Winter Ecology
BIOC60H

Course Syllabus

Course description

The goal of this course is to understand what means organisms have evolved to survive our Canadian winters. In particular, you will learn about the three main ways to face the cold season: 1. winter evasion in the form of migration to warmer areas; 2. cold avoidance, thus shorter or longer periods of hibernation or torpor, and finally 3. cold resistance, a state of activity even during the coldest winter days and nights. This course takes a very integrative approach to the topic, putting focus on both plants and animals, and approaching winter survival from an ecological, evolutionary, as well as physiological perspective.

We will learn how selected species prepare for their, in part, very long migrations to their overwintering grounds and see what winter evasion costs. You will learn about the physical property of frozen water, because this is integral for understanding coping mechanisms of species, which spend the winter in Ontario. All of Ontario's plants hibernate in one way or another and we will put special emphasis on understanding the adaptations in plants, which have organs exposed above the snow. The main emphasis of the course will be to investigate the survival of animals overwintering in Ontario. Many go into a prolonged state of hibernation, such as invertebrates, amphibians or reptiles (poikilotherms). Homeotherms face the especially hard task of needing a lot of energy to remain warm. You will learn how heat is produced and in what various ways animals use to stockpile for their winter energy budgets. Among homeotherms, some animals are able to decrease their energetic needs by entering hibernation or torpor, whereas others have to remain active all the time. Life under the seal of our frozen winter lakes is hard to observe or imagine, but organism face very particular sets of limitations and have evolved ingenious adaptations to meet them. Many winter survival adaptations are present in people, which have been living in cold areas since a long time. We will look at how Inuit, African Koisan and Australian Aborigines survive annually occurring or nightly cold periods. The last topic of the course is to look at what is already happening, but what will become even more pronounced in the future: global warming. Things will not just become cushier due to warmer and shorter winters. Instead, a lot of plants and animals adapted to winter are expected to suffer large fitness decreases and possibly extinction.

Students will study winter adaptations during class time and during tutorials (presentations). Over the period of seven weeks and paralleling what will be discussed in class, there will be weekly student presentations. In particular and in groups of two, students will have to give two presentations over this duration, as well as prepare a short-answer question for their audience. Students will also be required to hand in a short-answer question about the physical properties of snow, plant winter survival (lectures 5/7) and about humans in the winter (lectures 21/22). Note that some of the student short-answer questions will be on the midterm and final exam.

Learning outcomes

1. Understand the limiting effects of cold winter conditions across different ecosystems.
2. Understand the benefits and costs of migration.
3. Understand how plants, poikilothermic and homeothermic animals including humans survive the winter.
4. Appreciate that all organisms are products of natural selection and that interpretation of morphology can only make sense in light of evolution.
5. Relate the structure of particular types of cells, tissues, and organs to their functions in particular environments.

Instructor

Ivana Stehlik
Phone: 416-287-7422
Email: ivana.stehlik@utoronto.ca
Office hours: Mon 4-5 PM, Tue 2-3 PM or by appointment (just send me an email suggesting a few possibilities fitting your schedule and we will make it work!), SW563C

Lectures and other course material

Lectures will be posted in a dedicated BIOC60H class folder on dropbox, typically 24 hours before class. In the first week of classes, you will be sent an invitation by email (to your official university email) to join the dropbox class folder. It is thus vital that you check your email inbox as soon as the course starts (no lecture material will be posted on Quercus beyond the first week), so it is in your own interest to get access to all course materials through dropbox ASAP. Lectures will be posted typically the evening before class.

Marks breakdown

Two PPT presentations (8% each)	16%
Two multiple choice quiz questions related your PPT talks (1% each)	2%
Three medium-answer questions and answers (3%)	9%
Six quizzes about student presentations (0.5% each)	3%
Midterm (lectures 1-13)	30%
Cumulative final exam	40%

Times and location

Course lecture time and place: Mon 3 - 5 in IC212
Lab time and place: Thu, 3 - 5, in HW214

