



Nunavut Research Institute

License Holder Reporting requirements

For research undertaken in the 2026 calendar year (commencing January 01, 2026 and ending December 31, 2026)

Project Title:

Arctic Ice Thickening Field Test, Qikiqtarjuaq, Nunavut

Project Leader(s): Full name, affiliation, and contact information (address, phone number, email) of each project leader (principal investigator and co-investigators)

- Fonger Ypma (Principal Investigator): Arctic Reflections, Paardenmarkt 1, Delft, The Netherlands, fonger@arcticreflections.earth, +31615897768)
- Tom Meijeraan (Coordinator): Arctic Reflections, Paardenmarkt 1, Delft, The Netherlands, tom@arcticreflections.earth, +31654670419)

Project Team: Full name, affiliation, and address (name of city/community and province/territory/state) of each member of the project team

- Arctic Reflections (Delft, The Netherlands / St John's, Canada): Cody Owen, Willem Schellingerhout, Bipasha van der Zijde, Tom Heyning, Wytse Petrie, Soroosh Afzali, Rob Pritchett
- Local experts (Qikiqtarjuaq, Nunavut) via SmartIce (St John's, Newfoundland): David Iqqaqsaq, Edmon Kooneeliusie, Colin Kooneeliusie
- Local experts via HTO (Qikiqtarjuaq, Nunavut): Albert Arnaquq, Jordan Audlakiak, Noah Qiyuqtaq
- Aalto University (Aalto, Finland): Samuli Mikkola, Felix Levy
- Arctic University of Norway (Tromsø): Robbie Mallett
- Cambridge University (Cambridge, United Kingdom): Faye Parker
- Manchester University (Manchester, United Kingdom): Geoff Ewatt

Abstract: A concise summary of what was done, found, and concluded to date, and how the results/information will be used. This summary must be translated into the appropriate dialect of Inuktitut. Suggested length: 250-300 words. *This section will be published in the NRI's annual compendium of licensed research.

Arctic Reflections is testing whether pumping seawater onto snow-covered landfast sea ice during winter can produce thicker, longer-lasting ice than forms naturally. The research investigates whether this approach could contribute to preserving Arctic sea ice and its reflective properties, and examines the potential implications for the Arctic environment and communities that depend on sea ice. During the 2026 field campaign near Qikiqtarjuaq, Nunavut (a six-week period from 1 February to 8 March, with a follow-up week in June), two field teams of seven people, supported by six local sea-ice experts, pumped seawater onto the ice surface across five study sites: three inside pumped ("test") zones and two outside them as natural-growth "control" sites. Over 19 pumping days the team ran 86 flooding events, covering about 13 hectares of ice. Sites were monitored with ice mass-balance buoys, radiometer stations, and we took 55 ice cores and 275 point measurements, and conducted 33 drone flights, all feeding a single database and a live dashboard.

Preliminary results show the intervention worked as intended for ice growth: flooded sites gained roughly 28 cm more ice than control sites, about 18 cm of new surface ice plus 10 cm of extra bottom growth compared to the control sites, and ended the season thicker despite starting thinner. Flooded ice also stayed thicker and held its reflectivity later into the melt season. This makes longer survival plausible, but it has not been confirmed, because the melt-out timing of the surrounding ice could not be tracked after break-up. The extra salt introduced by flooding drained away by the end of melt, leaving no lasting salinity difference. Effects on nutrients and plankton are not yet analysed. Findings will guide future campaigns and will be shared with the community and regulators.

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Annual activities: A description of activities and methods carried out during the current reporting period. This section should answer the questions: What? Where? When? Who? How? Include dates team members conducted research at remote field sites or collected data (including interviews) in communities; append a map with locations and/or coordinates of remote field sites, if applicable.

What?

A controlled field experiment flooding landfast sea ice with pumped seawater, paired with intensive monitoring. The team ran 86 pump (flooding) events totalling ~61 hours of pumping ($\approx 3,649$ minutes; best single day 459 min on 28 Feb), flooding ~13 ha of ice. Monitoring comprised 2 SIMB3 and 3 SIMBA ice mass-balance buoys, radiometer stations at two sites, 55 ice cores, 275 point measurements, and 33 drone flights. Additionally, our SmartIce operator has executed SmartQamutik for larger area combined ice and snow thickness measurements.

