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Development of best practices for scientific research vessel operations in a changing Arctic: A case study for R/V *Sikuliaq*

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ABSTRACT

Reduced sea ice has made the Arctic Ocean more accessible for vessel traffic. In turn, the heightened interest to better understand rapidly changing sea ice dynamics, ecosystems, and related ocean processes in the Arctic Ocean has led to closer interactions with and the need to avoid potential conflicts between scientific researchers and Indigenous coastal communities. In particular, researchers need to minimize spatial and temporal overlap of science activities with subsistence hunts as the Arctic is essential to Indigenous communities for their food security and cultural heritage. In this regard, a Community and Environmental Compliance Standard Operating Procedure (CECSOP) was recently developed for the R/V *Sikuliaq*, which is owned by the National Science Foundation and operated by the University of Alaska Fairbanks College of Fisheries and Ocean Sciences and is part of the University-National Oceanographic Laboratory System. The CECSOP was developed with input and guidance from Alaska Indigenous community groups, state and federal agencies, and sea-going scientists. Here the document's basic principles and procedures are described, as well as its utility in helping guide constructive discussions and interactions between scientific users of R/V *Sikuliaq* and subsistence hunting communities when research and subsistence hunt activities have spatial and temporal overlap. The CECSOP is a "living" document and subject to future modifications and improvements. It may serve as a model for other scientific, commercial and industrial vessel operators to ensure best practices between subsistence hunting communities and vessel operators in the Arctic.

1. Introduction

Commensurate with the decrease in sea ice extent, thickness, and volume [22,23], and predictions of a seasonally ice-free Arctic Ocean in the coming decades [27,36], are the increasing commercial, industrial and scientific research interests in sea-going operations throughout the Arctic [21]. When these activities occur in waters close to Indigenous coastal communities, spatial and temporal overlap between scientific and community subsistence hunt activities are best avoided. Indigenous coastal communities have local subsistence hunts for various species of whales, seals and walrus (Fig. 1). These communities have relied on Arctic marine resources for their food supply and cultural heritage for centuries [3]. As such, vessel operations should strive to avoid temporal and spatial overlap of research activities with local subsistence hunts as research activities (i.e., ship presence, noise) may change the behavior and migratory patterns of marine mammals [14,18]. Avoidance of overlap can be difficult. Researchers often target animals (or prey of those animals) that communities hunt [2], which can result in researchers and hunters wanting to occupy the same area at the same time.

To assist researchers in communicating and avoiding conflicts with Indigenous coastal communities, the University of Alaska Fairbanks/College of Fisheries and Ocean Science (UAF/CFOS) and the National Science Foundation (NSF) have developed a Community and Environmental Compliance Standard Operating Procedure (CECSOP). This document, which is described in this paper, outlines the standard operating practices for the University-National Oceanographic Laboratory System (UNOLS)'s R/V *Sikuliaq*. The intent of the CECSOP is to provide guidance to identify, communicate and mitigate potential impacts on, or spatial/temporal conflicts with, maritime subsistence harvest areas, activities, and resources; explains environmental compliance procedures; and describes the roles and responsibilities of individuals involved in these processes. These standard operating procedures are intended to support best practices while facilitating use of this unique vessel, enhance cruise success, and encourage appropriate and necessary outreach to potentially interested community and regional organizations including Tribal leadership, Alaska Indigenous organizations, and co-management entities that participate in management of

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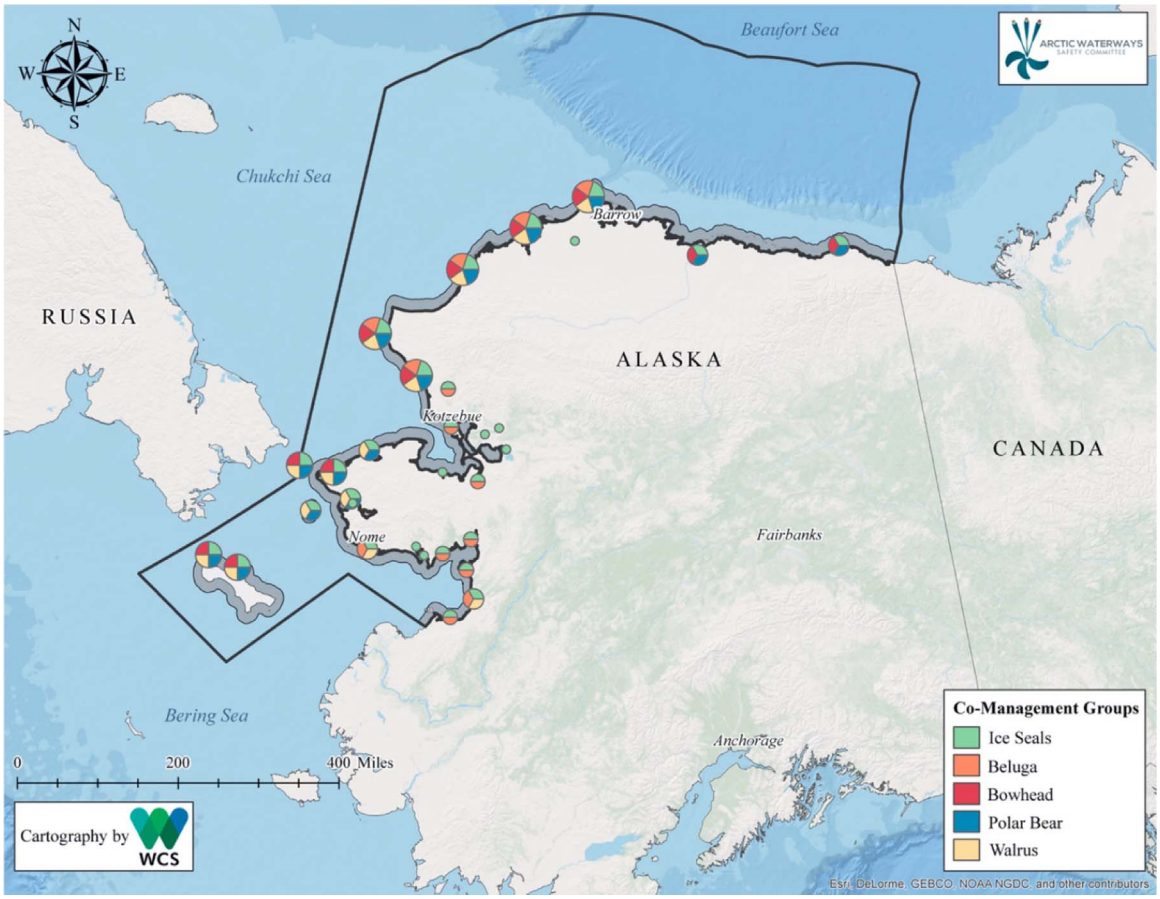

