The icebreaker lowers the CTD/rosette instrument to sample water at depths that can exceed four kilometres. This drawing shows the ship in scale with a 4000-metre depth.

LINKING COMMUNITIES

Remote Northern communities depend on icebreakers, which travel Arctic waters from mid-June to mid-November escorting ships that deliver food, building supplies and fuel. In remote communities such as Arctic Bay, (below) sometimes it is the icebreaker that delivers supplies.

TRACKING CONTAMINANTS

NO PLACE TO HIDE

Contaminants drifting into the North from all over the world become part of the Arctic food chain. Toxins are concentrated as one animal eats another. Toxins may rise to levels that jeopardize human food supplies and harm the ecosystem. Marine mammal studies can play a key role in tracking the movement of contaminants in the Arctic ecosystem.

ARCTIC INSIGHT

COMMUNITY-BASED MONITORING

DFO scientists are enlisting the help of year-round Arctic residents to conduct science observations through community monitoring programs. When local Northerners record a complete series of observations during a season, their efforts add tremendous value to projects like the Canada's Three Oceans Project. Successful community monitoring programs benefit local communities, decision-makers, and scientific researchers.

Landing Craft

In locations where the shore is not too rugged, the icebreaker's landing barges can land supplies and transport passengers more economically than a helicopter.

SEA CHANGES

Three great oceans surround our nation in the North, where tremendous change is underway. Scientists are studying the changing ocean, its melting ice and links to change in the Pacific and Atlantic via Arctic Ocean currents that connect them. In the summer of 2007, for the first time in recorded history, the legendary northern route of the Northwest Passage through McClure Strait was ice-free and navigable. During the summers of 2006, 2007 and 2008 other routes through the Canadian Archipelago were also briefly ice-free.

NORTHERN SCIENCE AND RESEARCH

Change in this sensitive environment is raising awareness that the issues and challenges facing the Arctic and Northern residents concern all Canadians. Given the vast areas that have to be measured, sufficient data could not be collected without the help of icebreakers like the CCGS *Louis S. St-Laurent*, helicopters, dozens of floating or ice-based beacons equipped with global positioning system tracking equipment, satellite imagery, and environmental observations by local Northern community members. Ice studies must be continuous and carried out in collaboration with many partners.