Course schedule/Important dates

Week, day, date	Lectures	Activity
1, Mon, 1/7	1/2	Migration
1, Thu, 1/10	*No tutorial*	
2, Mon 1/14	3/4	Physical properties of snow
2, Thu 1/17	Tutorial: how to give presentations in BIOC60; how to write questions and their answers	
3, Mon, 1/21	5/6	Winter survival of plants
3, Thu, 1/24	*No tutorial*	
3, Sun, 1/27, 11:59PM	**Submit question about lectures 3/4 to turnitin**	
4, Mon, 1/28	7/8	7: winter survival of plants; 8: Winter survival of poikilotherms
4, Thu, 1/31	*No tutorial*	
5, Mon, 2/4	9/10	Winter survival of poikilotherms
5, Thu, 2/7	Student presentations: winter survival poikilotherms	
6, Mon, 2/11	11/12	11: Heat 101; 12: Animal energy budget
6, Thu, 2/14	**Tutorial: Midterm exam**	
	Reading week	
Sun, 2/24, 11:59 PM	**Submit question about lectures 8-10 to turnitin**	
7, Mon, 2/25	13/14	13: Animal energy budget ; 14: hibernating homeotherms
7, Thu, 2/28	Student presentations: homeotherms - hibernation	
8, Mon, 3/4	15/16	Resisting homeotherms
8, Thu, 3/7	Student presentations: homeotherms - birds	
9, Mon, 3/11	17/18	17: resisting homeotherms; 18: Life under the ice
9, Thu, 3/14	Student presentations: homeotherms - resisting mammals	
10, Mon, 3/18	19/20	19: Life under the ice; 20: Plant animal interactions
10, Thu, 3/21	Student presentations: life under the ice	
11, Mon, 3/25	21/22	Humans and winter
11, Thu 3/28	*No tutorial*	
12, Mon, 4/1	23/24	Winter ecology and global warming
12, Thu, 4/4	Student presentations: global change	
12, Sun, 4/7, 11:59PM	**Submit question about lecture 21/22 to turnitin**	
Apr TBA (exam period)	**Final exam (cumulative; lectures 1-24)**	

Paper presentations and quizzes associated with them

There are six tutorials in which students will be presenting papers (see table with dates on previous page). Ivana Stehlik will provide the class with detailed information what is expected in these presentations (second week; during tutorial time). Presentations on papers will be prepared and delivered in groups of two students and each group will have to present twice, in two out of the six possible weeks.

In addition to the two presentations, each presenting group will have to submit one multiple choice question for each the two presentations including its answers. Ivana Stehlik will provide the class with detailed information what is expected from these questions and answers (second week; during tutorial time). The questions will be assembled to make up a quiz covering all presentations of a given presentation day. Each presenting group will have to submit their question to the TA via email before the associated tutorial presentation, more specifically, by the Tue before their presentation (by 11:59 PM). This will give the TA time to assemble all quiz questions onto one page and print them to give to the tutorial audience. If you are late with this submission, you will receive a zero for this part of the assignment (instead of the possible maximum points of 2%). For the audience students, the actual quizzes for you to answer will be handed out at the end of the tutorial and the answers to each quiz are worth a max of 1%. Unless you attend the lab, you will not be able to submit the quiz.

To summarize, presentation tutorials are associated with three marks: i. marks for presenting (9% on two occasions for a maximum total of 18%), ii. marks for handing in one quiz question per presentation and its answer (2% for a maximum total of 4%) and iii. as an audience member, answering the quizzes of the day (six tutorials thus six quizzes worth 1% for a maximum total of 6%).

If you miss any of these events due to illness or other causes beyond your control, submit, within one week of the missed event, a written request for special consideration to the instructor explaining the reason for missing the event, and attaching appropriate documentation, such as the official University of Toronto medical certificate

(www.utoronto.ca/health/form/medcert.pdf).

Quizzes associated with lectures

In a group of 2 to 3 students (the same or different students from the presentation team), you are expected to hand in three medium-length quiz questions including their answer key based on material discussed in class, specifically based on lectures 3-4 (physical properties of snow), lectures 8-10 (winter survival of poikilotherms) and lectures 21-22 (humans and winter survival). The purpose of these assignments is to encourage you to think about course material in a critical way. You will be expected to determine the key points underlying a given block of course material, and then use logic and creativity to design a good question to assess understanding of these points. Finally, you will have to outline a complete answer key for marking your question. You may select your own group, or be assigned to a group. Group registration will be during the first tutorial (week 3).

