

# Energy use and emissions from Great Lakes-St. Lawrence Seaway vessels in 2019

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Presented by: Bryan Comer, PhD, Marine Program Lead

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# The ICCT

- Independent, non-profit research org
- Founded in 2005 to provide independent technical and scientific analysis to environmental regulators
- Mission is to improve the environmental performance of transportation to benefit public health and mitigate climate change
- HQ in Washington, DC, with offices throughout the world
- 125 staff (7 on the Marine Team)
- Funded by philanthropy and government grants and contracts



# ICCT's Marine Team

7 staff, including...



**Bryan Comer, PhD**  
Marine Program Lead  
Emissions inventory expert  
Co-author 4<sup>th</sup> IMO GHG Study



**Zhihang Meng**  
Associate Marine Researcher  
Modeler and health impacts expert



**Xiaoli Mao**  
Senior Marine Researcher  
Emissions inventory expert and modeler  
Co-author 4<sup>th</sup> IMO GHG Study

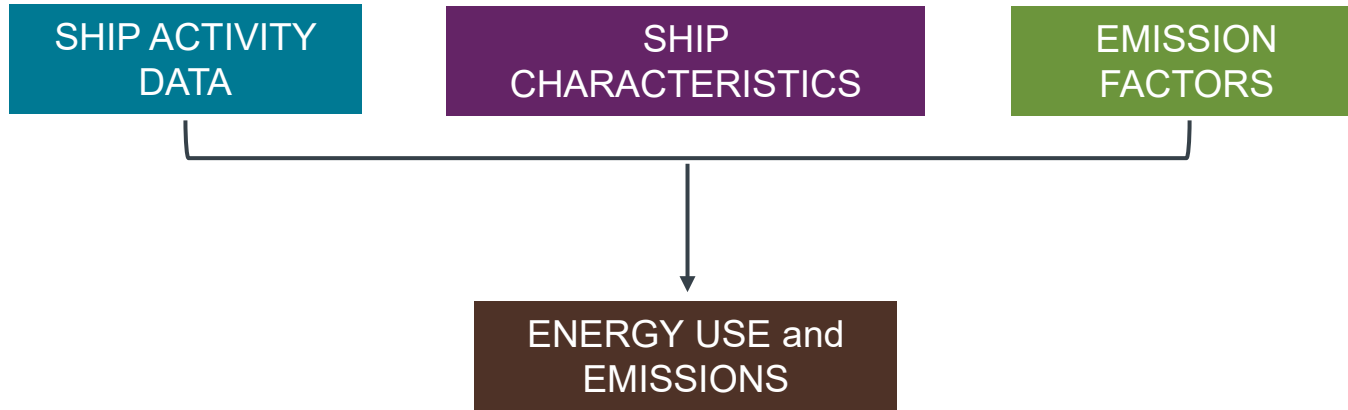


**Elise Georgeff**  
Associate Marine Researcher  
Modeler and US policy analyst

## Marine Program Mission:

The ICCT marine program is dedicated to providing policymakers with the data and analysis they need to avoid, reduce, and eliminate pollution from the global shipping sector.