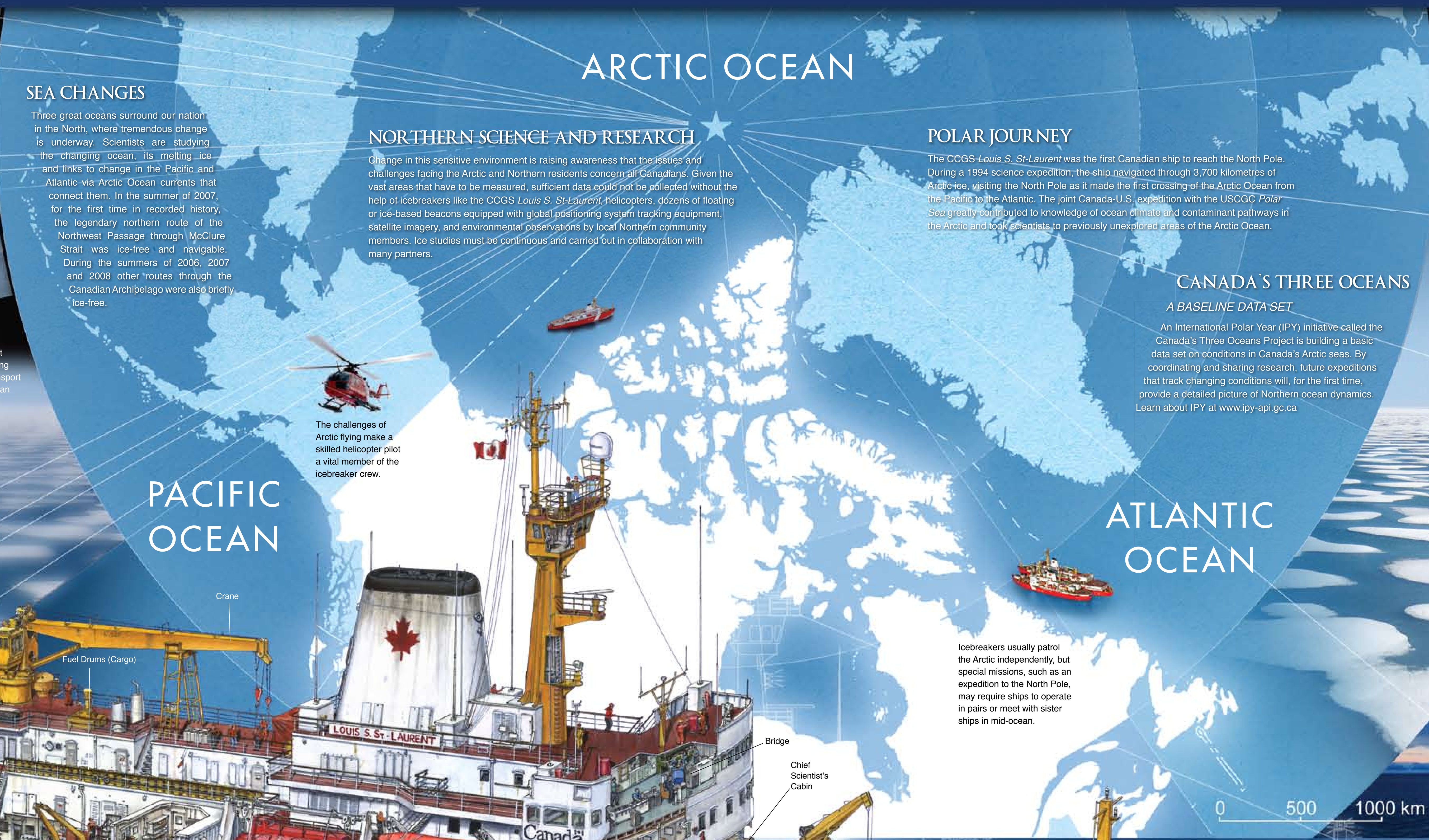
POLAR JOURNEY

The CCGS *Louis S. St-Laurent* was the first Canadian ship to reach the North Pole. During a 1994 science expedition, the ship navigated through 3,700 kilometres of Arctic ice, visiting the North Pole as it made the first crossing of the Arctic Ocean from the Pacific to the Atlantic. The joint Canada-U.S. expedition with the USCGC *Polar Sea* greatly contributed to knowledge of ocean climate and contaminant pathways in the Arctic and took scientists to previously unexplored areas of the Arctic Ocean.

CANADA'S THREE OCEANS

A BASELINE DATA SET

An International Polar Year (IPY) initiative called the Canada's Three Oceans Project is building a basic data set on conditions in Canada's Arctic seas. By coordinating and sharing research, future expeditions that track changing conditions will, for the first time, provide a detailed picture of Northern ocean dynamics. Learn about IPY at www.ipy-api.gc.ca



The challenges of Arctic flying make a skilled helicopter pilot a vital member of the icebreaker crew.

Icebreakers usually patrol the Arctic independently, but special missions, such as an expedition to the North Pole, may require ships to operate in pairs or meet with sister ships in mid-ocean.

Large mammals at the top of the food chain, such as whales and polar bears, tend to accumulate high concentrations of toxins. Projects such as the International Polar Year Circumpolar Flaw Lead (CFL) System Study have tracked contaminants coming into Northern regions, and have showed us where they are ending up. With a clearer understanding of toxin pathways, we can minimize the negative impacts on humans and animals.

LOOKING AHEAD

The teamwork among scientists, Northern residents, decision-makers and the Canadian Coast Guard is giving us a better understanding of the Arctic, leading to improved policy development, decision-making and resource management.