Each quiz question is worth 4% towards your final course mark for a possible total of 12%. When writing your questions, please follow the provided detailed information on what is expected from these questions as provided to you by Ivana Stehlik in the second week (during tutorial time; overview on this assignment can also be found in the sections below). Please note

that Ivana Stehlik will select, from the best entries, question to be featured on the midterm and final exams…

Evaluation
Your mark will depend on our assessment of the quality and clarity of your question and answer, and the extent to which it tests understanding of concepts, rather than just straight recall of details (marking rubric see below).

Equal work-load assessment
To get a mark for this assignment, **each member of your group must hand in a confidential assessment of work-load sharing** in which they briefly outline whether work was shared equally by all group members (this can be hand-written). You must put your full name, student#, and group# on these assessments, which ***only*** Ivana Stehlik will review. Ivana Stehlik will keep these reports confidential, they will not be read by anyone else, and will be destroyed after final marks are submitted. If everything was fine, then you need only write: 'equal work by all group members'. If you feel that someone in your group did not do their fair share, you should outline the problem, along with the name of this group member. If there is consensus within a group that one member did not do a fair share of the work, then a penalty may be applied to that individual's mark. **Your work-load assessment must be handed in at the same time as the question & answer assignment.**

Format guidelines for the answer questions and answers about lecture material
1. Your question should result in an answer worth approximately 10-15 marks. Your answer key must clearly indicate which points would receive marks, and the total mark-value of the question.
2. You may construct multi-part questions as long as the parts are related to each other. You may include figures or tables for interpretation questions if you wish.
3. You may refer to real organisms, places, data, or situations, or you may invent hypothetical ones for your question. For example, you may choose to write a question about *Planta edulis*, a plant that has been recently discovered in Fairyland.
3. This assignment should be between 1 and 1.5 written pages plus one additional page for any figures or tables you may use. Font size is 11pts in Times Roman, and the line spacing is 1.5 lines.
4. Your answer key must be clear and understandable, but can be written in point form.
5. The best questions/answers will test understanding of material, rather than straight recall of memorized facts.

Tips for writing a good question & answer
Tip 1: One approach to designing an exam question is to first decide on the main points you wish to have emerge in a good answer to your question, then work backwards to design a question that should elicit these answers. Your group should work out together which aspects of the topic you want to highlight in your question.
Tip 2: One way to split the work of this assignment fairly across your group and to ensure your question and answer are reasonable is:

3 group members: have one person draft a question (without discussing it with the rest of the group), have each of the other 2 members independently sketch out an answer to the

question. Meet as a group—did both members interpret the question the same way? Work together as a group to fine-tune the question and answer.

2 group members: have one person draft a question and the other sketch out the answer. Meet and see whether the interpretation was the same.

I strongly advise you to follow Tip 2 when writing your assignment. The most common error on this assignment arises when a group is unable to objectively recognize what answers would reasonably arise from their question, or does not anticipate how a naïve audience will interpret their question.

Handing in your assignment

1. Each group must submit ONE digital copy of their assignment via Turnitin.com by the due date (see overview table page 3). Your assignment must have the full names of all group members printed on the first page.

2. Each individual must submit their own confidential work-load assessment via email to the course coordinator (TBA).

3. Marking of this assignment is by your course TA.

Marking scheme (max total 25 pts)

Tests understanding (5 pts max)

- Requires application of concepts to novel data or examples and/or explanation of concepts
- Minimizes straight recall

Question & answer are correct (5 pts max)

- Accurate representation of course material and other published data in the subject area

Question would reasonably lead to answer given (5 pts max)

- Interpretation of question is clear
- Informed person in this course would be likely to give answers on key after first exposure to the question

Clarity and quality (5 pts max)

- Grammar, vocabulary and structure contribute to ease of reading and interpretation
- Citations given where needed
- Question is at the right level for this course

Answer has clear and appropriate mark distribution (2.5 pts max)

- Item of more importance or requiring more explanation have higher marks assigned to them than less important or straight recall answers
- Items of similar difficulty have similar mark value.

