Emma J. Hudgins, PhD

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Research

Research Experience

Carleton University, Postdoctoral Fellow, **Supervisor:** Prof. Joseph Bennett — 2020-present
The production of rules of thumb for the best management strategies for invasive pests and trees experiencing climate-induced range shifts, informed by Mixed Integer Linear Program-based management optimizations, in collaboration with Natural Resources Canada-Canadian Forest Service (NRCan-CFS) and Environment and Climate Change Canada (ECCC).

McGill University, MSc/PhD student, **Supervisor:** Prof. Brian Leung — 2015-2020
General multispecies models for various stages of United States invasive forest insect and pathogen invasions that are applicable at large scales, including a more descriptive understanding of the initial establishment and dispersal phases of invasions, and delineating the impacts caused by species across space and time.

University of Queensland, Visiting Scholar with Eve McDonald-Madden's group — 2018
A 3-month Michael Smith Foreign Study term during which I learned Mixed Integer Linear Programming techniques and developed skills in decision theory as it is applied to conservation planning and invasive species management. This required teaching myself Python.

McGill University, Honours Researcher**, Supervisor:** Prof. Brian Leung — 2014-2015
The creation of a GLM-based model of spatial predictors of invasive species spread in the U.S., validated through theoretical simulations.

Canadian Rivers Institute, University of New Brunswick, Summer Student (3 NSERC USRAs), **Supervisor:** Prof. R. Allen Curry — 2012-2015
Field technician for a variety of limnological and fish conservation studies, including a lake classification system for the province of New Brunswick and an impact assessment of a large dam on Atlantic salmon populations.

Redpath Museum, McGill University, Independent study researcher**, Supervisor:** Prof. Anthony Ricciardi — 2014
A behavioural ecology experiment testing the impact of predator chemical cues on an invasive invertebrate's predatory behaviour.

Education

McGill University, PhD in Biology — 2016-2020
Supervisory Committee: Brian Leung (Supervisor), T. Jonathan Davies, Patrick M. A. James
Thesis: *Predicting biological invasions across species: developing generalized models*

McGill University, MSc in Biology — 2015-2016
Supervisory Committee: Brian Leung (Supervisor), T. Jonathan Davies, Patrick M. A. James
(Fast-tracked to PhD after 1yr)

McGill University, Bachelor of Science, Honours Biology, Minor Environment — 2011-2015
CGPA: 3.97/4.0 (First Class Honours, Dean's Honour List)
Honours Supervisor: Prof. Brian Leung
Thesis: *Statistical modelling of forest pest spread across the United States*

Non-Academic Employment

Tierra Co., Independent Statistical Consultant — 2019-2019
Developing spatial metrics of crime risk.

Funding Earned (total = CAD $325,233)

Amount ($)		
90,000	NSERC Postdoctoral Fellowship	2022
90,000	FRQNT B3X Postdoctoral Scholarship	2020
990	McGill Research Travel Award	2018
6,000	NSERC Michael Smith Foreign Study Supplement	2018
105,000	NSERC Alexander Graham Bell CGS-D	2017
755; 988	Quebec Centre for Biodiversity Science Excellence Award	2016; 2018
500	McGill Biology GREAT Travel Award	2016
17,500	*NSERC Alexander Graham Bell CGS-M*	2015
13,500	*NSERC Undergraduate Student Research Award (x3)*	2012; 2013; 2014

Publications

29. **Hudgins, E.J.,** Hanson, J.O., MacQuarrie, C.K., Yemshanov,D., Baker, C., Holden, M.H., McDonald-Madden, E., & Bennett, J. R. Optimal emerald ash borer (*Agrilus planipennis*) control across the United States. *Submitted. Biological Conservation. Preprint:* *https://doi.org/10.21203/rs.3.rs-1998687/v3*

28. Ahmed, D.A., Beidas, A., ... **Hudgins, E.J.,** ... & Haase, P. Capture efficiency of pitfall traps based on sampling strategy and the movement of arthropods. *Submitted. Methods in Ecology and Evolution.*

27. Ahmed, D.A., Haubrock, P.J., Cuthbert, R.N. ..., **Hudgins, E.J.,** ..., & Courchamp, F. Recent advances in availability and synthesis of the economic costs of biological invasions. *In review. Ecology Letters. Preprint: https://doi.org/10.22541/au.167907497.77590504/v1*