Where?

Landfast sea ice near Qikiqtarjuaq, Qikiqtaaluk region, Nunavut, reached by a daily ~30-minute snowmobile drive from the research base. Five sites: control A, B (natural growth, outside pumped zones) and test C, D, E (inside pumped zones). Site A carried a SIMBA + radiometer; Site B a SIMB3; radiometer stations at A (control) and C (test); ice cores at all sites.

When?

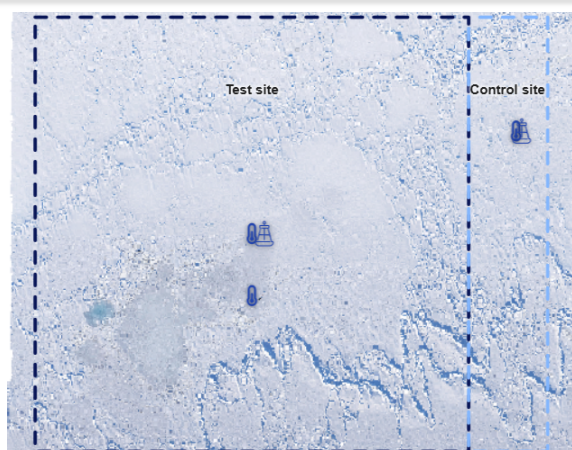
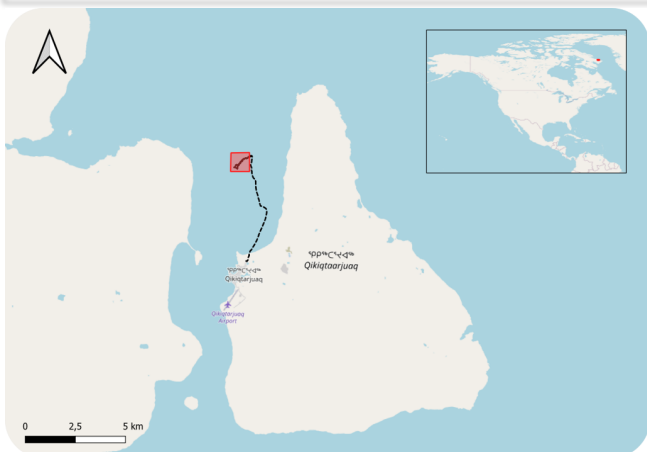
Main campaign 2 February – 8 March 2026 (pumping 8 Feb – 7 Mar, 19 pumping days), plus a one-week campaign in June 2026. Analysis is organised into season phases: baseline ($\rightarrow$ 18 Feb), flooding (18 Feb – 19 Mar), growth (19 Mar – 26 May), melt (26 May – 22 Jun).

Who?

Two field teams of seven, supported by six local sea-ice experts from the community.

How?

Seawater was pumped from beneath the ice onto the snow-covered surface at the test sites; control sites were left to grow naturally. Ice thickness, temperature, snow, albedo/radiation, salinity/density and surface imagery were tracked continuously (buoys, radiometers) and periodically (cores, drone flights) and consolidated into one spatial database feeding a live dashboard.



Results and Achievements: Findings and results to date of the above activities, highlighting any key research achievements (see guide below for formatting tips regarding tables and figures).

Q1: Does flooding produce thicker ice?

YES. Test sites grew ~45% more ice over the season and ended ~16 cm thicker despite starting thinner. Surface (flood) ice of +14–34 cm formed only where water was pumped; control sites gained none. Basal (bottom) growth was slightly higher at test sites (+64 cm vs +54 cm). Net advantage: +28 cm ($\approx$ +18 cm surface + $\approx$ +10 cm basal).

Q2: Does thickened ice last longer through melt?