HELICOPTER

ESSENTIAL ARCTIC TRANSPORT

Every icebreaker on Arctic operations* carries at least one helicopter, a necessity for landing people and cargo onshore and bringing them aboard in places where there may be no accessible docks or piers for thousands of kilometres. The helicopter uses a long line hooked to cargo nets to transfer tons of cargo quickly and safely between ship and shore. *Except the CCGS *Terry Fox*.

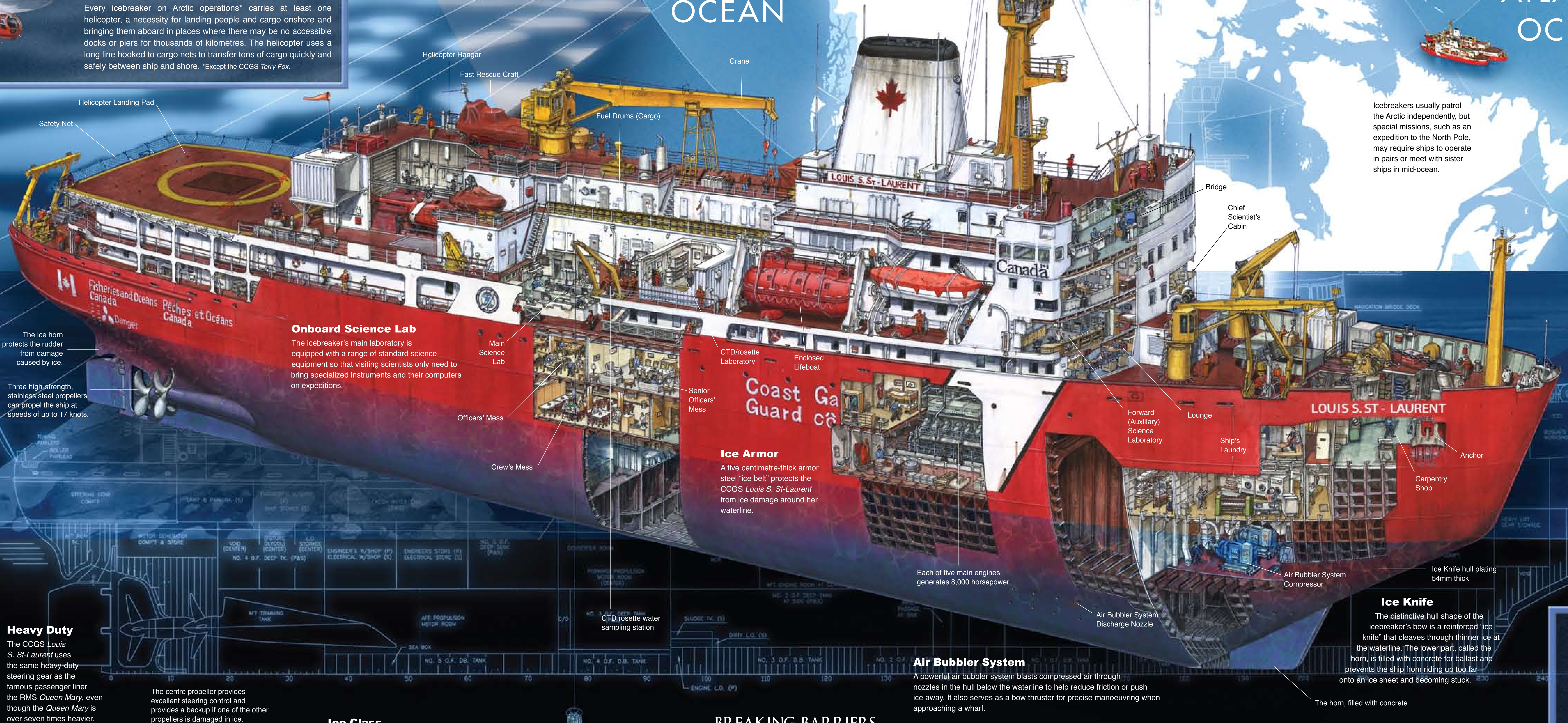
TEAM WORK

SCIENTISTS AND SEAMEN

Canada's Arctic sovereignty is strengthened by the presence of Canadian Coast Guard (CCG) icebreakers like the CCGS *Louis S. St-Laurent*, and by knowledge of the Arctic gained from scientists working onboard CCG ships, from both Canadian and Canadian-led international marine research expeditions, such as those for International Polar Year.

