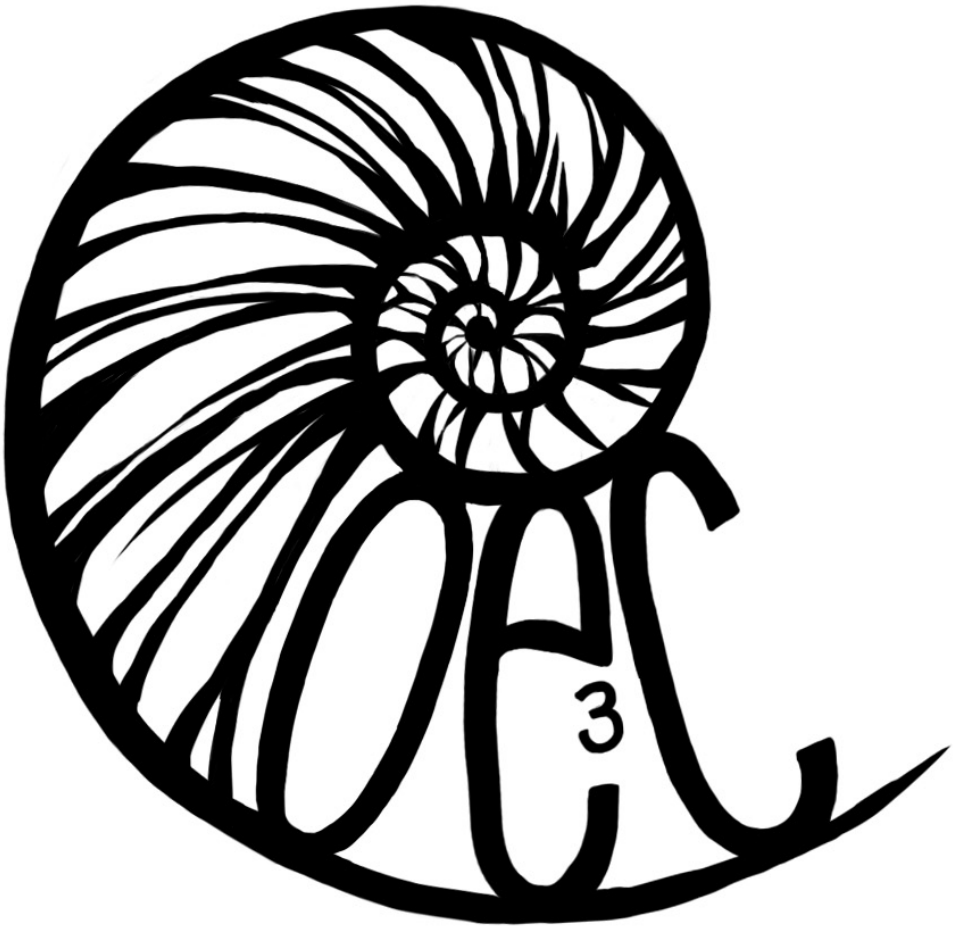

Ontario Ecology, Ethology and Evolution Colloquium

May 2-4, 2013
Western University

General Information

Conference Proceedings

Introduction and Welcome

We wish to extend a warm welcome to the 43rd Ontario Ecology, Ethology and Evolution Colloquium!

The Oe^{3}C is a conference that is constantly evolving. In fact, it was only within the last 3 years that the third E was added – *Evolution*. Western's Department of Biology last hosted Oe^{3}C in 2007, but as the scope of the conference has expanded, so has the base that supports it. Therefore, this year's conference is co-hosted by the graduate students of Western's Biology and Psychology departments.

We are excited to welcome presentations from the undergraduate to the faculty level. We have four plenaries scheduled that showcase recent and exciting findings within the fields of ecology, ethology and evolution. In addition, we have over 95 contributed talks and posters from Ontario and beyond that will cover such diverse topics as communication, genetics, sexual reproduction, environmental plasticity, conservation and restoration, social interactions and behavioural neuroscience. And don't worry - we will have lots of coffee available to help you keep pace!

For many young researchers, Oe^{3}C is their first academic meeting. And for the more experienced researcher, it is a place to meet up with old friends to share new ideas. We strive to make this meeting a collaborative environment where research and ideas can be discussed freely among all our participants. We hope you find the atmosphere at Oe^{3}C to be friendly, constructive, and that this will serve as a platform to further the research interests of Ontario's biologists, psychologists and neuroscientists.

Welcome to Western and Oe^{3}C 2013!

Scott Colborne & Tara Farrell
Co-chairs of the Oe^{3}C 2013

2013 Organizing Committee

This year's conference would not have been possible without the hard work and dedication from the following members of the Departments of Biology and Psychology at Western:

Chris Austin

Scott Colborne

Tara Farrell

Mélanie Guigueno

Aimee Lee Houde

Chelsea Kirk

Krista MacPherson

Neil McMillan

Jenn McPhee

Caroline Strang

Information for Presenters

Oral Presentations

Please report to your scheduled room in the Valley Wing of Huron College 15 minutes *before* your session begins so a moderator can help you load your presentation onto the audio-visual equipment. You will not be allowed to present from your own computer and all presentations must be loaded prior to the beginning of the session. ***All presenters should bring their presentations saved as a PowerPoint .ppt file (not .pptx or any other format) to avoid compatibility issues.*** Oral presentations are 15 minutes maximum (12 minutes + 3 minutes for questions). Moderators in your session will signal to you at 10 minutes, and will ask you to wrap up at 14 minutes. At 15 minutes the next presentation will be loaded and begin immediately.

Please be prompt and respectful to help us stay on schedule!

Poster Presentations

Poster boards will be set up in the Kingsmill Room in the West Wing of Huron College by lunchtime on Friday, May 3. Please feel free to hang your poster any after 1pm with the materials provided. ***Posters are portrait orientation. Please ensure your poster is no more than 4ft tall by 3 ft wide.*** Light food and drinks will be served during the poster session. Be sure to remove your poster after the session is over. Posters unclaimed by the end of the conference will be discarded.

Student Awards

Thanks to generous donations by the Psychology Graduate Student Association, Members of the Biology Department and other private donors, we will be distributing student awards for presentations. Awards will be given for best graduate student talk, best graduate student poster, best undergraduate talk and best undergraduate poster.

Registration, Meals, & Parking

Registration

Registration will be open Thursday from 5:30 to 7:00pm in the Huron Dinning Hall.

Registration on Friday and Saturday will be open an hour before the first scheduled talks of the day and during the coffee breaks outside room V214 in the Valley Wing.

Registration at the conference includes snack foods at the opening registration reception on Thursday evening and poster session, coffee breaks, and lunches on Friday and Saturday. In addition, two drink tickets will be available for use at either the opening registration or the poster session.

We have done our best to accommodate food requests for vegetarians and vegans. We ask that if you did not select vegetarian/vegan on your registration form that you refrain from eating these lunch options.

Parking

Parking is available on the Huron campus. Please see the map provided for directions.

Thursday evening and Saturday: Parking is free*. Drive past the gate and park in lot B. *Ensure you park past the gate and not at the metered parking beside the gate otherwise you may receive a ticket.

Friday: Parking is $10. Please have cash available for the gate attendant.

Acknowledgments

As the Oe3C has no society to fund the conference, many generous sponsors have donated funds to make this year's conference possible. We would like to extend a hearty thank you to those who contributed financial and product donations.

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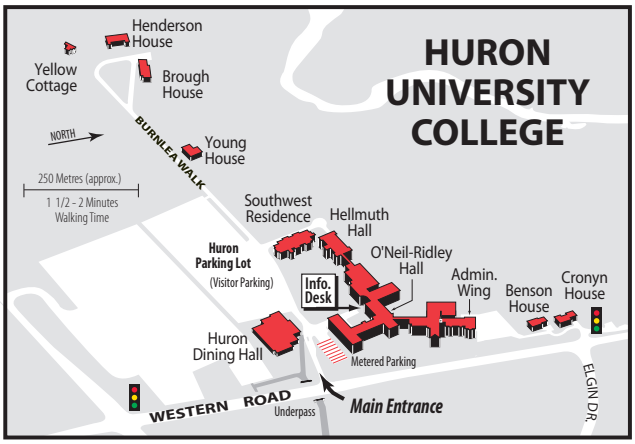
We would also like to acknowledge Pralle Kriengwatana for designing our logo and the organizing committees of Oe^{3}C 2011 and 2012 for start-up funds and guidance.

Finding your way at Huron



HURON
UNIVERSITY COLLEGE at WESTERN

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London, Ontario, Canada, N6G 1H3
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Website: www.huronuc.ca

Schedule at a Glance

Time	Thursday, May 2
5:30	Opening Reception & Registration Huron Dining Hall
7:00	Plenary: Dr. Bryan Neff "The Evolving Nature of Behavioural Ecology: Mating Systems to Genomes" V214

Time	Friday, May 3	
8:00	Registration V214 Hallway	
9:00	Dr. Louis Lefebvre "Feeding Innovation in Birds and their Implications for Ecology, Evolution and Neuroscience" V214	
10:00	Mid-Morning Break V214 Hallway	
10:30	Talk Session 1A "Communication" V208	Talk Session 1B "Invertebrates" V214
12:15	Lunch Southwest Field/Huron Dining Room	
1:30	Talk Session 2A "Genetics" V208	Talk Session 2B "Sexual & Reproductive Processes" V214
3:00	Mid-Afternoon Break V214 Hallway	
3:30	Dr. Merritt Turetsky "Assessing the Resilience of Northern Ecosystems to Changing Climate and Disturbance Regimes" V214	
5:00	Poster Session Kingsmill Room	

Time	Saturday, May 4	
8:00	Registration V214 Hallway	
9:00	Talk Session 3A "Response to Environment Change" V208	Talk Session 3B "Aquatic Ecology" V214
10:15	Mid-Morning Break V214 Hallway	
10:45	Talk Session 4A "Conservation & Restoration" V208	Talk Session 4B "Social Interactions" V214
12:15	Lunch Huron Dining Room	
1:30	Talk Session 5A "Terrestrial Ecology" V208	Talk Session 5B "Behavioural & Cognitive Neuroscience" V214
3:30	Mid-Afternoon Break V214 Hallway	
4:00	Dr. David Sherry "Timing, Anticipation, and Consolidation of Memory in Food-storing Birds" V214	
5:00	Closing Remarks & Student Awards V214	

Plenary Speakers

Dr. Bryan Neff
Department of Biology, Western University

The Evolving Nature of Behavioural Ecology: Mating Systems to Genomes

Dr. Louis Lefebvre
Department of Biology, McGill University

Feeding Innovations in Birds and their Implications for Ecology, Evolution and Neuroscience
Sponsored by the Zoological Education Trust (ZET)

Dr. Merritt Turetsky
Department of Integrative Biology, University of Guelph

Assessing the Resilience of Northern Ecosystems to Changing Climate and Disturbance Regimes

Dr. David F. Sherry
Department of Psychology, Western University

Timing, Anticipation, and Consolidation of Memory in Food-storing Birds

Friday May 3rd – Morning

Time	Talk Session 1A: Communication V208
10:30	The relationship between vocal performance, age, morphology, and song complexity in the song sparrow *(Melospiza melodia).* Drew Moore, Western University
10:45	Clear and present danger: the behavioural response of migratory sea lamprey (*Petromyzon marinus*) to chemosensory alarm cues. István Imre, Algoma University
11:00	Threat assessment: The response of sea lampreys (*Petromyzon marinus*) to repeated exposures of chemosensory alarm cues. Cowan Belanger, Algoma University
11:15	Daytime avoidance of chemosensory alarm cues by sea lamprey (*Petromyzon marinus)*. Richard Di Rocco, Algoma University
11:30	An experimental test of functional reference in avian alarm calls. Leanne Grieves, McMaster University
11:45	The sounds of recession: does voice pitch influence voting preference during economic decline? Michael Barone, McMaster University
12:00	ZENK expression in the song-control system for song and learned calls in the black-capped chickadee (*Poecile atricapillus*). Shannon Mischler, Western University

Time	Talk Session 1B: Invertebrates V214
10:30	If you can't take the pressure, stay out of the bedroom. A direct test of atmospheric pressure shifts on mating success in Drosophila. Christopher Austin, Western University
10:45	Extreme variability in bee abundance and diversity over short and long time periods. Thomas Onuferko, Brock University
11:00	From solitary to eusocial: The reproductive ground plan hypothesis in the primitively eusocial sweat bee. David Awde, Western University
11:15	Specific hunger in fruit fly larvae (*Drosophila melanogaster*). Dr. Sebastian Schwarz, McMaster University
11:30	Habitat use of the eastern tiger ans spicebush swallowtail butterfly species: Testing for positive edge responses in a fragmented landscape. Jenna Siu, Western University
11:45	Effects of pollinators and male density on the reproductive success of the dioecious shrub *Shepherdia canadensis* (Elaeagnaceae). Shang-Yao Peter Lin, Trent University
12:00	Where does selection act Out-of-Africa: Population genomics of the honey bee, *Apis mellifera*. Brock Harpur, York University

Friday May 3rd - Afternoon

Time	Talk Session 2A: Genetics V208
1:30	Effects of long-term experimental manipulation of biotic and abiotic factors on the phylogenetic structure of plant communities. Nash Turley, University of Toronto
1:45	Arbuscular Mycorrhizal Communities in Tallgrass Prairies at Walpole Island,Ontario. Aniruddho Chokroborty-Hoque, Western University
2:00	Five 'exceptional' stories in the Resupinateae. Jennifer McDonald, Western University
2:15	Phylogenetic analysis of the black widow spiders (Latrodectus, Theridiidae, Araneae): a preliminary investigation using mitochondrial and nuclear DNA. Charmaine Condy, University of Toronto
2:30	A candidate gene for behavioural isolation between *Drosophila simulans* and *D. melanogaster* due to female mate preference. Ryan Calhoun, Western University
2:45	The evolution of sociality in cichlid fishes: insights from behaviour and gene expression. Dr. Constance O'Connor, McMaster University

Time	Talk Session 2B: Sexual & Reproductive Processes V214
1:30	Assortative mating and sympatric speciation of pumpkinseed sunfish (*Lepomis gibbosus*). Scott Colborne, Western University
1:45	Identification and characterization of a behavioural isolation gene. Dr. Amanda Moehring, Western University
2:00	Do hybrids of poplar crosses differ in their herbivory damage compared to the parent species? Zoryana Gorin, University of Toronto
2:15	Binding of bisphenol A in the uterus of female rats: implications for wildlife reproduction. Tyler Pollock, McMaster University
2:30	Stress and reproductive failure: steroid dynamics and pregnancy disruption in mice exposed to predators. Joelle Thorpe, McMaster University
2:45	Sexual dimorphism in N content of leaves in *Sagittaria latifolia*: does it explain differences in reproductive costs between the sexes? Veronika Wright, Trent University

Saturday May 4th - Morning

Time	Talk Session 3A: Response to Environment Change V208
9:00	Increasing atmospheric nitrogen deposition: Implications for tallgrass prairie restoration. Jennifer McPhee, Western University
9:15	Interactive effects of soil freezing and nitrogen deposition on nitrogen retention over winter and the following growing season. Mat Vankoughnett, Western University
9:30	Tree seedling establishment in response to warmning and nitrogen deposition. Bryana McWhirter, Western University
9:45	Effects of herbivory, intraspecific genetic variation and rapid evolution in plants on ecosystem processes. Connor Fitzpatrick, University of Toronto Mississauga
10:00	Seed production and germination rates of a hybrid cattail *Typha* × *glauca* and its parent species Sara Pieper, Trent University

Time	Talk Session 3B: Aquatic Ecology V214
9:00	The effect of non-native salmonids on the performance of Atlantic salmon during the juvenile life stage. Aimee Lee Houde, Western University
9:15	Tracking the round goby: How site contamination load influences population characteristics of an established invasive species. Erin McCallum, McMaster University
9:30	The effect of regional dispersal on zooplankton responses to *Dreissena polymopha* invasion. Katrina Furlanetto, Queen's University
9:45	Ecology of behavioral variation: How boldness affects growth, survival, and ontogenetic niche shifts in bluegill sunfish. Melissa Kjelvik, Michigan State University
10:00	Foraging ecomorphology of pumpkinseed sunfish (*Lepomis gibbosus*). Andrienne Berchtold, Western University

Time	Talk Session 4A: Conservation & Restoration V208
10:45	Population distribution of reintroduced elk in Central Ontario. David McGeachy, Laurentian University
11:00	Habitat loss differently affects predators with different hunting modes. April Clyburne-Sherin, University of Guelph
11:15	Evaluation of Range Expansion of Trumpeter Swans (*Cygnus Buccinator*) Re-Introduced Into Southwestern Ontario Sara Handrigan, Western University
11:30	Bee Communities in Restored Landfills of the Niagara Region. Rola Kutby, Brock University
11:45	Predator or prey driven instability with a restored tallgrass prairie. Stefan Schneider, University of Guelph