26. Turbelin, A. J.*, **Hudgins, E. J**.*, Catford, J. A., Cuthbert, R. N., Diagne, C., Kourantidou, M., Roiz, D., & Courchamp, F. Biological invasions as burdens to primary economic sectors. *In review. Global Environmental Change. Preprint: https://doi.org/10.21203/rs.3.rs-2444595/v1*
joint first author

25. Soto, I., …., **Hudgins, E.J.,** & Briski, E. The faunal Ponto-Caspianization of European Waterways. *In Revision. Biological Invasions.* Preprint: https://doi.org/10.21203/rs.3.rs-1702320/v1

24. Braga, P.H.P, Hébert, K., **Hudgins, E. J.,** Scott, E. R., Edwards, B., Sánchez-Reyes, L. L., … , & Crystal-Ornelas, R.,. Not just for programmers: How GitHub can accelerate collaborative and reproducible research in ecology and evolution. *Accepted. Methods in Ecology and Evolution. Preprint: https://doi.org/10.31222/osf.io/x3p2q*

23**. Hudgins, E.J.*, Cuthbert, R.*, Haubrock, P.*,** Taylor, N., Kourantidou, M., Nguyen, D., ... & Courchamp, F. The ecological dimension of global trade: origin and recipient regions of biological invasion costs. Accepted in principle. *Nature Sustainability. Preprint: https://doi.org/10.21203/rs.3.rs-1762292/v1*
joint first author

22. Riva, F.* Graco-Roza, C.*, Daskalova, G., **Hudgins, E.J.,** Lewthwaite, J. M. M., Newman, E. A., Ryo, M., & Mammola, S. Towards a cohesive understanding of ecological complexity. Resubmitted. *Science Advances. https://ecoevorxiv.org/tzy9k/*
joint first author

21. Hudgins, J.A., **Hudgins, E.J.**, Köhnk, S., Mohamed Riyad, E., & Stelfox, M.R. A brighter future? Stable and growing sea turtle populations in the Republic of Maldives. *In press.* PLoS oNE.

20. Gomes, D.G.E, …, **Hudgins, E.J.,** & Gaynor, K.M. Why don't we share data and code? Perceived barriers and benefits to public archiving practices. *Proceedings of the Royal Society B.,* 289(1987). *https://royalsocietypublishing.org/doi/10.1098/rspb.2022.1113*

19. Hanson, J.O., McCune, J.L., Chadès, I., Proctor, C.A., **Hudgins, E.J.,** & Bennett, J.R., Optimizing ecological surveys for conservation. Journal of Applied Ecology, 60, 41-51 https://doi.org/10.1111/1365-2664.14309

18. Palacio, F., Callaghan, C.T., Cardoso, P., **Hudgins, E.J.,** Jarzyna, M., Ottaviani, G., Riva, F., Roza, C., Shirey, V., & Mammola, S. A protocol for reproducible functional diversity analyses. *Accepted. Ecography. Preprint: https://ecoevorxiv.org/yt9sb/*

17. Soto, I., Cuthbert, R.N., Kouba, A., Capinha, C., Turbelin, A., **Hudgins, E.J.,** Diagne, C., Courchamp, F., & Haubrock, P.J. (2022) Global economic costs of herpetofauna invasions. *Scientific Reports* 12, 10829. *https://doi.org/10.1038/s41598-022-15079-9*

16. Edwards, B.P.M, Binley, A.D., English, W.B., **Hudgins, E.J.**, & Snow, S.S. (2022). A highly anomalous Red-winged Blackbird (*Agelaius phoeniceus*) song. *The Canadian Field Naturalist* 136(1), 1-4. *https://doi.org/10.22621/cfn.v136i1.2877*

15. Haubrock, P.J., Ahmed, D.A.A., Cuthbert, R.N., ….**Hudgins, E.J.,** *et al.* (2022). Invasion impacts and dynamics of a European-wide introduced species. *Global Change Biology* 28(15), 4620-4632. *https://doi.org/10.1111/gcb.16207*.

