DRAFT

Great Lakes Binational Strategy for Short-Chain Chlorinated Paraffins (SCCPs) Risk Management

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Draft prepared by Environment and Climate Change Canada and the United States Environmental Protection Agency

Disclaimer

The purpose of this document is to focus efforts in implementing Short Chain Chlorinated Paraffins (SCCPs) risk mitigation and management strategies in accordance with Annex 3 of the Great Lakes Water Quality Agreement (GLWQA). The mention of trade names, commercial products, or organizations does not imply endorsement by the United States or Canadian governments.

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Executive Summary

The Canada- United States Great Lakes Water Quality Agreement (GLWQA) seeks to reduce the anthropogenic release of chemicals of mutual concern (CMCs), including short-chain chlorinated paraffins (SCCPs), into air, water, land, sediment, and biota that may impair the quality of the Waters of the Great Lakes. Under the GLWQA the Parties have agreed to adopt, as appropriate, the principles of virtual elimination and zero discharge for releases and control of CMCs.

This document provides a Binational Strategy for SCCPs to focus efforts of the Governments of Canada and the United States, in cooperation and consultation with State and Provincial Governments, Tribal Governments, First Nations, Métis, Municipal Governments, watershed management agencies, other local public agencies, industry and the public, in implementing risk mitigation and management options aimed at reducing SCCPs in the Great Lakes basin. The Parties and their partners will use this strategy as a guide to identify, prioritize, and implement actions to reduce CMCs. Strategy options are organized under five categories: Regulations and Other Risk Mitigation and Management; Compliance Promotion and Enforcement; Pollution Prevention; Monitoring, Surveillance, and Other Research; and Domestic Water Quality. As noted in the GLWQA, the Parties' obligations are subject to the appropriation of funds in accordance with their respective procedures. The Strategy is a compilation of recommendations that can be considered by a variety of stakeholders, including industry, academia, and non-government organizations. In addition, some of the recommendations reflect work that the parties are already performing.

Chlorinated paraffins ("CPs," also known as chlorinated alkanes) are a class of synthetic organic chemicals that are subdivided into groups based upon carbon chain length. CPs consist of extremely complex mixtures allowing for many possible positions of the chlorine atoms. Depending on the degree of chlorination, they are grouped into low (<50%) and high (>50%) chlorine content by weight. Depending on the chain length, the commercial products of CPs are often subdivided into short, medium, and long chain chlorinated paraffins [SCCPs (C10–C13), MCCPs (C14–C17) and LCCPs (C>18)], respectively.

This document is specific to SCCPs, which can cause a variety of harmful human health and environmental effects. SCCPs are manufactured for use as lubricants, coolants, plasticizers, and fire retardants (US EPA, 2009). They are environmentally ubiquitous: found in air, soil, sediment, water, fish, marine mammals, birds, and human breast milk within the Great Lakes basin and around the globe. SCCPs are persistent and remain adsorbed onto soil or sediment particles and, due to very low vapor pressures, SCCPs are easily volatilized and transported through the atmosphere. Emissions from wastes containing SCCPs may be a potential long-term source in the environment, but information is not readily available on the future emissions from such sources.

To date, binational attempts to reduce the amount of SCCPs released to the environment have focused on a variety of regulatory actions at the Federal level in the United States and Canada, including a prohibition in Canada on the manufacture, use, sale and importation of SCCPs and products that contain them. Limited data suggest that top-predator fish from Lake Ontario (and hence potentially throughout the Great Lakes) do not exceed environmental guidelines, and that SCCP concentrations in these fish are on the decline. An overall lack of data (i.e., usage in consumer goods, products, and environmental concentrations) is the largest gap to understanding the current SCCP concentrations within the Great Lakes basin.

To address these challenges, this Binational Strategy document proposes multiple strategic options as outlined in **ES Table A**. By implementing the options presented in this Binational Strategy, governments and stakeholders will be improving human and ecosystem health within the Great Lakes basin and their respective communities. Where Canada or the United States are not listed against an activity it reflects the fact that the option presented has already been undertaken, or is not appropriate within the context of the existing risk management programs and activities, within that country.

ES Table A. Summary of the Canada-United States Strategy Options for SCCPs

Category of Action				
Regulations and Other Risk Mitigation and Management Actions	**Compliance Promotion and Enforcement**	**Pollution Prevention**	**Monitoring, Surveillance, and Other Research Efforts**	**Domestic Water Quality**
Strategy Options				
Maintain the prohibition on import, manufacture, sale and use of SCCPs and products that contain them (Canada) Ensure that manufacture and importation of SCCPs has been addressed (US) Maintain information on SCCPs as part of regular updates to the TSCA Inventory (US) As science develops and becomes available, review and update regulations (US)	Continue to promote and enforce compliance with the *Prohibition of Certain Toxic Substances Regulations, 2012* as they relate to SCCPs (Canada) Promote and enforce Toxic Substances Control Act Significant New Use Rule regulations for SCCPs (US)	Enhance public outreach and educate the public and facility staff on potential sources of SCCPs and proper actions to follow should products containing SCCPs be found (Canada and US) Encourage industries to use P2 activities reported by facilities to EPA's TRI, and disclose their own P2 achievements when filing TRI reports (US) Promote proper disposal and waste management of SCCPs-containing products (Canada and US)	Develop standardized, cost-effective analytical methodologies to support environmental monitoring programs (US) Consider establishing environmental guidelines and standards (US) Regularly monitor long-term SCCPs trends in Great Lakes environmental media and publish results in a variety of formats (e.g., on-line and open data portals, government reports, and scientific journals) to maximize the intended audience (Canada and US) Use monitoring and modeling to better characterize select SCCPs sources as a basis for potential actions, measuring progress, and formulating an international decision-making framework (US) Use existing data sources and exposure data to continuously inform future strategic directions and plans using an adaptive management approach (US) Identify and conduct further risk analyses for safer alternative SCCP chemicals (US) Consider exposure and risk assessments of other SCCP categories (US)	Implement appropriate domestic water quality standards for drinking water and surface waters, as resources allow (US)

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Acronyms and Abbreviations

BAF	Bioaccumulation Factors
BCF	Bioconcentration Factors
CASRN	Chemical Abstracts Service Registry Number
CSMI	Cooperative Science and Monitoring Initiative
CEPA	*Canadian Environmental Protection Act*, 1999
CMC	Chemicals of Mutual Concern
CPs	Chlorinated Paraffins
EB	Executive Body
ECCC	Environment and Climate Change Canada
FEQG	Federal Environmental Quality Guidelines
GLNPO	Great Lakes National Program Office
GLWQA	Great Lakes Water Quality Agreement
ISO	International Organization for Standardization
ITT	Identification Task Team
LAMP	Lakewide Action and Management Plan
LCCP	Long-Chain Chlorinated Paraffin
LRTAP	Long-Range Transboundary Air Pollution
MCCP	Medium-Chain Chlorinated Paraffin
MPO	Manufactured, Processed or Otherwise Used
MPCA	Minnesota Pollution Control Agency
NGO	Non-Government Organization
NOEC	No Observed Effect Concentration
NPRI	National Pollutant Release Inventory
P2	Pollution Prevention
PMN	Premanufacture Notices
POP	Persistent Organic Pollutants
PSL1	Priority Substances List, first
PVC	Polyvinyl Chloride
RME	Risk Management Evaluation
SCCP	Short-Chain Chlorinated Paraffin
SNU	Significant New Use
SNUR	Significant New Use Rule
TRI	Toxics Release Inventory
TSCA	Toxic Substances Control Act
UNECE	United Nations Economic Commission for Europe
US EPA	United States Environmental Protection Agency

1 Introduction

The purpose of Annex 3 of the Canada-United States Great Lakes Water Quality Agreement (GLWQA) is to reduce the anthropogenic release of chemicals of mutual concern (CMCs) into the Waters of the Great Lakes, recognizing: (1) the importance of life cycle management, (2) that knowledge and information are fundamental to sound management, (3) that CMCs may be managed at the federal, state, provincial, tribal, industrial, and local levels through a combination of regulatory and non-regulatory programs, (4) that international efforts may contribute to reductions from out-of-basin sources, and (5) that the public can contribute to achieving reductions. While there is no requirement in the GLWQA to set reduction targets, consideration should be given to existing guidelines and the work of other Annexes.