Fig. 1. Alaska Native Marine Mammal Co-management organizational representation for coastal villages within the Arctic Waterways Safety Committee's area. A 12 nm buffer is shown along the coast for scale.
Source: Arctic Waterways Safety Plan, April 2016.

marine mammals. The document also facilitates compliance with applicable federal environmental regulations, including the National Environmental Policy Act (NEPA), Marine Mammal Protection Act (MMPA), and Endangered Species Act (ESA).

In an effort to more broadly disseminate the CECSOP best practices and procedures to other potential vessel operators, this study first describes the methods used to develop the CECSOP, including the various groups that provided input and guidance (Section 3). The general guidance adopted for research activities aboard R/V *Sikuliaq* is described in Section 3.1, and the specific SOPs are described in Section 3.2, organized as pre-cruise, cruise, and post-cruise activities. Section 3.3 outlines specific personnel roles and responsibilities in the conduct of the CECSOP. While the SOPs reflect current best practices, it is recognized that each research cruise is unique and may require additional, or modified, procedures to successfully achieve specific research goals on R/V *Sikuliaq*. In this regard, CFOS seagoing and shore-side support personnel that manage R/V *Sikuliaq* operations are dedicated to assist and support PIs in complying with the CECSOP.

2. Marine research and ship operations in Alaska

Reduced seasonal sea ice cover in the Arctic has opened new vessel traffic routes such as the Northern Sea Route and the Northwest Passage [17,30,33,6]. These emerging routes will shorten transit times compared to traditional routes through the Panama and Suez Canals, expand natural resource extraction and infrastructure build-up, and allow for new tourism [26,32]. In addition, the ongoing loss of sea ice is opening the Arctic for marine research. This is happening alongside an increased need for researchers to more fully understand sea ice dynamics [19], functioning of marine ecosystems [13,16], invasive species [28,35], and climate [25,29] as well as how the ocean is changing with respect to attributes such as position along shelves, freshwater stratification, nutrient upwelling, etc. [7]. While risk analyses are being developed for ships in poorly chartered Arctic waters with challenging hydro-meteorological conditions (e.g., [8,1]), and plans are being developed for the increase in cruise tourism (e.g., [5]), little attention has been given to interactions between the increase in vessel traffic with Indigenous communities that rely on these waters for food and cultural needs.

The general increased interest in Arctic research has spurred the NSF to invest in an ice-capable research ship. R/V *Sikuliaq*, launched in 2012, is a 261-ft Polar Class 5 research vessel operated through a Cooperative Agreement between the UAF/CFOS and NSF. The vessel is designed to support a wide variety of research activities. R/V *Sikuliaq* allows researchers to collect sediment samples directly from the seafloor, host remotely operated vehicles, use a flexible suite of winches to raise and lower scientific equipment, and conduct surveys throughout the water column and sea floor using an extensive set of research instrumentation. This vessel operates best in Arctic and sub-Arctic regions where there are many Alaska Indigenous communities who use marine resources and where marine mammal subsistence harvest activities may simultaneously occur with research (Figs. 2 and 3). Concerns on the environmental impacts of the vessel, such as the impacts of ship operational noise on marine mammal behavior and migration routes, have been expressed by Alaska Indigenous communities [31] and have spurred research on ship noise [10,12]. Subsistence hunters have reported changes in sea ice and weather that have affected the timing of marine mammal migrations, their distribution and behavior, and the

