Science and Technology Branch

Environment and
Climate Change Canada

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Table of Contents

1. Introduction

1.1 Opening ADM Remarks

The Science and Technology Branch (STB) of Environment and Climate Change Canada (ECCC) is dedicated to the delivery of publicly funded science to help confront the environmental threats of today and to inform protection of the environment for future generations. The science conducted by STB serves as an evidence base to shape policy, regulations, and programs that fulfill ECCC's mandate and address our expanding responsibilities. As a horizontal delivery branch, our commitment to science excellence is essential to facilitating informed decision-making, policy development and robust service delivery across the department, the Government of Canada, and beyond.

This report includes highlights from the past fiscal year that demonstrate this commitment to science excellence. These achievements support the four core departmental responsibilities (nature, climate change, pollution, weather/environmental conditions) and exemplify the values and priorities for science of the recently renewed ECCC Science Strategy 2024 to 2029.

In 2023-2024, STB emphasized diversity and inclusion, further developed the talent of our people, strengthened our partnerships, and innovated in how we work. As a branch we can be proud of our contributions to the Department, and to protecting the environment. I invite you to read about these recent accomplishments to inspire continued efforts.

Marc D'Iorio
Assistant Deputy Minister, Science & Technology Branch

In 2023-2024, STB directly supported 18 of ECCC's Mandate Letter Commitments, including:

- Development and implementation of Canada's National Adaptation Strategy
- Modernization of the *Canadian Environmental Protection Act, 1999*
- Implementation of a strengthened Freshwater Action Plan
- Climate Adaptation and Mitigation
- Biodiversity, Conservation, and Nature Agenda
- Reconciliation with Indigenous Peoples
- Experimental Lakes Area
- Canada Water Agency
- Plastics agenda
- Meteorological Service of Canada renewal and High-Performance Computing

Overview of ECCC's Science Strategy 2024-2029

Vision

ECCC: Trusted source of science and innovation to inform policy and provide services that protect people and the environment across Canada, now and into the future.

Science Directions

Enable
the prediction and projection of weather, extreme events, and environmental conditions in a changing climate

Inform
climate change mitigation and adaptation for a net-zero, resilient Canada

Guide
the conservation, restoration, and sustainable management of nature and enhance ecosystem resilience and services

Support
protection of the environment now and into the future

Values For Science

- Bridging, Braiding, and Weaving Indigenous Science
- Scientific Integrity
- Collaboration
- Transparency
- Diversity, Inclusion, and Equity
- Responsiveness

Foundational Supports

- Knowledge Synthesis and Mobilization
- Infrastructure
- People
- Data
- Communication
- Science Advice Governance

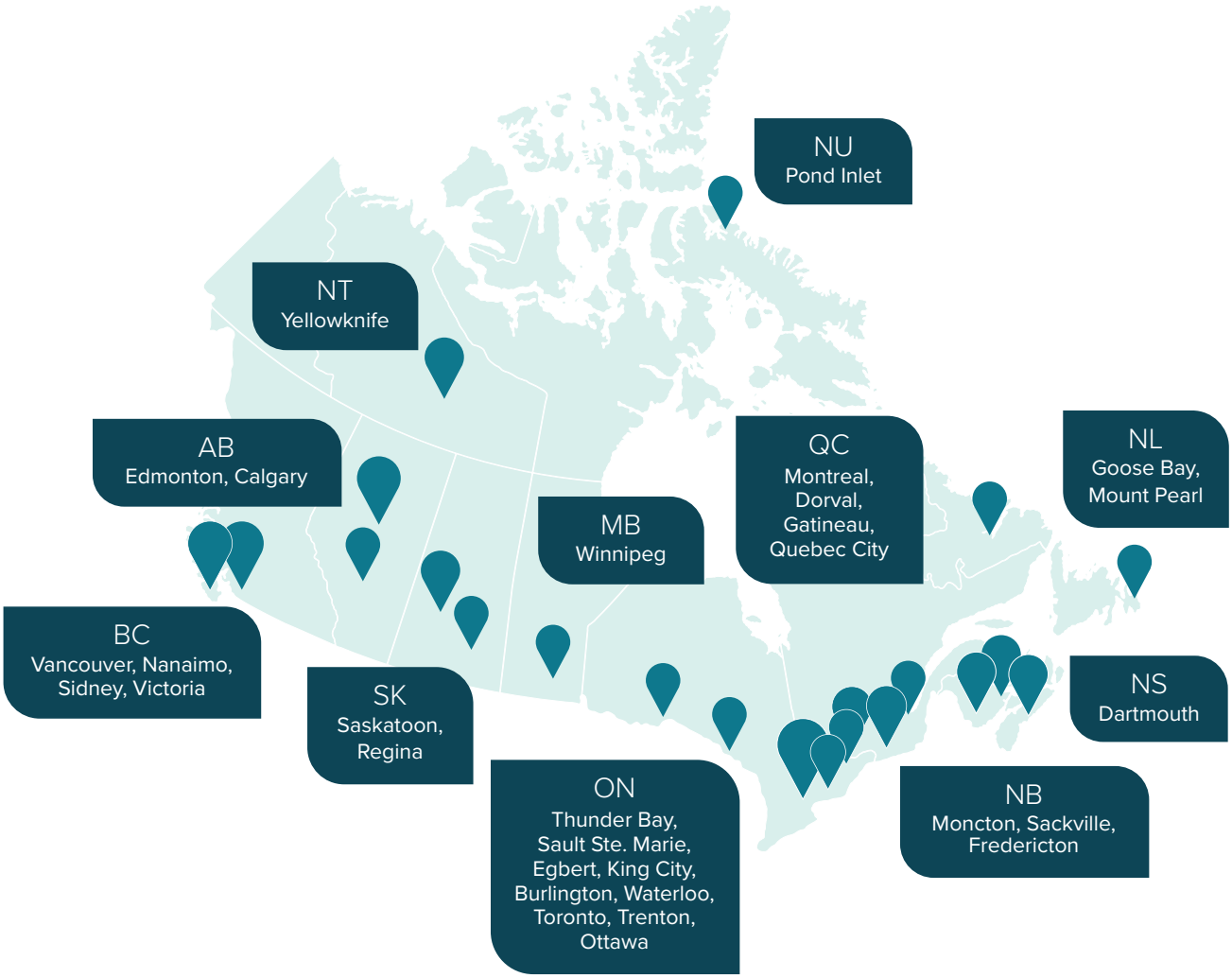
1.2 Our People, Our Values

Across Canada and through collaboration and partnerships, teams of dedicated STB professionals advance, apply and communicate scientific knowledge. Our achievements as a branch over the past year are the result of the dedication of STB personnel to core values and the continual improvement of how we deliver science advice to inform policy, regulations and departmental operations to protect the environment.