Creativity (2.5 pts max)

Correct length: -10% of the total mark if too long or too short

Penalty for late submission

There will be a penalty of 5% per day for assignments received late. Weekend days count as individual days. Unless there are extenuating circumstances (e.g. medical reasons with an official University of Toronto medical certificate), a mark of zero will be applied to assignments submitted one week late or more. Heavy workloads or malfunctioning computer equipment are not legitimate reasons for late submission. If you know ahead of time that you have a legitimate reason why you cannot hand in an assignment, let the course instructor know two weeks before the due date.

Missed exams

Students who miss an exam or a deadline of an assignment for reasons entirely beyond their control must notify the instructor within 3 days that you missed the exam or deadline of the assignment. In case you do not do this, you will receive a 0 on the exam or assignment. Then submit your doctor's note or other documentation to Jennifer Campbell in SW421D. You may submit the doctor's note or other documentation for the reason AFTER you notify the instructor, ie you need to first and foremost notify the instructor for missing the exam or assignment. A make-up will be scheduled within 10 days of the original date, unless you provide a second form indicating that your problem has persisted. The appropriate documentation is the official University of Toronto medical certificate (www.utoronto.ca/health/form/ medcert.pdf).

Submission of reports to Turnitin

Students will be asked to submit their quiz questions and answers to **Turnitin** for a review of textual similarity and detection of possible plagiarism. In doing so, students will allow their work to be included as source documents in the Turitin.com reference database, where they will be used solely for the purpose of detecting plagiarism. The terms that apply to the University's use of the Turnitin.com service are described on the Turnitin.com web site:
(http://www.utoronto.ca/ota/turnitin/ConditionsofUse.html)
Turnitin is most effective when it is used by all students; however, if and when students object to its use on principle, the course offers a reasonable offline alternative. The student will then be asked to meet with the course instructor to outline and discuss the report before its final submission to demonstrate the process of creating the report according to the academic integrity policy.

Academic integrity policy

According to Section B of the University of Toronto's *Code of Behaviour on Academic Matters*, it is an offence for students to:

• use someone else's ideas or words in their own work without acknowledging that those ideas/words are not their own with a citation and quotation marks, i.e. to commit plagiarism.

• include false, misleading or concocted citations in their work.

• obtain unauthorized assistance on any assignment.

• provide unauthorized assistance to another student. This includes showing another student completed work.

• submit their own work for credit in more than one course without the permission of the instructor

• falsify or alter any documentation required by the University. This includes, but is not limited to, doctor's notes.

• use or possess an unauthorized aid in any test or exam.

Violation of the Code of Behaviour on Academic Matters will force the instructor to provide a written report of the matter to the Chair/DeanProvost's and a penalty according to the U of T's guidelines on sanctions will be put into place.

Communication policy

Students are required to regularly and often check their university email to receive announcements relating to the course. To inquire about course-related issues, students are strongly encouraged to solely use their university email, as hotmail or other email providers are spam-filtered on a regular basis. It is the responsibility of the student to make sure his or her email reaches the instructor.

The instructor will not answer any questions related to material discussed in class or during the labs by email (unless it is a clear yes-no answer), but the student is encouraged to ask these questions during official office hours or to schedule a meeting outside office hours by email.

Accessibility

Students with diverse learning styles and needs are welcome in this course. In particular, if you have a disability/health consideration that may require accommodations, please feel free to approach the course instructor and/or the AccessAbility Services Office as soon as possible. Enquiries are confidential. The UTSC AccessAbility Services staff (located in S302) are available by appointment to assess specific needs, provide referrals and arrange appropriate accommodations (416) 287-7560 or ability@utsc.utoronto.ca.

Readings

There is no required reading and no course book, because no single book covers adequately all course topics. The course heavily relies on sources from the primary literature. In case of conceptual problems, students are encouraged to do their own online research, consult the primary sources referred to on the slides or get help from the instructor before or after class or during office hours.

Student presentation topics

WINTER SURVIVAL POIKILOTHERMS (WEEK 5)

1. **Woolly bear (*Pyrrharctia Isabella*)**

Layne J.R., Edgar C.L. and Medwith R.E. 1999. Cold hardiness of the woolly bear caterpillar (*Pyrrharctia Isabella*, Lepidoptera: Arctiidae). American Midland Naturalist 141: 293-304.

