



# Integration of biodiversity into the curricula of select Ontario universities

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# INTEGRATION OF BIODIVERSITY INTO THE CURRICULA OF SELECT ONTARIO UNIVERSITIES

## Introduction:

As countries around the world face complex environmental issues, there is a growing recognition that education has a key role to play. Environmental education, including an awareness of the importance of biodiversity, is a vital tool to help people understand the nature and complexity of environmental challenges and build their capacity to take appropriate action.

The conservation of Ontario's biodiversity depends upon a public that understands and values biodiversity, is aware of the threats to it and understands how to take action to help protect and promote it. This awareness may come from a variety of sources, but formal education has a key role to play (Pooley and O'Connor 2000; Smith, Bazely and Yan 2011). Universities serve two important societal roles: conducting research and educating and training professionals in environmental protection (Kassas 2002; Sibbel 2008). This environmental education is most effective when students are not only informed of the key issues (e.g., biodiversity loss), but also when students' values and attitudes are engaged (Pooley and O'Connor 2000; Shephard 2007).

Target 1 of the Ontario's Biodiversity Strategy (OBC 2011) identifies the need for integrating biodiversity into the curriculum of Ontario schools including postsecondary institutions and schools of business. Assessing progress in achieving this target and others relies on the development of indicators that can be regularly updated. An assessment of how and to what degree biodiversity has been incorporated into university education has not previously been conducted in Ontario. This report outlines the process used to develop the indicator that explores the extent to which biodiversity has been integrated into the curriculum of select Ontario universities and the results of the first assessment. It establishes a baseline for reporting on biodiversity education at the university level for future assessments.

Although this is the first time that biodiversity content has been evaluated in Ontario universities, previous research has explored the degree to which the related topics of sustainability, environmental assessment and invasive species education have been incorporated into Canadian universities (Moore 2005; Stelmack, Sinclair and Fitzpatrick 2005; Beringer, Wright and Malone 2008; Smith *et al.* 2011). Most relevant for this index is the study conducted by Smith *et al.* (2011), who explored invasive alien species (IAS) education across Canada. Invasive species pose a threat to the health and habitat of native species (e.g., through competition and predation; Simberloff, Parker and Windle 2005), so understanding IAS education across Canada is also relevant to biodiversity education. Smith *et al.* (2011) examined all 94 members of the Association of Universities and Colleges of Canada for IAS content within undergraduate and graduate programs. They focused on agriculture, biology, conservation, ecology, environmental science or studies and similar programs, and they reviewed the program content online for IAS. They found that none of the 94 member institutions had undergraduate or graduate programs specifically dedicated to IAS. However, most universities had programs in environmental science or studies, which included IAS content. IAS was usually the focus of a single lecture within courses in these programs. Importantly, there was often interdisciplinary training within the undergraduate and graduate programs studied that dealt with IAS issues, such as problem-solving,

creative and critical thinking, and considering environmental, social and economic factors. Smith *et al.* (2011) concluded that invasive alien species are not a major focus of Canadian universities, and that institutions should strive to increase IAS education.

**Methods:**

A detailed review of the curriculum of six Ontario universities was conducted to create an index of the degree to which biodiversity has been integrated into university undergraduate and graduate education, with a special focus on business schools. The universities in the index included: Carleton University (1), University of Guelph (2), Lakehead University (3), the University of Toronto (4), Trent University (5) and the University of Ontario Institute of Technology (UOIT; 6). These universities were considered to be a representative selection because they included small, medium and large universities covering a wide geographic scale (northern, southern and eastern Ontario). The universities within this index represent 30% of the 20 universities in Ontario. There is a total population of nearly 158,000 students enrolled at these six universities (Table 1).

Table 1: Student enrollment by university within this index.

UNIVERSITY	LOCATION	STUDENT ENROLLMENT	ENROLLMENT DETAILS (WHEN AVAILABLE)
CARLETON	Ottawa	28,000	
GUELPH	Guelph	20,500	18,000 undergraduate, 2,500 graduate
LAKEHEAD	Thunder Bay	8,680	
TORONTO	Toronto	83,010	67,130 undergrad, 15,880 grad
TRENT	Peterborough	8,120	7,640 undergrad, 480 grad
UOIT	Oshawa	9,600	
<b>Total student enrollment:</b>		<b>157,910</b>	

The course descriptions within 386 undergraduate and 327 graduate programs were assessed to determine whether or not the concept of biodiversity was included in core or elective courses (Table 2). An estimated 13,500 courses were assessed at the undergraduate level and 4,500 courses at the graduate level, giving a total of approximately 18,000 courses. (See Table 5 in the Appendix for a summary how the number of courses was estimated, and the number of courses at each university).