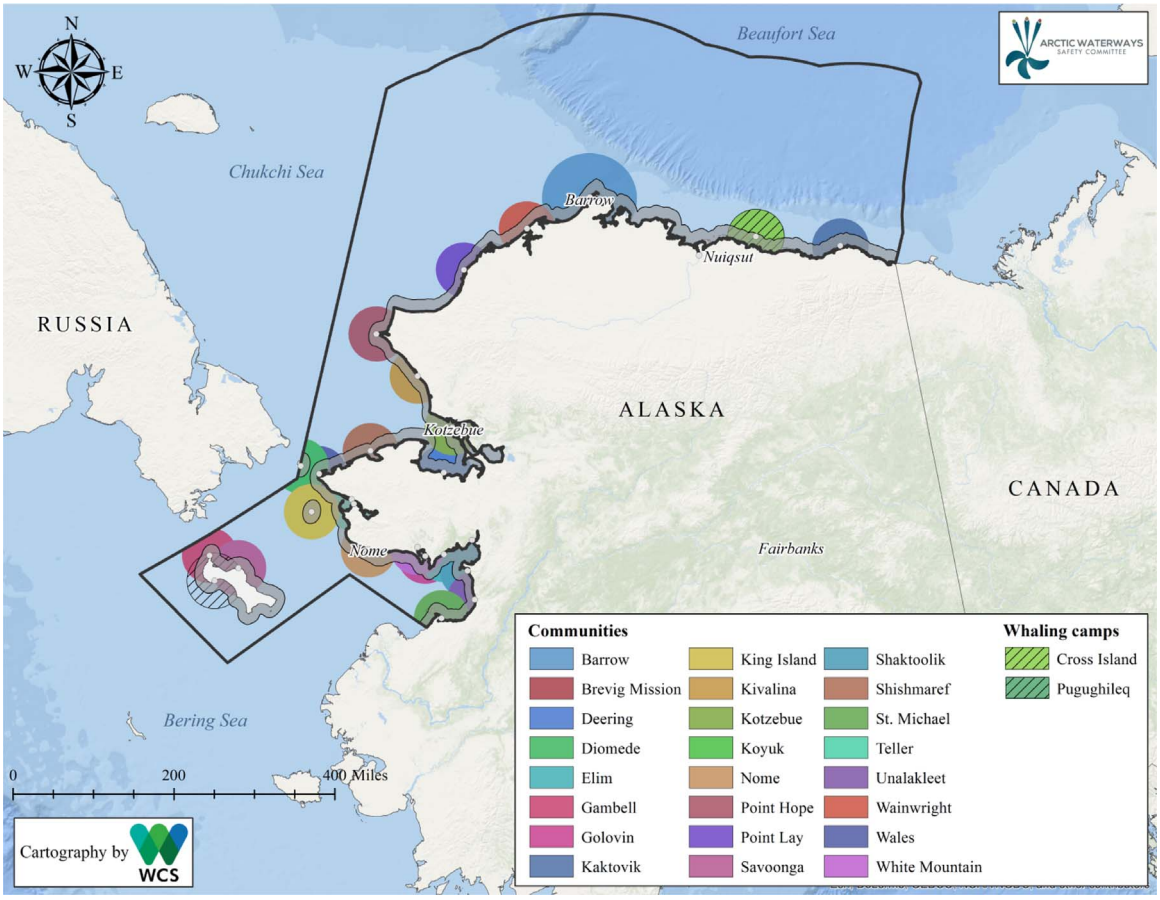

Fig. 2. Arctic villages and coastal areas of concern according to the Arctic Waterways Safety Committee (AWSC) Standards of Care (SOC) for Research Cruise Operations Draft 22 Feb 2017 Version. Although not included in this graphic, Nuiqsut is also recognized as having a 30 nm boundary associated with the Colville River delta.

efficacy of certain hunting methods [15]. These local communities also have an interest in understanding how the Arctic is changing physically with climate change. As a result, many local residents will scrutinize research plans, and require information on the timing and location of a research cruise as well as the results of the scientific research.

R/V *Sikuliaq* was designed to have the lowest possible impact on the environment, which is advantageous in light of the importance of maritime subsistence activities in coastal communities in these regions, and potential for research overlap. The ship's hull was specifically designed to reduce airborne and underwater noise, which reduces impacts to marine mammals that rely on echolocation. R/V *Sikuliaq*'s double bottom hull does not have fuel or oil storage tanks next to the shell of the vessel, which reduces the potential for a fuel spill in the event of collision. The ship was engineered to run on biodegradable hydraulic oil, which minimizes risk and impact in the event of hydraulic oil discharges. The ship's integrated power plant combines a common electrical plant with a load management system. In this system, electrical generation can be adjusted to match demand, which increases energy efficiency.

In addition to ship structure, a plan needed to be developed to help guide researchers in Arctic waters. Currently, groups like the USCG Icebreakers (http://icefloe.net/front_page), the Arctic Icebreaker Coordinating Committee (AICC; https://www.unols.org/committee/arctic-icebreaker-coordinating-committee-aicc), and the Arctic Waterways Safety Committee (AWSC; http://www.arcticwaterways.org/) have begun to develop protocols and guidelines to reduce potential time/space conflicts between research ships and Indigenous communities. The USCG Icebreakers have a Community Primer for marine scientists planning shipboard work in Alaskan Arctic and Sub-Arctic waters (http://icefloe.net/community-primer). This primer lists steps for scientists to follow to assist in having a conflict-free research cruise. The AICC provides polar science projects with planning assistance and liaisons, and facilitates communication among scientists, funding agencies, and facility providers. The purpose of the AWSC is to bring together local Alaskan Arctic marine interests in a single forum to develop best practices to ensure a safe, efficient, and predictable operating environment for users of the waterways. Similar to these groups, CFOS and NSF developed a Community and Environmental Compliance Standard Operating Procedure (CECSOP) to provide guidance and outline standard operating procedures to Principal Investigator (PI) scientists who intend to use R/V *Sikuliaq* to conduct research activities in Arctic waters. To our knowledge, this document is the only one that has been developed for a specific vessel.

3. CECSOP

The CECSOP was prepared by CFOS by first taking into consideration the AWSC Standard of Care (SOC) for Research Cruise Operations 2017 document (http://www.arcticwaterways.org/safety-plan.html), which was developed separately at the time of the CECSOP's preparation. The AWSC is a coordinating group comprised of Arctic waterway stakeholders, including individuals and representatives from Alaska Indigenous Organizations, industry, local government, research, and others. The AWSC is meant to provide a broad-based forum for local marine interests in Alaska's Arctic, and to act collectively on behalf of those interests to ensure a safe, efficient, and predictable operating environment for all current and future users of Arctic waterways. The CECSOP document described here is a living document specific to R/V *Sikuliaq* operations, and may be modified in the future based on new guidance, such as a revised AWSC SOC or other best practices that are

