# Arctic Marine Subsistence Use Mapping: Tools for Communities

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*Summary*

Identifying marine areas of significance for Arctic communities is crucial for preventing future conflicts between coastal communities and marine-based industries. The Arctic Marine Shipping Assessment 2009 Report recommends that states conduct surveys on Arctic marine use by indigenous communities to help assess impacts from Arctic shipping activities. Arctic indigenous use mapping practices employed to date include a range of practices used in mapping the indigenous use of Arctic marine resources. Techniques employed in both the terrestrial and marine context can inform a methodology developed specifically for marine use mapping.

The objective of this Article is to provide a broad overview of Arctic indigenous use mapping practices employed to date and to identify a range of practices used in mapping the indigenous use of Arctic marine resources in order to provide Arctic communities with the information they need to map their use of Arctic waters. Although a number of studies examine the methodology of subsistence use mapping in the Arctic, most focus on terrestrial use mapping and do not specifically address the marine environment.[1] Thus, a closer look at methodologies that work in the marine environment is needed. In addition, the choices for how a community maps its use will depend on the purpose for which the maps are created and upon the preferences and resources of each particular community. Thus, a full range of options should be presented. Finally, regardless of the options selected, a community will want to ensure that its maps are appropriately created for their intended use. Thus, it is important to ensure that the maps meet minimum requirements tailored to their intended purpose. This Article begins with an overview of techniques employed in both the terrestrial and marine context that can inform the choices available to communities that want to map their use of the marine environment. The Article then examines specific examples of Arctic marine use mapping in order to provide a baseline understanding of options for creating Arctic indigenous marine use maps.

Identifying marine areas of significance for Arctic communities is crucial for preventing future conflicts between coastal communities and marine-based industries. The Arctic Marine Shipping Assessment (AMSA) 2009 Report identified the need for "regional analyses of traditional marine use patterns (spatial and seasonal) for application in the development of strategies and measures to reduce potential conflicts and impacts of multiple users of arctic waterways."[2] AMSA recommendation IIA provides, "the Arctic States should consider conducting surveys on Arctic marine use by indigenous communities where gaps are identified to collect information for establishing up-to-date baseline data to assess impacts from Arctic shipping

1. *See, e.g.*, Linda J. Ellanna et al., *Subsistence Mapping: An Evaluation and Methodological Guidelines*, Alaska Department of Fish and Game, Department of Subsistence, Tech. Paper No. 125 (1985); Terry N. Tobias, *Living Proof: The Essential Data-Collection Guide for Indigenous Use-and-Occupancy Map Surveys*, Ecotrust Canada, Vancouver (2009); Mike Robinson, *Mapping How We Use Our Land Using Participatory Action Research*, Arctic Institute of North America, Calgary, AB (1994); Terry Garvin et al., A Guide to Conducting a Traditional Knowledge and Land-Use Study (Edmonton: Northern Forestry Centre 2001); Jamie Honda-McNeil, *Best Practices Handbook for Traditional Use Studies*, Alberta Aboriginal Affairs and Northern Development and Denise Parsons, Alberta Department of Energy (2003).
2. Arctic Council, Arctic Marine Shipping Assessment 2009 Report 132 (2009) [hereinafter AMSA].

activities."[3] The purpose of this Article is to provide information that may inform the development of a process for mapping Arctic indigenous marine use.

One of the primary methodologies for mapping traditional use is the map biography process, where interviewers ask knowledgeable community members about their subsistence use, and mark this information onto base maps.[4] This Article will focus on the map biography process, but will also discuss examples of other methodologies that have been employed to document indigenous use.

In addition to assessing the current state of knowledge for indigenous marine use mapping, the aim of this Article is to examine existing indigenous use mapping methodologies with two particular goals in mind. The first goal is to support the ability for Arctic communities to create their own indigenous use maps. The second goal is to highlight methodologies that may strengthen a community's ability to successfully influence government management decisions.

Because indigenous use maps often contain sensitive information and are frequently created to deal with local issues, communities should have control over the creation, ownership, and use of these maps. Historically, one of the ways that community members have gained greater power over the design, collection, analysis, and control of the information from the study was through "participatory action research," which involves the direct participation of community members in all phases of the study.[5] Community-based mapping began to incorporate the use of computerized mapping techniques as they were developed, including data management, geographic information system (GIS), and global positioning system (GPS), and these methodologies are often referred to as participatory GIS or PGIS.[6]

However, most of these projects involve at least some participation by outside researchers or consultants, who assist with defining the methodology to be employed and with organizing and managing data and digitizing the information. Similarly, most handbooks designed to guide communities through a mapmaking process do not provide sufficiently detailed guidance or materials to enable a community to conduct a mapping project without at least some help from outside researchers or consultants, and in fact, many of the handbooks include guidance on how a community can select a consultant or research institution for assistance with its mapping project.

As indigenous communities exert increasing control over the mapping process, there is a risk that the information generated will not be viewed by decisionmakers as credible. One concern is that information coming from indigenous communities will not be viewed as scientifically justifiable. Another concern is that maps created by indigenous communities will be viewed as biased, because the community may stand to gain by characterizing their use in a particular way. This report identifies various aspects of indigenous marine use mapping that can increase the likelihood that the maps will be successful in influencing management decisions. Camilla Brattland notes that three factors playing a role in success are credibility (based on a scientific process), legitimacy (included the appropriate people and input), and saliency (relevant to the decisionmaking process at issue).[7] However, the outcome of government management decisions is influenced by a number of factors, many of which do not relate to the mapmaking process. Often, whether or not an indigenous use map is influential in a government management decision will depend on the interests of the people involved and on the politics of the situation. However, as Brattland points out, the same is also true in the role of scientific knowledge in government decisionmaking.[8] Brattland finds that fishers' ecological knowledge has a greater likelihood of acceptance if it fulfills different social groups' criteria of social justice and if it meets the most relevant management goals. The same is likely true for maps.

Various factors in the mapping process can help to support the successful use of the maps in influencing government decisions. As Karim-Aly Kassam points out: "Validity is achieved by practice, through the lived experiences and accumulated knowledge of the indigenous peoples who participate in the creation of the maps."[9] In addition, the very process of documenting traditional knowledge and indigenous land use lends credibility to the information it reflects.[10] A rigorous survey method and a report documenting this methodology will also provide credibility.

One important part of the survey methodology in this regard is the selection of the study population, which should be representative of the community's subsistence use. Other important aspects of the survey methodology that influence its credibility are the design of the questionnaire, how the interviews are conducted, and how the information is documented, managed, and presented. A rigorous methodology that is carefully documented will not only improve the credibility of the maps, but it will also improve their usefulness, especially when the intention is to compare indigenous use over a period of time. For example, the state of Alaska has been collecting subsistence use data for the past 50 years. However, most early survey efforts were not systematic, the population sizes and sampling rates were not recorded, and the data analysis methods were not published. Therefore, it is not possible to compare the information from these earlier surveys to more recent surveys.[11]

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3. *Id.* at 6.
4. Tobias, *supra* note 1.
5. Garvin et al., *supra* note 1, at 4.
6. Mac Chapin et al., *Mapping Indigenous Lands*, 34 Ann. Rev. Anthropology 619-38, 623 (2005).
7. Camilla Brattland, *Proving Fishers Right: Effects of the Integration of Experience-Based Knowledge in Ecosystem-Based Management*, Acta Borealia: A Nordic J. Circumpolar Societies 4 (2013).
8. *Id.* at 16.
9. Karim-Aly S. Kassam, Biocultural Diversity and Indigenous Ways of Knowing: Human Ecology in the Arctic 198 (Univ. of Calgary Press 2009).
10. Brattland, *supra* note 7, at 12.
11. James S. Magdanz et al., *Subsistence Harvests in Northwest Alaska, Kivalina and Noatak During 2007*, Alaska Department of Fish and Game, Technical

After the initial maps are created, their credibility can be strengthened by verifying the information they contain. Verification can occur in a variety of ways that are discussed in more detail below.

## I. Indigenous Use Mapping

### A. *The Purpose of Arctic Indigenous Use Mapping*

Before conducting a mapping exercise, the community usually identifies the purpose and goals of the project. It is helpful to identify the specific purpose for which the maps will be used because this will shape the particular methodology that is chosen and the presentation (in the form of maps and associated data) of the information that is collected.