# Our approach for estimating emissions and energy use



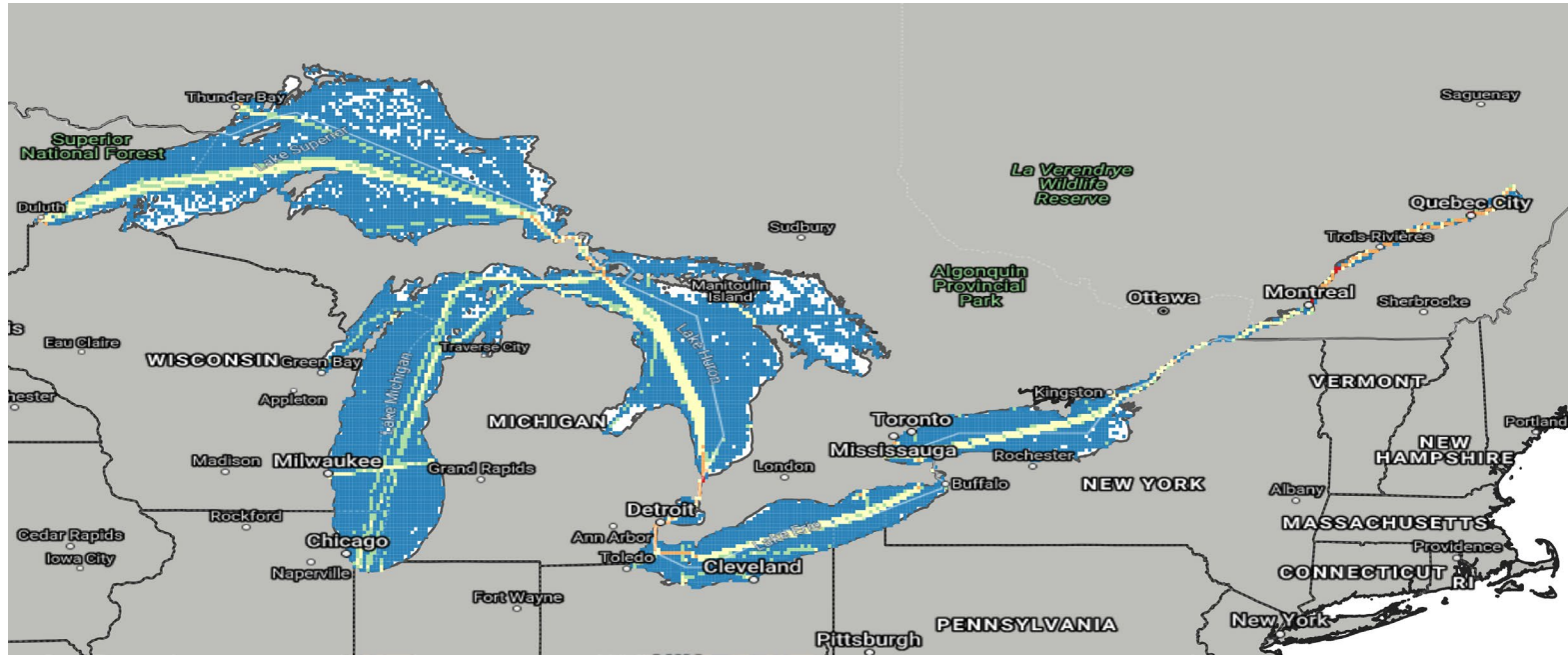
Data Source:

Satellite AIS

Ship Registry Data

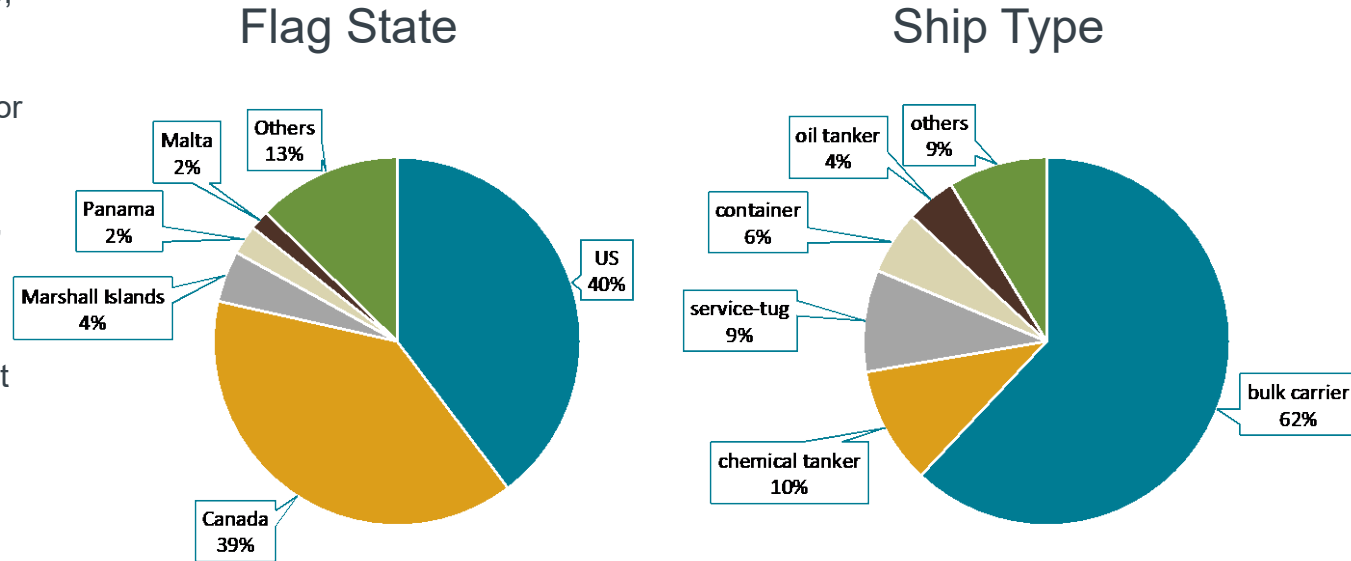
4<sup>th</sup> IMO GHG Study

# Distribution of fuel consumption in the GL-SLS in 2019



# GL-SLS fuel consumption and CO<sub>2</sub> emissions 2019

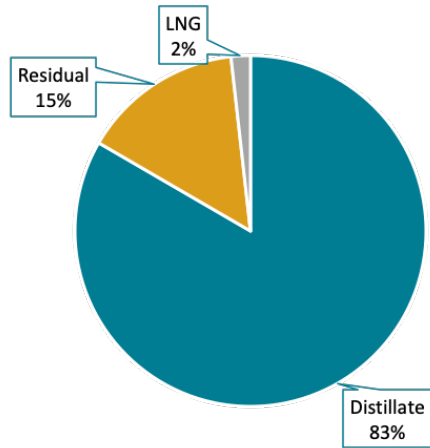
- 510,000 t fuel consumed in 2019, equal to 6 terawatt-hours or 20 trillion BTU, about enough to power a 70,000-person GL city for a year.<sup>1</sup>
- 1,625,000 t CO<sub>2</sub> emitted in 2019, equivalent to ~350,000 cars.<sup>2</sup>
- Mainly by US and Canada flag ships, each responsible for about 40% of fuel consumption and emissions.
- Mainly bulk carriers, but also chemical tankers, tugs, and container ships (on the SLS).



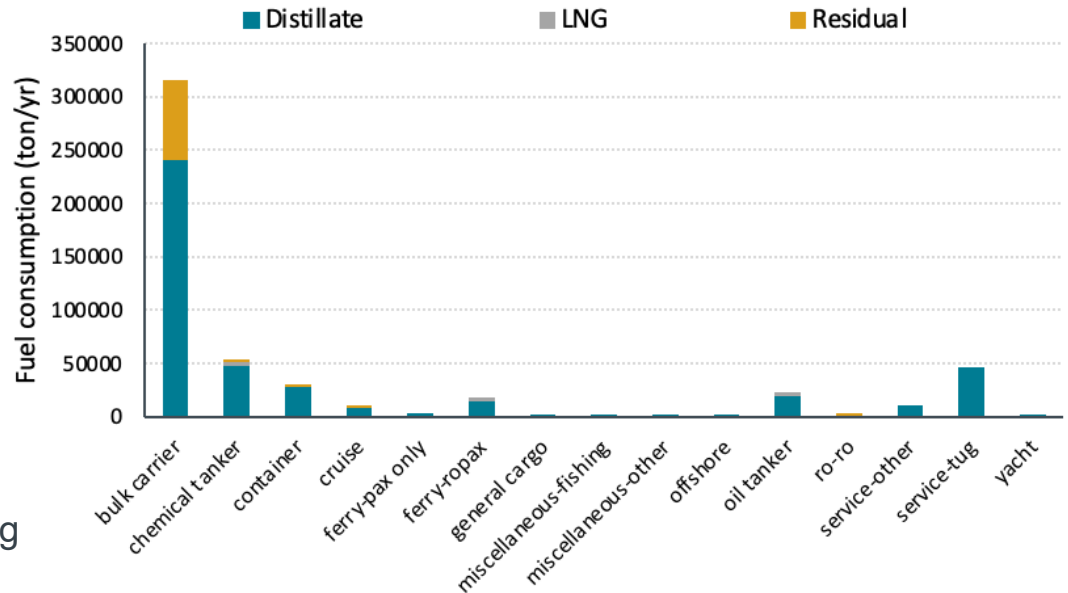
<sup>1</sup>Based on 289 MMBTU/person/yr energy consumption by Michigan Residents in 2019 according to the US EIA <https://www.eia.gov/state/print.php?sid=MI>

