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Advancing Engineering With Nature Initiatives in Point Hope, Alaska

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PURPOSE: Growing environmental risk threatens communities in cold regions, particularly as climate change contributes to permafrost thaw, a reduction in sea-ice extent, and some of the largest rates of coastal erosion on earth. In the context of these significant and growing risks, the Engineering With Nature® (EWN®) program formed its cold regions work unit in 2021 to explore the potential to apply EWN approaches in these areas to mitigate environmental risk while supporting resilient outcomes. The work unit's objectives include working with communities to preserve the natural environment and traditions, advancing the work unit's understanding of cold-region environments, and providing guidance on the implementation of natural and nature-based features (NNBF) and EWN in cold regions to increase resilience. This technical note (TN) provides an overview of the EWN in cold regions technical approach as applied to Point Hope, Alaska, which includes community engagement, the integration of traditional ecological knowledge (TEK) throughout the project, and the development of cold-regions-specific knowledge and tools.

BACKGROUND AND PROBLEM: High-latitude regions experience faster rates of global warming relative to lower latitudes (Rantanen et al. 2022), driving sea-ice loss, increasing rates of sea-level rise, coastal erosion, and permafrost thaw (Irrgang et al. 2022; Liew et al. 2022; Wang et al. 2022). These changes affect ecosystem function, civil infrastructure, and personal livelihoods. In Alaska, nearly 100 communities have a moderate-to-high risk of infrastructure damage from coastal erosion in the next decade, and nearly 90 communities have a moderate-to-high risk of infrastructure damage from thawing permafrost (UAFINE et al. 2019). Wildlife migration patterns are also changing, contributing to growing food insecurity for largely subsistence communities. While communities in low- and midlatitude sites have increasingly turned to NNBF to mitigate these risks, adapting standard approaches to NNBF in colder regions presents unique constraints, such as a lack of long-term datasets and established datums, remote project sites in seasonally frozen locales, and limited materials. Recognizing both these limitations and the significant need for NNBF strategies to protect vulnerable communities in high-latitude sites, EWN initiated a cold regions work unit within the EWN research and development program to explore multidimensional NNBF and EWN strategies capable of enduring cold-regions environments and engage with Indigenous and local communities in the Arctic, sub-Arctic, and other regions affected by these cold-region-related threats. Additional critical threat elements that must be addressed include those threats and impacts to subsistence and culturally significant activities inextricably intertwined with the same variables that threaten infrastructure.

Advancing NNBF implementation in these sites requires the participation of the community with all aspects of project development, overcoming issues of data scarcity and complex logistics for site access, sensor limitations for field collection in extreme environments, and limited raw material availability for engineering construction. The establishment of the cold region work unit provides an opportunity to address these as well as additional, cold-region-specific, challenges. This US Army Engineer Research and Development Center (ERDC) TN describes initial work at Point Hope aimed at advancing EWN strategies in cold-region settings.

PROJECT DESCRIPTION: The remote community of Point Hope, one of North America's longest continuously inhabited settlements, is located in northwestern Alaska above the Arctic Circle on the western tip of the Lisburne Peninsula. The Lisburne Peninsula juts out into the Chukchi Sea towards the migratory routes of the whales that have traditionally sustained the Iñupiat people for over 2,000 years. The region is experiencing an increase in relative sea level as compared to the southern portion of Alaska, which is experiencing a decrease in relative sea level due to isostatic rebound (Sweet et al. 2022). In the last few decades, the northern shoreline along the peninsula has eroded at a rate of approximately 1–2 m[*] per year (Gibbs et al. 2019). This erosion and additional flooding prompted the inland relocation of the City of Point Hope, which mitigated risk to the main community infrastructure.

In recent years, the community has created makeshift coastal defenses by bulldozing sediment and placing armored rocks, defunct equipment, sand-filled drums, and supersacks along the northern shoreline to mitigate erosion. However, erosion and flooding along the northern coastline still threaten the historically and culturally important sod houses and *siġluaq* (Iñupiaq for *ice cellars*) at Old Tikigaq and the Ipiutak National Historic Landmark, which contains grave sites and ancient house ruins dating from the Ipiutak culture's settlement of the peninsula (Figures 1 and 2; Figure 3 provides a map showing the siġluaqs and sod houses' location). The northern end of the Point Hope airport's runway is similarly exposed, and the costly realignment of the angle of the runway to reduce this exposure is planned in coming years.