Time	Talk Session 4B: Social Interactions	V214
10:45	Influence of larvae on food patch choice in fruit flies. Blake Anderson, McMaster University	
11:00	Causes and consequences of social learning in fruit fly larvae. Zachary Durisko, McMaster University	
11:15	Dynamics of social interactions in fruit fly larvae. Rameeshay Mubasher, McMaster University	
11:30	Why copy others? Biasing personal decisions with social information. Shane Golden, McMaster University	
11:45	Comparing resource contests between cichlid fishes that differ in their degree of sociality. Adam Reddon, McMaster University	
12:00	Social brains in context: lesions targeted to the song control system in female cowbirds affect their social network. David White, Wilfrid Laurier University	

Saturday May 4th – Afternoon

Time	Talk Session 5A: Terrestrial Ecology	V208
1:30	Home-field advantage in a host-parasite system. Yanina Sarquis-Adamson, Western University	
1:45	Long-term herbivore exclusion drives plant defense evolution in multiple species. Teresa Didiano, University of Toronto Mississauga	
2:00	Diversity of insect-eating bats as illustrated by bite force and size. Terrence Chang, Western University	
2:15	Initial colonization constraints on foodweb assembly. Eric Harvey, University of Guelph	
2:30	Quantifying “Fatness” - Measures of polar bear body condition in Western Hudson Bay. Luana Sciullo, York University	
2:45	The role of herbivory in limiting the altitudinal range of *Rhinanthus minor* in the Canadian Rocky Mountains. Lindsey Falk, Queen's University	
3:00	A test of whether local genetic stocks yield better restored populations in an endemic Pacific coastal dune plant. John Viengkone, Queen's University	

Time	Talk Session 5B: Behavioral & Cognitive Neuroscience V214
1:30	Pigeons rank-order responding to temporally ordered stimuli. Neil McMillan, Western University
1:45	Memory in an avian brood parasite: Testing the adaptive specialization hypothesis. Mélanie Guigueno, Western University
2:00	Effects of nutritional stress at different developmental periods on song, associative learning, and behavioral flexibility on zebra finches. Buddhamas Pralle Kriengwatana, Western University
2:15	Natural selection on cognitive traits? Individual variation in problem-solving performance and reproductive fitness in wild great tits. Dr. Julie Morand-Ferron, University of Ottawa
2:30	Alloparental care in a solitary bee. Vern Lewis, Brock University
2:45	The link between dopamine and ecologically relevant behaviours in the Trinidadian guppy, Poecilia reticulata. Alex De Serrano, University of Toronto
3:00	Early-life stress in European starlings (*Sturnus vulgaris*) affects body composition and a sex-specific deficit in auditory learning. Amanda Morgan, Western University.
3:15	Interval timing and numerical discrimination in the domestic dog. Krista Macpherson, Western University

Poster Session

#	Friday 5-7pm in Kingsmill Room
1	The behavioural response of larval sea lamprey (*Petromyzon marinus*) to damage-released chemical alarm cues Kerry Perrault, Algoma University
2	Contrasting latitudinal herbivory patterns in *Oenothera biennis* (Onagraceae) Daniel N. Anstett, University of Toronto
3	Evidence of Restricted Pollen Dispersal in Broadleaf Cattails(*Typha latifolia*) Jordan Ahee, Trent University
4	Using comparative methods to investigate welfare issues in captive parrots (Psittaciformes): Preliminary data from species kept as pets Heather McDonald-Kinkaid, University of Guelph
5	Heritability of Spatial Learning in Honeybees Nadejda Tsvetkov, York University
6	Pollinator-mediated selection on corolla tube length in an artificial flower system: Can bumblebees facilitate assortative mating? Felicity J. Ni, University of Toronto
7	The Role of Hippocampal Estrogen Receptor GPER in the Rapid Regulation of Learning and Memory in Female Mice Jennifer Lymer, University of Guelph
8	Variability and inheritance of egg protein in Apis mellifera Tabashir Chowdhury, York University
9	Effects of the D1-type receptors with SCH23390 in the hippocampus on the social transmission of food preferences in male and female mice. Richard Matta, University of Guelph
10	The role of specific estrogen receptors in estrogenic facilitation of social learning Kelsy Ervin, University of Guelph
11	Quantitative Genetic Consequences of Losing Recombination and Segregation in the Evening Primroses (*Oenothera: Onagraceae*) Ryan Godfrey, University of Toronto
12	Low Heritability of Innate Immunity Function in *Apis mellifera* Anna Chernyshova, York University
13	Selective mating and diploid male production in bees Jennifer Albert, York University
14	Demographic consequences of hybridization and selection on an annual weed Zachary Teitel, Ryerson University
15	Spatial variation in the fatty acid composition in polar bear (*Ursus maritimus*) adipose tissue in the Canadian Arctic Melissa Galicia, York University
16	The effects of biotic and abiotic factors on springtail diversity and function Matthew Turnbull, University of Western Ontario
17	A geographical perspective on the research and conservation of Canadian at risk peripheral plant populations Raeya Jackiw, Queen's University
18	Epigenetics of invasive weeds: The contribution of maternal effects to phenotypic plasticity in *Raphanus raphanistrum* Rebecca J. Parker, Ryerson University
19	Forty-two years of forest measurements support the continuation of the carbon sink in Northeastern U.S. forests Kate Eisen, University of Guelph

20	Nectar replenishment in wildflowers of Colorado Elaine Luo, University of Toronto
21	The effect of nutrient deprivation and mating status on excretion in foraging gene variants of *Drosophila melanogaster* Mackenzie Urquhart-Cronish, University of Toronto
22	Effects of diethylhexyl phthalate on blastocyst implantation in inseminated female mice (*Mus musculus*). Evan Borman, McMaster University
23	Selectivity of Young Male Fruit Flies May Contribute to Speciation Carling Baxter, McMaster University
24	Investigating anhedonia in a non-conventional species: are some riding horse depressed? Carole Fureix, University of Guelph
25	Multigenerational Demography of Unexploited Brook Trout (*Salvelinus fontinalis*) in Algonquin Park, Ontario. Erin Brown, Trent University
26	Pollination, floral herbivory & striking variation in the mating system of a coastal dune plant Christopher Eckert, Queen's University
27	Habitat Selection by Eastern Population Tundra Swans, *Cygnus columbianus* Katelyn Weaver, Western University
28	Generosity as a Costly Signal Sara Kafashan, University of Guelph
29	Players gonna play: juvenile rough-and-tumble play enhances adult male sexual performance in American mink Jamie Ahloy Dallaire, University of Guelph
30	Proposed study - Rapid evolution of smoltification traits in anadromous pacific salmon introduced into an adfluvial environment Steve Sharron, University of Western Ontario
31	Nestedness of fish communities in the Black and Hollow River watersheds Georgina Braoudakis, University of Toronto
32	Factors Influencing Autumn and Winter Distributions of Dabbling Ducks in the Atlantic and Mississippi Flyways of North America Lena M. Vanden-Elsen, Western University
33	Impacts of Urban Landscape Features on Bird-Window Collisions in Toronto Marine Cusa, University of Toronto
34	Energetics of Wild Ruby-throated Hummingbirds Lily Hou, University of Toronto
35	Do genomic consequences of the transition to selfing influence extinction risk in *Collinsia* spp.? Adriana Salcedo, University of Toronto
36	The effect of growth on the expression of reproductive tactics in female Kokanee salmon Yelin Xu, Western University
37	Genomic consequences of mating system evolution in a Pacific coastal dune endemic Stephanie Greer, Queen's University

Verbal Presentation Abstracts
(By scheduled session, *Presenter)

Session 1A – Communication

The relationship between vocal performance, age, morphology, and song complexity in the song sparrow (*Melospiza melodia*)

Moore, Drew*; Schmidt, Kim; MacDougall-Shackleton, Scott; MacDougall-Shackleton, Beth

Birdsong, like many mating signals, comprises multiple aspects to which receivers may attend. One such aspect is vocal performance, defined as the ability to perform physically demanding song. Well-studied in species with simple song, vocal performance may encode information about the singer's current condition, more so than more permanent traits such as song repertoire size. Furthermore, the mechanics required to produce difficult broadband trills may be constrained by morphological characters such as bill or body size. We measured maximum vocal performance of free-living male song sparrows (Melospiza melodia), a species known for their complex song. Vocal performance did not vary with age, nor did it appear constrained by bill or body size. Instead, vocal performance was correlated with song complexity, such that better-performing males also had larger song repertoires. Moreover, paternal repertoire size predicted subsequent vocal performance of their sons, even when offspring were raised and tutored under standardized conditions. This suggests that the developmental timing of cognitive ability necessary for song learning, may overlap with that of sensi-motor ability required to produce high-performance songs. If so, vocal performance and song complexity may provide redundant information as to male quality.

Clear and present danger: the behavioural response of migratory sea lamprey (*Petromyzon marinus*) to chemosensory alarm cues

Imre, István*; Di Rocco, Richard; Belanger, Cowan F.; Brown, Grant E.; Johnson, Nicholas S.;

Sea lamprey invaded the upper Great Lakes in the early 20th century and caused extensive economic damage to a variety of native fish populations. We conducted an experimental study to investigate 1) whether sea lamprey show avoidance of injured conspecific, injured heterospecific, and predator cues, and 2) whether this is a general response to injured heterospecific fish or a specific response to injured sea lamprey. Migratory sea lamprey were exposed to the following stimuli: distilled water (control) , extracts prepared from migratory sea lamprey, decayed migratory sea lamprey (conspecific stimuli), sympatric white sucker (*Catostomus commersonii*), exotic sail-fin

catfish (*Pterygoplichthys pardalis*) (heterospecific stimuli), 2-phenylethylamine (PEA), northern water snake (*Nerodia sipedon sipedon*) washing, human saliva (predator cues), and a migratory sea lamprey extract and human saliva combination (injured conspecific and predator cue). Mobile sea lamprey showed a significant avoidance response to all conspecific cues as well as to white sucker, human saliva, PEA and the combination cue. The avoidance response to these stimuli lasted for 20 minutes after a 20 minute exposure. For mobile sea lamprey, the northern water snake cue induced behavior consistent with predator inspection. Consistent with objective (2), the exposure to *P. pardalis* extract induced a weak/delayed avoidance response in mobile sea lamprey. Our findings support the use of natural repellents for the behavioural manipulation of sea lamprey populations.

Threat Assessment: The Response of Sea Lampreys (*Petromyzon marinus*) to Repeated Exposures of Chemosensory Alarm Cues

Belanger, Cowan F.; Di Rocco, Richard; Imre, István; Brown, Grant E. ; Johnson, Nicholas S.

Habituation of aquatic organisms to repeated exposure to chemical alarm cues has been widely studied. This experimental study was conducted to observe whether migratory sea lampreys (*Petromyzon marinus*) habituate to repeated exposure to a variety of known chemosensory alarm cues. These cues included deionized water (control), migratory sea lamprey extract (injured conspecific cue), decayed migratory sea lamprey extract (conspecific necrophobic cue), white sucker (*Catostomus commersonii*) extract (prey guild injured heterospecific cue), sail-fin catfish (*Pterygoplichthys pardalis*) extract (exotic injured heterospecific cue), northern water snake (*Nerodia sipedon sipedon*) washing (predator cue), human saliva (predator cue), phenylethylamine hydrochloride (PEA, a predator cue from mammalian carnivore urine), and a human saliva and sea lamprey extract combination (simultaneous predator and injured conspecific cue). Two experiments were conducted with doubling the level of pre-exposure (4X and 8X) to alarm cues that the subjects received the day prior to the experimental treatments. The sea lampreys did not respond to water snake washing after being pre-exposed only 4 times, whereas they were non-responsive to saliva after 8 pre-exposures. The sail-fin catfish extract treated subjects demonstrated a slight increase in avoidance after the 8X pre-exposure. All other treatments resulted in little to no habituation.

Daytime avoidance of chemosensory alarm cues by sea lamprey (*Petromyzon marinus*)

Di Rocco, Richard*; Belanger, Cowan; Imre, István; Brown, Grant E.; Johnson, Nicholas S.

Many species of fish are known to avoid chemosensory alarm cues as an antipredator adaptation. A recent study demonstrated that sea lamprey (*Petromyzon marinus*) show a strong nocturnal avoidance response when subjected to both injured conspecific cues

and predator cues. We explored the effects of daytime and water temperature on this behavior in two semi-natural laboratory experiments. We predicted that more sea lamprey should be active with increasing water temperature and moving animals should show a stronger avoidance response with increasing temperature. Ten groups of ten migratory sea lamprey per treatment were exposed to one of the following stimuli: distilled water (control); migratory sea lamprey tissue extract, decayed sea lamprey tissue extract (conspecific stimuli); white sucker tissue extract (*Catostomus commersonii*) (heterospecific stimulus); water snake (*Nerodia sipedon sipedon*) washings, 2-phenylethylamine (a compound found in mammalian carnivore urine), and human saliva (predator cues). The two experiments were conducted early and late in the migration season, respectively, to quantify the effect of temperature on avoidance behaviour. As predicted, a higher proportion of animals were active during daytime as water temperature increased. Moving sea lampreys showed a strong avoidance response to migratory sea lamprey extract and 2-phenylethylamine during the late season experiment. Hiding sea lampreys did not avoid any of the stimuli.

An experimental test of functional reference in avian alarm calls

Grieves, Leanne*; Quinn, James; Logue, David

Avian vocal communication is a rich and complex field of study. In the literature the concept of referential communication, that signals can code specific information about the environment, has focused mainly on primates and other mammals. The paucity of research in birds creates an exciting opportunity for study. I conducted two playback experiments to test the prediction that Smooth-billed Anis (*Crotophaga ani*), a highly social cooperatively breeding bird, respond adaptively to two different types of alarm call. Anis responded to playback of aerial alarms by diving and hiding in vegetation and to terrestrial alarms by flying up from the ground to an exposed position. These responses are appropriate to avoid predation by aerial predators like hawks and terrestrial predators such as mongooses, dogs, and cats. Referential signaling may more common in avian vocal communication than previously recognized.

The Sounds of Recession: does voice pitch influence voting preference during economic decline?

Barone, Michael*; Tigue Cara; Feinberg, David

In group-living animals, evolutionary pressures may have provided opportunities for species to develop mechanisms that allow us to evaluate the quality of potential leaders through physical characteristics, such as specific acoustic features found in their voice. Previous research has demonstrated that voters prefer to vote for candidates with lower-pitched voices. Furthermore, candidates with a lower voice pitch than their competitor were selected even more, if the hypothetical election occurred during a time of war than during peace. We investigated whether the increased effects of lower voice pitch on voting behavior during a war scenario would also be stronger during a previously unexamined situational context, economic recession. We found that there

was no significant difference between the preferences for a leader's voice pitch when primed to a recession condition compared to being primed with a control. The implications of these results for voting behavior will be examined and discussed.

ZENK expression in the song-control system for song and learned calls in the black-capped chickadee (*Poecile atricapillus*)

Mischler, Shannon K.*; MacDougall Shackleton, Scott A.

Black-capped chickadees are characterized by the production of highly complex vocalizations used in a variety of contexts. One of these vocalizations is the fee-bee song, which is often produced by males during breeding season. It seems that the song control nuclei are instrumental for the learning, production and maintenance of song in songbirds. These include the brain regions HVC, the robust nucleus of the arcopallium (RA), the dorsomedial nucleus of the midbrain's intercollicular complex (DM), and area X. The volume of these areas does not seem to change seasonally in chickadees, as in other species. The multitude of learned calls produced by the chickadee may be why we do not see the seasonal change in the song control nuclei. Wild black-capped chickadees were caught and were subjected to behavioural manipulations to elicit the *fee-bee song*, gargle, chick-a-dee, and *tseet* calls. Once produced consistently, the birds were euthanized, and brains extracted and processed by immunohistochemistry to examine ZENK expression (used to identify particular areas of the brain that are activated by specific stimuli or behaviours). If the birds show strong expression during learned vocalizations, it would change the interpretation of these nuclei as song control "nuclei" to "vocalization control nuclei", which would stipulate, that these areas are crucial for the learning, production and maintenance of all vocalizations.

Session 1B – Invertebrate

If you can't take the pressure, stay out of the bedroom. A direct test of atmospheric pressure shifts on mating success in *Drosophila*.

Austin, Christopher*; Guglielmo, Christopher; Moehring, Amanda

While much attention has been given to the effect of environmental characteristics such as temperature on the survival of species, many other characteristics have been ignored, such as the effect of pressure on the survival of different organisms. Since changes in weather, indicated by pressure shifts, can be catastrophic for small insects, it would be highly adaptive to be able to sense when a weather shift is approaching and respond appropriately. The cosmopolitan *D. melanogaster* was collected from two sites in Ontario, which are located at different altitudes above sea level. Using a pressurized chamber, flies were treated with pressures corresponding to 600m above sea level overnight, and then flies' mating activity was examined. Then, the pressure was either increased to 300m or decreased to 900m, to simulate a weather front approaching, and then a new batch of flies' mating activity was examined. As predicted, some flies reduced their mating activity when exposed to a change in pressure. But, surprisingly,

some flies also increased their activity, and this effect depended on the strain's native population location and intra-population variation. This indicates that flies are able to anticipate weather patterns and change their behaviour depending on the pressure they experience.

Extreme variability in bee abundance and diversity over short and long time periods

Onuferko, Thomas M.*; León, Cordero, Rodrigo; Richards, Miriam H.

