Habitat utilization and recruitment sources of Eurasian Tench in the St. Lawrence River by otolith microchemistry

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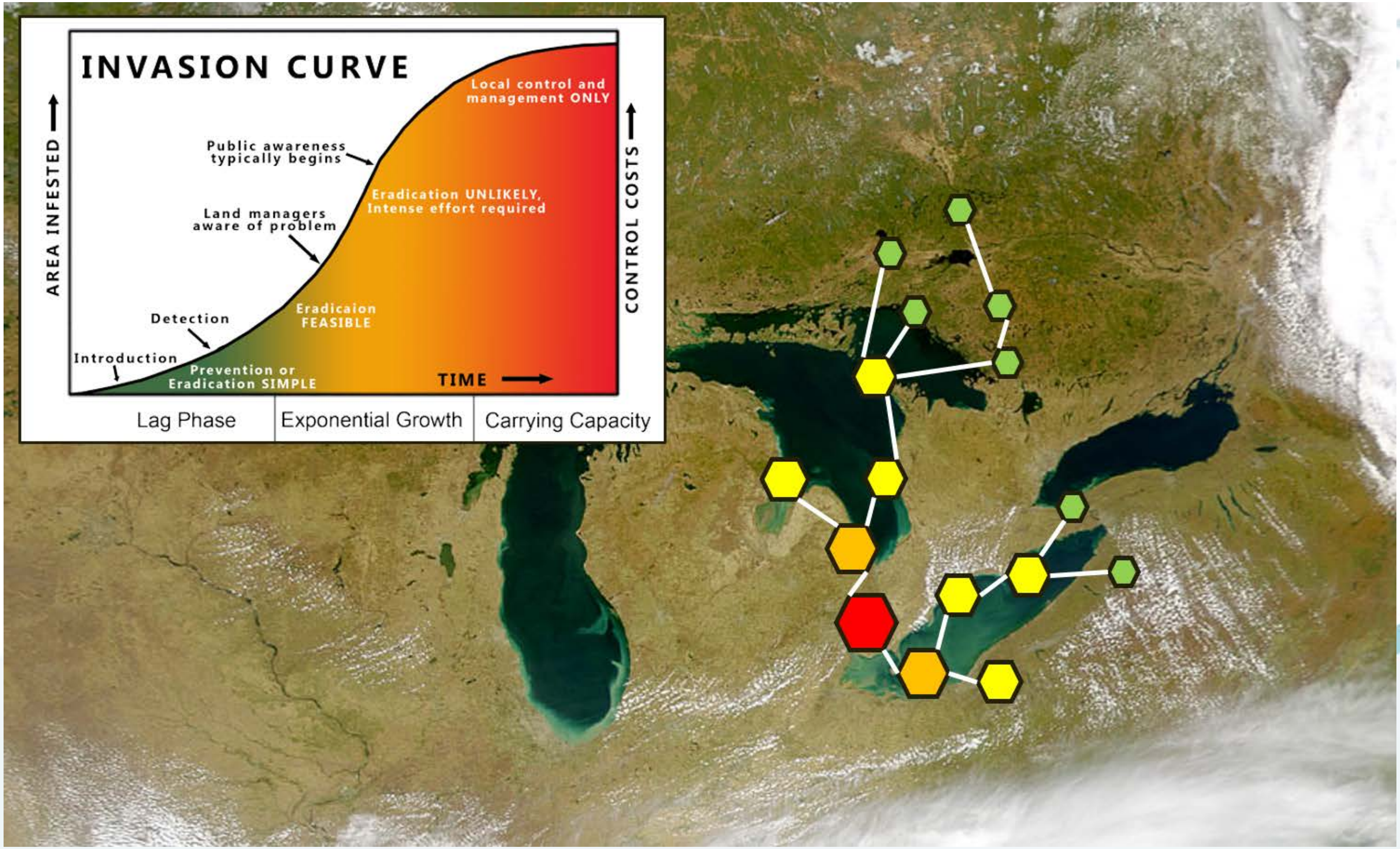
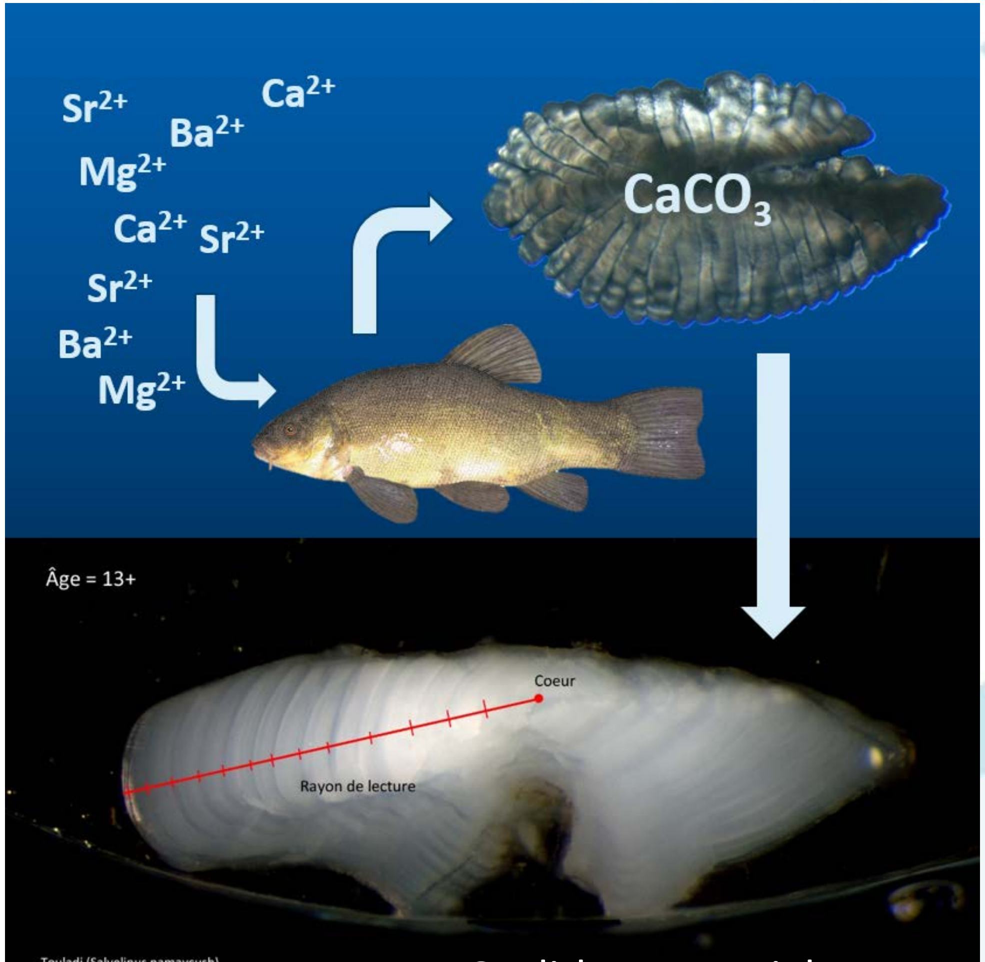
Invasion dynamics and critical period