In 2016, the two governments designated short chain chlorinated paraffins (SCCPs) as one of eight CMCs. In designating SCCPs as CMCs, the Parties have agreed that SCCPs pose a threat to the Great Lakes, that current management actions are insufficient, and that further action addressing risks to the Great Lakes basin is warranted. These possible actions are documented in binational strategies which may include research, monitoring, surveillance and pollution prevention and control provisions. The purpose of the binational strategies is to reduce releases of CMCs by focusing efforts of Governments, agencies, and the public in implementing risk mitigation and management actions. The Governments of the United States and Canada are responsible for the implementations of the GLWQA. Within the United States, the United States Environmental Protection Agency's (US EPA) Great Lakes National Program Office (GLNPO) coordinates these efforts. Within Canada, Environment and Climate Change Canada's (ECCC) Ontario Regional Director General's Office coordinates these efforts.

The Parties and their partners will use this strategy as guidance to identify, prioritize, and implement actions to reduce CMCs. Reductions will only be achievable with widespread on-the-ground action, but it will take time to implement actions to the extent that significant reductions are achieved, and it will take time for the aquatic environment to respond. Factors such as climate change, legacy sources, and changing human activities on the landscape make it difficult to predict the rate at which we could see significant changes in the lakes. The ultimate success of the strategy depends on the combined efforts of the Great Lakes community. The strategy and its implementation will be reviewed on a regular basis and reported through the Progress Report of the Parties. While the GLWQA does not provide timelines for strategy implementation, the strategy should be reviewed periodically.

This SCCP strategy includes a list of 17 management options, in Canada and/or the United States, to address threats to water quality by reducing SCCP releases. While there are other chlorinated paraffins, this document is specific to SCCPs. These actions can be used to help identify, support or coordinate ongoing or new projects. The actions are organized under five categories: Regulations and Other Risk Mitigation and Management; Compliance Promotion and Enforcement; Pollution Prevention; Monitoring, Surveillance, and Other Research; and Domestic Water Quality. As noted in the GLWQA, the Parties' respective obligations are subject to the appropriation of funds in accordance with their respective procedures. The Strategy is a compilation of recommendations that can be considered by a variety of stakeholders, including industry, academia, and non-government organization. In addition, some of the recommendation reflect work that the parties are already performing. Implementation of some CMC actions may be supported through other GLWQA Annexes, for example, Lake Superior Partnership projects to address chemical contaminants in the Lake Superior Lakewide Action and Management Plan (LAMP) under the Lakewide Management Annex.

2 Chemical Profile

A more detailed summary of chemical profiles, environmental data, and other pertinent information considered part of the process of designating this class of chemicals as CMCs is available in the Binational Summary Report: Chlorinated Paraffins (Short, Medium, and Long Chain) prepared by the Identification Task Team (ITT) (2015). A synopsis of the various properties of SCCPs is presented in the following subsections.

2.1 Chemical Identity

Chlorinated paraffins ("CPs," also known as chlorinated alkanes) are a class of synthetic organic chemicals consisting of chlorinated hydrocarbons (n-alkanes) that can have carbon chain lengths ranging from 10 to 38 carbons. CPs are generally grouped by carbon chain length: SCCPs (containing 10-13 carbon atoms), MCCPs (containing 14-17 carbon atoms), and LCCPs (with 18 or more carbon atoms) (**Table 1**). The average chlorine content of SCCPs ranges from approximately 30 to 70 percent by weight following the broad chemical formula: $C_xH_{(2x-y+2)}Cl_y$, where x = 10-13 and y = 3-12 (**Figure 1**) (US EPA, 2009; ITT, 2015; UNEP 2015).

2.2 Physical and Chemical Properties

SCCPs are synthetic compounds manufactured for use as lubricants, coolants, plasticizers, and fire retardants (US EPA, 2009). SCCPs are viscous, colorless/yellowish oils with the degree of chlorination differentiating the physical/chemical properties of each SCCP (ECCC, 2008b). SCCPs have very low vapor pressures, making them easily volatized into the atmosphere (Li et al., 2016). In general, SCCPs have high octanol:water (K_{OW}), octanol:air (K_{OA}), and organic carbon (K_{OC}) partition coefficient values (ITT, 2015; Li et al., 2016). The range of physical properties for SCCPs can be found in **Table 2**.

Commercial SCCPs may contain stabilizers to improve the thermal or light stability of the product. Such stabilizers may include epoxidized esters, soy bean oils, erythritol, thymol, urea, glycidyl ethers, acetonitrile, or organic phosphates (ECCC, 2008a).

2.3 Environmental Fate and Transport

SCCPs are environmentally ubiquitous given their chemical properties. They are found in air, soil, sediment, water, fish, marine mammals, birds, and human breast milk within the Great Lakes basin and around the globe (Feo et al. 2009; Gluge et al., 2015). SCCPs released to the atmosphere are expected to exist in the vapor and particulate phase in the ambient atmosphere given the range of vapor pressures reported for these substances. SCCPs do not undergo direct photolysis under environmental conditions, but may be subject to indirect photolysis by oxidizing radicals in the troposphere (Feo et al., 2009). Vapor phase constituents are degraded in air by reaction with hydroxyl radicals with half-lives of less than one to slightly greater than ten days. A half-life greater than about two days in the atmosphere can be a significant factor in facilitating long-range transport of persistent chemicals (US EPA 2009). In the atmosphere, the theoretical half-life of SCCPs is 1.2 to 1.8 days (Feo et al., 2009).

SCCPs released to water are expected to adsorb to sediment and suspended particulate matter based on log Koc values. They are stable to hydrolysis and photolysis. SCCPs released to soil are expected to have low mobility given their log Koc. Volatilization from water and moist soil surfaces is expected to be moderate based on estimated Henry's Law constants of the individual congeners; however, adsorption to suspended solids and sediment in the water column or in soils may attenuate the rate of volatilization (US EPA 2009). Detection of SCCPs in sediment cores dating back to the 1940s provides evidence that SCCPs are persistent (UNEP, 2009).

No degradation was observed in sediments under anaerobic conditions. Several government assessments and published reviews have concluded that only slow biodegradation in sediment may be expected to occur, even in the presence of adapted micro-organisms (ECC 2008).Under optimum environmental conditions, SCCPs can be completely degraded by microorganisms; however, as carbon chain length and degree of chlorination increases, the rate of abiotic and biotic degradation decreases (Feo et al., 2009).

Studies seeking to determine the half-lives of SCCPs in sediments have found a wide range of results. In one study, the aerobic degradation of C_{12} with 69% chlorine was 30 days (Fisk et al., 1998; Feo et al., 2009). Another experiment estimated a mean half-life for C_{10-13} with 65% chlorine to be 1630 days in freshwater sediments and 450 days in marine sediments under aerobic conditions (European Chemicals Bureau, 2008; Feo et al., 2009).

Bioaccumulation factors (BAFs) for SCCPs chain length groups in Lake Ontario plankton, alewife (*Alosa pseudoharengus*), slimy sculpin (*Cottus cognatus*), rainbow smelt (*Osmerus mordax*) and lake trout (*Salvelinus namaycush*) were determined based on a whole organism (wet weight) and filtered water concentrations using data from Houde et al. (2006). SCCPs were found in all components of the food chain and BAFs ranged from 9,900 to 51,200 (wet weight). SCCPs bioaccumulated to the greatest extent in fish, with the highest BAFs (51,200) in sculpin, smelt and trout (ECCC 2008a).