In recent years, there has been growing concern about long-term changes in abundance and diversity of wild bees, but we have yet to understand shorter term, year-to-year changes in bee population dynamics. To address this lack, from 2003-2012, we monitored bee abundance and diversity at control and restored sites in southern Ontario, normalizing collecting effort among sites and years. We found significant variation in abundance and diversity among years, collection sites, and seasons. An overall decline in bee numbers over the course of the study was likely due to restoration effects, as bees were most abundant and diverse within the first several years after barren sites were re-vegetated. In addition, summer droughts appear to considerably depress bee abundance. These results demonstrate that abundance and diversity within a single bee community can be quite variable over short spatial distances and over short and long time periods.

From solitary to eusocial: The reproductive ground plan hypothesis in the primitively eusocial sweat bee.

Awde, David*; Richards, Miriam

The reproductive ground plan hypothesis (RGPH) states that divisions of reproductive labour in eusocial insects has evolved through the uncoupling of reproductive and non-reproductive phases of an ancestral solitary life cycle. Genes regulating reproduction and foraging are homologous in social and non-social taxa and are now differentially expressed between castes in social descendants. Candidate genes associated with this differential expression have been extensively described in the highly eusocial honey bee (*Apis melifera*). To further explore this hypothesis I will compare gene expression between queens and workers of a primitively eusocial sweat bee, *Lasioglossum laevissimum*. Gene expression that agrees with *A. mellifera* work will lend support to the RPGH and highlight potential genes whose expression has become uncoupled. On the other hand, gene expression that does not agree with *A. mellifera* work will suggest that these genes are not appropriate RGPH candidates.

Specific hunger in fruit fly larvae (*Drosophila melanogaster*)

Schwarz, Sebastian *; Durisko, Zachary; Dukas, Reuven

Fruit fly larvae are eating machines whose primary goal is consuming enough food to grow and eventually reach adulthood. Since the larvae feed on yeasts (protein source) and sugars associated with decaying fruit they typically experience large variation in nutrients across their local environments. For instance, differences or certain deficiencies in macronutrients (i.e., protein and sugar ratio) substantially influence growth rate, survival and adult body mass, which in turn greatly affect individual fitness. Thus larvae should compensate for a lack of macronutrients by later preferring food with a greater concentration of the missing nutrient. This increased preference is called specific hunger. In this study we demonstrate for the first time that fruit fly larvae deprived for six hours on either sugar (sucrose) or protein (casein) significantly prefer food, which contains the missing nutrient. Furthermore we compare pupation rates and adult body mass between larvae fed on diets containing yeast and sugar or yeast only. Although yeast naturally contains sugar we found that larvae develop faster on the additional sugar diet indicating an ecological relevance for specific hunger in fruit fly larvae.

Habitat use of the eastern tiger ans spicebush swallowtail butterfly species: Testing for positive edge responses in a fragmented landscape

Sui, Jenna*; Keyghobadi, Nusha; Koscinski, Daria

Landscapes are becoming increasingly fragmented and natural habitat is being lost, contributing to a global decline in biodiversity. Research on the impact of habitat fragmentation on wildlife populations has mainly focused on species that rely on the interior of one habitat type. However, species that respond positively to the boundary between two habitat types should also be considered to gain a full understanding of these landscape changes. The eastern tiger (*Papilio glaucus*) and the spicebush (*Papilio troilus*) swallowtails require two different, or complementary, resources (larval host plants and adult nectar sources) that occur in different habitat types (forest and field). They must cross habitat boundaries to obtain these resources, making them edge species. My behavioural study quantifies the edge response of these charismatic swallowtail butterfly species at field/forest edges by assessing the distribution of their relative abundance and flight orientation in both habitats and at the field/forest boundary. My work contributes to better understanding of the connectivity of populations in the fragmented landscape of southwestern Ontario.

Effects of pollinators and male density on the reproductive success of the dioecious shrub *Shepherdia canadensis* (Elaeagnaceae)

Lin, Shang Yao Peter*; Nol, Erica; Dorken, Marcel

Shepherdia canadensis is a dioecious shrub common to forested ecosystems throughout Canada. This study examines patterns of sexual dimorphism and the pollination biology of *S. canadensis* at the northern limit of its distribution in Ivvavik National Park, Yukon. I found that females were larger than the males, but that males occurred at higher frequencies and produced more flowers than females at most

sites. *Shepherdia canadensis* flowers were primarily visited by ants and flower flies (Syrphidae), however, a manipulative experiment revealed that only flying insect visitors contributed to the reproductive success of the females. To examine the relationships between male densities across spatial scales against two measures of reproductive success (stigmatic pollen load and fruit set), all flowering individuals were mapped in two study sites. I detected a significant positive association between fruit set and male densities at spatial scales of 6 m or less, and this association disappeared with increasing distances between females and males. This study clarifies the roles of crawling versus flying insects in the pollination of *S. canadensis* and reveals the spatial scale over which the majority of pollen is transferred and successfully fertilized females within populations.

Where does selection act Out-of-Africa: Population genomics of the honey bee, *Apis mellifera*

Harpur, Brock*; Kent, Clement; Zayed, Amro

The honey bee, *Apis mellifera*, has a global distribution resulting from ancient expansions out of Africa. This distribution has lead to distinct phenotypic differences between populations in traits of economic importance. Populations vary substantially in honey production, disease susceptibility, aggression, brood quality, and body size. The incredible phenotypic diversity of the honey bee is likely reflected as patterns of divergence across the genome. In order to understand the evolutionary and adaptive basis of the phenotypic variation, we ask which regions of the genome were selected on using a large genomic database. We re-sequenced 53 honey bee workers from progenitor populations using Illumina Hi-Seq sequencing. Genomic regions with high differentiation between populations suggest the actions of positive selection and local adaptation. Using the power of large genomic scans, we have identified clear signals of adaptive divergence between populations of honey bee resulting from ancient population expansions.

Session 2A – Genetics

Effects of long-term experimental manipulation of biotic and abiotic factors on the phylogenetic structure of plant communities

Turley, Nash*; Schaefer, Hanno; Davies, Jonathan; Crawley, Michael

One goal of the field of community phylogenetics is to understand the ecological processes leading to phylogenetic structures within communities. In the acid grasslands at Silwood Park, England, we manipulated presence-absence of rabbits, insects, mollusks, nutrients, and lime in a fully factorial design and recorded the relative abundance off all plant species after 22 years. Using community composition data and a dated molecular phylogeny of all species in the community we asked: What is the effect and relative importance of rabbits, insects, mollusks, nutrients, and lime in shaping phylogenetic structure of plant communities? Removal of rabbits decreased mean

pairwise distance (MPD) by 20% meaning that individuals within ungrazed communities are more likely to be closely related than in grazed communities. This suggests that grazing helps maintain evolutionary diversity. Insects and mollusks, however, had no effect on the phylogenetic structure of communities. The addition of lime increased MPD by 21%, similarly, addition of nutrients also increased MPD. These patterns are consistent with habitat filtering. Together our results show that both biotic and abiotic factors can be equally important in shaping phylogenetic structure of this plant community.

Arbuscular Mycorrhizal Communities in Tallgrass Prairies at Walpole Island, Ontario

Chokrborty Hoque, Aniruddho*

Arbuscular mycorrhizal (AM) associations, symbioses between fungi of the Glomeromycota and the roots of many land plants, are common in grasslands, where they support and maintain plant diversity. A PCR-based approach was used to compare AM fungal communities in disturbed and undisturbed tallgrass prairie sites at Walpole Island First Nation. Total genomic DNA was extracted directly from soil samples and ribosomal gene sequences of AM fungi were amplified using primers specific to AM fungi. Sequences of what are thought to be 32 species of Glomeraceae (29 of Glomus group A and 3 of Glomus group B) and 2 species of Diversispora (Diversisporaceae) were recovered. Phylogenetic diversity measures were used to ascertain whether soil tillage affects the AM fungal community and showed phylogenetically distinct AM communities in disturbed and undisturbed sites. This study, although preliminary, represents the first molecular survey of AM fungi at Walpole Island.

Five 'exceptional' stories in the *Resupinateae*

McDonald, Jennifer*; Thorn, R. Greg

Cyphelloid fungi (small, cup-shaped agarics with a smooth spore-bearing surface) are, compared to their gilled relatives, very poorly studied and understood. Within the tribe Resupinateae (which includes*Resupinatus, Stigmatolemma, Aphyllotus and Stromatocyphella*), little is known about the evolution of the cyphelloid fruit body form. How many times has this reduced morphology evolved within the group? Do all cyphelloid members that are currently treated in this group belong? Are there other species of cyphelloid fungi currently treated in other genera that belong within the *Resupinateae*? Are there distinguishing characteristics that may be used to determine if a species of fungi belongs in the *Resupinateae*? I will present five short case studies to illustrate the number of times the cyphelloid fruit body has evolved in the *Resupinateae*, examples of perceived versus actual host specificity using molecular data, morphological convergence of unrelated fungi to the fruit body morphologies in the *Resupinateae*, the problem with determining species using morphological data, and an example of taxonomic confusion due to species misidentification.

Phylogenetic analysis of the black widow spiders (*Latrodectus*, Theridiidae, Araneae): a preliminary investigation using mitochondrial and nuclear DNA

Condy, Charmaine*; Andrade, Maydianne

Widow spiders (*Latrodectus*, Theridiidae) are greatly feared by the general public, but poorly understood. Reproductive strategies of black widows are diverse, including sexual cannibalism, insertion of mating plugs, mate guarding, and the occurrence of varied degrees of female-biased sexual size dimorphism. Widow spiders remain taxonomically problematic and few species have been studied in detail or in a comparative context. An existing phylogenetic analysis of *Latrodectus*, based on a one-gene approach, failed to fully elucidate evolutionary relationships within the group. Here we increased the number of genes used as this is predicted to increase the resolution of evolutionary relationships. 17 of 30 recognized *Latrodectus* species were sampled and a Bayesian phylogenetic analysis completed using four genes (mitochondrial: COI and 16S rRNA; nuclear: Histone H3 and 28S rRNA). Monophyly of the genus Latrodectus was supported by this analysis, and two reciprocally monophyletic clades were identified. Although species clustered according to geographic locality, relationships among several included species were poorly resolved. We conclude that using a minimal number of genes and representative species does not result in a well-resolved, robust phylogenetic hypothesis in Latrodectus. In the future we plan to complete a multiple-gene DNA sequence data approach, and broader sampling of all 30 species to provide a clearer picture of phylogenetic relationships.

A candidate gene for behavioural isolation between Drosophila simulans and D. melanogaster due to female mate preference

Calhoun, Ryan*; Moehring, Amanda

New species are expected to form rapidly when diverging populations begin to develop variant means of exchanging and evaluating sexual information during mating. Behavioural divergence in female mate preference is thought to be among the earliest reproductive isolation barriers to develop during speciation, yet little is understood of the functional genomic elements that enable these behaviourally discrete species to form. In the genus *Drosophila*, mating success is dependent on the female's acceptance of copulation following her assessment of olfactory, auditory, and visual signals from males during courtship. Female preference for these cues often varies between species and there are numerous examples of *Drosophila* species pairs where females avidly reject courtship attempts from interspecific males. Deficiency mapping within closely-related species of the *Drosophila melanogaster* species complex has led to the identification of multiple regions harbouring putative behavioural isolation genes. Here we use*P*-element insertions to test candidate genes within these regions and have identified the first putative gene for interspecific female mate preference. This gene, *It's not you* (*Ntu*), is involved in microtubule dynamics associated with several cellular activities in *Drosophila* including neuronal morphogenesis.

The evolution of sociality in cichlid fishes: insights from behaviour and gene expression

O'Connor, Constance* M.; Marsh-Rollo, Susan; Hick, Kristina; Cortez-Ghio, Sergio; Tan, Joanne; Wong, Marian Y.L.; Reddon, Adam R.; Aubin-Horth, Nadia; Balshine, Sigal

It is widely assumed that complex sociality evolves from modifications to simple behaviours and associated changes to underlying hormonal pathways. However, few empirical studies have explored variation in simple dimensions of social behaviours and how they build along a sociality axis between species. The rapid and repeated radiation of African cichlid fishes has resulted in extraordinary diversity of species and variation in sociality. We compared two closely-related cichlids with highly divergent social systems to determine if they differ in different dimensions of social behaviour, and in gene expression of candidate neuropeptides and receptors thought to be involved in modulating social behaviour. Consistent with predictions, we found that the social species displays more prosocial behaviour and more complex conflict resolution behaviour than the non-social species. Furthermore, we found that the social species had higher gene expression of the vasotocin and isotocin neuropeptides and their receptors. Our results suggest that changes in simple behaviours and underlying mechanisms related to hierarchy formation are critical in the evolution of group-living and cooperation.

Session 2B – Sexual & Reproductive Processes

Assortative mating and sympatric speciation of pumpkinseed sunfish (*Lepomis gibbosus*)

Colborne, Scott F.*; Longstaffe, Fred J.; Neff, Bryan D.

Sympatric speciation, occurring without physical barriers isolating populations, requires the evolution of strong reproductive barriers limiting the gene flow between diverging groups. Without reproductive barriers, adaptations to divergent selection pressures and genetic differentiation between groups is restricted by the homogenizing effects of gene flow. Assortative mating behaviours has been identified as a key process that could restrict gene flow between groups in sympatry and thereby facilitate genetic divergence. We tested for assortative mating in a population of pumpkinseed sunfish (*Lepomis gibbosus*) that have diverged into two distinct foraging ecomorphs ('littoral' and 'pelagic'). We sampled both male pumpkinseed and eggs from their nests in both the littoral and pelagic habitats of Ashby Lake, Ontario. Stable isotope analyses of carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$) was used to estimate the diets of the males and females via the eggs. The isotopic compositions are able to differentiate the two ecomorphs. If assortative mating was occurring we expected the isotopic compositions of males and eggs to match. We found that male pumpkinseed nest in the habitat that they spend most of their time foraging in, but females move between habitats and mate with both types of males. The movement of females maintain gene flow between the pumpkinseed ecomorphs and appear to be preventing sympatric speciation in this population.

Identification and characterization of a behavioural isolation gene

Calhoun, Ryan; Chan, Stephen; Laturney, Meghan; Moehring, Amanda*

Behavioural divergence is thought to be among the earliest reproductive isolation barriers to develop during speciation. While genetic mapping has elucidated the genetic architecture underlying behavioural isolation, no individual genes have been identified, limiting our understanding of the underlying mechanisms that enable species to develop and remain discontinuous from one another. In *Drosophila simulans*, females reject courtship from *D. melanogaster males*, while females of *D. melanogaster* do not display similar rejection behaviour against *D. simulans* males. Here we use fine-scale mapping, followed by tests of individual candidate genes, to identify and characterize a locus underlying *D. simulans*-like female rejection behaviour.

Do hybrids of poplar crosses differ in their herbivory damage compared to the parent species?

Gorin, Zoryana*; Eckenwalder, James E.

Mating isolation between some closely related plants might not be absolute, thereby giving the possibility of viable crosses between species. A hybrid offspring that inherits parental lines can express novel genotypic and phenotypic traits. The recombination of hybridization can lead to many alterations in the plant and its defense system against herbivory. Hybrids may exhibit a breakdown of defense mechanisms compared to parental lines, and thus experience higher levels of herbivore damage. If this holds true than hybrid zones can act as herbivore sinks, implementing changes in ecosystems. However, an increase in the effectiveness of the defense system may occur if the new recombinant hybrids inherit beneficial traits from parental lines. A variety of poplar species were used to test these alternative hypotheses. Poplar species express a wide range of viable hybrids which experience herbivory. In total 210 trees were sampled, collecting 30 leaves from each tree. Herbivory was determined by calculating a ratio of total leaf area to chewed leaf area. Autodesk Quantity Takeoff 2013 was the computer software used for surface area examination. Preliminary analyses indicate that there are differences in the level of herbivory between different species of trees. Degree of hybrid herbivory in species of poplar crosses can give important insight into evolutionary structure of defense systems and selective forces that act on trees.

Binding of bisphenol A in the uterus of female rats: implications for wildlife reproduction

Pollock, Tyler*; Afonso, Morgan; deCatanzaro, Denys

Bisphenol A is a known xenoestrogen used in the manufacture of polycarbonate plastics and epoxy resins. Given widespread exposure of bisphenol A to humans and wildlife, we examined the deposition and binding of a single, low dose of bisphenol A in adult females. Following oral administration of 50 µg/kg bodyweight ^{14}C-bisphenol A to

cycling and inseminated female rats, we measured radioactivity in several tissues. For both cycling and inseminated females, radioactivity was present in the heart, lung, adrenal gland, muscle, adipose, uterus, and ovaries. In inseminated females, trace amounts of radioactivity were present in the olfactory bulb, cerebellum, frontal cortex, striatum, hippocampus, hypothalamus, and amygdala. In cycling females, radioactivity was negligible in all brain tissues. When females were administered estradiol prior to bisphenol A, radioactivity was significantly reduced in the uterus compared to that of females administered bisphenol A in the absence of estradiol. We suggest that decreased radioactivity in the uterus of females pre-treated with estradiol is evidence for the in vivo binding of bisphenol A to estrogen receptors.