PLAUSIBLE. Test site reflected more energy over the season (cumulative reflected shortwave 231.3 vs 228.8 kWh/m²) and had a ~5% higher energy-weighted albedo (0.697 vs 0.662). During pumping the wet surface darkened (0.61 vs 0.70) then refroze bright. From ~10 June the control site collapsed toward ~0.31 while the test site held ~0.49–0.53. Longer survival has not been demonstrated: what is observed is that the test ice ended thicker and held a higher albedo (~ reflectivity) later into the melt season. Longer persistence is a plausible consequence, but it could not be observed, because the thickened ice drifted away after breakup of the surrounding ice.

Q3: Does added brine accelerate melt?

NO. We took salinity profiles of the ice by taking ice cores. Before flooding, control and test salinity profiles were comparable. The added salt was clearly visible in the flooded/upper layers through the growth phase, but by the end of melt (22 June cores) there was no significant salinity difference between test and control. The brine drained out.

Q4: Does flooding change nutrients / plankton?

IN DEVELOPMENT. Samples were collected, but nutrient and chlorophyll analysis and a proper sampling design are still to be done — this is groundwork for next season.

Challenges/Obstacles: In this section, please comment on any challenges/obstacles (if any) that you experienced during this project year. If there were any actions to mitigate or resolve these challenges, please list them here. Were any concerns raised regarding the conduct of research team members or the impacts of the project?

Yes, we encountered several challenges during the fieldwork, but none significantly affected the overall planning. One challenge was determining the exact field test location. The permit provides two designated research areas, within which the final location is determined in cooperation with the Hamlet and HTO of Qikiqtarjuaq. Since sea ice only forms towards the end of December or beginning of January, the exact location can only be determined a few weeks in advance. This is important to avoid areas where wildlife, particularly seals, are concentrated. Last year, the Hamlet, HTO and Arctic Reflections jointly selected the final location the day after our arrival. For the upcoming field test, we hope and expect to be able to determine the location somewhat earlier. Scientifically, we would ideally use the same location again to facilitate comparison of results, but the final decision will depend on ice conditions and wildlife concentrations immediately before the fieldwork.

Weather also presented some challenges: on three days, conditions prevented the team from going onto the ice. However, this was within our expectations for Arctic fieldwork and did not jeopardize the schedule.

We also experienced some technical issues, including pump breakdowns and problems with measurement equipment, such as a tilted radiometer mast, temporary disturbance of a reference sensor, and differences between thermistor-chain and rangefinder methods for measuring ice and snow thickness.

We initially expected some challenges in developing an effective way of working together on the ice with local sea ice experts. In practice, however, the collaboration went very smoothly and proved to be a major strength of the fieldwork, with the local experts contributing valuable knowledge and experience.

Expected Project Completion Date: Provide month and year of expected completion date of the project.

July 2027.

Project website (if applicable): If your project has a presence on the internet, including a website and/or social media page, please provide the link and/or account handle.

www.arcticreflections.earth

<https://www.linkedin.com/company/arctic-reflections>

<https://aria.org.uk/exploring-climate-cooling-rethickening-arctic-sea-ice>

Citations: Please append a complete reference list if citations are used anywhere in the document.

POLICY RELEVANCE

Does this research support policy development or decision-making in Nunavut? If yes, please describe.

No (though it could be in future if our research shows that sea ice thickening turns out to be a relevant climate adaption methodology)

RESEARCH OUTCOMES: BENEFITS

Community engagement: Briefly list and describe any community consultation, engagement, collaboration and outreach activities that you have undertaken for the project; describe the role(s) that community members and/or specific organizations have played in research co-design and activities.

From September 2025 to June 2026, Arctic Reflections engaged extensively with the Qikiqtarjuaq community, including the Hamlet Council, Hunters and Trappers Organization, community members, local organizations and elders. Consultations focused on site selection, local observations of sea-ice changes, community concerns, employment opportunities and how to conduct the research in a mutually beneficial way.

Following community feedback, the initial test site was changed to a location closer to the Hamlet while remaining within the permitted area, and letters of support were obtained from the Hamlet Council and HTO.

