

Jarrett D. Phillips, Ph.D.  
School of Computer Science  
Department of Integrative Biology  
Department of Population Medicine  
University of Guelph  
 [jphill01@uoguelph.ca](mailto:jphill01@uoguelph.ca)  
 [phillipsjarrett1@gmail.com](mailto:phillipsjarrett1@gmail.com)  
 [jphill01](#)  [Jarrett D. Phillips](#)  
 [Jarrett D. Phillips](#)  [Jarrett Phillips](#)  
 [Jarrett Phillips](#)  
 [Dr. Jarrett D. Phillips](#)

---

## **EDUCATION**

My university education has primarily focused on the use of quantitative approaches to solve open problems in biodiversity science and conservation, with an overarching theme of aiding rapid specimen identification and species discovery in academic, applied, and regulatory settings using DNA-based techniques such as DNA barcoding.

**Ph.D.** in Computational Sciences, University of Guelph 2016-2022

**Co-Advisors:** Dr. Daniel Gillis and Dr. Robert Hanner

**Advisory Committee Members:** Dr. Deborah Stacey and Dr. Graham Taylor (School of Engineering)

**Thesis:** A Novel Statistical Framework for Assessment of Intraspecific Haplotype Sampling Completeness: Implications for DNA Barcode Gap Estimation

**Master of Bioinformatics (MBinf.),** University of Guelph 2013-2014

**Co-Advisors:** Dr. Robert Hanner and Dr. Daniel Ashlock (Department of Mathematics and Statistics)

**Thesis:** Assessing DNA Barcode Haplotype Sampling Diversity in the Ray-finned Fishes (Chordata: Actinopterygii)

**BSc. (Hons.)** in Biological Science, University of Guelph 2009-2013

Coursework in bioinformatics, ecology, evolutionary biology, comparative physiology, mathematics, and statistics

## **RESEARCH EXPERIENCE**

I bring extensive past research experience in the use of bioinformatics, computational, mathematical, and statistical tools for the analysis of a wide range of big data in the biological sciences.

**Postdoctoral Fellow** 2023

University of Guelph

GBADs Informatics Team

Stacey Lab, School of Computer Science

Bernardo Lab, Department of Population Medicine

- Development of an R package to run the Animal Health Loss Envelope (AHLE) compartmentalized agent-based model for the Global Burden of Animal Diseases (GBADs) initiative

#### **Postdoctoral Fellow**

2023

University of Guelph  
Gillis Lab, School of Computer Science  
Hanner Lab, Department of Integrative Biology

- Developed a Bayesian hierarchical binary logistic time-series regression model and a R Shiny dashboard of seafood fraud in the Canadian supply chain
- Mentored and supervised an undergraduate STAT\*4600/CIS\*4900 student and an Undergraduate Research Assistant (URA) working to develop models in R, Stan, and Shiny

#### **Postdoctoral Fellow**

2022

University of Guelph  
Hanner Lab, Department of Integrative Biology  
Supervisor: Dr. Robert Hanner

- Mentored and supervised a Master of Bioinformatics (MBINF.) BINF\*6999 student on research project examining DNA barcoding in Canadian pests and disease vectors
- Participated in conceptualization and drafting of various manuscripts and invited book chapters

#### **Summer Research Assistant**

2016

Algoma University  
Plant and Soil Ecology Lab, Department of Biology  
Invasive Species Research Institute (ISRI)  
Supervisor: Dr. Pedro Antunes

- Offered bioinformatics and statistical analysis support in R
- Assisted Principal Investigator and undergraduate thesis student with initial drafting of a manuscript on invasive plant root lesion staining quantification

#### **Lab Assistant Volunteer**

2014-2016

Algoma University  
Plant and Soil Ecology Lab, Department of Biology  
Invasive Species Research Institute (ISRI)  
Supervisor: Dr. Pedro Antunes

- Offered bioinformatics and statistical analysis support in R
- Assisted with collaborative and outreach initiatives for the Terrestrial Invasive Plant Species (TIPS) Network Project through drafting communication letters to public and private conservation agencies across Canada and the USA seeking volunteers to collect invasive plant species for root lesion quantification

**Undergraduate Research Assistant**

2013

University of Guelph

Vaccine Discovery Research Group

Supervisor: Dr. Mario Monteiro

- Performed various experimental techniques (gas chromatography-mass spectrometry (GC-MS) and Nuclear Magnetic Resonance (NMR)) on bacterial polysaccharide samples for vaccine synthesis and development under the supervision of qualified graduate students

**TEACHING EXPERIENCE**

In addition to co-teaching three undergraduate courses, I was directly involved in grading assignments, creating course outlines and lab content, as well as materials for midterms and final exams.