2. **Emerald ash borer (*Agrilus planipennis*)**

Crosthwaite J.C., Sobek S., Lyons D.B., Bernards M.A. and Sinclair B.J. 2011. The overwintering physiology of the emerald ash borer, *Agrilus planipennis* Fairmaire (Coleoptera: Buprestidae). Journal of Insect Physiology 57: 166-173.

3. **Honey bee (*Apis mellifera*)**

Villa J.D., Rinderer T.E. and Collins A.M. 1993. Overwintering of Africanized, European, and hybrid honeybees (Hymenoptera, Apidae) in the Andes of Venezuela. Environmental Entomology 22: 183-189.

4. **Multicolored Asian lady beetle (*Harmonia axyridis*)**

Labri G., Coderre D. and Lucas E. 2008. Overwintering strategy of multicolored Asian lady beetle (Coleoptera: Coccinellidae): Cold-free space as a factor of invasive success. Annals of the Entomological Society of America 101: 860-866.

5. **Woolly adelgid (*Adelges tsugae*)**

Tobin P.C., Turcotte R.M., Blackburn L.M., Juracko J.A., Simpson B.T. 2017. The big chill: quantifying the effect of the 2014 North American cold wave on hemlock woolly adelgid populations in the central Appalachian Mountains. Population Ecology 59: 251-258.

6. **Spring peeper (*Pseudacris crucifer*)**

Layne J.R. and Kefauver J. 1997. Freeze tolerance and postfreeze recovery in the frog *Pseudacris crucifer*. COPEIA 2: 260-264.

7. **Garter snake (*Thamnophis sirtalis*)**

Churchill T.A. and Storey K.B. 1992. Freezing survival of the garter snake *Thamnophis sirtalis parietalis*. Canadian Journal of Zoology 70: 99-105.

8. **Blanding's turtle (*Emydoidea blandingii*)**

Dinkelacker S.A., Costanzo J.P., Iverson J.B. and Lee R.E. 2005. Survival and physiological responses of hatchling Blanding's turtles (*Emydoidea blandingii*) to submergence in normoxic and hypoxic water under simulated winter conditions. Physiological and Biochemical Zoology 78: 356-636.

WINTER SURVIVAL OF HOMEOTHERMS – HIBERNATION (WEEK 7)

1. Little brown bat (*Myotis lucifugus)*

Thomas D.W., Dorais M. and Bergeron J.M. 1990. Winter energy budgets and cost of arousal for hibernating little brown bats (*Myotis lucifugus*). Journal of Mammology 71: 475-479.

2. Little brown bat (*Myotis lucifugus)*

Ben-Hamo M., Munoz-Garcia A., Williams J.B., Korine C. and Pinshow B. 2013. Waking to drink: rates of evaporative water loss determine arousal frequency in hibernating bats. Journal of Experimental Biology 216: 573-577.

3. Little brown bat (*Myotis lucifugus)*

Frick W.F., Pollock J.F., Hicks A.C., Langwig K.E., Reynolds D.S., Turner G.G., Butchkoski C.M. and Kunz T.H. 2010. An emerging disease causes regional population collapse of a common North American bat species. Science 329: 679-682

4. Little brown bat (*Myotis lucifugus)*

Jonasson K.A. and Willis C.K.R. 2011. Changes in body condition of hibernating bats support the thrifty female hypothesis and predict consequences for populations with white-nose syndrome. PLOS ONE 6: e21061

5. Hoary bat (*Lasiurus cinereus cinereus*)

Cryan P.M., Stricker C.A. and Wunder M.B.2014. Continental-scale, seasonal movements of a heterothermic migratory tree bat. Ecological Applications 24: 602-616.

6. Tri-colored bat (*Perimyotis subflavus*)

Fraser E.E., McGuire L.P., Eger J.L., Longstaffe F.J. and Fenton M.B. 2012. Evidence of latitudinal migration in tri-colored bats, *Perimyotis subflavus*. PLOS ONE 7: e31419.

7. Polar bear (*Ursus maritimus*)

The effects of prolonged fasting of the body composition and reproductive success of female Polar bears (*Ursus maritimus*). 1995. Functional Ecology 9: 559-567.