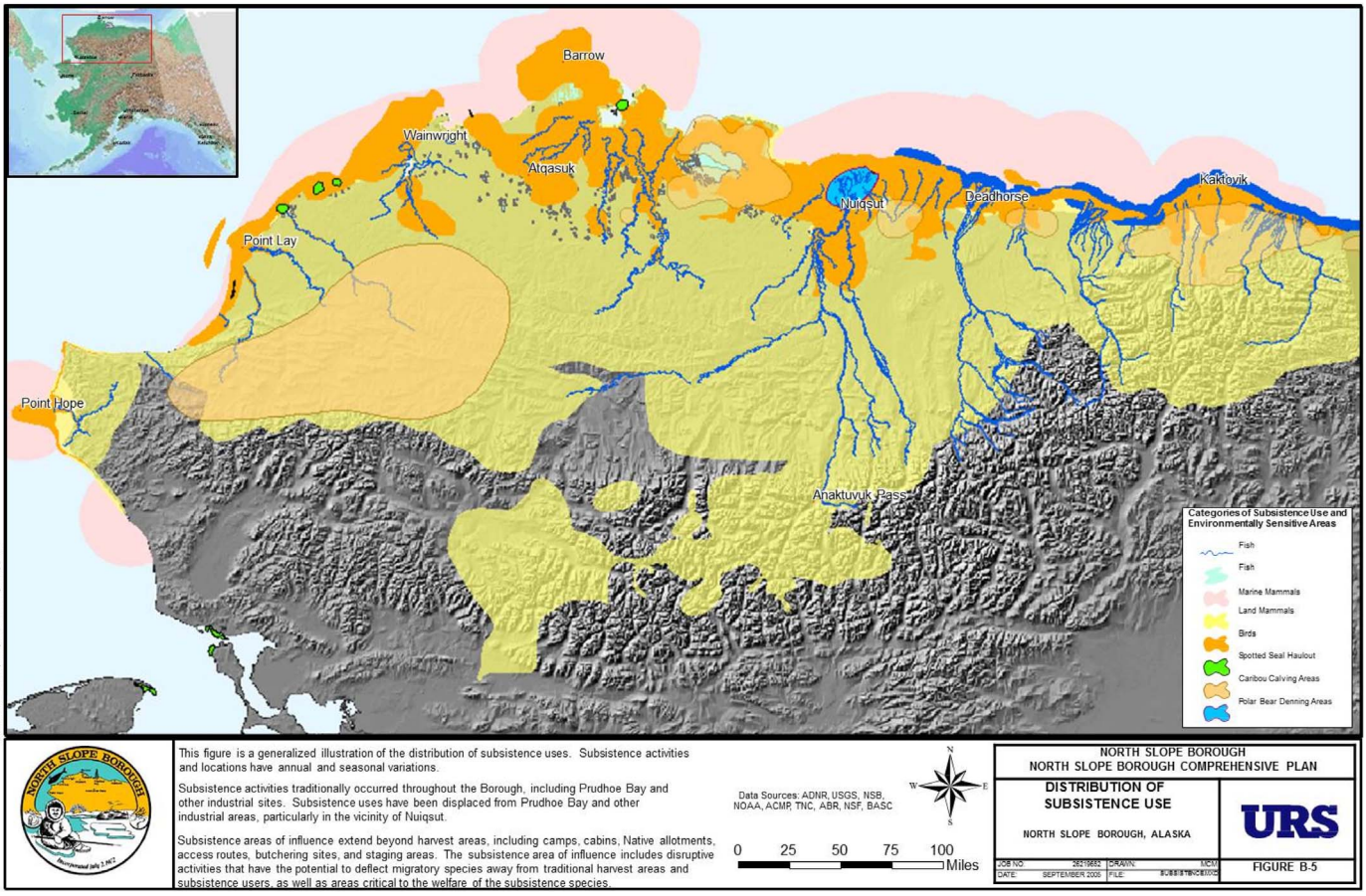

Fig. 3. Map of the distribution of subsistence users in Northern Alaska from the North Slope Borough.
Source: http://www.north-slope.org/assets/images/uploads/b5.pdf

identified.

Following the development of an initial draft of the CECSOP, the document was circulated by CFOS to various groups from which comments were requested. Redrafting of this document occurred multiple times over the course of one year. Local subsistence communities were contacted through the AWSC and the Alaska Eskimo Whaling Commission (AEWC). Outreach experts were involved using the Alaska Sea Grant Marine Advisory Program Agents located in Nome and Dutch Harbor, Alaska. The research community was included in this review process through the Arctic Icebreaker Coordinating Committee, the CFOS Ship Committee, and by contacting past and current research ship users. Additionally, staff of research funding agencies, including NSF, the National Oceanic and Atmospheric Administration, and the North Pacific Research Board participated in the review process.

3.1. General guidance for research activities

As a first step, when possible, research activities should be planned to avoid impacts on, or spatial/temporal conflicts with, maritime subsistence harvest areas, activities, and marine resources. Along with harvest areas, migration pathways of marine mammals need to be considered during certain times of the year (Fig. 4). To achieve research goals while minimizing community impacts, discussions may be needed with potentially affected coastal communities if research activities cannot avoid impacts on and spatial/temporal conflicts with maritime harvest areas, activities, and resources. Examples include 1) activities that are expected to cause conflict, 2) research activities to be conducted within 50 nautical miles (nm) of Utqiaġvik or within 30 nm of other coastal villages or established whaling camps (Figs. 2), or 3) research to be conducted within a distance of 12 nm, the U.S. territorial limit, from the rest of the Arctic coastline. The distances listed here were recommended by the communities represented in the AWSC and included in the AWSC SOC Draft February 22, 2017. Any transits through the Bering Strait are conveyed to interested parties by the R/V *Sikuliaq* Marine Superintendent, and PIs are notified if further action is necessary.

