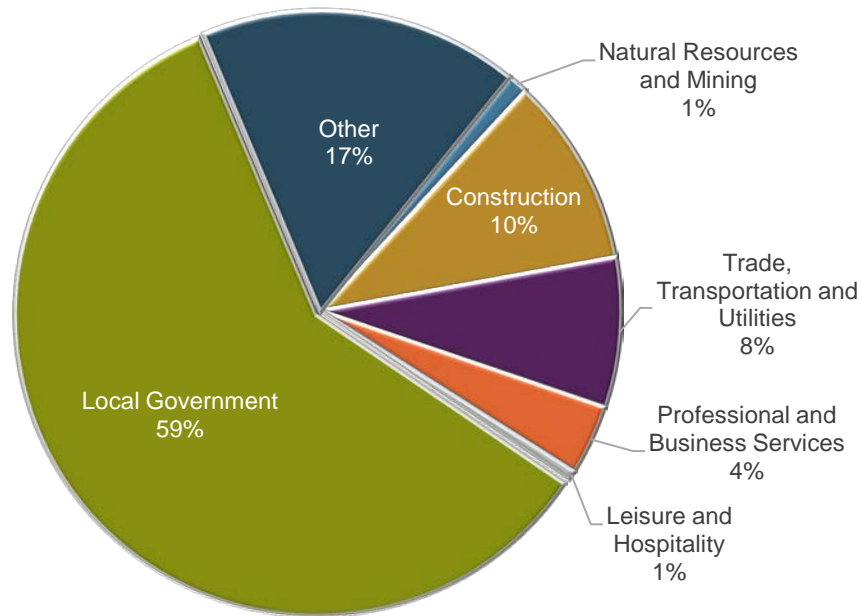
Like many other North Slope communities, the development of oil and gas has had both direct and indirect influences on Nuiqsut’s economy due to increased services offered by the NSB as a result of taxation on oil and gas facilities. The effects on Nuiqsut are more direct than most given the city’s proximity to both onshore and more recent offshore oil development activities. Nuiqsut’s proximity to development in the Colville River delta on land owned by the Kuukpik Corporation is especially notable. Most business licenses issued in Nuiqsut relate to enterprises for the Kuukpik Corporation or the City of Nuiqsut (EDAW 2008).

Nuiqsut’s proximity to development in the Colville River delta has increased the number of Nuiqsut residents being employed by the petroleum industry, with a limited number of current Nuiqsut residents finding employment in the oil and gas industry. For example, CPAI funds a subsistence oversight panel that employed 12 ASRC shareholders and/or Nuiqsut residents in the 2015–2016 season and 16 ASRC shareholders and/or Nuiqsut residents in the 2016–2017 season. Approximately 21 ASRC shareholders and/or Nuiqsut residents were hired by CPAI during the ice road season of 2015–2016, while approximately 37 ASRC shareholders and/or Nuiqsut residents were hired during the 2016–2017 GMT-1 construction season. Overall, however, the pattern was and continues to be that such employment is

generally in lower-level positions and is temporary in the sense that it does not lead to a career (EDAW 2008).

In 2015, the majority of Nuiqsut’s workforce was employed by local government (Figure 4). Construction and trade, transportation, and utilities represented the next single-largest industries, accounting for 10 percent and 8 percent of jobs in Nuiqsut, respectively. The top three occupations reported in Nuiqsut in 2015 were clerks (bookkeeping, accounting, and auditing), truck drivers (heavy and tractor-trailer), and general maintenance and repair workers (Table 1).¹ It should also be noted that trapping and craft-making also provide some income, and subsistence harvest is a foundational aspect of the local economy. However, these data are not included by the U.S. Census or Alaska Department of Labor.

Figure 4. Local Employment by Industry, 2015



Source: State of Alaska 2017a

Table 1. Top Occupations, 2015

Occupation	Number of workers
Bookkeeping, Accounting, and Auditing Clerks	27
Heavy and Tractor-Trailer Truck Drivers oil and gas occupation	11
Maintenance and Repair Workers, General	10

Source: State of Alaska 2017

Note: Occupation data represent resident workers only

Based on household surveys conducted for the 2011–2015 American Community Survey, the per capita income in Nuiqsut was estimated to be \$22,682 and the median household income was estimated to be \$80,938 (U.S. Census Bureau, 2017b). This represents a decrease in the per capita and median household incomes reported in the year 2010 (\$22,981 and \$86,042, respectively). When adjusted for

¹ Occupation data represent resident workers only.

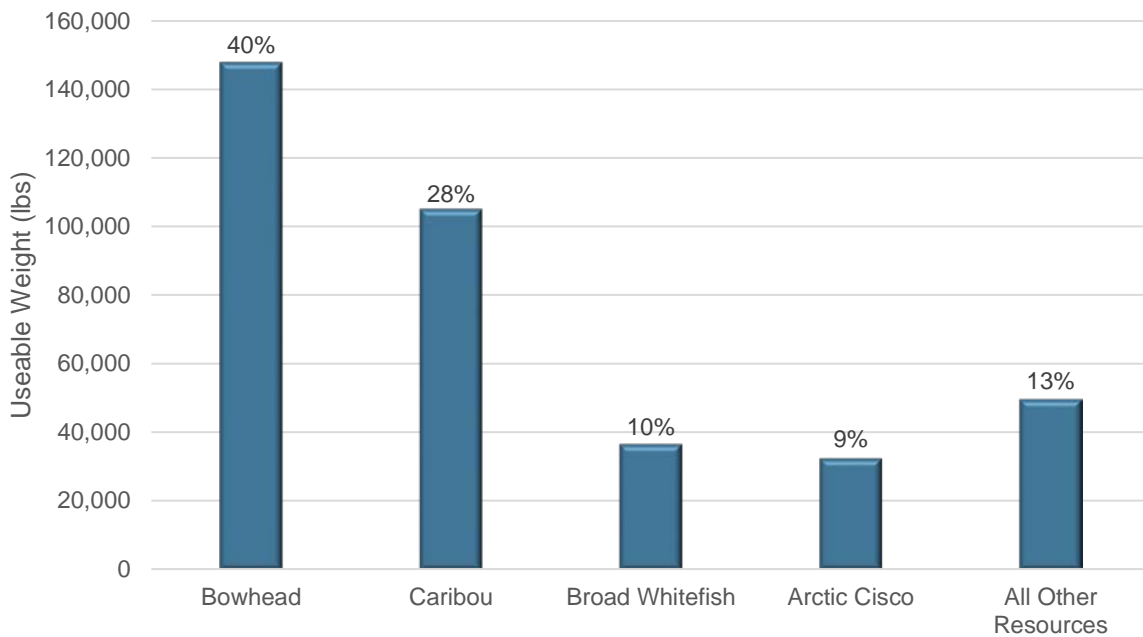
inflation, the decreases in per capita and median household incomes increase, with 2010 estimates reaching \$24,974 and \$93,503, respectively. Nuiqsut’s decrease in income is likely the result of a decline in oil prices that started in the summer of 2014. In 2015, Nuiqsut ranked 159th of 320 Alaskan communities with per capita income data that year, and 34th in median household income, out of 284 Alaskan communities with household income data.