2.4 Sources and Releases of SCCPs in the Great Lakes

SCCP exposure and release sources within the Great Lakes are anthropogenic and may come from domestic (defined as Canada or the United States) or global sources via long-range transport.

2.4.1 Uses and Quantities in Commerce

SCCPs are primarily used as additives to reduce metal tool wear in metalworking fluids. They are also used as a secondary plasticizer and a flame retardant in some plastics, especially polyvinyl chloride (PVC), and in select rubber formulations, paints, other coatings, adhesives, and sealants. In limited cases, SCCPs may be used as a flame retardant in underground mining conveyer belts and in dam sealants (US EPA, 2009; ITT, 2015). As of 2009, the reported use of chlorinated paraffins (SCCP, MCCP, and LCCP) in the United States was on the order of 150 million pounds (68,000 tonnes) per year. Production of short-chain and medium-chained chlorinated paraffins (C9 to C17) was 100 million pounds (45,000 tonnes) in 2007 although only a small proportion of that amount was attributable to import/export business (US EPA 2009). As reported by the Chlorinated Paraffins Industry Association (CPIA) in 2009, MCCPs represented the largest production and use category for chlorinated paraffins in North America (46.4%); LCCPs were second (33.1%); and, SCCPs accounted for the rest (20.5%) (CPIA, 2009). Marketing and use of SCCP has been restricted in the European Union (ECHA 2008a). SCCPs and products that contain them were prohibited in Canada in 2013 (ECCC, 2013a) and are considered to be no longer in commerce in Canada.

2.4.2 Release Sources

SCCPs do not occur naturally in the environment. The worldwide release of SCCPs from their production and use between 1935 and 2012 has been in the range of 1,690 – 41,400 tonnes to air and 1,660 – 105,000 tonnes to surface water (Gluge et al. 2016). Releases of SCCPs may occur during production, storage, transportation, industrial and consumer use of chlorinated paraffin-containing products, disposal and burning of waste, leaching, runoff or volatilization from landfills, and sewage sludge or other waste disposal sites (Tomy et al., 1998). The most likely release source of SCCPs is during manufacturing (spills, facility wash down and drum rinsing/disposal) and lubricant applications in the metalworking industry. These releases often ultimately end up in the effluents of sewage treatment plants. Losses from the use of SCCPs in paint and sealants are generally regarded as much lower than those from metalworking. (US EPA, 2009). Other releases could be associated with use of gear oil packages, fluids used in hard rock mining and equipment use in other types of mining, fluids and equipment used in oil and gas exploration, manufacture of seamless pipe, metalworking and operation of turbines on ships (ECCC 2008). Landfilling is a major disposal route for polymeric products in Canada. SCCPs would be expected to remain stabilized in these products, with minor losses from percolating water although leaching from landfill sites is likely to be negligible owing to strong binding of SCCPs to soils. Another potential source of release of SCCPs to the environment is from losses during the service life of products containing chlorinated paraffin polymers such as plastics, paints, and sealants (ECCC 2008). These releases are predicted to be mainly to urban/industrial soil and to wastewater.

2.4.3 SCCPs in Environmental Media

SCCPs occur in complex mixtures that are difficult to analyze in environmental matrices. Therefore, air/water and sediment/water interchanges are not well understood, and concentration data for the Great Lakes are limited (ITT, 2015). Monitoring studies have documented the presence of SCCPs in the Great Lakes basin, but are limited in scope and comparisons are constrained by differences in analytical methods. SCCPs have been analyzed in Great Lakes prey fish, predator fish, invertebrates, plankton, sediment, water and air (ITT 2015; Marvin et al., 2003; Houde et al., 2008; Ismail et al., 2009(; Saborido Basconcillo et al., 2015).

A 2015 review of analytical methods for CPs in environmental matrices highlighted the challenges associated with their chromatographic separation and detection of SCCPs, as well as the lack of suitable standards. This study concluded, however, that substantial progress in the analysis of these compounds had been made over the previous five years (van Mourik et al. 2015). A more recent study (van Mourik et al. 2018) involving an interlaboratory comparison concluded that SCCP analysis remains challenging. Although a relatively small number of laboratories participated in the interlaboratory studies, many different techniques were applied and differences between laboratories were substantial with coefficients of variation ranging from 23 to 137%. Nonetheless, these differences are decreasing over time, indicating an improved analytical performance (van Mourik et al. 2018). Also in this study, fish was found to be the most difficult environmental extract to analyse, probably because of the very low SCCPs levels compared to house dust, sediment, and soil (van Mourik et al. 2018). Another recent study (Krätschmer, et al. 2018) recommended the use of a specific analytical method (GC/ECNI-Orbitrap-HRMS) as being well-suited for the analysis of CPs since it overcomes a range of mass interference problems and, thus far, has unmatched sensitivity.

2.4.3.1 In Air

Global SCCP concentrations in air vary by region. Concentrations are lowest in the Arctic and Antarctic (2-40 pg/m^3), followed by North America and Europe (80-4000 pg/m^3). Concentrations are highest in Asia, particularly in China (maximum 330,000 pg/m^3) (Gluge et al., 2015). Results of a Chinese study conducted in Beijing investigating SCCPs associated with particulate matter showed average SCCP concentrations associated with the PM_{10} fraction in outdoor air of 23,900 pg/m^3, while the mean indoor values were 61,100 pg/m^3 (Huang et al. 2017). The levels of SCCPs in indoor air samples were higher than the corresponding values in outdoor air, presumably as the result of products containing CPs such as paints and coatings, leather and rubber products. In both outdoor and indoor air, CPs are mainly associated with particles ≤2.5 µm in diameter (Huang et al. 2017). Data on atmospheric concentrations of SCCPs within the Great Lakes basin are lacking. Available data for Lake Ontario show that between

1990 and 1999, atmospheric SCCPs concentrations over Lake Ontario ranged from 120 to 1,510 pg/m^3 (Muir et al., 2000; ITT, 2015).

2.4.3.2 In Surface Water

Extremely limited data (1999 to 2004) for Western Lake Ontario indicate that SCCP concentrations have ranged from 0.606 to 1.935 ng/L (Muir et al., 2000; Houde et al., 2008; ITT, 2015). SCCPs were detected in all eight sewage treatment plant final effluents from southern Ontario, Canada, sampled in 1996. Total SCCPs (dissolved and particulate) ranged from 59 to 448 ng/L. The highest concentrations were found in samples from treatment plants in industrialized areas, including Hamilton, St. Catharine's (ECCC 2008). As noted in **Table 3**, the Canadian Federal Environmental Quality Guideline for water is 2,400 ng/l (ECCC 2016).

2.4.3.3 In Sediments

SCCPs are very persistent in sediments; core samples dating back to the 1940s indicate the presence of SCCPs (US EPA, 2009). Concentrations of SCCPs have been measured at around 245 ng/g dry weight (dw) in sediment from the mouth of the Detroit River at Lake Erie and Middle Sister Island in western Lake Erie, in 1995 (Tomy et al. 1997). SCCPs have also been detected in all surface sediment samples from harbour areas along Lake Ontario at concentrations ranging from 5.9 to 290 ng/g dw in 1996 (Muir et al. 2001). The highest concentrations were found at the most industrialized site (Windermere Basin, Hamilton Harbour), which has well-documented heavy metal, PAH and PCB contamination. Similarly, Marvin et al. (2003) reported a maximum SCCP concentration of 410 ng/g dw in Lake Ontario sediments at an index station in the Niagara (western) basin. SCCPs were detected in all 26 samples from Lake Ontario with an average concentration of 49 ng/g dw. This is much higher than sediment concentrations reported for lakes influenced primarily by atmospheric sources (Tomy et al. 1999; Stern and Evans 2003). The Canadian Federal Environmental Quality Guideline for sediment is 1,800 ng/g normalized to 1% total organic carbon (TOC). Since TOC typically ranges from 0.5 to 5% for surficial sediment in Lake Ontario depositional basins (Lozano et al. 2001; Halfman et al. 2006) it is apparent that this guideline has not been exceeded.

