A Learning Outcomes Perspective on Animal Use in Teaching
Integrative Biology Undergraduate Curriculum Committee

Summary
This document provides guidance to instructors and students in the Department of Integrative Biology with respect to animal use in teaching. It briefly reviews the regulatory context of animal use at the university and the pedagogical use of animals in the biological sciences. Eight learning outcomes addressing the use of animals for instructional purposes are presented, linked to specific learning outcomes of degree programs, and categorized with respect to whether the use of animals is necessary, preferable, or unnecessary. For instructors, the document is intended to stimulate consideration of whether animal use is necessary to meet a learning objective and to guide accommodations for students expressing ethical concerns about the use of animals. For students, the document is intended to clarify why animals are being used and when accommodations can be reasonably requested.

Purpose and Rationale
The University of Guelph is committed to learner-centered education, including valuing and promoting independent learning that falls outside of traditional practice. The University is also committed to course and program design and evaluation of student performance based on explicit learning outcomes. These conditions may sometimes generate tension between instructors who use animals for instruction and some students who have concerns about the value of using animals in instruction. The Department of Integrative Biology (IB) has a strong organismal focus in its research and teaching that often includes the close examination of animals. This can pose a significant challenge in education when the benefits of close examination oppose the ethical standards of some students who are uncomfortable with participating in invasive investigations of animals. The Department has received a low but persistent number of requests from students, sometimes supported by the Central Student Association Academic Commissioner, to consider allowing students with ethical concerns about animal use to avoid certain instructional exercises involving animals (Appendix 1).

This document summarizes departmental discussions occurring from 2013-2016 with the expectation that such discussion will continue. For course instructors, the document provides guidance to help ensure that animal use in a course is aligned with the learning outcomes of that course, this document, and each of IB's majors (Appendices 2-5). For students, the document provides guidance on when they may be required to work closely with animals, as well as when they may be excused from working closely with animals, depending on the learning outcome specified in a course.

Regulatory context of animal use in teaching and research at the University of Guelph
All animal use in teaching and research at the University of Guelph is regulated under the jurisdiction of the Animal Use Committee (www.uoguelph.ca/research/for-researchers/ethics-and-regulatory-compliance/animals). That committee oversees compliance of all aspects of animal use under the directives of provincial and federal legislation and also reflects the continual development of national standards by the Canadian Council on Animal Care (www.ccac.ca/en_/about).

The proposed uses of animals in all teaching and research are evaluated at Guelph against the three ethical principles of animal replacement, reduction and refinement. These principles collectively attempt to minimize animal use, minimize discomfort to animals, and maximize animal care balanced against other unavoidable constraints (such as utility of using the animal in research or teaching, costs, etc). Current national standards apply to all vertebrates but currently to only a few invertebrates, such as the octopus. Nonetheless, the discussion below is intentionally designed to encompass the use of vertebrates and invertebrate animals and of live and dead animals in teaching. The Department of Integrative Biology has steadily reduced the number of vertebrate animals used in teaching over time in two ways: by reducing number of animals used overall (through fewer exercises or through shared group work with single specimens) and/or by replacement of vertebrates with invertebrates in some instructional exercises.

Animal use in the Biological Sciences

Biology is about the study of life and its many processes. Zoological studies unavoidably require observation along a broad spectrum of animal invasiveness that can be minimal (e.g., passive observations of live organism behaviour) to moderate (e.g., active manipulation of live whole organism) to highly invasive (e.g., active manipulation of parts of living organisms or examination of prepared dead organisms). All observation has the potential to negatively impact animals and in some cases cause death. It is important for students to recognize that different fields of biology by nature of their focus will tend to occupy different regions of this animal invasiveness spectrum (e.g., botany requires no invasive animal use by a focus on plants whereas animal physiology often uses invasive procedures in order to understand processes and mechanisms that occur within an animal). Students should not expect a single standard of invasiveness to apply in all fields of biology. It is equally important for biology students, instructors and researchers to respectfully recognize the validity of diverse ethical positions on the use of animals in teaching and research and the evolving discourse on ethical animal use in society.