**Graduate Teaching Assistant (GTA)**

2016-2020

University of Guelph

**CIS\*3130 – System Modelling and Simulation**

2020

~ 30 students · Python

**CIS\*1910 – Discrete Structures in Computing I**

2017

~ 300 students (~ 40 students per section)

**CIS\*2460 – Modelling of Computer Systems**

2016-2019

~ 60 students · R, Excel, Java

**STUDENT SUPERVISION AND MENTORSHIP**

I have either directly or indirectly supervised and mentored 14 undergraduate/graduate students in the School of Computer Science, the Department of Mathematics and Statistics, and the Department of Integrative Biology, all of whom are, or will be, coauthors on my publications. My primary role has been to guide students through the entire scientific process (*i.e.*, formulating research questions, designing, and setting up experiments to test hypotheses, collecting data and analyzing results and writing the manuscript drafts), among other responsibilities, such as providing feedback on students' draft reports. Students completed research both as part of a course and as lab volunteers.

**Fynn De Vuono-Fraser (with Dan Gillis)**

2023

University of Guelph

CIS\*4900 · Bayesian modelling of seafood fraud in the Canadian supply chain

**Zaid Al-Gayyali (with Dan Gillis)**

2023

University of Guelph

Summer Undergraduate Research Assistant (URA) · Seafood Fraud Visualization Tool Shiny app

**Fynn De Vuono-Fraser (with Dan Gillis)**

2023

University of Guelph

STAT\*4600 · Bayesian modelling of seafood fraud in the Canadian supply chain

**Amina Asif (with Bob Hanner)**

2022

University of Guelph

BINF\*6999 · DNA barcode gap analysis of Canadian disease vectors and agricultural pests

<b>Navdeep Singh</b> (with Dan Gillis) University of Guelph CIS*4900 · HACSim RShiny web application	2021
<b>Maya Persram</b> (with Bob Hanner) University of Guelph Hanner Lab volunteer · R reporting ecological meta-analysis	2020-present
<b>Ashley Chen</b> (with Bob Hanner) University of Guelph Hanner Lab volunteer · R reporting ecological meta-analysis	2020-present
<b>Olivia Friesen Kroeker</b> (with Bob Hanner) University of Guelph Hanner Lab volunteer · R reporting ecological meta-analysis	2020-present
<b>Scarlett Bootsma</b> (with Dan Gillis) University of Guelph CIS*4900/4910 · HACSim simulation study	2020-2021
<b>Christina Frangel</b> (with Bob Hanner) University of Guelph BINF*6999 · DNA barcode sequence classification with machine learning	2018-2019
<b>Jiaojia (Paula) Yu</b> (with Bob Hanner) University of Guelph BINF*6999 · MDMAPR R Shiny app	2018-2019
<b>Danielle St. Jean</b> (with Dan Gillis) University of Guelph MSc. thesis · DNA barcode sequence classification with machine learning	2018-2019
<b>Steven French</b> (with Dan Gillis) University of Guelph CIS*4900/4910 · HACSim R package	2018
<b>Julia Harvie</b> (with Bob Hanner) University of Guelph MCB*4500/4510 · Data mining GenBank and BOLD	2018-2019
<b>Ankita Bhanderi</b> (with Bob Hanner) University of Guelph BINF*6999 · Data mining GenBank and BOLD	2018

### **ASSISTANTSHIPS, AWARDS, SCHOLARSHIPS AND GRANTS**

Throughout my Ph.D. studies, I have been recognized and awarded numerous assistantships, awards, scholarships, and grants recognizing my research excellence and potential.

