CSL Preliminary Analysis of Potential AIS Transfer Risk:

Cross-Referencing Ballast Water Activities and Known AIS in the Great Lakes Trade

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Overview

- Introduction
- Project Goals
- Part 1: Vessel Transit Study
- Part 2: Cross-Reference Analysis
- Part 3: Preliminary AIS Risk Assessment Model

Introduction

- Canada Steamship Lines (CSL)
- CSL is an active stakeholder as part of efforts to address AIS risk posed by ballast water:
  - Member of CSA Ballast Water Working Group
  - Participant in the Ballast Water Collaborative
- This preliminary analysis contributes to broader efforts to explore measures for existing vessels
  - Improve understanding of risk posed by transfer
  - Identify appropriate risk management activities

Goals of the Analysis

1. How much ballast water is potentially being moved between domestic ports?
   - Built upon methodology from Vessel Transit Study
2. Which AIS are potentially being transported between domestic ports?
   - Cross-reference known AIS to vessel transits
3. What is the potential risk level of the transportation of these AIS?
   - Assign risk level to transfer

Part 1: Vessel Transit Study

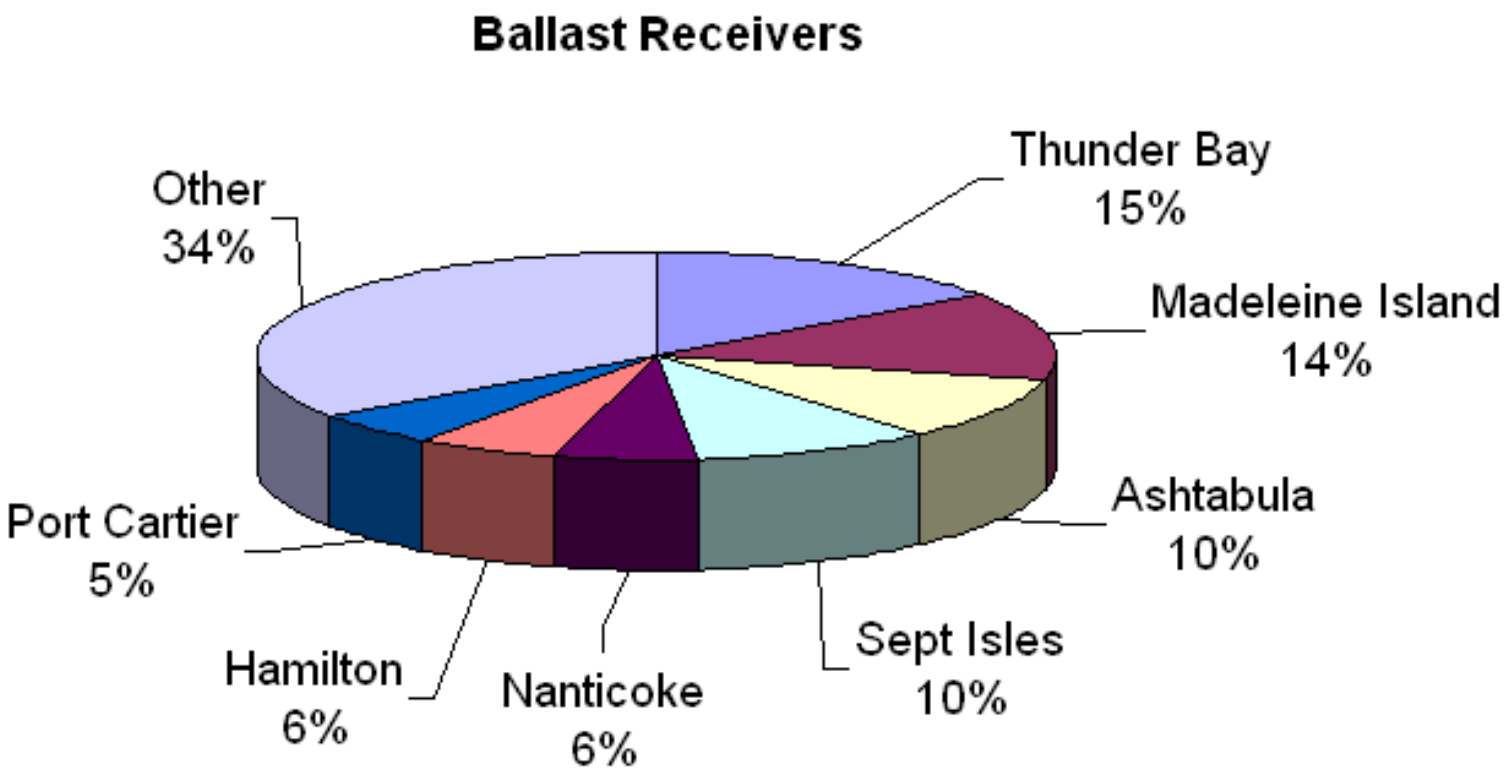
- CSL drew from objectives of the Vessel Transit Study*:
  1. Compile database of ballast water movement between Great Lakes ports
  2. Light port (donor) to Load port (receiver)
  3. Determine potential top ports for the spread of AIS
- Methodology:
  - Vessel Transit Study:
  - Primary data sources included INNAV and NBIC (CDN and US Coast Guard)
  - Vessel Transits based on the year 2005
  - CSL Preliminary Analysis:
  - Vessels transits tracked for the year 2009.
  - CSL primary data sources and ballast tonnages derived from the CSL Vessel Ballast Water Management Logs.