With a grant from the National Fish and Wildlife Foundation's (NFWF) National Coastal Resilience Fund and matching funds from the North Slope Borough, E.A. Engineering, Science, and Technology, Inc., PBC (EA) was subcontracted to Agviq Environmental Services (AES) to lead an effort focused on exploring potential NNBF strategies at Point Hope on behalf of the City of Point Hope as the grant holder. Project partners included the US Army Corps of Engineers' (USACE) EWN research and development program, which further involved scientists from ERDC's Cold Regions Research and Engineering Laboratory (CRREL) and Coastal and Hydraulics Laboratory (CHL); and landscape architects at the Dredge Research Collaborative (DRC) and the University of Pennsylvania. This collaborative project aimed to gather data, conduct alternative analyses for different shoreline-adaptation and resiliency priorities identified in the Point Hope Comprehensive Plan, and develop preliminary designs for the highest-priority projects. Additional funding through EWN supported efforts to enhance the understanding of natural-infrastructure projects through advancing research efforts and conceptual design

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[*] For a full list of the spelled-out forms of the units of measure used in this document, please refer to *US Government Publishing Office Style Manual*, 31st ed. (Washington, DC: US Government Publishing Office, 2016), 248–52, https://www.govinfo.gov/content/pkg/GPO-STYLEMANUAL-2016/pdf/GPO-STYLEMANUAL-2016.pdf.

development on the northwestern Alaska coast. To accomplish this objective, this research effort seeks to document and synthesize efforts related to data collection, the incorporation of TEK, and stakeholder engagement and collect additional data to address data gaps identified at Point Hope. The project team also sought and secured an additional NFWF grant to fund the design and engineering of a proposed shoreline-resiliency project along the north shore.

Figure 1. A community member opens a siġluaq to show the project team. (Photo courtesy of E.A. Engineering, Science, and Technology, Inc., PBC).

Figure 2. A traditional sod house at Point Hope, Alaska, constructed of bowhead whale bones and sod. (Photo courtesy of E.A. Engineering, Science, and Technology, Inc., PBC)