2.1.3 Subsistence

In the fall of 1973, after the resettlement of Nuiqsut, one of the original founders (and mayor at the time) of Nuiqsut took the first whale for the community, which was important for qualifying Nuiqsut as one of the original whaling communities that formed the Alaska Eskimo Whaling Commission. Because Nuiqsut is not located on the coast, but rather 17 miles inland on a channel of the Colville River, the community is atypical of most whaling communities. However, the residents of Nuiqsut harvest bowhead whales from Cross Island in the fall, which is located approximately 19 miles north of Prudhoe Bay. In the 1980s and into the early 1990s, some whalers used Narwhal Island as a base and still have structures there (EDAW 2008; Galginaitis 2014)

Nuiqsut is a highly active, subsistence-based community. In 2014, subsistence users utilized 16,322 square miles across the central Arctic slope, both terrestrially and in the Beaufort Sea. Bowhead whales were the single largest resource harvested by the community of Nuiqsut at nearly 150,000 useable pounds—representing 40 percent of all wild resources harvested (Figure 5). Together, bowhead whale, caribou, and whitefishes provided over 86 percent of the edible weight for Nuiqsut households in 2014.

Figure 5. Composition of Usable Weight Harvest (pounds) by Resource, Nuiqsut, 2014

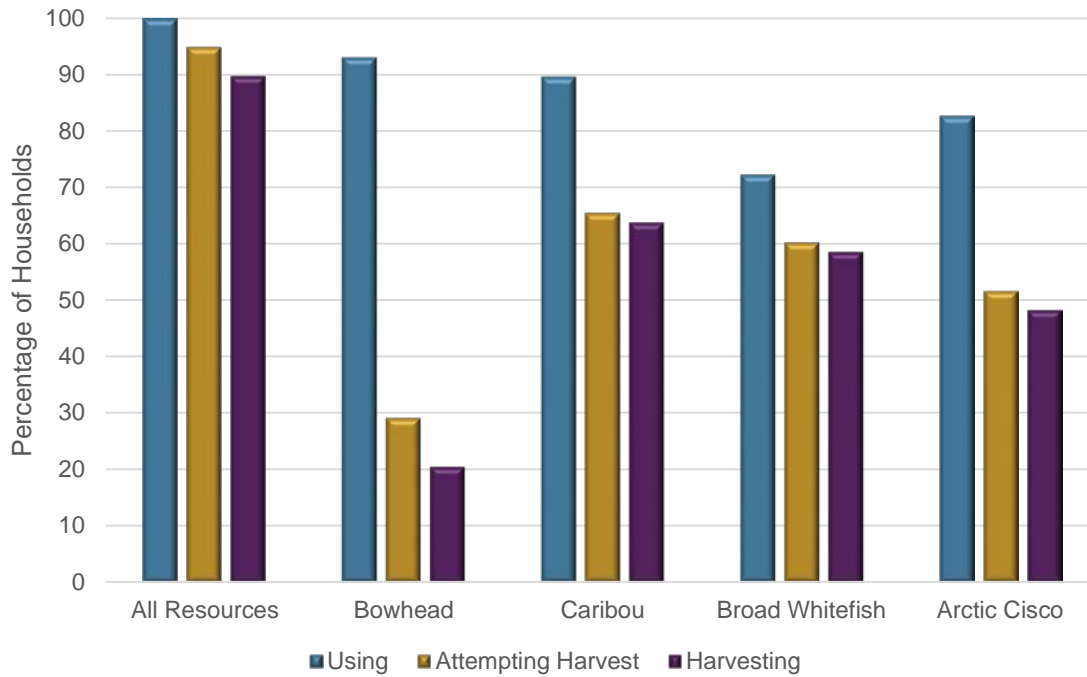


Source: Brown et al. 2016

Subsistence activities are seasonal, depending upon the resource, and often depend on weather. Despite the challenges of maintaining a subsistence lifestyle, all households in Nuiqsut used wild foods in 2014, with 95 percent of households attempting to harvest wild foods, and 90 percent successfully

harvesting these resources (Figure 6), including bowhead whales, caribou, broad whitefish, and Arctic cisco.

Figure 6. Percentage of Nuiqsut Households Using, Attempting to Harvest, or Harvesting Wild Resources, 2014



Source: Brown et al. 2016

2.2 Past Efforts to Model the Economic Value of Subsistence

Researching the interrelationship between subsistence activities and outside economic influences is not particularly new.

Researchers find that subsistence hunters who participate in the wage economy value the opportunity to take time off and schedule flexibility and that complementary work roles were created by household members; for example, the woman would hold a wage position and the man participated more heavily in subsistence activities (Wolfe et al. 1984).

At the theoretical level, Becker started work that reinterpreted the concepts of “work” and “leisure” to include “productive consumption” and the value of products that take time to produce. The underlying theory was that households were producers as well as consumers, and that there was a mathematical relationship between income earned and that forgone by the use of time and goods to obtain utility (Becker 1965). By 1986, Gronau explored the various approaches to a “Home Production” model that went past the traditional assumption that consumers should be regarded as welfare maximizers, but instead extends the approach by challenging the assumption that market goods and services are the direct source of utility and acknowledges that there are a range of outside constraints confronting the household. The survey of the literature found that home production theories recognize the importance of time in the analysis of demand for market goods and services, including the implication of the opportunity cost for time (Gronau 1986).

Brown and Burch (1992) suggested that estimating the economic value of the subsistence harvest in Alaska relied on evaluating either a person's "willingness to pay" for a replacement of a subsistence resource, or a "willingness to accept" payment for a subsistence resource on the open market. They also discuss a range of methods that can be used to estimate economic value, including the observation of market behavior, an alternative cost method (which estimates the gross value of a loss as the cost of replacing it with a substitute), the travel cost method (which values the activity by measuring how much people are willing to spend to visit a site), and a contingent valuation method (which tests estimates of monetary value for resources through a series of questions).

An economic model presented by Matthew Berman in 1998 provided an outline by which one kind of economic study of subsistence could be performed in Alaska. In his presentation, Berman outlined what he considered a modified household production model that could be used to test hypotheses about subsistence sustainability. He noted that households are known to make tradeoffs between how much time is taken to conduct subsistence activities versus how much time is spent participating in the wage economy, suggesting that a model should include an identification of separate structural relationships for each important household decision. It is argued that the sustainability of the subsistence economy could be simply conceived as a question of ensuring successful harvests of local resources to achieve consumption targets; however, in the Arctic context, two important cultural considerations were important to include: sharing with other households and time spent in direct engagement with the land. The variables for his model included:

- Consumption of market goods
- Consumption of subsistence goods
- Time spent in activities: subsistence, leisure, family, wage employment
- Total time
- Total cost of market goods used in subsistence activities
- Knowledge: subsistence and wage activities
- Household and community demographic factors (which can influence sharing practices)
- Availability of subsistence resources
- Subsistence production
- Wage rate
- Total household income
- Exogenous income (e.g., permanent dividend fund)
- Price of goods
- Purchases of market goods for consumption
- Purchases of market goods, used as cash inputs for subsistence
- Sharing of goods
- Measurement of "traditionality", or a preference for traditional activities

The model calculated the utility of the household understanding that the household was constrained by available subsistence production technology, limits on money, and limits on time. Another input was focused on the uncertainty of subsistence production, which was a function of time, capital and operating costs, knowledge, and availability of subsistence resources. The purchases of market goods

and services were also added into the model, with the assumption that all purchases may not exceed income (which, in itself, is based on assumptions related to education and other demographics). Limits related to time spent performing subsistence activities, wage labor, family responsibilities, and leisure were also entered into the model. The final piece of the model assumed a certain amount of resource sharing; resources could include market goods, subsistence capital (cash inputs), or subsistence harvests (Berman 1998).