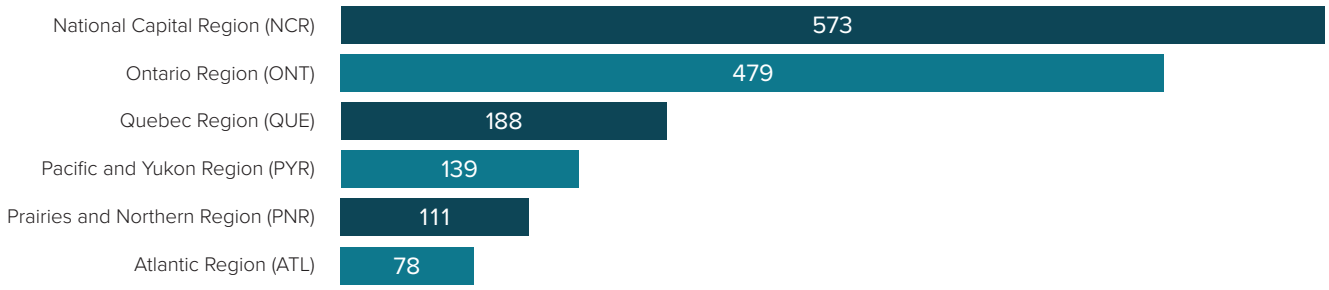
> Over 1,500 STB employees work in 43 buildings in 32 communities across Canada. Five STB employees are based in the Arctic, including at the Pond Inlet Research Facility in Nunavut. From this broad base in Canada, STB scientists conduct research in all ecosystems and environments across the country.

Science and Technology Branch Across Canada

~1,500 staff in 43 locations



Regional Distribution of STB Staff



STB's 2023-2024 budget reflected a diversified investment mix to deliver mandate-critical scientific research and innovation. With nearly $34 million allocated to Grants and Contributions, STB continues to mobilize the Canadian innovation system to further advance vital environmental science. STB is increasingly mobilizing knowledge outside the walls of the department to address today's complex environmental challenges.

Diversity, Inclusion and Equity

STB is proud of its diverse and inclusive workforce and recognizes the underrepresentation of equity groups in certain fields, such as science, technology, engineering, and mathematics. STB continues to make the recruitment and retention of Employment Equity group talent its top human resources priority.

- In late 2023, the workforce composition of STB included 23.4% visible minorities, with Black employees constituting 2.1%. Similarly, Indigenous employees comprised 2.1% of the workforce, while persons with disabilities represented 6.1% of the STB population during the same period.[1]
- STB will continue to build on recent progress in employment equity to improve representation and inclusion in our science and our workforce.

[1] Data on visible minorities and persons with disabilities represent employees who voluntarily self-identify as members of an employment equity group.

With the active engagement of management and employees, the STB Diversity and Inclusion Working Group is making remarkable strides to realize the Branch's multi-year **Action Plan on Diversity and Inclusion**. To date, the Working Group has delivered over 25 events and initiatives through its five employee-led subgroups on Recruitment and enablement; Training and development; Communications and outreach; Indigenous Braiding and approaches; as well as Healthy Workplace. In addition to hosting discussion forums on antiracism, unconscious bias, accessibility, neurodiversity and inclusive leadership, the Working Group has released an onboarding package for new employees, developed an inclusive hiring toolkit for managers and prepared a targeted action plan to address some of the issues raised in the 2022-2023 Public Service Employee Survey.

Further, STB's collaborative joint activities during 2023-2024 with departmental employee-led networks raised awareness among STB staff and promoted a respectful, supportive, and inclusive workplace. A spring panel discussion co-hosted with the Women in Science and Technology Committee put the spotlight on accomplished women leaders in the public service to share their experiences, provide advice, and articulate the importance of diversity to innovation in science. An event in partnership with the ECCC Indigenous Employees Network honoured National Indigenous Peoples Day in June 2023. Over the course of the year, events in partnership with the ECCC Black Employees Network, ECCC Employee Accessibility Network, and ECCC Pride Network raised awareness and provided resources and support for employees.

A Gender Based Analysis Plus (GBA Plus) review was conducted in 2023-2024 on ECCC's application of the Career Progression Management Framework for Federal Researchers. Results of the GBA Plus exercise pinpoint challenges and systemic barriers faced by science professionals in their career progression, particularly those belonging to employment equity groups. These findings will inform STB's efforts to enhance ECCC's delivery of the federal Research Scientist (RES) career progression framework, better support employee development, and bolster the branch's capacity to attract and retain research talent. In fall 2023, STB established a branch GBA Plus Working Group, to coordinate efforts and share information to better understand and address the branch's GBA Plus needs. This initiative is interconnected with broader ECCC efforts, including the GBA Plus Branch Advisory Network—a forum comprising of representatives from each branch.

- Women comprise 31% of the overall SE-RES[2] population.
- Women hold 14% of the positions within the RES-05 category, the top level of RES positions.
- Over the last decade, 23% of SE-RES promotion applicants were women, with a promotion success rate of 76%.

[2] Scientific Research group – Research Scientists subgroup

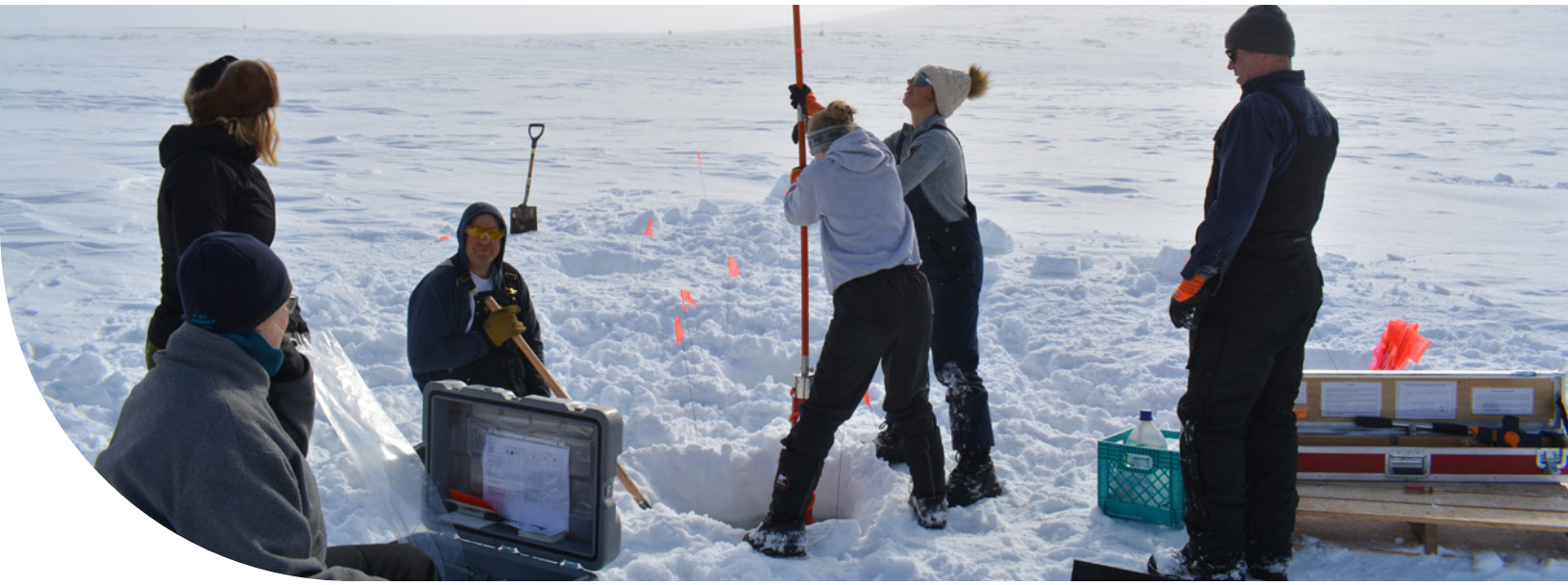
Collaboration and Partnerships

STB collaborates with a wide network of domestic and international research partners and data community members. Continuing to diversify and deepen these partnerships is crucial to how STB contributes to a greener, more sustainable future.