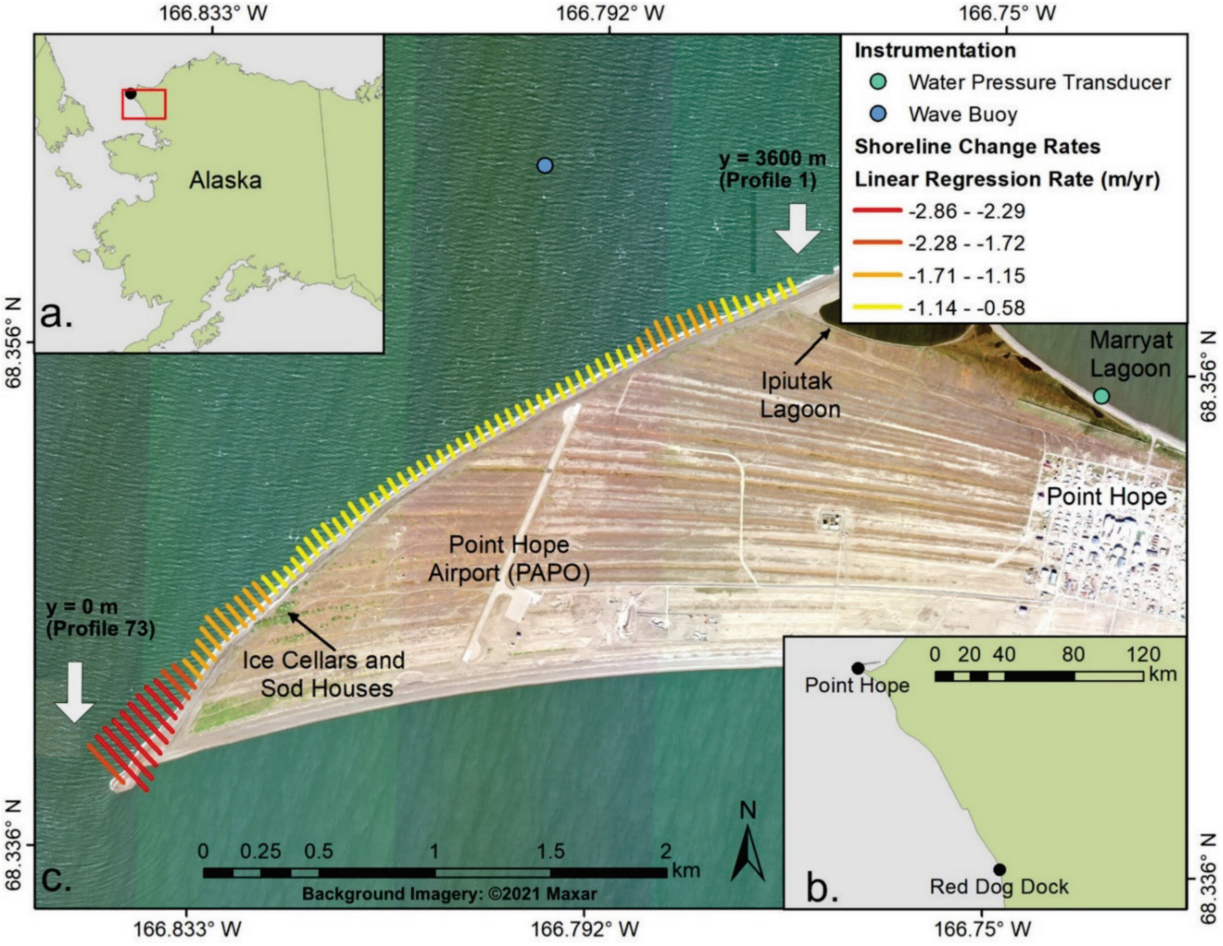


Figure 3. Shoreline change rate assessed along the northern coastline show rates from −0.58 to −2.86 m per year, with change rates largest at the western tip of the peninsula. A wave buoy was placed about 1 km north of the northern coastline, and a water-pressure transducer was placed at Marryat Lagoon. (Reproduced from Cohn et al. 2022, 3. CC BY 4.0.)

Community engagement and traditional ecological knowledge (TEK). One of the objectives of the EWN cold regions work unit is to integrate the local community as part of the entire project process to ensure preservation and enhancement of natural-environment function and associated traditions. This integration leverages the enduring knowledge accumulated from the community's years of direct experience, keeps the community apprised of the project, and provides them with a better understanding of the EWN and NNBF process. At Point Hope, the project team regularly engaged the community to center the community's interests in the NNBF approach and incorporate TEK into the project, which is the knowledge that Indigenous and local people have accumulated through their direct experiences in their local environment. The inclusion of TEK has informed data-collection efforts and insights on local beach dynamics, the design of the proposed natural-infrastructure measure along the shoreline, and other aspects of the project. At Point Hope, the community engagement and TEK efforts were driven by an understanding and respect for the community's ancestral history at the project site and their strong emotional connection to the land.

The project team's engagement with the predominantly Iñupiaq community of Point Hope was informed by historic interactions on the peninsula and recent regional efforts. Early on in the project, the project team participated in a cultural-awareness workshop to gain a better understanding of Iñupiaq culture and focus on cross-cultural communication practices. They took part in a discussion that acknowledged the history of Project Chariot, a 1958 plan to create a port near Point Hope using atomic bombs. Though the port was never realized, the project included radioactive iodine experimentation on the local people and left a legacy of negative interactions between the government and scientists and the local communities. With an understanding of this history, the project team adapted an ethical research protocol written by nearby Kotzebue, Alaska, as it provided guidance for respecting Iñupiaq values, history, and knowledge sovereignty (Whiting 2022). The ethical research protocol informed the development of the project's community involvement plan (CIP), which outlines the iterative process of effective, responsible, and equitable engagement with the community.

The initial community meeting held in July 2021 communicated project-team goals and solicited feedback from the community. The meeting opened with an Iñupiaq prayer per the community's request, after which community members spoke with the project team and asked questions, provided anonymous notes, and recorded ecological observations on large-format maps and posters. The conversations at this initial meeting facilitated the next steps in engagement, which included interviews, site visits, and informal discussions. Formal compensated interviews, brief informal interviews, and site visits with community members provided additional insights on the four community priorities identified:

1. Preserve cultural and historic sites located along the north shore of Point Hope.
2. Maintain and improve the functionality of the village's siġluaqs.
3. Improve the reliability of 7-Mile Road.
4. Provide safe boat access to the Arctic Ocean.

The project team then worked to develop different preliminary alternatives to address these four priorities. A second community meeting held in February 2022 provided the opportunity for the project team to present initial designs for each of the community priorities and receive feedback. In addition to the second community meeting, project team members hung up posters in the local grocery store that displayed landscape architectural renderings of each design along with a folder where community members could vote and provide feedback on the different alternatives (Figure 4). The project team developed seven preliminary alternatives, including a no-action alternative, to address the first priority. One of these alternatives included a newly constructed siġluaq and therefore contributed to the second priority. The team then applied a multicriteria decision analysis (MCDA) model to compare the alternatives developed for all potential projects considering criteria such as community acceptance, maintenance, use of NNBF, cost, and the effectiveness in slowing or preventing erosion. The MCDA model identified the dynamic revetment and dune system with enhanced siġluaq as the preferred alternative for the first community priority, which aligned with the community's selection (Figure 5). The enhanced siġluaq featured in the design is based on TEK and includes innovative features to improve its performance, including foam insulation, sod insulation, an entrance shelter, a ventilation system, thermosyphons, and a deeper siġluaq depth. The dune design also features beach access points and lookout points, which can be used by whaling-crew spotters when they look for beluga whales and other marine mammals.