Other economic models have also been developed that focus on the relationship between subsistence activities and wage labor engagement, including in their considerations that security and well-being were closely tied to subsistence traditions in many traditional communities; they are not a recreational or “lifestyle choice”. The model put forth by Usher began with the assumption of the household as the basic economic unit and the factors of production included land, labor, and capital. The authors put forth a series of key features of a model that took into consideration the village economies with strong subsistence-based ties:

1. The local economy consists of both market and subsistence spheres, and many, if not most, households are oriented to both of these spheres, not exclusively to one or the other.
2. Income flows to households from both of these spheres in the form of wages, commodity production, and transfers (cash income), and of subsistence (income in kind).
3. The household deploys the factors of production available to it (land, labor, capital), so as to capture these sources of income in a flexible manner.
4. Household success requires successful integration of market activities, subsistence production, and household reproduction. The model explicitly rejects the assumption that those without paid jobs are “unemployed” and hence make no productive contribution to economic well-being.
5. Individuals maximize their ability to provide for their households not necessarily by having a single skill, occupation, or job, but several. Nor is it appropriate to assume that individuals derive their livelihood from any single sector of the regional economy.
6. There is substantial cooperation and sharing among households, generally along lines of kinship, to optimize these flows of income and to ensure a general distribution of benefits.
7. Most importantly, because there are not two separate economies, people do not choose between living in a “traditional” economy or “modern” economy, nor are they in transition between the two. The modern economy in northern communities is in fact a mixed, subsistence-based economy. (Usher, Duhaime, and Searles 2003)

More recently, Berman employed a rational choice economic approach for modelling participation in subsistence hunting in a mixed subsistence/market economy. The authors also found that direct participation from community experts in subsistence hunting also helped influence the model, providing insight on the environmental conditions, availability of harvest resources, and hunting effort required for various zones within the region. The economic team found that an index of the likelihood of encountering subsistence resources (in this case, caribou) in different areas could be calculated and, as an input, could be used to gain more insight into how community members spent their limited time. They concluded with a strong endorsement of including local knowledge in the development of the economic model (Berman et al. 2004). Other research by Kruse et al. also strongly suggested the value of directly engaging local knowledge holders regarding subsistence activities. In their research, they found that inputs related to tourism, climate change, and oil and gas development were major factors that could influence subsistence activities beyond simple participation in wage economies (Kruse et al. 2004).

A recent quantification of subsistence activities for various subregions in the State of Alaska in 2012 was published by the state in 2014. For the Arctic, the researchers noted that 438 pounds of wild food was harvested per person, totaling over 11 million pounds for the region. It was estimated that this harvest accounted for 39 percent of all necessary calories per day. Quantifying the value of the subsistence harvest was noted as an estimate, but the state provided figures assuming a cost of \$4/lb and \$8/lb (Fall 2014). Other recent research efforts in the Arctic have explored the limits of societal adaptation to ecosystem changes (Adger et al. 2009), and the resilience of indigenous communities to changes in the cash economy, oil and gas development, and biological and management changes related to the annual caribou harvest (Martin 2015). One recent article explored the economic effects of a new industrial road on subsistence activities in north-central Alaska. The researchers found that the communities near to the proposed road were more involved in subsistence activities than those comparable communities already accessible by road by a measure of 1.8 to 2.5 times. It was projected through their zero inflated negative binomial models that the financial cost of lost subsistence resources resulting from the road would be between \$6,900 and \$10,500 per household with an assumed \$17.64/kg “replacement” cost (Guettabi et al. 2016).

As noted in the quantitative modelling literature, the accuracy of any model is highly dependent on the accuracy and validity of the inputs. The communities of the Arctic and their subsistence activities have been the subject of research for decades and quantitative and qualitative data have regularly been published. This includes the literature already cited, but also Chance (1987) and Stabler (1990), which provide early data on the activity patterns of Arctic community residents. Specific to the North Slope, Kruse also published the results of two community surveys that explored wage labor participation, household income, and changes in community demographics and household size. Kruse found that continued participation in the subsistence harvest held other benefits for participants beyond that of nutrition, including benefits to perceived quality of life (Kruse 1991). A study on whaling behavior on the North Slope also aimed to quantify the use of time by subsistence hunters, concluding that there is an inverse relationship between active subsistence harvesting and wage labor time, but also that traditional and economic incentives influence the allocation of time between subsistence activities and wage labor (Kerkvliet and Nebesky 1997).

A recent study directed by the Army Corps of Engineers in the community of Little Diomed, Alaska, had very similar goals to this project. The *Economic Value of Subsistence Activity* (ResourceEcon et al. 2011) report included a specific definition of subsistence that included cultural aspects and influences. The report included economic, social, cultural, and nutritional elements of subsistence in its valuation methods and ultimately decided upon a production cost methodology that quantified the amount of money invested in harvesting activities in cash and labor. The authors noted that this approach ignored a large share of social and cultural aspects of subsistence harvest value, but believed that the approach was theoretically defensible and could be updated and replicated across various communities. Their model included a range of inputs, including the hours used to make and maintain subsistence tools, the money used to purchase subsistence tools, the time and money used to travel to subsistence areas, money spent on fuel and food, subsistence pounds harvested, hours spent processing subsistence foods, and other variables. The authors then calculated the hours spent conducting the subsistence harvest (including preparation and post-harvest processing) and the amount of money spent directly on tools used in the subsistence harvest. Based upon an average wage rate of \$22.94 per hour, the authors calculated that the average value of subsistence harvests in the community of Little Diomed was \$17,100 per household, per year (\$8.04/lb using 2010 harvest rates). In the community of Wales, the estimated value per household was \$22,300 per household, per year (\$22.73/lb using 2010 harvest rates).

3 Economic Model of Subsistence

The economic model of subsistence harvesting for the community of Nuiqsut is generally focusing on market and subsistence economy trade-offs and complementarities at the household level. In this characterization, modern microeconomic principles are used to represent the complex set of behaviors found in subsistence economies. Principles being applied include the random utility maximization model of site choice (McFadden) and Becker's insights on household production and the allocation of time. The overarching goal is the development of a baseline model that adequately represents existing behaviors, values, and costs that can be subjected to counterfactual specifications to identify changes in behaviors and costs.

The random utility maximization (site choice) model will reveal optimal subsistence trip choices given that a subsistence trip is made. It will also indicate the average cost and productivity of subsistence activities given site characteristics. The household choice model is based on utility maximization given income and time constraints. It characterizes the optimum resource allocation decisions of subsistence households.

Available and collected data will be used to characterize the approximately 475 members of the Nuiqsut community. This information will represent households that will be the subject of the simulation modeling. The natural environment and its role in subsistence activities will be characterized based on a description of the aquatic and terrestrial resources of the North Slope that sustain the Nuiqsut community. This will include fish, wildlife, and plant resources as appropriate. It will be sufficient to support a characterization of how the environment relates to the productivity of subsistence hunting and gathering. This will be quantified through the identification of subsistence foods (various fish, wildlife, and plant resources), their sources (locations from the Nuiqsut community), and harvest methods and productivity by season.

Related behavioral information will include the costs of getting to each site and the amount of effort undertaken at each site. Combined with household level characterization and site control totals (i.e. total harvest) this will represent the total amount of subsistence activity. This will be supplemented with information on Nuiqsut residents' retention of harvest for their own use and distribution to other community members. The final important subsistence behavioral information relates to how subsistence foods are prepared in the household—particularly the amount of effort involved in subsistence food preparation.

In the household model of a mixed subsistence and wage economy, income is used for subsistence goods and market goods. Relevant market income information categories include employment and wage income and transfers (e.g., Alaska Permanent Fund Dividend, Social Security, and native corporation dividends). Additional important information includes allocation of income across durable goods, nondurable goods, and services including the inputs to subsistence activities and food preparation.

Using this information, system production is modeled as the transformation of inputs given the technologies of production, the constraint of time, and the goal of maximizing household welfare (utility). This includes the travel to sites, expenditure of effort, and the harvest productivity of each representative household. Results of optimization are the time for each household allocated to subsistence activities, the share of the harvest shared outside the hunter-gather households, and the time for each household allocated to market activities and the consumption of market goods and services. Differences between baseline and counterfactual conditions will indicate changes in behaviors and costs.