Illustrations: Richard Chasemore, Hans Jenssen/Phaeton Group

Photos (π): DFO



Onboard Science Lab

The icebreaker's main laboratory is equipped with a range of standard science equipment so that visiting scientists only need to bring specialized instruments and their computers on expeditions.

Ice Armor

A five centimetre-thick armor steel "ice belt" protects the CCGS *Louis S. St-Laurent* from ice damage around her waterline.

Ice Knife

The distinctive hull shape of the icebreaker's bow is a reinforced "ice knife" that cleaves through thinner ice at the waterline. The lower part, called the horn, is filled with concrete for ballast and prevents the ship from riding up too far onto an ice sheet and becoming stuck.

Air Bubbler System

A powerful air bubbler system blasts compressed air through nozzles in the hull below the waterline to help reduce friction or push ice away. It also serves as a bow thruster for precise manoeuvring when approaching a wharf.

CANADIAN HYDROGRAPHIC SERVICE

The navigation season in the Arctic is short, so seafloor mapping to create nautical charts presents a major challenge. The Canadian Hydrographic Service (www.charts.gc.ca) works hard to survey and chart key channels in Canada's Arctic. Hydrographers onboard icebreakers like the CCGS *Louis S. St-Laurent* collect bathymetric data of the Arctic seafloor using state-of-the-art technologies.

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Photo (Δ): © Paul Galipeau, 2007.

SHIP'S CREW

THE CRITICAL ASSET

Even the most impressive vessel is only as good as its personnel. From tough "old salts" with the practical wisdom that comes only from decades of experience at sea to fresh new officers and specialists with cutting-edge scientific and technical expertise, it takes a wide range of talents and perspectives to build the ideal ship's crew. It is no exaggeration to say that under the leadership of a fine captain, the icebreaker's people become an asset more valuable than any of its equipment. Learn about the Canadian Coast Guard at www.ccg-gcc.gc.ca.

4000 Metres Under the Sea

This line shows the maximum depth to which a CTD/rosette is typically lowered to study ocean seawater, in scale with the tiny image of the icebreaker at the top of the line.

A CTD/rosette water sampler hanging four kilometres deep.

Heavy Duty

The CCGS *Louis S. St-Laurent* uses the same heavy-duty steering gear as the famous passenger liner the RMS *Queen Mary*, even though the *Queen Mary* is over seven times heavier.

OCEAN SCIENCE

FISHING FOR WATER

The CTD/rosette sensors measure the water's salinity (salt content) through electrical conductivity (C), temperature (T) and depth (D), displaying the data in real time on the operator's monitor. Additional sensors can be mounted to obtain other data, such as the water's dissolved oxygen or its fluorescence, a measure of microscopic plants in the water. The sample bottles around the rosette can be closed remotely by the operator to capture seawater at different depths. The CTD/rosette is used to obtain primary data about the Arctic Ocean, which helps scientists provide advice to decision-makers and information about oceans to the public. Remote sensing, such as satellite imagery, offers a valuable perspective on surface conditions, however, it takes first-hand readings to give us hard data and in-depth detail. Fisheries and Oceans Canada (DFO) scientists using data collected with the CTD/rosette have observed that changing conditions in Arctic waters will favour some organisms more than others; there will be ecological winners and losers from the smallest to the largest members of the food web. In the Arctic, rising air temperature, increasing precipitation, higher river flows, and declining snow and ice cover have all led to large and rapid change in the upper ocean. In recent years, surface waters in the Canada Basin have freshened due to increased sea ice meltwater and have become corrosive to shells because of increased CO_2 uptake from the atmosphere.