3.2. Community and Environmental Compliance Standard Operating Procedures (CECSOP)

3.2.1. Pre-cruise actions

PIs scheduled for, or potentially interested in, using R/V *Sikuliaq* should review the CECSOP and material available on the R/V *Sikuliaq* website prior to using the vessel. PIs are encouraged to contact the CFOS Associate Dean for Research Administration for additional guidance or clarification with respect to conducting research in the region and the R/V *Sikuliaq* Marine Superintendent regarding vessel capabilities and limitations.

Once a research activity has been scheduled on the vessel (regardless of the sponsoring agency or organization), the NSF Division of Ocean Sciences Environmental Compliance Officer sends the NSF "Organization Environmental Compliance Checklist" (NSF EC Checklist) to the PI; the NSF EC Checklist can also be found on R/V *Sikuliaq* and NSF websites. Within three weeks of receiving the NSF EC Checklist, PIs complete the form including their Institution's Authorized Organizational Representative signature, which indicates institutional concurrence, and return it to the NSF Division of Ocean Sciences Environmental Compliance Officer for review.

Within two weeks of the PIs being informed of an award recommendation by a sponsoring agency or organization, the PIs provide

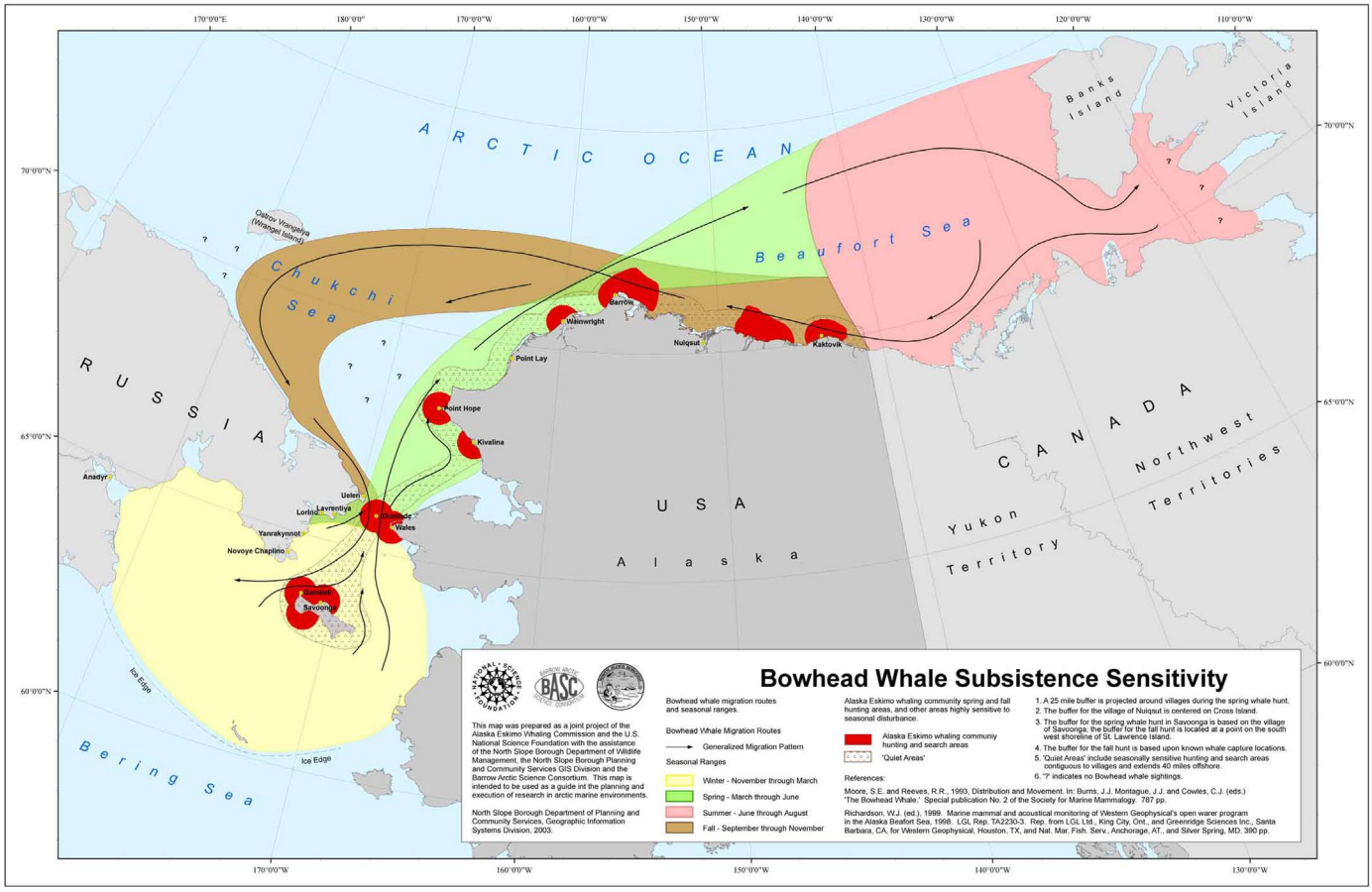

Fig. 4. Bowhead whale subsistence sensitivity areas highlighting migration paths.
Source: http://icefloe.net/files/Bowhead_Whale_Subsistence_Sensitivity.jpg

the Associate Dean, Research Administration with a one-page Pre-Cruise Plan project summary using the template found on the R/V *Sikuliaq* website that presents the research questions, location and timing of the research, and general research activities to be conducted. This document is used to communicate the planned scientific objectives to the AWSC one month prior to the annual fall meeting to determine if the PIs should attend future AWSC meetings, meetings of co-management organizations such as the AEWC, and/or meetings with potentially affected communities. If, after assessing the one-page summary, the Associate Dean, Research Administration determines there are no spatial/temporal conflicts, then the PIs need only supply the Associate Dean, Research Administration with a brief presentation that can be used by the Associate Dean, Research Administration at the fall AWSC meeting and/or an AEWC meeting to introduce attendees to the research and cruise plans.