We worked closely with the community and hired a team of six local sea-ice experts to support the field test. Community engagement included an open house, two community lunches with 80-100 participants each time, radio appearances, regular bilingual Facebook updates, posters in English and Inuktitut, informal daily drop-ins and discussions at the Northern Store. In June 2026 we already discussed early results with the Hamlet Council and the HTO and via posters with the broader community. Overall, we feel that the engagement demonstrated strong and ongoing community collaboration and provided valuable guidance for both the 2026 field test and future research.

Youth engagement: Briefly list and describe any outreach, school or classroom activities that you have undertaken for the project; describe the role(s) that youth have played in your research activities.

We actively involved local youth in the project through several activities. Members of the team visited the local school and gave a presentation, including an interactive experiment with iron and rock “meteorites” in the snow. We also hired a young local photographer to document parts of the field test, providing an opportunity for youth to contribute directly to the research activities. Towards the end of the field test, the team also joined a community film screening in the school, providing another opportunity to engage with local children and discuss our work. During the June Open House, parents were welcome to bring their children to the research centre, where we provided games and freshly baked muffins, creating an informal and welcoming environment for families

Training and Employment:

How many Nunavummiut received training from team members? Please describe training and/or compensation provided.

We trained our six local sea ice experts on the job to operate the ice-making equipment, including drilling and pumping. We trained to people on collecting ice cores for research. One of the local experts already had experience flying drones, and we provided additional training to operate our own drone specifically for creating high-resolution orthomosaic maps.

How many team members received training from Nunavummiut? Please describe training received and/or what knowledge sharing and/or skills exchange took place.

There has been no formal training, but all non-Nunavummiut crew members learned on the job - just by working together - how to navigate through (ridged) ice, better drive a Skidoo, properly pack a qamutik (including the right knots), troubleshoot gasoline engines in cold weather and look out for wildlife for safety reasons. During the trip in June two of us also learned how to navigate through sea ice with lots of melting ponds.

How many Nunavummiut received employment? Please describe employment type and length, role(s) and responsibilities, and compensation provided.

During the six-week field test, we employed a pool of 6 local people through our local partner, SmartIce. On each fieldwork day, typically 3–5 people from this pool were engaged, consisting of 1–2 polar bear guards and 1–3 local sea ice experts responsible for operating the ice-making equipment and supporting safe operations on the sea ice. All fieldwork personnel were compensated for their services through SmartIce. Also, we paid for the use of their snowmobiles and qamutiks, covered their fuel costs, and provided lunch during fieldwork days.

In addition, we provided several short-term employment opportunities to other Nunavummiut. We hired one local youth for one day to support photography, one local woman to assist with community engagement, local cooks to prepare the community soup, and a local translator for a radio interview.

How many Nunavummiut received honoraria as research participants? Please describe method of participation (interview, observation, sample, survey, etc.), including compensation provided.

We held a joint Hamlet/HTO meeting in September to inform participants about our planned research and seek their advice, identify any concerns, and gather other comments. All participants were compensated through a fixed fee per attendee, invoiced by the Hamlet and HTO.

In March, we also participated in a SmartIce Community Management Committee (CMC) meeting, which provides a forum for mutual knowledge sharing and brings together community members, including local Elders and traditional knowledge holders. Participants were compensated through our local partner, SmartIce.

Please explain how the project directly benefited Nunavut organizations and/or businesses (e.g., through contract services, local purchases, equipment donations, etc.)

We rented 4 Skidoos and 2 qamutiks from a local outfitter for almost 6 weeks and rented the community garage and made use of the services of local welders for maintenance. We booked accommodation for 7 people for 6 weeks across two local B&Bs, the local hotel, and the research centre. We also ordered meals from the local hotel restaurant on most field days and purchased groceries and other supplies from the Co-op and Northern Store. We hired local cooks for the two well-attended community lunches (80-100 people per lunch) we organized.

OPTIONAL: Nunavut Team Members, hires, and/or trainees (excluding research participants e.g., interviewees)

The NRI is creating an inventory of Nunavummiut who are skilled and/or interested in research. The information provided below will not be shared publicly but will support long-term capacity sharing by connecting local and visiting researchers with research talent in each community.