Assessment of fish migration by otolith microchemistry

Can act as a passive biological tag, influenced by surrounding habitat.

Trace elements may directly substitute for Ca in the otolith $CaCO_3$ (Campana 1999) in a concentration (*relatively*) representative of water chemistry.



Otolith sequential nature

Eurasian tench (Tinca tinca) invasion in Québec

Illegally imported from Germany by a farmer in 1986.

- ~ 30 small individuals stocked in a network of ponds, drained several timed between 1986 and 1991.
- First reported catch, by a commercial fisherman, in 1999 (*but probably occurred before, pers comm.)* in the upper Richelieu River.
- Steady spread in the system, with first detection in lower Richelieu in 2007

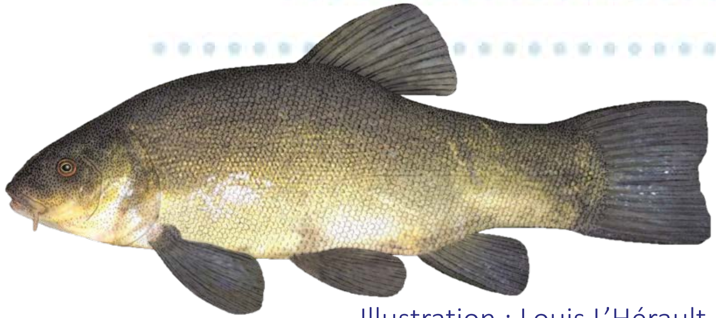
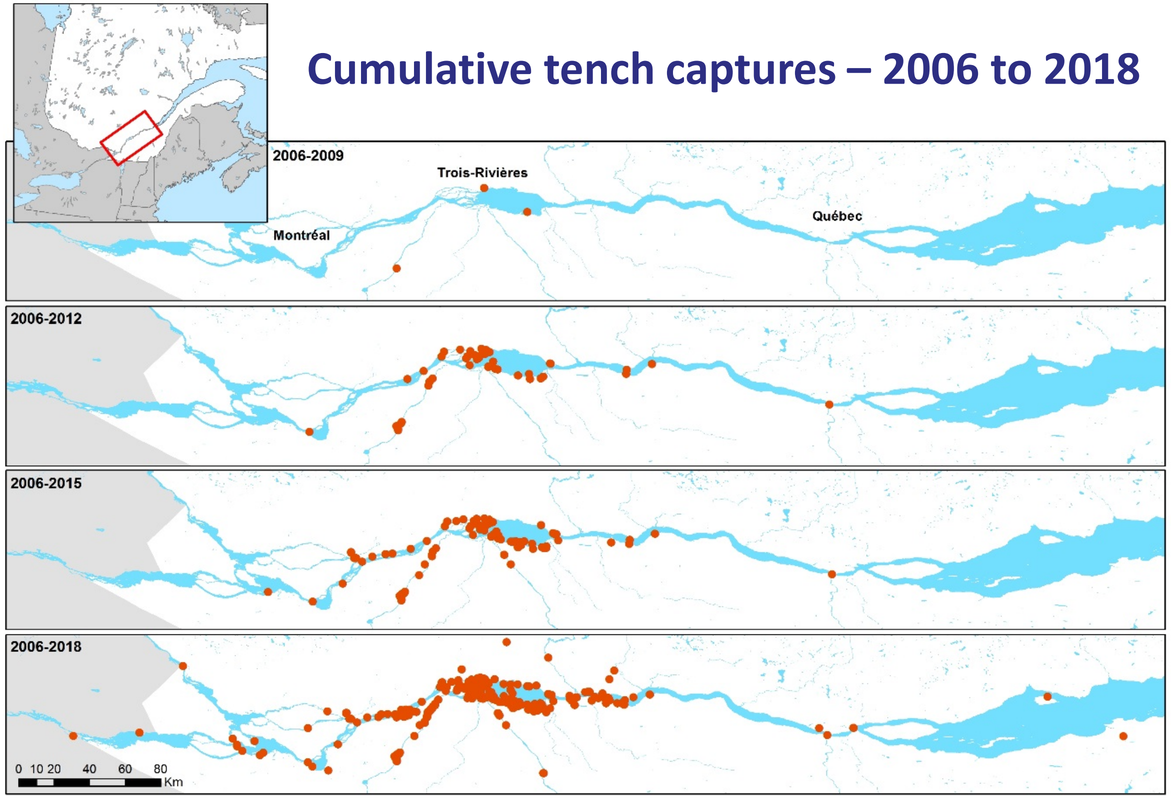


Illustration : Louis L'Hérault

Cumulative tench captures – 2006 to 2018



Study objectives

Can otolith microchemistry be used to assess invasion process and document population reproductive/colonization dynamics?

St. Lawrence River tench is a well-suited system for this test :

- Well-known invasion history, multiple freshwater habitats.
- Assumed low genetic variability in the system.

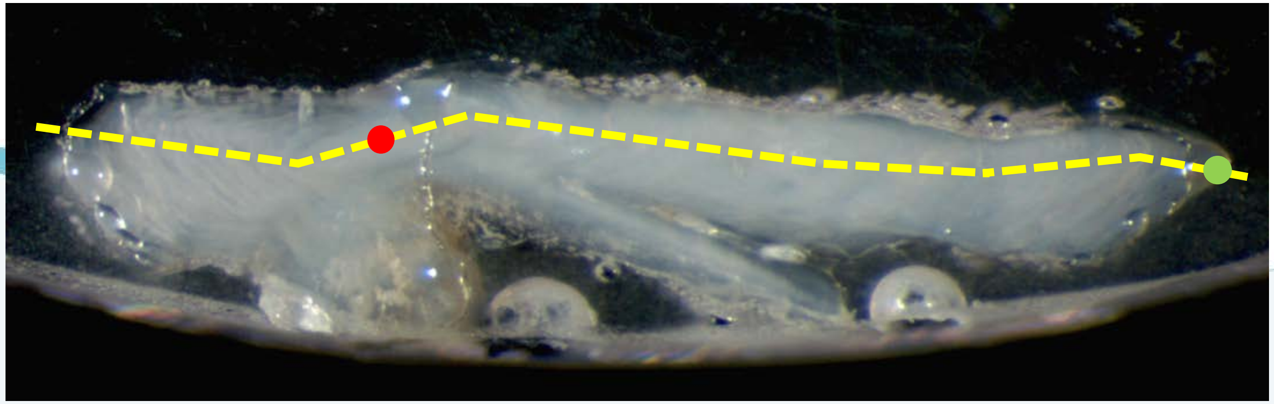
Represent a occasion to document finer population information, guiding and informing management plans in the future.