In 2023-2024, STB expertise, data, and coordination efforts contributed to advancing Canada's involvement and leadership in various international partnerships, including, the Arctic Council, the Commission for Environmental Cooperation, the Intergovernmental Panel on Climate Change, the International Methane Emissions Observatory, the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services, the World Meteorological Organization, and the Organisation for Economic Co-operation and Development, among others. Details on STB contributions to these international efforts are highlighted in Chapter 2.

Domestically, STB works closely with other publicly funded federal departments and agencies, through working groups, committees and formal arrangement, such as Memoranda of Understanding with National Research Council Canada, Health Canada, Agriculture and Agri-Food Canada and the Canadian Space Agency. STB is the ECCC lead for several important science initiatives led by other departments, including the genomics initiatives (Genomics Research & Development Initiative; Canadian Genomics Strategy), Canada's involvement in the G7 Open Science Working Group, and the Science, Technology and Innovation agreement with the United States.

In 2023-2024, STB continued to innovate in how we engage with partners and cultivate strong relationships with stakeholders, including industry, civil society, other levels of government, and Canadians. For example, improvements to the National Pollutant Release Inventory (NPRI) focused on enhancing data quality with updated guidance documents and adding data visualization features that respond to feedback from diverse stakeholders, such as the improved NPRI dashboard and newest online map. Innovative training partnerships, such as through the Canadian Aquatic Biomonitoring Network, supported hands-on experience for citizen scientists. Ongoing partnerships with Provinces and Territories enabled long-term air and water quality and wildlife monitoring such as in the operation of the National Air Pollution Surveillance network, the oil sands monitoring program, as well as continual refinement of ECCC's Single Window Information Manager for emissions and pollution reporting.



Each year, collaborations between STB and external co-authors yield hundreds of peer-reviewed science publications and technological innovations that contribute to the advancement of environmental science; this is the science that ultimately forms the evidence base for ECCC, and government of Canada, policies and programs. This past year was no different, with 515 of 586 STB publications in 2023 involving co-authors from a total of 704 organizations!

STB also drafted a new academic agreement plan that will help further STB's productive relationships with academia through a structured, strategic approach to improving communication, facilitating workshops, and identifying joint priorities. To foster Canada's emerging science talent STB hired 127 students in diverse fields of study in 2023-2024. STB has eight facilities co-located with universities across Canada.

> In 2023-2024, STB's Science Horizons program helped about 650 graduates across Canada obtain practical work experience in Canada's green economy.

To continue to support Canadian researchers, industry, and community-based organizations, all the while developing world class environmental science, STB issued 108 Grants and Contributions (G&C) agreements with 71 external organizations in 2023-2024, a total of nearly $34 million in funding. Of these agreements, 62 were with Canadian universities to enable science research with some of Canada's foremost experts on a wide range of environmental issues such as monitoring dispersion of plastics in the environment, analyzing contaminants in fish and ecosystem effects, tracking urban methane emissions, and modelling wildfire climate effects. STB increased support to Indigenous partners with 27 G&C funded projects in 2023-2024 including evaluating the impacts of oilsands development on traditional land use in Sucker Creek First Nation Traditional Territory and funding to Mushkegowa Council for using geospatial tools and techniques to coordinate carbon and biodiversity research in the Mushkegowak Territory.

Collaboration In Action: Study Of Winter Air Pollution In Toronto (SWAPIT)

Air quality studies have historically taken place during the summer months. However, winter air is affected by different sources of pollution and ambient conditions. The Atmospheric Science and Technology Directorate has conducted the first study of its kind in Canada to study the impact of weather, furnaces, wood-burning fireplaces, road salt and other wintertime factors on urban air quality. The study consisted of an intensive Toronto-based field campaign in collaboration with partners from all levels of government and several universities.

Transparency and Openness

The impact of ECCC's science efforts is strengthened when scientific information and advice, along with associated uncertainties, can be easily accessed and understood by decision-makers and the public. STB staff supported the work of Parliamentary Committees by providing subject matter expertise in 19 committee appearances in 2023-2024. Materials prepared by STB informed over 10 other Parliamentary Committee Meetings. Sustained domestic and international engagement with science producers and users informs how we are evolving the delivery of data and advice, growing the impact of science.