Name	Expertise/skills	Training/interest areas	Contact Info	Community
David Iqqaqsaq	Smart Qamutik / drone	Sea ice	Whatsapp 867-2251407	Qikiqtarjuaq
Leah Iqiyuqtaq	Biological research (e.g. chlorophyll sampling)	Sea ice	Iqiyuqtaq@gmail.com	Qikiqtarjuaq

Academic Mobility

If you are affiliated with an academic institution, please answer the following question: For which Level of Project(s) will the data be used? (Check all that may apply)

- ☒ Research
- ☐ Post-Doctoral Research
- ☒ PhD Thesis
- ☐ Masters (Major Research Paper)
- ☒ Masters (Thesis)
- ☐ Graduate Course Project
- ☐ Staff/Administration Research
- ☐ Undergraduate Honours Thesis

BUDGET

Please complete the table below to detail your projected and actual research expenditures during the reporting period.

Category	Planned / Approved expenditure	Actual expenditure
Travel and Accommodation		CAD 145,000
Equipment, Materials and Supplies		CAD 316,000
Salaries /Wages for Nunavut residents		CAD 85,000
Salaries/Wages for non-Nunavut residents		CAD 80,000
Professional Fees and services in Nunavut		CAD 34,000
Professional Fees and Services outside of Nunavut		CAD 101,000
TOTAL EXPENDITURES	CAD 500,000	CAD 761,000

List the total \$ amount of funding from each funding source for your full research program, including in-kind support

All funding is derived from the ARIA “Re-thickening Arctic Sea Ice” (RASI) project: <https://aria.org.uk/exploring-climate-cooling-rethickening-arctic-sea-ice>.

The budget calculation includes salaries and wages incurred during the field test in February/March, as well as all travel and accommodation, equipment, materials, and supplies costs incurred during the six months leading up to the field test. Professional services primarily cover equipment rentals and logistics.

RESEARCH OUTPUTS / REPORTING TOOLS

What research outputs were generated? Please list below and append copies of each. Specify which outputs (if any) may be made public on the NRI research licensing database.

The research outputs are still being finalised. The main outputs are:

- Research results and findings: The answers to the four research questions presented in the Results and Achievements section of this report.
- Research data: All underlying research data will be made publicly available through Data in Brief, following the approach used for our previous two publications in the journal.
- Peer-reviewed scientific publication: We are preparing a peer-reviewed scientific article based on the research results.

The answers to the four research questions, the Data in Brief publication, and the underlying research data may be made publicly available through the NRI research licensing database. The peer-reviewed scientific article will be made available in accordance with the publication and journal requirements.

Have peer-reviewed manuscripts been published as a result of your project? If Yes,
complete the following table:

Full citation	Publicly accessible/ free to access (Y/N)	Link (if available) and DOI (if available)
N/A	N/A	N/A

If No, do you intend to submit a manuscript (or manuscripts) for peer reviewed publication?

No, no peer-reviewed manuscripts have been published yet.

During the remainder of 2026, we intend to submit a manuscript to Data in Brief, an open-access Elsevier journal, in order to publish a description of our methods, materials, and open access to our dataset which will be hosted in the public repository Zenodo. We also intend to submit a manuscript or manuscripts to the peer-reviewed, open-access science journal Earth's Future (or similar) which will analyze and discuss the results of the research in even greater detail than what has thus far been shared in this report. Other manuscripts might be submitted to other journals pending their development.

Were non-peer reviewed materials produced to either communicate or synthesize results to the public?
 Examples of these materials include (but are not limited to): websites, reports, brochures, podcasts, webinars, presentations, non-peer reviewed publications, etc.

If Yes, complete the following table:

Title	Description of Materials	Link (if available)	DOI (if available)
What we found	Posters for community		
First results & plans 2027	Presentations HTO & Hamlet		
Blog posts	Website Arctic Reflections	https://arcticreflections.earth/news/	

Did your project develop a communications plan? Please describe communications/reporting tools used, and list the target audience for each and/or who requested which.

For this project, we developed visit-specific community engagement and communications plans. Community-focused activities included HTO presentations, Hamlet Council meetings, supermarket posters, an open house, local radio and Facebook, a school visit, community lunches, and an open-door research centre. These activities aimed to inform the Qikiqtarjuaq community, facilitate dialogue, and provide opportunities for local input and feedback. The primary audiences were community members, Elders, the HTO, Hamlet Council, youth, and other local stakeholders.