*Vessel Transit Study: Bailey, Rup and Wiley et al. 2010

Part 1 Results

- Results of the ballast water inventory and trade route identification:
  - Rup et al study examined routes of 90 ships, including 7 CSL ships operating in inland waters (2005-2007)
  - CSL preliminary analysis includes current CSL fleet of 18 vessels operating in internal waters (2009)
  - These 18 CSL vessels visited 60 light ports (donor) and 50 load ports (receiver) on 130 individual trade routes totaling 555 transits in 2009
  - 13% of those transits were in ballast with approximately 8,553,302 MT of ballast water transferring from donor to receiver ports

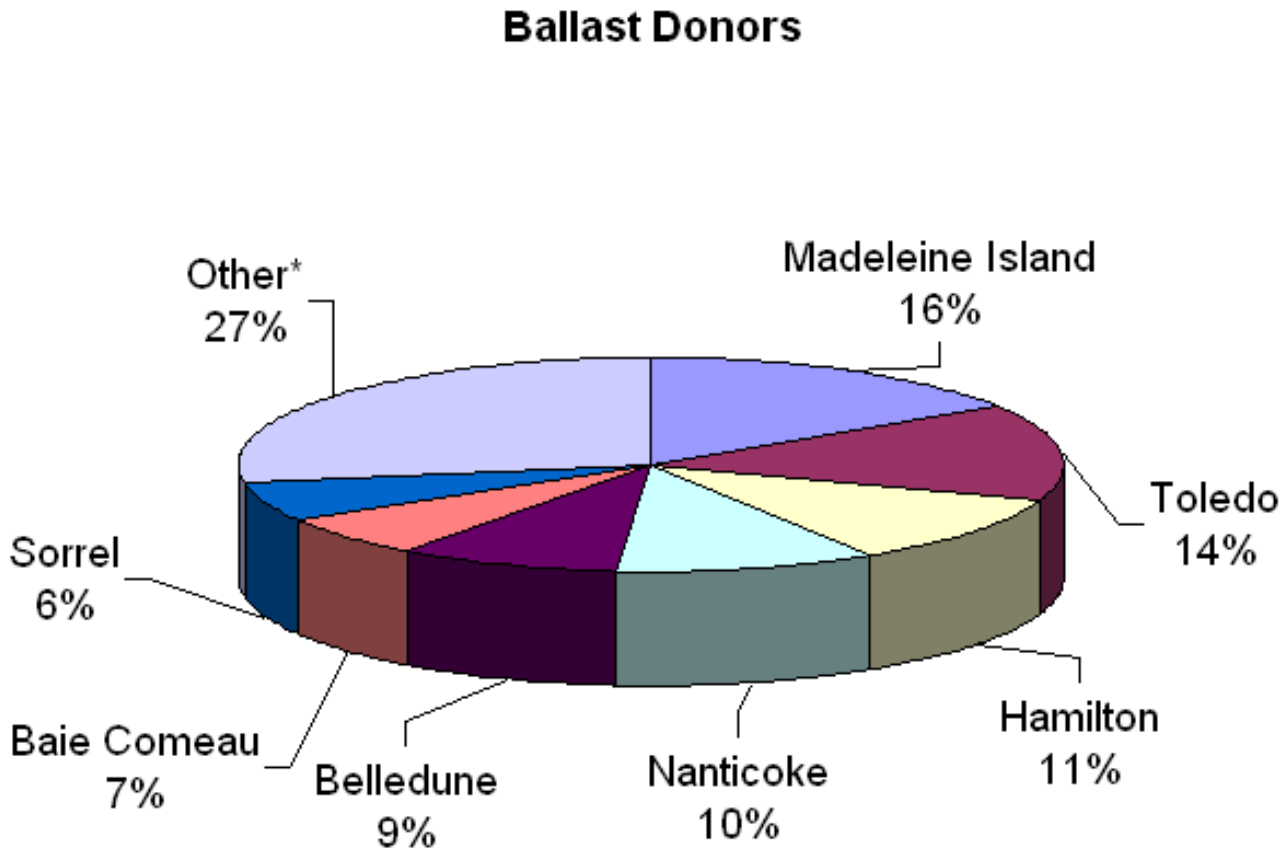
CSL Ballast Receiver Ports (Load Ports)



