GRADUATE AND POSTDOCTORAL STUDIES

McGILL UNIVERSITY

FINAL ORAL EXAMINATION
FOR THE DEGREE OF
DOCTOR OF PHILOSOPHY

OF

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DEPARTMENT OF NATURAL RESOURCE SCIENCE
DENSITY DEPENDENCE AND DISPERSAL MECHANISMS IN A POND BREEDING AMPHIBIAN

October 11th, 2017
1:15 PM

Raymond Building, R3-037
McGill University, Macdonald Campus

COMMITTEE:
Dr. Stan Kubow (Pro-Dean) (School of Human Nutrition)
Dr. Benoit Cote (Chair) (Natural Resource Science)
Dr. David M. Green (Supervisor) (Redpath Museum)
Dr. Anna Hargreaves (Internal Examiner) (Biology Department)
Dr. Jessica Head (Internal Member) (Natural Resource Science)
Dr. Andrew Hendry (External Member) (Redpath Museum)

Dr. Josephine Nalbantoglu, Dean of Graduate and Postdoctoral Studies
Members of the Faculty and Graduate Students
are invited to attend

ABSTRACT

Dispersal is ultimately a process by which populations exchange genetic material, escape unfavorable conditions, and rescue each other from local extinction. Due to its apparent impact on behaviour and physical condition of individuals, a major contributing factor to their probability of dispersal is the level of density-dependence. This phenomenon may affect organisms at multiple life stages, so the ultimate effect of density may not become apparent until the life stage where dispersal occurs. Therefore, the effect of tadpole density on the growth, survival and behaviour of individuals over multiple life stages was examined to determine if their dispersal is ultimately impacted, in an isolated population of Fowler's toads, *Anaxyrus fowleri*.

By raising tadpoles at eight density levels, I was able to show strong negative correlations between density and tadpole growth rate, size at metamorphosis, as well as a delayed timing to metamorphosis. The behaviour, or activity level, of tadpoles showed to increase with density as a response to increased competitive behaviour, but activity level declined with density when examining the same groups at the next life stage, called toadlet. This suggested that tadpole density may negatively impact individual competitiveness at later life stages, as a carryover effect.

Next, I examined individual jumping ability, or endurance at the toadlet stage, and did not find a strong relationship with density. However, there was a significant positive relationship with body size, suggesting that tadpole density may only effect endurance secondarily at this life stage since body size is still density-dependent. Interestingly, these tested endurance levels did not reflect a better dispersal ability when those individuals were released into their natural habitat. Rather, having an intermediate body size better predicted dispersal and movement rates. This interesting result may suggest that body size plays an important role in amphibian dispersal decisions, where very large and thus competitive individuals choose to remain local since the environment proved to be good for their growth and development up to this point. Conversely, very small individuals choose to remain local because they are physically not able effectively move throughout the environment.

Finally, I used the information gathered for size-dependent dispersal probabilities, and calculated the populations density-dependent dispersal rates using historical data, to inform model

simulations to predict the extinction risk of this Fowler's toad population. I discovered that this population has a quadratic relationship between dispersal probability and population density, where very low and very high densities coincided with the highest dispersal rates. Additionally, I was able to predict a low extinction risk for the population if carrying capacity was kept at a minimum of 16 toads, however if continuous habitat management, which translates into continuous habitat disturbances, were to be employed on a short 7-year cycle, extinction risk could be as high as 78%.

Human activities, including fragmentation and restoration, continue to impact the animals living in the surrounding environment. As dispersal is a key process that can save many populations from local extinctions it is important to understand how movement is restricted on a species-specific level. My thesis provides a detailed examination of density-dependence and movement capabilities across multiple life stages in a pond breeding amphibian and advances our understanding of how density itself can impact dispersal under different mechanisms.

CURRICULUM VITAE

UNIVERSITY EDUCATION

B.Sc. (Hon) 2008, University of Guelph
M.Sc. 2010, Laurentian University
PhD 2017, McGill University – in progress

EMPLOYMENT

- Field Technician, 2004-2010, Ontario Ministry of Natural Resources and Fisheries (OMNRF)
- Habitat Stewardship Technician, 2010-2011, Land Care Niagara
- Species at Risk Biologist, 8-month contract in 2011, (OMNRF)

AWARDS

Delise Allison Travel Award (2013)
Canadian Herpetological Society Student Award (2014)
Niagara Peninsula Conservation Authority Excellence Award

PUBLICATIONS

Yagi, K.T. and D.M. Green. 2017. Post-metamorphic carry-over effects in a complex life history: behaviour and growth at two life stages in an amphibian, *Anaxyrus fowleri*. *In Review at Copeia.*

Yagi, K.T. and D.M. Green. 2017. Performance and Movement in Relation to Post-Metamorphic Body size in a Pond-breeding Amphibian. *In Press at Journal of Herpetology*.

Yagi, K.T. and D.M. Green. 2016. Mechanisms of density-dependent growth and survival in Fowler's toads, (*Bufo*) *Anaxyrus fowleri*: volume vs. abundance. Copeia 104(4):942-951.

Yagi, K. and J. Litzgus. 2013. Thermoregulation and Behavior of Spotted Turtles (*Clemmys guttata*) in a beaver-flooded bog in Southern Ontario, Canada. Journal of Thermal Biology 38(5): 205-213.

Yagi, K. and J. Litzgus. 2012. The Effects of Flooding on the Spatial Ecology of Spotted Turtles (*Clemmys guttata*) in a Partially Mined Peatland. Copeia 2012(2):179-190.