We also communicated about the project to audiences outside the community. This included press engagement and interviews in Nunavut (<https://nunavutnews.com/2026/02/09/dutch-sea-ice-researchers-in-qikiqtarjuaq-hiring-inuit-workers/>), the UK and the Netherlands, as well as LinkedIn posts and news and blog articles on the Arctic Reflections website. These communications were aimed at the broader public, scientific and research communities, partners, policymakers, and other stakeholders interested in Arctic research and sea-ice restoration.

Reporting to research partners and funding organisations was conducted through regular project updates, meetings and formal reporting.

How were Nunavummiut credited and/or acknowledged in all project outputs, such as co-authorship, participant biographies, article acknowledgements, etc.

Regarding the peer-reviewed publications to be submitted, all locally hired experts involved in the project will either be co-authors on the publications, or acknowledged in the acknowledgements section of the publication, depending on their role/contribution and preference on how they wish to be credited.

DATA AND INTELLECTUAL PROPERTY

Did you enter into a research agreement, data-sharing agreement and/or intellectual property rights agreement with a community and/or designated Inuit organization (DIO)? If yes, please explain.

No

Do intellectual property rights apply to your research? If yes, please explain.

No

Who owns the data? Has the raw data been shared with the appropriate community and/or DIO? If yes, how? How is data security and storage handled by community-based co-owners?

The research data are currently held and managed by Arctic Reflections and our academic research partners. The raw research data will be stored and made publicly available for everyone on the public data repository Zenodo.

Where is the data stored and will the data be destroyed within a set timeframe?

The data is currently stored on local storage devices (hard drives and SD cards) and web-based servers of Arctic Reflections. The data will be stored on the public data repository Zenodo within the next two months. The data will not be destroyed.

Is the data trackable and/or available in a public data repository? If yes, please provide the appropriate information and/or link to ensure the findability and accessibility of the data.

The data will be made available in a public data repository, Zenodo, within the next two months, with an accompanying peer-reviewed, open-access data description publication in Data in Brief. Previous examples of our approach to making research data publicly available through Data in Brief:

- Field data on sea ice restoration by artificial flooding (2024) — DOI: 10.1016/j.dib.2024.111117
- Field data on sea ice restoration by artificial flooding in subarctic Canada (2025) — DOI: 10.1016/j.dib.2025.112147

Please append a copy of your data management plan.

CLIMATE CHANGE

Is your research about climate change (causes, impacts, mitigation, adaptation, etc.)? If yes, explain.

Yes. The research directly addresses climate change mitigation and adaptation by investigating Arctic Ice Thickening (AIT) as a potential approach to slow the loss of Arctic sea ice. The project tests the effectiveness, feasibility, and scalability of artificially thickening sea ice during winter, with the longer-term objective of contributing to the preservation of Arctic sea ice and reducing the impacts of Arctic warming and sea-ice loss.

PHOTOGRAPHS

If possible, please provide high-resolution photos of licensed research activities that NRI may use in communication materials, organizational reporting, and other promotional purposes. Please also complete the table below for each photo provided and submit to NRI along with all required NRI photo release forms. The photographer/owner will be credited in all uses of the photograph(s).

File Name Location Description Subjects Photographer/Owner Date

File name	Location	Description	Subjects	Owner	Date
ArcticReflections team 2 Feb 2026.jpg	Qikiqtarjuaq	Team picture of 2 nd team	Arctic reflections employees, local experts and scientists from partner universities	Arctic Reflections	Feb 2026
Basecamp.jpg	Qikiqtarjuaq	Base camp	Tent + qamutik	Arctic Reflections	Feb 2026
Areal view.jpg	Qikiqtarjuaq	Areal view ice thickening operations	Icemaker, people, skidoos and qamutik	Arctic Reflections	Feb 2026
Icemaker 2026.jpg	Qikiqtarjuaq	Icemaker for ice thickening	Icemaker pumping water and operator	Arctic Reflections	Feb 2026