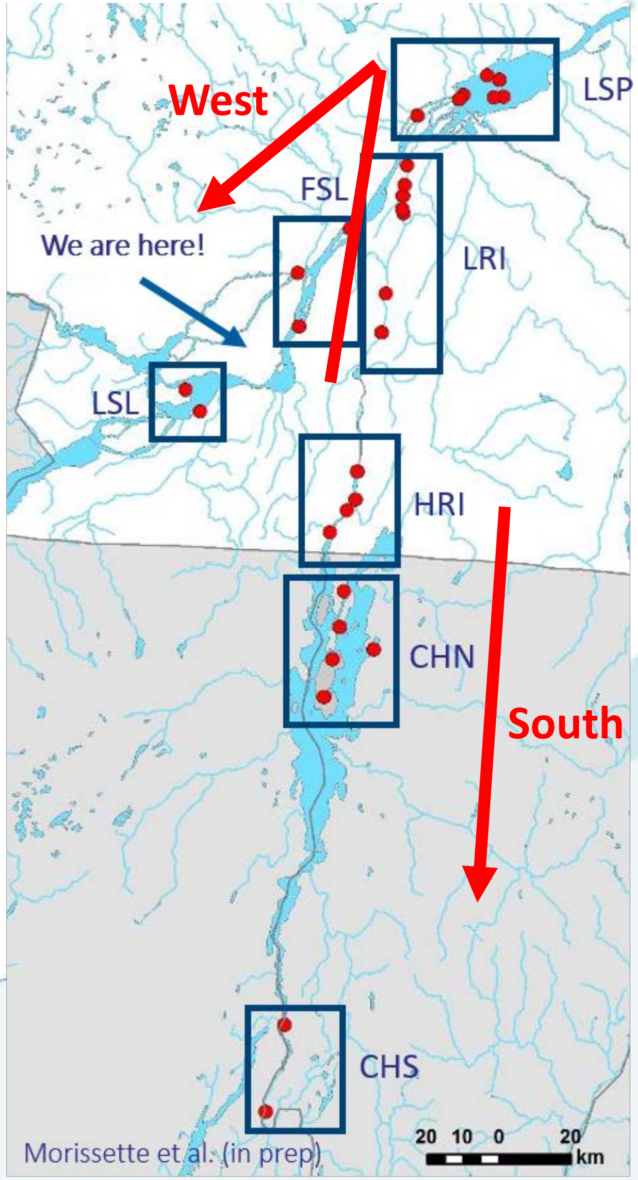
Study design and LA-ICP-MS analyses

85 tench captured in 2016 (MFFP & McGill) between Lake St. Louis (LSL) and Southern Lake Champlain (CHS)

Right asteriscus analyzed by laser ablation inductively coupled mass spectrometry (LA-ICP-MS) *Resonetics Excimer 193 mm coupled in Agilent 7900 LA-ICP-MS, 19 µm beam @ 20Hz, 5 µm*sec^{-1}*

35 elements quantified, integration with 3 standard materials (NIST-610 and MACS3/GP4) and ^{43}Ca as an internal standard.