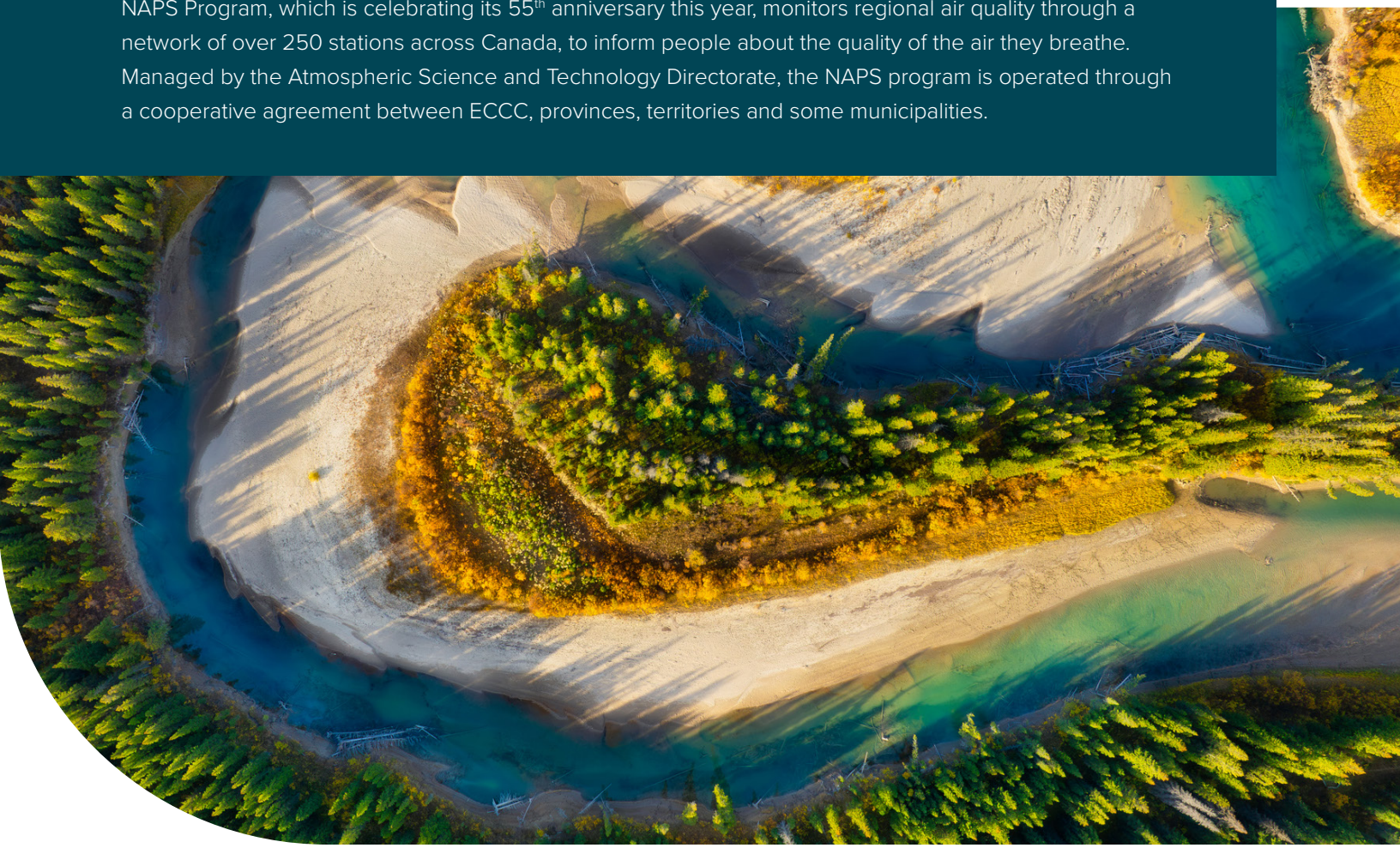
> In 2023, STB authors produced roughly 586 peer-reviewed scientific publications, which accounts for approximately 86% of all peer-reviewed scientific publications published by ECCC. Notably, 71% of STB's peer-reviewed scientific publications are open access, available broadly to educators, researchers, decision makers and the public, ensuring widespread accessibility to knowledge irrespective of geographic location and institutional affiliation.

Aligned with government-wide efforts, STB leads the ECCC approach toward open and accessible federal science through the Department's Open Science Action Plan: 2021-26. In January 2024, STB was a leader and key contributor to the launch of the Federal Open Science Repository of Canada, and one of the first participating science-based departments and agencies (SBDAs) to onboard many of its publications. This web-based platform hosts the research output of participating SBDAs, providing a secure and transparent tool to access federal science at no cost to end users.

Some of the information and datasets generated by STB include Canada's National Inventory Report, Greenhouse Gas Reporting Program, the National Pollutant Release Inventory, substances referred to in certain Canadian legislative and regulatory instruments, the Air Pollutant Emission Inventory, Black Carbon Emissions Inventory, the National Air Pollution Surveillance, and the National Long-Term Water Quality Monitoring program. They are disseminated and routinely accessed on Canada's Open Data Portal and various other open access portals such as the DataStream—an open access platform for sharing freshwater Data in Canada. Data for the co-managed Canada-Alberta oil sands environmental monitoring project is made available on both Canada's Open Data portal as well as Alberta's Oil Sands Monitoring Program portal.

Did You Know?

STB's National Air Pollution Surveillance (NAPS) Program is ECCC's second most visited data site! The NAPS Program, which is celebrating its 55th anniversary this year, monitors regional air quality through a network of over 250 stations across Canada, to inform people about the quality of the air they breathe. Managed by the Atmospheric Science and Technology Directorate, the NAPS program is operated through a cooperative agreement between ECCC, provinces, territories and some municipalities.



Bridging, Braiding and Weaving Indigenous Science

Bridging, braiding and weaving Indigenous science throughout the entirety of ECCC's science is essential to support reconciliation, inform policy and program work, and enhance decision-making at ECCC.

In its second year of existence at ECCC, STB's Indigenous Science Division (ISD) continued efforts to develop and apply an Indigenous lens to ECCC science, policy, and program activities. To this end, ISD aims to produce and mobilize Indigenous-led science and continues to apply an Indigenous-first staffing approach. The new Division started the year with only two employees but has since grown fourfold, now comprising nine staff members, six of whom self-identify as Indigenous. Key highlights of ISD's initiatives in 2023-2024 include: **Indigenethics** workshop, focused on creating an Indigenous ethics framework for conducting respectful research on migratory birds and other animals, Weather Predictions Workshop, Places and Spaces, and Clam Gardens (Loxiwe).

STB's Indigenous Voices speaker series in 2023-2024 featured seven distinguished guest speakers. These Indigenous science practitioners engaged in insightful discussions on topics such as Indigenous co-management, Indigenous fisheries, and research involving Arctic marine mammals, among others. Notably, Dr. Jesse Popp's presentation titled "Weaving Ways of Knowing Among the Trees" attracted over 600 participants to the live event.

Moving forward, the speaker series remains dedicated to amplifying Indigenous voices within the scientific community. It aims to inspire ECCC employees to embrace diverse perspectives and challenge preconceived notions, fostering an inclusive space that values and makes space for various ways of knowing and being in science.

STB also partnered on initiatives such as the Gwa'sala —'Nakwaxda'xw Nations project on **Food, Social and Ceremonial harvest** in Blunden Harbour BC; the development of training to support **community monitoring** of aquatic ecosystems with the First Nations of Quebec and Labrador Sustainable Development Institute; and an Indigenous community-based monitoring project for air quality in Fort McKay in the Oil Sands region. More detailed information on these and other Indigenous science and collaborative initiatives can be found throughout this report.

2. Highlights and Achievements in 2023-2024

2.1 Cross-cutting activities

Scientific Integrity

Scientific integrity, led by STB, is the cornerstone of ECCC's evidence-informed decision-making and the Department's reputation as a trusted and reliable source of scientific information.

Over the past year, STB has enhanced awareness and understanding of the ECCC Policy on Scientific Integrity (SIP), with the roll out of new resources and information sessions for ECCC employees to learn about the policy and how it guides their work. The branch also developed a new guidance document on how allegations of breaches of scientific integrity are investigated within ECCC. STB chairs the interdepartmental SIP Implementation Working Group. This collaborative forum engages federal science-based departments and agencies, the Office of the Chief Science Advisor, research councils, bargaining agents, and other stakeholders. In the past year, this working group contributed to initiatives like the development of new training courses on evidence-informed decision-making. These courses, now available through the Canada School of Public Service as TRN502 and TRN503, further enhance professional skills in this critical area.