14. Turbelin, A.J., Diagne, C., **Hudgins, E.J**., Moodley, D., Haubrock, P.J., *et al.* (2022). Introduction pathways of economically costly invasive alien species. Biological Invasions. *Biological Invasions* 24, 2061-2079. *https://doi.org/10.1007/s10530-022-02796-5*

13. **Hudgins, E. J.,** Koch, F.H., Ambrose, M.J., & Leung, B. (2022). Hotspots of pest-induced US urban tree death, 2020-2050. *Journal of Applied Ecology*. *https://doi.org/10.1111/1365-2664.14141/*

12. Ahmed, D.A.*, **Hudgins, E.J.*,** Cuthbert, R.N.*, Kourantidou, M., Diagne, C., *et al.* (2022). Managing biological invasions: the cost of inaction. *Biological Invasions* 24, 1927-1946. *https://doi.org/10.1007/s10530-022-02755-0*
joint first author

11. Cuthbert, R.N., Diagne, C*. **Hudgins, E.J.,*** Turbelin, A.J.*, Ahmed, D. A., Albert, C., Bodey, T.W., Briski, E., Essl, F., Haubrock, P.J., Gozlan, R.E., Kirichenko, N., Kourantidou, M., Kramer, A. M., & Courchamp, F. (2022). Biological invasion costs reveal insufficient proactive management worldwide. *Science of the Total Environment, 153404.* *https://doi.org/10.1016/j.scitotenv.2022.153404*.
joint second author

10. Haubrock, P. J., Cuthbert, R. N., **Hudgins, E. J.,** Crystal-Ornelas, R., Kourantidou, M., Moodley, D., Liu, C., Turbelin, A.J., Leroy, B., & Courchamp, F. (2022). Geographic and taxonomic trends of rising biological invasion costs. *Science of the Total Environment*, 152948. *https://doi.org/10.1016/j.scitotenv.2022.152948*

9. Ahmed, D. **Hudgins, E.J.,** Cuthbert, R., Haubrock, P.J., Renault, D., Bonnaud, E., Diagne, C., & Courchamp, F (2021). Modelling the damage costs of invasive alien species. *Biological Invasions.* *https://doi.org/10.1007/s10530-021-02586-5*.

8. Reid, C.H., **Hudgins, E.J.,** Guay, J.D., Patterson, S., Medd, A.M., Cooke, S.J., & Bennett, J.R. The state of Canada's biosecurity efforts to protect biodiversity from species invasions (2021). *FACETS* 6: 1922-1954. *https://doi.org/10.1139/facets-2021-0012*

7. Crystal-Ornelas, R., **Hudgins, E.J.,** Cuthbert, R.N., Haubrock, P.J., Fantle-Lepczyk, J., Angulo, E., Kramer, A., Ballesteros-Mejia, L., Leroy, B., Leung, B., López-López, E., Diagne, C., & Courchamp, F (2021). Economic costs of biological invasions within North America. *NeoBiota 67, 485-510.* *https://doi.org/10.3897/neobiota.67.58038*

6. **Hudgins, E.J.,** Liebhold, A.M., & Leung, B. Comparing generalized to customized models for United States invasive forest pests (2020). *Ecological Applications 30(1), e01988.* *https://doi.org/10.1002/eap.1988*

5. Leung, B., **Hudgins, E.J.**, Potapova, A., & Ruiz-Jaen, M. A new baseline for countrywide α-diversity and species distributions: illustration using >6000 plant species in Panama. (2019). *Ecological Applications 29(3): e01866.* *https://doi.org/10.1002/eap.1866*

4. **Hudgins, E.J.,** Liebhold, A.M., & Leung, B. (2018). Corrigendum: Predicting the spread of all invasive forest pests in the United States. *Ecology Letters 21(11): 1752-1754.* *https://doi.org/10.1111/ele.13149*

3. **Hudgins, E.J.,** Liebhold, A.M., & Leung, B. (2017). Predicting the spread of all invasive forest pests in the United States. *Ecology Letters 20(4): 426-435.* *https://doi.org/10.1111/ele.12741*