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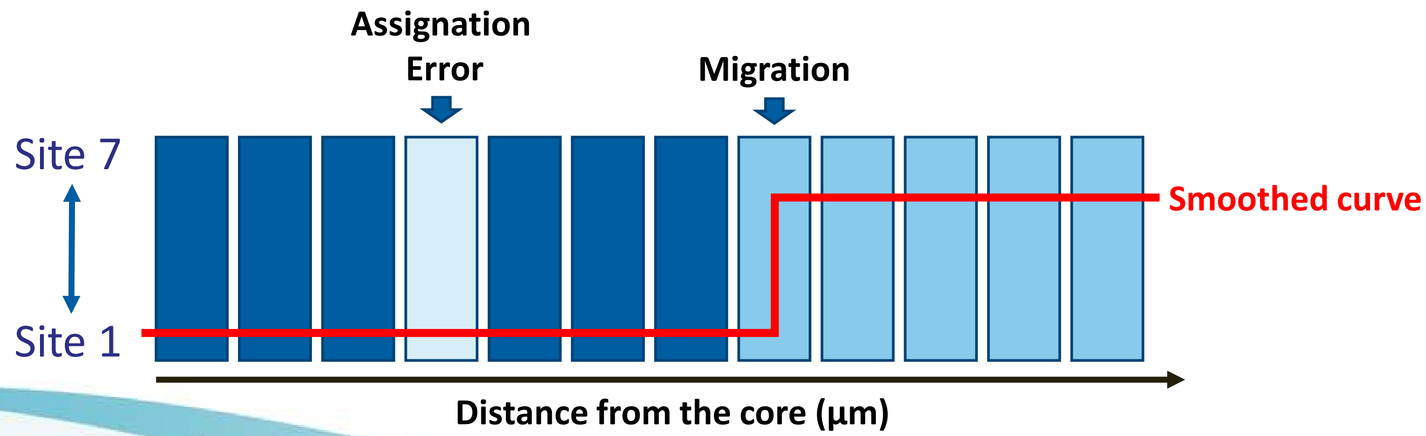
Elemental fingerprint classification

Random Forest classification method (Mg:Ca, Mn:Ca, Sr:Ca, Ba:Ca) using edge samples (10 last sample points of the transect)

- 68.8 ± 0.05 % of good classification (Accuracy)

Assignation of every sample points (numerical values between 1 & 7) coupled with a denoising and smoothing procedure (Loess α = 0.10):



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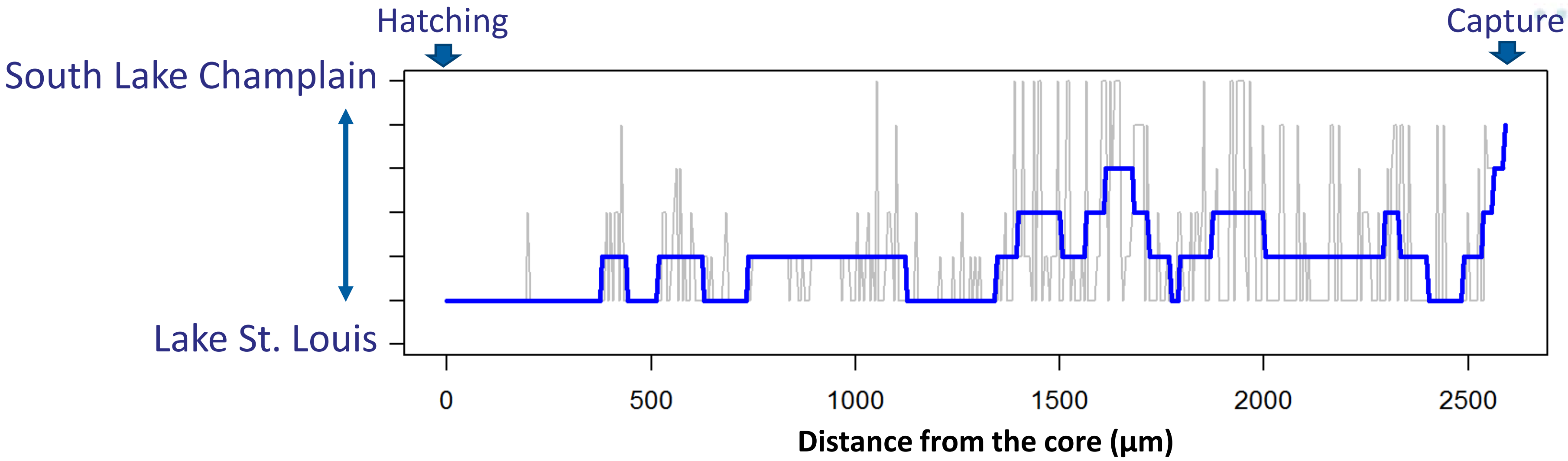
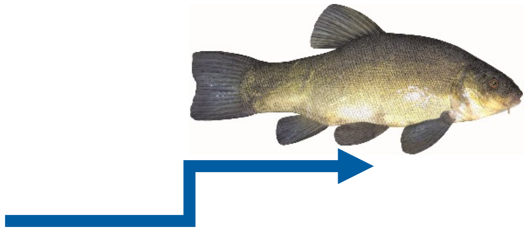
Migration reconstruction and metrics