Use of Animals to achieve Learning Outcomes (LOs)

The department recognizes that some aspects of biology may be best learned through observation of real animals or their parts whereas other aspects of biology may be learned by other methods. The Integrative Biology Undergraduate Curriculum Committee (IBUCC) consulted with a variety of IB faculty and instructors, the chair of IB and the Associate Dean Academic of the College of Biological Sciences in order to develop and evaluate a set of eight learning outcomes (LOs) that are often related to instructional demonstrations involving animals. Below, we organize these LOs under three general categories: Required or Professional skills; Conceptual Knowledge; Research and Knowledge Discovery. For each LO, we then evaluated whether the use of animals falls into one of three categories in order to achieve that LO: Necessary, Preferable, or Unnecessary, and also summarize the classification rationale.

Distinguishing learning outcomes on the basis of the animal use requirement is beneficial because it:

- Allows instructors the opportunity to consider accommodating students around the method of achieving a particular LO, such as when LOs fall into the ‘preferable’ or ‘unnecessary’ animal use categories.

- Stimulates instructors to consider other instructional methods to achieve those LOs where animal use is not necessary.
- Informs students about the nature of animal use decisions in courses so that they can determine when they can and cannot expect accommodation around animal use in a course/program (because of the LO need).

Required or Professional Skills LOs

(*indicates specific outcomes from degree programs. See Appendices 2-5)

1. *Develop tactile skills involved in effective collection and observation of live animals and dissection, cell and tissue preparation of animal specimens*.

   Necessary, because the motor, tactile and judgment skills required cannot be taught through currently available alternative abstract methods.

   (BIOD, MFB, WBC, ZOO: A3c)*

2. *Gain experience at proper techniques for observing, collecting, and handling live animals and tissues that minimize stress and so improve the accuracy and reliability of observation*.

   Preferable, because observing/evaluating animal stress is often species-specific and learning stress cues comes about through experience from animal observation.

   (BIOD, MFB, WBC, ZOO: A1b, B1b; MFB, ZOO: B2d; BIOD, WBC: B3b)*

3. *Identify and quantify the inherent natural variation and diversity within and among individuals, populations and species through examination of variability among real organisms or their parts*.

   Necessary, because the challenge of accurate quantification requires understanding the true nature of the variation that exists within and among groups of organisms to be classified.

   (BIOD, MFB, WBC, ZOO: A1b, B1b; MFB, ZOO: B2d; BIOD, WBC: B3b; MFB: B3c)*

4. *Identify and hierarchically classify the complexity and function of real animal tissues among cells, tissues, organs, systems*.

   Preferable, because the judgment required to classify complexity is often enhanced by direct experience of that complexity.

   (ZOO: A1b, B2e; MFB: B2d)*

Conceptual Knowledge LOs

5. *Demonstrate knowledge transfer between conceptual and practical knowledge domains by synthesizing observation of real animals (e.g., dissection, measurement, observation with or through various instruments) with complementary conceptual and more abstract presentations of similar material (e.g., reading, watching, listening, etc)*.

   Necessary, because the act of knowledge transfer between domains requires and can only be evaluated through participation in those domains.

   (BIOD, MFB, WBC, ZOO: A1b)*

For example:

- Demonstrate or identify aspects of physiological process (circulation, respiration etc) operating within animals as they respond to changes in local conditions (acclimation), and integrating these processes and their effects over different parts of the body or different tissues.
- Demonstrate an understanding of the structure and function of tissues and organs, the material properties of different tissues and organs, and the physical and functional relationships between parts in real organisms.

6. *Develop an aesthetic and/or scientific appreciation for the similarity and differences in the organization of animals (e.g., variation) that will enhance understandings of organismal function, performance, ecology and evolution*.