<sup>2</sup>Based on US EPA estimates that a typical passenger car emits 4.6 t CO<sub>2</sub>/yr, <https://www.epa.gov/greenvehicles/greenhouse-gas-emissions-typical-passenger-vehicle>

# Detailed fuel consumption GL-SLS 2019



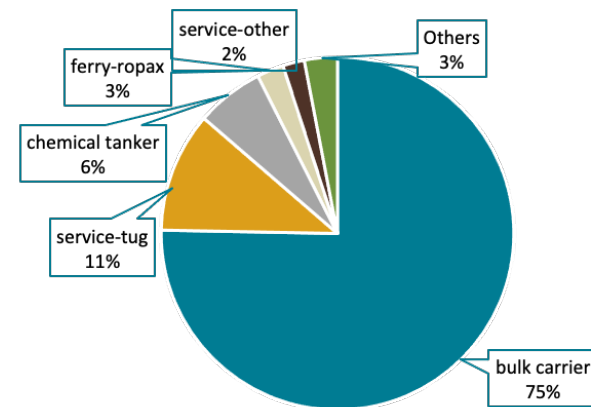
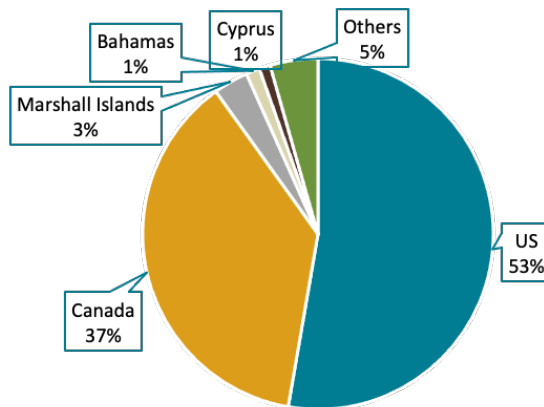
Residual fuel, also called “heavy fuel oil,” is used by ships that have exhaust gas cleaning systems, also known as “scrubbers.”



# Great Lakes fuel consumption and emissions in 2019

(divided at Cornwall, ON)

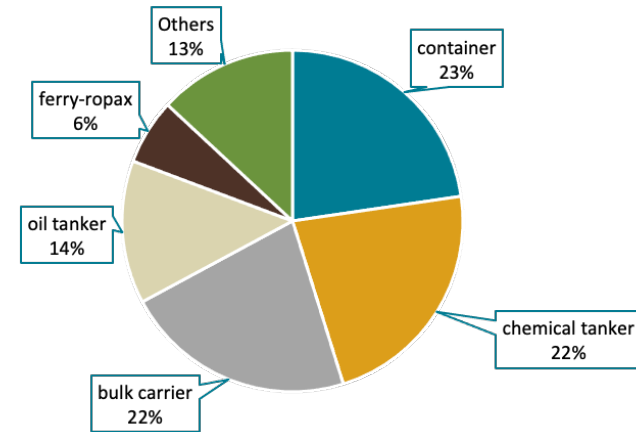
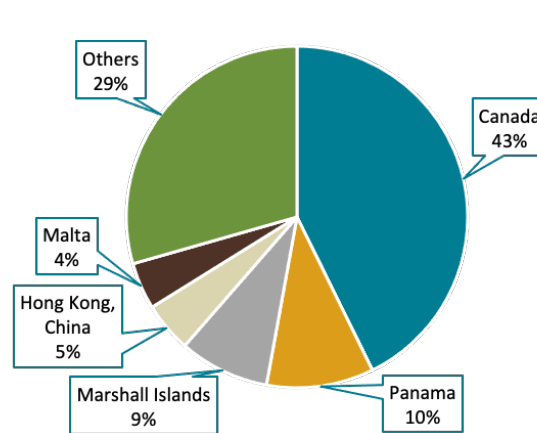
- Nearly 400,000 t fuel consumed in the GL in 2019, equal to 4.5 TWh or 15 tBTU.
- 1,224,000 t CO<sub>2</sub>.
- About 75% of GL-SLS fuel consumption and emissions occurs on the Great Lakes.
- Mainly US and Canada flag ships.
- Three-quarters of GL CO<sub>2</sub> emissions are from bulk carriers.