Figure 7 depicts the overarching structure being developed to evaluate the implications of changing conditions for Nuiqsut.

Figure 7. Model Architecture

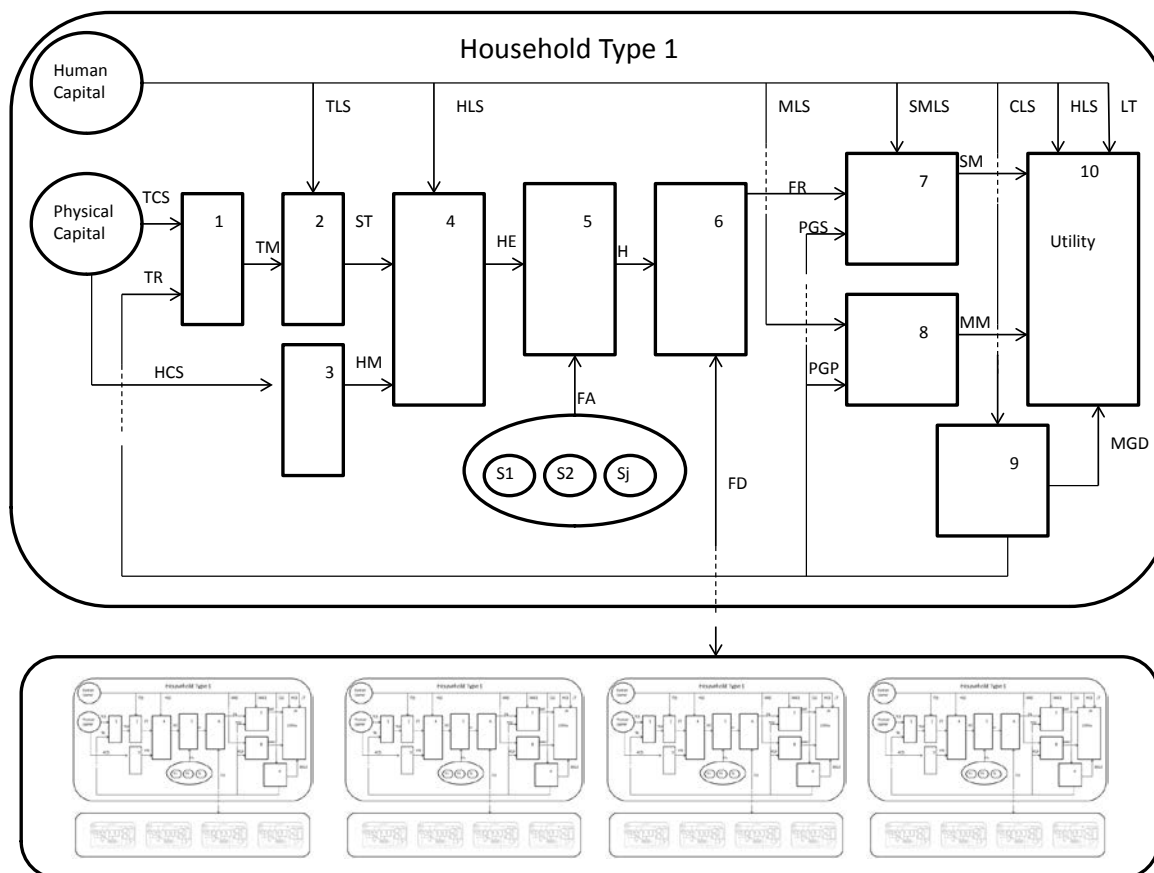


Table 2. Model Architecture Legend

Symbol	Description	Relationship within the Model Architecture
TLS	The household's time spent to transport self to a subsistence site	The self-transport to a subsistence site (2)
HLS	The household's time spent in an effort to secure subsistence resources	The on-site harvest of resources (4) and the personal enjoyment of subsistence activities (10)
MLS	The household's time spent to prepare and clean up from meals prepared primarily with market foods	The preparation of at home meals (8)
SMLS	The household's time spent to prepare and clean up from meals prepared primarily with subsistence foods	The preparation of at home meals (7)
CLS	The household's time spent working for wages in the market economy	The employment and wages received (not shown) in the commercial sector (9)
LT	The household's time spent in leisure/personal activities	Directly contributes to household utility (10)
TCS	The capital services provided by self-owned transport resources	An input to the production (1) of transport services
TR	The purchased material resources used to transport to site	An input to the production (1) of transport services

Symbol	Description	Relationship within the Model Architecture
TM	The combined transport capital services and materials used to transport to a site	The production of transport services (ST)
ST	The trip made to a site	Places the subsistence hunter on site (4)
HCS	Harvest gear capital services	An input to the production of harvest effort (4)
HR	The purchased materials used to harvest subsistence resources	An input to the production of harvest effort (4)
HM	The combined harvest gear capital services and materials used to harvest subsistence resources	The combined inputs to the production of harvest effort (4)
HE	The effort spent on-site to harvest subsistence resources	The combined application of harvest labor, capital, and materials (4)
FA	The availability of subsistence resources at a site	The natural productivity of the environment
H	The harvest of subsistence resources at a site	The result of applying effort to the environment (5)
FR	The share of the harvest retained by the harvesting household	An input to the production of subsistence-based meals (7)
FD	The share of the harvest shared with other households or received from them	A gift to other households or input to the production of subsistence-based meals (7)
PGS	The purchased ingredients used in subsistence-based meals	An input to the production of subsistence-based meals (7)
PGP	The purchased ingredients used in market-based meals	An input to the production of market-based meals (7)
SM	Subsistence-based meals	The result of the preparation of a subsistence-based meal (7)
MM	Market-based meals	The result of the preparation of a market-based meal (8)
MGD	Other market purchases	Items purchased by the household (except those covered above) that contribute to household welfare (10)

This figure depicts the entirety of activities and outcomes from the perspective of an individual household and its interaction with the environment and other households in the village. Physical capital represents the capital (e.g., skin boat, snowmobile) and material resources owned by the household. Environment represents the resources and systems that support subsistence communities. The 10 rectangles represent the household’s physical (1, 3, 4, 5, 6, 7, 8), spatial (2), or psychological (10) processes that transform inputs into outputs of value to the household plus the job sector (9) that absorbs time but provides wage income. The variables shown in the diagram and described in Table 2 are quantities (amount, weight, etc.). The arrows represent the direction of flows of resources from one process to another. In some cases, there is a reverse flow of dollars that is not shown here but is included in the model.

Although households may differ, the general structure depicted applies to all. This is illustrated by the example household (depicted in the upper box) interacting with the village (depicted in the lower box). The households in the lower box have similar processes to the detailed household and are included to represent interactions between households. As can be seen in the lower box, the village is composed of households following similar process and also interacting with the village. The source of this interaction is sharing (FD) which is a transfer of subsistence food among households (vertical arrow from 6 to village) and also serves as a source of utility (horizontal arrow from box 6 to utility). As depicted by circles/ovals in the figure, households are relying on human capital, physical capital, and the natural environment.

Considering human capital, residents use their time in subsistence travel (TLS), effort on-site (HLS), market labor services (MLS), preparing subsistence meals (SMLS), and leisure time (LT). Effort on-site (HLS) appears twice to indicate that it is an input to production and utility.

Considering other capital, households use gear (TCS) and other inputs (TR) to take subsistence trips. For example, a snowmachine is a fixed physical capital. Variable inputs that directly affect a trip cost are purchased from markets (9). In (1) these are combined to develop trip cost outlays (TM). These are combined with time getting to a site to develop the total trip cost in time and dollars (2). These individual trips become total trips per period of time (ST).