Table 2: Definitions of university programs and core and elective courses.

<b>Program</b>	An assortment of courses that lead toward a degree at the undergraduate or graduate level. Programs consist of a certain number of core and elective courses. Programs were grouped into three categories: sciences, business and arts. (Table 6 within the Appendix provides a detailed description of how programs were grouped into these categories).
<b>Core course</b>	A course that is required within a particular undergraduate or graduate program.

<b>Elective course</b>	A course that is not required, but is optional to take within a particular program.
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Programs that are only offered as ‘Minors’ within universities were excluded from assessment. A list of keywords associated with the concept of biodiversity (Table 3) was generated and a keyword search was conducted on university academic calendars in PDF format, using the program Mendeley<sup>®</sup>. If a keyword was present within core or elective courses for a particular program, then that program was considered to include biodiversity content.

Table 3: List of keywords used to search university academic calendars for biodiversity education content.

There are two key assumptions within this assessment. The first is that courses listed within academic calendars are offered within their respective programs and students within the programs have the option of taking the courses listed. In practice, academic calendars sometimes list courses that are only offered every other year, or only during certain semesters (e.g., fall, winter or summer). Thus, while a course may be listed within the academic calendar, it may not be accessible to students. The second

Biodiversity/biological diversity/diversity	Preservation
Biosphere	Biodiversity threats
Composition, structure and function of biological systems	Climate change
Conservation/conservation biology	Human impacts on the environment
Ecology/ecological	Invasive Alien Species
Ecosphere/ ecospheric security	Pollution
Ecosystem/ ecosystem diversity/ ecosystem health or integrity	Species diversity
Endangered species/species at risk	Species extinction
Environment/ environmental	Stewardship
Evolution	Sustainability
Genetic diversity	Taxonomy
Nature	Value of nature
Nature education	Wilderness
Natural resource(s)	Wildlife

assumption is that course descriptions reflect the concepts that are covered in the classroom setting. For example, if a business course features the word “sustainability”, it is assumed that students are exposed to sustainability concepts (e.g., considering the environment and society while also ensuring economic prosperity). In reality, professors who teach courses listed within the academic calendar may or may not address the content listed within the course descriptions. Importantly, this index assumes that the course content on paper reflects actual course content, which may or may not be the case.

Within academic calendars the keyword with greatest frequency was “environment”. Some courses that included keywords were excluded, because the course descriptions did not suggest biodiversity content. For example, education courses that discussed learning in a “seminar environment”, or computer courses about the “ecology of online learning” were not considered to have biodiversity content.

On many occasions, it was necessary to make judgement calls about whether a certain program did or did not include biodiversity content. For instance, the University of Toronto has an undergraduate program in Religion, for which students may choose to take a course in Religion and Science (course code: RLG231H1). Although this course features the keyword “evolution”, it was not considered to have biodiversity content because the course was thought to focus on the concept of evolution, rather than a focus on diverse species on Earth that adapt and evolve. The Religion program was deemed to not include biodiversity as a result of this decision. Similar judgment calls were required throughout the process of evaluating university programs.

The assessment of multiple keywords used to identify biodiversity content, the large number of courses evaluated (about 18,000) and the judgment calls regarding whether or not programs included biodiversity content, meant that this research was extremely time-consuming. Although this research covered only six universities, while Smith *et al.* (2011) examined 94, there was a much greater depth of analysis in the present study.

### **Results:**

At the undergraduate level, 386 program descriptions were reviewed for inclusion of biodiversity keywords. Reference to the concept of biodiversity was indicated in nearly half (49.5%) of undergraduate programs. Meanwhile, 327 programs were reviewed at the graduate level, 29.4% of which included biodiversity keywords. Figure 2 illustrates the results of this index, and further details are provided below. (Table 7 in the Appendix, provides complete results about the six universities’ biodiversity content).