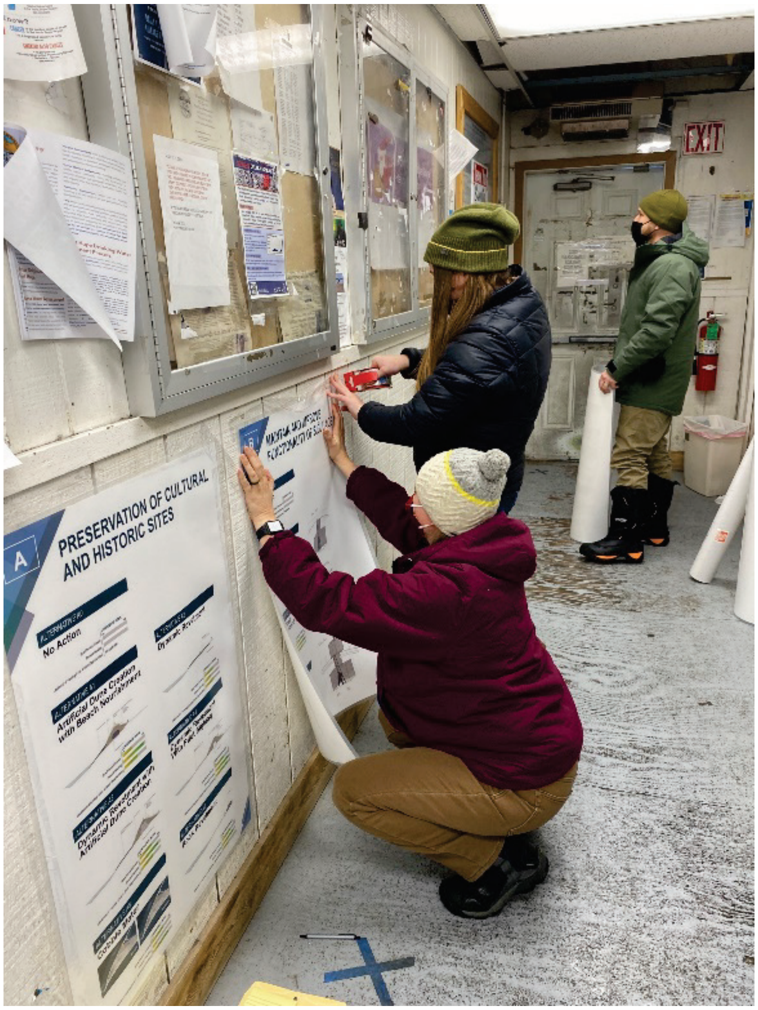
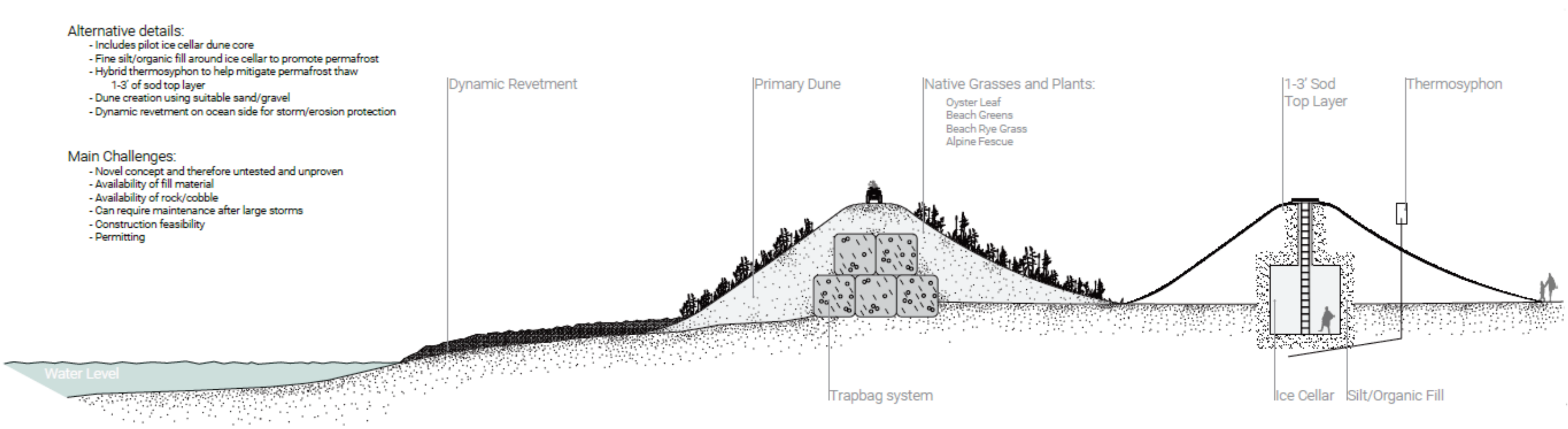


Figure 4. Hanging posters in the local grocery store to share information on the proposed alternatives with the community. (Photo credit: Lauren Bosche.)