Once on-site, harvest gear (guns, traps, rods) are combined with time on-site to produce harvest (4). In the production function (5) the total amount of effort (HE) combines with the quality/productivity of the natural environment (in oval) to result in the total harvest of subsistence goods (H). The productivity of the natural environment is a function of the quality of individual sites (S_1, S_2, S_j) and households choose among them based on cost (travel time and expense) and productivity.

The sharing decision (6) results in food that is distributed (FD) and food that is retained (FR). Distributed food (FD) goes to other households and also results in an increase in utility for the giver. Retained food (FR) is used in subsistence meal preparation (7) which also requires the time input (SMLS) and may use complementary market goods (PGS). The preparation of market meals requires time (MLS) and purchase of market goods (PGP).

The productive activities of (7) result in subsistence meals (SM) which are an input to utility. The productive activities of (8) result in market meals (MM) which are an input to utility. Finally, the market production (9) represents the conversion of work time (CLS) into money which is spent on goods related to subsistence activities (TR), market produced meals and other market goods. Spending on TR is an input to productive activity which results in subsistence related utility and spending on market meal and other market goods also leads to utility.

The model will be formulated as a two-stage optimization. The first stage will be specified based on McFadden's random utility maximization model in the site-choice context. Key inputs will be time and costs required to reach sites, expected harvest by site and the amounts of trips to the site. This information will be used to construct a calibration-based (as opposed to econometrically estimated) model of site choice. The calibrated simulated choices (and their costs and productivity) from this model will be used to estimate baseline average cost per unit of relevant subsistence good across all sites.

The second stage will be based on Becker's household utility model wherein households choose how to allocate their time and money based upon a utility function and the relative costs and effort of activities. For Nuiqsut, households will choose how to allocate their time across leisure, work, and subsistence activities so as to maximize utility. This maximization is subject to constraints on available time and expenditure requirements (i.e., all time expenditures sum to calendar time, expenditures on goods are less than or equal to total income). This model will be created to be consistent with observed behaviors and values.

Counterfactual evaluation will allow understanding changes in utility, behaviors, and costs that accompany changes in inputs. The most important expected evaluation is change in site productivity. This will be evaluated by changing inputs to the first optimization stage to characterize optimal site choice under a change in site productivity. The change in average site productivity will be fed from this model of site choice to the household production model, at which point reallocations of time, changes in costs, and changes in utility will be observed.

4 Economic Model Inputs and Gap Analysis

4.1 Model Inputs and Data Gaps

This chapter presents the economic value of subsistence model inputs along with bibliographic information that identifies quantitative data that may be used to inform the model. Table 3, below, presents the draft inputs for the economic subsistence model. Overall, previously published literature related to the volume of subsistence harvests, the location of subsistence harvests, the annual timing of subsistence harvests, and the income earned and received by Nuiqsut residents were relatively well developed; in most cases, model inputs could be adequately filled with previously published data easily or with some simplifying assumptions (e.g., averaging community-wide estimates per the number of identified households). The reviewers found that recently published studies from the Alaska Department of Fish and Game, NSB, and the Bureau of Ocean Energy Management (including those funded by the oil and gas industry) contained the most relevant information.

Despite this review task, data gaps remain. The reviewers did not find substantial previously published information regarding the cost of subsistence harvesting tools (e.g., guns, ammunition, snowmobiles), costs associated with subsistence harvest travel, quantifications of existing household market spending on food, or easily quantified preferences for subsistence foods in a typical Nuiqsut diet. In those instances where some quantifying information was found, the data were specific to individual subsistence species (e.g., caribou, bowhead whale). Finally, some excellent research has been conducted in the community of Nuiqsut identifying the cultural relevance of subsistence activities, its role in Iñupiaq culture, and community perceptions regarding how recent industrial developments and weather variabilities have affected subsistence harvesting (e.g. Galginaitis 2014; EDAW 2008; SRBA 2016); however, these reports were generally qualitative in nature and did not include dollar values or other quantifications that could form inputs into the model.

Table 3 includes columns that identify the existing source from which data can be used, if available. The letters used to identify the source match the sources listed in Section 6, References. All references in the table have been included in a .zip file and were digitally transmitted with this report. Page number ranges are also provided when necessary. In some cases, data related to the model input could be found in multiple publications. In these cases, the reviewers found a clear trend that one dataset should be considered “primary” and would likely serve as the key piece of information for that input, based either on its recent publication, geographic specificity to the community of Nuiqsut, specific discussion of multiple subsistence resources, or a combination of these elements.

The table also includes a column that identifies issues with the referenced data that may need to be considered before its use in the model. These considerations include, but are not limited to:

- Data are related to a specific subsistence resource (e.g., bowhead whale, caribou, fish)
- Data are generalized across all subsistence resources and aggregated
- Data are over 10 years old
- Data show generalized harvest locations
- Data are at the NSB geographic level and not specific to Nuiqsut
- Data are at the generalized Arctic geographic level and not specific to Nuiqsut
- Data are not at a household level of detail

Finally, Table 3 also includes a color-coded column that provides a qualitative indication as to the adequacy of the data for the economic model. The legend for the colors is as follows:

- Existing data are adequate; no data gap
- Existing data are nearly adequate; minor assumptions may be required for use
- Existing data are not adequate; substantial assumptions may be required for use
- Existing data are not present; data gap exists

Table 3. Model Inputs and Identified Data Gaps

Input Name	Description	Source	Consideration	Data Adequacy
Senior males	Number of senior males household type Hi	[(Brown et al. 2016), p338]; [(U.S. Census Bureau 2017), p1, p3, p4, p6, p19]; [(State of Alaska 2017b), p6]; [(State of Alaska 2017a), p9-p10]; [(North Slope Borough 2016), p69, p230]	[(Brown et al. 2016), Data not at household level]; [(U.S. Census Bureau 2017), Data not at household level]; [(State of Alaska 2017a), Data not at household level]; [(North Slope Borough 2016), Data at NSB level, data not at household level]	
Adult males	Number of adult males household type Hi	[(Brown et al. 2016), p338]; [(U.S. Census Bureau 2017), p1, p3, p4, p6, p19]; [(State of Alaska 2017b), p6]; [(State of Alaska 2017a), p9-p10]; [(North Slope Borough 2016), p69, p230]	[(Brown et al. 2016), Data not at household level]; [(U.S. Census Bureau 2017), Data not at household level]; [(State of Alaska 2017a), Data not at household level]; [(North Slope Borough 2016), Data at NSB level, data not at household level]	
Child males	Number of child males household type Hi	[(Brown et al. 2016), p338]; [(U.S. Census Bureau 2017), p1, p3, p4, p6, p19]; [(State of Alaska 2017b), p6]; [(State of Alaska 2017a), p9-p10]; [(North Slope Borough 2016), p69, p230]	[(Brown et al. 2016), Data not at household level]; [(U.S. Census Bureau 2017), Data not at household level]; [(State of Alaska 2017a), Data not at household level]; [(North Slope Borough 2016), Data at NSB level, data not at household level]	
Senior females	Number of senior females household type Hi	[(Brown et al. 2016), p338]; [(U.S. Census Bureau 2017), p1, p3, p4, p6, p19]; [(State of Alaska 2017b), p6]; [(State of Alaska 2017a), p9-p10]; [(North Slope Borough 2016), p69, p230]	[(Brown et al. 2016), Data not at household level]; [(U.S. Census Bureau 2017), Data not at household level]; [(State of Alaska 2017a), Data not at household level]; [(North Slope Borough 2016), Data at NSB level, data not at household level]	
Adult females	Number of adult females household type Hi	[(Brown et al. 2016), p338]; [(U.S. Census Bureau 2017), p1, p3, p4, p6, p19]; [(State of Alaska 2017b), p6]; [(State of Alaska 2017a), p9-p10]; [(North Slope Borough 2016), p69, p230]	[(Brown et al. 2016), Data not at household level]; [(U.S. Census Bureau 2017), Data not at household level]; [(State of Alaska 2017a), Data not at household level]; [(North Slope Borough 2016), Data at NSB level, data not at household level]	