Stress and Reproductive Failure: Steroid Dynamics and Pregnancy Disruption in Mice Exposed to Predators

Thorpe, Joelle*; deCatanzaro, Denys

In inseminated female mammals, stress can disrupt blastocyst implantation. Implantation is also sensitive to estradiol and progesterone, with the ratio of these two steroids being important. Concentrations of both estradiol and progesterone can be altered by exposure to stressors. In initial experiments, exposure of inseminated mice to rats across a wire-mesh grid during gestation days (GD) 1-5 significantly reduced the number of implantation sites on GD6. This was associated with behavioural and hormonal indicators of stress. On GD6, in rat-exposed females, progesterone levels were elevated in those that maintained their pregnancies, and estradiol levels were elevated in those that lost their pregnancies. In a subsequent experiment, we investigated whether exogenous progesterone, estradiol, or a combination of both could influence stress-induced pregnancy failure. A dose of 100ng estradiol per day on GD 1-5 led to the complete absence of implantation sites on GD6, regardless of the presence of stress. Administration of 500&,956;g progesterone per day was insufficient to prevent the stress-induced pregnancy loss. However, 500&,956;g progesterone plus 10ng estradiol per day did prevent stress-induced implantation failure. These data are consistent with the hypothesis that estradiol elevations contribute to stress-induced pregnancy loss, but show paradoxically that low doses of estradiol can act together with progesterone to mitigate stress-induced pregnancy loss.

Sexual dimorphism in N content of leaves in *Sagittaria latifolia*: does it explain differences in reproductive costs between the sexes?

Wright, Veronika*; Dorken, Marcel

Females and males in dioecious populations produce different reproductive structures entailing divergent costs. In plants, dimorphism in the cost of reproduction can result in differences in nitrogen (N) content of vegetative organs. Nitrogen usually limits plant growth, which can occur via a reduction in photosynthetic rates if low N availability reduces the production of RuBisCo. The aim of this study was to evaluate (1) if differences in reproductive costs between the sexes are apparent as differences in the

N content of leaves and (2) if these differences result in contrasting photosynthetic rates. We predicted that male *Sagittaria latifolia* would have reduced leaf N and photosynthetic rates because of greater N demands for pollen production in this plant. As predicted, we found that females had more N per unit mass than males (mean N per unit mass Â± SE % for flowering females = 4.1 Â± 0.1; fruiting females = 4.2 Â± 0.2; flowering males = 3.6 Â± 0.1; males during fruiting = 4.0 Â± 0.2). Although photosynthetic rates were slightly lower for males than females, the difference was not significant (mean photosynthetic rate Â± SE Î¼mol m^{-2} s^{-1} for flowering females = 17.5 Â± 0.8; fruiting females = 16.8 Â± 1.1; flowering males = 16.0 Â± 0.7; males during fruiting =15.7 Â± 1.0). Our study confirmed an underlying difference in N content between the sexes, but this difference was not sufficient to cause substantial divergence in photosynthetic rates.

Session 3A – Response to Environment Change

Increasing atmospheric nitrogen deposition: Implications for tallgrass prairie restoration

McPhee, Jennifer*; Henry, Hugh

As the use of fossil fuels and synthetic fertilizers continue to increase, so does the emission of nitrogen pollution into the atmosphere, resulting in increased nitrogen deposition across the landscape. Typically, terrestrial ecosystems are nitrogen limited, and increased nitrogen deposition has a strong effect on plant biomass and species composition, in that it favors fast-growing, nitrogen-demanding species. Therefore, increasing nitrogen deposition has important implications for plant community restoration. I am using a field experiment to assess the effects of nitrogen addition on tallgrass prairie restoration, and the ability of native trees to establish in the restored prairie. I will also use a common garden experiment to examine the success of transplanted tree seedlings in response to competition from tallgrass versus non-tallgrass species in the context of nitrogen addition. Overall, this project will lead to an improved understanding of how tallgrass prairie restoration will be influenced by increased atmospheric nitrogen deposition due to global change.

Interactive effects of soil freezing and nitrogen deposition on nitrogen retention over winter and the following growing season.

Vankoughnett, Mat*; Henry, Hugh

In northern temperate regions, climate warming is projected to decrease the portion of precipitation that falls as snow. Reduced snow cover can increase the occurrence of soil freezing, which can damage plant roots and cause microbial lysis, resulting in increased N leaching over the growing season. These N losses may be exacerbated under future projected increases in N deposition. The objective of this study was to investigate the interactive effects of soil freezing and N deposition on plant productivity, bacteria and fungal biomass, and soil N losses. To do this, we established plots crossed with snow removal and N addition. The snow removal treatment reduced plant productivity,

increased soil N losses, but had no effect on bacterial and fungal biomasses. Interestingly, N addition interacted with soil freezing to enhance plant productivity in the snow removal plots, but had no effect on N losses or bacterial and fungal biomasses. Our results highlight the potential importance of changes in winter soil temperatures on plant and soil dynamics during the growing season.

Tree Seedling Establishment in Response to Warmning and Nitrogen Deposition

McWhirter, Bryana*; Henry, Hugh

In some northern temperate regions, areas previously used for agricultural production have been abandoned, leading to increased old field habitat. While in the absence of disturbance these old fields will develop into secondary forest, increased temperature and nitrogen deposition may alter the ability of woody species to germinate and compete with grasses and forbs. We transplanted newly germinated seedlings of four early successional species into plots of a field experiment receiving warming and nitrogen addition treatments. We predicted seedling survival would decrease with warming and nitrogen addition and surviving seedlings in the treatment plots would have decreased growth, leaf area and biomass. As we predicted, *Malus coronaria* (crab apple) seedlings had higher survival, leaf number, leaf area, and total biomass in control plots than in treatment plots. However, the other species had higher survival and growth in treatment plots than in control plots. Both the nitrogen addition and warming treatments increased grass biomass and percent cover, despite decreased soil moisture in warmed plots. Our results suggest that increases in temperature and nitrogen deposition may exert strong effects on survival and productivity in temperate old fields, particularly for species that are shade intolerant or drought sensitive. However, for shade tolerant species, increased aboveground grass biomass may provide a beneficial microclimate during stressful hot and dry periods.

Effects of herbivory, intraspecific genetic variation and rapid evolution in plants on ecosystem processes

Fitzpatrick, Connor*; Johnson, Marc

Herbivores can influence plant community structure and the genetic composition of plant populations, which can in turn drive ecosystem-level effects. Here we investigated the effects of herbivory on ecosystem-level processes of soil. We used plots from a long-term field experiment that were either exposed or protected from ambient insect herbivory. This manipulation caused rapid evolution in*Oenothera biennis* populations and altered plant communities. Our specific research questions were: 1) What are the relative contributions of altered plant community and rapid evolution in plant populations to the ecosystem-level effects caused by herbivory? 2) Can these ecosystem-level effects feedback to alter the performance of *O. biennis*? In each plot we quantified leaf decomposition and net N mineralization rates, as well as soil microbial activity under additions of natural and synthetic substrates. Additionally, we examined the effect of intraspecific genetic variation in *O. biennis* on these ecosystem-level responses. We

also quantified germination success and seedling performance of the experimental *O. biennis* genotypes grown in soil from all plots to assess the possibility of a feedback between the soil ecosystem and the performance of evening primrose genotypes. Overall, we found evidence that divergent herbivore regimes led to differences in ecosystem-level processes by way of altered plant communities and evolution within plant populations.

Seed production and germination rates of a hybrid cattail *Typha* × *glauca* and its parent species

Pieper, Sara*; Dorken, Marcel; Freeland, Joanna

Invasive plant species pose a serious threat to wetlands in Ontario. The role of interspecific hybridization is increasingly being regarded as a driver of invasiveness in some species. Cattails (*Typha* spp.) are aggressive wetland plants that have rapidly increased in abundance in eastern North America. Three *Typha* species occur in Ontario – the native *T. latifolia* L., the introduced *T. angustifolia* L., and their F_1 hybrid *T.* × *glauca* Godr. Field observations indicated that the hybrid was sterile, but genetic evidence has revealed substantial backcrossing and the formation of advanced-generation hybrids. To compare patterns of seed fertility between the three *Typha* species, we collected fruits from 5 mixed stands and estimated total seed production per shoot, germination rates, and seedling survival. Our data suggest that germination rates do not differ between species, but that seed production is highest for *T. angustifolia* and seedling survival is highest for seedlings from *T. latifolia* plants. Higher seed production in *T. angustifolia* in mixed stands may result from its ability to produce seeds following fertilization by *T. latifolia*. Future work will involve determining species status of seeds from maternal plants of different species and growing seedlings under competition to better understand species interactions.

Session 3B – Aquatic Ecology

The effect of non-native salmonids on the performance of Atlantic salmon during the juvenile life stage

Houde, Aimee Lee S.*; Wilson, Chris C.; Neff, Bryan D.

Atlantic salmon (*Salmo salar*) were extirpated from Lake Ontario by 1900 primarily as a result of habitat degradation. While the habitat has improved enabling ecologically-similar salmonids to establish, reintroduction efforts of Atlantic salmon have largely been unsuccessful. Competition with non-native salmonids has been suggested as an impediment to the restoration of Atlantic salmon. Here we examine juvenile Atlantic salmon of two populations (LaHave River and Sebago Lake) within semi-natural streams containing 50% juvenile non-native salmonids, i.e. rainbow trout (*Oncorhynchus mykiss*), brown trout (*S. trutta*), coho salmon (*O. kisutch*), and chinook salmon (*O. tshawytscha*). Atlantic salmon had decreased survival, mass, and body condition in treatments with rainbow trout, brown trout, and all four non-native species.

Atlantic salmon also displayed no changes in microhabitat preferences and plasma hormones when in a competitive environment. We discuss these findings in the context of stream selection for Atlantic salmon stocking and for habitat remediation.

Tracking the round goby: How site contamination load influences population characteristics of an established invasive species.

McCallum, Erin*; Charney, Rachel; Balshine, Sigal

Research on invasion biology often focuses on the early stages of species introductions, while less attention is devoted to how an invasive population changes after establishment and during integration into the non-native ecosystem. We present results from a long-term population-monitoring study of the round goby *Neogobius melanostomus*, an invasive fish species in the Laurentian Great Lakes, in Hamilton Harbour, ON, Canada. To assess how an established invasive population interacts with unique aspects of non-native environments, we have sampled round goby at 6 distinct locations in Hamilton Harbour for the past 11 years (2002 – 2012). These sites differ in substrate type and relative contaminant load. Focusing on differences between sites of high and low contamination across our sampling years, we address changes in population abundance, and changes in morphological and physiological characteristics such as body size, body condition, proportion reproductive and the abundance of male reproductive morphs.

The effect of regional dispersal on zooplankton responses to *Dreissena polymopha* invasion

Furlanetto, Katrina*; Arnott, Shelley

Aquatic systems are becoming increasingly susceptible to invasive species, whereby local species can be depleted in abundance, richness and diversity leading to changes in species composition, and altered trophic interactions. Regional dispersal may therefore provide a mechanism for recovery from the stress of an invader if lost individuals are supplemented by more tolerant regional species. This study examined if regional zooplankton dispersal could reduce the effects of the invasive zebra mussel, *Dreissena polymorpha*, on cladoceran, copepod and rotifer community. Field experiments were conducted in 20 cattle tanks, with five replicates, to observe zooplankton community response to (1) the presence and absence of zebra mussels, and (2) the presence and absence of regional zooplankton dispersal. In the presence of mussels, edible and total chlorophyll reduced, decreasing resource availability. Cladoceran and copepod abundance decreased with zebra mussels suggesting strong resource competition or direct predation by mussels. Dispersal did not affect crustacean diversity or community structure. The effect of zebra mussels on rotifers depended on dispersal, such that richness and abundance was lowest in the zebra mussel treatment with dispersal. Results suggest that regional species influence zooplankton community structure and responses to zebra mussel invasion, but the effect is to exacerbate rather than mitigate the impact of zebra mussels on rotifer communities.

Ecology of behavioral variation: How boldness affects growth, survival, and ontogenetic niche shifts in bluegill sunfish

Kjelvik, Melissa*

Behavioral variation within populations has been ubiquitously documented in a variety of animals ranging from damselflies to deer. There has been a recent surge of interest in the ecological consequences and maintenance of this intra, population variation. However, due to logistical difficulties, very few studies have followed individuals of varying behavioral types in the field. In this study, we follow juvenile bluegill sunfish that have been assayed for boldness, individually marked, and stocked into experimental ponds. In a series of experiments, we show that bolder individuals grow faster and switch to feeding in pelagic habitats sooner than their shyer conspecifics, but do not exhibit decreased survivorship as a cost to risk, taking. These results are some of the first to document differences in the ecology of individuals across the boldness continuum in the field, a key step to understanding the maintenance of behavioral variation.

Foraging ecomorphology of pumpkinseed sunfish (*Lepomis gibbosus*)

Berchtold, Adrienne*

Associations between feeding morphology and foraging behaviour were investigated in three populations of pumpkinseed sunfish (*Lepomis gibbosus*); two populations contain only littoral individuals and the other contains both littoral and pelagic individuals. Pharyngeal jaw bone and muscle masses were positively associated with littoral foraging within and across populations, demonstrating the relevance of this structure to resource specialization on molluscs as well as potential sympatric speciation. Gill raker number, length, and density showed no relationship to diet but all pumpkinseed demonstrated gill raker density representative of zooplanktivorous morphology seen in other species, indicating that gill rakers have little relevance to molluscivory and may experience convergent selection for filter-feeding across pumpkinseed populations. Overall, this research suggests that the pharyngeal jaw is a key component of pumpkinseed divergence based on foraging ecomorphology and is likely to be involved in driving selective processes in this species.

Session 4A – Conservation & Restoration

Population distribution of reintroduced elk in Central Ontario

McGeachy, David*; Hamr, Josef; Mallory, Frank

Elk (*Cervus canadensis*) were once common across North America. Unregulated hunting, land use conflicts and habitat loss led to their extirpation from the eastern half of the continent, including Ontario. Elk were reintroduced into Ontario over a decade ago. Understanding current population distribution and structure, is paramount to

evaluating the success of the reintroduction and to obtain essential information for management decisions. We hypothesize that spatial behaviour will be affected by habitat quality. We predict that elk in satellite groups will have lager home ranges to compensate for lower habitat quality. We also predict that elk will form an ideal free distribution with no individual fitness costs associated with satellite versus core populations. A clearly defined core population has been established, surrounded by satellite groups. Elk were collared using net guns fired from helicopters in both the core area as well as the outlying satellite locations. Individuals were tracked weekly on an annual basis. Spatial behaviour was assessed using two home range estimators, minimum convex polygon (MCP) and 95% fixed kernel. Distinct populations exist within the regional population forming a classic metapopualtion structure. A notable exception in the population structure is the well-defined core area associated with the atypically habitat complex in Burwash. Implications for management are discussed.

Habitat loss differently affects predators with different hunting modes

Clyburne-Sherin, April

The hunting mode of a predator indicates the frequency and nature of its encounters with other predators and prey, which makes it a useful trait for understanding predator and prey interactions. Several hunting mode mediated interactions can predict the selection and consumption of prey, the probability of intraguild predation, and the behaviour and foraging efficiency of other predators and prey. Because loss of habitat continues to impact ecosystems globally, it is important to know how habitat loss will affect predators with different hunting modes. I used a fragmented tallgrass prairie experiment to study how arthropod predators with different hunting modes were impacted by four habitat areas. Based on four important hunting mode mediated interactions, I tested my hypotheses that different hunting modes will be differently affected by habitat loss. The ratio of predator density to prey density was negatively impacted by decreasing habitat area, reducing predator pressure on prey with habitat loss. Although both ambush hunter density and active hunter density significantly declined with habitat area, the ratio of ambush hunter density to active hunter density did not significantly change, meaning that ambush intraguild predation and non-consumptive effects may not change with habitat loss. The ratio of hunting predator density to web-weaving spider density was significantly negatively impacted by declining habitat area, reducing the probability of hunting predator intraguild predation with habitat loss. Finally, the ratio of generalist predator density to parasitoid density was significantly negatively impacted by decreasing habitat area, which could decrease predator – predator facilitation with habitat loss.

Evaluation of Range Expansion of Trumpeter Swans (*Cygnus Buccinator*) Re-Introducted Into Southwestern Ontario

Handrigan, Sara*; Petrie, Scott; Schummer, Michael

Trumpeter swans (*Cygnus buccinator*) were extirpated from southwestern Ontario in 1886 due to hunting and habitat loss. From 1982-2006, 584 trumpeter swans were released in 42 different locations within southwestern Ontario by The Ontario Trumpeter Swan Restoration Group. The southwestern Ontario trumpeter swan population abundance is now believed to be increasing in size; but little is known about the populations breeding range. As the abundance of trumpeter swans increases an increase in breeding range is expected if there is density dependence, but the potential for range expansion has not yet been investigated. If the population is failing to expand its range, there is potential for it to become a nuisance species as occurred in the Alaskan population. Sighting locations of marked swans collected since 1982 are being used to calculate the area of the population's home range per year using a kernel-density estimator in ArcGIS. In conjunction the average migration distance per year will be calculated and expected to increase as nesting habitats are occupied. The population has been expanding their range at a rate of 617757 hectares every two years, but the r

Bee Communities in Restored Landfills of the Niagara Region

Kutby, Rola*; Richards, Miriam

This study examined the impact of habitat restoration on bee fauna (Hymenoptera: Apoidea) of the Niagara Region, Ontario, Canada. I studied bee abundance and diversity in three restored landfills, Glenridge Quarry Naturalization Site (GQNS) in St. Catharines, Elm Street Naturalization Site in Port Colborne, and Station Road Naturalization Site in Wainfleet. GQNS represented older sites that were restored from 2001-2003. Elm and Station represented landfills newly restored in 2011. I compared these to control sites at Brock University where bees have always been present compared to other landfills where no stable habitat was available before restoration. A total of 7173 bees was collected using pan traps and flower collections, from May to October 2011 and 2012. Bees were classified to five families, 21 genera and sub-genera, and at least 78 species. The bee abundance was not difference among restoration levels, which proves that habitat restoration resulted in bee community restoration. The bee species richness was highest in the newly restored sites followed by restored control sites followed by the control site. The current study relate the bee diversity and abundance to habitat restoration.