The concept of biodiversity was most prevalent within undergraduate science programs. Of the 167 undergraduate science programs reviewed across the six universities, 74.3% included biodiversity keywords, mostly within life sciences. At the graduate level, 37.4% of the 147 science programs included biodiversity keywords, again, most commonly within life sciences.

Business programs at the undergraduate and graduate levels were also assessed. Of the 33 undergraduate business programs, 57.5% included biodiversity keywords. At the graduate level, 34.8% of the 23 business programs included the concept of biodiversity.

There was less integration of biodiversity within the arts than within the sciences or business programs. Of the 186 undergraduate arts programs assessed, only 25.8% included relevant keywords, with anthropology and geography programs including keywords most frequently. One-fifth (21%) of the 147 arts programs at the graduate level included biodiversity keywords.

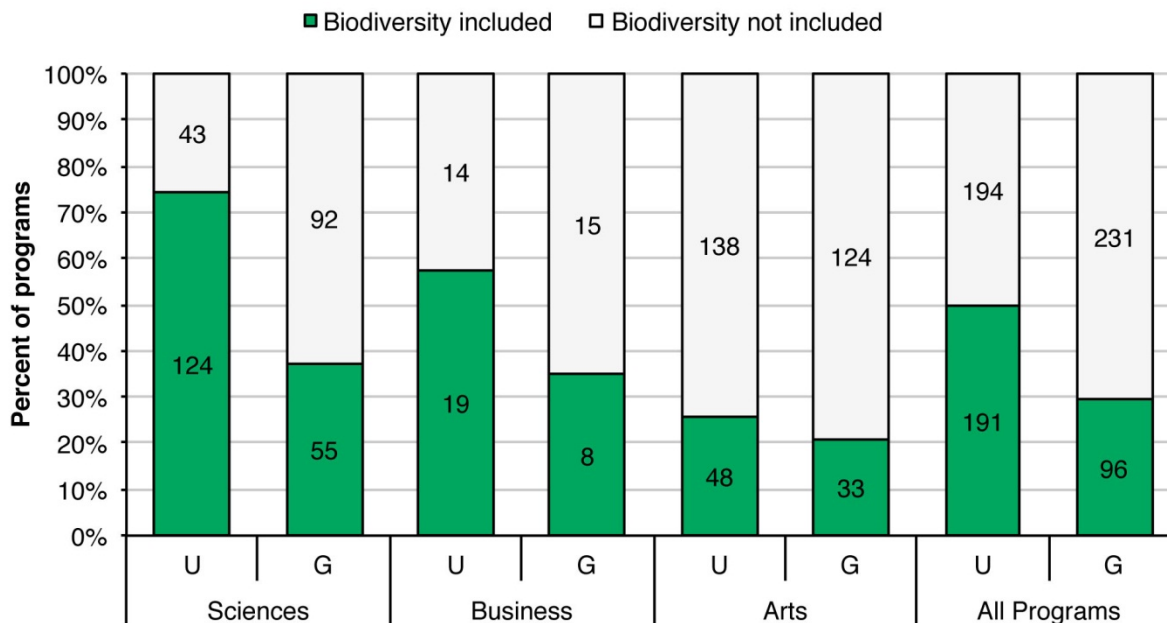


Figure 2: Summary of university biodiversity content overall (all programs) and by category (sciences, business and arts) within undergraduate (U) and graduate (G) programs.

**Discussion:**

Unsurprisingly, biodiversity was most commonly included in life science programs at the university level, although physics, chemistry and engineering programs sometimes featured a life sciences course that included biodiversity keywords (especially an introductory biology course, such as BIO120H1 Adaptation and Biodiversity at the University of Toronto). Anthropology and geography arts programs often included biodiversity keywords within their course requirements. For example, ANTH 3033 Science, Technology and the Environment (anthropology) and GEOG 3209 Sustainability and Environment (geography) are two courses offered at Carleton University that contain the keywords. Business programs often included the concepts of sustainability or environmental awareness (e.g., ADMN 4450H: Perspectives and Practices for Organizational Sustainability at Trent University, and TRMH\*6250 Tourism and Sustainable Development at Guelph). Fine arts, history, philosophy, psychology and computer science courses often did not include biodiversity-related courses.