   Preferable, to the extent that the inherent beauty and complexity of natural organisms can motivate excitement, curiosity and the search for meaning and understanding in many (although not all) students.

   (BIOD: B2d; MFB: B3c; ZOO: B2d; WBC: B2f, B3b)*

7. *Develop an appreciation about the ethical and appropriate use of animals in teaching and research that attempts to balance the costs and benefits of animal use*.

   Unnecessary, because this can be taught by other abstract methods.

   (BIOD, MFB, WBC, ZOO: B2b)*

Research and Knowledge Discovery LOs

8. *Observe real animals (alive or dead) or their component parts to pose questions about form and function that motivate self-directed research leading to enhanced understanding of process in animal biology*.

   Necessary, because observing and manipulating nature is often the only way to both ask and answer questions about natural processes; with the exception of entirely mathematical modeling based approaches or a focus on non-animal organisms.

   (BIOD, MFB, WBC, ZOO: B3a, B3b; MFB, ZOO: B3c)*

Over time, it is expected that more learning outcomes could be added to this list or new technologies could become available that would change the department's assessment of the use of animals in teaching for a specific LO.

Appendix 1. Historical development of the departmental position on animal use in teaching

2016: The current document represents the outcome of extensive discussions within the Undergraduate Curriculum Committee of Integrative Biology over 2013 - 2016. It was partially motivated by issues surrounding the redesign of Comparative Animal Physiology courses and issues raised by the CBS academic counselors with respect to IB majors taking alternatives to IB physiology courses that did not require any animal experiential components. At that time, the IBUCC also concluded that IB majors with core requirements that included experiential animal laboratory components could no longer be substituted with courses without such experiential components when those labs were designed to achieve any of the LOs designated above as Necessary or Preferable.

2008: The IBUCC document, *Position on the use of animals and alternatives to dissection*, was drafted in 2008 in response to a request from the Guelph Students for the Ethical Treatment of Animals (GSETA) that IB consider adopting a 'Student Choice Policy' with respect to use of animals in its undergraduate courses. Specifically, GSETA asked that alternatives to dissection be made available to those students who object, for whatever reason, to using real animals in class. The 2008 document was meant to address the request of GSETA and more generally to foster additional discussion among instructors. That document reflected discussions over 2007-2008 in the IB curriculum committee, input from a collection of staff involved in animal-related courses, and consultations with Open Learning, Teaching Support Services and members of the University of Guelph Animal Care Committee. That document did not take a learning outcomes approach to analyzing the use of animals in teaching.

Appendix 2. Learning Outcomes for the Biodiversity Major

The Biodiversity major provides broad education in the diversity and evolution of life and more specialized understanding of biology at the level of the organism. It is the most flexible of the majors offered by the Department of Integrative Biology and allows students to design customized program around specific interests. The major qualifies students for postgraduate work in biodiversity, botany, zoology and other life sciences and provides a sound science background for students wishing to pursue professional life science degrees or careers in teaching, government service or the private sector.

A. GENERAL SKILLS

1. Problem Solving & Critical Thinking

a. Critically evaluate ideas and arguments by gathering and integrating relevant information, assessing its credibility, and synthesizing evidence to formulate a position.
b. Identify problems and independently propose solutions using creative approaches, acquired through interdisciplinary experiences, and a depth and breadth of knowledge/expertise.
c. Accurately interpret and use numerical information to evaluate and formulate a position.

2. Communication

a. Accurately and effectively communicate ideas, arguments and analyses, to a range of audiences, in graphic, oral and written form.

3. Professional and Ethical Behaviour

a. Demonstrate personal and professional integrity by respectfully considering diverse points of view and the intellectual contribution of others, and by demonstrating a commitment to honesty and equity, and awareness of sustainability, in scientific practice and society at large.
b. Collaborate effectively as part of a team by demonstrating mutual respect, leadership, and an ability to set goals and manage tasks and timelines.
c. Plan for professional growth and personal development within and beyond the undergraduate program.

