

Ship-Source Underwater Noise in the Northwest Passage

A GIS-Based Assessment of Exposure Risks to Marine Mammals in Nunavut



uOttawa

Breana Sanders | Dr. Jackie Dawson | Dr. William Halliday

Department of Geography & Institute of the Environment, University of Ottawa

Background

- Rapid Arctic warming has reduced sea ice, increasing access to marine routes
- Shipping activity in Nunavut is increasing along the Northwest Passage
- Arctic marine mammals rely on sound → vulnerable to disturbance

Methodology

- Vessel traffic data (1990–2025) from AIS and NORDREG
- Modelled ship-source underwater noise using RL120 (120 dB re 1 μPa threshold)
- Raster-based noise surfaces representing cumulative exposure
- Culturally Significant Marine Areas (CSMAs) derived from Arctic Corridors research
- Spatial overlay and zonal statistics used to assess overlap between vessel activity, noise exposure, and sensitive marine areas

All spatial analysis conducted using ArcGIS Pro and ArcGIS Online

Shipping Activity

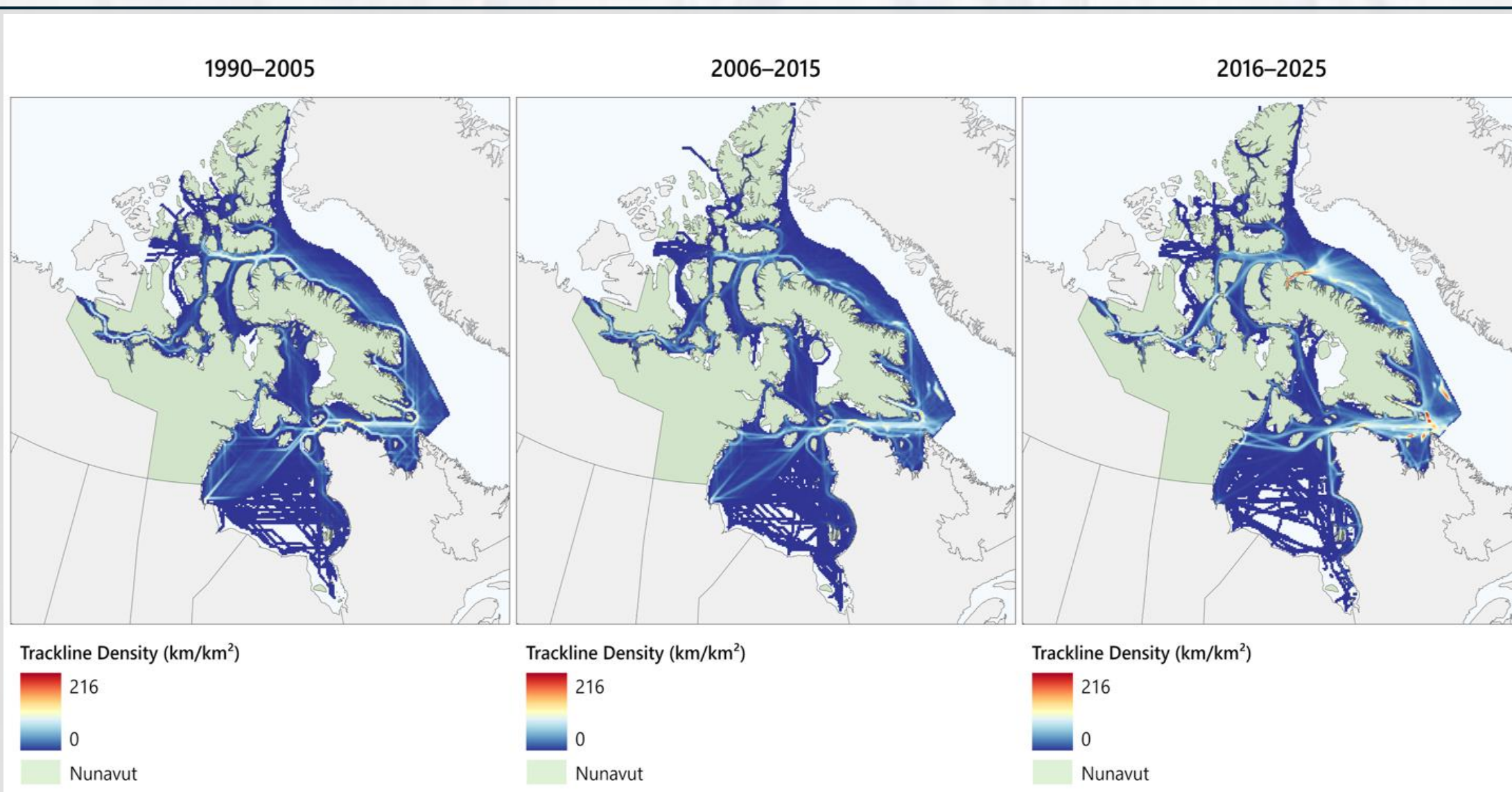


Figure 2. Vessel track line density across the Northwest Passage for three time periods: 1990–2005, 2006–2015, and 2016–2025. Values represent cumulative vessel track density (km/km²).