Assessment of core profiles and estimates of SCCP fluxes (Marvin et al. 2003) indicated that an area of the western end of Lake Ontario is heavily impacted (SCCP flux of 170 µg/m^2 yr) and potentially influenced by local industrial sources of SCCPs. Maximum accumulation of SCCPs in this area of the western basin occurred in the mid-1970s and have decreased since (Marvin et al. 2003, Ismail et al. 2009). In contrast, SCCP concentrations in a core from a site in the central area of the lake (SCCP flux of 8.0 µg/m^2 yr) were more similar to levels characteristic of remote locations primarily impacted by atmospheric sources (Marvin et al. 2003).

Agricultural soils have been flagged as a potentially major reservoir of CPs due to sewage sludge application (ECCC 2008) however there are limited data for soils. A study examining concentrations and distribution of SCCPs in farm soils from a wastewater irrigated area in China (Zeng at al. 2011) found SCCPs were detected in all topsoil samples, with the sum of the concentrations in the range of 159.9−1450 ng/g dw. Soil vertical distributions indicated that lower chlorinated and shorter chain congeners were more prone to migrate to deeper soil layers compared to highly chlorinated and longer chain congeners. This work demonstrated that effluents from wastewater treatment plants could be a significant source of SCCPs to the ambient environment and wastewater irrigation can lead to higher accumulation of SCCPs in farm soils. A U.K. study (Nicholls et al. (2001) did not detect SCCPs in farm soils amended with sludges containing µg/g concentrations of CPs at a detection threshold of 100 ng/g dw. Examination of total SCCPs concentration in soils at a background area in China (Wang et al. 2013) showed concentrations ranging from 0.42 to 420 ng/g dw with a median of 9.6 ng/g dw. Although these concentrations are low, the ubiquitous occurrence of SCCPs at a remote location suggests that long-range atmospheric transport and soil–air exchange may be an important pathway for SCCP contamination.

2.4.3.4 In Biota

Measurements of SCCPs in fish collected from Lake Ontario and Lake Michigan, between 1996 and 2001 showed concentrations of total SCCPs ranging from 4.6 to 2,630 ng/g wet weight (ww) (Muir et al. 2001; Houde et al. 2006). The highest concentration was measured in carp collected at Hamilton Harbour (Muir et al. 2001). Houde et al. (2006) determined the concentration of SCCPs in plankton, Diporeia sp. and Mysis sp. from Lakes Ontario and Michigan. In Lake Ontario, total SCCPs concentrations in plankton, Diporeia and Mysis were 5.5, 6.3, and 2.8 ng/g ww, respectively, and in Lake Michigan they were 23, 24, and 7.5 ng/g ww, respectively. A more recent Canada wide screening of SCCPs in fish conducted in 2011 (Saborido Basconcillo et al., 2015) showed that within the Great Lakes, the lowest concentration of SCCPs was observed in lake trout from Lake Erie (3 ±2 ng/g ww), and the highest concentration was observed in Lake Ontario lake trout (5 ±3 ng/g ww). Concentrations in lake trout from Lake Superior (3 ±3 ng/g ww) and Lake Huron (3 ±2 ng/g wet weight) were not significantly different (Saborido Basconcillo et al., 2015).

These studies have shown that concentrations of total SCCPs in Lake Ontario lake trout increased from 1979 until 1988, followed by a significant decrease through 2011 (Ismail et al., 2009; ITT, 2015; Saborido Basconcillo et al., 2015). More recently, a comparison of 2001 and 2011 lipid normalized fish tissue results from Lake Ontario-focused studies showed a significant decline in SCCPs (Houde et al., 2008; ITT, 2015; Saborido Basconcillo et al., 2015). These limited data suggest that top-predator fish from Lake Ontario (and hence potentially throughout the Great Lakes) do not exceed the Canadian Federal Environmental Quality Guideline of 2,700 ng/g lipid listed in **Table 3**, and that SCCP concentrations in these fish are on the decline (ITT, 2015).

There are no data for other biota in the Great Lakes basin, however measurement of SCCPs in liver tissue from Arctic char and seabirds (little auk and kittiwake) collected at Bear Island (European Arctic) as well as in cod from Iceland and Norway showed concentrations between 5 and 88 ng/g ww for SCCPs (Reth et al. 2006). SCCPs have been detected in the blubber of belugas from the St. Lawrence River at an average concentration of 785 ng/g ww (ECCC 2008). The Canadian Federal Environmental Quality Guideline (FEQG) for protection of mammals that consume aquatic biota is 18,000 ng/g ww (i.e. the concentration in aquatic biota, expressed on whole body basis that could be eaten by terrestrial or semi-aquatic wildlife).

2.5 High Level Summary of Risks

The majority of non-occupational human exposure to SCCPs is from food consumption although there is likely some exposure resulting from inhalation and dermal contact (UNEP, 2016). Due to their potential for environmental transport, SCCP exposure may occur from sources far from their use and release. For example, SCCPs have been found in breast milk samples taken from Inuit women (UNEP, 2009). SCCPs can cause toxicological effects in mammals and may affect the liver, thyroid function, and the kidneys which in the long-term can lead to malignancies in these organs (UNEP 2016). SCCPs are also listed as endocrine disrupters for human health according to the former preliminary criteria for prioritization of potential endocrine disrupting substances (UNEP, 2016).

SCCPs have been measured in human liver, kidneys, adipose tissue, and breast milk. Limited toxicokinetic studies in experimental animals suggest that SCCPs are expected to concentrate in the liver, kidney, intestine, bone marrow, adipose tissue, and ovaries (ITT, 2015). The US National Toxicology Program identified SCCPs as having very low acute toxicity and may cause skin and eye irritation upon repeated application (ITT, 2015).

No human data are available to assess whether SCCPs are carcinogenic in humans. However, the US National Toxicology Program lists SCCPs (C_{12}, 60% chlorine) as “reasonably anticipated to be human carcinogens,” and the International Agency of Research on Cancer lists SCCPs as “Group 2B –possibly carcinogenic to humans” (US EPA, 2009; ITT, 2015). Both programs base their designations on evidence from studies involving animal models.

High bioconcentration factors (BCFs) (1,000-50,000) and bioaccumulation factors (BAFs) (> 1 million) have been recorded for SCCPs, indicating that SCCPs bioaccumulate in biota (US EPA, 2009). Invertebrates appear to be the most sensitive group, showing high toxicity to acute (48-hr EC_{50} = 0.043 to 11 mg/L) and chronic (no observed effect concentration [NOEC] = 0.005 to 2 mg/L) exposures of SCCPs (US EPA, 2009). High toxicity is associated with chronic exposures of SCCPs to fish, but not for acute exposures (96-hr LC_{50} = 300 to 10,000 mg/L and NOEC = 0.0096 to 0.05 mg/L). For aquatic plants, both acute and chronic exposures of SCCPs are highly toxic (96-hr EC_{50}s range from 0.043 to 0.39 mg/L and NOEC ranges from 0.012 to 0.39 mg/L) (US EPA, 2009).

3 Existing SCCP Management/Control Policies, Regulations, and Programs

3.1 United States

The US EPA published a Final Action Plan for SCCPs in 2009, based on initial review of readily available use, exposure, and hazard information.

3.1.1 Existing Statutes and Regulations

Prior to 2013, only four chlorinated alkane substances based on fractions were on the TSCA Inventory (Alkanes, C_{6-18}, chloro [Chemical Abstracts Service Registry Number (CASRN) 68920-70-7]; Alkanes, C_{12-13}, chloro [CASRN 71011-12-6]; Alkanes, chloro [CASRN: 61788-76-9]; Paraffin waxes and Hydrocarbon waxes, chloro [CASRN 63449-39-8]) (US EPA, 2009) Based upon the findings of its Action Plan for SCCPs, US EPA initiated action under TSCA in January of 2010 to consider proposing to ban or restrict the manufacture, import, processing, or distribution in commerce, export, and use of SCCPs. However, actions were withdrawn in 2013 because US EPA reached settlement agreements with the last two manufacturers of SCCPs in the United States.