In 2023, Dr. Jennifer Winter was appointed as the new Departmental Science Advisor and ECCC's Science Integrity Lead.

Dr. Winter provides advice on advancing a culture of scientific excellence and on strategic academic collaboration to leverage external science perspectives. As the Science Integrity Lead, Dr. Winter ensures alleged breaches of the ECCC Policy on Scientific Integrity are addressed with impartiality, confidentiality and respect. Dr. Winter's contributions support ECCC as a credible science-based regulator and policy-maker, and an authoritative source of scientific information.

Data and Infrastructure

Strategic investment in **science and research infrastructure** is essential for leveraging scientific data and information, enhancing domestic science capacity, and fostering collaboration. In line with its world class monitoring, modelling, regulatory and research focused on air, aquatic ecosystem health, water quality, nature conservation, chemical management and more, STB produced and managed massive volumes of scientific data and information at local and national levels throughout 2023-2024.

> STB scientific data holdings are varied, complex, quickly changing, and rapidly increasing in volume. This includes point data, time series data, 3-dimensional gridded geospatial data, numeric data, text data, image data, audio data, video data, modelling data, and regulatory data.

These multidisciplinary and varied datasets cover a range of critical areas such as greenhouse gas emissions, national water quality, genomics, climate, biodiversity, air quality, deposition, aerosols, and stratospheric ozone. These datasets help deliver crucial science advice and enable informed decision making, policy development and scientific discovery at both national and international levels. In 2023-2024 they were used to inform initiatives such as national carbon pricing efforts and forecasts of environmental conditions, and to contribute to reports produced by influential international organizations such as the Intergovernmental Panel for Climate Change's Assessment Reports, and the United Nations Environment Programme's Global Biodiversity Framework.

In 2023-2024, STB implemented numerous improvements to how growing volumes of data are managed. STB deployed a Laboratory Information Management System to automate lab analysis and reporting for the National Air Pollution Surveillance program. The branch is implementing a National Water Quality Data Management Solution to modernize the management of water quality data and provide a seamless, broadly accessible data platform for Canadians. The branch also continued to lead on ECCC's Single Window system that integrates data for close to thirty federal and provincial programs that regulate pollution. STB acquired an additional 900 TB of storage for sharing climate model data, and 1.1 PB of High-Performance Computing storage for collaborative projects in meteorological, environmental, climate, and air quality research.

STB is actively involved in numerous satellite Earth Observation missions that gather crucial data. For example, the U.S. National Aeronautics and Space Administration's TEMPO satellite mission (Tropospheric Emissions: Monitoring of Pollution), launched in April 2023. STB's participation ensured that TEMPO will provide data on local air pollution sources and patterns for more than 99% of Canada's population.

The Atlantic Science Enterprise Centre (ASEC), a new aquatic science facility planned for Moncton, NB officially broke ground in 2023. This world-class research centre will bring together ECCC, Fisheries and Oceans Canada, the National Research Council, the Canadian Food Inspection Agency, and the Canadian Space Agency. In coming years, STB staff located at the ASEC will collaborate with others from across the federal family on transformational science initiatives to better understand, protect, and sustain Atlantic freshwater and coastal ecosystems.

Knowledge Synthesis, Mobilization, and Communication

In 2023-2024, **STB prioritized making its science more openly accessible**, aiding government decision-making and everyday choices for Canadians nationwide. This effort sought to bolster public trust in science, facilitated informed discussions and partnerships, and translated into tangible real-world applications.

ECCC's Science and Technology X (formerly Twitter) account published 105 original posts in 2023-2024.

STB delivered 11 Science Café presentations in 2023-2024 on a variety of topics such as realizing the potential of genomics and the effects of plastic pollution. Science Café sessions provide a venue for ECCC scientists to share their important work and make connections across the Department.

In 2023-2024, STB partnered with the Science Media Centre of Canada to offer science communications training to STB researchers across Canada to help them better communicate their research to the media, the Canadian public and decision makers.

The new Wildlife Science Seminar series showcased the high-quality wildlife science produced collaboratively by STB and the Canadian Wildlife Service. Seminar topics covered key science that informs wildlife conservation and recovery action for species such as chimney swifts, Leach's storm-petrel, and monarch butterfly.

In spring 2023, STB launched the development of a second **Canada's Changing Climate Report**, first published in 2019. This national scientific assessment will describe how Canada's climate has changed, the causes of these changes and what changes are projected for the future and will involve experts from across the federal government, Canadian universities, and Indigenous science and knowledge holders.

STB is also leading Canada's participation in the **trinational Continental Assessment of Biodiversity and Climate Change**. This landmark study will summarize the understanding of key linkages between climate change and biodiversity, including identifying important knowledge gaps and implications for biodiversity and climate change policy from diverse areas of expertise in Canada, the United States and Mexico. The assessment will represent a continental contribution to the future work of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services, and other international biodiversity forums.

A **Synthesis of Freshwater Science in Canada** was released in early 2024 to support engagement through the National Freshwater Science Agenda. STB experts contributed to a team of over 100 federal government colleagues to produce the synthesis paper, which serves as a starting point for discussion with partners and stakeholders on freshwater science priorities, gaps, and needs in Canada. Ultimately, STB contributions to the National Freshwater Science Agenda will help support the Canada Water Agency and a strengthened Freshwater Action Plan.

Within STB, the newly formed **Expert Scientific Advice Section** (ESAS) in the Wildlife and Landscape Sciences Directorate is making expert science advice on wildlife and landscape science available to decision-makers in the Canadian Wildlife Service and beyond. ESAS brings together experts from within ECCC, academia, non-governmental organizations and industry to formulate consensus science advice and recommendations. These reports are then made publicly available. Over the coming years, ESAS intends to further weave Indigenous science into traditional science activities to better consider all knowledge sources in the development of the best advice.

STB led the completion of a Wildlife Science Advice pilot project on monarch butterflies. STB worked closely with the science end user—the Canadian Wildlife Service (CWS)—to identify their priority research question. Staff then conducted a research study to answer the question and communicated the research results and advice to CWS through an in-person meeting and formal report. The lessons learned from the pilot process have helped inform the development of new science advice processes in the department. This client-centric approach is an indicator of where the branch intends to further move over the coming years.

Establishing Governance and Policy for Science at ECCC

The ECCC Science Strategy 2024–2029 was published in February 2024 as a guide for the Department's science over the coming years. The Strategy supports the modernization and continual improvement of how we conduct, use, govern and communicate science at ECCC to keep pace with a rapidly changing environment. Led by STB, the Strategy was developed through engagement across the Department, guided by ECCC's science governance forums, and reviewed by other science-based departments and agencies, and by unions.