Arctic indigenous use maps have been created for a variety of purposes. One purpose has been to define indigenous rights to use or occupy certain places. For example, during the 1970s, land use mapping studies in the Arctic were conducted for comprehensive land-claim settlements in Canada and the United States, such as the Inuit Land Use and Occupancy Project of 1976, used to resolve Canadian Inuit land claims.[12] In the United States, mapping was similarly conducted to resolve land claims and to determine eligibility for subsistence preferences.[13] More recently, the Sami have created marine use maps to document traditional rights to fish in certain marine areas.[14]

Indigenous use maps have also been produced to address potentially conflicting land/water and resource uses.[15] For instance, the Bering Sea Sub-Network (BSSN) has created maps to identify existing or potential conflicting marine uses and to work toward cooperative resolution of these conflicts.[16]

Similarly, maps have been created to establish baseline data and to support social and environmental impact assessments for specific projects, such as the numerous terrestrial and marine subsistence use maps in the U.S. Arctic that have been generated to assist the federal government in assessing potential impacts from development activities.[17]

Arctic indigenous use maps have also been created in order to strengthen the development of indigenous organizations and to support the co-management of subsistence resources between these groups and government resource managers. In this way, the question of indigenous land use rights has become broader than the question of land title and legal access to resources, and includes political rights such as the right to self-determination.[18] For example, a project to map Russian Sami reindeer herder land use on the Kola Peninsula was designed to support co-management on the Kola Peninsula and to introduce Russia to participatory action research.[19] The Sami shared the maps with the Russian mayor of the town of Lovozero, on the Kola. Although he was not Sami and did not participate in the production of the maps, he supported their authenticity and value in a meeting with the governor of the capital of the region, Murmansk. Soon thereafter, a gold mine was proposed in the area, which would have threatened the reindeer grounds. The maps were used to illustrate the potential impacts of the mine to the environment and the livelihoods of the people in the area, and the mining company withdrew its plans.[20] Kassam observes, "the map alone is not sufficient. It can serve as a catalyst as long as the indigenous community has the basic organizational infrastructure and institutions that can enable the production of the maps and the realization of its sociopolitical potential."[21]

Another project mapping marine mammal presence and harvest along the coast of eastern Russia had as one of its goals to strengthen the development of nonprofit organizations managing marine mammal hunts in eastern Russia.[22] As discussed in more detail below, the information collected helped to create a report substantiating the need of indigenous residents of Chukotka for a bowhead whale quota from the International Whaling Commission (IWC), and in 1998, the Chukotka Natives received a quota of five bowhead whales.

In Norwegian waters, much of the recent research on Norwegian Sami use of the marine environment developed as a result the co-management role of the Sami Parliament in fisheries management.[23] Another purpose for creating indigenous use maps is to document and preserve traditional knowledge.[24] It is important for a community to consider the purpose for which its maps will be used and to select methodologies that will ensure its maps are designed with the outcome in mind.

Paper No. 354 (2010).

12. Milton Freeman, *Inuit Land Use and Occupancy Project*, Department of Indian and Northern Affairs (1976).
13. Magdanz et al., *supra* note 11, at 3-4.
14. Camilla Brattland, *Mapping Rights in Coastal Sami Seascapes*, 1 Arctic Rev. L. & Pol. 28-53 (2010).
15. Chapin et al., *supra* note 6, at 624.
16. Maryann Fidel et al., *Subsistence Density Mapping Brings Practical Value to Decision Making*, *in* Fishing People of the North: Cultures, Economies, and Management Responding to Change (C. Carothers et al. eds., 2012).
17. *See, e.g.*, S.R. Braund & Associates (SRB&A), *Subsistence Mapping of Nuiqsut, Kaktovik, and Barrow*, MMS OCS Study No. 2009-003 (2010); Magdanz et al., *supra* note 11.
18. Kerry Abel & Jean Friesen, Original Resource Use in Canada: Historical and Legal Aspects (Univ. of Manitoba Press 1991).
19. Mike Robinson & Karim-Aly Kassam, *Sami Potatoes, Living With Reindeer and Perestroika*, Arctic Institute of North America, Calgary (1998).
20. Kassam, *supra* note 9, at 214.
21. *Id.*
22. Ludmilla Ainana & Mikhail Zelensky, Preservation and Development of the Subsistence Lifestyle and the Traditional Use of Natural Resources by Native People (Eskimo and Chukchi) in Several Coastal Communities (Inchoun, Uelen, Lavrentiya, Lorino, Yanrakynnot, Novoye Chaplino, Sireniki, Nunligran, Enmelen) of Chukotka in the Russian Far East During 2000 (2000).
23. Camilla Brattland, Making Sami Seascapes Matter: Ethno-Ecological Governance in Coastal Norway (2012) (dissertation for the degree of Philosophiae Doctor, Univ. of Tromsø) (on file with author).
24. *See, e.g.*, Inuit Sea Ice Use and Occupancy Project (ISIUOP), https://gcrc.carleton.ca/confluence/display/ISIUOP/Inuit+Sea+Ice+Use+and+Occupancy+Project+%28ISIUOP%29; Kassam, *supra* note 9, at 218.

### B. Planning an Indigenous Use Study

Once a community identifies a need for mapping, it will typically develop a strategic plan, also referred to as a term of reference or a study framework. This plan outlines the methodology to be used, identifies how the project will be managed, and provides a budget. This document can be used to communicate the project to potential funders and consultants. Before the research begins, the community might also address the question of how the information generated from the study will be used. An information-sharing protocol can outline the community's agreement on how the information will be owned, controlled, and shared.

Developing community support for the mapping process, obtaining and administering funds, and managing a relationship with the funders are important components of the process, but are not further discussed in this Article. Rather, the issues discussed below focus more specifically on the methodologies employed to create indigenous use maps.

### C. Structuring Leadership, Responsibility, and Oversight for the Project

Early in the process, a community must identify a project manager or research director who will be the primary person in charge of the project and will have team members who help carry out the study. The project manager may be responsible for managing the project budget, facilitating the community's participation, and communicating with the community and funders about progress of the study. Often, outside contractors or researchers have filled this role, with the assistance of a community coordinator. Sometimes, the role of the contractor includes transferring the skills needed to manage the study to someone from the community. Similarly, a consultant might be hired to provide technical advice on issues such as how to digitize and manage the information from the project.

Communities that are engaged in a mapping exercise often create a community advisory committee. The role of a community advisory committee is particularly important if consultants or outside researchers are involved, in order to ensure local oversight and control over the project and to facilitate community participation. However, some communities find that an advisory committee is unnecessary.

### D. Identifying the Study Area

A study area may cover an area of particular concern or the entire traditional use area. Study areas are as small as a few square miles or extend for thousands of square miles. The study area might be chosen because it encompasses the majority indigenous users. For example, the Russian Sami project created two maps, one for each of the areas surrounding two villages selected on the Kola Peninsula, where most Sami inhabitants were located.[25] A study area may also be selected because it is considered representative of a larger area. For example, a study of Norwegian Sami land use focused on the area around the village of Deanodat, at the head of the Tana Fjord, because the Sami communities in this area represented both migrating reindeer herding communities and a sedentary coastal Sami community and was considered to be representative of the region as a whole.[26]

### E. Designing the Interview Process

When using the map biography process, the interview is the heart of the study. However, there are a number of steps that must be taken before the interview process begins.

First, the interviewers must be identified. The interviewers are often community members who are respected and trusted by the community and who have good knowledge of their people, language, and subsistence use. The interviewers are often trained by a consultant in how to conduct the interview. However, in some cases, an interviewer well-known to the community may not feel comfortable asking, or documenting the answers to, questions for which the interviewer already knows the answer. In this case, an interviewer from outside the community may be more appropriate.

The study population is then selected. There are a variety of ways to ensure that the information from the study is representative of the overall community, which strengthens the credibility of the maps. One option is to identify people who are considered especially knowledgeable in the community. For example, in the Russian Sami mapping project, more than 80 elders and herders identified as experts were interviewed.[27] Another way to identify a study population is to create an initial list of experts and then ask those experts to identify others who are also knowledgeable, known as snowball sampling. This larger list can be prioritized according to those with most hunting experience and knowledge, as well as those who are most often mentioned by others as experts.[28] Yet another way is to interview elders and active hunters until a "saturation point" is reached, where no interviewees have any new information to add to what has already been collected.[29]

If one of the purposes of the study is to measure a community's reliance on subsistence use, it will be important to interview more than just the most active hunters. One study showed that the most active hunters in Wainwright accounted for 69% of the community's total subsistence harvest over a two-year period. Thus, 31% of the harvest came from less-active and occasional hunters.[30] Much of

25. Robinson & Kassam, *supra* note 19.
26. Stine Barlindhaug, *Mapping Complexity: Archaeological Sites and Historical Land Use Extend in a Sami Community in Arctic Norway*, Fennoscandia Archaeologica XXIX (2012).
27. Robinson & Kassam, *supra* note 19, 1998.
28. SRB&A, *supra* note 17, at 13.
29. Brattland, *supra* note 23, at 12.
30. SRB&A and Institute of Social and Economic Research (ISER), *North Slope Subsistence Study—Wainwright 1988-1989*, prepared by S.R. Braund et

the subsistence research conducted by the Alaska Department of Fish and Game (ADF&G) is quantitative, documenting the amount of subsistence resources harvested by a community. In small communities, the researchers aim to get a complete census of each household. In larger communities, random samples are used to estimate the community's use.[31]

Interviews are conducted with the help of supplies, including base maps or overlays, writing equipment, and audio or video recorders. Base maps with scales of 1:50,000 (for smaller areas) to 1:250,000 (for larger areas) are most commonly used for indigenous use mapping.