- Vessel activity in the NWP has increased over time, with accelerated growth after the mid-2010s
- Traffic is concentrated along narrow Arctic corridors shaped by sea ice and geography
- Highest activity occurs near Pond Inlet and Lancaster Sound

Shipping & Noise Exposure Within CSMAs

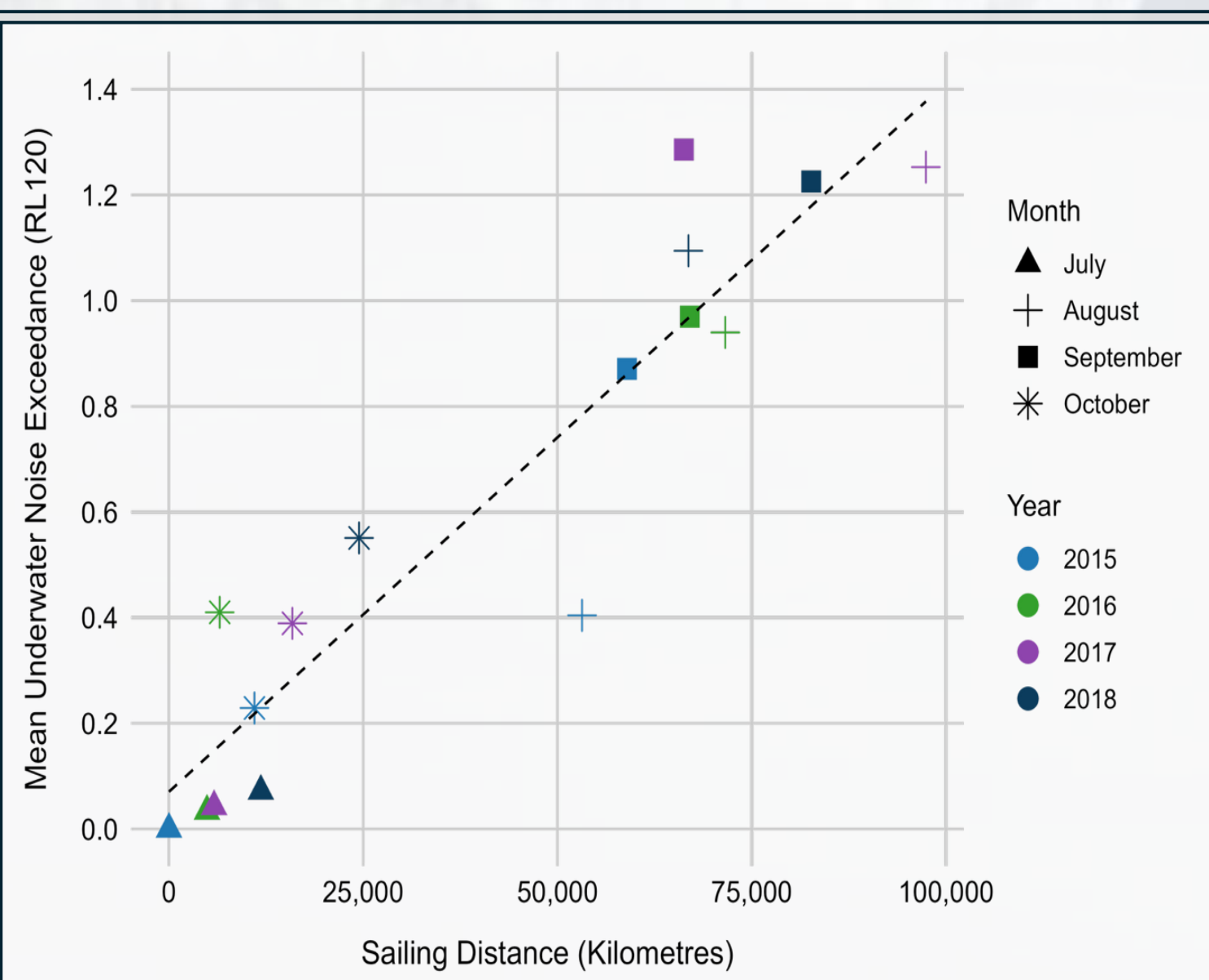


Figure 4. Relationship between total sailing distance (km) and RL120 exceedance values across the Northwest Passage. The positive trend indicates that higher vessel activity is associated with increased underwater noise exposure.

