Ecological Dynamics Under Temporal Variation
Dynamique écologique soumise à des variations temporelles
(Org: **Frithjof Lutscher** (Ottawa) and/et **Rebecca C. Tyson** (British Columbia))

MATT CALDER, University of Western Ontario
Net Reproductive Number for a Matrix Population Model with Dispersion and an Application to Neogobius Melanostomus

The round goby fish, *Neogobius melanostomus*, is an invasive species that was first detected in St. Clair River in 1990, was present in all of the Great Lakes by 2000, and has led to the decline or displacement of many native species such as the mottled sculpin, sturgeon, and trout. In this talk, I will present a general matrix population model that includes dispersion which is applicable to the round goby. Moreover, I will derive the global net reproductive number and relate it to the global growth rate, the local net reproductive numbers, and the local growth rates. Numerical results involving the round goby will be provided and these results should lead to practical control strategies.

HERMANN EBERL, University of Guelph
The role of spatial effects for temporally varying biofilm control strategies

Bacterial biofilms are microbial depositions on immersed biotic or abiotic interfaces. They have been characterised both as spatially structured microbial populations and as continuum mechanical objects. Recently we showed that both points of view lead to strongly degenerate cross-diffusion models. In this talk we investigate the response of a biofilm to temproally varying disinfection strategies, and the role of spatial effects in this process.

FRÉDÉRIC GUICHARD, McGill University
Marine reserve networks for non-equilibrium metacommunities

Changes in fishing practices have promoted the depletion of commercial stocks around the world and caused significant damage to marine habitats. Recent empirical studies have shown that marine reserves can play an important role in reversing these harmful effects. Equilibrium metapopulation models predict that networks of marine reserves can provide similar benefits so long as individual reserves are sufficiently large to achieve self-sustainability, or spaced based on the extent of dispersal of the target species in order to maintain connectivity between reserves. However, these guidelines have not been tested in non-equilibrium models that exhibit spatial and temporal variability typically seen in natural marine communities. Using a spatially-explicit predator-prey model whose predictions have been validated in a marine system, we show that current guidelines are not optimal for trophic metacommunities. In equilibrium metacommunities, there is a community-level tradeoff for designing effective reserves: networks whose size and spacing are smaller than the extent of dispersal maximize global predator abundance but minimize global prey abundance because of trophic cascades, whereas the converse is true for reserve networks whose size and spacing are larger than the extent of dispersal. In non-equilibrium metacommunities, reserves whose size and spacing match the extent of spatial autocorrelation in adult abundance escape this community-level tradeoff by maximizing global abundance and persistence of both the prey and the predator. These results suggest that using the extent of adult patchiness instead of the extent of larval dispersal as the size and spacing of reserve networks is critical for designing management strategies.

QIHUA HUANG, University of Alberta
Mathematical Risk Assessment of Contaminants on Fish Population Dynamics

We formulate a basic toxin-dependent population model by introducing a dose-dependent mortality rate function. We analyze positive invariant region and stability of boundary and interior steady states. The model is connected to experimental data via model parametrization. In particular, we investigate the effect of mercury on the persistence and likelihood of extinction of a small native rainbow trout (*Oncorhynchus mykiss*) population.

FRITHJOF LUTSCHER, University of Ottawa
Modeling seasonal behavior change and disease transmission in wildlife

Behavior and habitat of wildlife change seasonally according to environmental conditions. Since transmission of infectious diseases among wildlife depends strongly on social behavior, mechanisms of disease transmission could also change seasonally. A specific consideration in this regard is whether disease transmission is frequency-dependent or density-dependent. We argue that seasonal behavior changes could lead to a seasonal shift between density and frequency dependence. We explore the effects of such a change in disease transmission via a two-season model for Chronic Wasting Disease in wild ungulates. We derive a system of impulsive differential equations and determine the basic reproduction number for our model. We parameterize the model from published CWD data and perform a sensitivity analysis by Latin Hypercube sampling. We discuss how effective culling could be to slow the spread of the disease.

GUNOG SEO, Ryerson University
Effect of Temporal Variability on Persistence Conditions in Rivers

Most recent modeling approaches assume that flow speed of the river is constant. In reality, however, flow speeds in rivers vary significantly on various temporal scales due to seasonality, weather conditions, or human generated disturbance. In this talk, I present persistence conditions by deriving the upstream invasion speed in simple reaction-advection-diffusion (single-compartment and two-compartment) models with coefficients chosen to be periodic step functions. The key idea to derive the minimum traveling wave speed is to take the exponential transform to obtain a moment generating function. In a temporally periodic environment, the averages of each coefficient function determine the minimal propagation speeds for a single-compartment model. For a two-compartment model, the temporal variability can promote population persistence in rivers when average conditions would lead to washout.

REBECCA TYSON, University of British Columbia Okanagan
How seasonality, behavior and climate affect predator-prey cycles

Predator-prey interactions can generate cyclic population dynamics in temporally constant environments. Seasonal environmental variation can affect such cycles via organisms' behavioral adaptation to external constraints. Seasonal forcing is particularly strong in northern climates, and northern latitudes are also predicted to experience more significant climatic change than any other area on the globe. How these ecosystems respond to the expected changes is of central importance to our management of these areas. Previous modelling work on this topic has limited descriptions of seasonal forcing to a sinusoidal variation in parameters. We argue that some organisms display a more fundamental mechanistic shift in behaviour from one season to another, and that a different model structure is needed to explore the resulting dynamic regime shifts. We show how seasonal forcing and climate change impact the dynamics of these populations in a simple two-season environment.

JAMES WATMOUGH, University of New Brunswick
Modelling the spread of aquatic invasives in tidal currents with both drift and maturation delay.

The Vase Tunicate (*Ciona Intestinalis*) is a nuisance species troubling Mussell farmers in Prince Edward Island, Canada. The life-cycle of the tunicate consists of a drifting larval stage, followed by settlement and a long maturation delay before the reproductive stage. Suitable habitat for settlement is patchy, and the drift is due to tidal currents. In this talk we present some results for a partial differential equation model including a maturation delay for the spread of the tunicate. This is joint work with Lisa Kanary and Andrea Locke.

XIAOQIANG ZHAO, Memorial University of Newfoundland
A Reaction-Diffusion Lyme Disease Model with Seasonality

In this talk, I will report our recent research on a reaction-diffusion Lyme disease model with seasonality. In the case of a bounded habitat, we obtain a threshold result on the global stability of either disease-free or endemic periodic solution. In the

case of an unbounded habitat, we establish the existence of the disease spreading speed and its coincidence with the minimal wave speed for time-periodic traveling wave solutions. We also estimate parameter values via some published data, and use them to study the Lyme disease transmission in Port Dove, Ontario. Our numerical simulations are well consistent with the obtained analytic results. This talk is based on my joint work with Yuxiang Zhang.

HUAIPING ZHU, York University

Modeling of Mosquito Abundance and West Nile Virus Risk Using Weather and Environment Conditions

In this talk, I will present modeling studies of mosquito abundance and West Nile virus risk considering weather and environmental conditions. The surveillance data from Region of Peel, Ontario will be used to estimate the parameters in both of the statistical and dynamical models. I will then present the tools and practice in collaboration with Region of Peel and Public Health Agency of Canada on forecasting the mosquito abundance and West Nile risk in the region.