# St. Lawrence Seaway fuel consumption and emissions 2019

- 126,000 t fuel consumed, equal to 1.5 TWh or 5 tBTU.
- 402,000 t CO<sub>2</sub>.
- About 25% of GL-SLS fuel consumption and emissions occur on the SLS.
- Mainly Canada flag ships, hardly any fuel consumption or emissions from US flagged ships.
- CO<sub>2</sub> emissions mainly from container ships, chemical tankers, and bulk carriers.



# Additional ICCT capabilities

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ICCT can estimate and map emissions of CO<sub>2</sub>, CO<sub>2</sub> equivalents (100-year and 20-year), CH<sub>4</sub>, N<sub>2</sub>O, black carbon, PM<sub>10</sub>, PM<sub>2.5</sub>, NO<sub>x</sub>, SO<sub>x</sub>, CO, NMVOC, as well as energy use and discharges of heavy metals, polycyclic aromatic hydrocarbons, and nitrates from scrubbers. We can summarize results by ship type & size, flag, fuel type, engine type, in-port emissions vs. emissions underway, etc.

We're also experienced in zero emission vessel technologies (fuel cells, batteries, wind-assisted propulsion, etc.), health impacts of air pollution, life-cycle analysis for marine fuels, and policy design.

Our focus is on policy-relevant quantitative analysis.

Recent publications are available at <https://theicct.org/marine>

# What questions can I answer?

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I'm happy to have a discussion today and you can also reach out to:  
Bryan Comer, Marine Program Lead, [bryan.comer@theicct.org](mailto:bryan.comer@theicct.org).

# Appendix A: Detailed fuel consumption and emissions by ship type by region

# Appendix A1:

## GL-SLS results by ship type, 2019, tonnes per year

Ship type	Number of ships	Fuel	CO <sub>2</sub>	CH <sub>4</sub>	N <sub>2</sub> O	BC	SOx	PM <sub>10</sub>	PM <sub>2.5</sub>	NOx	CO	VOC
bulk carrier	379	315,259	1,010,113	15	54	69	421	719	662	21,397	809	799
chemical tanker	208	52,434	166,289	46	13	11	65	41	38	2,416	122	101
container	63	28,432	91,201	2	7	7	39	28	26	1,989	84	89
cruise	37	9,858	31,578	0.4	3	4	13	15	14	514	24	19
ferry-pax only	16	3,090	9,909	0.1	1	1	4	2	2	136	7	5
ferry-ropax	24	17,490	54,943	54	4	4	21	12	11	658	45	33
general cargo	13	975	3,131	<0.1	0.2	0.3	1	1	1	59	3	2
miscellaneous-fishing	6	449	1,440	<0.1	0.1	0.1	1	0.4	0.4	27	1	1
miscellaneous-other	1	81	260	<0.1	<0.1	<0.1	0.1	0.1	0.1	3	0.1	0.1
offshore	5	347	1,112	<0.1	0.1	0.1	1	0.3	0.3	24	1	1
oil tanker	70	22,229	70,327	19	5	5	27	15	14	756	46	37
ro-ro	2	1,699	5,446	0.1	0.3	1	2	2	2	99	5	5
service-other	26	10,087	32,340	1	2	3	14	9	8	626	28	25
service-tug	96	45,545	146,023	2	8	13	62	39	36	2,963	122	112
yacht	7	452	1,448	<0.1	0.2	0.1	1	0.4	0.4	26	1	1
<b>Total</b>	<b>953</b>	<b>508,428</b>	<b>1,625,559</b>	<b>139</b>	<b>98</b>	<b>118</b>	<b>672</b>	<b>884</b>	<b>813</b>	<b>31,692</b>	<b>1,297</b>	<b>1,231</b>