- Strong positive relationship between sailing distance and noise exposure
- Areas with higher vessel activity experience more frequent exceedance of the RL120 threshold
- Indicates vessel traffic is a key driver of underwater noise in the region

Key Findings

- Noise exposure is spatially concentrated rather than evenly distributed
- High-exposure zones align with community-identified marine areas
- Overlap between shipping activity and sensitive habitats identifies priority risk areas
- High-exposure zones carry an increased potential for disturbance to marine mammals

Study Area

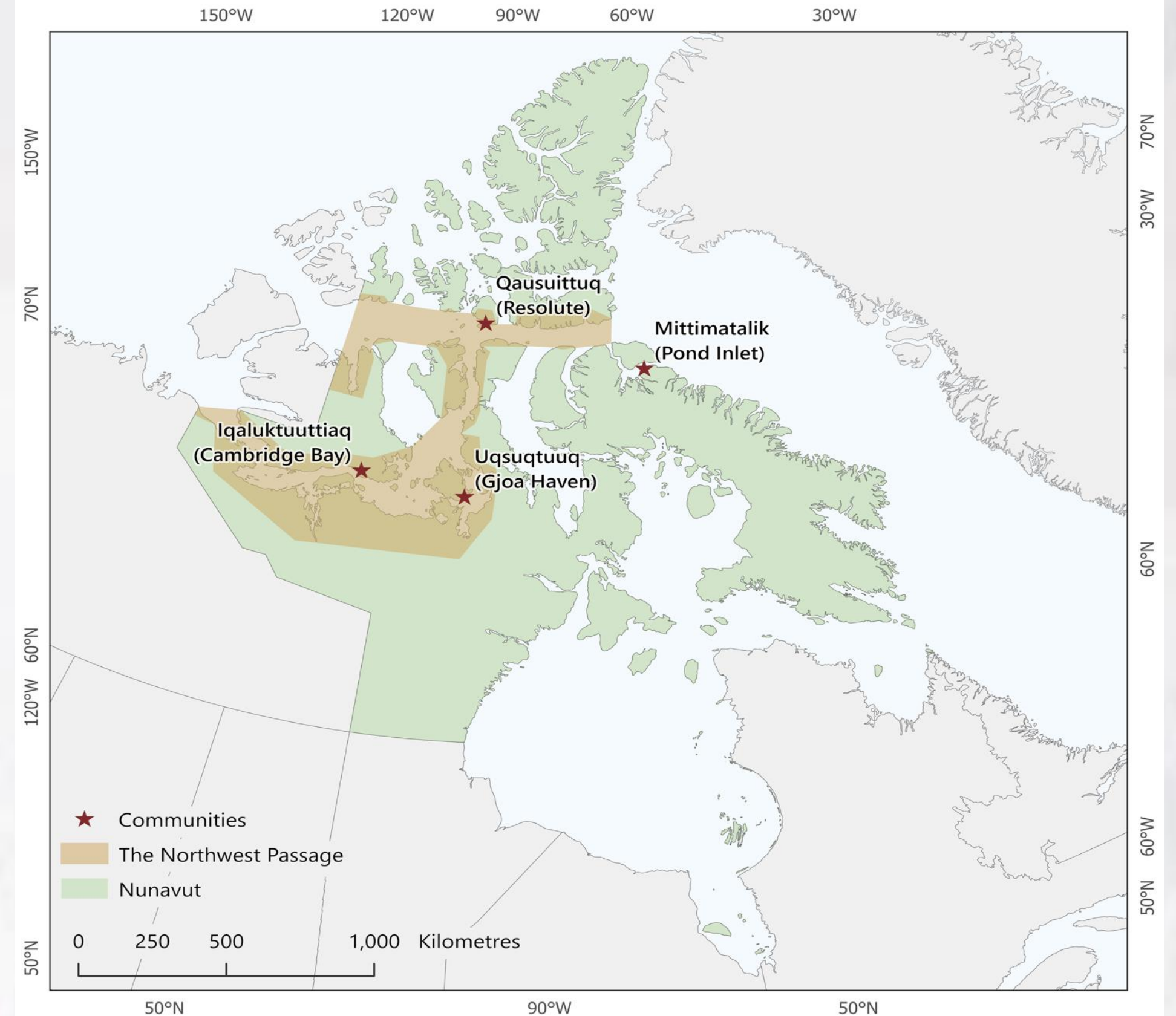


Figure 1. Study area within Nunavut, Canada, highlighting the Northwest Passage shipping corridor and the four focal communities examined in this study: Mittimatalik (Pond Inlet), Qausuittuq (Resolute), Uqsuqtuuq (Gjoa Haven), and Iqaluktuuttiaq (Cambridge Bay).