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Input Name	Description	Source	Consideration	Data Adequacy
Child females	Number of child females household type Hi	[(Brown et al. 2016), p338]; [(U.S. Census Bureau 2017), p1, p3, p4, p6, p19]; [(State of Alaska 2017b), p6]; [(State of Alaska 2017a), p9-p10]; [(North Slope Borough 2016), p69, p230]	[(Brown et al. 2016), Data not at household level]; [(U.S. Census Bureau 2017), Data not at household level]; [(State of Alaska 2017a), Data not at household level]; [(North Slope Borough 2016), Data at NSB level, data not at household level]	
Subsistence Meat Productivity ij	Amount of meat per hour at Site j by Household type i	[(SRBA 2010), p240-p337]		
Subsistence Fish Productivity ij	Amount of fish per hour at Site j by Household type i	[(SRBA 2010), p240-p337]; [(Carothers, Cotton, and Moerlein 2013), p13, p24]	[SRBA 2010, calculation by day and CPUE]; [(Carothers, Cotton, and Moerlein 2013), Data at NSB level]	
Subsistence Meat Effort ij	Amount of effort for meat at Site j by Household type i	[(Braem et al. 2011); p64, p65, p77-p81]; [(Brown et al. 2016); p351, p354, p356, p359, p362, p356, p367]; [(SRBA 2016) ² ; p30, p33, p37, p67, p74]; [(Brower and Hepa 1998), p32]	[(Braem et al. 2011), Data specific to caribou; data over 10 years old]; [(Brown et al. 2016), generalized harvest locations]; [(SRBA 2016), Caribou only]; [(Brower and Hepa 1998), Data not specific to resource type, data over 10 years old]	
Subsistence Fish Effort ij	Amount of effort for fish at Site j by Household type i	[(Brown et al. 2016); p351, p354, p356, p359, p362, p356, p367]; [(Seigle et al. 2016), p15, p22-p23, p25, p29-p30]	[(Brown et al. 2016), generalized harvest locations]; [(Seigle et al. 2016), Specific to Arctic cisco, Data not by household]	
Subsistence Meat Mode ij	Mode of accessing site j by Household type i when going for meat	[(SRBA 2016), p56, p59-p64]; [(SRBA 2010), p240-p337];	[(SRBA 2016), Caribou only]	
Subsistence Fish Mode ij	Mode of accessing site j by Household type i when going for fish	[(SRBA 2010), p240-p337];		
Subsistence Meat Time ij	Average time accessing Site j by Household type i for meat	[(SRBA 2016), p58]; [(SRBA 2010), p240-p337]	[(SRBA 2016), Caribou only]	
Subsistence Fish Time ij	Average time accessing Site j by Household type i for fish	[(SRBA 2010), p240-p337]; [(Seigle et al. 2016), p15, p22-p23, p25, p29-p30]	[(Seigle et al. 2016), Specific to Arctic cisco, Data not by household]	
Subsistence Meat Gear ij	Typical gear at Site j by Household type i for meat	[(SRBA 2010), p240-p337]; [(North Slope Borough 2015), p76, p92]		
Subsistence Fish Gear ij	Typical gear at Site j by Household type i for fish	[(SRBA 2010), p240-p337]; [(Fall and Utermohle 1995), p393-p398]; [(North Slope Borough 2015), p76, p92]	[(Fall and Utermohle 1995), Data not by site]	

² SRBA 2016 is year seven of a multiyear study. SRBA 2016 contains results from previous years and is in a similar format from year to year. For the purposes of simplicity, other SRBA citations in this series are not included in this table, but can be accessed if need be.

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Input Name	Description	Source	Consideration	Data Adequacy
Subsistence Meat Consumption i	Amount of subsistence meat consumed per year by Household type i	[(Braem et al. 2011), p54]; [(Brown et al. 2016), p342-346]; [(Fall 2014), p3]; [(Braund and Kruse 2009), p211, p240]; [(U.S. Bureau of Land Management 2005), p28-p29]; [(CSIS 2017)]; [(Fall and Utermohle 1995), p384-p386, p390-p392]; [(Bacon et al. 2009), p82-p99, p135]	[(Braem et al. 2011), Data specific to caribou]; [(Fall 2014), Generalized to Arctic, subsistence resources aggregated]; [(Braund and Kruse 2009), Over 10 years old]; [(U.S. Bureau of Land Management 2005), Over 10 years old]; [(CSIS 2017), Data over 10 years old, data specific to some species]; [(Fall and Utermohle 1995), Over 10 years old]; [(Bacon et al. 2009), Data over 10 years old]	
Subsistence Fish Consumption i	Amount of subsistence fish consumed per year by Household type i	[(Brown et al. 2016), p342-346]; [(Braund and Kruse 2009), p211, p240]; [(U.S. Bureau of Land Management 2005), p28-p29]; [(CSIS 2017)]; [(Fall and Utermohle 1995), p384-p386, p390-p392]; [(Bacon et al. 2009), p82-p83]	[(Braund and Kruse 2009), Over 10 years old]; [(U.S. Bureau of Land Management 2005), Over 10 years old]; [(CSIS 2017), Data over 10 years old, data specific to some species]; [(Fall and Utermohle 1995), Over 10 years old]; [(Bacon et al. 2009), Data over 10 years old]	
Market Meat Consumption i	Amount of market meat consumed per year by Household type i			
Market Fish Consumption i	Amount of market fish consumed per year by Household type i			
Non-Protein Consumption i	Amount of non-protein consumed per year by Household type i			
Subsistence Meat Shared i	Amount of subsistence meat shared (+/-) per year by Household type i with other households	[(Braem et al. 2011); p54]; [(Brown et al. 2016), p342-346]; [(Braund and Kruse 2009), p249]; [(SRBA 2016), p66]; [(U.S. Bureau of Land Management 2005), p28-p29]; [(CSIS 2017)]; [(Fall and Utermohle 1995), p387]; [(Bacon et al. 2009), p15]	[(Braem et al. 2011), Data specific to caribou]; [(Braund and Kruse 2009), Subsistence resources generalized, data over 10 years old]; [(SRBA 2016), Specific to caribou]; [(U.S. Bureau of Land Management 2005), Over 10 years old]; [(CSIS 2017), Data over 10 years old, data specific to some species]; [(Fall and Utermohle 1995), Over 10 years old]; [(Bacon et al. 2009), Data not specific to any subsistence resource, data at village level, data are over 10 years old]	
Subsistence Fish Shared i	Amount of subsistence fish shared (+/-) per year by Household type i with other households	[(Brown et al. 2016), p342-346]; [(U.S. Bureau of Land Management 2005), p28-p29]; [(CSIS 2017)]; [(Fall and Utermohle 1995), p387]	[(U.S. Bureau of Land Management 2005), Over 10 years old]; [(CSIS 2017), Data over 10 years old, data specific to some species]; [(Fall and Utermohle 1995), Over 10 years old]	