<b>Graduate Teaching Assistantships</b> University of Guelph	2017-2020 \$34,506.00-35,148.00 CAD
<b>Graduate Research Assistantships</b> University of Guelph	2017-2019 \$11,000.00 CAD

<b>CPES Graduate Dean's Scholarship</b>	2017
University of Guelph	\$3500.00 CAD
<ul style="list-style-type: none"> <li>Awarded in recognition of achieving over 85% in Master's coursework</li> </ul>	
<b>CPES Graduate Excellence Entrance (GEE) Scholarship</b>	2016
University of Guelph	\$30000.00 CAD
<ul style="list-style-type: none"> <li>Awarded in recognition of achieving over 85% in Master's coursework</li> </ul>	
<b>Arthur D. Latornell Graduate Travel Grant</b>	2019
University of Guelph	\$500.00 CAD
<ul style="list-style-type: none"> <li>Awarded for first-class academic standing in Ph.D. coursework</li> <li>Supported travel to the 8<sup>th</sup> International Barcode of Life Conference in Trondheim, Norway to present work related to resource management and conservation</li> </ul>	
<b>SoCS Travel Grant</b>	2019
University of Guelph	\$1000.00 CAD
<ul style="list-style-type: none"> <li>Supported travel to the 8<sup>th</sup> International Barcode of Life Conference in Trondheim, Norway to present doctoral research</li> </ul>	
<b>Guelph Institute for Environmental Research Small Grants Program (GIER SGP)</b>	2020
University of Guelph	\$15000.00 CAD (not funded)
<ul style="list-style-type: none"> <li>1-year postdoctoral funding to develop a Bayesian hierarchical binary logistic time-series regression model of seafood fraud in the Canadian supply chain</li> </ul>	
<b>NSERC Postdoctoral Fellowship</b>	2021
University of Waterloo	\$90000.00 CAD (not funded)
<ul style="list-style-type: none"> <li>2-year postdoctoral funding to develop an ensemble machine learning model for taxonomic classification of regulated species in Canada</li> </ul>	
<b>Food from Thought Advancing Research Impact (ARIF) Fund</b>	2022
University of Guelph	\$30000.00 CAD
<ul style="list-style-type: none"> <li>1-year postdoctoral funding to develop a Bayesian hierarchical binary logistic time-series regression model of seafood fraud in the Canadian supply chain</li> </ul>	

## **ACADEMIC SERVICE**

I have contributed to the growth of the SoCS through serving on two hiring panels for faculty positions in cybersecurity, specifically to support the new coursework-based Master of Cybersecurity and Threat Intelligence program. Duties included reviewing and ranking candidate applications, conducting in-person interviews, and hosting invited candidates for scheduled luncheons to meet with other faculty members.

<b>School of Computer Science (SoCS) Search Committee</b>	2018
University of Guelph	
<ul style="list-style-type: none"> <li>Associate Professor position in cybersecurity</li> </ul>	
<b>School of Computer Science (SoCS) Search Committee</b>	2017-2018
University of Guelph	
<ul style="list-style-type: none"> <li>Two-year contractually-limited Assistant Professor position in cybersecurity</li> </ul>	

## **ACADEMIC PEER REVIEW SERVICE**

I have served as a reviewer for 17 manuscripts in 8 different journals, both alone or under the guidance of my Ph.D. supervisors.

<i>Ecology and Evolution</i> (2)	2021-2022
<i>F1000 Research</i> (1)	2022
<i>Frontiers in Ecology and Evolution</i> (2)	2022
<i>Lifestyle Genomics</i> (2)	2022
<i>Mitochondrial DNA Part A</i> (2)	2023
<i>Molecular Ecology Resources</i> (6)	2019-2022, 2023
<i>Molecular Biology Reports</i> (1)	2020
<i>Methods in Ecology and Evolution</i> (1)	2020

## **PROCEEDINGS**

I have presented or attended graduate research at six national or international conferences, including both oral presentations and posters. Sessions listed here also include presentations by supervised undergraduate students.

<b>Pathway to Increase Standards and Competency of eDNA Surveys (PICSeS)</b> <b>International Conference</b> (poster presentation) University of Guelph	2023
<b>8<sup>th</sup> International Barcode of Life Conference</b> (oral presentation) NTNU University Museum and Norwegian Biodiversity Information Centre	2019
<b>Guelph BioMathematics and Statistics (BioM&amp;S) Symposium</b> <b>Artificial Intelligence and Machine Learning in Biology</b> (attended) University of Guelph	2019
<b>CEPS Undergraduate Poster Session</b> (student poster presentation) University of Guelph	2018
<b>7<sup>th</sup> International Barcode of Life Conference</b> (oral presentation) University of Johannesburg	2017
<b>6<sup>th</sup> International Barcode of Life Conference</b> (poster presentation) University of Guelph	2015

## **SOFTWARE DEVELOPMENT**

I have been directly or indirectly involved with the development and deployment of two R software package tools for molecular biodiversity analysis.