# Appendix A2:

## Great Lakes results by ship type, 2019, tonnes per year

Ship type	Number of ships	Fuel	CO <sub>2</sub>	CH <sub>4</sub>	N <sub>2</sub> O	BC	SO <sub>x</sub>	PM <sub>10</sub>	PM <sub>2.5</sub>	NO <sub>x</sub>	CO	VOC
bulk carrier	186	287,715	921,798	14	48	62	383	692	637	19,472	734	723
chemical tanker	66	23,782	75,898	22	6	5	31	21	19	1,260	61	50
container	1	9	28	<0.1	<0.1	<0.1	<0.1	0.1	0.1	1	<0.1	<0.1
cruise	7	3,370	10,812	0.1	1	1	5	3	3	161	8	6
ferry-pax only	9	1,427	4,575	0.1	1	0.4	2	1	1	87	4	3
ferry-ropax	7	9,375	30,057	0.4	2	2	13	8	7	468	23	20
general cargo	10	599	1,925	<0.1	0.1	0.2	1	1	1	40	2	2
miscellaneous-fishing	5	440	1,412	<0.1	0.1	0.1	1	0.4	0.4	27	1	1
miscellaneous-other	0	0	0	0	0	0	0	0	0	0	0	0
offshore	4	274	877	<0.1	0.1	0.1	0.4	0.3	0.3	19	1	1
oil tanker	3	5,031	15,855	8	1	1	6	4	3	191	14	10
ro-ro	0	0	0	0	0	0	0	0	0	0	0	0
service-other	19	7,560	24,237	0.4	2	2	10	7	6	467	21	19
service-tug	72	42,104	134,991	2	7	11	58	36	33	2,757	112	103
yacht	7	384	1,231	<0.1	0.2	0.1	1	0.4	0.3	22	1	1
<b>Total</b>	<b>396</b>	<b>382,070</b>	<b>1,223,695</b>	<b>48</b>	<b>67</b>	<b>86</b>	<b>509</b>	<b>772</b>	<b>711</b>	<b>24,970</b>	<b>980</b>	<b>938</b>

# Appendix A3:

## St. Lawrence Seaway results by ship type, 2019, tonnes per year

Ship type	Number of ships	Fuel	CO <sub>2</sub>	CH <sub>4</sub>	N <sub>2</sub> O	BC	SOx	PM <sub>10</sub>	PM <sub>2.5</sub>	NOx	CO	VOC
bulk carrier	340	27,545	88,315	1	7	7	38	27	25	1,925	75	76
chemical tanker	206	28,652	90,390	24	7	6	35	21	19	1,157	61	51
container	62	28,424	91,173	2	7	7	39	28	26	1,988	84	89
cruise	37	6,488	20,766	0.3	2	3	9	12	11	353	16	13
ferry-pax only	7	1,664	5,334	<0.1	0.4	1	2	1	1	49	3	2
ferry-ropax	17	8,114	24,886	53	2	2	8	4	4	189	22	13
general cargo	12	376	1,206	<0.1	0.1	0.2	1	0.3	0.3	19	1	1
miscellaneous-fishing	3	9	28	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	1	<0.1	<0.1
miscellaneous-other	1	81	260	<0.1	<0.1	<0.1	0.1	0.1	0.1	3	0.1	0.1
offshore	2	73	235	<0.1	<0.1	<0.1	0.1	0.1	0.1	5	0.2	0.2
oil tanker	70	17,198	54,472	11	4	4	22	11	10	566	32	27
ro-ro	2	1,699	5,446	0.1	0.3	1	2	2	2	99	5	5
service-other	18	2,527	8,103	0.1	1	1	4	2	2	159	7	6
service-tug	48	3,441	11,032	0.2	1	2	5	3	3	206	10	9
yacht	5	68	217	<0.1	<0.1	<0.1	0.1	0.1	0.1	4	0.2	0.2
<b>Total</b>	<b>830</b>	<b>126,358</b>	<b>401,864</b>	<b>91</b>	<b>31</b>	<b>33</b>	<b>163</b>	<b>112</b>	<b>103</b>	<b>6,722</b>	<b>317</b>	<b>293</b>