If the one-page summary, as assessed by the Associate Dean, Research Administration, indicates that there may be a spatial/temporal conflict, then the PIs, or a qualified designee (such as an individual capable of addressing questions about the proposed research, techniques, methodologies, and cruise routing and tracks[3]) may need to attend the fall AWSC meeting and/or the AEWC meeting to present an overview of the research plans, draft cruise plans, and any other relevant research-related activities. The PI is accompanied by the Associate Dean, Research Administration and/or other representatives of the vessel (e.g., Marine Superintendent, CFOS Marine Advisory Program agent, R/V *Sikuliaq* Science Liaison). Input is sought at the meeting as to whether the funded research activity has the potential to impact maritime subsistence activities and/or marine resources, and if additional discussions with potentially affected parties (e.g., co-management entities, whaling captains associations, tribal governments) is recommended. PIs, or a qualified designee, may need to attend additional meetings to discuss funded research activities with potentially affected parties and develop monitoring and mitigation measures in order to avoid or minimize potential impacts to maritime subsistence harvest areas, activities, and resources. The Associate Dean, Research Administration coordinates and assists PIs with this effort. For NSF funded projects, NSF Program Managers are aware that additional travel funds may be needed for these purposes. For non-NSF projects, PIs should consult with their funding entities.

If necessary, a modified research pre-cruise plan, incorporating any agreed upon monitoring or mitigation measures, is presented by the Associate Dean, Research Administration, PI, or qualified designee, at a meeting to be determined by the Associate Dean, Research Administration (typically the spring AWSC or winter AEWC meeting). If not present at the meeting, the PI or qualified designee may need to be available remotely to provide assistance to the Associate Dean, Research Administration during the meeting.

The NSF environmental compliance process, including compliance with federal environmental regulations and any additional consultations, must be completed prior to cruise commencement. Compliance with the required environmental regulations can be a lengthy process. For example, formal authorizations associated with the MMPA take a minimum of 120 days and formal consultations associated with the ESA take a minimum of 135 days. Informal consultations under the ESA can take a minimum of 30 days. The NSF Division of Ocean Sciences Environmental Compliance Officer will confirm with the Associate Dean, Research Administration, Marine Superintendent and PI when documentation is complete.

Since R/V *Sikuliaq* is an NSF-owned research vessel, NSF retains the discretion to deny any research activities from going forward if

environmental or subsistence concerns are revealed and not resolved during the environmental compliance process. PIs should not rely on the scheduling of the cruise as an indicator that NSF cannot or will not cancel the cruise for concerns revealed during the environmental compliance process.

3.2.2. Cruise actions

The Captain and crew of R/V *Sikuliaq* comply with all applicable regulations (international, federal, state, and local) and UNOLS Research Vessel Safety Standards, and navigate the vessel responsibly, particularly when operating in the vicinity of marine mammals. For research activities that do not involve impacts on, or spatial/temporal conflicts with, maritime subsistence harvest areas, activities and/or resources, no special monitoring or mitigation measures are warranted unless required by other regulatory requirements, such as through consultation under the ESA. For research activities that may involve potential impacts on, or spatial/temporal conflicts with maritime subsistence, harvest areas, activities, and/or resources, the Captain and crew of R/V *Sikuliaq* report location, speed, direction and purpose of transit to interested communities via their Tribal office or designated local contact as requested.

Any additional monitoring and mitigation measures agreed upon during Pre-Cruise Actions are implemented during cruise operations, which may include having a Protected Species Observer or Local Expert onboard. A Protected Species Observer is a person who has been typically approved by the National Marine Fisheries Service (NMFS) and can identify, document and report on marine mammal observations per MMPA authorization or ESA consultation requirements. A Protected Species Observer is typically responsible for enforcing monitoring and mitigation measures and any formal reporting requirements identified in permits or authorizations, such as per the MMPA and ESA. A Local Expert may not be a qualified Protected Species Observer but observes or participates in research activities, interacts with the research team, and communicates during the research cruise with Indigenous communities. Whether a Local Expert is needed is determined during discussions with local communities. The Local Experts can be suggested by NSF, ship users or community members. The ship user (i.e., the researcher or their funding agency) is responsible for paying for the Protected Species Observer and Local Expert if required. Regardless of whether a Protected Species Observer or Local Expert is required, researchers are encouraged to retain the services of a Local Expert from subsistence hunting villages on Arctic cruises whenever possible. All Local Expert personnel are asked to provide documentation of their communication efforts to local communities during and after the cruise (e.g., written reports and social media).

3.2.3. Post cruise actions

A Post-Cruise Summary is prepared by the PI using the template found on the R/V *Sikuliaq* website. The Post-Cruise Summary is submitted to the Associate Dean, Research Administration within 90 days of cruise completion and posted on the R/V *Sikuliaq* website. If a Protected Species Observer and/or Local Expert participated during the cruise, a final report by each is compiled within 90 days of cruise completion, submitted to the Associate Dean, Research Administration, and posted on the R/V *Sikuliaq* website. This report may be incorporated into a Post-Cruise Summary for the research activity. A Protected Species Observer is responsible for preparing and submitting any formal reports required by permits or authorizations, such as per the MMPA and ESA. A summary of past year research cruise activities involving R/V *Sikuliaq* may be presented by the Associate Dean, Research Administration at the fall and spring AWSC meetings, and possibly other meetings as appropriate.

If the project required mitigation to avoid impacts to subsistence hunt activities or resources (as determined prior to the cruise), the PI, or their designee, may need to report on preliminary research results, mitigation highlights, and any areas for improvements at the next scheduled AWSC meeting. If agreed upon during Pre-Cruise Actions, PIs may need to report preliminary research results to affected coastal communities.