B. DEGREE RELATED SKILLS & KNOWLEDGE

1. Scientific Method

a. Apply scientific methods and processes by formulating questions, designing investigations and synthesizing data to draw conclusions and make scientifically-based decisions.
b. Generate and interpret scientific data using quantitative, qualitative and analytical methodologies and techniques.

2. Breadth & Depth of Understanding in a Particular Scientific Discipline

a. Apply the core concepts of math, physics, chemistry and biology to a chosen scientific discipline.
b. Demonstrate knowledge of the ethical, economic, commercial and social implications of scientific discovery and technological innovation.

c. Interpret current scientific concepts and gaps in knowledge (and methods) in light of the historical development of a chosen discipline.
d. *Evaluate the origin, distribution an challenges of biodiversity at various spatial an temporal scales.*
e. *Summarize examples of how changes in biodiversity have economic and social impacts through the provision of ecosystem goods and services.*
f. *Apply critical thinking, analysis, and independent inquiry skills to complex interdisciplinary issues in biodiversity recognizing the inherent complexity and uncertainty in its assessment.*
g. Synthesize knowledge and effectively communicate in both written and oral forms about a specific biodiversity issue in society.

3. Scientific Technology & Techniques in a Scientific Discipline

a. Apply contemporary research methods, skills and techniques to conduct independent inquiry in a chosen scientific discipline.
b. *Quantify variation within and among taxa and implement sampling methods and analyses utilizing data from real collections or surveys in biodiversity research, including expertise in specific taxonomic groups of interest.*
c. Work collaboratively with peers in community-engaged research to propose, execute and report o biodiversity issue.

Note: Italics indicates major specific outcomes; non-italic are BSc learning outcomes.

Appendix 3. Learning Outcomes for the Marine and Freshwater Major

The Marine and Freshwater Biology Major will allow you to study organisms living in marine and freshwater environments. You will gain a firm understanding of the ecology, evolution and physiology of both vertebrate and invertebrate organisms. This program prepares students for post-graduate work in the aquatic sciences, and provides a sound scientific background for students wishing to pursue careers in government service, private sector (e.g., fisheries, aquaculture, biotechnology, consulting), conservation, education and research either in government or private sectors.

A. GENERAL SKILLS

1. Problem Solving & Critical Thinking

a. Critically evaluate ideas and arguments by gathering and integrating relevant information, assessing its credibility, and synthesizing evidence to formulate a position.
b. Identify problems and independently propose solutions using creative approaches, acquired through interdisciplinary experiences, and a depth and breadth of knowledge/expertise.
c. Accurately interpret and use numerical information to evaluate and formulate a position.

2. Communication

a. Accurately and effectively communicate ideas, arguments and analyses, to a range of audiences, in graphic, oral and written form.

3. Professional and Ethical Behaviour

a. Demonstrate personal and professional integrity by respectfully considering diverse points of view and the intellectual contribution of others, and by demonstrating a commitment to honesty and equity, and awareness of sustainability, in scientific practice and society at large.
b. Collaborate effectively as part of a team by demonstrating mutual respect, leadership, and an ability to set goals and manage tasks and timelines.
c. Plan for professional growth and personal development within and beyond the undergraduate program.

B. DEGREE RELATED SKILLS & KNOWLEDGE

1. Scientific Method

a. Apply scientific methods and processes by formulating questions, designing investigations and synthesizing data to draw conclusions and make scientifically-based decisions.
b. Generate and interpret scientific data using quantitative, qualitative and analytical methodologies and techniques.

2. Breadth & Depth of Understanding in a Particular Scientific Discipline

a. Apply the core concepts of math, physics, chemistry and biology to a chosen scientific discipline.
b. Demonstrate knowledge of the ethical, economic, commercial and social implications of scientific discovery and technological innovation.

c. Interpret current scientific concepts and gaps in knowledge (and methods) in light of the historical development of a chosen discipline.
d. Demonstrate an understanding of the structure, function and evolutionary relationships of the major taxonomic groups of aquatic organisms.
e. Characterize and integrate the diversity of biological, chemical and physical features that structure marine and freshwater aquatic environments.
f. Understand how natural and impacted aquatic systems function and interact with other systems.