Alternative details:
- Includes pilot ice cellar dune core
- Fine silt/organic fill around ice cellar to promote permafrost
- Hybrid thermosyphon to help mitigate permafrost thaw
  1-3' of sod top layer
- Dune creation using suitable sand/gravel
- Dynamic revetment on ocean side for storm/erosion protection

Main Challenges:
- Novel concept and therefore untested and unproven
- Availability of fill material
- Availability of rock/cobble
- Can require maintenance after large storms
- Construction feasibility
- Permitting

Figure 5. Landscape architectural cross-sectional rendering of dynamic revetment and dune system with enhanced siġluaq. Between the shallow-water shoreline (*left*) and the dune (*right*) is a dynamic revetment composed of cobble over existing beach. Native grasses and plants (oyster leaf, beach greens, beach rye grass, and alpine fescue) grow on top of the dune, which lies over silt and organic fill. (Image credit: Dredge Research Collaborative [DRC] and E.A. Engineering, Science, and Technology, Inc., PBC.)

The team incorporated TEK throughout the project, and TEK largely informed the identification of data gaps. Regarding the development of the siġluaq in the dune system, community members provided information on environmental conditions, such as the sediment grain size conducive to successful siġluaqs, and spoke to how and why siġluaqs fail. These insights informed the pilot siġluaq design. The community's understanding of the timing of freeze-up in early November also helped focus field efforts, as the project team accordingly installed a shoreline camera over a shorter time period to study erosion impacts. Throughout the project the team encountered various challenges in engaging with the community and in incorporating TEK, pertaining to potential cross-cultural miscommunication, unexpected delays and disruptions in communications arising in part because of the COVID-19 pandemic, and conflicting information. However, the project team mitigated these challenges' impacts on the iterative integration of TEK into the project.

Environmental characterization and numerical modeling. The Arctic differs from most global coastal sites because of critical thermal controls on both oceanographic processes and morphology. Much of the engineering guidance and numerical tools that USACE uses to design soft and hard engineering structures have been developed and applied specifically for sandy sites that lack ice. The transferability of these classic engineering approaches to cold-regions settings is therefore not yet entirely understood, particularly in the context of NNBF planning, design, and implementation. For this reason, another objective of the EWN cold regions work unit is to advance our understanding of cold-region environments and assess predictive technologies of coastal hazards in these locations. Currently, few morphology-change tools exist suitable for Arctic coastlines, and those tools that do exist have often only been applied and tested at the limited number of sites with high quantities of data. To pursue this objective at the Point Hope site, field data collection and numerical-model development and application of beach and tundra retreat at Point Hope was completed by ERDC. This section provides a short synopsis of the environmental characterization and modeling efforts originally published in Cohn et al. (2022).

To understand the morphologic and environmental drivers of tundra retreat, the project team modified the analytical model of Palmsten and Holman (2012; henceforth, *PH12*) as a cross-shore profile model for use in the low-lying cuspate foreland system at Point Hope. The PH12 model is based on a wave-impact theory model (Larson et al. 2004) and an understanding that effects to dune or bluff systems are controlled by total water levels (TWLs) (Ruggiero et al. 2001; Stockdon et al. 2007), which are comprised of still water levels (SWL) and wave run-up on the beach. The team adapted the model to specifically account for shoreline retreat to extend suitable timescales of the tool for medium-range morphologic systems. Additional assumptions, such as a static elevation of the bluff toe, were also included in the numerical framework, as described in Cohn et al. (2022). The project team used this modified model to understand the future exposure of the archaeological resources and infrastructure along the northern shoreline at Old Tikigaq, the Ipiutak site, and the Point Hope Airport.

The model requires time-series inputs of offshore wave and SWL properties and a definition of the intial morphology of the beach-tundra system. To provide the continuous SWL record necessary, an RBR*solo*³ D (RBR Global, Ottawa, Canada) pressure sensor was deployed in Marryat Inlet to characterize local SWL fluctuations (Figure 3). Though the pressure sensor recorded data from late July to early September 2021, the limited duration does not afford the assessment of water levels over a longer period. To characterize SWLs over a timescale of years, the nearest tidal water-level gauge located at Red Dog Dock (RDD), approximately 100 km southeast of Point Hope was used (NOAA Station 9491094). The SWL time series from RDD and Marryat Inlet are qualitatively coherent with a moderate correlation, indicating that nonlocal SWL measurements can generally be suitable for describing water-level fluctuations at this location because of consistency in the tidal and wind forcings over regional scale. The RDD data are available since 2004 with intermittent gaps in the record. To fill in the time series, outputs from the global HYbrid Coordinate Ocean Model (HYCOM) model are used (HYCOM 2023), and together the RDD and HYCOM datasets are interpolated to create a single SWL time series from 2004 to 2019 for use in the model.