The departmental **Science Advice Governance Framework** was established by STB in May 2023, with the approval of the department's Executive Management Committee The new framework features executive Science Tables to foster horizontal collaboration across branches and to strengthen the role, relevance, and impact of science in decision-making and delivery of departmental responsibilities. The five Science Tables had a productive year, convening three to four meetings for each table. Discussions at the science tables examined topics such as establishing a prioritization process for better coordination of science needs on pollution across the department, initiatives for addressing challenges, opportunities and priorities in monitoring greenhouse gas emissions, efforts to identify scientific requirements to align with the Global Biodiversity Framework targets and support its implementation, and the development of ECCC's Artificial Intelligence Roadmap for enhancing weather forecasting and environmental predictions. Having a transparent and structured approach to science advice bolsters the Department's ability to address science-based issues effectively and increases public confidence in decision-making at ECCC.

Within the Science and Technology Branch, a renewed Science Council, comprised of science thought leaders from across the branch, was established in 2023-2024 to serve as an advisory body to senior management on science and research priorities. Over the past year, the Council has discussed science activities and emerging areas such as the recent Canadian Council of Academies Arctic report; the development of an STB academic engagement strategy; the ECCC Science Strategy 2024–2029; recognition of excellence in science within the branch and department; and, outcomes from the Departmental Science Advisor Network.

2.2 Enabling the prediction and projection of weather, extreme events and environmental conditions in a changing climate

High-impact weather-related events such as flooding, heatwaves, wildfires, tornadoes and poor air quality can lead to disastrous consequences. STB continuously contributes to the Department's capacity to predict and provide warnings of weather and environmental risks, information critical to emergency management and day-to-day decisions made by people living across Canada.

STB researchers contribute to 35 operational numerical weather and environmental prediction systems, which has led to over 100 innovations aimed at improving weather and environmental predictions—crucial support for organizations such as the Meteorological Service of Canada. Some notable advancements include enhanced spatial resolution in certain systems and improved forecasting capabilities concerning ice in marine environments.

Wildfires and Extreme Events

Last year (2023) saw unprecedented wildfire activity in Canada. Smoke from wildfires is a major source of air pollution in Canada and, because it can be carried thousands of kilometres downwind, it has far-reaching impacts that extend across borders, affecting regions as distant as the United States and Europe. ECCC's **FireWork model** is an air quality prediction system that forecasts the movement of wildfire smoke across North America. This capability was invaluable in 2023 when smoke from Canadian fires blanketed much of Canada and most of the northern and northeastern United States. Forecasters from the U.S. state of Maryland and the National Oceanic and Atmospheric Administration contacted STB to express their thanks:

> "During the month of June, the FireWork model has been instrumental for providing smoke guidance to our State. The FireWork model became our primary numerical guidance and was the best-performing model for our needs. There are many air quality forecasters around the eastern United States that found this model useful."

Over the past year, STB researchers initiated the development of a **rapid extreme event attribution system**, a key initiative under Canada's National Adaptation Strategy, to quantify the influence of human-induced climate change on extreme weather events in Canada. This kind of information is critical for informing local adaptation (e.g., designing infrastructure rebuilding after an event or planning heatwave response procedures), as well as for improving Canadians' awareness of the effects of climate change. The new system now automatically calculates human influence on the risk of observed heatwaves in Canada. This system will next be developed to use new high-resolution model simulations and to consider other types of extreme events, such as heavy rainfall. In 2023-2024, researchers in STB also carried out an in-depth study to quantify the influence of human-induced climate change on Canada's exceptional 2023 wildfire season, in collaboration with Natural Resources Canada.

Indigenous Science Weather Workshop

In October 2023, STB supported an Indigenous science weather scoping workshop seeking to bridge Indigenous and Western science for an improved understanding of weather patterns and their impacts on historic and contemporary Indigenous cultures and communities. Indigenous Knowledge Holders from across Canada contributed to sessions on Indigenous scientific methods in weather prediction, weather and harvesting activities, differences in weather patterns, and impacts of severe weather. The workshop findings emphasized the importance of collaboration and mutual respect between Indigenous and Western scientific knowledge systems for a holistic understanding of weather as interconnected with physical and biophysical systems, as well as human cultures and health. A workshop report and journal article are forthcoming. The workshop was based in respect, and adherence to the principles of Free, Prior, and Informed Consent (FPIC), and Ownership, Control, Access, and Possession (OCAP) of data, supporting good relationships and setting an example for future bridging, braiding, and weaving initiatives.

Making Use of Technological Advances

Artificial intelligence (AI) has been leveraged by STB researchers to generate the first-ever **year-round pan-Arctic sea-ice thickness dataset**. As sea-ice diminishes with climate warming, commercial interests have increased but so have the potential safety risks to maritime users. This new dataset creates opportunities to understand Arctic climate feedback on different timescales including the potential to extend the lead time of August—October sea-ice forecasts at the peak of the Arctic shipping season.

To advance the use of AI into ECCC's weather and environmental predictions capabilities, STB, and the Meteorological Service of Canada collaborated on the development of the **first AI Roadmap for Weather and Environmental Predictions**. The ECCC interdisciplinary expert team elaborated the roadmap to foster the integration of AI across the entire prediction production chain, from the minute to the seasonal timescale. Scheduled for release in spring 2024, the Roadmap is already driving ongoing project development.

2.3 Informing climate change mitigation and adaptation for a net-zero, resilient Canada

Given costs and impacts of climate warming on the environment and communities, increasing resilience is a key priority for Canada. STB plays a key role in supporting emissions reductions, climate change adaptation and risk-based decision making to respond strategically to the effects of climate change.

In partnership with provinces, territories and municipalities, STB has 312 stations monitoring long-term air pollution and 23 stations measuring long-term greenhouse gas concentrations across Canada.

Climate Science

The **Climate Science 2050: National Priorities for Climate Change Science and Knowledge Report**, released in spring 2024, follows two years of extensive engagement with over 500 climate leaders, academics and experts across governments, sectors and the Canadian climate change science community. It brings together perspectives from both Western and Indigenous science to guide ongoing coordination and research efforts crucial for delivering science results leading up to 2030. Serving as a north star for those involved in climate change science, policy and programs, it outlines priority actions to achieve six key societal goals essential for a resilient, net-zero Canada by 2050. A dedicated chapter of the report highlights the importance of Indigenous science, creating an equitable science system, and learning from Indigenous Peoples' sacred relationship to land, water and ice.

In 2023-2024, ECCC developed and validated a **novel hybrid emission inventory for methane** from Canada's upstream oil and gas operations. Previous work had reported significant discrepancies between reported and atmospheric-derived emission estimates (up to +90%). Using aerial observations, STB implemented methodological updates to the National Inventory Report and validated them against long-term atmospheric observations. ECCC's new hybrid inventory and atmospheric-derived estimates now agree within 10%. It was also demonstrated that atmospheric-derived estimates provide a reliable baseline for methane emissions in Western Canada and that continuing atmospheric observations and inverse modelling will allow tracking of emission reductions expected from current and future regulations by the Government of Canada to achieve its 75% methane reduction goal for the oil and gas industry.