As part of the settlements, the companies agreed to cease manufacturing and/or importing SCCPs, thus negating the need to consider an action under TSCA Section 6 (US EPA/OECA, 2012, 2012a). The companies also agreed to submit pre-manufacture notices (PMNs) for MCCPs and LCCPs. As a result, from 2013 to 2017, various medium- (C_{14-17}), long- (C_{18-20}), and very long- (C_{21} and above) chain CPs were submitted as PMNs, completed review and have been listed on the TSCA Inventory. Also a result of this review, the Agency imposed certain limitations under a consent order (testing, recordkeeping and use restrictions) to protect against any potential unreasonable risks. The Agency required certain testing within five years that is potentially useful to evaluate the potential for environmental persistence, bioaccumulation and toxicity (to both aquatic and sediment organisms).

In 2014, a Significant New Use Rule (SNUR) under TSCA was put into effect for Alkanes, C_{12-13}, chloro (CASRN: 71011-12-6), given that US EPA had no evidence to suggest that there was any manufacture or processing of these chemical substances in the United States. This SNUR requires all manufacturers (including importers) and processors to notify US EPA before starting or resuming significant new uses (SNUs) of these chemicals (US EPA, 2016). The notification required by SNURs, known as a Significant New Use Notice (SNUN), obligates EPA to assess risks that may be associated with the significant new use, including risks to potentially exposed or susceptible subpopulations identified as relevant by EPA under the conditions of use; make a determination under the statute; and, if appropriate, regulate the proposed activity before it occurs.

3.1.2 Pollution Prevention Actions

The US EPA and individual states and tribes have Pollution Prevention (P2) programs that seek to reduce, eliminate, and/or prevent pollution at its source. Due to the limited knowledge base of SCCP use and release information in the United States, few pollution prevention actions have been formally conducted (US EPA, 2009).

SCCPs (C10-C13) are included on the U.S. EPA's Toxics Release Inventory (TRI) list of chemicals as a category called "polychlorinated alkanes" (identification number N583). Facilities subject to the TRI reporting requirements that manufacture or process more than 25,000 pounds, or otherwise use more than 10,000 pounds of a TRI listed SCCP within a calendar year must report the quantities they released to the environment or otherwise managed as waste (e.g., quantities recycled, treated for destruction, burned for energy recovery), and any P2 activities they implemented during that calendar year to EPA's TRI Program by July 1st of the following year. This information is made available to the public, and can be accessed and analyzed via several EPA online tools. The P2 information can be readily accessed and analyzed through the TRI P2 Search Tool.

For the 2016 calendar year only four facilities throughout the U.S. filed a TRI report for an SCCP (i.e., as C10-C13 polychlorinated alkanes) included on the TRI chemical list. Of these facilities, only two reported release quantities greater than zero pounds. One of the facilities is located in Sevierville Tennessee, and reported it released 351 pounds in the form of fugitive air emissions. This same facility reported that it sent 68,000 lbs of SCCPs off-site to be recycled. The other facility, located in Sauget, Illinois, reported it sent 1 pound of SCCPs off-site for release (disposal). This same facility also reported it treated 10,904 pounds of SCCPs on-site and 4 pounds off-site.

The other two facilities are located in Rochester, New York and East Liverpool, Ohio. The facility in Rochester, New York reported it sent off-site: 4,600 pounds of SCCPs for recycling; 3,000 pounds to be burned for energy recovery; and 7,200 pounds to be treated. The facility in Ohio reported it treated 62,893 pounds of SCCPs on-site. Both facilities reported zero release quantities of SCCPs.

The TRI database shows that from 1995 (the first year of TRI reporting for SCCPs) to 2016 the number of facilities that filed TRI reports for SCCPs has declined sharply: from 76 facilities (reported for 1997) to four facilities (for 2016). Total releases have also sharply declined over this same period: from hundreds of thousands of pounds, to 352 pounds (during 2016).

The TRI P2 Search Tool reveals that facilities have been implementing P2 practices that have greatly reduced releases of SCCPs into the environment. These P2 practices include installation of vapor recovery systems, and substitution of SCCPs with substances that are not (or do not contain) SCCPs. It is anticipated that with the accumulation of SCCP data in TRI and alternative metalworking additives research, additional P2 programs involving SCCPs will come into effect in the future.

3.1.3 Risk Management Actions

While production, importation, and processing of SCCPs have been addressed in the United States through regulatory and enforcement actions, the use of previously acquired SCCPs and/or waste management facilities that have acquired used SCCPs remain potential sources of environmental exposure.

3.1.4 Monitoring, Surveillance, and Other Research Efforts

MCCPs and LCCPs are on the 2014 update of the TSCA Work Plan for Chemical Assessments. TSCA, as amended by the Frank R. Lautenberg Chemical Safety for the 21st Century Act, requires EPA to prioritize and evaluate risks of chemicals on the TSCA Work Plan.

While SCCPs contamination is not regularly monitored by the US EPA in the Great Lakes basin, the Minnesota Pollution Control Agency (MPCA) has conducted multiple statewide studies of environmental concentrations of SCCPs in fish, surface water, sediment, and wastewater influents, effluents, and biosolids. In the statewide fish tissue study, CPs were detected in fish from 27% of lakes and 69% of rivers tested.

3.1.5 United States Guidelines and Standards

None issued to date.

3.2 Canada

ECCC has published a Proposed Risk Management Approach for Chlorinated Paraffins, prepared for Environment Canada and Health Canada (ECCC and Health Canada 2008). This document proposes actions for chlorinated paraffins of all lengths.

In 2013, the Government of Canada published the *Prohibition of Certain Toxic Substances Regulations, 2012* to protect Canada's environment from the risks associated with SCCPs by preventing their manufacture and significantly restricting their use in Canada, thereby minimizing their release into the environment. Specifically, the regulations prohibit the manufacture, use, sale, offer for sale, or import into Canada of products containing SCCPs, with a limited number of exemptions (ECCC, 2012).

3.2.1 Federal Risk Management Measures

In 1993, ECCC and Health Canada assessed chlorinated alkanes, which appeared on the first Priority Substances List (PSL1), to determine whether they met criteria set out in section 11 of the 1988 *Canadian Environmental Protection Act* (CEPA) (Environment Canada, 1993). This report concluded that SCCPs could pose a danger to human life or health. However, there was insufficient information to conclude whether CPs could be harmful to the environment.

In 2008 and 2012, ECCC and Health Canada published two follow-up assessment reports on CPs that concluded the following (ECCC, 2008b; Health Canada, 2012):

- CPs containing 10 to 20 carbon atoms are entering or may be entering the environment in a quantity or concentration or under conditions that have or may have an immediate or long-term harmful effect on the environment or its biological diversity, and thus meet the definition of “toxic” under paragraph 64(a) of CEPA.

- CPs containing 10 to 17 carbon atoms are entering, or may enter, the environment in quantities or concentrations or under conditions that constitute or may constitute a danger in Canada to human life or health, and thus meet the definition of “toxic” under paragraph 64(c) of CEPA.
- In addition, CPs containing up to 20 carbon atoms meet the criteria for virtual elimination of releases to the environment.

In 2008, the Government of Canada published a Risk Management Approach for CPs with the objective of minimizing human exposure to short-chain, medium-chain, and long-chain CPs to the extent practicable. The environmental objective for chlorinated paraffins with up to 20 carbon atoms is virtual elimination, as specified under subsection 77(4) of CEPA 1999 (ECCC, 2008b). To achieve the risk management objective and to work towards achieving the environmental or human health objective, the Government of Canada added SCCPs to the *Prohibition of Certain Toxic Substances Regulations, 2012*. These regulations were published in the *Canada Gazette*, Part II, on January 2, 2013 and came into force on March 14, 2013 (ECCC, 2013; ITT, 2015).