Just as there are limited water-level data for the Chukchi Sea, there are also limited in situ wave records. To validate the use of long-term wave data from regional or global hydrodynamic models for the Point Hope field site, the project team deployed a Spotter wave buoy (Sofar Ocean, San Francisco, California) offshore of the northern coastline (Figure 3). The buoy collected bulk wave statistics from late July to early November 2021. The team then obtained model outputs from the ECMWF Reanalysis v5 (ERA5) hindcast model (ECMWF 2023), which showed considerable agreement with the wave buoy measurements, and so the team used the ERA5 modeled waves with the exception of waves propagating from the south because of the sheltering effect of the Point Hope peninsula exhibited in the wave buoy data.

Erosion rates of 0.3–2.4 m per year had most recently been assessed along the northern shoreline of Point Hope by Overbeck et al. (2020) using the US Geological Survey’s Digital Shoreline Analysis System (DSAS) tool to build off work by Gibbs et al. (2019) (USGS 2022). The source data used in these prior analyses included a NOAA topographic sheet (t-sheet), aerial photography, and satellite imagery. For the present analysis, the project team calculated long-term shoreline change rates using DSAS to update the results to include historical archive satellite images from the Global Enhanced GEOINT Delivery, or G-EGD, platform (Maxar Technologies, Westminster, Colorado) and tasked imagery from 2021. Open-source archives of shoreline rate of change are commonly available, even in remote sections of Alaska, and these data can be used or updated according to project needs. However, in areas of the coastline where such data are unavailable, local satellite-image analysis will be necessary to assess trends in shoreline change at potential NNBF and EWN sites. Because of the long time period of the shoreline change-rate assessment and the microtidal classification of the study site, the team determined the instantaneous land-water interface to be an acceptable shoreline proxy and thus manually digitized it in Esri’s ArcMap (Esri, Redlands, California) for each of the acquired images. The DSAS results assessed the rate of change across the shoreline at transects placed every 50 m (Figure 3), and the team tasked additional satellite imagery to assess changes on a shorter storm timescale to understand changes in morphology during high-energy regimes. However, the potential shoreline changes assessed using DSAS were smaller than the horizontal uncertainty of the satellite imagery and the shoreline digitization methods. Finally, the project team digitized vegetation lines on the imagery to assess the potential to track tundra impacts on a shorter timescale, but they assessed nearly no net change.

Airborne lidar sourced from NOAA Digital Coast from 2004, 2018, and 2019 enabled the assessment of the coastal profile change of the beach and tundra, though the geographic coverage of the datasets varied, with the greatest section of overlap by Old Tikigaq (NOAA 2023). The project team used lidar topography to run two model hindcast sets: one from 2004 to 2018 and one from 2018 to 2019. The model showed skill at hindcasting tundra retreat at annual to decadal timescales at given transect locations using the fast, empirical modified PH12 model (Figure 6). The results of the model at Point Hope indicated that steeper beach slopes produce high wave run-up, which can increase the rate of tundra retreat in given sections along the coastline. The field datasets and modeling also concluded that tundra-retreat events are driven by a combination of high wave energy and SWLs that are most likely to occur in September and October before shorefast ice develops. Modeling exploration used modified shoreline-change rates, sea-level-rise rates, and changes in wave energy to understand the impact that these different parameters had on driving future changes. Further, this work determined that the global hydrodynamic models reasonably resolve their given oceanographic processes in the southeastern Chukchi Sea. This result has implications for the use of publicly available datasets for deriving baseline environmental measurements for nearby coastal stretches in the Arctic and the design of NNBF for coastal protection at these remote sites. Accuately characterizing the environment and modeling the longevity and protective services of NNBF features at cold-region sites into the future is vital to EWN projects and the interest of growing environmental resilience.