Canada was successful in its nomination and election of an independent Canadian expert to the **Intergovernmental Panel on Climate Change (IPCC)** Bureau for the Seventh Assessment Report (AR7), and STB representatives participated fully in IPCC meetings to ensure the AR7 work program was responsive to Canadian needs. Expertise from STB and partners was also in demand to scope upcoming reports such as the Methodology Report on Short-Lived Climate Forcers and the Special Report on Climate Change and Cities.

Ongoing Support for Emissions Reductions

This past year, STB continued with various initiatives to support the Department's ongoing efforts for emissions reduction. The Black Carbon Emissions Inventory, prepared annually, continued to assess progress in reducing black carbon emissions, contributing to climate change mitigation, addressing human health concerns, and advancing the Arctic Council's collective aspirational goal. Additionally, the National Inventory Report, a significant, highly cited STB publication since 1994, provided crucial information on greenhouse gas (GHG) estimates to inform decision-making in reducing emissions and achieving net-zero targets. Complementing this effort, the Greenhouse Gas Reporting Program (GHGRP), collecting data under section 46 of the *Canadian Environmental Protection Act, 1999*, sustained its collection of emissions data from facilities nationwide. The GHGRP aids in consistent and accurate tracking of GHG emissions to inform policies related to climate change, industrial activities and energy use.

2.4 Guiding the conservation, restoration and sustainable management of nature and enhancing ecosystem resilience and services

The widespread and increasingly rapid loss of biodiversity threatens ecosystem functions and services essential to life on Earth. STB activities focus on improving outcomes for biodiversity in meaningful partnership with Indigenous Peoples and draw from the insights of bridging, braiding and weaving of Indigenous science with Western science.

In 2023-2024, STB collected samples at 346 biomonitoring sites across Canada including many sampled in partnership with Provinces and Territories and Parks Canada.

In 2023-2024, STB monitored over 400 shellfish growing areas in Canada in support of safe harvest of shellfish for interprovincial and international trade as part of the **Canadian Shellfish Sanitation Program** (CSSP). Monitoring and other CSSP-related activities such as pollution source surveys and modelling in response to emergency events (such as severe meteorological events) have also contributed to safe harvest of shellfish for Indigenous Food, Social and Ceremonial and recreational uses.

In 2023-2024, STB collected 8,744 samples at 996 water quality monitoring sites across Canada with many samples collected in partnership with external partners, including Provinces and Territories. STB monitoring activities support initiatives such as a pesticide monitoring project with Health Canada's Pest Management Regulatory Agency (PMRA). The 2023-2024 fiscal year was the final year of this collaborative pilot project to inform PMRA's risk model, an essential component of regulations governing the marketing and use of pesticides in Canada.

Conserving and Restoring Biodiversity

STB has developed a project that analyzes pollutant data sourced from the National Pollutant Release Inventory and Fisheries and Oceans Canada within the critical habitat of the **St. Lawrence Estuary beluga whale**. This comprehensive data integration is designed to assess the potential effects, encompassing both direct and indirect ramifications, of these substances on the endangered population of beluga whales, thus contributing to their conservation and recovery efforts. This work was built on the approach developed by STB to assess contaminants of concern in the Fraser Basin that enter the critical habitat of the **Southern Resident Killer Whale**.

The **Kunming-Montreal Global Biodiversity Framework (GBF)** seeks to halt and reverse biodiversity loss by 2030 and restore biological diversity levels by 2050. The GBF proposes 4 long-term goals and 23 targets that require the best available scientific advice for coherent and effective implementation. To explore specific themes within the GBF's targets and goals, STB convened several virtual science advisory panel sessions that included experts from the academic community, Indigenous organizations, government agencies, non-governmental organizations and industry. The sessions explored specific themes within the GBF's targets and goals. Based on these sessions and other recent biodiversity initiatives, a report identifying 78 target-specific science needs and four cross-cutting opportunities to aid in Canada's implementation of the GBF was produced by this multi-sectoral team. To mobilize the information, STB convened a one-day Science Forum in January 2024 to connect scientists with policy-makers and to discuss how science can support meeting the GBF targets.

STB serves as National Focal Point for Canada's participation in the **Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES)**. STB led the Canadian delegation at the 10th IPBES plenary in Bonn, Germany, where an important assessment and summary for policy-makers of the global impact of Invasive Alien Species was approved, alongside an ambitious future work plan. Canada was also successful in nominating experts to various IPBES task forces and the scoping of the Second Global Assessment on Biodiversity and Ecosystem Services. STB has been broadening the engagement and expert contributions of federal scientists as well as mobilizing broader Canadian expertise and Indigenous knowledge in support of IPBES work.

In Canada, **Highly Pathogenic Avian Influenza Virus** is exhibiting significant risks and costs to wildlife health, biodiversity, livelihoods, food safety and security (including country foods), economies, and livestock health, and is currently showing increasing human health risks. As part of a One Health approach aimed at optimizing the health of animals, people and the environment, STB researchers have partnered with federal, provincial, territorial, and international collaborators and Indigenous organizations to deliver an interdisciplinary science program that supports an evidence based One Health approach to outbreak response. In 2023-2024, One Health activities focused on coordination and implementation of disease surveillance activities including antibody testing, wild bird mortality and population impact assessments, data and knowledge integration, epidemiological analysis, and expert input in numerous interagency One Health committees and working groups.

Citizen Science

STB scientists participate in numerous initiatives that support citizen science. The **Canadian Aquatic Biomonitoring Network (CABIN)**, an ECCC-led collaborative biomonitoring network supports citizen science assessment of freshwater ecosystem health using standardized protocols, web-accessible tools, and training. In 2023-2024, ECCC continued to offer training and certification for aquatic biomonitoring, hosted by the Canadian Rivers Institute based at the University of New Brunswick. This innovative program features a combination of online and field training modules. The online modules provide guidance for data entry, analysis and reporting. The field course, conducted in a river setting with certified CABIN trainers, offers hands-on experience for the collection of benthic macroinvertebrates and river habitat data according to CABIN protocols.

Supporting Indigenous Stewardship Practices and Collaborative Monitoring

STB is collaborating on research with the Wei Wai Kum Kwiakah community on **clam gardens** **or *Loxiwe***, an ancient Indigenous stewardship practice to enhance the productivity of clams and other shellfish or to create new habitat within intertidal beaches. The project weaves Indigenous and Western sciences while respecting the rights and sovereignty of Indigenous Nations and providing insights into food security, biodiversity conservation and climate change adaptation.

In 2023-2024, Canadian Shellfish Sanitation Program (CSSP) partners (ECCC, Canadian Food Inspection Agency, and Fisheries and Oceans Canada) collaborated with the Gwa'sala—'Nakwaxda'xw Nations to pilot water quality monitoring, pollution source surveys and biotoxin monitoring in areas of interest along the BC coastline. This initiative helped advance collaboration and better understanding of the Nations' needs to improve access to safe and sustainable shellfish sources for Food, Social, and Ceremonial uses. The CSSP is leveraging this and other experiences with First Nations to inform CSSP modernization.