These regulations prohibit the manufacture, use, sale, and offer for sale or import of SCCPs and products containing them, with a limited number of exemptions. Reporting requirements were also instituted for the manufacture and import of incidentally present SCCPs. As such, SCCPs are considered to be no longer in commerce in Canada, thereby minimizing human and environmental exposure to the extent practicable.

Canada plays a role with regards to SCCPs in two international agreements related to persistent organic pollutants (POPs): the United Nations Economic Commission for Europe (UNECE) Long-Range Transboundary Air Pollution (LRTAP) and the Stockholm Convention.

3.2.2 Pollution Prevention Actions

In 2018, Canada launched the Great Lakes Protection Initiative (GLPI), a funding program designed to help deliver on commitments under the GLWQA. One of the priority areas under GLPI is the reduction of releases of CMCs (including SCCPs) to the Great Lakes from Canadian sources through projects that support beyond compliance measures and innovative approaches.

3.2.3 Monitoring, Surveillance, and Other Research Efforts

Two commercial mixtures that contain SCCPs (CAS RNs: 85535-84-8 and 68920-70-7) were added to the NPRI list of substances under Part 1A in 1999. Reporting of these substances was required if they were manufactured, processed, or otherwise used (MPO) at a facility at a concentration ≥ 1% by weight (except for by-products and mine tailings) and in a quantity of 10 tonnes or more, and employees worked 20,000 hours or more at a facility.

Past and current reporting for SCCPs (chlorinated alkanes, C_{10-13}, CAS RN 85535-84-8) to the NPRI reflects changes in industrial use of these substances and the prohibition of SCCPs. Facilities have never reported releases of SCCPs to NPRI, and have only reported disposals and transfers for recycling which peaked in 2003 and have been decreasing since then (**Figure 2**).

NPRI reporting for the chlorinated alkanes, C_{6-18} (CAS RN 68920-70-7), which can contain SCCPs (C_{10-13}), MCCPs (C_{14-17}) and LCCPs (C_{18-20}), is shown in **Figure 3**. Similar to SCCPs (CAS RN 85535-84-8), no facility has ever reported releases of chlorinated alkanes, C_{6-18} (CAS RN 68920-70-7) to the NPRI. On the other hand, reporting of disposals and transfers for recycling of chlorinated alkanes, $C_{6-18,}$ (CAS RN 68920-70-7) has increased in recent years.

In order to reflect changes in industrial practices in response to SCCP prohibition regulations, the NPRI deleted the following SCCP commercial mixtures that were listed on the NPRI: C_{10-13} (CAS RN 85535-84-8) and C_{6-18} (CAS RN 68920-70-7) (ECCC, 2017). These substances are being replaced with MCCPs (C_{14-17}) and LCCPs (C_{18-20}) as well as commercial mixtures containing these substances as they are listed on Schedule 1 of CEPA (i.e. List of Toxic Substances), but are currently used in industrial processes. MCCPs and LCCPs will be reported at a threshold of 1 tonne instead of 10 tonnes to ensure adequate coverage of these substances. Under the new requirements, information reported to the NPRI on releases, disposals and recycling of MCCPs and LCCPs will be available as of late 2019 and annually thereafter.

Water bodies in Canada are routinely monitored for priority contaminants as part of ECCC's National Fish Contaminants Monitoring and Surveillance Program. The most recent survey of the levels of SCCPs in fish from Canadian water bodies was conducted between 2010 and 2011 (Saborido Basconcillo et al., 2015). As a CMC, SCCPs are being incorporated into monitoring plans for the Great Lakes in cooperation with the USEPA.

Monitoring and measurements of SCCPs are conducted in air, precipitation, and wildlife (including fish and bird eggs) at sites across Canada, including the Great Lakes basin. Results are published in peer-reviewed articles.

3.2.4 Canadian Environmental Quality Guidelines and Standards

ECCC published Federal Environmental Quality Guidelines (FEQGs) for SCCPs in 2016, which provide benchmarks for the quality of the ambient environment (**Table 3**). The FEQGs for SCCPs are being met in all areas within the Great Lakes (i.e., water, fish tissues, sediment, and mammalian wildlife diet). Therefore, the potential of adverse effects on the target receptor (e.g., aquatic life or the wildlife that consume them) is expected to be negligible. While FEQGs do not have any legal status, when incorporated into permits or other regulatory instruments they may become legally enforceable as part of the instrument.

3.3 Binational

3.3.1 Lake-wide Action and Management Plans

Additional binational SCCP pollution prevention actions have been initiated through LAMPs for each Great Lake. The purpose of a LAMP is to assess the status of each Great Lake and identify the environmental stressors that are best addressed on a lake-wide scale. Each LAMP will incorporate the activities of the SCCP strategy and any additional efforts, as appropriate.

3.3.2 The Great Lakes Water Quality Agreement

One aspect of the GLWQA is the establishment of a Cooperative Science and Monitoring Initiative (CSMI) Task Team through Annex 10. The charge of the CSMI is to implement a joint United States/Canadian effort to provide environmental and fishery managers with the science and monitoring information necessary to make management decisions for each Great Lake. A five-year rotating cycle in which the lakes are visited one per year is followed by an intensive CSMI field year (**Table 4**). By studying one Great Lake per year, science and monitoring activities can focus on information needs not addressed through routine agency programs, and specific science assessments can be coordinated. Individual Lake Wide Partnerships identify science needs according to the CSMI schedule, and the Task Team implements these recommendations, as appropriate.

3.4 International

Efforts are underway at the international level to limit the availability, usage, discharge, and overall number of SCCP sources.

3.4.1 United Nations Economic Commission for Europe Protocol on Persistent Organic Pollutants

In 1998, the Executive Body (EB) of UNECE adopted the Protocol on Persistent Organic Pollutants (POPs), and singled out 16 substances for elimination. In 2009, the EB of the Commission agreed that SCCPs also meet the criteria for being a POP under the convention set out in EB decision 2009/2. As such, SCCPs were added to the protocol for elimination, subject to two exemptions: use as fire retardants in rubber used in conveyor belts in the mining industry and use in dam sealants. Once suitable alternatives are identified, these two uses will be eliminated (EU, 2015).

3.4.2 The Stockholm Convention on Persistent Organic Pollutants

The Conference of the Parties to the Stockholm Convention on Persistent Organic Pollutants decided at its eighth meeting, in 2017, to list SCCPs in Annex A with specific exemptions. The objective of the Stockholm Convention is to protect human health and the environment from POPs and a listing in Annex A aims to eliminate the production, use, import and export of the substances. The Convention was originally signed in 2001, and came into force in 2004 after 50 parties joined. Canada signed and ratified the Convention in 2001. The United States has signed the Convention, but has yet to provide ratification, acceptance, approval or accession, and therefore the Convention has not yet entered into force for the US. Canada has not yet ratified the listing of SCCPs to the Convention.

4 Gap Analysis

4.1 Gaps and Needs for Action

Environmental concentrations of SCCPs are a clear data gap. One aspect related to filling this gap is the difficulty associated with measuring complex mixtures of SCCPs (individually and in conjunction with MCCPs and LCCPs) in environmental matrices. Clearly, research is needed to develop standardized methods for quantifying the complex mixtures of CPs in a variety of environmental matrices. The International Organization for Standardization (ISO) has developed new methods to analyze SCCPs in water, sediment, sewage sludge, suspended matter, and leather (UNEP, 2016). The ISO methods will help to advance the effort to develop standardized methods.

Canada has federal regulations mandating the manufacture, use, sale and import of SCCPs and products that contain them. In the United States, US EPA has taken enforcement and regulatory action to address the manufacturing (including import), processing, distribution in commerce, and use of certain SCCPs. These actions include enforcement settlement agreements for SCCPs, a finalized SNUR for SCCPs, and required PMN review of medium-, long-, and very-long CPs under TSCA.