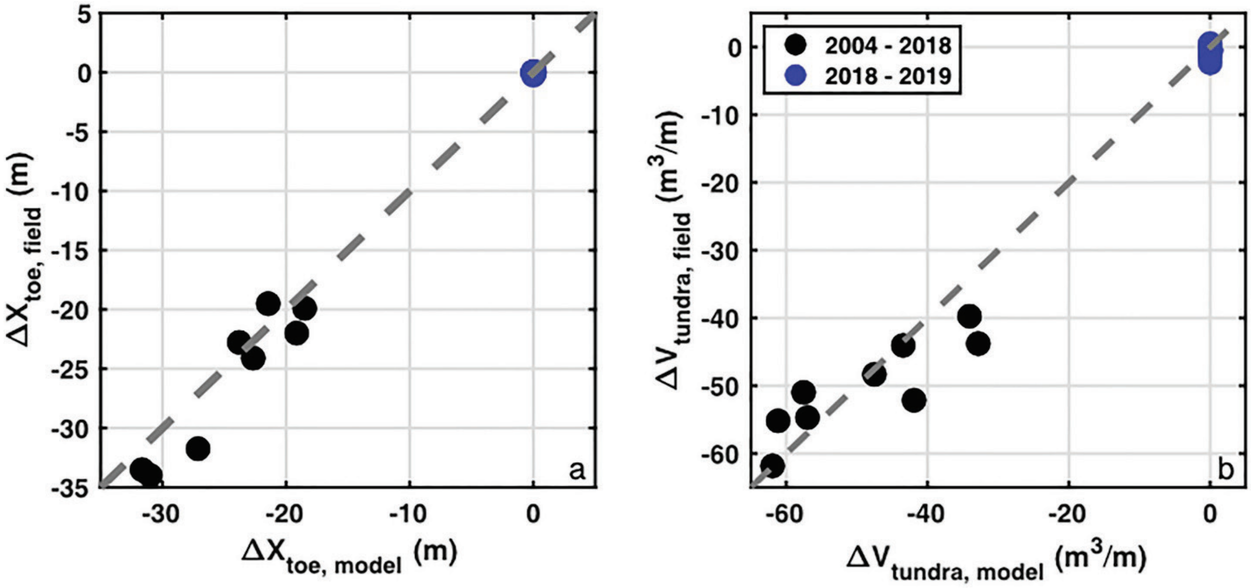


Figure 6. Comparison of the measured and modeled (*a*) horizontal tundra retreat at the 3.5 North American Vertical Datum (NAVD) of 1988 contour and (*b*) volumetric tundra losses from 2004 to 2018 (*black dots* at *lower left*) and 2018 to 2019 (*blue dots* at *upper right*) at the transect locations. (Reproduced from Cohn et al. 2022, 18. CC BY 4.0.)

Additional project efforts. A field campaign in the fall of 2022 by the EWN cold regions work unit and EA aimed to fill certain data gaps identified during earlier project phases. This effort included two additional visits to the community in September and October 2022 to collect additional data related to permafrost distribution, groundwater, and coastal hydrodynamics. These data will be critical to inform the design and engineeering of the proposed shoreline-protection feature. Despite significant attention and interest in protecting the community's northern coastline from coastal erosion and permafrost thaw, permafrost investigations on the peninsula have been limited. A prior study assessed that the peninsula is underlain by freshwater permafrost approximately 1 m below the surface, though the permafrost was evaluated at one site on the east side of town, some 4 km from the northern shoreline (McFadden and Collins 1978). CRREL scientists used ground-penetrating radar (GPR) as a noninvasive geophysical method with the potential to identify and map permafrost and standing water in the shallow (up to 10 m) subsuface (Figure 7). Researchers walked a total of 9.6 km of GPR transects with the GPR antennae, across shoreline-sedge transitions, high-center polygons, and near the relic infrastructure of Old Tikigaq. However, positive identification of subsurface features was limited because of the conductivity of the nearby salt water and subsurface gravel that scattered the radar signal. In addition, thaw probing, which was the intended ground-truth method, was not possible because of the pebbles and gravel present. Still, researchers did identify near-surface soil-moisture signatures and cross bedding in well-drained, elevated sections of the peninsula. Because of the limitations present, the positive identification of permafrost or a water table at depth with high confidence was not possible. Assessing the thermal aspects of coastlines for site evaluations for NNBF and EWN measures is generally important but not always feasible through leveraging remote-sensing instrumentation such as GPR because of project constraints or site characteristics that limit the assessment of subsurface features; for example, salt intrusion. In future fieldwork at Point Hope, a lower-frequency GPR and sediment core, water table, and soil temperature profile could help to inform the presence and extent of groundwater and permafrost.

Figure 7. Project team member uses ground-penetrating radar (GPR) along the shoreline to assess permafrost and groundwater in the subsurface. (Photo credit: Lauren Bosche.)

Two different methods were executed to inform coastal hydrodynamics at the site. The first method involved the installation of a shallow groundwater well on the foreshore of the north shore to quantitatively measure water levels and storm surge. The second method involved stationary photography to qualitatively observe water levels, storm surge, wave heights, and erosion. The 21-day record of these measurements extends from approximately 28 September to 19 October 2022. Water-level data covering the same 21-day period was downloaded at 6-minute intervals from the RDD station. The plot of the water-level comparison is shown in Figure 8, with *blue Xs* representing the Point Hope data and *red dots* representing the RDD data. The well water-level data fluctuate above the approximate mean higher high water, or MHHW, value of 1.14 m for the area. Both datasets depict a significant increase in water levels resulting from a large storm that occurred around 8 October 2022. This storm caused a peak of 10.8 ft and 7.4 ft at Point Hope and RDD, respectively. At this water level, the surge would be encroaching on the dune toe or sandbag coastal-protection measures at the top of the beach near the siġluaqs. This interpretation is supported by the observations shared by community members. Given that there are cases where the SWLs at Point Hope and RDD differ considerably at the storm timescale, despite general consistency in SWLs between the two sites over longer timescales (see section “Environmental characterization and numerical modeling”), this interpretation also highlights the need for site-specific measurements to quantify local hydrodynamics and their forcings to put drivers of extreme total water levels and erosion in context.