HACSim (**H**aplotype **A**ccumulation **C**urve **S**imulator) · R package · R Shiny web app

- A novel nonparametric stochastic (Monte Carlo) local search optimization method of iteratively generating species' haplotype accumulation curves through extrapolation to assess within-species sampling completeness
- R package and Shiny app respectively available for download through the Comprehensive R Archive Network ([CRAN](https://cran.r-project.org/)) package repository or at [shinyapps.io](https://shinyapps.io)

- Publication in *PeerJ Computer Science* was one of the top five most viewed papers in the category *Optimization Theory and Computation*
- Has been downloaded over 23000 times (c. 634 times per month) since being published in May 2019

#### VLF (Very Low Frequency) · R package

- A tool to assess PCR errors, sequencing errors, etc. in the form of very low frequency variants, within DNA sequences using a sliding window approach
- R package available for download through [CRAN](#)
- Manuscript published in the *Biodiversity Data Journal*
- Has been downloaded over 34000 times (c. 227 times per month) since publication

#### The Seafood Fraud Visualization Tool · R Shiny web app

- A tool to collate and visualize North American seafood fraud studies

### **REFEREED WORK**

I have been directly or indirectly involved with the conceptualization, research, supervision, and eventual publication of several academic and non-academic projects.

#### **Journal Articles**

Citations: 139 · H-index: 4 (According to Google Scholar, as of September 13, 2023)

\* Indicates students under my direct mentorship or supervision

\*\* Indicates students under my indirect mentorship or supervision

#### Published or Accepted

6. **Phillips, J.D.**, Athey, T.B.T., Hanner, R.H. and McNicholas, P.D. VLF: An R package for the analysis of very low frequency variants in DNA sequences. *Biodiversity Data Journal*, e96480. DOI: [10.3897/BDJ.11.e98480](https://doi.org/10.3897/BDJ.11.e98480). Journal Impact Factor: 1.55.
5. **Phillips, J.D.**, Gillis, D.J. and Hanner, R.H. (2022). Lack of statistical rigor in DNA barcoding likely invalidates the presence of a true species' barcode gap. *Frontiers in Ecology and Evolution*, 10: 859099. DOI: [10.3389/fevo.2022.859099](https://doi.org/10.3389/fevo.2022.859099). Journal Impact Factor: 4.49. Number of article citations: 2.
4. D'Ercole, J., Dincă, V., Opler, P.A., Kondla, N.G., Schmidt, C.B., **Phillips, J.D.**, Robbins, R., Burns, J.M., Miller, S.E., Grishin, N., Zakharov, E.V., deWaard, J.R., Ratnasingham, S. and Hebert, P.D.N. (2020). A DNA barcode library for the butterflies of North America. *PeerJ*, 9: e11157. DOI: [10.7717/peerj.11157](https://doi.org/10.7717/peerj.11157). Journal Impact Factor: 3.06. Number of article citations: 9.
3. **Phillips, J.D.**, \*French, S.H., Hanner, R.H. and Gillis, D.J. (2020). HACSim: An R package to estimate intraspecific sample sizes for genetic diversity assessment using haplotype accumulation curves. *PeerJ Computer Science*, 6(192): 1-37. DOI: [10.7717/peerj-cs.243](https://doi.org/10.7717/peerj-cs.243). Journal Impact Factor: 3.80. Number of article citations: 17.
2. **Phillips, J.D.**, Gillis, D.J. and Hanner, R.H. (2019). Incomplete estimates of genetic diversity within species: Implications for DNA barcoding. *Ecology and Evolution*, 9(5): 2996-3010. DOI: [10.1002/ece3.4757](https://doi.org/10.1002/ece3.4757). Journal Impact Factor: 3.17. Number of article citations: 77.

1. **Phillips, J.D.**, Gwiazdowski, R.A., Ashlock, D. and Hanner, R. (2015). An exploration of sufficient sampling effort to describe intraspecific DNA barcode haplotype diversity: examples from the ray-finned fishes (Chordata: Actinopterygii). *DNA Barcodes*, 3: 66-73. DOI: [10.1515/dna-2015-0008](https://doi.org/10.1515/dna-2015-0008). Number of article citations: 23.