However, compliance with the regulations has yet to be fully assessed within each nation. Emissions from used or disposed articles containing SCCPs may be a potential long-term source to the environment. No information is available on the likely future emissions from such articles.

Although SCCPs are targeted under international agreements, and SCCPs are now being manufactured and used to much less of an extent in North America, SCCPs continue to be manufactured and used in other parts of the world, and long-range transport is a likely continued source of SCCPs to the Great Lakes basin. Current levels of SCCPs in Great Lakes air, water, sediment, fish, and wildlife species need to be established in both the nearshore and off-shore environments of the Great Lakes. Based on these results, monitoring plans should be developed to fill the gaps in the temporal and spatial distribution of

SCCPs in various Great Lakes media and to better understand the potential risk this class of chemicals poses within the Great Lakes basin.

Furthermore, there is a need to ensure that chemical data collected by US EPA, Canada, State, Provincial, Tribal, First Nations, Métis, and other government programs are consistent, standardized, and structured to allow for improved binational monitoring for SCCPs. Consistent communication among parties is necessary to ensure that uniform data are collected by independent sampling actions. Such data could be used collectively to address and identify concerns. Ideally, a repository in which data on a binational level can be cataloged by media (e.g., air, water, land, biota) and accessed by external stakeholders should be implemented.

4.2 Exceedances of or Non-compliance with Environmental Quality Guidelines

The United States has not established environmental quality guidelines and standards for SCCPs. The limited available data suggest that SCCP concentrations in the Great Lakes do not surpass the Canadian FEQGs (**Table 3**). However, only limited data are currently available for each medium in the Great Lakes.

5 Risk Mitigation and Management Options to Address Gaps

The following subsections present both new and the continuation of current risk mitigation and management actions that may result in measurable (either qualitatively or quantitatively) human health and/or environmental benefits, or enhanced understanding of SCCP sources, fate, and human health/environmental effects.

5.1 Regulations and Other Risk Mitigation and Management

Canada has federal regulations prohibiting the manufacture, use, sale and import of SCCPs and products that contain them. In the United States, US EPA has taken regulatory and enforcement action to address SCCPs. However, neither country has issued rules concerning waste management practices of SCCPs.

Because of these regulatory gaps in the US, quantities of commercial and industrial products containing SCCPs and any industrial emissions or other waste management quantities reported to the US' TRI should be tracked on a regular basis to observe whether such quantities and the number of facilities that report such quantities are declining, and whether P2 efforts are responsible for such declines. Regulations concerning SCCPs should be regularly reviewed and updated to ensure they are current with the available scientific understanding. Finally, within the United States, efforts to identify additional safer alternative chemicals for the remaining current uses of SCCPs should be encouraged.

The Risk Management Evaluation (RME) of short-chain chlorinated paraffins under the Stockholm Convention concluded that technically feasible alternatives are commercially available for all known uses of SCCPs such as in metalworking fluids, polyvinyl chloride, rubber applications, sealant and adhesive applications, paint and coating applications, textile applications, and leather applications (UNEP, 2016).

Summary of Regulations and Other Risk Mitigation and Management Strategy Options

- Maintain the prohibition on import, manufacture, sale and use of SCCPs and products that contain them (Canada)
- Ensure that manufacture and importation of SCCPs has been addressed (US)
- Maintain information on SCCPs as part of regular updates to the TSCA Inventory (US)
- As science develops and becomes available, review and update regulations (US)

5.2 Compliance Promotion and Enforcement

Tracking and compliance strategies are needed in both Canada and the United States to ensure that regulations limiting or eliminating the use of SCCPs are enforced. .

Summary of Compliance Promotion and Enforcement Strategy Options

- Continue to promote and enforce compliance with the *Prohibition of Certain Toxic Substances Regulations, 2012* as they relate to SCCPs (Canada)
- Promote and enforce Toxic Substances Control Act Significant New Use Rule regulations for SCCPs (US)

5.3 Pollution Prevention

The US EPA, through the TRI, will continue to track industrial progress in reducing SCCP emissions. ECCC, through the NPRI, will now be shifting focus from SCCP, to MCCP and LCCP in tracking industrial progress in reducing emissions. Both databases should be maintained to showcase P2 activities being conducted by industries within the Great Lakes basin. Highlighting P2 and waste reduction successes in the Great Lakes basin may be beneficial in increasing and coordinating awareness in affected sectors throughout the basin and elsewhere, and furthering the reduction of SCCPs in the environment. Success stories may be noted in journals, websites, government documents, and/or at conferences, and other GLWQA reporting (e.g., LAMP documents, triennial reporting, etc.).

Promotion of proper disposal and waste management practices may also contribute to a reduction of SCCP releases to the environment.

Summary of Pollution Prevention Strategy Options

- Enhance public outreach and educate the public and facility staff on potential sources of SCCPs and proper actions to follow should products containing SCCPs be found (Canada and US)
- Encourage industries to use P2 activities reported by facilities to EPA's TRI, and disclose their own P2 achievements when filing TRI reports (US)
- Promote proper disposal and waste management of SCCPs-containing products (Canada and US)

5.4 Monitoring, Surveillance, and Other Research Efforts

The development of a cost-effective and standardized means of collecting and detecting SCCP concentrations from a variety of sources is needed. Models should be refined to include the air/water interchange, and a meta data study that reviews all existing monitoring and modeling studies would be very useful for all stakeholders.

There is a need for uniform environmental quality guidelines and standards. While Canada has established FEQGs, the United States has not established environmental guidelines for SCCPs.

The US EPA and ECCC have published a report entitled "State of the Great Lakes 2017" to provide accessible information on the environmental status of the Great Lakes basin (ECCC and US EPA, 2017). Additional monitoring and surveillance reports have been published in peer-reviewed journals, websites, and social media. Each form of reporting is designed to target specific audiences to maximize the application of the results. Results of future monitoring efforts should continue to be published in multiple formats to effectively communicate changes observed within the Great Lakes basin.

There is a lack of temporal and spatial Great Lakes environmental information for inclusion in basin-wide reports. Such systematic monitoring efforts by the two nations would be invaluable for understanding the overall status of the Great Lakes basin with respect to SCCPs. Monitoring efforts undertaken by both nations should be coordinated to aid in acquiring comparable analytical data that can be used to build a national and/or international decision-making framework. Effective communication to agree on a binationally uniform method and/or advisory could reduce confusion and improve compliance by the public.

Summary of Monitoring, Surveillance, and Other Research Options

- Develop standardized, cost-effective analytical methodologies to support environmental monitoring programs (US)
- Consider establishing environmental guidelines and standards (US)
- Regularly monitor long-term SCCPs trends in Great Lakes environmental media and publish results in a variety of formats (e.g., on-line and open data portals, government reports, and scientific journals) to maximize the intended audience (Canada and US)
- Use monitoring and modeling to better characterize select SCCPs sources as a basis for potential actions, measuring progress, and formulating an international decision-making framework (US)
- Use existing data sources and exposure data to continuously inform future strategic directions and plans using an adaptive management approach (US)
- Identify and conduct further risk analyses for safer alternative SCCP chemicals (US)
- Consider exposure and risk assessments of other SCCP categories (US)

5.5 Domestic Water Quality

Domestic waters include all water used for indoor and outdoor household purposes. Currently there are no SCCP drinking water standards in the United States.

Summary of Domestic Water Quality Strategy Options

- Implement appropriate domestic water quality standards for drinking water and surface waters, as resources allow (US)

6 Conclusion

Under Annex 3 of the GLWQA, SCCPs have been identified as a CMC. Although very limited, the available data suggest that the overall concentration of SCCPs in Great Lakes top-predator fish species may be in decline, while sediment concentrations remain steady. The decline observed in Great Lakes fish may reflect a positive response to recent regulations and voluntary initiatives in Canada and the United States eliminating or reducing the manufacture, importation or use of SCCPs in both Canada and the United States and, therewith, the environmental releases of these substances within both countries.