Predator or Prey Driven Instability with a Restored Tallgrass Prairie

Schneider, Stefan*; MacDougall, Andrew

Oscillations are ubiquitous to predator-prey interactions, although the root causes of fluctuations – whether they are prey or predator based - can be difficult to determine. Resource based models predict that food availability can create an overshoot of predators initiating instability while predator based models predict that strong selection against palatable species create fluctuations. Testing these two alternatives is difficult as seasonality creates limitations for both at different times of the year. We tested these

two alternatives within a prairie food web, examining interactions between plant consumption [prey] and seasonal fluctuations in rodents [predators] over a twelve-month period. Our work combined live-trapping, cafeteria trials, exclosures, feeding trials with captive animals as well as DNA scat analyses to test which species are being eaten and when. Our results found evidence for both the consumer and resource model at different times of the year. The consumer model was evident during summer/ early autumn with high populations, consumption, prairie diet and damage to monitored plots while the resource model was evident during late autumn/winter where a low population had high consumption of available palatable food while otherwise eating unpalatable non-natives. The consumer model ultimately drives the system as exotic species subsidize small mammal populations until seasonal times of plenty where palatable species are voraciously consumed.

Session 4B – Social Interaction

Influence of larvae on food patch choice in fruit flies

Durisko, Zachary; Anderson, Blake*; Dukas, Reuven

The use of social information allows animals to better inform their decisions while circumventing costs typically associated with the acquisition of individual experience. We examined social information use in fruit flies (*Drosophila melanogaster*), which provide an excellent model for studying the proximate and ultimate mechanisms underlying social behaviour. We found that adult flies were attracted to odours emanating from food patches occupied by foraging larvae, and that females were more likely to lay eggs at these sites than equivalent unoccupied patches. Females also learned to prefer flavours of foods previously associated with the presence of larvae over flavours concurrently experienced in the absence of larvae. When controlling for the duration of exposure to each flavour of food, females no longer showed a preference for the flavour associated with feeding larvae. Our results suggest that adults can rely on salient and distinct odours emanating from feeding larvae to guide their foraging behaviour. Adult flies have a limited ability to assess food quality, and the tendency of mobile larvae to aggregate on the highest quality site available to them may provide females with an accurate indication of site quality for egg laying, and males with a reliable means of locating females.

Causes and consequences of social learning in fruit fly larvae

Durisko, Zachary*; Dukas, Reuven

Social learning, defined as learning from others, allows fast spread of novel behaviors within and between generations. Although social learning may have played an important role in the ecology and evolution of insects, neither its evolution nor its neural mechanisms have been closely studied. We examined socially influenced behavior and social learning in larval fruit flies (*Drosophila melanogaster*). Individual larvae are attracted to odour cues given off by groups of other foraging larvae, and prefer novel

odours previously paired with either: food that has recently contained others, or groups of others on fresh food. This suggests that odours associated with foraging larvae serve as long-distance attractant for others, and that larvae may socially learn other associated cues both from these indirect odours and from direct interactions with others. Additionally, we show that although group foraging among larvae is associated with competition costs, the cues associated with foraging groups may be a good source of information leading other larvae to higher quality foraging sites. Fruit fly larvae are an excellent model system for further work on the ecology, evolution and neurogenetic mechanisms of social learning.

Dynamics of social interactions in fruit fly larvae

Mubasher, Rameeshay; Durisko, Zachary; Dukas, Reuven

We have developed a protocol to quantify the extent and dynamics of social behaviour in fruit fly (*Drosophila melanogaster*) larvae, a simple model organism whose tractable nervous system and capacity to display both social attraction and social learning make it ideal for understanding the evolution and neurogenetics of social behaviour. We measured degree of aggregation at regular time intervals throughout larval development, from hatching until pupation, under different realistic conditions, to determine the effect of ecological factors on larval social interactions. We found that larvae are moderately social, regardless of initial egg distribution (uniform of aggregated). Interestingly, larval aggregation increased on harder substrates, and when only one patch was softer than the rest, indicating that larvae may aggregate in order to dig cooperatively. Under natural settings, digging may help larvae hide from predators, maintain homeostasis, and fight competitive mould growth. Importantly, we found reduced but significant aggregation when the food was entirely soft, indicating that larvae may aggregate for reasons other than digging. Finally, we found that larvae possessing a mutation homologous to that causing Fragile X Syndrome in humans, a disorder associated with mental retardation and social deficits, exhibit significantly greater aggregation than wild type larvae.

Why copy others? Biasing personal decisions with social information.

Golden, Shane*; Dukas, Reuven

Animals that copy others can save a lot of time and energy. They do not have to undergo a lengthy learning process and can engage in appropriate behaviour simply by observing others. Fruit flies are an excellent system for studying copying behaviour. Females will observe where other females lay their eggs and then copy their decisions. However, there may not always be an opportunity to do this. Another strategy is to lay eggs where you find eggs or larvae. Females do not bias their egg laying decision based on the presence of eggs but they do heavily bias their decision in the presence of larvae. They reliably lay a large proportion of their eggs on a food source that has actively foraging larvae. Even when that food source is sub-optimal, the females still bias their decision based on the social information available. Females likely canâ€™t

detect the presence of some micronutrients in the food. If a food source has active larvae, it must be able to support larval growth and development. This has an obvious cost. Competition between larvae slows larval development and reduces adult body mass. There are some benefits to larval density. It promotes beneficial yeast cultures and reduces the growth of harmful molds. Even though fruit flies are not historically considered a very social species, they show copying behaviours and heavily bias personal decisions with social information.

Comparing resource contests between cichlid fishes that differ in their degree of sociality

Reddon, Adam R.*; O'Connor, Constance M.; Hick, Kristina; Balshine, Sigal

The costs and benefits of engaging in resource contests may differ depending on social system. If so then understanding contest behaviour may help to elucidate the costs and benefits of sociality and shed light on social system evolution. In the current study, we compared contest behaviour in two closely-related species of cichlid fish. *Neolamprologus pulcher* is a highly social cooperatively breeder, while *Telmatochromis temporalis* is a less social pair-breeder. We staged contests over a shelter, a resource that is highly valued by both species. Contestants were either two males or two females, and either familiar or unfamiliar to each other. We found that *N. pulcher* engaged in fewer costly aggressive acts during contests than did *T. temporalis*. Having a familiar opponent also significantly dampened aggression during contests for *N. pulcher*, but not for *T. temporalis*. Further, *N. pulcher* were more likely to resolve conflicts through the use of submissive displays.

Social Brains in Context: Lesions Targeted to the Song Control System in Female Cowbirds Affect Their Social Network

White, David J*; Maguire, Sarah E; Schmidt, Marc F.

Social experiences can organize physiological, neural, and reproductive function, but there are few experimental preparations that allow one to study the effect individuals have in structuring their social environment. We examined the connections between mechanisms underlying individual behavior and social dynamics in flocks of brown-headed cowbirds *(Molothrus ater)*. We conducted targeted inactivations of the neural song control system in female subjects. Playback tests revealed that the lesions affected females' song preferences: lesioned females were no longer selective for high quality conspecific song. Instead, they reacted to all cowbird songs vigorously. When lesioned females were introduced into mixed-sex captive flocks, they were less likely to pair-bond and they no longer showed preferences for dominant males. This in turn created a cascade of effects through the groups. Social network analyses showed that the introduction of the lesioned females created instabilities in the social structure: males in the groups changed their dominance status and their courtship patterns, and even the competitive behavior of other female group-mates was affected. These results reveal that inactivation of the song control system in female cowbirds not only affects

individual behavior, but also exerts widespread effects on the stability of the entire social system.

Session 5A – Terrestrial Ecology

Home-field advantage in a host-parasite system

Sarquis-Adamson, Yanina*; MacDougall-Shackleton, Elizabeth

The local adaptation hypothesis predicts that local populations of a species are better adapted to their specific home environments than are individuals dispersing from other such populations. In the context of a songbird host-bloodborne parasite system, previous findings that birds of local origin have lower parasite loads are consistent with, but do not definitively support, the local adaptation hypothesis. I hypothesized that host individuals remaining to breed close to where they were born should be better able to defend against the local parasites, relative to hosts immigrating from other populations. To test this, I captured song sparrows (*Melospiza melodia*) from two geographically separated populations, and conducted reciprocal infectivity trials challenging birds with *Plasmodium* parasites from either the local or non-local site. My results will shed light on how well hosts can cope with parasites from different areas, and ultimately help understand the importance of parasites in restricting host dispersal.

Long-term herbivore exclusion drives plant defense evolution in multiple species

Didiano, Teresa J.*; Turley, Nash E.; Everwand, Georg; Schaefer, Hanno; Crawley, Michael J.; Johnson, Marc T. J.

Plant defense traits have evolved over macro- and microevolutionary timescales in response to herbivores. Although a number of studies have investigated the evolutionary impacts of herbivores over short timescales, few studies have considered what defense traits frequently evolve and whether coexisting species exhibit parallel evolutionary responses to herbivores. To address these questions, we used a long-term grassland experiment at Silwood Park, England, where we excluded rabbits from 38 plant populations for &,706;1 to 34 years. To assess the evolutionary impacts of rabbits on plant defense traits, we collected seeds of *Anthoxanthum odoratum L. (Poaceae), Festuca rubra* L. (Poaceae), *Holcus lanatus* L. (Poaceae), and *Stellaria graminea* L. (Caryophyllaceae), grew them in a common garden, and measured defensive and morphological traits. We found evidence for the evolution of defense traits in three of the four species, however the evolutionary response of species was idiosyncratic. Following the removal of rabbits, F. rubra was the only species that evolved a 9% decline in tolerance to herbivory and a 26% decline in leaf number. In contrast, the removal of rabbits caused all grass species to evolve an erect growth form suggesting that plants grow close to the ground to avoid grazing. Our results show that

there is a commonality to evolution in prostrate growth among the three grasses, but this is not the case for other defense traits.

Diversity of Insect-Eating Bats as Illustrated by Bite Force and Size

Chang, Terrence*

Over 1200 species of bats (Chiroptera) are distributed around the world. Bats represent approximately 20% of all mammal species and occupy a large number of niches. Most bat species are insectivorous, but others eat plant products, animals, or blood. If diet underlies the diversity of bats, then the bite force that bats can exert should also reflect this diversity. Here I examine the bite force of bats that are primarily insectivorous, as well as bats from the family Phyllostomidae that include animal, blood, and plant-eaters. I used Freeman and Lemen's model (2010), which predicts jaw strength, to determine the relative bite force of approximately 600 bat specimens representing 464 species from 16 families. I found that size and bite force have a significant relationship (R = 0.736). Size-corrected bite force is significantly different among families. Ultimately, bite force reflects diversity of bats, however, it is probably a better predictor for diet than family membership.

Initial colonization constraints on foodweb assembly

Harvey, Eric*; MacDougall, Andrew

Island biogeography theory predicts area and isolation to drive assembly irrespective of traits, a view supported by aspects of metacommunity theory where initial colonization is mostly constrained by stochastic processes while species sorting only occurs later in assembly. Data supporting these predictions, however, have been inconsistent. Here, we tested for the importance of biogeographic and trophic constraints on the colonization of an insect food web in a 24 ha grassland metacommunity experiment, controlling for patch size (25,100,400 m2) and isolation. Food web assembly was the result of biogeographic and trophic factors happening simultaneously or in sequence, to produce three distinct food webs: (i) grass dominated (ii) forb dominated, and (iii) communities of the above two with or without certain herbivores, depending on isolation distance. The food web structures of our islands derived from mechanisms operating regionally in a way such that each local community structure could not be predicted solely by diet-based traits or by the spatial characteristics of the islands but rather by a complex interaction between both. This work clarifies how complexity shapes assembly through simultaneous and sequential interactions of spatial and trophic processes, consistent with recent theoretical predictions on trophic island biogeography.

Quantifying "Fatness"- Measures of polar bear body condition in Western Hudson Bay

Sciullo, Luana*; Thiemann, Gregory

Polar bears (*Ursus maritimus*) use sea ice to forage on seals, providing high energy intake through lipid content of prey blubber. Upon ice melt, bears fast for four months, therefore foraging during the ice-covered season is imperative to build energy reserves needed to maintain body condition. Body condition has been assessed using various tools including morphometric measurements (body mass, girth, fatness index), relative lipid content of adipose tissue, and bioelectrical impedance analysis (BIA). Our goal was to assess and compare morphometric measures, lipid content and BIA in determining body condition of free-ranging polar bears during the ice-free period in Western Hudson Bay. We found fat content retrieved from adipose tissue was positively correlated with both BIA and total energy density calculated using body length and mass. Females had higher lipid than males using all body condition measures, consistent with hyperphagia to prepare for gestation, lactation and birthing cubs. Conversely, lower lipid content in males was due to reduced energy expenditure on shore when individuals do not engage in mating, foraging or aggressive interactions. Because adipose tissue samples can be collected from polar bears harvested each year by Inuit hunters, a quantitative relationship between adipose lipid content and body fat is useful to monitor polar bear condition across their Canadian range, particularly in response to increasing environmental change.

The role of herbivory in limiting the altitudinal range of *Rhinanthus minor* in the Canadian Rocky Mountains

Falk, Lindsey*; Hargreaves, Anna; Eckert, Christopher

Biotic factors, such as herbivory, can strongly influence fitness and may vary across plant species' geographic ranges. Yet, the extent to which variation in herbivory can limit species' distributions is poorly understood. We experimentally manipulated the intensity and fitness effects of insect herbivory on the annual hemiparasite *Rhinanthus minor* (Orobanchaceae) towards its upper elevational limit across two elevational transects in the Rocky Mountains of southern Alberta. Proportion of leaves suffering insect herbivory increased towards the upper range limit. However, lifetime seed production of *R. minor*individuals was not affected by either natural insect leaf herbivory or experimental removal of 25% leaf area. Pesticide application successfully reduced the proportion of leaves with herbivory but did not increase fitness. The proportion of reproductive structures with herbivory did not vary predictably with elevation, but did negatively affect lifetime seed production at one transect. Given that both natural and simulated insect leaf herbivory did not cause reductions in individual fitness it is unlikely insect leaf herbivory plays a role in setting the altitudinal limit of *R. minor* in Alberta.

A test of whether local genetic stocks yield better restored populations in an endemic Pacific coastal dune plant

Viengkone, John*; Lopez, Adriana; Eckert, Christopher

As undisturbed habitat dwindles in the wake of human activity, restoration of disturbed habitats by recreating native plant and animal communities is increasingly important in

conservation. It is expected that restoration will be most effective when it involves genetic stock adapted to the site under restoration. We retrospectively determined the genetic provenance of *Camissoniopsis cheiranthifolia* planted in coastal dune restoration in California, and tested the hypothesis that populations restored with local genotypes experience higher fitness. Among natural populations, this species is strongly differentiated for floral morphology and the mating system across its geographic range. There is also marked geographic structure at microsatellite loci. Most restored populations resembled nearby natural populations in terms of both floral morphology measured using image analysis and microsatellite allele frequencies determined by Bayesian assignment analysis. However, three restored sites in a region characterized by small-flowered populations had particularly large flowers and exhibited unusual genetic admixture at microsatellite loci. As expected, plants at these sites experienced lower fruit set, which likely translates into lower fitness in this short-lived plant. Although restoration of *C. cheiranthifolia* appears to have largely used local stock, the use of nonlocal stock seems to reduce the fitness and possibly the persistence of restored populations.

Session 5B – Behavioural & Cognitive Neuroscience

Pigeons Rank-Order Responding to Temporally Ordered Stimuli

McMillan, Neil*; Roberts, William A.

We examined the ability of pigeons to track the identity of multiple stimuli presented in order across a temporal interval terminating in reinforcement. When presented with a sequence of three stimuli on baseline trials and tested on probe trials, the birds attended only to the reinforced stimulus and not to the order of stimuli. When pigeons were presented with baseline non-reinforced trials in which the order of the first two stimuli was reversed, they responded based on the order of stimuli. These results were extended to a five-stimulus sequence. Though birds showed only a weak appreciation of order, they nonetheless responded differentially based on temporal order.

Memory in an avian brood parasite: Testing the adaptive specialization hypothesis

Guigueno, Mélanie F.*; MacDougall-Shackleton, Scott A.; Sherry, David F.