This past year, STB supported the development and delivery of a new hands-on Indigenous marine technician certificate program under the Oceans Protection Plan's "Community-based Partnerships for Marine Response" initiative. The goal of the program is to support local emergency preparedness and response, prepare participants to conduct marine monitoring, and enhance Indigenous involvement in the marine safety system.

2.5 Supporting protection of the environment now and into the future

STB science and implementation of mandatory information gathering initiatives under the *Canadian Environmental Protection Act, 1999*, help to identify, better understand and mitigate the impacts of government operations and infrastructure, as well as the evolving risks of pollution and harmful substances in the environment. STB science activities also inform emergency response and risk management measures that support the protection of people and the environment.

STB addressed over 1,350 inquiries and received over 450 public comments on the Chemicals Management Plan in 2023-2024.

STB researchers have been tracking over 7,000 facilities reporting on more than 300 substances in the Government of Canada's National Pollutant Release Inventory.

STB New Substances Program addressed 722 inquiries related to new substances and completed risk assessments of 231 chemicals and polymers. The Existing Substances Program published seven final risk assessments.

Protecting Urban Greenspace and Wildlife

STB science is at the forefront of understanding the critical role of urban green space in supporting migration and other important life cycle stages for boreal-breeding birds. Together with academic partners, STB is conducting collaborative research across disciplines to quantify the effects of the loss of green infrastructure on human well-being and biodiversity. This research comes at a critical juncture when building new housing to meet the needs of an increasingly urbanized Canadian public is a primary government priority. Research on bird collisions conducted by STB also informed the revised Greening Government Strategy, especially its aim to reduce bird strikes on federal buildings. This effort contributes to lessening the negative effects of government activities on wildlife.

Protecting Canadians and the Environment from Chemical Substances

The modernized *Canadian Environmental Protection Act, 1999* (CEPA) presents a landmark step in keeping the environment and people living in Canada safe and healthy. STB contributed to the science that informed amendments to CEPA and will continue to innovate in how we support its implementation. For example, STB has partnered with the Université du Québec en Abitibi-Témiscamingue on a project that aims to assess the potential for exposure to environmental pollutants of Indigenous communities located in Quebec's boreal forest. Investments in STB's National Pollutant Release Inventory (NPRI) in 2023-2024 focused on enhancing data quality, adding features to data visualization tools, and updating several information products tailored to a diverse range of users. 2023 marks the 30th year of data reporting for the NPRI and the milestone was observed with a social media promotion and the publication of an interactive timeline of the NPRI. To align with new CEPA obligations to transparency regarding living organisms, the New Substances program held public comment periods for four lines of genetically modified fish and one line of genetically modified fruit fly. Thanks in part to scientific analysis by STB, ECCC was successful in legal action against a company for non-compliance with emissions standards under CEPA.

In collaboration with colleagues in the Environmental Protection Branch and at Health Canada, STB developed the **draft State of Per- and Polyfluoroalkyl Substances (PFAS) Report**, which was released for public comment in May 2023. Referred to as "forever chemicals," PFAS are found in all areas of the environment (air, water, fish and wildlife) and are commonly found in everyday products. They can adversely affect the health of humans and wildlife, including organ functions, immune and nervous systems, reproduction and development. Canada has nominated a subgroup of PFAS, known as long-chain perfluorocarboxylic acids (LC-PFCAs), for inclusion in the Stockholm Convention on Persistent Organic Pollutants. This important work informs Canada's action to protect people and the environment from the effects of pollutants, including support for more holistic research and monitoring programs, and for reducing the replacement of harmful substances with alternatives that are not yet known to be harmful.

STB research continues to help advance Canada's Zero Plastic Waste agenda. Through data generation and assessment, STB has supported several ECCC-led initiatives dedicated to reducing plastic pollution, including a pollution prevention (P2) planning notice for primary food plastic packaging.

Transboundary Air Pollution

Since 1991, Canada and the United States have reduced the impact of cross-border air pollution through the **Canada-U.S. Air Quality Agreement**. In 2023-2024, STB and U.S. Environmental Protection Agency colleagues provided the scientific foundation for a comprehensive Review and Assessment, which occurs every five years under the Agreement. The Review and Assessment report used monitoring data and modelling output to assess progress in reducing acid rain and ground-level ozone and to evaluate the transboundary impacts from fine particulate matter ($PM_{2.5}$), which is not currently part of the Agreement. The Report recommended updating emissions reduction commitments for acid rain and ground-level ozone and considering adding commitments for $PM_{2.5}$. The Review and Assessment will form the basis for the proposed renegotiation of the Agreement, beginning in 2024, an opportunity to deepen collaboration to reduce cross-border air pollution and its harmful effects on the environment and human health.

Ongoing Support for Water Protection

In 2023-2024, STB continued to provide crucial science support to policy and programs that conserve and protect freshwater, coastlines, and oceans. STB's **national long-term water quality monitoring program**, a legislated obligation under the *Canada Water Act* since 1970, analyses water quality status and trends in partnership with Provinces and Territories. This program supports initiatives such as the Freshwater Action Plan, the St. Lawrence Action Plan, the Oil Sands Monitoring Program, the Whales Initiative, and the Chemicals Management Plan.

To guide freshwater monitoring activities and objective decision-making, STB designed and continues to apply a **Risk-Based Adaptive Management Framework**. This science-based, modernized approach is informed by ecosystem risks and vulnerabilities and is responsive to emerging issues and organizational requirements. It is adaptive through a continuous cycle of improvements to ensure ongoing relevance and efficiency of monitoring activities, including the identification of high-risk areas in freshwater sub-basins across Canada.

This past year, STB also advanced various sub-initiatives under the **Oceans Protection Plan**. Activities included delivering an Arctic Marine Oil Spill Technical Seminar on preventing, assessing, and cleaning up spills of oil and other hazardous materials. Two shoreline assessments were completed—the first co-developed with Cowichan Nation to assess Cowichan Bay, British Columbia and the second in cooperation with the Canadian Coast Guard in Cornwall, Ontario. STB also continues to provide and improve sampling and analytical capacities to support emergency response, emergency preparedness, and management of wrecked and abandoned vessels.

3. The Road Ahead in 2024-2025

STB, and more broadly, the Environment and Climate Change Canada science community, can be proud of its many accomplishments in the past year. These achievements not only bolster our ongoing commitment to preserving environmental quality, ensuring public health and safety, and fulfilling federal mandates and global agreements but also serve to protect our environment for generations to come. The environmental challenges confronting Canada and the global community are increasingly complex and urgent. By making scientific and technological progress, fostering inclusivity and collaboration, investing in our workforce, and optimizing the way we deliver science advice to serve as the evidence base for policies and programs, STB is poised to effectively address these challenges and support the department in the delivery of its mandate.

Moving forward, annual reports will highlight progress against the ECCC Science Strategy 2024–2029 and emphasize the role and impact of science across the Department. We remain committed to delivering the science needed for the department, and government as a whole, to confront the increasingly complex environmental challenges that we will continue to face moving forward.