Physical & Environmental Sciences
UNIVERSITY OF TORONTO
SCARBOROUGH

EESC04 – Biodiversity and Biogeography
Winter 2023

Instructor: Dr. Adam Martin (adam.martin@utoronto.ca).

Teaching assistants:
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Lectures: Tuesdays 5-7pm, IC 208, with Web Option videos and PDF of slides posted on the course Quercus page after lectures.

Office hours: Tuesdays 10:00-11:00 am, Room EV 464.

Practicals: Thursdays, 9-11 am **OR** 11 am-1 pm **OR** 1-3 pm, Room EV 222

Course readings: Peer-reviewed papers listed below.

Course description:

Biogeography is the study of the geographic distribution of species, and biodiversity is the study of species richness and relative species abundance. Through lectures and in-class discussions, this course explores the origin, maintenance, and loss of biodiversity, from a biogeographic perspective. The course aims to provide students with a broader understanding of what constitutes biodiversity, how it has come to be, and what geographic factors help explain and drive the patterns observed today.

The first half of the course will examine key themes within the sphere of biodiversity, including:

i) Species concepts.
ii) The number of species on Earth.
iii) How biodiversity is distributed globally.
iv) The value of biodiversity to humans.

The second half of the course then switches gears and evaluates key themes in the realm of biogeography including:

i) Biodiversity changes across geologic time scales.
ii) The major biomes of the world.
iii) The Island Theory of Biogeography.
iv) The SLOSS debate.
v) The Anthropocene Epoch and the geological scale of human-caused extinctions.

Course Evaluation:

Course Item	Due Date	Percent
Lab Report 1. Introduction to R statistical software for environmental science (* Independent).	Feb. 2nd	10%
Lab Report 2. Analyses of biodiversity using R (* Independent)	Feb. 16th	20%
Lab Report 3. Independent biodiversity research using R (* Groups of 3 students).	March 23rd	30%
Lab 3 Research presentation. (* Groups of 3 students).	March 30th	15%
Final Exam (take home)	TBD	25%

In-class content and schedule:

Week	Date	Lecture topic	Related paper review	During this week
1	Jan. 10	Introduction to Biodiversity and Biogeography		
2	Jan. 17	Species concepts and classification	Reading 1	
3	Jan. 24	How many species are there in the world?	Readings 2.1, 2.2, and 2.3	
4	Jan. 31	The latitudinal diversity gradient	Reading 3	**Lab 1 report due (10%)** *** Independent assignment**
5	Feb. 7	Biodiversity and ecosystem function	Reading 4	
6	Feb. 14	Biodiversity through geologic time Pt. 1	Reading 5	**Lab 2 report due (20%)** *** Independent assignment**
	Feb. 21	**Reading week**		
7	Feb. 28	Biodiversity through geologic time Pt. 2	Reading 6	
8	March 7	Biodiversity through geologic time Pt. 3		
9	March 14	Biomes of the world	Readings 7.1 and 7.2	
10	March 21	Island biogeography	Reading 8	**Lab 3 report due (30%)** *** Small group assignment**
11	March 28	The SLOSS debate	Reading 9.1 and 9.2	**Lab 3 presentation (10%)** *** Small group assignment**
12	Apr. 4	The Anthropocene and species extinctions	Reading 10.1 and 10.2	

Course readings

Reading 1. Zachos, F.E. (2016) An annotated list of species concepts. Species Concepts in Biology, pp. 77-96. Springer, Cham.

Reading 2.1 May, R.M., 1988. How many species are there on Earth? *Science*, *241*(4872), pp.1441-1449.

Reading 2.2 Mora, C., Tittensor, D.P., Adl, S., Simpson, A.G. & Worm, B. (2011) How many species are there on Earth and in the ocean? PLoS Biology, 9, e1001127.

Reading 2.3 Stork, N.E., 2018. How many species of insects and other terrestrial arthropods are there on Earth. Annual Review of Entomology, 63, 31-45.

Reading 3. Mittelbach, G.G., Schemske, D.W., Cornell, H.V., Allen, A.P., Brown, J.M., Bush, M.B. & McCain, C.M. (2007) Evolution and the latitudinal diversity gradient: speciation, extinction and biogeography. Ecology Letters, 10, 315-331.

Reading 4. Costanza, R., de Groot, R., Sutton, P., Van der Ploeg, S., Anderson, S.J., Kubiszewski, I., Farber, S. & Turner, R.K. (2014) Changes in the global value of ecosystem services. Global Environmental Change, 26, 152-158.

Reading 5. Zhang, X., Shu, D., Han, J., Zhang, Z., Liu, J. & Fu, D. (2014) Triggers for the Cambrian explosion: hypotheses and problems. Gondwana Research, 25, 896-909.

Reading 6. Benton, M.J. & Twitchett, R.J. (2003) How to kill (almost) all life: the end-Permian extinction event. Trends in Ecology & Evolution, 18, 358-365.