Concentrations of the persistent SCCPs remain in sediment, water, air, and biological tissues throughout the Great Lakes basin and globally. Binational efforts addressing the manufacture and importation of SCCPs have reduced any new SCCP sources, but limited information suggests that existing environmental concentrations due to historical releases of these compounds remain a concern in the Great Lakes. Thus, binational efforts are needed to further reduce the risks that SCCPs pose to human health and the environment. Continued focus is needed to implement current regulations, update analytical methods to allow consistent monitoring of environmental occurrence and source identification of SCCPs, increase pollution prevention actions, and strengthen outreach/education activities.

Binational cooperation is needed to coordinate monitoring and surveillance efforts, maximize ongoing research initiatives, and cost-effectively monitor and track concentrations of SCCPs within the Great Lakes (wastes, soil, water, air, tissues, etc.). A broad audience of Great Lakes stakeholders who are committed to protecting and restoring the Great Lakes ecosystem is encouraged to implement the risk mitigation and management options outlined in this document. Continued progress in implementing novel ways and/or improving upon existing ways to mitigate and manage SCCP risks is encouraged to better protect human and ecosystem health within the Great Lakes basin.

7 Tables

***Table 1**. Short-, Medium-, and Long-Chain Chlorinated Paraffin Designations*

Chlorinated Paraffin ($C_xH_{(2x-y+2)}Cl_y$)	**Carbons (x)**	**Chlorines (y)**
Short-Chain (SCCPs)	10-13	3-12
Medium-Chain (MCCPs)[b]	14-17	
Long-Chain (LCCPs)[b]	18-38	

[b] This subdivision of CPs is outside the scope of this Binational Strategy, but may be referenced due to scientific and technical factors involving SCCPs.

***Table 2**. Range of Physical Properties of SCCPs*

Property	**Range**	**% Chlorination**
Molecular Weight	320 — 500	
Vapor Pressure (Pa)	2.8 x10^{-7} — 0.028	48 — 71
Henry's Law Constant (Pa·m^3/mol)	0.68 — 17.7	48 — 56
Water Solubility (µg/L)	6.4 — 2370	48 — 71
log K_{OW}	4.39 — 8.69	48 — 71
log K_{OA}	8.2 — 9.8	48 — 56
log K_{OC}	4.1 — 5.44	

Source: ECCC (2008a)

***Table 3**. Canadian Federal Environmental Quality Guidelines for SCCPs and Great Lakes Environmental Concentrations*

Medium	**Canadian FEQG**	**Great Lakes Concentrations**	**Units**
Water	2.4	0.000606 – 0.001935	µg/L
Fish Tissue	2.7	0.012-0.037	µg/g lipid
Sediment[a]	1.8	0.049	mg/kg dry weight
Mammalian Wildlife Diet	18	Not available	mg/kg food wet weight

[a] values normalized to 1% organic carbon. Sources: ITT (2015); Saborido Basconcillo et al. (2015); ECCC (2016)

Note: Canadian FEQGs are also available for medium and long-chain paraffins (ECCC, 2016)

***Table 4**. Cooperative Science and Monitoring Initiative Rotational Cycle.*

Great Lake	**Focus Year**
Huron	2002, 2007, 2012, 2017
Ontario	2003, 2008, 2013, 2018
Erie	2004, 2009, 2014, 2019
Michigan	2005, 2010, 2015, 2020
Superior	2006, 2011, 2016, 2021

8 Figures

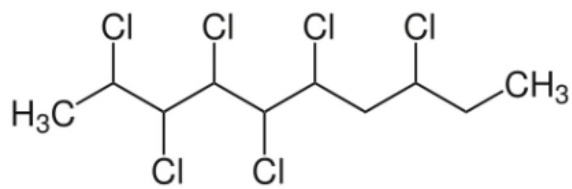

Figure 1. *Representative Structure of a SCCP*

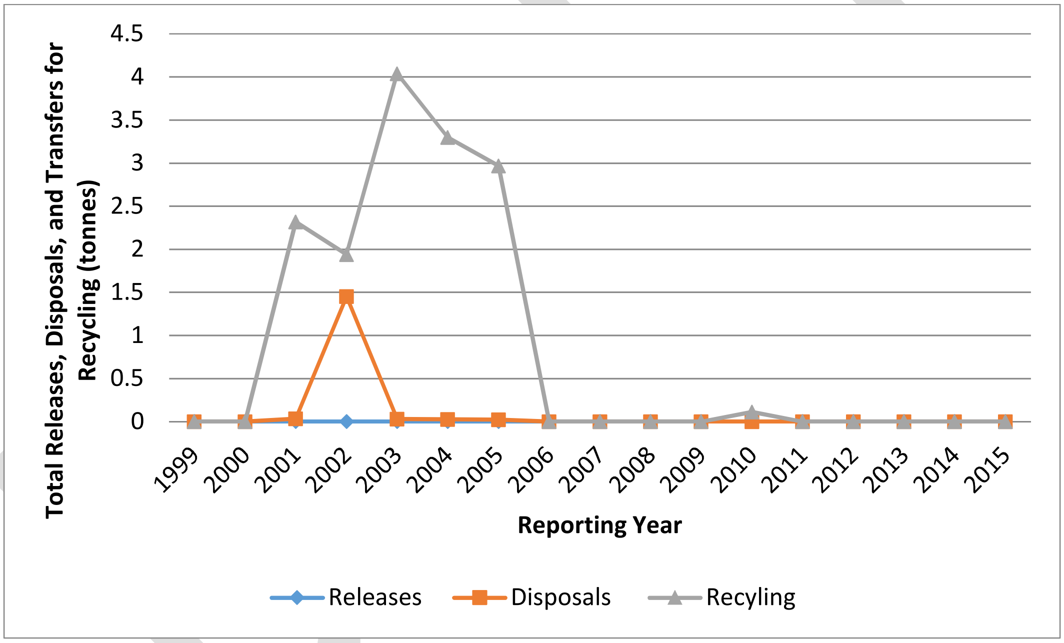

Figure 2. NPRI Releases, Disposals, and Transfers for Recycling of Alkanes, C_{10-13} chloro (CAS RN 85535-84-8).

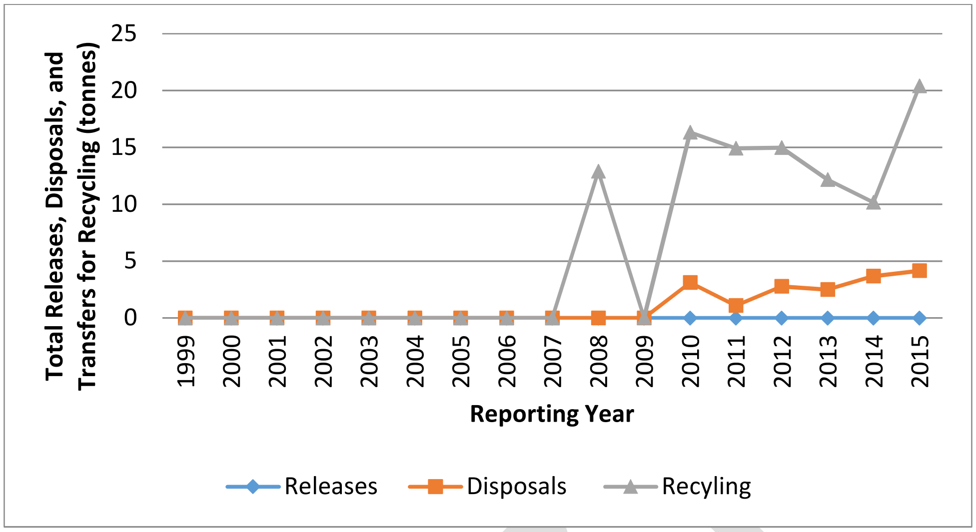

Figure 3. *NPRI Releases, Disposals, and Transfers for Recycling of Chlorinated Alkanes, $C_{6\text{-}18}$, (CAS RN 68920-70-7).*

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