8. Grizzly bear (*Ursus arctos*)

Pigeon K.E., Stenhouse G., and Cote S.D. 2016. Drivers of hibernation: linking food and weather to denning behavior of grizzly bears. Behavioural and Ecological Sociobiology 70: 1745-1754.

9. Woodchuck (Marmota monax)

Zervanos S.M., Maher C., and Florant G.L. 2014. Effect on body mass on hibernation strategies of woodchucks (Marmota monax). Integrative and Comparative Biology 54: 443-451.

WINTER SURVIVAL OF HOMEOTHERMS – BIRDS (WEEK 8)

1. Common Loon (*Gavia immer*)

Gray C.E., Paruk J. D., DeSorbo, C.R., Savoy L.J., Yates D.E., Chickering M.D., Gray R.B., Taylor K.M., Long D., Schoch N., Hanson W, Cooley J. and Evers D.C. 2014. Body mass in Common Loons (*Gavia immer*) strongly associated with migration distance. Waterbirds 37: 64-75.

2. Red crossbill (*Loxia curvirostra*)

Cornelius J.M. and Hahn T.P. 2012. Seasonal pre-migratory fattening and increased activity in a nomadic and irruptive migrant, the Red Crossbill *Loxia curvirostra*. IBIS 154: 693-702.

3. Overwintering arctic ducks

Schummer M.L., Petrie S.A., Bailey R.C. and Badzinski S.S. 2012. Factors affecting lipid reserves and foraging activity of buffleheads, common goldeneyes, and long-tailed ducks during winter at Lake Ontario. Condor 114: 62-74.

4. Wild turkey (*Meleagris gallopavo*)

Kane D.F., Kimmel R.O. and Faber W.E. 2007. Winter survival of wild turkey females in central Minnesota. Journal of Wildlife Management 71: 1800-1807.

5. Snowy owl (*Bubo scandiacus*)

Therrien J.-F., Gauthier G. and Bety J. 2011. An avian terrestrial predator of the Arctic relies on the marine ecosystem during winter. Journal of Avian Biology 42: 363-369.

6. **Barn owl (*Tyto alba*)**

Thouzeau C., Massemin S., Handrich Y. 1997. Bone marrow fat mobilization in relation to lipid and protein catabolism during prolonged fasting in barn owls. Journal of Comparative Physiology B 167: 17-24.

7. Woodpeckers

Koenig W.D., Walters E.L., Walters J.R., Kellam J.S., Michalek K.G. and Schrader M.S. 2005. Seasonal body weight variation in five species of woodpeckers. Condor 107: 810-822.

8. Mountain chickadee (*Poecile gambeli*)

Croston R., Kozlovsky D.Y., Branch C.L., Parchman T.L., Bridge E.S., and Pravosudov V.V. 2016. Individual variation in spatial memory performancein wild mountain chickadees from different elevations. Animal Behaviour 111: 225-234.

9. Mountain chickadee (*Poecile gambeli*)

Freas C.A., LaDage L.D., Roth II T.C., and Pravosudov V.V. 2012. Elevation-related differences in memory and the hippocampus in mountain chickadees, Poecile gambeli. Animal Behaviour 84: 121-127.

WINTER SURVIVAL OF HOMEOTHERMS – RESISTING MAMMALS (WEEK 9)

1. Porcupine (*Erethizon dorsatum*)

Coltrane J.A. and Barboza P.S. 2010. Winter as a nutritional bottleneck for North American porcupines (*Erethizon dorsatum*). Journal of Comparative Physiology B 180: 905 – 918.

2. White-footed mouse (*Peromyscus leucopus*)

Wilder S.M., Abtahi A.M. and Meikle D.B. 2005. The effects of forest fragmentation on densities of white-footed mice (*Peromyscus leucopus*) during the winter. American Midland Naturalist 153: 71-79.

3. Red squirrel (*Sciurus vulgaris*)

Larivee M.L., Boutin S., Speakman J.R., McAdam A.G. and Humphries M.M. 2010. Associations between over-winter survival and resting metabolic rate in juvenile North American red squirrels. Functional Ecology 24: 597-607.

4. Snowshoe hare (*Lepus americanus*)

Hodges K.E., Boonstra R. and Krebs C.J. 2006. Overwinter mass loss of snowshoe hares in the Yukon: starvation, stress, adaptation or artefact? Journal of Animal Ecology 75: 1-13.