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Input Name	Description	Source	Consideration	Data Adequacy
Wage income	Amount of income from wages per year by Household type i	[(Brown et al. 2016); p331, p369]; [(U.S. Census Bureau 2017), p10-p11]; [(State of Alaska 2017a), p1-p2]; [(State of Alaska 2017b), p6]; [(North Slope Borough 2010), p16-p19]; [(North Slope Borough 2016), p106-p111]		
Wage effort	Amount of time spent obtaining wages per year by Household type i	[(Brown et al. 2016); p331, p371]; [(North Slope Borough 2010), p8-p11]; [(Turcotte-Seabury 2011), p133-p137, p143-p144]		
Investment income	Amount of income from investments per year by Household type i	[(Brown et al. 2016); p331, p369]; [(U.S. Census Bureau 2017), p10-p11]; [(North Slope Borough 2010), p15]		
Assistance income	Amount of income from assistance per year by Household type i	[(Brown et al. 2016); p331, p369]; [(U.S. Census Bureau 2017), p10-p11]; [(North Slope Borough 2010), p15]; [(North Slope Borough 2016), p106-p111]		
Entitlement income	Amount of income from entitlements per year by Household type i	[(Brown et al. 2016); p331, p369]; [(U.S. Census Bureau 2017), p10-p11]; [(North Slope Borough 2010), p15]; [(North Slope Borough 2015), p94-p95]; [(North Slope Borough 2016), p104, p106-p111]		
Market meat	Amount spent per year on market meat by Household type i			
Market fish	Amount spent per year on market fish by Household type i			
Market not protein	Amount spent per year on food that is not protein by Household type i			
Subsistence activity spending	Amount of spending on subsistence activities per year by Household type i	[(U.S. Bureau of Land Management 2005), p45]; [(North Slope Borough 2010), p38]	[(U.S. Bureau of Land Management 2005), Data over 10 years old]	
Work time	Amount of time working for wages per year by Household type i	[(Brown et al. 2016); p331, p371]; [(Kruse et al. 2008), p4]; [(North Slope Borough 2016), p230]	[(Kruse et al. 2008), Over 10 years old, Generalized to NSB]	
Subsistence time	Amount of time spent subsistence hunting/fishing per year by Household type i	[(SRBA 2010), p240-p337]		
Subsistence preparation time	Amount of time spent preparing subsistence food per year by Household type i			
Subsistence preference	Relative preference for time spent on subsistence activities by Household type i	[(Turcotte-Seabury 2011); p147]; [(Kruse et al. 2008), p11]	[(Turcotte-Seabury 2011), Not specific to Nuiqsut]; [(Kruse et al. 2008), Not specific to Nuiqsut]	

Input Name	Description	Source	Consideration	Data Adequacy
Subsistence maximum	Maximum amount of time desired to spend in subsistence activities per year by Household type i			
Work preference	Relative preference for time spent on work by Household type i	[(Turcotte-Seabury 2011); p137-p138, p146-p147]; [(Kruse et al. 2008), p11]	[(Turcotte-Seabury 2011), Not specific to Nuiqsut]; [(Kruse et al. 2008), Not specific to Nuiqsut]	
Leisure preference	Relative preference for time spent on leisure by Household type i			
Subsistence meat consumption preference	Relative preference for consuming subsistence meat by Household type i	[(Brown et al. 2016), p374, p377]		
Subsistence meat consumption maximum	Maximum amount of subsistence meat consumption per year desired by Household type i	[(Brown et al. 2016), p374, p377]		
Subsistence meat sharing preference	Relative preference for sharing subsistence meat Household type i			
Subsistence meat sharing maximum	Maximum amount of subsistence meat sharing per year desired by Household type i			
Subsistence fish consumption preference	Relative preference for consuming subsistence fish by Household type i	[(Brown et al. 2016), p374, p377]		
Subsistence fish consumption maximum	Maximum amount of subsistence fish consumption per year desired by Household type i	[(Brown et al. 2016), p374, p377]		
Subsistence fish sharing preference	Relative preference for sharing subsistence fish Household type i			
Subsistence fish sharing maximum	Maximum amount of subsistence fish sharing per year desired by Household type i			

4.2 Qualitative Data

The documents and datasets reviewed included a substantial amount of quantitative data that could be used as inputs for the economic model. However, numerous resources reviewed by the team included descriptions regarding the cultural and societal importance of subsistence harvesting for people on the North Slope generally, and the people of Nuiqsut, in particular. These resources included qualitative information about the spiritual and cultural relevance of subsistence harvesting, the role subsistence harvesting plays in cultural transmission, and how subsistence practices have been changed by recent changes in the region. While the model will be quantitative and econometric in nature, information

from these documents will be used to inform the interpretation of modelling results and provide context for community-wide communication of the research process and results. These qualitative data will also provide our community outreach team with additional historical and cultural context as they develop and implement recommendations to fill the data gaps identified in this section.

For example, Galginaitis (2014) specifically details the spiritual aspects of subsistence whaling among hunters in Nuiqsut, which touches on subsistence hunting on land, as well. EDAW 2008 includes a citation from a published Bureau of Ocean Energy Management report (Minerals Management Service 2002) that specifically notes:

In spite of the rising cash income, these traditions remain as central values and activities for all Iñupiat on the North Slope. Bowhead whale hunting strengthens family and community ties and the sense of a common Iñupiaq heritage, cultural, and way of life. In this way, whale-hunting activities provide strength, purpose, and unity in the face of rapid change.

Fishing studies, including a recent study by Carothers et al (Carothers, Cotton, and Moerlein 2013), also discuss the cultural dimensions related to subsistence harvesting, citing Stairs and Wenzel (1992) in their conclusion that an Inuit becomes a “whole” person by being a conduit between the environment and their community. Carothers found that the act of fishing in Utqiagvik and Nuiqsut provided a forum for cultural transmission during which traditional knowledge about weather, plants and animals, survival skills, Iñupiaq language, and traditional methods of hunting and gathering could be shared with younger generations. The opportunity for younger members of the community to share the fish they caught with members of the community also would instill a sense of accomplishment and pride. A recent survey on health issues in Nuiqsut also noted having access to subsistence foods and teaching the younger generation to hunt and fish were the top concerns for community leaders (North Slope Borough 2013).

The cultural importance of subsistence resource sharing was explored recently by Kofinas et al (2016) in a report that looked at the range of social structures and economic patterns that characterize Arctic communities, the flows of subsistence resources along social networks, and sources of resilience of households and communities to change. The concept of reciprocity is discussed, including the role it plays in keeping households connected and food secure. The report also notes the concept of “balanced reciprocity” within the Iñupiat culture where there is a belief that the animal willingly gave itself to the hunter, and now the hunter must share the animal with others.

In many cases, the discussions of cultural importance and qualitative changes in subsistence activities are included in discussions focused on recent changes to subsistence practices in recent years, affected by changing demographics, industrial development, climate changes, or a combination of other factors. For example, SRBA’s annual reports (e.g., SRBA 2016) on caribou harvesting in Nuiqsut include direct quotes from subsistence hunters focusing on changes in hunt success, frequency, timing, area, and caribou health. These reports also include interviewee perceptions regarding how industrial development in the region has affected the caribou hunt, including impacts from helicopter traffic, airplane traffic, manmade structures, regulations, and seismic activity. The hunters noted regularly throughout this series of reports of timing and effort changing due to a variety of outside factors.

EDAW (2008) specifically surveyed North Slope residents about the perceived impacts to bowhead whaling and other subsistence practices they had seen in recent years resulting from industrial development. The authors found that 59 percent of the surveyed whaling captains responded that oil and gas development had a neutral effect or responded that they “don’t know” about an impact to whaling practices. Galginaitis (2014) provided additional information from Nuiqsut whale hunters, stating generally that recent hunting activities had been not been seriously affected adversely from oil and gas activities; however, commercial shipping (not oil and gas related) had affected hunts in the late 2000s.