Reading 7.1 Ellis, E.C., Klein Goldewijk, K., Siebert, S., Lightman, D. & Ramankutty, N. (2010) Anthropogenic transformation of the biomes, 1700 to 2000. Global Ecology and Biogeography, 19, 589-606.

Reading 7.2 Keith, D.A., Ferrer-Paris, J.R., Nicholson, E., Bishop, M.J., Polidoro, B.A., Ramirez-Llodra, E., Tozer, M.G., Nel, J.L., Mac Nally, R., Gregr, E.J. and Watermeyer, K.E., 2022. A function-based typology for Earth's ecosystems. *Nature*, *610*(7932), pp.513-518

Reading 8. Santos, A.M., Field, R. & Ricklefs, R.E. (2016) New directions in island biogeography. Global Ecology and Biogeography, 25, 751-768.

Reading 9.1 Gilbert-Norton, L., Wilson, R., Stevens, J.R. & Beard, K.H. (2010) A meta-analytic review of corridor effectiveness. Conservation Biology, 24, 660-668.

Reading 9.2 Resasco, J., (2019) Meta-analysis on a decade of testing corridor efficacy: what new have we learned? Current Landscape Ecology Reports, 4, 61-69.

Reading 10.1 Ceballos, G., Ehrlich, P.R., Barnosky, A.D., García, A., Pringle, R.M. & Palmer, T.M. (2015) Accelerated modern human–induced species losses: entering the sixth mass extinction. Science Advances, 1, e1400253.

Reading 10.2 Ceballos, G., Ehrlich, P.R. and Raven, P.H., 2020. Vertebrates on the brink as indicators of biological annihilation and the sixth mass extinction. *Proceedings of the National Academy of Sciences*, *117*(24), pp.13596-13602.

Assignments and graded material in brief

Lab Reports (*3 Witten Reports and 1 Presentation): The lab-based and technical skills that EESC04 will largely focus on this term, are scientific literacy, and analysis of biodiversity data using R statistical software. This program is quickly becoming the leading program with which scientific data is analyzed, and therefore represents a highly transferable skill. In EESC04 this term, students will be led through a series of exercises that introduce students to this program, use R for fundamental analyses of biodiversity, and explore an in-depth project related to biodiversity that includes R-based analyses. In sum, these three lab reports and associated lab presentation are as follows:

Lab 1 Report. Introduction to R statistical software for environmental science. * Independent assignment.

Lab 2 Report. Analyses of biodiversity data using R. * Independent assignment.

Lab 3 Report. Independent biodiversity research using R. * Groups of 3 students.

Lab 3 Presentation. Independent biodiversity research using R. * Groups of 3 students.

Final exam: A comprehensive final exam covering the course material, though weighted heavily to the final half of the course, will be given during UTSC examination period worth 40% of your final grade. The final exam will consist of long answer questions, and will be based on both lecture and readings. The final exam will be distributed approximately 24 hours prior to the due date.

Course policies – written assignments

Late assignments: All late assignments will be graded at a penalty of 10% per day.

Plagiarism: Plagiarism is a serious academic offence. Please read the faculty's guidelines on plagiarism. Do not hesitate to consult with your instructor or TA about strategies that you can use to avoid being accused of plagiarism. Please note that all of your assignments will be reviewed through Ouriginal, which will compare your content to both published material, and material submitted by others in EESC04.

Course website – Quercus: EESC04 uses Quercus as its course website. To access the EESC04 website go to the U of T portal login page at http://toolboxrenewal.utoronto.ca/, and log in using your UTORid and password. Once you have logged in to the portal, look for your course modules where you'll find the link to the EESC04 course website.

Email contact, office hours, and communication: The course instructor will send out important course information on Quercus. Therefore all students are required to have a valid UTSC email address. You are also responsible for ensuring that your UTSC email address is set up and properly entered in the ROSI system. You may also email me questions about course material. I will make an effort to respond to you within 24 hours during weekdays. My responses will take longer during weekends because I deliberately remain offline. **Email should not be a substitute to in-person course time.**

Accessibility Statement: Students with diverse learning styles and needs are welcome in this course. In particular, if you have a disability/health consideration that may require accommodation, please feel free to approach me and/or Accessibility Services Office as soon as possible. I will work with you and Accessibility Services to ensure you can achieve your learning goals in this course. Enquiries are confidential. The UTSC Accessibility Services staff (located in S302) is available by appointment to assess specific needs, provide referrals and arrange appropriate accommodations (416-287-7560 or ability@utsc.utoronto.ca).

The Writing Centre: The Writing Centre is a free service that provides support for teaching and learning through writing for all UTSC students. The Writing Centre provides service such as one-on-one consultation, drop-in hours, English language development and writing clinics. They are located in AC 210, in the Academic Resource Centre.

Health and Wellness Clinic: The Health & Wellness Centre has trained health professionals to provide medical, nursing, counseling, health promotion, and education services to University of Toronto Scarborough students. Any student with a current student card and a valid health card can use our services. They are located in the Student Centre, UTSC, SL 270.