(MT- Metric Tons of Ballast Water)

*Other includes 36 ports receiving less than 308,780 MT ballast water

CSL Ballast Donor Ports (Light Ports)



(MT- Metric Tons of Ballast Water)

*Other includes 20 ports with ballast water volumes less than 274,356 MT

Part 2: Cross-Reference Analysis

- Objectives:
  - Compile a database of known AIS in the Great Lakes and Great Lakes ports
  - Cross-reference information from all ports known to have invasive species with CSL vessel transits and ballast water activity
  - Incorporate probability of introduction / transport into the cross-referenced databases
    - Evaluate whether the invasive species is present at the receiver port
    - Evaluate the potential of an invasive species being transported through ballast water
    - Assign a percentage to the potential level of impact to the invasive species

Method: Cross-Reference Analysis

- Methodology:
  - The AIS data for the cross-reference was provided by NOAA and OFAH Databases.
  - The different sources of AIS data was compiled into a database that assigned the presence of an AIS at each port for the region it is associated with.
  - CSL sought input from NOAA* and OFAH* to assign a risk level to transfer by calculating the presence level at each port along with the likelihood of the AIS entering the ballast water
  - The probability of introduction / transport in ballast water was determined by the product of the AIS locality by the assigned aggressiveness
    - Locality is based on the presence of the AIS at donor and / or receiver ports
    - Aggressiveness is based on whether it is more likely to be transported by ballast water or not.
  - **CSL is seeking further input on extending model to incorporate risk assessment (probability of establishment in the recipient port and magnitude of impact)**

*Data on invasive species was provided by Rochelle Sturtevant (NOAA) and David Copplestone (OFAH)

Input to Cross-Reference Database

Light (Donor) Port

- Red = AIS are not present
- Green = AIS are present

1 indicates it is present at that port.
0 indicates it is not there.

Light	SOR	HAM	AST	BCO	BLD	COU	TOL	WIN	PCA
Species	Species #									
Potamothrix bedoti	25	0	0	0	0		0	0	0	
Potamothrix moldaviensis	26	0	0	0	0		0	0	0	
Potamothrix vejdovskyi	27	0	0	0	0		0	0	0	
Ripistes parasita	28	0	0	0	0		0	0	0	
Acentropus niveus	29	0	0	0	0		0	0	0	
Tanysphyrus lemnae	30	0	0	0	0		0	0	0	
Aeromonas salmonicida	31	0	0	0	0		0	0	0	
Renibacterium (Corynebacterium) salmoninarum	32	0	0	0	0		0	0	0	
Lophopodella carteri	33	0	0	0	0		0	0	0	
Cordylophora caspia	34	0	0	0	0		0	0	0	
Craspedacusta sowerbyi	35	0	0	1	0		0	1	0	
Echinogammarus ischnus	36	0	0	0	0		0	0	1	
Gammarus tigrinus	37	0	0	0	0		0	0	0	
Bythotrephes longimanus	38	0	1	1	0		1	0	0	
Cercopagis pengoi	39	1	1	0	1		0	0	0	
Daphnia galeata galeata	40	0	0	0	0		0	0	0	
Daphnia lumholtzi	41	0	0	0	0		0	0	0	

Load (Receiver) Port

- Red = AIS are present
- Green =AIS are not present

0 indicates it is present at that port.
1 indicates it is not there.