3.3. Roles and responsibilities

The following are general descriptions (i.e., not all-inclusive) of the roles and responsibilities of individuals associated with research cruises conducted on R/V *Sikuliaq*.

3.3.1. CFOS Dean

The CFOS Dean has overall responsibility for CFOS personnel and facilities, including R/V *Sikuliaq* operations. As required, the Dean works closely with the Associate Dean, Research Administration, Marine Superintendent, R/V *Sikuliaq* Science Liaison, Marine Advisory Program agents and NSF in support of R/V *Sikuliaq* outreach activities and in accordance with the CECSOP.

3.3.2. CFOS Associate Dean, Research Administration

R/V *Sikuliaq* has a single point of contact for issues related to maritime subsistence harvests and environmental compliance: the Associate Dean, Research Administration. The Associate Dean, Research Administration maintains constant and close contact with the Marine Superintendent as well as communicates and coordinates with the R/V *Sikuliaq* Science Liaison, Marine Advisory Program agents, AWSC, NSF, and PIs. The Associate Dean, Research Administration reviews all plans for pre-and post-cruise research operations and distributes them to the NSF Division of Ocean Sciences Environmental Compliance Officer, the Marine Superintendent, the R/V *Sikuliaq* Science Liaison, Marine Advisory Program agents and the AWSC. The Associate Dean, Research Administration also works with the R/V *Sikuliaq* Science Liaison to review and distribute the one-page research summaries, and provides needed research presentations at appropriate meetings.

3.3.3. Marine Superintendent

The Marine Superintendent works with the Associate Dean, Research Administration with primary responsibilities to include reviewing all pre- and post-cruise reports. The Marine Superintendent also works with NSF Division of Ocean Sciences Environmental Compliance Officer to ensure the NSF compliance process is properly completed prior to cruise commencement. The Marine Superintendent participates in the UNOLS Arctic Icebreaker Coordinating Committee (AICC) activities and reports on all ship activities to this group.

3.3.4. CFOS Public Information Officer and R/VSikuliaq Science Liaison

The CFOS Public Information Officer acts as the R/V *Sikuliaq* Science Liaison. The R/V *Sikuliaq* Science Liaison assists the Associate Dean, Research Administration in working with communities, Marine Advisory Program agents and the PIs. The R/V *Sikuliaq* Science Liaison provides potential ship researchers working in the Arctic and sub-Arctic regions with the CECSOP for R/V *Sikuliaq* Research Operations, and ensures that researchers are aware of the current AWSC SOC and the AWSC Safety Plan. The R/V *Sikuliaq* Science Liaison assists PIs with required compliance meeting presentations (such as for the AWSC meeting and/or the AEWC meeting). The R/V *Sikuliaq* Science Liaison also assists in general outreach activities for the vessel.

3.3.5. Marine Advisory Program Agent

If applicable, the Associate Dean, Research Administration and R/V *Sikuliaq* Science Liaison work with appropriate Marine Advisory Program agents to connect the vessel (through the Marine Superintendent) with local communities. The Marine Advisory Program agent duties may include assisting with R/V *Sikuliaq* logistic support and regional community communications. If requested, the Marine Advisory Program agent may also assist the PIs with local outreach activities.

3.3.6. NSF Division of Ocean Sciences Environmental Compliance Officer

The NSF Division of Ocean Sciences Environmental Compliance Officer provides the NSF "Organization Environmental Compliance Checklist" (NSF EC Checklist) to the PIs; the NSF EC Checklist can also be found on the R/V *Sikuliaq* website and the NSF website. The NSF environmental compliance process, including compliance with federal environmental regulations and any necessary consultations, must be completed prior to cruise commencement. The NSF Division of Ocean Sciences Environmental Compliance Officer confirms with the CFOS Associate Dean, Research Administration, Marine Superintendent and PIs when documentation is complete. The NSF Division of Ocean Sciences Environmental Compliance Officer also clarifies any questions regarding compliance with federal environmental regulations.

3.3.7. Principal Investigator (PI) processes

The PI(s)/Institutions are responsible for completing and submitting the NSF Organization Environmental Compliance Checklist. The PIs are also responsible for completing the Pre- and Post-Cruise Reports. They are responsible for ensuring that their research complies with NSF and R/V *Sikuliaq* policies and procedures, including those outlined in the CECSOP. They are also responsible for providing a one-page summary of their research, any requested presentations, and possibly attending meetings. Additionally, the PI(s) are responsible for obtaining any necessary permits for the proposed activities (e.g., North Slope Borough Study Permit). For clarification, the term "permit" is often colloquially used in reference to all environmental compliance activities, including authorization received under a federal regulation such as the MMPA or ESA. Obtaining a "permit", however, does not include NSF's federal environmental compliance responsibilities, such as compliance with NEPA, MMPA, and ESA, or the resulting associated decisions and authorizations. Additionally, authorization is often necessary for proposed activities (e.g., construction) to be conducted on federal, state, and local government lands. If applicable, the PI(s) are responsible for obtaining needed permits from the appropriate governing agencies (e.g., Bureau of Land Management, National Park Service, and North Slope Borough).

3.3.8. Protected Species Observer

The Protected Species Observer assists with monitoring of marine species. Qualifications necessary for the Protected Species Observer are determined during consultations and negotiations with regulatory agencies. Protected Species Observers are subject to the regular code of conduct on board the vessel and UNOLS standards. Protected Species Observers are typically National Marine Fisheries Service (NMFS) approved and can identify, document, and report on marine mammal observations per consultation requirements, such as per the MMPA. The Protected Species Observer records marine mammals observed during the cruise during daylight hours. The Protected Species Observer is typically responsible for enforcing monitoring and mitigation measures and any formal reporting requirements identified in permits or authorizations, such as per the MMPA and ESA. Although CFOS personnel assist with identifying the Protected Species Observer, funding for the Protected Species Observer is borne by the ship user.