The adaptive specialization hypothesis (ASH) proposes that cognition and the brain are adaptively specialized to serve specific ecological functions. Brown-headed cowbirds (*italics*Molothrus ater *italics*) are an ideal species for testing the ASH because they show seasonal and sex differences in spatial behaviour. Cowbirds are brood parasites, only females search for host nests, and breeding females have a larger hippocampus than males. We therefore predicted that females would outperform males on a spatial memory task, especially during breeding. We tested cowbirds on spatial and colour

memory operant tasks on touchscreens in breeding and non-breeding conditions. There was no overall sex difference in performance on either task. On the spatial task, males actually performed better than females at the shortest retention interval, although non-breeding females were better able to handle successive increases in retention interval compared to non-breeding males. On the color task, females performed much better when in breeding condition than in non-breeding condition. The most straightforward prediction from the ASH of better spatial memory in females is not supported by these results. However, a number of more subtle and unexpected sex differences, and effects of breeding condition, were found to occur in spatial and non-spatial memory in cowbirds.

Effects of nutritional stress at different developmental periods on song, associative learning, and behavioral flexibility on zebra finches.

Kriengwatana, Buddhamas*; Brooymans, Quinn, James, F.; MacDougall, Shackleton, Scott, A.

Developmental environments can have long-term effects on learning and cognition. Multiple aspects of cognition may be affected by unfavorable conditions during development if underlying systems are maturing simultaneously. We investigated the effects of nutritional stress at different stages of development on adult song, associative learning, and behavioral flexibility in a songbird. Zebra finches (Taeniopygia guttata) were raised in consistently high (HH) or low (LL) food conditions until 65 days post-hatch (DPH), or were switched from high to low conditions (HL) or vice versa (LH) at 35 DPH. Results indicated no effect of treatment on any parameters of song (output, learning accuracy, stereotypy, or complexity). Treatment affected associative learning and behavioral flexibility and effects were dependent on sex and timing of stress.

Natural selection on cognitive traits? Individual variation in problem-solving performance and reproductive fitness in wild great tits.

Morand-Ferron, Julie*; Cole, Ella; Quinn, John

Cognition -the mechanisms by which animals acquire, process, store, and act upon information from the environment- has been studied intensively for several decades, but the evolutionary processes that shape individual variation in cognitive traits remain elusive. We assessed innovative problem-solving performance in 468 wild great tits *Parus major* temporarily taken into captivity and subsequently followed up their reproductive success in the wild. Problem-solver females produced larger clutches and fledged more offspring than non-solvers. This fecundity benefit did not arise because solvers timed their breeding better, occupied better habitats, or compromised offspring quality or their own survival. In contrast, problem-solvers were more likely to desert their nest, and therefore to fledge no young at all, compared with non-solvers. These contrasting links between problem-solving performance and two important life-history traits resulted in non-significant directional selection coefficients over four successive years. I discuss approaches to the young sub-discipline of evolutionary ecology of

cognition, and introduce a new device that can be used to conduct learning tests with free-ranging songbirds in their natural habitat.

Alloparental care in a solitary bee

Lewis, Vern*

Research into the evolutionary origins of sociality in insect colonies has, in recent years, changed emphasis from understanding how eusociality is maintained to how insects transition from solitary to social lifestyles. Popular model systems for investigating social behavior such as the Hymenoptera and Isoptera focus on highly derived species such as Apis mellifera. However such model systems can only tell us about the maintenance of social structure, and can say very little about the biotic and abiotic constraints and benefits of social evolution. The pygmy carpenter bees (*Ceratina* spp.) offer an excellent model for investigating such factors as they have been historically thought of as solitary but possess some subsocial and eusocial characteristics, which may indicate they are currently in a transitive phase. In order to show that members of the genus *Ceratina* may be transitioning from a solitary life history to a higher form of sociality, a primitive form of cooperative brood care must be present. By utilizing behavioural observation and experimental removal protocols, I attempted to show whether sibling care played a role in offspring development. I found, upon removal of the mother, that female offspring take up foraging and maintenance roles in the nest. Not only does evidence show that female offspring forage at the same frequency as the mothers, but secondary individuals were found to guard the nest entrance and eject nest debris while the foraging fem

The link between dopamine and ecologically relevant behaviours in the Trinidadian guppy, *Poecilia reticulata*

De Serrano, Alex*; Rodd, Helen

Dopamine (DA) is a neurotransmitter that is widely studied for its role in movement, the reward pathway, risk-seeking, and addiction and disease. However, studies investigating how variation in an individuals' DA levels can affect ecologically relevant behaviours, and in turn, intra-specific interactions and population dynamics, are not nearly as prevalent. Although most studies involving DA have focused on mammals, the dopaminergic system is conserved in vertebrates, making it plausible that DA functions similarly in other species as well. One species that is a model organism for studies of behavioural evolution is the Trinidadian guppy, *Poecilia reticulata*. Guppies show natural variation in several behaviours, including novelty-seeking and mating behaviour, that have been linked to DA in rodents. For example, guppies from low-predation populations explore novel habitats and objects more than their high-predation counterparts, and female guppies prefer males with novel phenotypes, suggesting that these behaviours could have fitness consequences. Recent work in our lab has focused on understanding the link between DA and these ecologically relevant behaviours in guppies. To do this, we have been exposing individuals to compounds known to alter

DA levels, and have been comparing these treated-individuals to controls using behavioural assays. Here we provide our preliminary results on the link between DA and these behaviours, and discuss the implications of our results.

Early-life stress in European starlings (Sturnus vulgaris) affects body composition and a sex-specific deficit in auditory learning

Morgan, Amanda*; Farrell, Tara M.; MacDougall-Shackleton, Scott A.

Adverse early developmental conditions negatively affect song learning and song quality in songbirds. Most research on developmental stress and birdsong focuses on males. Females are understudied in part because they do not produce song in a manner like males. However, song has evolved through signaler-receiver networks and the effect stress has on the ability to receive auditory signals is equally important, especially for females who use song as an indicator of mate quality. We subjected juvenile European starlings (*Sturnus vulgaris*) to either an *ad libitum* or unpredictable food-supply from 35-115 days of age. During the treatment period, birds were weighed and body composition (fat and lean mass) was quantified using Quantitative Magnetic Resonance (QMR). As adults, starlings' abilities to perceive differences in absolute frequency were assessed in an operant conditioning task. We found there was no significant difference in weights between the two treatment groups during the treatment period. However, control birds did have more fat that the unpredictable group. In the post-treatment period, unpredictable group birds gained significant weight compared to controls; this increase in weight was due to gains of lean mass, not fat mass. In the auditory task, we found that control females acquired the discrimination faster than females raised in our unpredictable condition. Our results indicate that developmental stressors have effects on body composition and sex-specific effects on cognition.

Interval Timing and Numerical Discrimination in the Domestic Dog

Macpherson, Krista*; Roberts, William A.

It has been shown that animals are sensitive to time, and can track fixed intervals of a given duration. Animals have also been shown to "count", making numerical discriminations of varying magnitudes. These processes are thought to operate through similar mechanisms, however neither process has been studied thoroughly in the domestic dog. A 2 year old female rough collie named Sedona was taught to make numerical discriminations in a simultaneous two-choice task. Geometric shapes of varying size were presented to Sedona on two magnet boards. If Sedona chose the board with the majority of the items, she was rewarded with a piece of food hidden underneath the boards. If she made an incorrect choice, she received no reinforcement. Sedona was tested on ratios of 0vs1, 0vs3, 1vs2, 1vs3, 1vs9, 2vs4, 3vs4, 3vs9, 4vs8, 6vs8, 6vs9, and 8vs9, and performed significantly above chance on all ratios except the most difficult, 8vs9. Importantly, Sedona's accuracy decreased systematically as the

ratios became more difficult, demonstrating that her behavior was ratio dependent and in accordance with Weber's Law. In a second study, Sedona was taught to hit a button in order to receive a reward from a food dispenser. A 1 minute interval was then imposed, making it impossible for Sedona to receive a reward until the machine was armed. Consistent with other species, Sedona's response rates diminished at the beginning of the interval, and increased systematically across the interval.

Posters Abstracts

(*Presenter)

The behavioural response of larval sea lamprey (*Petromyzon marinus*) to damage-released chemical alarm cues

Perrault, Kerry*; Imre, István

Sea lamprey (*Petromyzon marinus*) invaded the Great Lakes early in the 20th century and have since caused economic and ecological damage to native fish species. The search for low cost and less toxic alternatives to lampricides could involve the use of repellents in the form of chemical alarm cues. The objective of this study was to determine whether larval sea lamprey show behavioural avoidance when exposed to damage-released chemical alarm cues. We predicted that larvae exposed to conspecific damage-released chemical alarm cues would increase their time spent swimming, as well as the number of direction changes and/or escape attempts while swimming. The experiment was carried out in semi-natural stream channels with a refuge in place for the larvae to rest under. Larval sea lamprey were exposed to two experimental and a control stimulus: a heterospecific Hawaiian swordtail (*Xiphophorus hellerii*) whole body extract, conspecific larval sea lamprey whole body extract, and distilled water. The larvae increased their escape attempts after exposure to the swordtail and lamprey experimental stimuli but did not increase swimming time or direction changes. We hypothesize that larval lamprey respond to heterospecific cues due to their early ontogenetic stage. This is the first study to successfully show that larval sea lamprey respond to conspecific damage-released chemical alarm cues.

Contrasting latitudinal herbivory patterns in Oenothera biennis (Onagraceae)

Anstett, Daniel N.*; Naujokaitis, Lewis, Ilona; Johnson; Marc T.J.

The prediction that herbivory and plant defenses increase towards the equator is a called the Latitudinal Herbivory Defense Hypothesis (LHDH). Recent studies call this hypothesis into question, which suggests alternative hypotheses might explain biogeographic patterns of herbivory and plant defense. Here we test the LHDH by sampling herbivory by multiple generalist and specialist insect herbivores over the entire latitudinal native range of a single plant species, *Oenothera biennis*. We sampled 80 populations on a 16-degree North-South gradient from Ontario to Florida. We quantified

leaf herbivory caused by a diverse community of generalist insects, damage by a specialist weevil on stems, and damage by three different lepidopteran fruit specialists. Our results show that latitudinal patterns in herbivory exist, but they vary dramatically among herbivores. While generalist leaf herbivory showed no pattern, Tyloderma damage increased with decreasing latitudes matching the LHDH prediction. By contrast, three specialist flower and fruit moth species all show decreased herbivory with decreasing latitudes. Overall, we show that in *O. biennis*, every pattern of herbivory across a latitudinal gradient is possible, and this variation depends on the tissues examined and the herbivores studied. These results give testable predictions for ongoing experiments that seek to tease apart the roles of the environment versus adaptive evolution in both the plant and insect populations.

Evidence of Restricted Pollen Dispersal in Broadleaf Cattails(*Typha latifolia*)

Ahee, Jordan*; Van Drunen, Wendy; Dorken, Marcel

In the Great Lakes region of North America the abundance of native Broadleaf Cattail (*Typha latifolia*) appears to be decreasing via hybridization with non-native *T. angustifolia*. Pure stands of *T. latifolia* now occur at low frequencies in Southern Ontario. Wind-pollination is often assumed to promote long distance pollen dispersal, which would promote hybridization between native and non-native cattails. We investigated the spatial dynamics of pollination in *T. latifolia* by evaluating spatial correlations in pollen and seed production. Surprisingly, we detected significant spatial cross-correlations between pollen and seed production only at distances of less than 1 m. This finding suggests that even though *T. latifolia* produces copious amounts of pollen, dispersal is highly localized. Moreover, although *T. latifolia* is self compatible and has been described as largely selfing, our results suggest that there is substantial pollen transfer between nearby inflorescences.

Using comparative methods to investigate welfare issues in captive parrots (Psittaciformes): Preliminary data from species kept as pets

McDonald Kinkaid, Heather*; Mason, Georgia

Millions of parrots are kept in zoos, breeding centres, and homes. They span 200+ ecologically-diverse species widely assumed to differ in susceptibilities to health/behaviour issues in captivity. We are investigating the magnitude of species differences in captive welfare (abnormal behaviour in pets, reproductive success in breeding centres, lifespan in zoos). Inspired by conservation biologists' analyses of risk/protective factors for, e.g., extinction, we will use comparative methods to examine why these differences occur. In a preliminary study, we analyzed survey data on pet parrots to determine whether species identity predicted the presence/absence of abnormal "feather-damaging behaviour" (FDB). Across 538 individuals from ten species (n=17/species), strong predictors of FDB status were age (P=0.001) and sex (P=0.006) (odds of FDB lower for juveniles vs. adolescents or adults [P=0.036]; lower for individuals of unknown, vs. known, sex [P=0.037]). "Species" also predicted FDB status

(P=0.047; odds of FDB lower for Senegal vs. eclectus parrots or white-crested cockatoos, P=0.027), even after controlling for other variables. These findings provide preliminary empirical evidence for intrinsic species differences in FDB susceptibility: We will extend them with data from a new survey that permits improved statistical control for systematic differences in housing; and then investigate which natural biological traits underpin taxonomic differences in captive parrot welfare.

Heritability of Spatial Learning in Honeybees

Tsvetkov, Nadejda*; Zayed, Amro

Learning occurs in multiple ways: from the fundamental classical conditioning to the more complex spatio-temporal. In honeybees, simple learning processes have been found to be heritable, but an understanding of the genetics of more complex learning is lacking. Here, I propose to investigate the underlying genetic basis of complex learning in the honeybee by using a maze. A maze requires spatial pattern recognition and can provide a powerful tool to investigate variation in maze-learning ability between families. If heritability is found, I will focus on candidate genes that maybe responsible for learning. For example, the foraging gene is associated with spatial learning in the fruit fly. I will examine foraging gene expression in the bees before and after maze learning, and in 'poor' and 'good' learners. Moreover, I will test whether treatment with cGMP, which is a product of foraging, increases spatial learning, as it does in the fly.

Pollinator-mediated selection on corolla tube length in an artificial flower system: Can bumblebees facilitate assortative mating?

Ni, Felicity, J.*; Thomson, James, D.

This study investigates pollinator-mediated selection, specifically the preferences of the common Eastern bumble bee, *Bombus impatiens*, for corolla tube lengths. We looked at whether or not corolla tube preferences are involved in assortative mating. Previous studies have found that bumble bees prefer longer tubes but few studies have been done with our study species. The experiment uses a novel system of artificial dioecious flowers with food dye as an analog for pollen. Using spectrophotometry, we were able to analyze dye deposition and use it as a measure of male fitness in a controlled, hypothetical setting. We found that flowers with long corolla tubes had higher dye deposition, suggesting preferences for deeper corolla tubes. We also found more dye transfer within morphs than between morphs; female flowers of a certain tube length received a significantly higher proportion of dye from male flowers of the same "phenotype". This finding supports our hypothesis of positive assortative mating between flowers of similar corolla tube lengths.

The Role of Hippocampal Estrogen Receptor GPER in the Rapid Regulation of Learning and Memory in Female Mice

Lymer, Jennifer*; Gabor, Christopher; Phan, Anna; Magahay, Alexandra; Baines, Nicolette; Choleris, Elena

Estrogens have been shown to rapidly affect learning and memory in ovariectomized female mice (Phan et al., 2011; 2012). These effects are thought to be due to the non-genomic actions of estrogens through estrogen receptors alpha and beta as the learning and memory paradigms were completed within 40 minutes of drug administration. The recently discovered G-protein coupled estrogen receptor (GPER) has also been shown to systemically mediate rapid improvements in the same learning and memory paradigms. However, the brain regions involved in these effects are unknown. We investigated the role of the hippocampus, which has high expression of GPER, in the rapid effects of GPER on learning and memory in female mice. To do this, the GPER agonist, G-1 (50, 100, 200, 300, or 400 nM) was infused directly into the CA1 of the hippocampus (rate of 0.0002 mL/min for total volume of 0.0005 mL per side) and the mice were tested on social recognition, object recognition, and object placement tasks. Social recognition was improved with infusions of 200 nM and 400 nM G-1. However, object recognition was impaired with 50 nM and 100 nM G-1 and object placement was impaired with 50 nM and 200 nM G-1. Therefore, GPER in the hippocampus may, in part, mediate the rapid improvements of estrogens on social recognition while opposing the enhancing effects of estrogens on object recognition and object placement. Supported by NSERC.

Variability and inheritance of egg protein in *Apis mellifera*

Chowdhury, Tabashir*; Zayed, Amro; Tsvetkov, Nadia; Xu, Zhixing; Mahjoorighasrodashti, Mohammad

Protein concentration and total Protein in honeybee eggs from queens and their corresponding queen daughters were quantified using the colorimetric Bradford assay. The heritability for protein concentration, total protein and weight for *A. mellifera* eggs were estimated using parent offspring regression and half-sibling analysis using a univariate ANOVA model. Both egg protein concentration and total egg protein were distributed normally. We observed a significant negative correlation between protein concentration and egg weights. Total protein showed a significant positive correlation with egg weight. No significant correlation was found between egg protein concentration and total protein in eggs. We also observed a significant negative heritability estimate for protein concentration from the parent offspring regression. Heritability estimates for total egg protein and egg weights were positive but not significant. Analysis of variance for egg protein concentration, total egg protein and egg weights for family groups of half sister queens showed no significant variation suggesting heritability for these traits are not significant.