Load	HSP	AST	TBY	DUL	SIL	SUP	LCO	PCA	CHI	SAN
Species	Species #									
Alosa pseudoharengus	55	1	0	1	1	1	0		1	1	1
Apeltes quadracus	56	1	1	1	1	1	1		1	1	1
Carassius auratus	57	1	1	1	0	1	1		1	0	1
Cyprinus carpio	58	1	1	1	0	1	0		1	0	1
Enneacanthus gloriosus	59	1	1	1	1	1	1		1	1	1
Esox niger	60	1	1	1	1	1	1		1	1	1
Gambusia affinis	61	1	1	1	1	1	1		1	0	1
Gymnocephalus cernuus	62	1	1	0	0	1	0		1	1	1
Lepisosteus platostomus	63	1	1	1	1	1	1		1	1	1
Lepomis humilis	64	1	1	1	1	1	1		1	1	1
Lepomis microlophus	65	1	1	1	1	1	1		1	1	1
Morone americana	66	0	0	1	0	0	0		0	0	1
Neogobius [=Apollonia] melanostoma	67	0	0	0	0	0	0		0	0	0
Notropis buchanani	68	1	1	1	1	1	1		1	1	1
Oncorhynchus gorbuscha	69	1	1	1	0	1	1		1	1	1
Oncorhynchus kisutch	70	1	1	1	0	1	1		1	1	0
Oncorhynchus mykiss	71	1	1	1	0	1	0		1	1	0
Oncorhynchus nerka	72	1	1	1	1	1	1		1	1	1
Oncorhynchus tshawytscha	73	1	1	1	1	1	1		1	1	0
Osmerus mordax	74	0	1	0	0	0	0		0	1	0
Petromyzon marinus	75	1	1	1	1	1	1		1	1	1
Phenacobius mirabilis	76	1	1	1	1	1	1		1	1	1
Proterorhinus semilunaris	77	1	1	1	0	1	1		1	1	1

Cross-Referenced Database

- Below is the assignment of the potential risk level per voyage

Risk Level																	
	Voyage	SORHSP	HAMAST	ASTTBY	HAMDUL	BCOSIL	BLDSIL	COUDUL	TOLSUP	WINDUL	BCOHSP	PCASIL	QUESIL	COUTBY	QUESUP	CHTLCO	CSCPCA
Species																	
Cordylophora caspia	34	0%	0%	0%	0%	0%		0%	0%	0%	0%	0%	0%	0%	0%		0%
Craspedacusta sowerbyi	35	0%	0%	50%	0%	0%		0%	0%	0%	0%	0%	0%	0%	0%		0%
Echinogammarus ischnus	36	0%	0%	0%	0%	0%		0%	0%	100%	0%	0%	0%	0%	0%		0%
Gammarus tigrinus	37	0%	0%	0%	0%	0%		0%	0%	0%	0%	0%	0%	0%	0%		0%
Bythotrephes longimanus	38	0%	0%	0%	0%	0%		0%	0%	0%	0%	0%	0%	0%	0%		0%
Cercopagis pengoi	39	0%	100%	0%	100%	0%		0%	0%	0%	0%	0%	0%	0%	100%		0%
Daphnia galeata galeata	40	0%	0%	0%	0%	0%		0%	0%	0%	0%	0%	0%	0%	0%		0%
Daphnia lumholtzi	41	0%	0%	0%	0%	0%		0%	0%	0%	0%	0%	0%	0%	0%		0%
Eubosmina coregoni	42	0%	0%	0%	0%	0%		0%	0%	0%	0%	0%	0%	0%	0%		0%
Eubosmina maritima	43	0%	0%	0%	0%	0%		0%	0%	0%	0%	0%	0%	0%	0%		0%
Cyclops strenuus	44	0%	0%	0%	0%	0%		0%	0%	0%	0%	0%	0%	0%	0%		0%
Eurytemora affinis	45	0%	0%	0%	0%	0%		0%	0%	0%	0%	0%	0%	0%	0%		0%
Heteropsyllus nr. nunni	46	0%	0%	0%	0%	0%		0%	0%	0%	0%	0%	0%	0%	0%		0%
Megacyclops viridis	47	0%	0%	0%	0%	0%		0%	0%	0%	0%	0%	0%	0%	0%		0%
Neoergasilus japonicus	48	0%	0%	0%	0%	0%		0%	0%	0%	0%	0%	0%	0%	0%		0%

