Proposed Invited Mini-Symposium for CMPD5 May 19-24, 2019

Proposed (organized) by H. T. Banks

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Title: Parameter Estimation in Population Models

Brief Synopsis: All four talks concern the proper identification of appropriate parameters in describing population models (cells, insects, plants, pests) in science and their use in computational modeling and simulation. Discussions include patient care in cancer treatments, models of poorly understand population declines, heterogeneous habitats and their profound effects on the growth, movement, reproduction, and mortality of resident plants and animals.

Confirmed Speakers:

Annabel Meade, NCSU, Raleigh, NC aemeade@ncsu.edu

Celia Schacht, NCSU, Raleigh, NC cmschach@ncsu.edu

John Banks, Cal State-Monterey Bay, CA jebanks@csumb.edu

Heiko Enderling, H. Lee Moffitt Cancer Center, Tampa, FL heiko.enderling@moffitt.org

Titles and Abstracts:

Annabel Meade

Title: Population Model for the Decline of *Homalodisca vitripennis* (Hemiptera: Cicadellidae) Over a Ten-year Period

Abstract: The glassy-winged sharpshooter, *Homalodisca vitripennis*, is an invasive pest which presents a major economic threat to the grape industries in California by spreading a disease-causing bacteria, *Xylella fastidiosa*. We create a time and temperature dependent mathematical model to analyze aggregate data from a 10-year study consisting of biweekly monitoring of *H. vitripennis* population on unsprayed citrus, during which *H. vitripennis* decreased significantly.

The model was fit to the data using iterative reweighted weighted least squares (IRWLS) with assumed probability distributions for certain parameter values. Results indicate that the *H. vitripennis* model fits the phenological and temperature data reasonably well, but the observed population decrease may possibly be attributed to factors other than the abiotic effect of temperature such as parasitism of *H. vitripennis* eggs by the mymarid parasitoid *Cosmocomoidea ashmeadi*.

Celia Schacht

Title: A Mathematical Model to Determine T-cell Behavior with Cancer Chimeric Antigen Receptor (CAR) Therapies

Abstract: Chimeric antigen receptor therapy, or CAR T therapy, utilizes the body's immune system to fight cancer by genetically modifying T-cells to recognize cancerous cells. We investigate three different types of CAR T therapy (CAR T therapy alone, CAR T therapy with added CXCR1 chemokine receptors, and CAR T therapy with added CXCR2 chemokine receptors) by modeling the flow of T-cells in the tumor, blood, and spleen of a cancerous body with a set of ordinary differential equations that utilize laws of mass balance. Each type of CAR T therapy has a different effect on antigen recognition, so we focus on the parameter which alters the flow of T-cells between the blood and tumor. Our goal is to fit our model to aggregate and sparse data collected from mice at the Moffitt Cancer Center using iterative least squares inverse problems and to inform future data collection using optimal design.

John Banks

Title: Effects of Field Spatial Scale and Predator Colonization Behavior on Pest Suppression in an Agroecosystem: A Modelling Approach

Abstract: Ecological field studies and theory over the past several decades have demonstrated that the spatial scale at which heterogeneous habitats are deployed can have a profound effect on the growth, movement, reproduction, and mortality of resident plants and animals. Increasing evidence from studies in agroecosystems, however, has revealed that landscape complexity affects different organisms in different ways. Very little is known about the underlying mechanisms driving such differences in species responses, creating challenges for determining how best to manage landscapes in order to maximize environmental services such as biological control/pest suppression. Diversifying agroecosystems by establishing or retaining natural vegetation in and around crop areas has long been recognized as a potentially effective means of bolstering pest control by attracting more numerous and diverse natural enemies, though outcomes are not consistent. We address here gaps in our understanding of the link between non-crop vegetation in field margins and pest suppression by using a system of partial differential equations, which include population-level predator-prey interactions as well as spatial processes, to capture the dynamics of crop plants, herbivores, and two generalist predators. We focus on differences in how these two predators (a carabid and a ladybird beetle) colonize crop fields where they forage for prey, examining differences in how they move into the fields from adjacent vegetation as a potential driver of differences in overall pest suppression. Furthermore, we examine how differences in colonization behavior may interact with spatial scale in determining the ability of predators to suppress prey in diversified agroecosystems. We show that predator colonization behavior and spatial scale are important factors in determining pest suppression, and discuss the implications of our results in terms of habitat management for biological control in agroecosystems.

Heiko Enderling

Title: Population Carrying Capacity as Patient-specific Biomarker for Cancer Radiotherapy

Abstract: In current clinical practice, radiation dose and dose fractionation are based on average clinical outcome data from large dose-escalation clinical trials, resulting in a "one size fits all" approach. In current radiation oncology, there exists no explanation for why two patients with similar clinical stage and molecular profile would have different responses and outcomes. Reliable biomarkers and frameworks are direly needed to predict RT responses to personalize dose and fractionation based on individual tumor features. We propose the tumor volume carrying capacity in a classic logistic growth model to be patient-specific. We train the growth and treatment response parameters from data in training sets, and use the model to simulate untreated and treated tumor growth to predict response to radiotherapy in independent patient cohorts. This model can help stratify patients into different radiation protocols in an accruing clinical trial to improve response and ultimately treatment outcomes for cancer patients.