Effects of the D1-type receptors with SCH23390 in the hippocampus on the social transmission of food preferences in male and female mice.

Matta, Richard*; Tiessen, Angela N; Choleris, Elena

Dopamine (DA) is involved in many rewarding and socially relevant tasks such as food intake and social learning. Our previous systemic work has implicated the involvement of the DA D1-type receptors in social learning (Choleris et al., 2011), however, the brain site of action remains unknown. DA neurons in the ventral tegmental area project to numerous limbic structures, including the hippocampus, a structure involved in various learning tasks, including social learning. Here, we investigated the effect of inhibiting D1-type receptors in the CA1 of the hippocampus with the antagonist SCH23390 (1, 2, 4, and 6 μg/mouse) in the social transmission of food preferences task. In an on-going experiment, we are microinfusing both adult male and female CD-1 mice 15 minutes before a 30 minute social interaction during which mice acquire a food preference from a conspecific. Preliminary results show that observers infused with 1 (n = 6) and 4 (n = 6) μg/μL preferred the diet eaten by a demonstrator, however, social learning was impaired in mice infused with 2 (n = 6) and 6 (n = 7) μg/μLa. In addition, total food intake was not affected, which is in agreement with our past systemic results. In view of the established estradiol-DA link, and estrogens influence on social learning, we will also assess possible sex differences in D1-type receptor involvement. Such findings may help our understanding of the neural basis of social behaviors governed by hippocampal DA. Supported by NSERC.

The role of specific estrogen receptors in estrogenic facilitation of social learning

Ervin, Kelsy*; Mulvale, Erin; Boyd, Jenna; Montini, Gregory; Melenez, Ayrton; Choleris, Elena

Social learning occurs when an animal acquires information from another. The social transmission of food preferences (STFP) is an adaptive form of social learning: an observer prefers a food it previously smelled on a demonstrator's breath. Estrogens act genomically to modulate performance on this task (Clipperton et al, 2008) and 17b-estradiol also rapidly improves learning on the STFP. Here we assessed the involvement of 3 receptors: ER-a, ER-b and G protein-coupled ER (GPER) in estradiol improving effects. We used the ER-a agonist PPT, the ER-b agonist DPN (30, 50, 75, 150ug per mouse), and the GPER agonist G1(30, 180, 300, 900ug per mouse), administered subcutaneously to ovariectomized female observer mice 15 min prior to interaction with previously fed demonstrator mice. Like the genomic effects, the ER-a agonist PPT rapidly impaired learning on the STFP. Similar to estradiol, G1 rapidly improved learning, under "difficult" conditions where vehicle control treated mice did not show social learning, while it impaired it under “easy" conditions. Hence GPER involvement in social learning depends upon the testing conditions. DPN did not rapidly improve social learning and may instead impair it. While ER-a improves social learning in the long-term, it may impair it in the short-term scale, similar to its effects on social recognition. Overall, estradiol rapid enhancing effects on social learning may be mediated by the GPER, while ER-a and ER-b may act counter to such effects.

Quantitative Genetic Consequences of Losing Recombination and Segregation in the Evening Primroses (*Oenothera*: Onagraceae)

Godfrey, Ryan*; Johnson, Marc

Despite over a century of theoretical advancements on the evolutionary consequences of sex, empirical validation of the theory remains scarce. The flowering plant genus *Oenothera* offers an ideal system to test long-standing theory concerning the evolutionary consequences of sexual and asexual reproduction. Many Oenothera species exhibit a functionally asexual genetic system called permanent translocation heterozygosity (PTH), which has evolved repeatedly during the diversification of the genus. We focused on four pairs of sexual/PTH *Oenothera* species (8 species total) and conducted a comparative quantitative genetics study to test several common theoretical predictions about sex. Each species was grown in a common garden with replication at the population (N=3-5), family (N=15-20) and sibling (N=4) level. We quantified phenotypic traits related to growth, physiology, defense against parasites and reproductive traits. With these data, it was possible to address the theoretical predictions that asexuals should have: 1) lower total genetic variation in populations, 2) greater resemblance among families, 3) lower heritability, 4) greater differentiation between populations and 5) stronger correlations between phenotypic traits. Our results largely support the theoretical predictions from the literature on the evolution of sex, and provide some of the first empirical evidence that the loss of sex has significant consequences on the population genetics of a species.

Low Heritability of Innate Immunity Function in *Apis mellifera*

Chernyshova, Anna*; Harpur, Brock A.; Xu, Zhixing; Mahjoorighasrodashti, Mohammad; Zayed, Amro

Some of the most spectacular examples of phenotypic plasticity have been distinguished in highly eusocial *Apis mellifera*. Among all, the individual innate immunity, which plays key roles in defending against pathogens and therefore contributes to the increased efficiency in task performance of each colony, is perhaps one of the fundamental traits to be studied. We present the results of an experiment designed to address the influences of genotype upon individual immune defenses in two honeybee (Apis mellifera) colonies by comparing the immunocompetence of individuals within patrilines and across colonies. We quantified the expression of immunity function in 1-day-old bees by performing the zone-of-inhibition (ZOI) assay and genotyped them with microsatellite DNA markers. We then determined paternity and assigned individuals to patrilines within each colony. Our findings conclude that patriline identity has low effect on the individual innate immunity trait of the 1-day-old workers and that significant differences exist in the immunocompetence of individuals across colonies. These results further demonstrate the true complexity of the selection pressures affecting the expression of the innate immunity trait within honeybee populations.

Selective mating and diploid male production in bees

Albert, Jennifer*; MacIvor, Scott J.; Zayed, Amro; Packer, Laurence

Sex determination in bees depends on their allelic composition at a single locus, the complementary sex determiner, whereby individuals who are heterozygous at this locus develop into females and hemizygous or homozygous individuals develop into males. Species with single locus complementary sex determination (sl-CSD) are at greater risk of extinction compared to most organisms due to the production of diploid males which are often inviable or sterile. This is of particular concern in small or fragmented populations where genetic diversity is low. Diploid male production is also of concern when these males are viable because they can mate with healthy females resulting in the production of inviable triploid offspring in the next generation. If mechanisms which allow individuals to recognize and avoid mating with relatives are in place then the predicted detrimental population wide effects of sl-CSD may be greatly reduced. We are performing a set of behavioural experiments to test whether or not males and females of multiple social and solitary species of bee are able to identify and avoid mating with close relatives. In addition we will test if females have a preference for mating with haploid over diploid males thereby preventing production of triploid females. These experiments will help us to better understand the risks associated with sl-CSD and contribute to the development of more effective conservation programs for bee pollinators.

Demographic consequences of hybridization and selection on an annual weed

Teitel, Zachary*; Campbell, Lesley G.; Miriti, Maria N.; Snow, Allison A.

Weed species are known to evolve rapidly with their associated crops, and a better understanding of the mechanisms and rates of weed evolution could aid in limiting or at least anticipating this process. Our study focused on two primary research questions: (1) How does hybridization affect demography and population growth rate?; and (2) To what extent do major, heritable changes in life history affect demography and population growth rate? Our previous research compared the lifetime fecundity of wild and hybrid plants after several generations of natural selection in experimental populations. We also documented the potential for rapid evolutionary responses in these populations to strong, natural or artificial selection for two traits of interest - early flowering and large size. Here we build on this work to determine the demographic consequences of hybridization and three generations of either natural or artificial selection on these same traits. By using this complementary approach, we take a novel, comprehensive approach to exploring the ecological consequences of evolution via hybridization and selection in an annual weed. Future work will use abiotic resource treatments meant to simulate climate change to tease apart seed germination, dormancy and mortality rates.

Spatial variation in the fatty acid composition in polar bear (*Ursus maritimus*) adipose tissue in the Canadian Arctic

Galicia, Melissa*; Gregory, Thiemann

We determined the fatty acid composition of individual polar bears (*Ursus maritimus*) in three Canadian Arctic regions: Baffin Bay, Gulf of Boothia, and Lancaster Sound. We

sampled the adipose tissue of 156 harvested polar bears from the annual subsistence hunting seasons from 2010 to 2012. We quantitatively extracted lipid from each polar bear's adipose tissue and expressed fatty acid (FA) data as the mass percentage of total FA ± 1 SEM. Fatty acid composition in adipose tissue of polar bears varied spatially across the three geographic regions and accurately classified polar bears into their respective subpopulations. When examining within each region age class, sex, and season had no significant effect on the fatty acid composition of polar bears. Regional differences in fatty acid composition represent varied foraging patterns across each region as a result of different resource availability and accessibility. The three subpopulations support some of the highest densities of polar bears in the world and the ecological factors supporting these densities are poorly understood. These findings can provide insight in the foraging ecology of polar bears and future shifts associated with changing sea ice conditions. Future work will include quantifying the proportion of prey found the diet of individual polar bears.

The effects of biotic and abiotic factors on springtail diversity and function

Turnbull, Matthew*

I research how global climate change will affect the diversity and function of soil fauna. I focus on the arthropods known as the Collembola, also called springtails, because of their global distribution, high densities, integral role in subterranean nutrient cycles, and relationships with soil and plant populations. Because much of the diversity of soil fauna is undescribed, I use functional diversity to describe the distribution of traits present in soil communities. This may be a stronger and more easily comparable metric of community function than species indices. I am particularly interested in body size spectra as an indicator of trophic transfer efficiency and extirpation risk. I am currently analyzing results of an experiment testing the effects of moisture, temperature, and elevated CO_2 levels on springtail community composition. I will also be using neutral lipid fatty acid analysis to quantify changes in springtail diets and therefore changes in their functional roles. I will soon be starting a field experiment providing various nutrients to boreal forest moss systems to test the effects of increased resource availability on soil communities. I hope to create a set of traits which can be used to compare the structure and function of soil communities even when species identities are unknown or undescribed.

A geographical perspective on the research and conservation of Canadian at risk peripheral plant populations

Jackiw, Raeya*; Eckert, Christopher

Canada is home to many locally rare species that are globally secure, many of which are at the northern periphery of ranges widespread in the USA. As a result, Canadian conservation research often focuses solely on peripheral populations, and may misrepresent the conservation priority of these at risk species. We determined that 80% of Canada's 184 federally listed at risk vascular plant species are peripheral. We further

found that listed peripheral species were more likely than non-peripheral species to be assigned a Canadian conservation priority higher than that assigned to their global range. Finally, through a comprehensive literature review of the studies on Canadian at risk species we found that 16% of listed species have not been studied to date. Additionally, conservation studies have examined only 16% of listed Canadian peripheral species, and only 4 % of these studies compare Canadian peripheral populations to populations in their species' range core. Overall there is a shortage of conservation research on Canadian at risk plant species, and existing studies are quite parochial in nature. As the conservation of peripheral populations is controversial, and future changes to the Species at Risk Act may include the de-listing of peripheral species, there is a need for studies that address peripheral populations in the context of their global ranges to more accurately determine their conservation priority.

Epigenetics of invasive weeds: The contribution of maternal effects to phenotypic plasticity in *Raphanus raphanistrum*

Parker, Rebecca J*.; Blakelock, Graham C.; Campbell, Lesley G.

Environmental maternal effects may alter offspring phenotype in response to the plasticity of the parent by contributing additional genetic and non-genetic potential for phenotypic plasticity in the offspring. Maternal effects may be important where environments are changing, in the evolution of invasive species, which by their nature move through new environments, and in the response of plant species to anthropogenic climate change. We explore the effect of water availability on phenotypic plasticity expressed in the invasive weed *Raphanus raphanistrum*. Comparing phenotypes of plants grown in a common garden but whose mothers come from environmental with differing water availabilities, any differences that arise in the phenotype of the individuals in the population should be explained by phenotypic plasticity, genetic evolution by adaptation, and maternal effects, or a combination. A field experiment was set up using the seeds of a wild *R. raphanistrum* population grown in four artificial environments differing in their soil moisture availability. Offspring were raised in either the maternal environment or in a control environment, representing a novel environment to the offspring. Soil moisture had a significant effect on seed weight ($p = 0.0010$). Dry plots produced smaller seeds than control open plots. Stem diameter, flower number, seeds per fruit, and total seeds per plant differ significantly between maternal lineages.

Forty-two years of forest measurements support the continuation of the carbon sink in Northeastern U.S. forests

Eisen, Kate*; Barker-Plotkin, Audrey

Using atmospheric and forest inventory measurements, previous studies have demonstrated that Northeastern U.S. forests act as a carbon sink, but few have used permanent plot data to examine relationships between stand-level processes and carbon uptake. I used 42 years of census data that have tracked over 6000 individual trees in a 2.9- hectare permanent plot at the Harvard Forest (Petersham, MA) to

analyze species composition and total forest aboveground biomass and determine if stand dynamics impact carbon uptake. From 1969 to 2011, *Quercus rubra* increased from comprising 52 to 60 percent of the stands total basal area, while *Acer rubrum* decreased from 30 to 23 percent. The biomass of living individuals is increasing linearly suggesting the stand has not experienced an age-induced decrease in biomass accumulation. *Q. rubra* accounts for between 77 to 87 percent of the linear increase in aboveground biomass, yet is relatively absent from the understory. This dynamic indicates that the species composition and carbon sequestration potential of the forest may change significantly as the dominant *Q. rubra* individuals senesce.

Nectar replenishment in wildflowers of Colorado

Luo, Elaine*; Ogilvie, Jane; Thomson, James

Calculating the potential energetic return of nectar feeding requires understanding the dynamic nature of nectar secretion. Studies on several plants have shown that nectar secretion increases in response to its removal, but it is not clear whether the phenomenon is widespread. We determined whether 11 species of Colorado wildflowers showed enhanced removal-enhance nectar replenishment (RENR). We measured floral phenology, standing nectar crops, rate of replenishment, and compared the cumulative nectar produced following five hourly removals with that accumulated after five hours. Nectar replenishment occurred rapidly, within minutes; statistically significant RENR was observed in 10 of our 11 study species, with strongest effects in bee-pollinated species. Considerations surrounding nectar measurements, the adaptive advantage of RENR, and energetic costs of RENR are discussed.

The effect of nutrient deprivation and mating status on excretion in *foraging* gene variants of *Drosophila melanogaster*

Urquhart-Cronish, Mackenzie*; Sokolowski, Marla B.

Metabolism is a topic of increasing public interest due to rising rates of obesity and metabolic disorders in human populations. Metabolic disorders have complex, multifaceted origins that encompass genetic, physiological, and environmental effects. Recently, the gastrointestinal tract has emerged as a key regulator of these processes. Cognigni et al (2011) developed a quantitative method based on excretion to investigate metabolic features. Here I apply their methodology to investigate the effects of nutrient deprivation and mating status on excretion in rover and sitter *foraging* gene variants of adult *Drosophilamelanogaster* in different nutritive environments. Well fed adult rovers excreted significantly more than adult sitters, but only when they were nutrient deprived as larvae. When well fed throughout their entire development, mated females had a larger ratio of reproductive oblong deposits (RODs) to round deposits compared to males. Further research into the differences in larval development of the gastrointestinal tract in rovers and sitters is required to elucidate the mechanisms behind the different excretion phenotypes observed. This study indicates the important role good nutrition plays in life history of an organism and its function in reproductive activity.

Effects of diethylhexyl phthalate on blastocyst implantation in inseminated female mice (*Mus musculus*).

Borman, Evan*; deCatanzaro, Denys

Xenoestrogens are synthetic chemicals can interact with estrogen receptors and mimic estrogenic responses in organisms. Using a common xenoestrogen that is used as a plasticizer in various household products, diethylhexyl phthalate (DEHP), we sought to determine the minimum dosage required to elicit an effect upon the blastocyst implantation in inseminated female mice (*Mus musculus*). Very low doses of natural estrogens can impede implantation, and we predicted that DEHP would at some dose mimic this effect. These results would then be compared to the amount of DEHP observed to be in the environment as well as exposure in humans and wildlife. Varied doses of DEHP mixed with peanut oil were administered through subcutaneous injections starting on gestation day (GD) 1 and ending on GD 4. The mice were then sacrificed and dissected on GD 6 in order to count implantation sites. Results of the study showed that the minimum dose required to exert a significant effect on implantation sites was 36 mg/animal, which is substantially greater than the average amount recorded in effluent sewage or human ingestion. While the amount of DEHP necessary to show an effect is substantial, thus indicating a weak estrogenicity, further research will look at subthreshold doses of this chemical paired with another xenoestrogen, bisphenol A, to determine its additive effects.

Selectivity of Young Male Fruit Flies May Contribute to Speciation

Carling, Baxter*; Dukas, Reuven

Learning in the context of courtship has been well documented in mature, four-day-old male fruit flies (*Drosophila melanogaster*). Mature males refine their courtship strategies through experience with different types of females, such as conspecific and heterospecific females. Mature males in these experiments were isolated until they were approximately four days old. However, young, one-day-old males are also able to court and mate with females and likely do so in the wild. Therefore, it is ecologically relevant to examine the courting behaviours of young males in order to fully understand males' possible contributions to behavioural isolation (a pre-mating isolation mechanism). First we compared the relative fertility of young and mature males and found that young males were as or more fertile than mature males. Then we compared initial selectivity and learning in young and mature males with respect to courting conspecific versus heterospecific females. Young males' learning through courtship experience was equal to that of mature males. Additionally, inexperienced young males were significantly more selective than inexperienced mature males with respect to courting conspecific over heterospecific females. This greater selectivity supports the idea that young males may be contributing to incipient speciation via behavioural isolation.