Information can be noted on the maps in a variety of ways. One way is to create icons of cultural sites and of different species and mass-produce these icons on plastic film with adhesive backing. The interviewee places these icons directly on the map during the interview process.[32] Another way is to document spatial information provided in the interview on the map as points, polygons, or lines.[33] Although Terry Tobias recommends that the interviewers document the information on the map to ensure consistency, others have found that it works to have the community members themselves draw on the maps.[34] An alternative to the map biography process is the use of observers, such as subsistence resource users, who document information they observe directly onto a map.[35] Another alternative is to provide subsistence users with GPS units, where they document information in the course of their activities.[36]

### F. Determining What Information Is Collected

The interview will usually be based on a questionnaire that was created for the project, which will guide what information is collected in the interview process. The research questions and the format of the survey should be designed according to the specific purpose for which the maps will be created, in order to ensure the maps are salient. Involving the decisionmakers for whom the map is intended to influence in the design of the questionnaire may help to ensure the relevance of the information generated through the mapping process.[37]

Some handbooks provide suggested lists of species, activities, and landmarks that might be identified.[38] Another approach has been to identify indigenous place names as indicators of indigenous use.[39] In order to examine how management decisions affect specific fishing communities, another researcher identified separate communities based on their port and the fishing gear they used, in order to identify the particular areas these communities used.[40]

Sometimes, the information that is collected is divided according to meaningful time periods in the community. For example, for the village of Jona on the Kola Peninsula, the Russian Sami project mapped reindeer herding practices over three eras: pre-1930, when extended Sami families practiced private reindeer herd ownership; the Stalin period, 1930-1974, when collectivization and state ownership occurred; and perestroika, 1985-present, when collective farms broke down and Sami asserted private ownership again.

Especially in the Arctic, mapping resource use according to seasons is often important.[41]

An important part of ensuring a rigorous methodology (and therefore credible maps) is to create conventions for conducting the interview, including the coding and documenting of information. Tobias recommends creating interview scripts and a data-collection manual that describes conventions for how the interview is conducted and how the data is coded.[42] For example, one convention might direct whether the interviewer or interviewee will mark information on the map, and another convention might guide the symbols, colors, or text to be used when marking the maps. Codes can be created for various types of information gathered during the interview in order to categorize the information and facilitate its translation into GIS. Jessica Jelacic, for example, created a six-digit code system comprised of two-digit fields describing an increasing level of detail.[43] The researchers reviewed video recordings of the interviews, noting the time stamp for each piece of information conveyed in the interview, assigning a six-digit code, and designating whether the information was geographically specific and whether it was described as a point, line, or polygon. After this, each interview logging sheet was combined into a master sheet that contained all the information from every video, from which the GIS dataset was created.[44]

A wide range of choices thus exists in determining what information to collect and how to collect it. Regardless of the choices selected, it is essential that the method for collecting and documenting the information is itself documented. This methodology report provides a backbone of credibility to the process and therefore to the final product.

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al., U.S. Department of the Interior, Minerals Management Service, Alaska OCS Region Social and Economic Studies Technical Report No. 147 (MMS 91-0073) 182 (1993).

31. Magdanz et al., *supra* note 11, at 8.
32. *See, e.g.*, Robinson, *supra* note 1; Robinson & Kassam, *supra* note 19.
33. *See, e.g.*, Tobias, *supra* note 1; Barlindhaug, *supra* note 26.
34. *See, e.g.*, Barlindhaug, *supra* note 26.
35. *See, e.g.*, Ainana & Zelensky, *supra* note 22.
36. *See, e.g.*, Michael Galginaitis, *Final Report, Annual Assessment of Subsistence Bowhead Whaling Near Cross Island 2001-2007*, prepared by Applied Sociocultural Research for USDOI, MMS (2009); *see also* ISIUOP, *supra* note 24.
37. Brattland, *supra* note 7, at 4.
38. *See, e.g.*, Tobias, *supra* note 1, Robinson, *supra* note 1; Garvin et al., *supra* note 1.
39. *See* Brattland, *supra* note 14.
40. Kevin St. Martin, *Mapping Community Use of Fisheries Resources in the U.S. Northeast*, 4:1 J. Maps 38-49 (2008).
41. Barlindhaug, *supra* note 26, at 116; SRB&A, *supra* note 17, at 27.
42. *See* Tobias, *supra* note 1.
43. Jessica Jelacic, The Development of an Indigenous Knowledge Participatory GIS for an Iñupiaq Community, North Slope, Alaska (May 19, 2010).
44. *Id.*

### G. *Verification*

Verification of the information collected in a map biography process usually occurs in two ways: through community mapping sessions and through field checking. During community mapping sessions, the community reviews the maps created in the interview process and provides feedback on their accuracy. The mapping process may be continued in the community meetings by adding additional details.[45]

During a field check, community members are taken to a location marked on an interview map and a GPS coordinate is taken. In the Arctic, where little infrastructure exists, field verifications can be very expensive. However, in addition to getting a precise GIS location for certain features, a visit to the site with the interviewee can help elicit additional information.[46]

Verification helps to strengthen the legitimacy of the maps. In addition, audio or video recordings that are indexed and linked to features on the map provide traceability of the information provided on the maps, improving the credibility of the map.

Conducting scientific studies to verify indigenous observations can also add credibility. For example, when the government of Norway created local marine fishing area maps, an additional scientific study confirmed the presence of spawning grounds identified by interviews with fishers.[47]

### H. *Information Management and Digitalization of Maps*

After the interviews are conducted, the information collected must be entered into a database. If the interview was recorded, the recordings must be transcribed and coded as well, and entered into a database. Many subsistence use projects use a Microsoft Access database because of its compatibility with ESRI's ArcGIS.[48]

Spatial data collected during interviews are often digitized (converted into digital form) through ArcGIS software developed by ESRI,[49] although some projects have used open-source GIS software.[50] This allows for the information given during the interview to be connected to the spatial locations drawn on the map. The interview data can be entered into traditional data-management software, such as SPSS, Excel, or Access, then joined to the spatial data using a unique identifier, or it can be entered directly into the GIS attribute table. Respondents' drawn locations can then be portrayed by selected attributes, for example all harvest locations for spotted seal, or all harvests that occurred during March. Any data collected during the interview process can be selected and used to create a map.

In Russia, it has been particularly difficult for researchers to create digitized maps, due to government security concerns. As the U.S. State Department notes,

> in general, mapping and natural resource data collection activities associated with normal commercial and scientific collaboration may result in seizure of the associated equipment and/or arrest. The penalty for using a GPS device in a manner which is determined to compromise Russian national security can be a prison term of ten to twenty years.[51]

This is perhaps due to a government view that geospatial information is a fundamental part of military defense and security.

Depending on what the maps will be used for, the community will also have to decide how the final maps will be designed. Indigenous use maps can show "extensivity" or "intensivity."[52] An extensivity map shows the geographic extent of subsistence use. They often depict large areas that communities have used for the harvest of a particular resource. Extensivity maps are better at protecting the confidentiality of respondents and communities, as all use areas are combined and depicted in one color. An intensivity map shows variations among subsistence use areas according to how much they are used. Intensivity can be shown through overlapping polygons where shading can show varying degrees of overlap. Intensivity can also be shown on hodgepodge maps, where different symbols denote harvest sites for different species. Finally, intensivity can be shown in density mapping, where colors are used to define the relative use of an area as compared to other areas. Intensivity maps are generally preferred for use in decisionmaking, as they allow decisionmakers to identify areas of more and less potential overlap of conflicting uses.

It is important that the scope of the map is clearly stated. Often, the assumption with these maps is that if the entire area is "protected," then communities will have access to sufficient resources. Yet, harvest areas alone do not necessarily represent the entire area necessary to support the particular resource or harvesting activity. For example, biologically productive areas, such as salmon spawning areas, may be extremely important for subsistence, but they may not be included in the maps. Similarly, intensivity maps display areas that are more heavily used, but do not capture other measures of value, such as areas with particularly high cultural value, or areas relied upon by certain hunters.[53]

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45. Barlindhaug, *supra* note 26, at 108.
46. Barlindhaug, *supra* note 26, at 110.
47. Brattland, *supra* note 7, at 9.
48. *See, e.g.*, SB&A 2010; Barlindhaug, *supra* note 26.
49. *See, e.g.*, Barlindhaug, *supra* note 26; SRB&A, *supra* note 17; Jelacic, *supra* note 43.
50. *See, e.g.*, ISIUOP, *supra* note 24.
51. U.S. Department of State, Russian Federation: Country Specific Information http://travel.state.gov/travel/cis_pa_tw/cis/cis_1006.html.
52. *See* Tobias, *supra* note 1.
53. Henry P. Huntington et al., *Mapping Human Interaction With the Bering Sea Ecosystem: Comparing Seasonal Use Areas, Lifetime Use Areas, and "Calorie-Sheds,"* 94 Deep-Sea Research II 292 (2013).