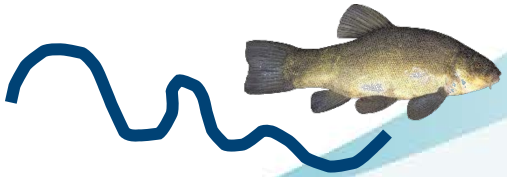


Otolith core assignation – most probable hatching site

Avg. Migration direction – lifetime movement in the gradient



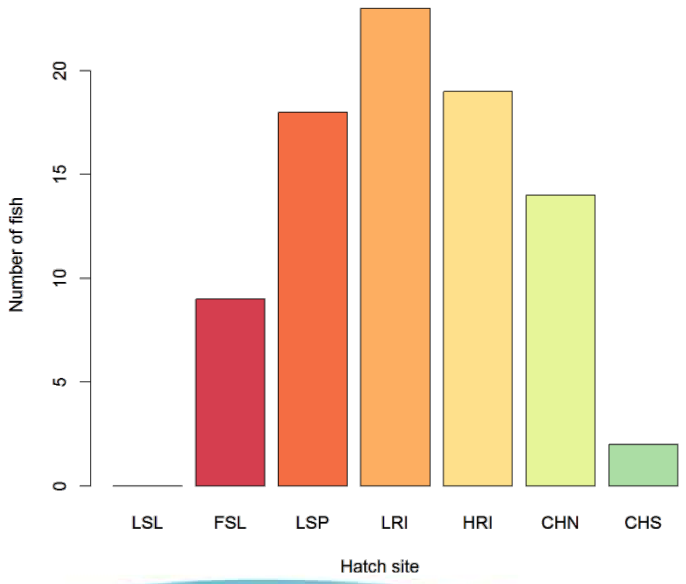
Migration variability – Magnitude of movements between sites



Reproduction and recruitment

Recruitment is mostly coming from Richelieu River and Lake Saint-Pierre

Local captures (captured at hatching site) were marginal (10.6%) compared to West expansion (Lake Saint-Louis [47.1%]) and South expansion (Lake Champlain [42.3%]).



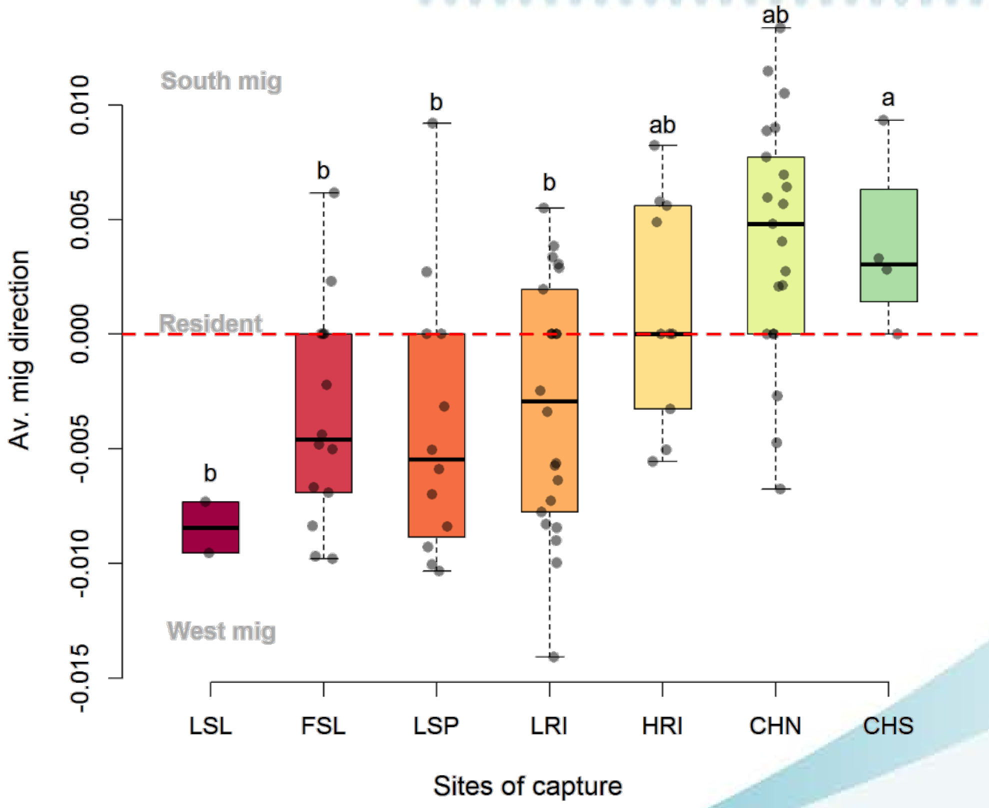
	Hatching site (core elemental fingerprints)						
Capture sites	LSL	FSL	LSP	LRI	HRI	CHN	CHS
Lake St. Louis	**0**	0	0	1	1	0	0
St. Lawrence River	0	**1**	5	5	1	2	0
Lake St. Pierre	0	0	**1**	2	6	3	0
Lower Richelieu	0	0	4	**4**	6	7	1
Upper Richelieu	0	3	2	4	**1**	0	0
North Lake Champlain	0	5	6	6	3	**1**	0
South Lake Champlain	0	0	0	1	1	1	**1**