#### Submitted or Under Revision

1. Raymond, K., Sobkowich, K.E., **Phillips, J.D.**, Nguyen, L., McKechnie, I., Mohideen, R.N., Fitzjohn, W., Szurkowski, M., Davidson, J., Rushton, J., Stacey, D.A. and Bernardo T.M. GBADs informatics strategy: User-centric tools, data quality, and model interoperability. *Scientific and Technical Review*.

#### In Preparation or To Be Submitted

7. **Phillips, J.D.**, \*Al-Gayyali, Z.B., \*De Vuono-Fraser, F., Hanner, R.H. and Gillis, D.J. The Seafood Fraud Visualization Tool: An R Shiny web app to summarize, model, and visualize seafood mislabelling trends in the supply chain.

6. **Phillips, J.D.**, \*De Vuono-Fraser, F., Hanner, R.H. and Gillis, D.J. A Bayesian model of seafood fraud in the Canadian supply chain.

5. Morey, K.C., **Phillips, J.D.**, Loeza-Quintana, T. and Hanner, R.H. Haplotype diversity reveals challenges and opportunities for developing targeted detection assays for COI in Canadian freshwater fish. Targeted for *Environmental DNA*.

4. Young, R.G., \*\*Persram, M., \*\*Friesen, O., \*\*Chen, A., \*\*Yu, J., **Phillips, J.D.** and Hanner, R.H. (Under review). Incomplete and irregular reporting of the R statistical and computing environment highlights the need for citation guidelines to support scientific reproducibility. *PeerJ Computer Science*.

3. **Phillips, J.D.**, \*Singh, N., Hanner, R.H. and Gillis, D.J. The HACSim R Shiny app: A web interface to estimate specimen sampling sufficiency for species genetic diversity assessment with DNA sequence data.

2. D'Ercole, J., Dapporto, L., **Phillips, J.D.**, Dincă, V.E., Vila, R., Talavera, G. and Hebert, P.D.N. Macrogenetics of North American butterflies—The impact of Quaternary climatic fluctuations. Targeted for *PNAS*.

1. **Phillips, J.D.**, \*Bootsma, S.E., Hanner, R.H. and Gillis, D.J. Solving the genetic specimen sample size problem with a local search optimization algorithm. Targeted for *Methods in Ecology and Evolution*.

#### **Book Chapters**

#### Submitted or Under Revision

2. **Phillips, J.D.**, Griswold, C.K., Young, R.G., Hubert, N. and Hanner, R.H. A measure of the DNA barcode gap for applied and basic research. *Methods in Molecular Biology*. Springer.

1. Hubert, N., **Phillips, J.D.** and Hanner, R.H. Delimiting species with single-locus DNA sequences. *Methods in Molecular Biology*. Springer.



## Conference Proceedings

4. Morey, K., Loeza-Quintana, T., **Phillips, J.** and Hanner R. (2023). Haplotype diversity reveals challenges and opportunities for developing targeted detection assays for *COI* in Canadian freshwater fish. Pathways to Increase Standards and Competency in eDNA Surveys (PISCeS) Conference. Poster.
3. **Phillips, J.D.**, Gillis, D. and Hanner, R. (2019). HACSim: Iterative extrapolation of haplotype accumulation curves for assessment of intraspecific COI DNA barcode sampling completeness Scientific abstracts from the 8th International Barcode of Life Conference, Trondheim, Norway (ed. Torbjørn Ekrem), *Genome*, 62(6): 349-453. Oral presentation.
2. **Phillips, J.D.**, Gillis, D. and Hanner, R. (2017). Intraspecific sample size estimation for DNA barcoding: Are current sampling levels enough? Scientific abstracts from the 7th International Barcode of Life Conference, Johannesburg, South Africa (ed. M. van der Bank), *Genome*, 60(11): 881-1019. Oral presentation.
1. **Phillips, J.D.**, Gwiazdowski, R.A., Ashlock, D. and Hanner, R. (2015). An exploration of sufficient sampling effort to describe intraspecific haplotype diversity in the ray-finned fishes (Chordata: Actinopterygii). Scientific abstracts from the 6th International Barcode of Life Conference, Guelph, ON., Canada (ed. S.J. Adamowicz), *Genome*, 58(5): 163-303. Poster

## NON-REFEREED WORK

I have communicated aspects of my research to non-technical audiences through various online media, including six blog posts and one newsletter. Throughout, plain language is employed to aid comprehension of often difficult concepts.