Presence At Light Port x Presence At Load Port x Aggressiveness = Potential Risk Level

s)	181	0%	0%	0%	0%	0%
	182	0%	0%	0%	0%	0%
	183	0%	100%	0%	0%	0%
		0%	3%	5%	2%	0%
		-	6	9	3	-
	Ballast	50580	231934	223342	26824	66000
	Ballast Load	64	33	19	18	15

Part 3: AIS Risk Assessment Model

Objectives:

- Cross-referencing the vessel ballast water activity to the known AIS in donor / receiver ports to the AIS characteristics has the potential to yield a model to understand the potential risk of transfer
- The model could be broken down into: per voyage, per load port, per light port, per species and per vessel, below is a screen shot of the results for a trade route:

Light Port	TOL							
Load Port	WIN							
Values								**Characteristics**
Number of Trips	Days/Voyage	Total Days	Species Number	Combined Species Number	Species	Risk Level	Total Risk Level	Group
5	0.1800	0.90					13.5	
			14		Skeletonema potamos	100%		Algae
			35		Craspedacusta sowerbyi	50%		Coelenterates-Hydrozoans
			55		Alosa pseudoharengus	100%		Fishes
			58		Cyprinus carpio	100%		Fishes
			61		Gambusia affinis	100%		Fishes
			64		Lepomis humilis	100%		Fishes
			73		Oncorhynchus tshawytscha	100%		Fishes
			75		Petromyzon marinus	100%		Fishes
			80		Corbicula fluminea	100%		Mollusks-Bivalves
			81		Dreissena polymorpha	100%		Mollusks-Bivalves
			82		Dreissena rostriformis bugensis	100%		Mollusks-Bivalves
			88		Bithynia tentaculata	100%		Mollusks-Gastropods
			93		Radix auricularia	100%		Mollusks-Gastropods
			182		Threespine Stickleback (Gasterosteus aculeatus)	100%		0

Preliminary Results

- Below are the top 3 AIS identified by the cross-referencing analysis that are potentially transferred between ports in ballast water.
  - These AIS have been present in the light (donor) port since 1998, 1931, and 2006 respectively
  - These trade routes have been in place for at least > 2 decades
- Of note, these species can potentially be blocked through filtration from the ballast water due to the size of the species.

*The species below are the top three species identified by this analysis with the potential to be transported

Species Name	Latin Name:	Size:	# combination of voyages for this species to move:
Fishhook Waterflea	Cercopagis pengoi	6-13 mm	35
Rudd	Scardinius erythrophthalmus	48 cm	33
Bloody Red Shrimp	Hemimysis anomala	6-13 mm	24

Preliminary Results

Trade Routes that de-ballast in Lake Superior Ports:

- Preliminary results identify that CSL vessel transits have the potential to move 6 (3% of all known invasive species) species for the Hamilton to Superior trade route. In 2009, 230,152 MT of ballast water was transported on this trade route. This trade has been in place for decades.
- The model demonstrates that CSL has transferred large volumes of ballast water into Lake Superior ports over the long term without evidence of AIS transfers from load ports.
- Reasoning: Does this model provide supporting evidence for Lake Superior being a "cold spot"?
- Other Voyages Into Lake Superior:

Light:	Load:	# of Voyages:	# of potential species moved:	Tonnage (MT):
Ashtabula	Thunder Bay	19	9	223,342
Toledo	Superior	12	9	136,831

Next Steps for Consideration

- Further consideration and improvement of model:
  - Validation of the preliminary results including method for calculating probability of introduction
  - Consideration of incorporating vessels on other trade routes within the Great Lakes system
  - Development and incorporation of other risk assessment factors
- Consideration of utilizing this analysis to further develop the understanding of risk of transfer and appropriate risk mitigation efforts
- Potential to contribute to developing a Made in the Great Lakes solution to addressing AIS transfer risk for existing vessels?
  - Incorporate a finalized AIS cross-referenced model with expanded Best Management Practices
  - Utilize to design filtering or strainer systems developed for Lakers or Coast trading vessels, in addition to, or in combination with other efforts