3.3.9. Local Expert

Qualifications for a Local Expert are determined on an ongoing basis and during negotiations with local communities. The Local Expert is subject to the regular code of conduct aboard R/V *Sikuliaq* and UNOLS standards. The Local Expert maintains a record of all communications made or received by the Local Expert, including ship-to-shore communications with subsistence hunting communities and vessels, as well as any marine mammal sightings. Observations are communicated via the tribal office or designated local contact during the cruise, and a final Local Expert report is compiled within 90 days of cruise completion and posted on the R/V *Sikuliaq* website. CFOS personnel assist with identifying Local Experts; however, funding for the Local Expert is borne by the ship user.

3.3.10. R/V Sikuliaq captain and crew

The Captain of R/V *Sikuliaq* has authority over the vessel and ensures compliance with all applicable regulations and UNOLS Research Vessel Safety Standards. The Captain has the right to refuse to perform any activities that are not contained within the agreed upon cruise plan if deemed contrary to the processes described in this document. The Captain and crew of R/V *Sikuliaq* ensure safe navigation of the vessel, including when in the vicinity of marine mammals and other marine resources. The Captain and crew of R/V *Sikuliaq* report location, speed, direction, local weather conditions, sea ice conditions and purpose of transit to interested communities via the tribal office or designated local contact as requested by interested communities. The Captain and crew may work directly with Marine Advisory Program agents regarding communications, outreach, and/or logistical assistance when underway and/or during a port call.

4. Discussion

Vessel traffic has increased in recent years because of the decrease in sea ice cover. Between 1979 and 2013, the duration of summer reduced sea ice periods across the Arctic increased on average by 5–15 weeks, except for in the Barents Sea, which increased by over 20 weeks [20]. In 2014, over 11,000 ships operated in the Arctic [6]. Of these ships, 18% were fishing vessels, 18% were cargo, 5% were tankers, and 3% were passenger. The remaining 56% were research, industry, and "other" (ships conducting activities that did not fit into one of these other categories; [6]). An example of industry is Quintillion Global Communications (http://qexpressnet.com/), a group that is laying and burying an extensive subsea fiber optic cable system, which includes kilometers of subsea fiber into Nome, Kotzebue, Utqiaġvik, Point Hope, and Wainwright, Alaska. Most of the ships operating in the Arctic were in the Norwegian and Barents Seas, followed by the Siberian and Canadian coasts, with the fewest in the Bering and Chukchi Seas around Alaska [6]. While there has been increased traffic in the Northeast Passage between 2011–2013 and 2014, the Northwest Passage has not seen an increase and is still rarely used because sea ice remains too thick for most safe vessel traffic (Haas and Howell [11]). As far as research vessels in the Alaskan Arctic, this summer was similar to previous years with nine vessels and 14 different cruises occurring between June 9 to October 16, 2017 (https://www.iarpccollaborations.org/index.html). The timing of all vessel traffic is also seasonally-dependent, with most traffic concentrated between July and October when sea ice cover is minimal [6].

The reduced ice period is also when marine mammals migrate and some subsistence hunts occur. For example, bowhead whales, summer in the Arctic and migrate each spring along the north coast of Alaska [24,9]. Similarly, migratory belugas occur along the northwest and northern part of Alaska's coast. At certain times of the year, belugas migrate thousands of kilometers, in some cases as far as 80° N into dense pack ice [34]. Both of these species are commonly hunted. In response to changing sea ice patterns, marine mammal distribution and migrations, and subsistence hunting practices are changing as well [15].

Largely because of these environmental changes, interactions between vessels and subsistence hunters will probably increase and both mariners and subsistence groups will need to be adaptive. The CECSOP described here includes information, such as safe working distances to Indigenous coastal communities described in Section 3.1, which can be used as a guideline for other research vessels in addition to R/V *Sikuliaq*. This information could be passed on to mariners via the commonly used Coast Pilot. Currently, the U.S. Coast Pilot 9 states that "during the months of May to June and September to October in the waters north of the Bering Strait as far as 30 miles offshore. Mariners should maintain a sharp lookout for marine mammals and small vessels, and exercise caution when operating in their vicinity" [4]. As this book is commonly used by mariners, it could be modified to include more detail on

community and environmental compliance, such as found in the Coast Pilot for distances around some specific marine mammal haul-outs [4]. Although some of the CECSOP could be easily transferred to other vessels, the roles of key personnel would need to be evaluated as R/V *Sikuliaq* is unique because of the extensive infrastructure that has been established for its success working in the Arctic. The CECSOP is a living document and is expected to change with lessons learned and the changing environment. The most recent 2017 research cruise received positive feedback regarding R/V *Sikuliaq* communications from whaling communities. The document should remain adaptable to specific needs, as the intent is to improve relations and communications between R/V *Sikuliaq* and Indigenous communities.

5. Conclusion

As Arctic ecosystems change rapidly, there is increased interest in conducting Arctic research to document the change. Simultaneously, Alaska coastal communities continue to rely on ocean resources like marine mammals as a source of food and vital component of cultural practices. The CECSOP is a working document for R/V *Sikuliaq,* but also outlines a basic structure that can be used to communicate and mitigate potential conflicts between Arctic researchers and Alaska Indigenous communities in light of increased research interest in the region. The CECSOP structure aims to unite varying researchers, communicators, and Alaska coastal community members to evaluate the best way to ensure that all research goals and cultural needs are met during a particular expedition, and all perspectives are considered. Specific processes must be reevaluated for each cruise on a case-by-case basis, reflecting the needs of individual communities and researchers involved in each expedition. This CECSOP is meant to serve as a living document. As a result, the steps necessary to ensure appropriate communication and compliance between researchers and communities are subject to change if future conditions render any processes to no longer be effective.

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