Investigating anhedonia in a non-conventional species: are some riding horse depressed?

Fureix, Carole*; Quinton, Margaret; Beaulieu, Cleo; Mason, Georgia

To determine the potential role of depression in a state involving inactivity and low responsiveness to external stimuli in horses (termed withdrawn), we investigated anhedonia (loss of pleasure: a core symptom of depression) in withdrawn horses and controls for the first time. Subjects were 20 horses (16 geldings, 4 mares, 7-20 y-old, 75% French Saddlebred) from the same stable. The time horses spent withdrawn was determined by scan sampling every 2min over 1h long periods repeated over 15d. We measured sucrose intake, a classic measure of anhedonia never previously applied to horses. Sugar blocks (novel to these horses) were provided and weighed 3h, 8h, 24h and 30h after provision. We hypothesized that if in depression-like states, withdrawn horses would consume less sucrose than controls. As predicted, horses spending the most time withdrawn ate less sucrose ($F_{1,18} = 4.7$, $p=0.04$; controlling for age, sex, and the time each horse spent in its stall). We then controlled for two possible alternative explanations for this pattern: food consumption levels (hay consumption over 5d), and neophobia towards novel foods. Hay consumption positively predicted sucrose consumption ($F_{1,14} = 4.5$, $p=0.051$), and long latencies to eat a novel food predicted low sucrose consumption ($F_{1,14} = 8.3$, $p=0.012$), but statistically controlling for them did not eliminate the relationship between being withdrawn and consuming less sucrose (a strong trend now: $F_{1,15} = 4.3$, $p=0.056$). This suggests that neither food consumption levels nor neophobia were major confounds. Our study illustrates the methodological challenges of investigating anhedonia in non-conventional species, and suggests riding horses might experience depression-like states.

Multigenerational Demography of Unexploited Brook Trout (*Salvelinus fontinalis*) in Algonquin Park, Ontario.

Brown, Erin*; Wilson, Chris; Ridgway, Mark

Understanding the demographic processes that drive and limit populations is central to population ecology, but abundance and mortality data for different life stages and sexes are often difficult to obtain. We used long term tagging records of a sanctuary population of brook trout (*Salvelinus fontinalis*) in Algonquin Park to investigate the demographics of an undisturbed population. Brook trout in Mykiss Lake (23.5ha) were surveyed biannually between 1991 and 2004. Fish were marked with T-tags from 1991 to 1996 and subsequently tagged with both T-tags and PIT-tags. Mark-recapture estimates were used to evaluate survival and abundance over multiple generations and quantify variation between sexes and life stages. Abundance estimates ranged from 234 to 823 fish per sampling period, with a slight female bias. Survival ranged from 85% to 96% per sampling period, and did not appear to be influenced by sex. Tag retention was greater for PIT tags, and their use did not appear to significantly affect survival estimates. Preliminary results suggest variation in abundance and survival at different life stages, providing annual estimates of the potential breeding population. Results suggest that unexploited brook trout populations exhibit relatively constant adult survival and abundance, with little effect of sex. These findings provide valuable insights into the

natural demography of unexploited populations, and should also help inform sustainable management of inland fisheries.

Pollination, floral herbivory & striking variation in the mating system of a coastal dune plant

Dart, Sara; Eckert, Christopher*

Floral evolution can be influenced by negative interactions with herbivores as well as positive interactions with pollinators because floral traits that attract pollinators might also attract flower herbivores. A transition from outcrossing to self-fertilization is the most prominent evolutionary trend in flowering plants, possibly because selfing provides reproductive assurance (RA) when pollinators are scarce. But a shift to selfing reduces floral attractive traits, hence it may also involve selection to reduce herbivory. We investigated these hypotheses in the Pacific coastal dune endemic *Camissoniopsis cheiranthifolia*, which exhibits striking geographic variation in mating system: from full outcrossing to full selfing. Consistent with the RA hypothesis, fruit set was lower and more variable among large- than small-flowered populations. Pollen supplementation increased seed production compared to natural pollination in large- but not small-flowered populations, however fruit set was not pollen limited. Instead, flower size correlated negatively with floral herbivory by a new species of moth in the genus *Mompha*. Hence herbivores, not pollinators , account for the marked geographical variation in fruit set. Although herbivory is more frequent in large-flowered populations, *Mompha* does not selectively attack large-flowered individuals. Higher herbivory in outcrossing populations is a consequence rather than a cause of mating system evolution.

Habitat Selection by Eastern Population Tundra Swans, Cygnus columbianus columbianus,"

Weaver, Katelyn*; Schummer, Michael; Petrie, Scott; Henry, Hugh

Around 1970, wetland loss, conversion to agriculture necessitated Eastern Population (EP) Tundra Swans (TUSWs) to incorporate waste agricultural grains into their diets in addition to traditional foods. Identifying how TUSWs select wetland and terrestrial (agricultural fields) habitats in these altered landscapes will enable conservation strategies to ensure adequate foraging habitats are available for these birds. Further, understanding habitat selection is essential to assess TUSW biological requirements, predict effects of further habitat change, and test hypotheses underlying ecological processes. Our study will use satellite telemetry data from 55 EP TUSWs to investigate seasonal selection of agricultural and wetland habitats during the nonbreeding period. I hypothesize that diurnal habitat selection will differ seasonally at the Atlantic Coast, Great Lakes and Prairies due to nutritional requirements, food availability and habitat accessibility. I predict that TUSWs will select wetland habitats during autumn, shifting to agricultural habitats during late autumn and early winter and continue using agricultural habitats throughout spring. When swans occur in aquatic habitats we hypothesize that

they will select wetlands based upon food availability and accessibility. We predict that swans will select palustrine and estuarine wetlands during autumn and winter and lacustrine wetlands during spring. We also predict that swans will select habitat with greater wetland cover.

Generosity as a Costly Signal

Kafashan, Sara*; Barclay, Pat; Stanley, David

Some researchers argue that generous behaviours, such as large charitable donations, may serve as costly signals to broadcast one's resources. Others, however, acknowledge that generosity may advertise one's physical ability (e.g., rescuing a person from danger) and/or honestly signal one's cooperative intent (e.g., volunteering at a homeless shelter). Although much evidence illustrates that generosity may be a costly signal of at least three fundamentally *different* qualities, researchers have not acknowledged the different forms of generosity and, instead, continue to treat generosity as a unidimensional construct. The primary goal of the current investigation was to provide empirical evidence that shows generosity can be broken into more than one factor. A three-way factor analysis (PARAFAC) was used to analyze the data. As hypothesized, generosity signalled three qualities: an individual's resources, physical abilities, and/or cooperative intent."

Players gonna play: juvenile rough-and-tumble play enhances adult male sexual performance in American mink

Ahloy Dallaire, Jamie*; Mason, Georgia J.

What is play for? Rough-and-tumble play (R&T) is hypothesized to prepare males for adult sexual behaviour. However, existing support from deprivation studies confounds play partner absence with social isolation. We tested this hypothesis using experimental manipulations more specific to R&T, using large populations of fur-farmed mink. In initial observations of 60 males, juveniles' R&T frequency positively predicted copulation number and duration in their first breeding season 6 months later. Using 2609 juveniles, we then tested nine modifications to housing or social groupings, identifying three that significantly increased R&T compared to standard mixed-sex, same-strain pair-housing (extra-large cages; male-male pair-housing; mixed-strain pair-housing). These three treatments also increased adult anogenital distance (corrected for body mass) above controls at least in one sex, suggesting increased masculinisation. One group (mixed-strain-housed males; n = 16) was followed to the breeding season. They initiated copulations faster and copulated for longer than controls (n = 15), with individual R&T again predicting copulation duration. Thus, experimentally promoting R&T enhanced male sexual performance, supporting this hypothesis about the function of play. Furthermore, effects were possibly mediated via increased masculinisation. Next, we

plan to investigate all three high-R&T treatments' effects on testosterone levels, as well as sexual performance, in both sexes.

Rapid evolution of smoltification traits in anadromous pacific salmon introduced into an adfluvial environment

Sharron, Steve*; Morbey, Yolanda E

Smoltification refers to the combined ontogenetic changes - physiological, morphological and behavioural - that salmonid fishes undergo in preparation for their juvenile migration from natal rearing streams to the large water bodies where they spend most of their lives. For anadromous fish migrating to the ocean, osmoregulatory transformations are the most important as they reduce osmotic disturbance during the environmental shift. One of these osmoregulatory transformations involves the replacement of freshwater adapted sodium potassium ATPase alpha protein subunit (NaK ATPase &,945;1a) in the gills with its saltwater isoform from a different allele, NaK ATPase &,945;1b. Anadromous Chinook salmon were introduced into Lake Huron c.10 generations ago and some naturalized populations have since been founded. My proposed study aims to test the hypothesis that the introduction from an anadromous to an adfluvial environment can select for individuals undergoing less of these unnecessary preparatory changes that are known to carry an energetic cost. I will test my hypothesis by first determining to what degree individual juveniles in one naturalized population perform these preparatory transformations. Secondly, I will compare juveniles from the Lake Huron population to those from the ancestral Pacific population in a common garden hatchery experiment to assess divergence patterns in the timing and expression of behavioural and osmoregulatory changes involved in smoltification.

Nestedness of fish communities in the Black and Hollow River watersheds

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Numerous studies support the idea that fish communities exhibit non-random structure. This is attributed to biotic and abiotic conditions at both the local and regional scales. Using a presence-absence matrix of species distribution across several sites, regional patterns of community assembly may be detected. Nestedness is a commonly studied pattern of species occurrence. In a nested presence-absence matrix, the species present in small assemblages are a nested subset of those present in larger assemblages. Recently, several studies have sought to elucidate the underlying mechanisms which result in this distribution pattern. Studies have found nested patterns of species occurrence at the watershed scale. The goal of this study was to determine whether fish communities in the lakes of the Black and Hollow River watersheds of South-Central Ontario are significantly nested and whether lake size, isolation and piscivorous predator richness contribute to this pattern. Using existing presence-absence data, I ranked lakes according species richness. Using two nestedness metrics, I found that species occurrence patterns in these watersheds are significantly nested. Lake size and isolation are significant drivers of the nested pattern, but overall

piscivore richness is not. However, largemouth bass (*micropterus salmoides*) and smallmouth bass (*micropterus dolomieu*) do contribute significantly to the nested pattern. Matrix size also impacts results.

Factors Influencing Autumn and Winter Distributions of Dabbling Ducks in the Atlantic and Mississippi Flyways of North America

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In migratory birds, evidence suggests northward latitudinal shifts in distribution during winter for a variety of species in North America (La Sorte and Thompson 2007). Severity of weather necessary to cause southern migration by waterfowl may differ among species. Also, some species of ducks may migrate independently of weather severity, where migration results from endogenous rhythms related to photoperiod (Gwinner 1996). Because wildlife habitats are predicted to change with changing climates, species of dabbling ducks that use weather cues to migrate may remain spatially linked to habitat resources relative to those using photoperiod cues. A Weather Severity Index (WSI) was developed for mallards (*Anas platyrhynchos*; Schummer et al. 2010). The WSI used temperature and snow cover data and explained change in relative abundance of mallards at mid-latitude staging areas during autumn and winter. However, in mallards, photoperiod explained substantially less variation in migration activity during the same period."

Impacts of Urban Landscape Features on Bird-Window Collisions in Toronto

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Bird collisions with building windows have become an increasing concern and variation in collision patterns are poorly understood. Migratory Bird-Window Collisions (BWCs) vary in numbers and in frequency depending on the surrounding landscape features and on the architectural characteristics of the buildings. This study focuses on commercial buildings in three particular regions of Toronto. BWC data was collected on a daily basis by volunteers of the Fatal Light Awareness Program (FLAP) for the fall and spring of 2009 and 2010. Urban landscape features were measured using infrared aerial photographs, orthorectified aerial images, and a high resolution land cover map of Toronto. Building attributes were estimated using land photographs. My primary objective was to assess the impact of window area and adjacent vegetation on bird-window collisions. Results suggest that the proximity of trees to building façades and the percent window cover may increase migratory BWCs in Toronto. In 2010, both percent canopy cover and percent exposed habitat explained a significant proportion of the variation in BWCs per building. This likely supports the idea that more bird window collisions will occur in areas were bird abundance is high. On the other hand, percent land area covered by structures and roads was negatively related with BWCs suggesting that the density of birds decreases in the presence of those landscape features.

Energetics of Wild Ruby-throated Hummingbirds

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Organisms are affected by biotic and abiotic factors. Small, highly energetic organisms, such as hummingbirds, may be especially sensitive to the latter. For example, temperature can dramatically alter energy balance in these endotherms. Inclement weather can impede foraging, thus uncoupling energy intake and expenditure, with consequences for survival. Traditionally, broad scale studies of wild hummingbird energetics have been difficult because repeated recapture of individuals and attachment of data loggers were impractical. Using ruby-throated hummingbirds (*Archilochus colubris*; RTHU) and radio-frequency identification (RFID) technology coupled with digital balances at specially outfitted commercial feeders, we have automated the serial collection of mass data of tagged hummingbirds at artificial feeding stations to track energy balance at a new scale. Six stations set up at the Koffler Scientific Reserve using this technology have redetected 74% of tagged RTHU and have generated mass data for over 2000 visitations in the summer of 2012. Analyses of mass at different stations within narrow time frames indicate repeatable and reliable data. Analyses of mass from specific time points each day closely match patterns observed in manually collected mass data from focal individuals, indicating a sensitive and robust technique. Along with weather data collected on site, our data allows a greater understanding of the effect of abiotic factors on wild RTHU energetics.

Do genomic consequences of the transition to selfing influence extinction risk in Collinsia spp.?

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Higher speciation and extinction rates in self-fertilizing (selfing) lineages compared to outcrossing lineages suggests mating system transitions are likely to influence speciation and extinction dynamics. Selfing species may be short-lived because their lower effective population size (Ne) relative to outcrossers could lower selection efficacy in selfers leading to the accumulation of slightly deleterious mutations in their genomes. Here we examined the transcriptomes of individuals from a recently diverged primarily outcrossing and selfing species pair in the mixed mating genus Collinsia (*C. parryi* and *C. concolor*) for evidence of decreased selection efficacy in the selfer. Following a de novo transcriptome assembly for each species, we compared potential indicators of selection efficacy including predicted substitution effects, the ratio of synonymous to replacement substitutions, codon usage bias, and heterozygosity between the species. Contrary to our prediction, no significant differences between selfers and outcrossers in these measures indicated reduced selection efficacy throughout the selfer's transcriptome. We also found a high ratio of shared polymorphisms to fixed differences implying Ne remained large throughout their divergence. We conclude that because mixed mating species maintain higher Ne throughout the transition to selfing, higher rates of selfing may not significantly reduce selection efficacy and increase extinction risk shortly after their divergence.

The effect of growth on the expression of reproductive tactics in female Kokanee salmon

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Different reproductive phenotypes occur in female kokanee salmon (*Oncorhynchus nerka*) returning in the fall spawning season to Meadow Creek, British Columbia. Female kokanees either arrive in the creek with a changed red skin colour, which is most common, or as others that maintain their silver colour. Red- and silver-arriving females differ in age and size at maturity with the silver females younger and smaller than the red ones. During the life history of a fish, growth is one of the characteristics which plays a significant role in decision-making of age and size at maturity. Theoretically,rapid growing fish tend to mature younger to decrease pre-maturation mortality risk, while the slow growing fish prefer delayed maturation with increased fecundity. The aim of my project is to use otolith growth as a proxy to compare fish growth in different life stages between two phenotypes, thereby investigating to what degree growth influences the difference in age and size at maturity of female kokanee salmon.

Genomic consequences of mating system evolution in a Pacific coastal dune endemic

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The transition from outcrossing to selfing has occurred thousands of times during the evolutionary history of angiosperms, and is significant because it profoundly influences population genetics and demography and thus the evolutionary potential of the species. *Abronia umbellate* is a coastal dune endemic that exhibits a striking geographic shift in mating system across its range, such that plants in populations north of San Francisco produce large flowers and are probably highly outcrossing and plants in populations to the south are small-flowered and likely highly selfing. We are studying the genomic consequences of this mating system shift in *A. umbellata* and are combining genetic and demographic data to infer the origin of selfing in this species. Illumina RNAseq was used to sequence the RNA of bud tissue from 12 individual plants spanning the species' geographic distribution and range of mating system differentiation. This generated ~38.1×10^6 100-base pair reads per sample. *De novo* transcriptome assembly of these reads generated ~200,000 transcripts, which were post-processed to develop a 'consensus' transcriptome of 36,524 transcripts with a mean length of 1,138 base pairs, 94.1% of which have a significant BLAST hit in the plant non-redundant protein database. Analysis of transcriptome variation as well as resequencing genomic DNA will be used to test hypotheses about the causes and genetic consequences of mating system differentiation.