## II. Examples of Arctic Indigenous Marine Use Mapping

### A. *Northern and Eastern Russia*

#### 1. Coastal Communities of Chukotka

The "Preservation and Development of the Subsistence Lifestyle and the Traditional Use of Natural Resources by Native People in Several Coastal Communities of Chukotka in the Russian Far East During 2000"[54] was a joint project between the Yupik Eskimo Society, the Naukan Production Cooperative, the North Slope Borough (NSB), and the U.S. National Park Service that occurred between 1997 and 2000. This project built on early work conducted through a cooperative agreement with the NSB to study the distribution and migration of bowhead whales, conducted during 1992-1996.

The purpose of the project was to promote mutual understanding between the indigenous people living on both sides of the Bering Strait sharing the same natural resources, and to make a more detailed study of these resources and their traditional subsistence use. The project included a number of specific objectives, such as documenting the importance of marine mammals to the Native people by documenting harvest, distribution, and utilization by a selected group of hunters and identifying Chukotka coastal areas that are heavily used by marine mammals and therefore of importance to the indigenous people. Another objective was to establish better contact and build relations between governmental and nongovernmental organizations (through the documentation of marine mammal hunting for use in the international management of marine mammals).

Nineteen hunter-observers participated in the project, about one per community. The hunters were selected based on their experience observing marine mammals and prior experience working on earlier research projects.

The study covered the coastal area of Chukotka Peninsula. Most of the observations were conducted within 10-25 kilometers (km) of the observer's home village or hunters' camp, with other more distant areas visited less frequently.

Observation posts were located in five villages in the Provideniya Region and in six villages and hunting camps in the Chukotka Region. Hunter-observers collected information in the course of their subsistence activities and wrote this information in tables and on sketch maps. Hunter-observers also questioned other hunters about their harvest and distribution data. Each month, observers would telephone a central office and communicate the data in their tables. The tables and sketch maps were sent by mail.

Hunter-observers collected information about the species (including marine mammals and birds) they encountered, the number sighted, and the place of the sighting. At the end of each month, this information was summed up in tables, including a marine mammals observation table (observations entered daily, as well as weather and ice conditions), subsistence activities, and utilization of subsistence harvest (containing information about distribution of the meat). The observer also used a sketch map to mark aggregations of different species, noted by points on the map. Often, the sketch maps do not show seasonality, but some of the sightings that are mapped also note the month in which the sighting occurred. Additional sketch maps show whaling grounds and harvest areas for bowhead and grey whale hunts in 2000, as well as traditional hunting grounds for whales, seals, walrus, and fish on a regional level (noted by polygons).

Information from hunters was verified during telephone calls and through in-person meetings when hunters travelled to the towns where the principle investigators were located.

To the best of our knowledge, the information was not digitized. Annual reports were created, and electronic copies of these reports do not appear to be available.

The information collected helped to create a report substantiating the need of indigenous residents of Chukotka for bowhead whales for quotas from the IWC, and in 1998, the Chukotka Natives received a quota of five bowhead whales from the IWC. The research also supported an agreement on polar bear utilization and harvest by the indigenous residents of Chukotka and Alaska. Management decisions under this agreement are made by a four-member commission consisting of an indigenous and federal representatives from the United States and Russia.

#### 2. Nenets Autonomous Okrug

The "Monitoring of Development of Traditional Indigenous Land Use Areas in the Nenets Autonomous Okrug, Northwest Russia,"[55] project was a collaboration between the Norwegian Polar Institute and the Association of Nenets People Yasavey. The goal of the project was to strengthen the ability of the indigenous population of the Nenets Autonomous Okrug (NAO) to promote their interests and traditional way of life in and to generate data to support decisionmaking on industrial development in the area.

The study population included a total of 103 traditional land users from 10 rural settlements, most of whom were reindeer herders, from six areas in the NAO.

The six areas in the study (Kanin Peninsula, Kolguev Island, and the villages of Indiga, Nelmin Nos, Krasnoe, and Khorey-Ver) were chosen because they included various degrees of oil development and impacts from oil-related activities.

A questionnaire on traditional land use issues was formulated by the project's anthropologist, and amended by

54. Ainana & Zelensky, *supra* note 22.

55. Winfried Dallmann et al., Monitoring of Development of Traditional Indigenous Land Use Areas in the Nenets Autonomous Okrug, Northwest Russia (Jan. 2010).

the project staff and members of the expert group. Seminars were held in the capital city, Naryan-Mar, where the project anthropologist trained representatives from villages in conducting the survey. These representatives went to their villages and carried out the interviews. Interviews were transcribed by hand and recorded on tape, then transcribed.

The questionnaire requested detailed information about the background of the respondent, his or her activities, and recent changes in traditional modes of livelihood, like fishing, hunting, sea mammal hunting, gathering, reindeer herding, and income. The questionnaire also included questions about the existence of sacred places, the condition of their natural environment, the influence of the oil industry on livelihoods, and general reflections on future development. Information about land use, including sacred sites, historical sites, camp sites, fishing sites, sea mammal hunting sites, reindeer calving areas, migration routes, gathering areas, winter pastures, and slaughtering sites were drawn on maps.

The database was developed using the ESRI software ArcGIS. The map information was transferred to kml files (GoogleEarth). In addition, satellite images in GoogleEarth were used to identify visible, physical damage of the tundra. These data were combined with various publicly available data in a bilingual (Russian and English) GIS database. The database was published on the Internet using GoogleEarth.[56]

The people of Yasavey are working with the NAO Department on Indigenous Peoples and Traditional Economies to promote the database as an additional tool for decisionmaking.

## *B. Sami*

### 1. Sami Place Names in Norwegian Sea Charts[57]

This research paper compared Sami and Norwegian names for marine fishing grounds in Porsanger Fjord, Norway, and conducted a historical and linguistic analysis of the names to reveal examples of cooperation and resource competition between Norwegians and Sami fishers. The premise of the study was that marine areas that have names are a result of activities such as fishing that "require greater exchange of information between groups of people than in other settings" and therefore represent in and of themselves areas of marine use.[58] The paper relied on a Sami marine place names and traditional knowledge database organized by the Coastal Sami Resource Center (CSRC) in Porsanger. This overview examines how the database of Sami marine use areas was created.

The study area, Porsanger Fjord, lies in the northernmost part of Norway, in Finnmark County. Respondents considered knowledgeable about local history and place names were selected from each of seven communities along the western side of the Fjord by teachers, resource managers from the municipality, and leaders of local history associations involved in local history projects. Respondents were interviewed in the Sami language and were asked to locate the Sami place names of any features or locations and write the information on either terrestrial or sea charts.

The local community associations who initially conducted the interviews turned their information over to the CSRC, which maintains and continues to augment the database. The database consists of place names and traditional knowledge collected among Sami language speakers in the villages along the western side of the fjord since the 1980s. In 2009, the CSRC held a database with over 1,400 Sami toponyms covering the fjord itself and the land along the west of the fjord from the bottom to its mouth. The CRSC entered map coordinates into excel sheets, containing the name identified and a short explanation if available. The sheets were then imported into Google maps and made available on their web page.[59]

Using ArcGIS, Brattland placed Sami marine toponyms in the CSRS database in the same coordinate system as the current sea charts for Porsanger and then compared them with already registered toponyms collected by the Norwegian surveyors in the same locations in the sea charts. In this way, the researcher was able to identify potential conflicts between local and large-scale fishers in the Fjord.

### 2. Fisheries in Lyngen Fjord[60]

The Norwegian Directorate of Fisheries conducted interviews with fishermen in Lyngen Fjord, in northern Norway, pursuant to the Norwegian marine habitat mapping program, which implements biodiversity conservation goals set out by national law (Convention on Biological Diversity and the Nature Diversity Act). The purpose of the mapping is to document local knowledge about fisheries to contribute to the overall knowledge of fisheries in order to improve the management of coastal fisheries.

The Directorate of Fisheries interviewed one or two fishermen who were part of each of the local fisher's associations that exist in communities along the fjord. To get information in places where no local fisheries associations existed, the Directorate of Fisheries interviewed other fishers recommended by the associations along the fjord. The resulting polygons therefore represent information provided by a small selection of respondents for each area, and do not represent marine use by non-organized fishers.