Noise Exceedance Overlap with CSMAs

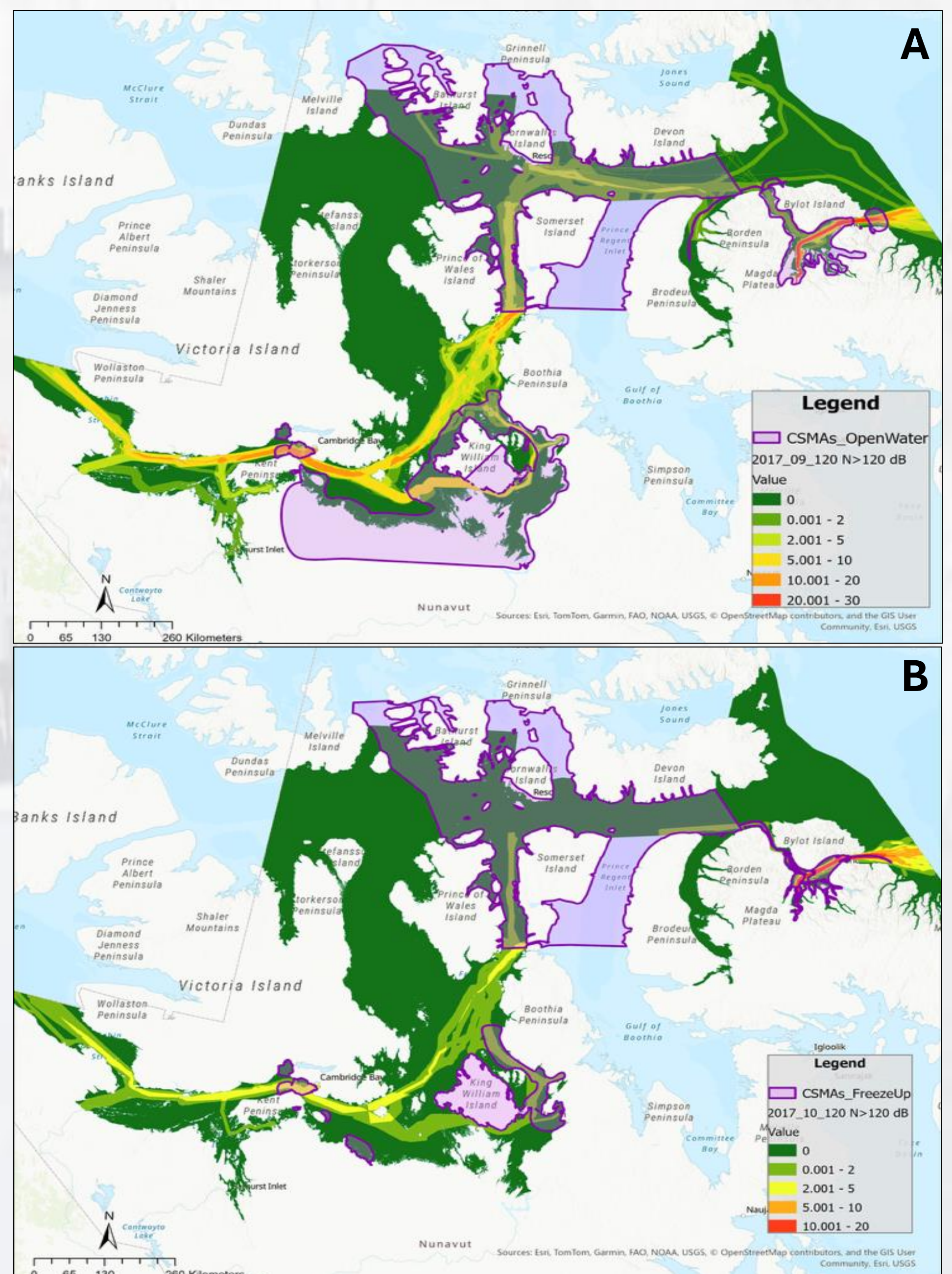


Figure 3. Spatial overlap between modelled ship-source underwater noise exceedance (RL120) and Culturally Significant Marine Areas (CSMAs) across the Northwest Passage. Panel (A) shows overlap with open-water CSMAs using September 2017 noise conditions, while panel (B) shows overlap with freeze-up CSMAs using October 2017 noise conditions.

GIS Applications

- Integrates vessel traffic, environmental, and community-identified spatial data
- Identifies overlap between shipping activity and sensitive marine areas
- Supports evidence-based spatial decision-making for Arctic marine management