### Blog posts

6. **Phillips, J.D.** (2022) Mind the Gap — The DNA Barcode Gap, That Is. Contributed CEPS Research Highlights article (<https://www.uoguelph.ca/ceps/news/2022/08/mind-gap—dna-barcode-gap>).
5. **Phillips, J.D.** (2020). Barcode Cracking. Contributed CEPS Research Highlights article (<https://www.uoguelph.ca/ceps/news/2020/02/barcode-cracking>).
4. **Phillips, J.D.** (2020). Protecting Biodiversity Through the Lens of Genetic Diversity. Contributed guest post to the blog of Dr. Daniel Gillis (<https://danielgillis.wordpress.com/2020/01/30/protecting-biodiversity-through-the-lens-of-genetic-diversity/>).
3. **Phillips, J.D.** (2019). IBOL8 and the Midnight Sun. Contributed guest post to the blog of Dr. Daniel Gillis (<https://danielgillis.wordpress.com/2019/07/02/reflections-ibol8-and-the-midnight-sun/>).
2. **Phillips, J.D.** (2017). The Big Five and IBOL7. Contributed guest post to the blog of Dr. Daniel Gillis (<https://danielgillis.wordpress.com/2017/12/06/reflections-the-big-five-and-ibol7/>).
1. **Phillips, J.D.** (2016). Sample size estimation for DNA barcoding: Are current sampling levels enough? Contributed guest post to the DNA Barcoding Blog of Dr. Dirk Steinke (<http://dna-barcoding.blogspot.com/2016/01/guest-post-sample-size-estimation-for.html>).

### Newsletters

1. **Phillips, J.D.** (2016). Sample size estimation for DNA barcoding of ray-finned fishes: Are current sampling levels enough? Contributed newsletter article to the Barcode Bulletin, 7(1).

## **VOLUNTEER EXPERIENCE**

I have volunteered in various capacities in the SoCS and the Department of Integrative Biology at the University of Guelph.

### **2. Pathways to Increase Standards and Competency in eDNA Surveys (PISCeS) Conference**

University of Guelph

2023

- Participated in international eDNA conference hosted by the Hanner Lab
- Duties included registration, upload, and audiovisual support

### **1. Wireframing session**

2021

University of Guelph

- Participated in student-led use case mobile app prototype demonstrations for CIS\*3750 – System Analysis and Design in Applications
- Graded students based on several factors via Qualtrics surveys

## **REFERENCES**

Dr. Daniel Gillis  
Associate Professor  
School of Computer Science  
University of Guelph  
50 Stone Road East  
Guelph, ON.  
N1G 2W1  
[dgillis@uoguelph.ca](mailto:dgillis@uoguelph.ca)

Dr. Deborah Stacey  
Associate Professor  
School of Computer Science  
University of Guelph  
50 Stone Road East  
Guelph, ON.  
N1G 2W1  
[dastacey@uoguelph.ca](mailto:dastacey@uoguelph.ca)

Dr. Dirk Steinke  
Associate Director – Analytics  
Adjunct Professor  
Centre for Biodiversity Genomics  
Department of Integrative Biology  
University of Guelph  
50 Stone Road East  
N1G 2W1  
Guelph, ON.  
(519) 824-4120 ext. 53759  
[dsteinke@uoguelph.ca](mailto:dsteinke@uoguelph.ca)

Dr. Robert Hanner  
Full Professor  
Department of Integrative Biology  
Biodiversity Institute of Ontario  
University of Guelph  
Guelph, ON.  
50 Stone Road East  
N1G 2W1  
(519) 824-4120 ext. 53479  
[rhanner@uoguelph.ca](mailto:rhanner@uoguelph.ca)

Dr. Graham Taylor  
Full Professor  
School of Engineering  
University of Guelph  
50 Stone Road East  
Guelph, ON.  
N1G 2W1  
(519) 824-4120 ext. 53644  
[gwtaylor@uoguelph.ca](mailto:gwtaylor@uoguelph.ca)

Dr. Sarah Adamowicz  
Associate Professor  
Department of Integrative Biology  
University of Guelph  
50 Stone Road East  
N1G 2W1  
Guelph, ON.  
(519) 824-4120 ext. 53055  
[sadamowi@uoguelph.ca](mailto:sadamowi@uoguelph.ca)