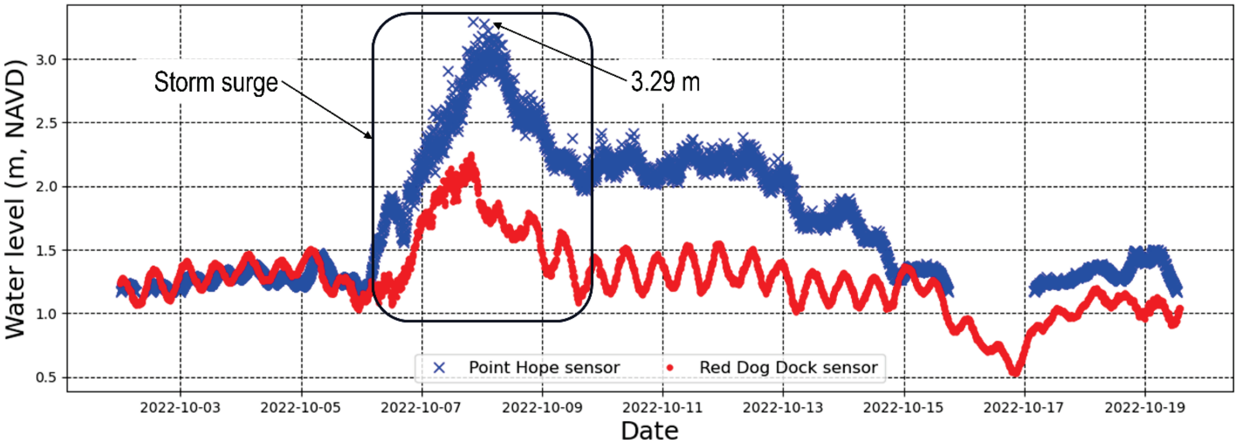


Figure 8. Water-level comparison between Point Hope shallow groundwater well (*blue Xs*) and Red Dog Dock (RDD) data (*red points*). *Black rectangle* shows the period of the storm surge, from 07 October 2022 to 10 October 2022. (NAVD—North American Vertical Datum of 1988.)

The project team also deployed a stationary camera over the same period to record photos and videos at an hourly interval over the deployment window to qualitatively assess storm conditions. In total, this temporary shoreline-monitoring camera captured 1,500 photographs and 10 second videos at 20 frames per second. Figures 9 and 10 show images collected by the camera during the early October storm, showing a large breaking wave and high water levels associated with this storm. These photographs confirm that the waves along the north shore break directly onshore as a result of the steep drop off the beach slope. While the videos captured afforded additional qualitative information across a range of shoreline conditions, photos were determined to be sufficient in this assessment. Future camera data collections could potentially derive quantitative data from this process by surveying in fixed points and rectifying the photos to extract the shoreline position.

Proposed measure and next steps. At the time of this publication, the proposed alternative selected to help mitigate erosion and flooding along the northern shoreline of the peninsula is being put through the engineering design process. Permitting and regulatory consultations have been assessed, as an extensive permitting process on the federal, state, and local level will be necessary to receive the required approvals to begin construction.

Figure 9. Wave breaking on the north shore recorded by the shoreline-monitoring camera at the Chukchi Sea (07 October 2022 at 14:00:00). (*Note*: 32°F = 0°C.)

Figure 10. Storm surge and wave run-up on the north shore recorded by the shoreline-monitoring camera at the Chukchi Sea (07 October 2022 at 16:00:00). (*Note*: 33°F = 0.6°C.)

SUMMARY: This TN summarizes the growing environmental risks in cold regions that affect communities and infrastructure, identifies challenges in the intial implementation of EWN in these environments, and provides a short profile of the coastal-resilience project at Point Hope, Alaska. It also highlights the way in which the project has fulfilled work-unit objectives, through its engagement with the community to preserve Iñupiat traditions and integrate TEK and through its advancement of the understanding of the Point Hope environment through coastal modeling, which will inform the proposed dune system. As the EWN cold regions work unit expands, the growing knowledge base will provide NNBF and EWN practitioners with a better understanding of working in these harsh environments. Projects like these will contribute to the third work-unit objective of ultimately providing guidance on the implementation of NNBF and EWN in cold regions to increase resilience. To reach this third objective, the work unit is planning to convene an international workshop to engage NNBF and EWN practioners who focus on cold regions, which will inform the development of the guidance.

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