5. **Tundra vole (*Microtus oeconomus*)**

Aars J. and Ims R.A. 2002. Intrinsic and climatic determinants of population demography: The winter dynamics of tundra voles. Ecology 83: 3449-3456.

6. Red fox (*Vulpes vulpes*)

Barton K.A. and Zalewski A. 2007. Winter severity limits red fox populations in Eurasia. Global Ecology and Biogeography 16: 281-289.

7. Coyote (*Canis latrans*)

Patterson B.R., Benjamin L.K. and Messier F. 2000. Winter nutritional condition of eastern coyotes in relation to prey density. Canadian Journal of Zoology 78: 420-427.

8. White-tailed deer (*Odocoileus virginianus*)

Dumont A., Crete M., Ouellet J.P., Huot J. and Lamoureux J. 2000. Population dynamics of northern white-tailed deer during mild winters: evidence of regulation by food competition. Canadian Journal of Zoology 78: 764-776.

9. Woodland caribou (*Rangifer tarandus*)

Joly K., Chapin F.S., and Klein D.R. 2010. Winter habitat selection by caribou in relation to lichen abundance, wildfires, grazing, and landscape characteristics in northwest Alaska. Ecoscience 17: 321-333.

LIFE UNDERNEATH THE ICE (WEEK 10)

1. Muskrat (*Ondatra zibethicus*)

Campbell K.L. and MacArthur R.A. 1996. Seasonal changes in gut mass, forage digestibility, and nutrient selection of wild muskrats (*Ondatra zibethicus*). Physiological Histological Zoology 9: 1215-1231.

2. Muskrat (*Ondatra zibethicus*)

Bazin R.C. and MacArthur R.A. 1992. Thermal benefits of huddling in the muskrat (*Ondatra zigethicus*). Journal of Mammology 73: 559-564.

3. Muskrat (*Ondatra zibethicus*)

MacArthur R.A. 1992. Foraging range and aerobic endurance of muskrats diving under ice. Journal of Mammology 73: 565-569.

4. Muskrat (*Ondatra zibethicus*)

MacArthur R.A. 1992. Gas bubble release by muskrats diving under ice - lost gas or a potential oxygen pool. Journal of Zoology 226: 151-164.

5. Large-mouth bass (*Micropterus salmoides*)

Hasler C.T., Suski C.D., Hanson K.C., Cooke S.J. and Tufts, B.L. 2009. The influence of dissolved oxygen on winter habitat selection by largemouth bass: an integration of field biotelemetry studies and laboratory experiments. Physiological and Biochemical Zoology 82: 143-152.

6. Large-mouth bass (*Micropterus salmoides*)

Fullerton A.H., Garvey J.E., Wright R.A., and Stein R.A. 2000. Overwinter growth and survival of largemouth bass: interactions among size, food, origin, and winter severity. Transactions of the American Fisheries Society 129: 1-12.

7. Alewife (*Alosa pseudoharengus*)

Snyder R.J. and Hennessey T.M. 2003. Cold tolerance and homeoviscous adaptation in freshwater alewives (*Alosa pseudoharengus*). Fish Physiology and Biochemistry 29: 117-126.

8. Common carp (*Cyprinus carpio*)

Bajer P.G. and Sorensen P.W. 2010. Recruitment and abundance of an invasive fish, the common carp, is driven by its propensity to invade and reproduce in basins that experience winter-time hypoxia in interconnected lakes. Biological Invasions 12: 1101-1112.

GLOBAL CHANGE (WEEK 12)

1. **Butterfly (*Erebia medusa*)**

Stuhldreher G., Hermann G. and Fartmann T. 2014. Cold-adapted species in a warming world - an explorative study on the impact of high winter temperatures on a continental butterfly. Entomologia Experimentalis et Applicata 151: 270-279

2. **Solitary bee (*Osmia lignaria*)**

Sgolastra F., Kemp W.P., Buckner J.S., Pitts-Singer T.L., Maini S. and Bosch J. 2011. The long summer: pre-wintering temperatures affect metabolic expenditure and winter survival in a solitary bee. Journal of Insect Physiology 57: 1651-1659.

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