The survey was conducted according to a handbook and an interview manual created by the Directorate. The handbook contains four different forms used to conduct interviews about fishery resources, fishing areas and storage locations, shellfish locations, and coral and sponge loca-

56. *See* http://ipy-nenets.npolar.no/main%20pages/frame.html.
57. Camilla Brattland & Steinar Nilsen, *Reclaiming Indigenous Seascapes: Sami Place Names in Norwegian Sea Charts*, 34:4 Polar Geography 275-97 (Dec. 2011).
58. *Id.* at 276.
59. *See* http://www.meron.no/index.php/nb/lokalkunnskap/stedsnavn/porsanger.
60. Brattland, *supra* note 7.

tions. The handbook also provides directions on how to fill out the forms.

The Directorate of Fisheries asked the fishermen to draw fishing areas and observations of spawning grounds for cod on sea charts.

The maps were systematized and digitized in a publicly available GIS system.[61]

The form for fishery resources includes the identification of spawning areas, key growth areas for fry/small fish, important feeding grounds for adult fish, and important migration routes for adult fish.

A single form is used to identify both fishing grounds and fish storage areas, since these areas are often the same. For fishing grounds, the form requires identification of the type of equipment used, the number of vessels that use the area, the month(s) fishing takes place, and whether fishing is commercial, leisure, or tourism. The form also requires identification of whether the fishing ground use is local, regional, or national. The identification of fish storage areas is rated in terms of "very important," "important," and "less important." All areas that have been used within the past 25 years as fish storage areas are to be identified.

The form for shellfish and coral includes information about the size of the area and how the area was identified (visually or with acoustic equipment).

In addition, the forms contain a place for any additional information to be noted, such as bottom topography, currents, and soundings, as well as information about other use (recreational vessels, shipping, etc.) and infrastructure in the sea (harbor/marina, cables, pipes and emissions, etc.).

Codes are associated with the categories of information collected, and these codes are used to identify the locations on a map during the interview.

The maps with the spawning grounds were verified as correct by the fishers present at a group meeting. In addition, the government conducted its own investigation of spawning groups later the same year. The study checked the fishermen's observation by conducting a study that collected eggs floating in the water and estimated where the eggs had come from based on the movement of the ocean currents. In this way, both the local knowledge and the scientific studies supported the management decisions that were made based on the information.

A cod fish farm operating in the fjord applied to expand its business from six to 10 locations. The Directorate of Fisheries declined the request because the proposed locations of the expanded farms overlapped with the mapped spawning grounds for wild cod, citing research that suggested there was a danger of genetic interaction between farmed cod and wild cod stocks in the fjord. The fish farm company appealed the decision, claiming that the mapping of spawning and nursery areas for coastal cod in the fjord was not based on scientific knowledge. The Minister of Fisheries affirmed the decision of the Directorate and implemented a new regulation disallowing the siting of cod farms in cod spawning fjords.

61. *See* http://kart.fiskeridir.no/default.aspx?gui=1&lang=1.

As Brattland notes, "the Storfjord controversy is an illustration of a case where FEK (fishers' ecological knowledge) was quite successfully transformed into fact, integrated in the knowledge base for spatial management of cod farm sites in the coastal zone, and also had an influence on aquaculture management policies."[62]

## C. *Canada*

### 1. Use and Occupancy Mapping in Nunavut[63]

The purpose of a use and occupancy study by the Nunavut Planning Commission (NPC) was to provide information necessary to create a Nunavut Land Use Plan. Participants were recruited using radio ads and notification posters placed in groceries stores, post offices, health centers, airports, and hamlet offices two weeks in advance of interviews held in the community. Interviews were conducted with over 400 participants from 25 communities in the territory.

The study area included the entire Territory of Nunavut.

Terry Tobias was hired as a consultant to help develop the Nunavut Planning Commission Use and Occupancy Map Survey Data-Collection Manual. Information on traditional, individual lifetime, and community use of water and land resources was mapped through detailed interviews with community members. Interviewers documented activities within a living memory time frame and created map biographies. Between one and 15 maps at a scale of 1:250,000 were generated by each participant.

Seventy categories of features were recorded as points, lines, or polygons and included animal and plant harvest sites; occupancy sites, i.e., cabins, tents, and igloos; sites of life events, i.e., births, deaths, and burials; and cultural sites, i.e., sacred areas and landforms.

The maps were incorporated into the Nunavut Land Use Plan. The NPC requested comments on the plan and held workshops in Nunavut communities to get feedback. The NPC then plans to review all feedback at a public hearing and to make final revisions, prior to submission for final approval by the government, expected later in 2013.

NPC staff scanned and sent the original map sheets to Geopraxis, a Canadian firm with expertise in digitizing. Geopraxis registered, digitized, error-checked the images, and created an aggregated dataset. The data are currently held onsite in a geodatabase with ESRI software.

The use and occupancy maps were used to inform the creation of the Nunavut Land Use Plan, by incorporation into one of the planning goals, Building Healthier Communities. A draft land use plan was issued in 2011/2012. The draft land use plan recommends that for areas identified as community use areas through the use and occupancy mapping (UOM) process, that all permitted uses of the land be allowed, but that for conforming and approved project proposals, the NPC should recommend

62. Brattland, *supra* note 7, at 10-11.
63. *See* http://npc.nunavut.ca/en/draft-plan.

to regulators and project proponents that they consider the cultural value of the area. The draft plan states that this is preferred over a designation that does not permit inappropriate uses, because the preferred option "reflects the uncertainty and lack of agreement regarding the management of the areas."[64]

### 2. Inuit Sea Ice Use and Occupancy Project[65]

Inspired by the Inuit Land Use and Occupancy Project of 1976, the Inuit Sea Ice Use and Occupancy Project (ISIUOP) documented and mapped sea ice knowledge and use around several Inuit communities between 2004-2008. The project includes two different mapping efforts, the Atlas of Inuit Sea Ice Knowledge and Use and the Igliniit. The atlases, created through a map biography process, characterize the importance of sea ice processes, use, and change around three Nunavut communities. "Igliniit" in Inuktitut (the Inuit language) refers to trails routinely travelled by members of a community. The Igliniit project equips hunters with GPS systems that are mounted on snow machines and used to track the hunter's routes, as well as log information such as observations by the hunters and weather conditions. Maps were then created from this information.

The purpose of the ISIUOP is to document elder knowledge of ice for youth safety, through the creation of educational materials. This includes documenting elder knowledge about ice to improve safety of youth travel on ice, as well as observations about changes in seasonal sea ice conditions, to ensure that youth are aware of these changes.

Information for the atlases and the Igliniit project was contributed by elders and hunters considered sea ice experts in their community. Their knowledge was shared with ISIUOP researchers during interviews, focus groups, and sea ice trips, between 2004 and 2008. Most of the time, interviews were one-on-one, with the help of an interpreter. Occasionally, small groups were interviewed together.

The general study area was Baffin Island, Nunavut. The Atlas of Inuit Sea Ice Knowledge and Use collected information for three villages: Cape Dorset, Igloolik, and Pangnirtung. The Igliniit project was conducted in the Clyde River.

For the atlases, the mapping sessions were conducted with community experts who drew sea ice features, travel routes, camps, or other notable features (e.g., fishing and hunting areas) on transparent film overlaid onto topographic maps. The project used National Topographic Service maps as the basemaps, available for free from GeoGratis.[66]

For the Igliniit project, Inuit hunters mounted a handheld computer and GPS system on their snow machines, which automatically logged their location and weather conditions every 30 seconds, for two full sea ice seasons. Hunters also logged observations on the system, such as animal and hunting locations. The data was used to create maps of a single hunter's travel routes and was integrated to create a map that reflects the routes and observations of the entire community.

The interviews were informal and unstructured. Community or university researchers asked about the local expert's background and experiences, including the extent and area of sea ice use, the location of notable sea ice hazards, key harvesting areas, and traditional and current ice routes. Interviewers also asked about the expert's understanding of the freezing and melting processes and seasonal sea ice conditions, Inuktitut toponyms or terminology associated with ice features, conditions, or dynamics, the importance and uses of sea ice in their community, safety concerns and survival strategies on the sea ice, and sea ice or weather changes observed and shifts in patterns of sea ice use due to social and/or climatic change. Interviews were conducted in various locations in a community, as well as out of town on the land or sea ice. Points, lines, and polygons were all used to represent information on the maps.

Focus groups, workshops, and various one-on-one meetings with local experts and/or community researchers were a critical part of verifying that the information collected was being interpreted and presented in appropriate and accurate ways.

The information collected on the transparency was converted to digital form and stored in GIS. In addition, detailed descriptions and stories related to a feature, the name of the expert who contributed the information, and photographs of the feature were stored and associated with the features on the map. The project used a second-generation iteration of the open source Nunaliit software.[67] Paper maps were then produced for the communities. The information was also made available electronically on the project website, using Google maps.[68]

## *D. United States*

### 1. Subsistence Mapping of Nuiqsut, Kaktovik, and Barrow[69]

In 2004, Stephen R. Braund & Associates (SRB&A), in association with the NSB Department of Wildlife, initiated a subsistence mapping study in Nuiqsut, Kaktovik, and Barrow designed to develop a GIS dataset to describe regional subsistence patterns and to measure changes in these patterns over time. The purpose of this mapping project was to assist the federal government in projecting, mitigating, and assessing the effects of offshore oil and gas activities on subsistence.

