

## 2021 Expedition Summary

The 2021 Expedition began on 4 July, when the Canadian research icebreaker CCGS *Amundsen* left Quebec City for its 18<sup>th</sup> annual mission to the Arctic. The multidisciplinary expedition ran until 3 November and allowed more than 140 scientists from national and international research teams to study the marine and coastal environments of the Labrador Sea, the Baffin Bay, the Canadian Arctic Archipelago and the Beaufort Sea. Overall, the ship travelled over 17 968 nautical miles (33 277 km, or six times Canada's width) during 122 days to support 8 major research programs, and additional ancillary collaborations. The 2021 Amundsen Expedition was overall very successful, and greatly benefited from the continuous collaboration with the Canadian Coast Guard, research programs and permitting agencies. All data acquired during the expedition is currently in the process of being analyzed and published, either by the Amundsen Science or by individual research teams. Core scientific data acquired by Amundsen Science will be publicly available on the [Polar Data Catalog](#).



### Leg 1

Led by NRCan, the Marine Spatial Planning program studies the Seabed habitats and marine geohazards in Northeast Newfoundland slope and aims at providing innovative regional geoscience products to support DFO's policies and decision-making. The program was also supported in 2020 in the midst of the COVID-19 pandemic when then icebreaker stayed in the subarctic.

Previous surveys showed that the seafloor in this region is marked by geological hazards, particularly submarine slope failures. Better interpretation of these features are necessary, in particular to identify and date the geological hazards and to understand how the geology can impact the ecological habitats and processes.

Storms in the Labrador sea affected the operations conducted during this short Leg. Overall, the teams recovered sediments from 2 piston cores and one box core, collected seawater with 2 CTD-Rosettes, surveyed the seafloor ecosystem with 3 submarine cameras, and mapped 3495 km<sup>2</sup> of seabed.

### Leg 2

Thirty-five scientists boarded the CCGS *Amundsen* to participate in an integrated study of the Coral habitats and seabed seep features in the Labrador Sea and Baffin Bay. This program, led by Dalhousie University in 2021, was conducted in partnership with other universities, federal departments (DFO, NRCan) and local governments. Scientists from the ArcticNet Marine Program were also onboard to study fish, kelp, and regional geology of the seafloor.

While dives with the ASTRID ROV were central to this scientific study and a high-priority of Leg 2, 17 different operations were conducted at 68 stations spanning from southern Labrador Sea to the fjords of Baffin Island. Amongst other experiments, it is interesting to note that: 1) the site of a submarine landslide caused by the grounding of an iceberg was revisited to study these hazards, 2) a coral was dyed and will be retrieved in a few years to study its growth, 3) two acoustic moorings were deployed close to Clyde River and Scott Inlet to support the development of the community's acoustic monitoring program.

### Leg 3

The KEBABB program was developed by DFO and Canadian Universities in 2019 and will provide crucial physical, chemical, and biological oceanographic data. The complementary KEBABS survey will do the same in Barrow Strait.

The ArcticNet Marine Program were onboard to help assess all aspects of the Canadian Arctic marine ecosystem, from nutrients and contaminants cycling to glacial history and fish. Finally, scientists from the Sentinel North research community in partnership with the Nunavik Marine Region Wildlife Board studied the links between the marine environment and the nutritional properties of bivalves and belugas near Quaqtaq.

Since numerous aspects of the marine environment were studied during Leg 3, a total of 302 operations were conducted over the 28-day Leg at 79 stations across Baffin Bay, Lancaster Sound and close to Quaqtaq (Nunavik). Mapping was also conducted in uncharted areas near the Mittie glacier terminus (Ellesmere Island) and water sampling took place in glacial river mouths, which were accessed with the vessel's helicopter. The helicopter was also used to sample river sediments and to deploy tracking beacons on icebergs and record their movements in Canadian and Greenlandic waters.

### Leg 4

During Leg 4, scientists from the international Permafrost Carbon in the Beaufort Shelf program (PeCaBeau) were studying fluxes, composition and fate of organic matter in Southern Beaufort Sea. Their goals were to identify the provenance of organic matter (from permafrost coastal erosion, Mackenzie River discharge or submarine permafrost degradation), and to investigate how these sources have changed in the last millennia.

The RADCARBBS program was on the *Amundsen* to study radiocarbon cycling within the Northwest Passage and the southwestern Beaufort Sea. More specifically, their work aimed to tell: 1) how and

where most marine carbon is produced in the Northwest Passage (i.e. produced by marine phytoplankton or by riverine input from land), 2) how long it will persist, and 3) how microbes can use this marine carbon, perhaps transforming it into stable forms that can be stored in the deep sea. Once again, scientists from the ArcticNet Marine Program were onboard to study fish, plankton, contaminants, carbon cycle and biogeochemistry along specific historical transects.

Sediment sampling was a substantial component of the research activities during Leg 4. Amongst other results, it is interesting to note that: 1) a submarine pingo was discovered and mapped North of Kugmallit Bay, 2) upwelling (the process through which rich waters from the ocean's depth resurface) was observed near Cape Bathurst.

### Leg 5

Leg 5 supported the international multidisciplinary DarkEdge study. The scientific objectives of DarkEdge were to study the fall-to-winter transition of the Arctic Ocean and its ecosystem as the ice is forming and light availability is reducing. To address this important process, researchers aimed to:

- 1) identify the key processes that control ocean mixing and sea ice cover by measuring physical parameters with buoys, an ice canoe, and other instruments,
- 2) survey the underwater and under-ice environments (light, nutrients, etc.) using an autonomous underwater vehicle (AUV) and a small ROV,
- 3) identify phytoplankton species and quantify how they adapt and grow under low-light conditions,
- 4) cartography and qualify zooplankton and fish stocks using various nets and acoustic instruments.

The sampling strategy during Leg 5 was to occupy stations at the transition between ice-covered and ice-free zones over the course of 3 days. Overall, the campaign was a success, with operations conducted at 6 stations across Northern Baffin Bay, the deployment of 38 CTD-Rosettes, 34 nets, and the first Arctic deployments of the AUV, the ice-canoe and an automated catamaran measuring air-ocean energy fluxes.

### Conclusion

Despite the persisting context of the COVID-19 pandemic and acute logistical and technical constraints, the 2021 Amundsen expedition spanning 122 days at sea across the entire Canadian Arctic represents the most extensive and scientifically productive campaign of the last five years. We can't emphasize enough how important and crucial the good collaboration between the Canadian Coast Guard, the scientific programs, the local communities and Amundsen Science has been. Thank you!

The research activities undertaken onboard the CCGS *Amundsen* in 2021 will allow a better understanding of coastal and marine ecosystems of the Canadian Arctic, help understand how climate change affects fragile marine ecosystems and human health, and facilitate locally-supported objectives targeting the offshore Arctic environment. Mapping conducted along the expedition will also increase the safety of shipping activities. The total seafloor area mapped by the ship in 2021 covers over 38 000 km<sup>2</sup>, which corresponds to a region larger than the Prince of Wales Island (NU) or the whole country of the Netherlands! Researchers and technicians are still working on further analysis on the data collected during the expedition.