TITLE: Synthesizing AIS ship tracking data, GNOME oil spill model results, and subsistence use information into a unique, interactive tool to aid research and planning in coastal communities bordering the Alaska Beaufort Sea.

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SUMMARY: This project will integrate data products describing vessel traffic patterns, estimated oil spill impacts, and subsistence use data from the communities of Barrow, Nuiqsut, and Kaktovik along the Beaufort Sea coast, and incorporate them into a unique tool for planners and subsistence community members. Spatial heat maps of vessel traffic density will be developed by analyzing Automated Identification System (AIS) data from the Marine Exchange of Alaska and NOAA to isolate marine vessel corridors experiencing the heaviest traffic. Investigators will run several hundred oil spill trajectory scenarios powered by ocean circulation and atmospheric wind models initialized at randomized locations and times coinciding with vessel traffic hotspots. Spill trajectory results will be summarized to produce a Spill impact density map for the Beaufort Sea. Subsistence-use patterns will be produced from aggregating individual subsistence mapping, harvest, and other socio-economic surveys from the Alaska Beaufort Sea communities of Barrow, Nuiqsut, and Kaktovik. These subsistence datasets have been previously unavailable, and include species descriptions, timing and area for targeted species, and other traditional ecological variables for each community. The subsistence mapping and species distribution data will be compared to the spill impact density maps to understand how different subsistence activities and their relative timing could be impacted in the event of a spill. The data gathered and synthesized through this project will be publicly accessible through an interactive web-based mapping tool as a mechanism for increasing public, private sector, government, and community knowledge about possible spill effects to subsistence uses in the US Arctic.

BACKGROUND: Climate conditions are undergoing rapid changes in the US Arctic, the effects of which are widely recognized by coastal communities in Alaska. In 2015, the US National Snow and Ice Data Center reported the smallest wintertime maximum (Vinas, 2015) and the fourth lowest summertime minimum (Vizcarra, 2015) sea ice extent on record. Coastal erosion rates doubled along the coast of the Beaufort sea since the middle of the 20th century (Jones et al., 2009), with increases in the number of ice-free, open water days (Overeen et al, 2011) and higher rates of permafrost warming (Smith, 2010) both contributing to accelerated coastal erosion. Customary and traditional uses of fish and wildlife are important to the economic and cultural livelihoods of Northern Alaskan communities in the Beaufort Sea. Resources that Alaska Native communities depend upon for subsistence purposes are vulnerable to the effects of a changing climate. Shrinking sea ice cover in the Arctic has fostered increased socioeconomic activity, such as increased ship traffic and oil exploration. Sea ice coverage has decreased to the point that existing northern shipping lanes around the world are open longer (Masters 2013) and are projected to experience increased marine vessel traffic (Arctic Council 2009), which in

turn increases the probability of accidents and potential for oil spills (e.g., Roelefen et al., 1995; Merrick et al., 2002) posing dangers to subsistence resources and the coastal environment. A spill in this region would be catastrophic to communities and difficult to respond to because of the Arctic's remoteness, harsh environmental conditions, and lack of sufficient facilities or ports for response. There are currently only three US marine ports on the Beaufort Sea — Wainwright, Prudhoe Bay, and Bernard Harbor — all of which are classified as "very small" (Institute of the North 2016), and thus, insufficient to respond to major spills. A small stash of local spill response equipment is present in Barrow (Alaska Chadoux Corporation 2016), but it is minimally outfitted for a spill volume of less than 5,000 gallons of oil. A larger inventory of response equipment resides in Deadhorse, at Prudhoe Bay (Alaska Clean Seas, 2015); however, that equipment is meant for spills from local oil and gas operations, not to be dispatched along the entire 400-mile coast from Barrow to Kaktovik. Understanding and mapping subsistence activities in this region is important to better inform the effects of vessel activity and oil exploration, particularly from a potential spill, and to incorporate that information into decision-making processes.

OBJECTIVES: This project will accomplish the following four objectives:
Objective 1. Process, standardize and make openly-available data products that describe vessel traffic patterns, oil spill risks, and subsistence uses along the Beaufort Sea coast.
Spatial heat maps of vessel activity will be developed using Automated Identification System (AIS) time-series data from the Marine Exchange of Alaska and NOAA to elucidate vessel corridors and isolate areas experiencing increased traffic from offshore oil and gas operations. Project investigators will run several hundred NOAA GNOME oil spill trajectory scenarios powered by ocean circulation and atmospheric wind models (Navy HYCOM and NCEP NAM) initialized at many randomized locations and times coinciding with high-density vessel traffic. Oil spill trajectories will be collectively analyzed to produce a cumulative impact density map for hypothetical spills from vessels in the Beaufort Sea. Spill trajectories from stationary oil exploration and drilling operations will also be produced in a randomized multi-scenario dataset that produces a cumulative impact map product.

Objective 2. Summarize subsistence-use patterns for Alaska Beaufort Sea communities.
Subsistence-use patterns will be determined by aggregating individual subsistence mapping, harvest, and other socio-economic surveys for the communities of Barrow, Nuiqsut, and Kaktovik, all of which depend on subsistence resources for their cultural livelihood. These data were collected over many years as distinct datasets for various government planning documents, but have not previously been available for incorporation into larger, synthetic data products or decision-support tools. Subsistence mapping data will aggregated across these communities to describe which subsistence species are targeted for harvest, harvest timing, location, and other variables.

Objective 3. Understand the timing of various offshore subsistence activities and the potential relative impacts of offshore oil and gas operations.
Spill impact density maps will be compared to and analyzed against the subsistence data to determine when offshore subsistence activities occur for each community and which of these

subsistence activities would most likely be impacted from a spill.

Objective 4. Integrate data into an interactive map to increase public knowledge and inform agency decision-making.
The project will primarily address the theme of coastal communities through the unique compilation and synthesis of existing data on vessel traffic, oil spill trajectory modeling: Alaska Native subsistence use patterns, subsistence species distribution, and ocean and coastal geophysical dynamics in the Beaufort Sea. These data will be integrated in novel ways into a publicly available, interactive data product for use by local, tribal, state and Federal government planning and regulatory agencies in analyzing the potential impacts of offshore oil and gas activities on Alaska Native communities subsistence uses.