These are some unique programs and courses identified from the academic calendars of these six universities. For instance, the University of Guelph offers a unique Bachelor of Science program with a specialization in Biodiversity. It was the only program of its kind at either the undergraduate or graduate levels within the six universities studied.

Two universities had courses featuring the term “biodiversity” in the title. These were the Universities of Guelph and Toronto, and they offered both first-year introductory courses and graduate level courses including biodiversity in the title (Table 4).

Table 4: Courses featuring biodiversity in the title at the Universities of Guelph and Toronto.

UNIVERSITY	INTRODUCTORY COURSE	GRADUATE COURSE
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<b>UNIVERSITY OF GUELPH</b>	BIOL*1070 Discovering Biodiversity	ENVS*6452 Special Topics in Ecosystem Science and Biodiversity
<b>UNIVERSITY OF TORONTO</b>	BIO120H1 Adaptation and Biodiversity	FOR 3001H Biodiversity of Forest Organisms

The University Of Ontario Institute Of Technology offers a number of undergraduate and graduate engineering courses that include biodiversity keywords. The course titles and descriptions suggest that these courses draw awareness to the impacts of engineering activities on the environment, such as emissions through burning fossil fuels. Some examples of these courses are:

- ENGR 3420: Energy and Environmental Impact
- ENGR: 3570: Environmental Effects of Radiation
- ENGR 5014: Pollution Prevention and Sustainable Engineering
- ENGR 5274: Design for Sustainable Mobility Systems
- NUCL 5080 Advanced Topics in Environmental Degradation of Materials

Lakehead and Trent University each have programs in sustainability. Lakehead’s undergraduate program is a Bachelor of Arts and Sciences in Environmental Sustainability, while Trent offers a Master of Arts program in Sustainability Studies. Meanwhile, there are a couple of majors or specializations using this keyword. For example, Carleton University offers a major in Conservation and Sustainability within its Architectural Studies undergraduate program and Lakehead University offers a Master of Education for Change, including a specialization in Environmental and Sustainability Education.

There were some courses that connected health and environmental science, in terms of how a health or polluted environment affects human health. UOIT and Lakehead have graduate courses on this topic, entitled HLSC 5314: Environmental Determinants of Health, and Health Sciences 5213 Environmental and Occupational Public Health, respectively. These courses may promote protecting the quality of the natural environment in order to maintain human health.

Overall, this assessment shows that although biodiversity concepts were present within all three categories of university programs (sciences, business and arts), there is room for improvement in all three areas. For instance, most computer science and graduate-level business programs did not feature biodiversity content. Thus, if promoting biodiversity conservation is a priority for the Ontario government, ensuring this content within university programs may help enhance awareness of the importance of biodiversity conservation.

This assessment establishes a baseline for biodiversity content within select Ontario universities. For the year 2020 assessment, it is recommended that these same six universities are analyzed for biodiversity content, in order to determine whether this content has increased, decreased, or stayed the same across curricula.

To supplement this assessment, it is recommended that future research examine the biodiversity content within the remaining 23 universities in Ontario. However, considering the extensive degree of analysis required using this method, it may be more realistic to assess another subset of other universities in the province. Research assessing biodiversity integration at the college level is also warranted. This would provide a greater breadth of information about the degree of biodiversity content within postsecondary education.

Future research can employ other methods to discover the degree to which the program and course descriptions reflect teaching practices in the university setting. For instance, a survey of university business professors may provide a more comprehensive understanding of how important sustainability concepts are within business courses and programs. Another option might be to interview program coordinators at Ontario universities to provide a sense of how important biodiversity is within science, business and arts programs.

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## Appendix

Table 5: Summary of the methods used for estimating the number of courses assessed for this index.

University	# Undergraduate courses assessed*	Method of estimation	# Graduate courses assessed*	Method of estimation	Total # of courses assessed
Carleton	3,600	counted manually, based on 10 courses/page <sup>†</sup>	1,500	# grad courses estimated based on others counted	<b>5,100</b>
Guelph	1,840	counted manually	1,000	counted manually	<b>2,840</b>
Lakehead	1,500	estimated based on Trent U # undergrad courses	150	estimated based on Trent U # grad courses	<b>1,650</b>
Toronto	3,930	estimated at 10 courses/ page <sup>†</sup> , multiplied by number of pages of courses	1,300	estimated as 1/3 # undergrad courses, and estimated based on Guelph # grad courses	<b>5,230</b>
Trent	1,300	counted manually	160	counted manually	<b>1,460</b>
University of Ontario Institute of Technology	1,500	estimated based on Trent U # undergrad courses	410	counted manually, based on 10 courses/page <sup>†</sup>	<b>1,910</b>
<b>SUM</b>	<b>13,670</b>		<b>4,520</b>		<b>18,190</b>
<b>Approximate sum (rounded up or down)</b>	<b>13,500</b>		<b>4,500</b>		<b>18,000</b>

\* Numbers of courses have been rounded to the nearest ten.