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64. Nunavut Planning Commission, Draft Nunavut Land Use Plan, Options and Recommendation, 2011-2012, *available at* http://www.nunavut.ca/en/downloads; Region Social and Economic Studies Technical Report No. 147 (MMS 91-0073).
65. ISIUOP, *supra* note 24.
66. GeoGratis, http://geogratis.cgdi.gc.ca/.
67. *See* http://nunaliit.org/.
68. *See* http://sikuatlas.ca/index.html.
69. SRB&A, *supra* note 17.

The NSB Department of Wildlife Management identified active and knowledgeable harvesters for each of the subsistence resources identified in the study. The researchers asked these people to name other knowledgeable harvesters in their communities. This list of 222 people was prioritized based on the number of times someone was mentioned. The researchers interviewed 146 people, including 75 from Barrow, 38 from Kaktovik, and 33 from Nuiqsut.

The study area included all areas used for subsistence involving the selected resources by residents of Barrow, Kaktovik, and Nuiqsut.

The researchers developed a field mapping guide and field mapping protocol.

Two study team members were present for each interview. One team member conducted the interview and recorded information on an acetate sheet positioned over a 1:250,000 U.S. Geological Survey (USGS) map. The overlays were marked with locations on the U.S. Coast Guard (USCG) map, so that it could be realigned for digitizing.

Information was recorded using color-coded permanent markers on the acetate sheet. The second team member took detailed notes of the discussion and responses of the interviewees using a laptop computer. Interviewers recorded each feature as either a polygon (subsistence use areas, harvest areas), line (travel routes), or point (harvest locations, camps, and cabins).

Researchers assigned numbers to each feature as the interview proceeded and recorded this number next to the feature on the map and in the notes about that feature. This provided a link between the notes and the map and was later used to create distinct feature codes in the GIS database.

The subsistence use resources identified were: caribou; moose; bowhead whale; Arctic cisco; Arctic char/Dolly Varden trout; broad whitefish; burbot; geese; eider; ringed seal; bearded seal; walrus; wolf; and wolverine.

Interviewers began by mapping the respondents' subsistence use areas for each resource over the last 10 years, then mapping use areas for the last 12 months. For each use area on the map, the researchers recorded the month that the area was used. Interviewees then were asked to identify camps and cabins used during the last 12 months and the last 10 years and travel routes taken.

After recording the hunting areas, interviewers mapped the location of the participants' most recent successful harvest activity for each resource, and recorded the harvest month, number of participants, and duration of hunt.

A code for each feature was assigned, which contained the community's airport code, interview date, respondent ID number, feature type, and the feature number. Each feature was entered once for each species harvested. The researchers entered all of the features on each overlay into an Access field database according to these codes to create a feature table. The Access database resulting from entry of field data consists of four related tables: (1) Feature; (2) Resource; (3) Respondent; and (4) Species. Geographic feature types include polygons, lines, and points. Types of Feature records include: (1) subsistence use ("harvest") areas; (2) cabins; (3) camps; (4) travel routes; and (5) harvest sites.

SRB&A digitized the features recorded on the acetate overlays using ArcGIS ArcEdit software, including polygons associated with subsistence use areas and key habitat areas; lines associated with travel routes and key migration routes; and points associated with camps, cabins, and harvest locations.

Each GIS field record was assigned a unique Feature Code matching the unique Feature Code assigned to the Access Feature Record containing data on the type of feature, months used, and travel method. The Feature Table contains one record for each geographic feature mentioned by a respondent in connection with an individual resource. The Merged Feature Table from the Access database was linked to the GIS field database to produce the Analysis GIS. The Analysis GIS was used to develop maps for the final report.

The SRB&A GIS mapping system consists of three possible methods of presenting mapped information. The first method is referred to as a "spaghetti map." The spaghetti map as shown is made up of vectors (e.g., a point, line, or polygon) and represents overlaying all of the individual respondent outlines of Barrow, Kaktovik, and Nuiqsut subsistence use areas for all resources. This representation is not used in map production, as it presents individual harvester data (e.g., individual polygons).

The second method uses a single polygon to depict the extent of subsistence use areas for all respondents and all resources combined. Researchers often use this method to represent subsistence use areas on maps, and it is the expected representation of subsistence use areas in this study. While this single-polygon approach clearly shows the extent of the use area, it does not differentiate between areas that are used by one person from those that are used by multiple persons.

In a third method, SRB&A converted polygons (use areas) to a grid with each pixel being assigned a value of one. Then, the number of overlapping pixels are summed and assigned a color, with the darkest color representing the highest density (or number) of overlapping pixels.

The maps generated by SRB&A and the information from this study have been incorporated into environmental impact analyses. For example, the 2012-2017 Outer Continental Shelf Lease Program incorporates information from this study to describe subsistence use patterns.[70] The National Marine Fisheries Service (NMFS) Draft Environmental Impact Statement (EIS) for Arctic Seismic and Drilling included the maps for Kaktovik, Nuiqsut, and Barrow.[71] However, neither document appears to rely on

70. BOEM, *Proposed Final Outer Continental Shelf Oil & Gas Leasing Program 2012-2017*, June 2012, at 12.
71. NMFS, *Effects of Oil and Gas Activities in the Arctic Ocean Supplemental Draft Environmental Impact Statement*, Mar. 2013, fig. 3.3-18.

this information for mitigation measures or conclusions about possible impacts to subsistence.

The spatial information from this study also appears to be incorporated into an online marine cadastre.[72]

## 2. State of Alaska Department of Fish and Game Mapping

The ADF&G has been collecting spatial data on subsistence harvests since the early 1980s, through the Division of Subsistence Technical Paper and the Division of Subsistence Special Publication series. The technical subsistence reports from the ADF&G characterize the customary and traditional uses of fish and wildlife resources and address various scientific and policy questions. Some reports document subsistence harvests.[73] Others deal with specific resource management issues, such as to determine what uses, users, and methods of harvest should be defined as "subsistence use" for purposes of preferences granted by various state and federal laws, evaluating the impact of state and federals laws and regulations on subsistence, and for the development of management plans that incorporate subsistence use. When a resource development project is proposed, there is often the need for updated baseline information to document subsistence economies, to assess and mitigate potential impacts of development, and to monitor long-term ecological conditions.[74]

Many different mapping methodologies have been used by the ADF&G, including intensivity maps with different sizes of points to convey harvest amounts[75] and intensivity maps quantifying harvests by management units.[76] Others have used a combination of points and polygons within the same map to differentiate between harvest areas (harvest effort areas) and harvest or kill sites, resulting in a maximum extent-type map (from the polygons) overlaid with an intensivity map (from the clusters of points).[77] Purely maximum extent maps made of polygons have also been used,[78] while some have used only points to denote harvest/kill sites.[79]

The ADF&G has mapped subsistence use in a variety of environments, including terrestrial,[80] coastal (for herring spawn and marine invertebrates such as clams),[81] marine, and a combination of marine and freshwater (for species such as salmon or waterfowl that are harvested in both environments).[82] Below, we discuss one specific example of subsistence mapping by the ADF&G in Kivalina and Noaktak.[83]

The ADF&G, in cooperation with SB&A, the city of Kivalina, and the Native Village of Noatak, conducted a subsistence use survey in February 2008 pursuant to this program. One of the specific needs for data in this year was to provide information for an EIS for an expansion of the Red Dog Mine, located near the two villages.

The researchers created a list of all households in both villages and attempted to interview every household in both villages. In Kivalina, the survey was administered to 52% of households and in Noatak, 76% of the households participated in the survey.

The study area included marine and terrestrial areas for subsistence searching and harvest by Kivalina and Noatak residents.

Researchers worked with the municipality and native organizations to review the surveys, prepare household lists, and obtain community approval. The Noatak traditional council selected the eight community surveyors, and in Kivalina, five community members were selected as surveyors. Before the survey, an orientation was held with all community and non-community surveyors.

Most surveys were conducted by two people (a community and non-community member) at the respondent's home. Community workers administered the survey, while non-community members did the mapping.

The survey asked questions about which foods were harvested and how much, for the past year. The survey also asked about employment, wages earned, and other sources of income. It also covered questions about food security, such as whether households were able to harvest sufficient amounts of food. The demography section included questions about gender, kin relationships, age, birthplace, etc.

To document subsistence use areas, the interviewers asked the respondent to locate on a map the area where they searched for and where they harvested 11 subsistence

72. *See* http://www.marinecadastre.gov/MMC%20Pages/gallery.aspx.