2. Iacarella, J.C., **Hudgins, E.J.**, Dick, J.T.A., & Ricciardi, A. (2017). Predatory behaviour of an invasive amphipod in response to the presence of conspecifics and predation risk. *Canadian Journal of Fisheries and Aquatic Sciences 75(1): 131-140.* *https://doi.org/10.1139/cjfas-2016-0417*

1. Hudgins, J., **Hudgins, E.J.,** Ali, K., & Mancini, A. (2017). Citizen science surveys elucidate key foraging and nesting habitat for two endangered marine turtle species within the Republic of Maldives. *Herpetology Notes 10: 463-471.*

Selected Presentations

Oral presentations

Hudgins, E.J.*, Bennett, J.R., & Leung, B. New perspectives in forest invader management. Presented at the Ecological Society of America's annual meeting, August 16, 2022.

Hudgins, E.J.*. New perspectives in North American urban forest pest management. Webinar for the International Pest Risk Research Group. July 13, 2022. Invited presentation. [link]

Hudgins, E.J.*. New perspectives in forest pest management for a resilient urban canopy. Presented at the Invasive Species Centre's Annual Symposium. Feb 3, 2022. Invited presentation. [link]

Hudgins, E.J.*. Optimal control of emerald ash borer (*Agrilus planipennis*) spread across the United States. Presented at the Forest Pest Management Forum (Canadian Federal-Provincial-Municipal-NGO meeting). Dec. 9, 2021.

Crystal-Ornelas, R., **Hudgins, E.J.*,** Cuthbert, R.N., Haubrock, P.J., Fantle-Lepczyk, J., Angulo, E., Kramer, A., Ballesteros-Mejia, L., Leroy, B., Leung, B., López-López, E., Diagne, C., & Courchamp, F. Economic costs of biological invasions within North America. Presented at the Invasive Species Council of British Columbia's annual meeting, Oct. 6, 2021. Invited presentation.

Hudgins, E.J.*, Koch, F.H., Ambrose, M.J., & Leung, B. Urban tree deaths from invasive alien forest insects in the United States, 2020-2050. Presented at the International Association for Landscape Ecology – North America conference, April 12, 2021, in the organised symposium "Forecasting Biological Invasions".

Hudgins, E.J.*, Koch, F.H., Ambrose, M.J., & Leung, B., *Estimating the economic damages of United States invasive forest pests.* Presented at the World Conference on Natural Resource Modelling, May 23rd, 2019. Winner – Best Student Presentation.

Hudgins, E.J.*, Liebhold, A.M., & Leung B. *General versus species-specific models for the spread of United States invasive forest pests.* Presented at the Quebec Centre for Biodiversity Science Symposium, December 12th, 2018.

Hudgins, E.J.*, Liebhold, A.M., & Leung B. *Customized versus generalized models of forest insect and pathogen spread.* Presented at the Ecological Society of America Annual Meeting, August 8th, 2018.

Hudgins, E.J.*. Optimal invasive forest pest management in the United States. Presented at the Mathematics of Biological Systems Management conference, University of Melbourne, April 6th, 2018.

Hudgins, E.J.*. Optimal control of the spread of invasive forest pests in the United States. Presented at the University of Queensland's Centre for Biology and Conservation Science's weekly seminar series, March 20th, 2018. Invited seminar.

Hudgins, E.J.*, Liebhold, A.M., & Leung B. *Comparing generalized to customized models for United States invasive forest pests.* Presented at the Quebec Centre for Biodiversity Science Symposium, December 15th, 2017.

Hudgins, E.J.*, Liebhold, A.M., & Leung B. *A comparison between general and species specific spread models for United States invasive forest pests*. Presented at the Ecology and Evolution Lunches series, Nov 23rd, 2017.

Hudgins, E.J.*, & Leung B. *The effect of host diversity on the establishment of United States invasive forest pests.* Presented at the McGill Conservation, Ecology, Evolution and Behaviour retreat, April 8th, 2017.

Hudgins, E.J.*, Liebhold, A.M., & Leung B. *Forecasting United States forest invaders: A general predictive model for pest spread.* Presented at the Quebec Centre for Biodiversity Science Symposium, December 16th, 2016.

Hudgins, E.J.*, Liebhold, A.M., & Leung B. *A general predictive model for forecasting United States invasive pest spread.* Presented at the Ecological Society of America Annual Meeting, August 11th, 2016

Hudgins, E.J.* *Modelling invasive forest pest spread across the United States.* Presented at McGill's Honours Symposium, April 15th, 2015.