† Ten courses per page is a reasonable estimate based on the number of courses counted manually, from Guelph's and Trent's academic calendars.

Table 6: Summary of programs included within each category: sciences, business, and arts.

<b>Sciences</b>	<b>Business</b>	<b>Arts</b>
Agriculture	Accounting	Architecture
Applied science	Administration	Anthropology
Biology	Business	Bachelor of Arts and Science
Bioinformatics	Commerce	Canadian studies
Biotechnology	Economics	Classics
Chemistry	Finance	Communication
Cognitive science	Hospitality	Criminology
Computer science	Management	Education
Conservation	Marketing	English
Earth science	Real estate and housing	Environmental studies
Engineering	Tourism	Geography
Environmental science		History
Forensic science		Humanities
Geographical Information Systems (GIS)		Indigenous studies
Geology		Law
Gerontology		Linguistics
Health science		Media studies
Immunology		Modern languages
Integrated science		Music
Kinesiology		Philosophy
Materials science		Political science
Mathematics		Psychology
Medicine		Public health studies
Nanoscience		Rural studies
Nanotechnology		Social sciences
Neuroscience		Sociology
Nutrition		Theatre studies
Nursing		Visual studies
Physics		Women's and gender studies
Statistics		
Toxicology		
Veterinary science		

Note: At times, it was difficult to place programs into these categories, especially for interdisciplinary programs. For instance, depending on which core and elective courses are taken, students may receive either a Bachelor of Science or a Bachelor of Arts in Geography. Thus, this table summarizes how these programs were categorized.

Table 7: Summary of biodiversity content within undergraduate and graduate programs at six Ontario universities.

University	Undergraduate												Graduate											
	# of programs	# featuring biodiversity	% of programs that feature biodiversity courses	# Business programs	# featuring biodiversity	%	# Science Programs	# featuring biodiversity	%	# Arts programs	# featuring biodiversity	%	# of programs	# featuring biodiversity	% of programs that feature biodiversity courses	# Business programs	# featuring biodiversity	%	# Science Programs	# featuring biodiversity	%	# Arts programs	# featuring biodiversity	%
Carleton	54	22	40.74	3	2	66.67	15	9	60	36	11	30.56	55	13	23.64	3	2	66.67	19	5	26.32	33	6	18.18
Guelph	##	65	60.75	16	9	56.25	59	49	83.05	32	7	21.88	53	25	47.17	5	3	60.00	27	14	51.85	21	8	38.10
Lakehead	38	17	44.74	2	0	0.00	14	8	57.14	22	9	40.91	40	12	30	2	0	0.00	22	8	36.36	16	4	25.00
Toronto	85	31	36.47	2	1	50.00	26	18	69.23	57	12	21.05	142	27	19.01	11	1	9.09	58	14	24.14	73	12	16.44
Trent	67	33	49.25	9	7	77.78	27	17	62.96	31	9	29.03	13	5	38.46	0	0	0.00	3	2	66.67	10	3	30.00
University of Ontario Institute of Technology (UOIT)	35	23	65.71	1	0	0.00	26	23	88.46	8	0	0	24	14	58.33	2	2	100.00	18	12	66.67	4	0	0.00
<b>Sum</b>	<b>##</b>	<b>191</b>	<b>49.5</b>	<b>33</b>	<b>19</b>	<b>57.6</b>	<b>167</b>	<b>124</b>	<b>74.3</b>	<b>186</b>	<b>48</b>	<b>25.81</b>	<b>327</b>	<b>96</b>	<b>29.4</b>	<b>23</b>	<b>8</b>	<b>34.8</b>	<b>147</b>	<b>55</b>	<b>37.4</b>	<b>157</b>	<b>33</b>	<b>21.0</b>