Ice Class

The CCGS *Louis S. St-Laurent* was refitted in 1993 with a diesel-electric propulsion system and an improved Arctic Class 4 bow for icebreaking operations. Although the Arctic Class 4 designation means the ship is capable of moving continuously through 1.2-metre thick ice at a speed of three knots, the ship can break much heavier ice.

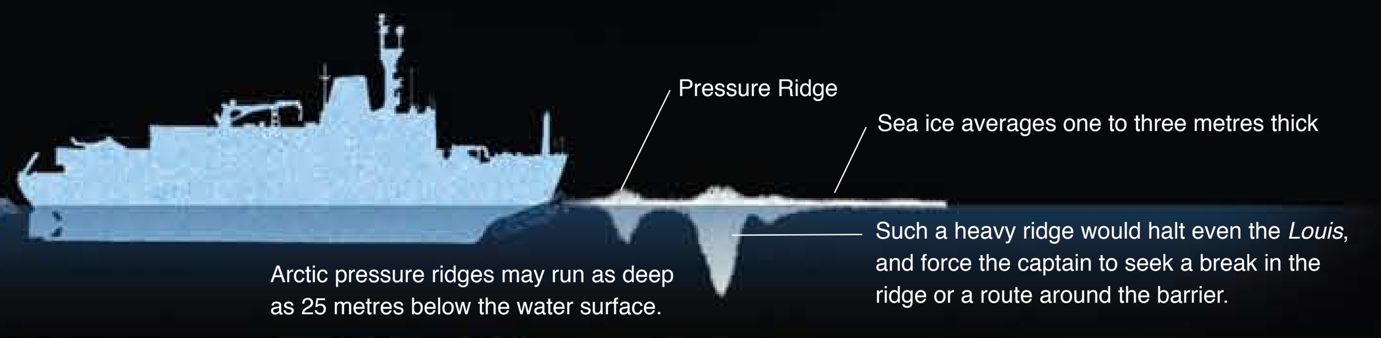
Seawater Probe

The CTD/rosette is the workhorse instrument of ocean science, going into action on nearly every research voyage. Technicians lower this "sea scout" into the water to take readings and collect study samples.

BREAKING BARRIERS

SEA ICE AND PRESSURE RIDGES

On average, ordinary sea ice is one to three metres thick and the powerful icebreaker ploughs through it as a matter of course. However, when wind drives large sheets of sea ice against each other, lines of crushed ice build up along their edges forming "pressure ridges" that can present more serious obstacles. The CCGS *Louis S. St-Laurent* has broken through ridges 13 metres thick and over 60 metres wide.



Learn more about the work of Canadian scientists at **www.science.gc.ca** and **www.dfo-mpo.gc.ca/science.**

IPY·API International Polar Year Année polaire internationale ᓄᓇᕐᔪᐊᕐ ᑲᔪᓯᓂᖅ ᐅᑭᐅᖅ 2007·2008

CCGS *Louis S. St-Laurent*

Canada's Largest Multi-Mission Icebreaker

FROZEN ARCTIC SEAS render a vast region impenetrable to most ships... but not icebreakers. With massive engines and reinforced hulls, these powerful vessels cut their way through solid ice sheets that would crush and sink ordinary ships. The Canadian Coast Guard's icebreakers carry vital cargo to isolated Northern communities and transport scientists to remote locations for research. Every year, busy icebreakers provide vital vessel traffic and communications services and maintain marine navigational aids. They also provide essential search and rescue services for accident victims. Proudly patrolling the North as no other ships can, the Canadian Coast Guard's icebreaker fleet embodies Canada's commitment to the Arctic.

Length: 119.8 m	Breadth: 24.38 m	Cruising Range: 23,000 nm

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