3. Scientific Technology & Techniques in a Scientific Discipline

a. Apply contemporary research methods, skills and techniques to conduct independent inquiry in a chosen scientific discipline.
b. Collect and assemble biological data and apply mathematical and statistical methods to the interpretation of data to address questions in aquatic biology.
c. Demonstrate an advanced understanding and appreciation of living aquatic organisms and specimens in field and/or laboratory settings through "hands on" experience including,
    - *Identify and/or quantify the external an internal characteristics of organisms (e.g. microscopy, physiology)*
    - *collect and handle organisms (e.g. netting, trapping)*
    - *determine the taxonomic affiliation of organisms (e.g. using morphological keys and molecular tools).*

Note: Italics indicates major specific outcomes; non-italic are BSc learning outcomes.

Appendix 4. Learning Outcomes for the Wildlife Biology and Conservation Major

The Wildlife Biology and Conservation (WBC) major will allow students to study three disciplines necessary to understand the origins, interactions and protection of biological diversity: evolution, ecology and conservation biology. They will have the opportunity to take a wide variety of electives to meet their specific interests within one or two of these disciplines. The program offers a sound scientific background in preparation for careers in resource management, conservation, ecological consulting, teaching and government service. This major also qualifies students for post-graduate work in ecology, evolutionary biology, environmental sciences or wildlife management.

A. GENERAL SKILLS

1. Problem Solving & Critical Thinking

a. Critically evaluate ideas and arguments by gathering and integrating relevant information, assessing its credibility, and synthesizing evidence to formulate a position.
b. Identify problems and independently propose solutions using creative approaches, acquired through interdisciplinary experiences, and a depth and breadth of knowledge/expertise.
c. Accurately interpret and use numerical information to evaluate and formulate a position.

2. Communication

a. Accurately and effectively communicate ideas, arguments and analyses, to a range of audiences, in graphic, oral and written form.

3. Professional and Ethical Behaviour

a. Demonstrate personal and professional integrity by respectfully considering diverse points of view and the intellectual contribution of others, and by demonstrating a commitment to honesty and equity, and awareness of sustainability, in scientific practice and society at large.
b. Collaborate effectively as part of a team by demonstrating mutual respect, leadership, and an ability to set goals and manage tasks and timelines.
c. Plan for professional growth and personal development within and beyond the undergraduate program.

B. DEGREE RELATED SKILLS & KNOWLEDGE

1. Scientific Method

a. Apply scientific methods and processes by formulating questions, designing investigations and synthesizing data to draw conclusions and make scientifically-based decisions.
b. Generate and interpret scientific data using quantitative, qualitative and analytical methodologies and techniques.

2. Breadth & Depth of Understanding in a Particular Scientific Discipline

a. Apply the core concepts of math, physics, chemistry and biology to a chosen scientific discipline.

b. Demonstrate knowledge of the ethical, economic, commercial and social implications of scientific discovery and technological innovation.
c. Interpret current scientific concepts and gaps in knowledge (and methods) in light of the historical development of a chosen discipline.
d. Demonstrate a broad understanding of ecology, evolution an conservation biology.
e. Recognize the origins an current methods of protection of plant and animal diversity.
f. Develop detailed knowledge of ecological and evolutionary factors that influence the persistence of species an communities.
g. Understand how to manage natural and impacted systems (e.g., invasive species, species at risk) an apply scientific approaches to adaptive management strategies in wildlife conservation.
h. *Assess the complex interplay between science, socio-economic factors and public opinion in the forging of public policy decisions and the value of interdisciplinary approaches to understanding complex problems in wildlife biology.*

3. Scientific Technology & Techniques in a Scientific Discipline

a. Apply contemporary research methods, skills and techniques to conduct independent inquiry in a chosen scientific discipline.
b. Gain "hands on" experience in the field working with plants and animals in a variety of ecosystems.
c. Develop written and oral communication skills for a variety of stakeholders (e.g., public, private sector, policy makers, scientists).
d. Assemble, analyze and evaluate biological data for development an execution of research project that integrates methods from evolutionary biology, ecology, and conservation biology within wider global contexts.