73. Lauren Sill & Terri Lemons, *The Subsistence Harvest of Herring Spawn in Sitka Sound, Alaska, 2011*, Alaska Department of Fish and Game, Division of Subsistence, Tech. Paper No. 369 (2012); Malla Kukkonen & Garrett Zimpelman, *Subsistence Harvests and Uses of Wild Resources in Chistochina, Alaska*, Department of Fish and Game, Division of Subsistence, Tech. Paper No. 370 (2012); James M. Van Lanen et al., *Subsistence Land Mammal Harvests and Uses, Yukon Flats, Alaska: 2008-2010 Harvest Report and Ethnographic Update*, Alaska Department of Fish and Game, Division of Subsistence, Tech. Paper No. 377 (2012).

74. For example, two studies address subsistence issues related to the Pebble Mine Project: Sarah Evans et al., *Harvests and Uses of Wild Resources in Dillingham, Alaska, 2010*, Department of Fish and Game, Division of Subsistence, Tech. Paper No. 375 (2013), and Davin Holen et al., *Subsistence Harvests and Uses of Wild Resources in Aleknagik, Clark's Point, and Manokotak, Alaska, 2008*, Department of Fish and Game, Division of Subsistence, Tech. Paper No. 368 (2012). Another study to assess potential impacts to subsistence from a possible natural gas pipeline: David Holen et al., *Subsistence Harvests and Uses of Wild Resources by Communities in the Eastern Interior of Alaska, 2011*, Department of Fish and Game, Division of Subsistence, Tech. Paper No. 372 (2012).

75. Sill & Lemons, *supra* note 73.

76. Nicole M. Braem, *Subsistence Wildlife Harvests in Noorvik, Shungnak, and White Mountain, Alaska 2008-2009*, Alaska Department of Fish and Game, Division of Subsistence, Special Publication Series No. SP2011-003 (2012); Nicole M. Braem, *Subsistence Wildlife Harvests in Ambler, Buckland, Kiana, Kobuk, Shaktoolik, and Shishmaref, Alaska, 2009-1010*, Alaska Department of Fish and Game, Division of Subsistence, Special Publication Series No. SP2012-003 (2012); Van Lanen et al., *supra* note 73.

77. Evans et al., *supra* note 74; Holen et al., *supra* note 74; Kukkonen & Zimpelman, *supra* note 73.

78. Holen et al., *supra* note 74; Kukkonen & Zimpelman, *supra* note 73.

79. Kukkonen & Zimpelman, *supra* note 73.

80. Braem (both sources), *supra* note 76; Holen et al., *supra* note 74; Kukkonen & Zimpelman, *supra* note 73, Van Lanen et al., *supra* note 73.

81. Sill & Lemons, *supra* note 73; Holen et al., *supra* note 74.

82. Evans et al., *supra* note 74; Holen et al., *supra* note 74.

83. James S. Magdanz et al., *Subsistence Harvests in Northwest Alaska, Kivalina and Noatak, 2007*, Alaska Department of Fish and Game, Tech. Paper No. 354 (2010).

resources in four resource categories. Maps used at the interviews were available at three different scales.

Surveys were coded for data entry by researchers and entered by ADF&G staff. During coding, the researchers recorded and summarized harvest reports for major species. These summaries were compared to the results of the data analysis and discrepancies were examined. In addition, all survey data was entered twice, and the sets were compared to each other to minimize data entry errors.

After the database and maps were created, community meetings were held to review the study information.

The survey responses were coded following ADF&G conventions. The data entered was backed up along the way. Information was processed using SPSS (statistical package for the social sciences).

The hand-drawn maps were entered into ESRI ArcGIS. For each resource and category, all search areas and harvest locations were combined to create a series of maps. Marine and terrestrial harvest areas were represented as points and search areas as polygons.

The EIS for the Red Dog Mine expansion incorporated information from this study and found that activities at the Red Dog Mine had led to wildlife disturbances and declines and had affected subsistence hunting of marine mammals near the port for the mine.[84] As a result, the EIS proposed a mitigation measure that would close the port during the beluga whale migration and hunt in June.[85] However, after the EIS took into account other factors beyond environmental impacts, such as economic and technical factors, the U.S. Environmental Protection Agency (EPA) concluded that the preferred alternative in the EIS was to allow the expansion of the mine without the discussed mitigation measures. In addition, EPA concluded that it did not have the authority to require the mining company to close the port during the beluga whale migration. EPA noted that the mining company stated that it would only proceed with shipping operations after a Subsistence Committee notified the company that whale hunting was finished for the year. EPA explained that it was not able to determine the effectiveness of the Subsistence Committee and suggested that its procedures be reviewed.[86]

The information from this study was also used by NMFS in its Draft EIS for Arctic Seismic and Drilling. However, no mitigation measures were proposed for the area around Kivalina in the Draft EIS.

### 3. Subsistence Bowhead Whaling Near Cross Island[87]

This study was part of the Continuing Arctic Nearshore Impact Monitoring in the Development Area (cANIMIDA) study funded by the U.S. Department of the Interior to monitor impacts associated with oil and gas activities in the Beaufort Sea. The purpose of the study was to measure basic parameters of Cross Island bowhead whaling at Cross Island in the Beaufort Sea, in order to analyze any potential future changes in hunting in relation to oil and gas activities, weather and ice conditions, or other variables and in order to inform agency oil and gas plans and decisions. The project is also working to develop a system for collecting hunting information that local whalers themselves can adopt, adapt, and maintain.

The study population was all of the bowhead whale subsistence hunters from the village of Nuiqsut. The study area was the marine travel route between Nuiqsut and Cross Island, and the marine areas around Cross Island used by the whalers during their subsistence hunt of bowhead whales.

The information was collected through observation by the researcher, GPS units, and self-reporting by the whalers. The whalers were given hand-held GPS units that recorded the travel route of the boat and other points entered by the whalers. This information was supplemented by subsequent conversations with each boat crew, while reviewing the mapped GPS information on a laptop computer with them. When reviewing tracks after their return, boat crew members would often identify locations where they saw whales, and these points were added to the GPS information. Observations by the whalers about whale behavior were also documented. The researcher completed a form for each boat trip that documented time spent whaling, way points, weather observations, and the associated GPS file name. A portable weather station on Cross Island provided additional information.

The following information was collected:

- Number of whaling crews actively whaling and number of boats used (observation)
- Size and composition of whaling and boat crews, and fluctuation over the whaling season (observation)
- Number of whales harvested (observation, self-report)
- Days spent whaling, and days prevented from whaling (observation, self-report)
- Days suitable for whaling when whaling did not occur (observation, self-report)
- Subsistence activities occurring other than whaling (self-report, observation)
- Location of whale searching, whale sightings, and whale harvest (GPS, self-report)
- Local weather and ice conditions (observation, self-report)
- Bowhead whale behavior in the Cross Island area, and differences from past experience (self-report)
- Changes in access or other issues related to the whale hunt, such as increased effort for the same (or reduced) harvest, increased risk, increased cost (self-report)

84. U.S EPA, *Red Dog Mine Extension Aqqaluk Project Final Supplemental Environmental Impact Statement* 3-38 (Oct. 2009).
85. *Id.* at 2-53.
86. *Id.* at 2-40.
87. Galginaitis, *supra* note 36.

The GPS data Garmin's MapSource software was converted to be used with the Manifold GIS system.

The project was designed to collect quantitative measures of Cross Island whaling, but not to collect similar information about oil and gas activities. In addition, no seismic or drilling activity occurred in the study area during the study period, so the study provided no conclusions on the impacts of oil and gas activities. However, the study did document impacts to subsistence from ice and wind conditions, the distribution (distance from Cross Island) and apparent abundance (how many whales the whalers could find) of whales, and the behavior of the whales.

The information in this study was included in a number of EISs and industry applications. For example, the Environmental Assessment of Shell's 2012 Beaufort Sea drilling plans relied on this study to describe subsistence activities at Cross Island, including the apparent effects of climate change on the timing for the start of the whale hunt and the effect of other (non-oil-and-gas-related) vessel traffic on whale behavior. A draft EIS for leasing in the Beaufort and Chukchi Seas relied on the study in drawing a connection between climate change and sea state conditions that affect hunting. An environmental assessment for GXT seismic activity in 2009 also relied on the study to describe subsistence activities at Cross Island and, in addition, the development and production plan for Liberty (drilling from an artificial island in the Beaufort Sea). ION and Statoil also relied on information from this study in their applications for Incidental Harassment Authorizations for seismic activity from NMFS. However, none of these analyses includes mitigation measures supported by the study.

The draft EIS for Arctic seismic and drilling by NMFS relied on the study in its discussion of subsistence activities at Cross Island and to support a mitigation measure that requires shutdown of exploration activities in the Beaufort Sea for Nuiqsut and Katovik bowhead whaling. Because this EIS is not yet complete, it is unclear whether the mitigation measure will be implemented.