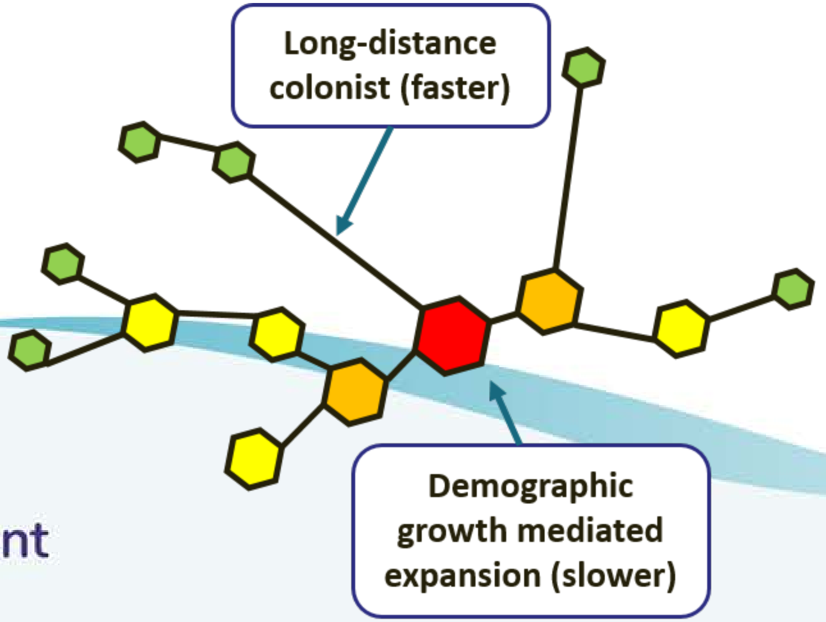
Local capture
West expansion
South expansion

Migratory direction at capture sites

A significant difference in the most common migratory direction by capture sites.

- Extremities of distribution are made of migrants.
- Populations are more mixed in the intermediate sites and residents are highly common in the distribution "core" (High Richelieu River).