*** presenting author**

Poster Presentations

Hudgins, E.J.*, Davies, T.J., Leung, B. *A unifying phylogenetic model for the effect of host phylogenetic diversity on invasive pest establishment.* Poster presented at the British Ecological

Society Festival of Ecology. Dec 14-18th, 2020.

Hudgins, E.J.*, Koch, F.H., Ambrose, M.J., Leung, B., *Estimating the economic damages of United States invasive forest pests.* Poster presented at Natural Resources Canada's Forest Pest Management Forum, December 3-5th, 2019.

*** presenting author**

Selected media coverage

Soto, I., & **Hudgins, E.J.,** September 13, 2022. Invasive reptile and amphibian species are causing billions of dollars in damages globally. The Conversation Canada. https://theconversation.com/invasive-reptile-and-amphibian-species-are-causing-billions-of-dollars-in-damages-globally-188680. *Coverage of publication # 17.*

McDiarmid, J. July 14, 2022. Scientists tackling one invasive species with another. https://www.nationalobserver.com/2022/07/14/news/scientists-tackling-one-invasive-species-another.

DiLonardo, M.J. May 13, 2022. Invasive Insects Will Kill 1.4 Million Urban Trees by 2050. https://www.treehugger.com/invasive-insects-kill-million-trees-2050-5271729. *Coverage of publication #13*

Blakemore, M. March 20, 2022.U.S. cities will lose over 1.4 million street trees to insects by 2050 https://www.washingtonpost.com/science/2022/03/20/trees-pests-ash-borer/. *Coverage of publication #13*

CBC Quirks and Quarks. March 19, 2022. The urban tree canopy is facing a worst-case scenario in the near future. https://www.cbc.ca/radio/quirks/mar-19-a-sabretooth-hypercarnivore-pack-hunting-spiders-urban-trees-and-invasive-insects-and-more-1.6388365 *Coverage of publication #13*

LePage, M. *Many US cities will lose nearly all ash trees by 2060.* May 6, 2021. The New Scientist. https://www.newscientist.com/article/2276885-many-us-cities-will-lose-nearly-all-ash-trees-by-2060/#ixzz7CuDAOcyD. *Coverage of publication #13 as a preprint.*

Reid, C.H., **Hudgins, E.J.,** Guay, J.D., Patterson, S., Medd, A.M., Cooke, S.J., & Bennett, J.R. *How well is Canada prepared to manage current and future invasive species threats to biodiversity?* Medium. https://medium.com/facets/how-well-is-canada-prepared-to-manage-current-and-future-invasive-species-threats-to-biodiversity-a43b0f817fc5. *Coverage of publication #8.*

Research Skills

Programming Languages: R (excellent), Python (very good), bash/shell (very good), STAN (very good), CSS (good), (R)Markdown (good), LaTeX (good), MATLAB (good), SAS (good), C/C++ (basic)**, Software:** GUROBI, QGIS/ArcGIS, RStudio, SAS, MATLAB, SPSS, Git(Hub), Open Science Framework

Quantitative methods: Routine use of GLMM, GAM, boosted regression trees, Bayesian methods, simulation modelling, Latin Hypercube sampling, Nelder-Mead methods, genetic algorithms, neural

networks, mixed-integer linear programming (MILP). I deploy many of my algorithms in a parallel-processing framework.

Field Techniques: Tropical ecology field course in Barbados, Limnology field course at Mont-Ste-Hilaire, QC, 4 years of limnological/fisheries field experience.