### 4. Barrow Participatory GIS[88]

This project was part of a thesis developed by a master of arts in geography student at the University of Cincinnati. The researchers created a traditional knowledge "Iñupiaq Web GIS," based on a five-year study. The website, "Arctic Cultural Cartography," was created to be an open portal through which the password-protected Iñupiaq Web GIS could be accessed. One of the main research focuses was to investigate, document, verify, and archive local observations about geomorphological processes, landscape changes, and local resource use. The project also sought to foster a positive and cooperative connection between the local community and scientists.

Over the course of five years, 52 Iñupiat elders and hunters from the North Slope villages of Barrow, Atqasuk, Wainwright, and Nuiqsut were interviewed. The study area covered a few thousand square miles in the Barrow area, extending from the west near Wainwright Inlet to the western edge of Smith Bay in the east, and extending north about 10 miles offshore of Barrow to around 50 miles south of Atqasuk.

Interviewees were asked to sign consent forms, and each interviewee was assigned a subject number. Interviews were video-recorded and assigned a coded number denoting the year, month, and sequential interview occurrence. Satellite and USGS topographical maps of the North Slope of Alaska were used in the interviews, which were semi-directed, and the information shared by the interviewees was diverse, dealing with landscape changes, water resources, hunting, fishing, and cultural and historical sites.

The researchers created a six-digit code system, comprised of three two-digit fields, to categorize geographically specific information from the interviews. A Microsoft Excel chart was used to create a log of time stamps from the video that corresponded to geographical information provided during the interview, including the six-digit code and whether the information was described as a point, line, or polygon.

The data layers included villages, various hydrological and geological features, resources (which included fish, caribou, seals, walrus, whales, waterfowl, and berries), historical/cultural sites (which included cabins, camping, and hunting locations), trails, and lakes. An additional layer contained elder videos that would link specific geographical points to selected clips from the interviews describing events at these points.

Some of the geographic information provided by interviewees was cross-referenced with other geological information. Otherwise, the project does not appear to have verified information received through the interviews.

The Excel charts from each interview were combined into a "Master Geocoding" sheet that contained all the information from every video. From these reference sheets, the GIS data set was created. The data set was created using ESRI's ArcGIS desktop application ArcCatalog. Video files were compressed into MPEG format.

The GIS information was then incorporated into a web-based platform using ArcGIS Server and a website framework from the ESRI community resource center. The website, called Arctic Cultural Cartography, can be found at http://northslope.arcticmapping.org/. To ensure privacy of data, a user login is required. An online survey was created to get feedback on the website, including its ease of use and usefulness. A website training tutorial was also created.

### 5. Subsistence Mapping in Gambell and Togiak, Alaska, by the Bering Sea Sub-Network[89]

The Bering Sea Sub-Network (BSSN) is a four-year, community-based project that builds on a two-year pilot,

88. Jelacic, *supra* note 43.

89. Maryann Fidel et al., *Subsistence Density Mapping Brings Practical Values to Decision Making*, *in* Fishing People of the North: Cultures, Economies, and Management Responding to Change, Alaska Sea Grant,

to collect quantitative, qualitative, and spatial data on subsistence activities in eight indigenous communities bordering the Bering Sea, in the Russian Federation and the United States. Here, two assessments based on the research conducted in the villages of Gambell and Togiak, Alaska, is discussed.

The overall goal of the BSSN is to improve knowledge of environmental changes that are of significance to understanding pan-arctic processes, and to enable scientists, Arctic communities, and governments to predict, plan, and respond to these changes.

The objective of the first assessment in Gambell, Alaska, was to identify the spatial relationships between subsistence use areas and shipping activity using an innovative mapping technique, in order to provide a tool that could empower communities in decisionmaking and as a research tool to examine change or variation over time.[90] The goal of the second assessment in Togiak, Alaska, was to demonstrate how LTK and subsistence mapping through a community-based observation network can be used to detect change. This analysis examined the ability of indigenous peoples to adapt to change resulting from converging factors, including climate change, a change in walrus population dynamics, socioeconomic conditions, regulations, and development.[91]

Respondent selection began with a complete list of all residents of the town. Community experts were then asked to identify people who have lived and harvested in the community for at least 15 years to identify all "high-harvesters" in each village. Different sample sizes occurred over each year of the project, due to out-migration, unknown factors, and deaths. Response rates also varied. For example, in Gambell, for the first year of the project, the response rate was 57% of the people identified (95 people). For the village of Togiak, the total response rate was 80% or 180 people out of the 224 identified high-harvesters.

Study areas include all areas where respondents harvested "focus species." These are four to five species selected by each community as important subsistence species. For the village of Gambell, the study area consisted of those areas used by residents of Gambell to harvest whale, walrus, seal, and salmon. In Togiak, the study area for this particular analysis was the location where residents harvest walrus, although other focus species include seal, red salmon, Dolly Varden trout, and smelt.

Community research assistants were hired from the community and trained to conduct semi-structured interviews with subsistence harvesters. The interview includes a participatory mapping component, where respondents circle areas used to harvest a particular species during a predefined six-month period (spring/summer and fall/winter). At the end of the project, interviews will have taken place twice a year for four years.

A small-scale (1:1,500,000) and a large-scale (1:375,000) map were used for the interviews. Respondents were assigned a code to protect confidentiality. Notes were taken on each interview by the Community Research Assistant, and recorded if given consent by the respondent.

The BSSN Steering Committee (SC) includes one person from each participating community. It was formed to advise the research team of sensitive issues, data accuracy, and to help with community coordination. All data that is released has been presented to the SC members who then may present it to the community or tribal council, if the information is deemed sensitive. Together, they may determine if the data is suitable for release.

Each map was digitized in GIS, and corresponding data from the survey were entered into excel and then joined with the spatial data. Polygons were selected based on months and species of concern. The concern in the first assessment was that an increase in shipping activity could cause marine mammals (bowhead whale, walrus, and three species of ice seal) to avoid an area or flush from the ice, making them less available to subsistence hunters. So, the resulting map displayed harvest areas for those species during the time period where most shipping activity occurs (fall). These data were aggregated using a kernal density function in Spatial Analysis Tools in ESRI's ArcGIS. Harvest areas are displayed as an intensivity using graduated colors.

In Togiak, walrus harvest data were selected throughout the four-year time period. At the start of the project, a baseline survey was used that asked respondents where they "normally go" to harvest walrus in order to capture areas commonly used over the course of one's lifetime. The baseline survey was compared with where respondents had gone for the four-year time period.

The map for Gambell was presented to the USCG officials to inform the USCG's Port Access Study of the Bering Strait. The final USCG decision is expected later in 2013 or 2014. In the second assessment, baseline data was compared with areas used over the four-year study period revealing a dramatic shift in where residents of Togiak harvest walrus. During the four-year period, the traditionally preferred location of Qayassiq was not used to harvest walrus. Two other main locations were used that were farther away and potentially more dangerous. Identified potential factors causing this shift included climate change, a change in walrus population dynamics, socioeconomic conditions, federal and state regulations, and development (trawling). Because the Qayassiq Walrus Commission does not believe Qayassiq has been permanently abandoned as a walrus harvest site and because the community generally feels comfortable with the regulations and with their communications with resource managers, the observed changes in this study are unlikely to lead to modifications in resource management regulations.

Univ. of Alaska Fairbanks, doi:10.4027/fpncemrc.2012.15 (2012); Maryann Fidel et al., *Walrus Harvest Locations Reflect Adaptation: A Contribution From a Community-Based Observation Network*, Polar Geography (forthcoming 2013).

90. Fidel et al. (2012), *supra* note 89.

91. *Id.*

## III. Conclusion

As the selected examples of subsistence mapping demonstrate, there are many techniques that can be used to capture spatial data on traditional harvest activities. Although the details will vary depending upon the goal of the project, some common best practices may be identified to strengthen the legitimacy of subsistence use maps in the research or decisionmaking arena. Important steps include the following: (1) At the onset of a project, the purpose and goals must be clearly defined. This will guide the techniques used. (2) A strategic plan may help to ensure that a project stays on track by clearly defining conventions used at each step and assigning responsibility and roles of the individuals involved. (3) The study area, methodology used to collect information, and what information will be collected should be clearly documented. (4) Sampling should follow established social science methodologies, such as snowball or representative random sampling. (5) The display of information should be catered to the purpose of the map, culturally appropriate, and protect the confidentiality of respondents as much as possible. (6) The resulting maps will need to go through some verification process with the respondents or communities involved.

The marine and terrestrial environments vary in the way they are experienced through travel and harvesting activities, and thus the most effective techniques for capturing subsistence use in these environments is also likely to vary. Understanding the strengths and weakness in the creation of mapped products will lead to more effective use in decisionmaking or research. The people of the Arctic are faced with increasing development, rapid environmental and socioeconomic change, and increased potential for conflict with shipping. Equipping communities with the opportunities and resources required to create their own maps of marine use for decisionmaking, detecting change, or to document use for historical purposes may also provide a tool for greater self-determination.