# Appendix B:

## Number of ships by ship type and flag by region



# Appendix B1:

## GL-SLS 2019 fleet by flag and number of ships

Flag state	bulk carrier	chemical tanker	container	cruise	ferry-pax only	ferry-ropax	general cargo	miscellaneous-fishing	miscellaneous-other	offshore	oil tanker	ro-ro	service-other	service-tug	yacht	Total
Canada	50	24	1	0	13	20	2	4	1	0	4	1	17	47	0	184
Marshall Islands	85	45	2	3	0	0	0	0	0	1	14	0	0	1	0	151
US	34	0	0	2	3	3	1	2	0	1	0	0	6	45	1	98
Panama	46	12	26	1	0	0	0	0	0	1	2	0	1	0	0	89
Liberia	30	20	8	0	0	0	1	0	0	0	10	0	0	0	0	69
Others	134	107	26	31	0	1	9	0	0	2	40	1	2	3	6	362
<b>Total</b>	<b>379</b>	<b>208</b>	<b>63</b>	<b>37</b>	<b>16</b>	<b>24</b>	<b>13</b>	<b>6</b>	<b>1</b>	<b>5</b>	<b>70</b>	<b>2</b>	<b>26</b>	<b>96</b>	<b>7</b>	<b>953</b>

# Appendix B2:

## Great Lakes 2019 fleet by flag and number of ships (divided at Cornwall, ON)

Flag state	bulk carrier	chemical tanker	container	cruise	ferry-pax only	ferry-ropax	general cargo	miscellaneous-fishing	miscellaneous-other	offshore	oil tanker	ro-ro	service-other	service-tug	yacht	Total
Canada	47	21	0	0	6	4	1	3	0	0	2	0	12	26	0	122
US	34	0	0	2	3	3	1	2	0	1	0	0	6	45	1	98
Marshall Islands	44	4	1	1	0	0	0	0	0	1	0	0	0	1	0	52
Cyprus	21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	21
Malta	10	6	0	0	0	0	0	0	0	0	0	0	0	0	0	16
Others	30	35	0	4	0	0	8	0	0	2	1	0	1	0	6	87
<b>Total</b>	<b>186</b>	<b>66</b>	<b>1</b>	<b>7</b>	<b>9</b>	<b>7</b>	<b>10</b>	<b>5</b>	<b>0</b>	<b>4</b>	<b>3</b>	<b>0</b>	<b>19</b>	<b>72</b>	<b>7</b>	<b>396</b>

# Appendix B3

## SLS 2019 fleet by flag and number of ships (between Cornwall, ON, and Montmagny, QC)

Flag state	bulk carrier	chemical tanker	container	cruise	ferry-pax only	ferry-ropax	general cargo	miscellaneous-fishing	miscellaneous-other	offshore	oil tanker	ro-ro	service-other	service-tug	yacht	Total
Canada	45	23	1	0	7	16	2	2	1	0	4	1	16	37	0	155
Marshall Islands	85	44	1	3	0	0	0	0	0	0	14	0	0	0	0	147
Panama	46	12	26	1	0	0	0	0	0	1	2	0	1	0	0	89
Liberia	30	20	8	0	0	0	1	0	0	0	10	0	0	0	0	69
Malta	25	24	0	5	0	0	0	0	0	0	6	0	0	1	0	61
US	0	0	0	2	0	0	0	1	0	0	0	0	0	8	0	11
Others	109	83	26	26	0	1	9	0	0	1	34	1	1	2	5	298
<b>Total</b>	<b>340</b>	<b>206</b>	<b>62</b>	<b>37</b>	<b>7</b>	<b>17</b>	<b>12</b>	<b>3</b>	<b>1</b>	<b>2</b>	<b>70</b>	<b>2</b>	<b>18</b>	<b>48</b>	<b>5</b>	<b>830</b>



San Francisco ●

Mexico City ○

Bogotá ○

● São Paulo

★ Washington, DC  
(headquarters)

● Berlin

● New Delhi

● Beijing

○ Jakarta