Languages: English (native) and French (conversational)

Certifications: PADI Open Water Diver, WHMIS, Pleasure Craft Operator's Card**,** Backpack Electrofishing Certificate

Teaching

Lecturing

Curriculum design and course delivery ISAP 2002, Research Principles for Interdisciplinary Science, Carleton University (Winter 2023)	2022
Course lecturer (co-Instructor of Record) ENSC 2002, Environmental Methods and Analysis, Carleton University	2021
Teaching Assistant, BIOL 373, Biometry (5 semesters)**,** McGill University	2015-2019
Teaching Assistant, ENVR 202, The Evolving Earth (4 semesters), McGill University	2015-2019
Undergraduate Teaching Assistant, BIOL 308, Ecological Dynamics, McGill University	2015

Supervision

PhD committee member, Ana Hernández De la Riva, Carleton University	2022
Honour's thesis Supervisor, Marie Wright, Carleton University	2021-2022
Research associate co-supervisor, Yuyan Chen, McGill University	2021
High school student mentor, Sarah Duguay, Talaria Summer Internship Program for marginalized students	2021
Independent Study Supervisor, ENSC 4901, Directed Studies (Chibudom Orji, Shujin Chen)**,** Carleton University	2020-2021
Mentor, BIOL 5512, Advances in Applied Ecology**,** Carleton University	2020

Service

Faculty and student governance

Carleton Biology Department Board, Postdoc rep.	2021-2022
Geomatics and Landscape Ecology Laboratory Friday Discussions, Journal club coordinator (mailing list of >350)	2021-2022
Carleton Biology Department Board, Alternate postdoc rep.	2020-2021
McGill Biology Graduate Students Association, Social media rep.	2019-2020
Faculty of Science Committee on Equity and Climate, McGill University, Graduate student rep.	2019-2020

Postgraduate Students Society of McGill University Equity Committee, Biology graduate student rep. 2017-2020
Biology Department Day and Equity Workshop (3 events), Co-organizer 2017-2019
STEMM Diversity @ McGill, Volunteer 2017
Equity in STEMM Working Group, Co-founder 2016-2019
McGill Biology Graduate Students Association, Equity and diversity rep. 2017-2019

Peer review

Reviewer for:
Applied Vegetation Science, Biological Invasions, Diversity, Diversity and Distributions, Ecological Applications, Ecology Letters, Forests, International Journal of Pest Management, Journal of Applied Ecology, Journal of Biogeography, Journal of Ecology, Journal of Forestry, Journal of Theoretical Biology, Management of Biological Invasions, Nature Conservation, Royal Society Open Science, Urban Forestry & Urban Greening

Editorial Duties:
Current Landscape Ecology Reports – Section Editor
Frontiers in Insect Science – Invasive Insect Species Section Review Editor

Workshop organization

Project-based workflows with GitHub. Two-hour training co-delivered with fellow postdoc Courtney Robichaud to Waterloo University Biology students Feb 16th, 2022.

A new perspective on forest pest management conventional wisdom. Two-day virtual workshop co-organized by myself, Joseph R. Bennett (Carleton University) and Brian Leung (McGill University). January 17-18, 2022 with 15 experts across disciplines.

Equitable Cities for Healthy People and Nature. Rapporteur, support person, web app developer, organized by Rachel Buxton virtually at Carleton University. September 2 and 29, 2021. (~50 virtual attendees, https://carleton.ca/naturalcities/)

Promoting GitHub use in EcoEvo Workshop. Co-organized with Rob Crystal-Ornelas and 5 others. July 12, 2021. Part of the Society for Open, Reproducible, and Transparent Ecology and Evolution (SORTEE) 2021 Conference.

Workshop attendance and committee membership

Carleton Geomatics and Landscape Ecology Laboratory Friday Discussion Group	2020-present
Carleton Kinàmàgawin Anti-Indigenous Racism Workshop	2022
Carleton Student Development Theory in Higher Education Workshop	2021
Carleton Cross-Cultural Competency Workshop	2021
Carleton Effective Communication and De-Escalation Skills Workshop	2021
Carleton Responding to Disclosures of Sexual Violence Workshop	2021
Carleton Indigenous Cultural Awareness Workshop	2021
InvaCost Workshop	2019
QCBS R Markdown Workshop	2019
McGill Conservation, Ecology, Evolution, and Behaviour Discussion Group	2017-2019
McGill Organismal Seminar Series	2015-2020
MARXAN Decision Support Tool Workshop	2018
Gender Summit North America	2017
Statistics and Biology Exchange Group	2015-2017
Joint NIMBioS-MBI-CAMBAM Summer School	2017
IGSF Feminist Pedagogy Workshop	2017
Quebec Centre for Biodiversity Science Data Visualization Workshop	2016