Note: Italics indicates major-specific outcomes; non-italics indicates BSc learning outcomes.

Appendix 5. Learning Outcomes for the Zoology Major

The Zoology Major will allow you to study ecology, evolution, and physiology with a focus on the structure, function and ecology of animals. This program prepares students for post-graduate work in zoology and other life sciences, and provides a sound scientific background for students wishing to pursue careers in management and conservation, biotechnology and industry, education, and research either in government or private sectors.

A. GENERAL SKILLS

1. Problem Solving & Critical Thinking

a. Critically evaluate ideas and arguments by gathering and integrating relevant information, assessing its credibility, and synthesizing evidence to formulate a position.
b. Identify problems and independently propose solutions using creative approaches, acquired through interdisciplinary experiences, and a depth and breadth of knowledge/expertise.
c. Accurately interpret and use numerical information to evaluate and formulate a position.

2. Communication

a. Accurately and effectively communicate ideas, arguments and analyses, to a range of audiences, in graphic, oral and written form.

3. Professional and Ethical Behaviour

a. Demonstrate personal and professional integrity by respectfully considering diverse points of view and the intellectual contribution of others, and by demonstrating a commitment to honesty and equity, and awareness of sustainability, in scientific practice and society at large.
b. Collaborate effectively as part of a team by demonstrating mutual respect, leadership, and an ability to set goals and manage tasks and timelines.
c. Plan for professional growth and personal development within and beyond the undergraduate program.

B. DEGREE RELATED SKILLS & KNOWLEDGE

1. Scientific Method

a. Apply scientific methods and processes by formulating questions, designing investigations and synthesizing data to draw conclusions and make scientifically-based decisions.
b. Generate and interpret scientific data using quantitative, qualitative and analytical methodologies and techniques.

2. Breadth & Depth of Understanding in a Particular Scientific Discipline

a. Apply the core concepts of math, physics, chemistry and biology to a chosen scientific discipline.
b. Demonstrate knowledge of the ethical, economic, commercial and social implications of scientific discovery and technological innovation.

c. Interpret current scientific concepts and gaps in knowledge (and methods) in light of the historical development of a chosen discipline.

d. Demonstrate a broad understanding of animal diversity, including knowledge of the scientific classification and evolutionary relationships of major groups of animals.

e. Recognize the relationships between structure an function at different levels of biological organization (e.g., molecules, cells, organs, organisms, populations, species) for the major groups of animals.

f. Characterize the biological, chemical, an physical features of environments (e.g., terrestrial, freshwater, marine, host) that animals inhabit.

g. Explain how animals function an interact with respect to biological, chemical, an physical processes in natural an impacted environments.

3. Scientific Technology & Techniques in a Scientific Discipline

a. Apply contemporary research methods, skills and techniques to conduct independent inquiry in a chosen scientific discipline.

b. Collect and assemble biological data and apply mathematical and statistical methods to the interpretation of data to address questions in zoology.

c. Demonstrate an advanced understanding and appreciation of living animals an specimens in field and/or laboratory settings through "hands on" experience including

- *Identify and/or quantify the external an internal characteristics of animals (e.g. microscopy, physiology)*
- *collect and handle animals (e.g. netting, trapping)*
- *determine the taxonomic affiliation of animals (e.g. using morphological keys and molecular tools).*

Note: Italics indicates major specific outcomes; non-italics indicate BSc learning outcomes.