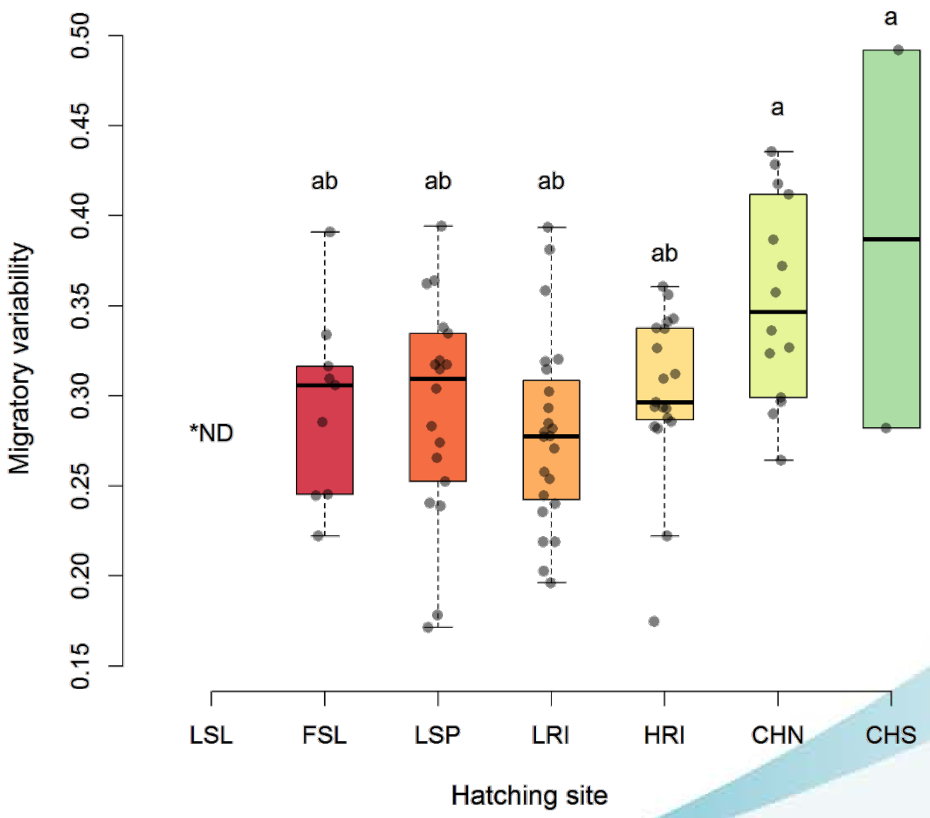


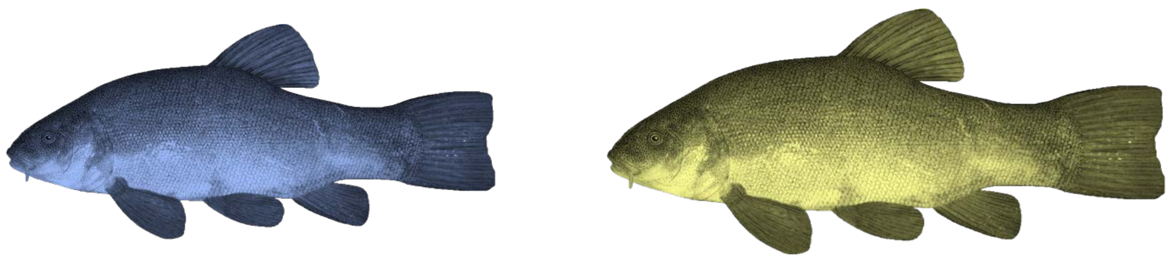


Influence of hatching site on migratory behavior

A significant influence of hatching site on the magnitude of migratory behaviour (num. of habitat changes).

Tench born in the extremities of the distribution are showing a higher tendency for migration, more frequent movements and, as shown by other analyses, of longer distances.





Intra-specific life-history variation during the invasion process (Cerwenka et al. 2017, Gutowsky & Fox 2012).

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What does it mean for management?

Provide a better understanding on the invasion status and process (2 expansion processes).

Improving perceptions of tench movement/swimming capacities, and their potential risk of further expansion.

Those results are providing insights on a potential removal strategy for tench and geographical.

Illinois DRN

Removal in *core* of the distribution

- High density
- Efficient
- Controlling further expansion?

Removal in *extremities* of the distribution

- Low density
- Resource-intensive
- Controlling further expansion

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What otolith chemistry could provide us?

Otolith chemistry appears to be a suitable tool for a posteriori assessment of fish invasion dynamics. Proposed framework is advantageous because:

- Random Forest is flexible modelling tool (number of fish, habitats);
- Provide information when others techniques can't (i.e. genetics).

But some considerations are important to take in account!

- Data acquisitions could remain a challenge for some agencies.
- Trace elements precipitation in biogenic carbonate is a complex phenomenon that remain to be better understood and quantified.
- *A machine learning classification model could only operate in the limits of provided information in building steps.*

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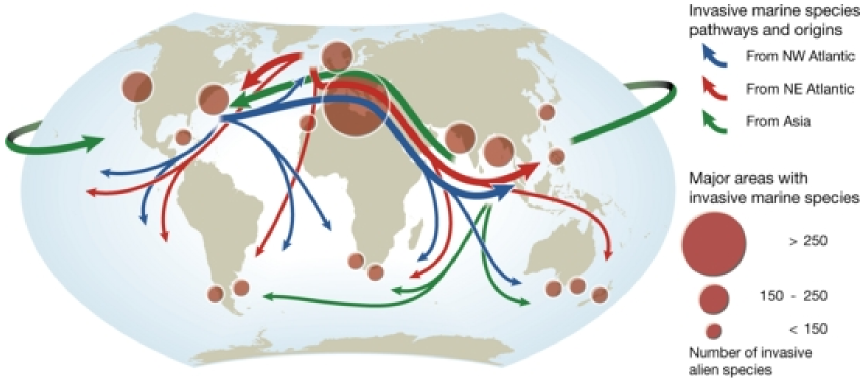
Future directions?

Otolith chemistry could provide tool in others fields, owing some developments and innovations, related to AIS management in the near future.



Pathways analysis

Risk and Impact assessments

Wildlife forensics

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Pêches et Océans Canada

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