SRBA (2009) completed a recent report synthesizing interviews with 215 active harvesters across the North Slope, including harvesters in Nuiqsut, regarding their perceptions of how oil and gas development had affected subsistence harvests. The team found that impacts related to caribou and bowhead displacement were of the most concern, with Nuiqsut residents stating that caribou were more affected than whales or other marine mammals. Nuiqsut residents, overall, stated that the impacts they mostly frequently experienced were difficulty hunting, displacement of wildlife, and disruption of wildlife. Pipelines and the presence of facilities and vehicles were two of the most mentioned activities associated with impacts for Nuiqsut residents. Benefits from increased activity included corporate dividend benefits, employment benefits, and subsistence mitigation benefits.

5 Recommendations

The preceding analysis has identified some gaps in the available data needed by the model to provide an economic valuation of subsistence harvesting in the community of Nuiqsut. In general, data related to harvest rates, sharing rates, the locations of harvests, and wage/income information are present. However, other inputs, including more detailed information on the time spent harvesting, the costs associated with harvesting tools and equipment, and overall preferences for subsistence foods are not present in the data. The team recommends that these data gaps may be filled through a public outreach process that will include a public workshop with subsistence harvesters.

5.1 Development of the Workshop

The project team is recommending that one hunter workshop take place. The team will remain in Nuiqsut for a period of five days to complete the workshop and to conduct individual interviews with hunters and/or subsistence foragers in order to gather the required information. The team members will also be available to answer community questions or facilitate additional workshops during this time, if requested by the community.

The purpose of the workshop is to identify key issues vital to Nuiqsut residents on the economic impacts of subsistence. Nuiqsut residents practice a mixed subsistence and wage economy; therefore, a dual approach focusing on both aspects will be incorporated. We will look at subsistence as a holistic practice—one that incorporates all aspects of subsistence life in Nuiqsut to include whales, caribou, fish, birds, polar bears, seals, terrestrial mammals, and berry harvesting.

The methods to be used in the workshops will rely on the information obtained from the data gap study. Methods employed during the workshop will be developed in an effort to try to close those data gaps. Based on a preliminary analysis of the available data, the following have been identified as areas in which more information is needed:

- Amount of fish and meat procured per household
- Average cost of procuring fish per household
- Amount of time households spend in subsistence hunting and fishing activities per year
- Household preference for time spent on subsistence activities
- Household preference for time spent on work activities

Other key issues to be discussed concerning economy and subsistence may include the following: market goods used in subsistence activities, wages, household and exogenous income, market goods used for consumption, sharing practices, and how/if regional issues may affect subsistence harvest-related travel activities (e.g., erosion, pollution, and food safety).

5.2 Presentation to Nuiqsut Leadership

Once a workshop questionnaire and methods have been developed and vetted with CPAI and the Bureau of Land Management³, the project team proposes introducing the project, workshop design, and timeline to leadership groups in Nuiqsut in order to gain early input. This includes the Kuukpikmiut

³ CPAI may also potentially solicit comments from the NSB Wildlife Department

Subsistence Oversight Panel, Inc. (KSOP), and the Nuiqsut Tri-Lateral Leadership (the Tri-lateral includes the Native Village of Nuiqsut, the City of Nuiqsut and Kuukpik Corporation).

If all parties agree, the workshop questions and methods can be facilitated to the Nuiqsut leadership groups as a means to gain additional vetting of the process and to receive their feedback on the research design. Receiving their feedback and input at an early stage in the process will be beneficial to the research design development.

5.3 Local Support/Community Buy-In

The project team accompanied CPAI to Nuiqsut for their community meeting, from June 5-7, 2017. The purpose of the trip was to offer a summary of the study and upcoming workshop to the community. The presentation was to include a discussion of the research, its purpose, what community members can expect, and a general timeline. This would not only introduce the project to community members, but would also stimulate interest in participation in the upcoming workshop.

During the project team's stay in Nuiqsut, brief presentations about the project were given to the Nuiqsut City Council during their regularly scheduled meeting and to a few KSOP members during an informal lunch meeting. Both parties seemed receptive to the study. The KSOP members present at the meeting suggested that a community-wide survey may be a better option than the workshop to get data from a greater number of residents.

Although the community meeting was cancelled due to a memorial service, the project team was able to visit public buildings and offices throughout the village and distribute the project flyer and comment card to numerous entities. The project team visited the following offices: ASRC, Native Village of Nuiqsut, NSB, the Nuiqsut AC Store, post office, police station, Kuukpik Hotel, and other public posting boards around the village. When possible, the project team introduced the project one-on-one with Nuiqsut residents and provided extra copies of the flyer and comment cards for additional distribution. Overall, reception to the project and workshop seemed positive.

Public buy-in and support for the project and methods will help inform the community of the project prior to the workshop and may increase overall participation. The team will employ different techniques to improve public support and increase participation that go beyond meeting attendance. These techniques are designed to stimulate the interest of Nuiqsut residents of all ages and genders. The project team will coordinate these activities with CPAI's regular stakeholder engagement and village outreach activities.

Some proposed ways to improve participation include:

- **Photo contest:** Nuiqsut residents submit a photo of themselves or a family member participating in their favorite subsistence activity.
- **Short story/poem contest:** Working with the Nuiqsut Trapper School, students write a short story or poem that describes something about subsistence.
- **Drawing/artwork contest:** Working with the Nuiqsut Trapper School, this contest focuses on students creating an artistic depiction of a subsistence activity or subsistence resource.

Although the project team was unable to present the contest ideas to the Nuiqsut community due to the cancelled introductory meeting,⁴ they can still be distributed to the community at subsequent CPAI-sponsored meetings or through coordination with CPAI and the CPAI Company Village Outreach

⁴ CPAI rescheduled a community meeting for June 20, 2017, and presented information about this study.

coordinators. The community can then decide which contest idea they prefer (or perhaps suggest a different one completely). Contest submissions could be made on the project's website or social media page. Nuiqsut community members would be able to vote for their favorite. Once the contest is finished, whoever receives the most votes will win a gift certificate.

5.4 Facilitating the Workshop

After the project has been introduced to the leadership and community at large, the project team will begin planning and scheduling the community/hunter workshop. The workshop will likely consist of 15 to 20 select individuals in each session. This type of interview can provide the most detailed and comprehensive information. The workshops will be administered by project team members, including anthropologists from AES Alaska and Michael Galginaitis. The project team will use the ASRC Village Resource Representative in Nuiqsut and the CPAI Company Village Outreach as much as possible in order to identify subsistence users as potential participants.

Participants will not be asked to provide personal or identifying information during the interviews in order to keep responses confidential. Volunteers will be asked to sign an informed consent form that explains the purpose of the study; what they will be asked to do as part of this study; the time required in participating; any risks and benefits of participation, a discussion of incentive or compensation; a note that volunteers' identities will be kept confidential; and acknowledgement that participation is voluntary and volunteers can withdraw at any time. The form will also include the name and phone number of the project manager to contact if questions arise.

Information presented in the workshops will be provided in both English and Iñupiaq. In addition, the project team suggests employing an Iñupiaq translator to accompany researchers in the event that a participant requires further instruction in Iñupiaq. Since this type of interview is time consuming for participants, each volunteer will be compensated for his/her time and effort with a stipend of \$100.

The scheduling and timing of workshops will be crucial in ensuring that the maximum number of volunteers can participate. Conflicts with subsistence activities, community activities, conferences, workshops, and other activities will be avoided or minimized. For example, village councils and corporations usually have monthly meetings, while communities have weekly church and bingo nights. The workshop schedule will be publicized as much as possible, through use of the ASRC Village Resource Representative in Nuiqsut, the CPAI Company Village Outreach coordinator, and other local outreach. Ideas include creating forums on social media or websites specific to this project in which schedules, timelines, and project descriptions can be advertised.

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