Modeling the transfer of organically bound tritium (OBT) through marine food chains

Jennifer Olfert (Project Lead) & Lars Brinkmann (Technical Lead)

Background and Objectives

- Tritiated water (HTO) released to the environment is a significant risk factor when it enters food webs in the form of organically bound tritium (OBT).
- In ecosystems, the transfer of OBT is expected to follow the transfer of key elements in bioenergetics metabolism: carbon (C) and nitrogen (N).
- Carbon and nitrogen stable isotopes track the flow of energy through ecosystems, and have been used extensively to understand trophic relationships in complex marine and freshwater food webs.
- Relationships between carbon and nitrogen stable isotope ratios and OBT have never been explored for their potential value in developing mechanistic models for the transfer of tritium through food webs.
- Risk models for marine ecosystems require an integration of both plume dispersion and ecological factors, such as food web structure and animal life cycles.
- **Project Objective**: To develop a radiological risk model for OBT by integrating ocean circulation and food web models for the Bay of Fundy near Point Lepreau.

- This is a 3-year project, currently in its first year
- Stakeholders: CNSC (primary), DFO
- Anticipated collaboration with DFO for FY 2020

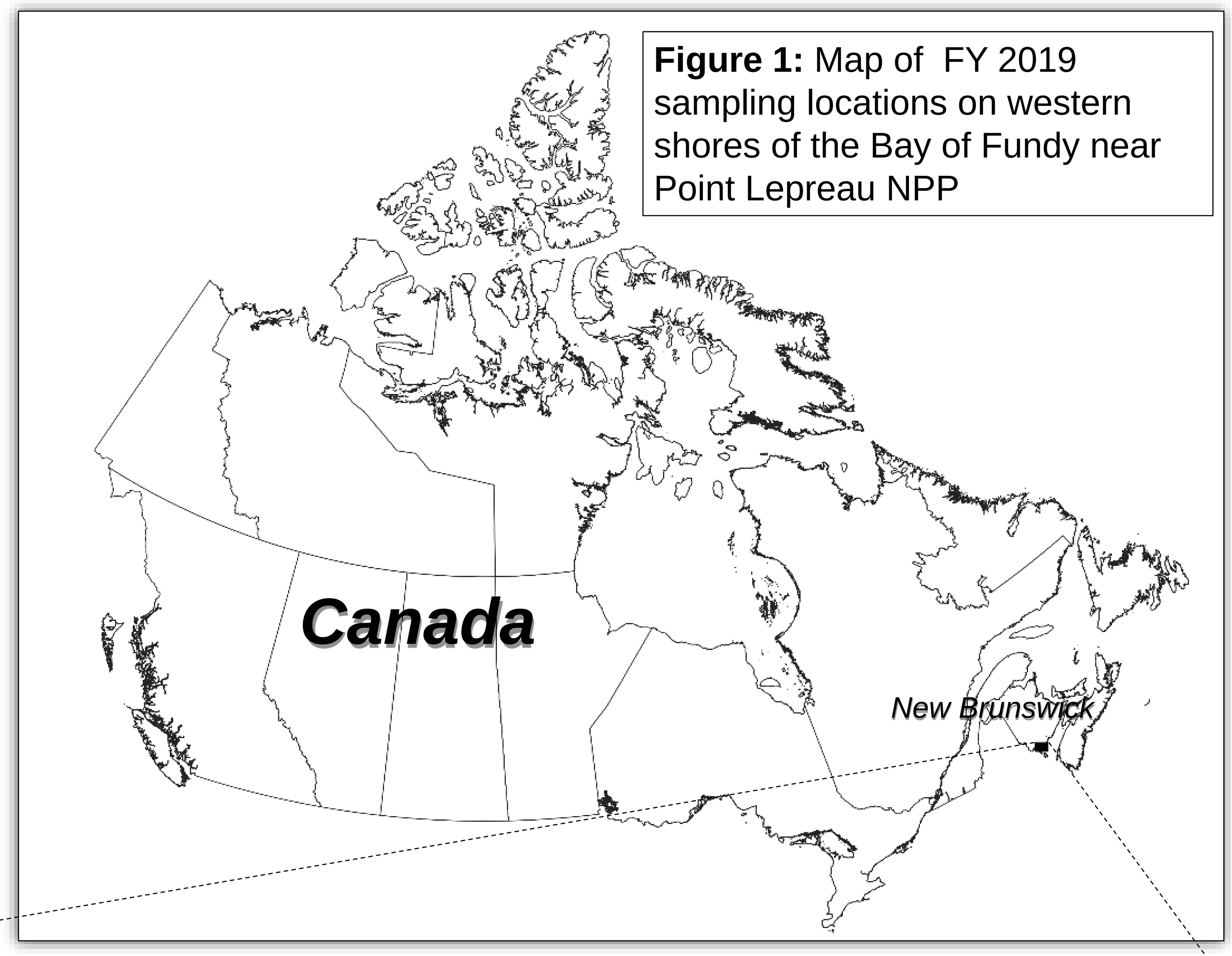
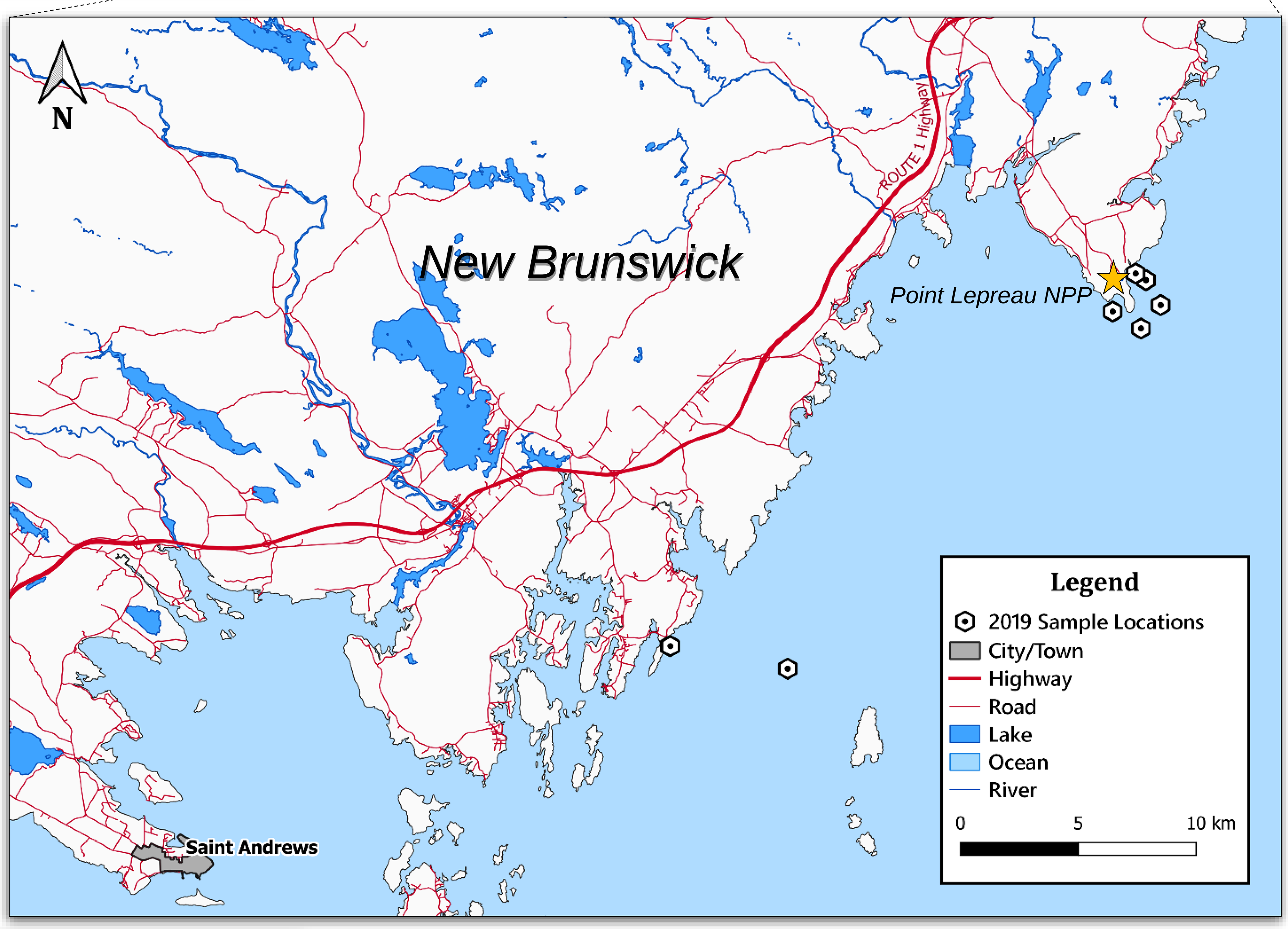


Figure 1: Map of FY 2019 sampling locations on western shores of the Bay of Fundy near Point Lepreau NPP



- In FY 2019, we conducted the first field sampling campaign for this project (Figure 1, Table 1).
- Initial sample processing for stable isotope analysis has begun.
- Sample processing for HTO and OBT analyses depends on progress with method improvements to control HTO background levels.
- Future work will encompass sampling to fill data gaps; anticipated collaboration with DFO.
- Potential engagement of expert ocean circulation modeller (post doc).

Table 1: Sampling sites and samples collected during the summer 2019 field campaign

Sampling site	Samples collected in 2019
Beaver Harbour NB	Fish: Mackerel, red hake, silver hake, sculpin Crustacea: American lobster, rock crabs Water samples (9m, 18m, 27m) Sediment
Pocologan NB	Crustacea: *Gammarus*, european green crabs Molluscs: Clams, whelks, periwinkles Algae: Brown algae
Sealey's Cove, NB	Fish: Winter flounders Molluscs: Blue mussels Algae: Kelp Echinoderms: Green sea urchins
Dipper Harbour	Crustacea: Mysis, *Gammarus* Molluscs: Clams, blue mussels, Periwinkles Algae: Kelp, brown algae Water samples (9m, 18m, 27m), 4 locations around Point Lepreau NPP Sediment

Modeling a complex food web using stable isotope analysis (Figure 2)

- **Carbon** isotopes have signatures characteristic of carbon sources at the base of the food web, and distinguish prey sources along onshore-offshore gradients and benthic versus pelagic organisms.
- Heavy **nitrogen** isotopes become enriched in successive consumer levels and reveal organisms' trophic positions.
- In combination with data from stomach contents analysis, mixing models using C and N stable isotope signatures can provide quantitative estimates of trophic interactions in complex food webs.
- **The trophic structure of food webs may influence the transfer of organically bound tritium and other contaminants.**

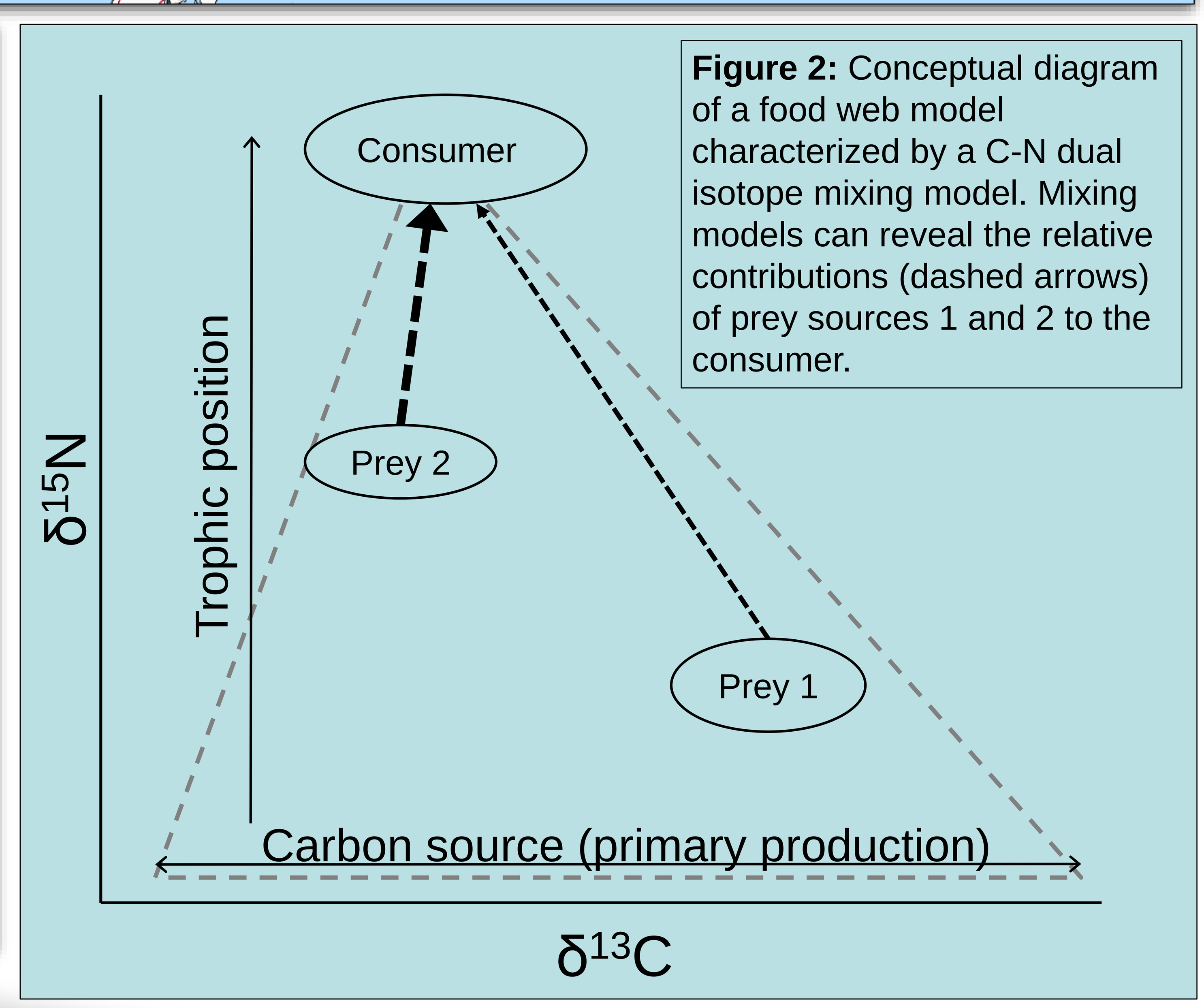


Figure 2: Conceptual diagram of a food web model characterized by a C-N dual isotope mixing model. Mixing models can reveal the relative contributions (dashed arrows) of prey sources 1 and 2 to the consumer.