

ZOO 4310C – Vertebrate Evolution and Ecology

Spring 2015, 4 credits

Instructor: Dr. Gregg Klowden (pronounced "Cloud - in")
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Phone: Please send an email instead

* I receive a large volume of emails. To help me help you please:

1. format the subject of your email as follows: "Course – Vert Evolution, Subject - Question about exam 1"
2. include your 1st and last name in the body of all correspondence.

I try to respond to emails within 48 hours however, response time may be greater. Please plan accordingly by not waiting to the last minute to contact me with questions or concerns. Due to confidentiality, I will only reply to questions emailed from your Knights email and any questions about grades must be discussed in person and cannot be discussed via email.

Office Hours: 12 January -2 March: Mondays, Wednesdays, and Fridays 10:30-11:20 am or by appointment
5 March – 23 April: Thursdays 11:30 am -1:30 pm or by appointment

Graduate Teaching Assistant: hariel@knights.ucf.edu

Class Meeting Times: Lecture: Tuesdays and Thursdays 2:00-2:50 PM in BSFS 105;
(BSFS = Biological Sciences Field Station (aka Biological Field Research Center (BFRC) or Building 92).
Lab: Tuesdays 8:00-1:50 PM in BSFS 105 or elsewhere as announced.

Course Prerequisite: BSC 2010C, BSC 2011C, PCB 3044, PCB 3063 with a grade of 'C' or better, or C.I.

Course Description: Vertebrate evolution and ecology, based on the paleontological and ecological literature. The laboratory places heavy emphasis on classification/identification and field research techniques.

Course Outline: Aldo Leopold declared: "There are some who can live without wild things, and some who cannot." This class is for those, like me, who cannot. It will blend natural history and ecological and evolutionary theory with the practical aspects of studying one group of "wild things" - the vertebrate animals. In lecture, we will address the systematics and natural history of all the vertebrates: fishes, amphibians, reptiles, birds and mammals. Lab will be devoted to as much hands-on experience as possible. You will learn some of the methods that biologists use to learn where vertebrates occur, what controls their abundance, how they interact with each other and their environment, etc. The goal is to provide you with some background and experience which will better equip you to begin independent or graduate-level research, to work as a field biologist, or just to become more aware of the "wild things" around you.

Course Objectives:

- * To provide a solid background in vertebrate natural history.
- * To introduce relevant ecological and evolutionary theories, which provide the intellectual underpinning of modern vertebrate biology.
- * To demonstrate the relationship between form and function, habit and habitat.
- * To provide hands-on research experience sampling vertebrates within a local conservation area.

Required Resources:

A. Text: Pough, F.H., C.M. Janis, and J.B. Heiser. 2012. *Vertebrate Life*, 9th Edition. Pearson Benjamin Cummings, San Francisco, CA. Available at Book Store.

B. Journal Articles: To obtain PDFs of scholarly articles you must have internet access to the UCF library.

C. Webcourses: Vertebrate Evolution and Ecology is a web-enhanced class. Announcements, lecture notes, grades, study tips, and relevant web links will be made available at this site. Use your PID and myUCF password to log in. Before emailing me, please check this site for frequently asked questions.

Optional Resources: For lab and field work and your own personal library, I highly recommend these guides:

- * *National Geographic Field Guide To The Birds Of North America*, 6th Edition By Dunn
- * *Peterson Field Guide To Freshwater Fishes*, 2nd Edition By Page & Burr
- * *A Field Guide To Reptiles And Amphibians Of Eastern And Central North America*, 4th edition By Conant & Collins
- * *Peterson Field Guide To The Mammals Of North America*, 4th Edition By Fiona Reid

Grades: Your final grade should reflect your abilities as a vertebrate zoologist. While a single exam or assignment is not necessarily a good estimator of your ability, a variety of exams and other evaluative tools (including the professional opinion of your instructors) will provide an accurate assessment. Grades do not necessarily measure how hard you've worked, how much you've learned, or even how much you've matured as a biologist, and they certainly do not reflect your value as a person. In college in general, and in this class in particular, there is much to be learned outside the classroom (e.g. in departmental seminars) and you will need to balance your personal goals and aspirations versus grades per se.

Your final grade will be determined by your performance as follows:

| Performance Evaluation: | Approximate proportion of grade |
|---|---------------------------------|
| Midterms (2) | 2 x 18% = 36% |
| Final Exam | 18% |
| Lab Exams (2) | 2 x 18% = 36% |
| Oral Presentation (optional) and/or Journal article reviews | 3 x 2% = 6% |
| Lab participation and notebook | 4% |

Grading Scale

| | | | |
|----|--------------|----|--------------|
| A | 93.0 – 100% | C | 73.0 - 76.9% |
| A- | 90.0 - 92.9% | C- | 70.0 - 72.9% |
| B+ | 87.0 - 89.9% | D+ | 67.0 - 69.9% |
| B | 83.0 – 86.9% | D | 63.0 – 66.9% |
| B- | 80.0 - 82.9% | D- | 60.0 - 62.9% |
| C+ | 77.0 - 79.9% | F | 0 - 59.9% |

For additional assistance in calculating your grade see: <http://www.conquercollege.com/gradecalc/>

Final Grade Rounding Policy: The overall semester grade will not be rounded. Either you have the grade or you don't. In other words, a 79.99 is still a 'C+'. No matter where we set the limit, there will ALWAYS be someone who is close to the next grade. As I strive for consistency and fairness there will be no exceptions to this policy and no extra credit or other adjustments will be made.

Student Responsibilities:

Attendance - It is to your advantage to regularly attend lectures and to be on time. Also, out of respect for your peers, please do not disrupt class by being tardy. If this is unavoidable then you should sit near the door to reduce disruption to the class. All cell phones should be turned OFF (not on vibrate) before entering the classroom. Students should not disrupt other students (or the instructor) in class by talking unless instructed to do so by the instructor. Anyone texting during lecture or lab will be asked to leave for the day.

Lab attendance is required. For EACH of the 1st two labs missed your course grade will be deducted by 5%. If you miss 3 labs you will receive an F for the course. The ONLY exceptions to this policy is for legitimate, documentable circumstances. Authorized absence must include written documentation from a competent authority (physician, coach, counselor, etc.). Acceptable absences are major illness, serious family emergencies, special curricular or professional requirements (e.g. attending a scientific meeting), court-imposed legal obligations, military obligations, severe weather conditions, religious holidays, and participation in official university-sponsored activities such as intercollegiate athletics.

It is your responsibility to contact Dr. Klowden prior to or as soon as is possible following an absence. An authorized absence does not excuse you from any missed work. You are individually and entirely responsible for all information, announcements, assignments, and/or handouts that you miss during an absence. Work missed due to unauthorized absence cannot be made up and a grade of zero will be recorded. Work missed due to an authorized absence must be made up or will be assigned a grade of zero. Late assignments will incur a penalty of 10% for each late day.

Readings – Readings are designed to coincide with and supplement the lecture component of the course. The order of reading assignments which generally follow the book chapter order are listed below. You are expected to have read the material prior to class.

Exams – There will be 2 midterm exams counting 18% of your grade each for a total of 36% and a Final exam counting 18% of your final grade. The final exam will be on **May 5 from 1:00-3:50 in BSFS**. It will not be comprehensive and will be a similar format to the midterm exams. Exams will be challenging. To be adequately prepared it is critical that you stay caught up and do not cram at the last minute. The questions will be predominantly short answer essay but may also include multiple choice, fill in the blank and other formats. All questions will pertain to material covered in lectures and textbook readings (but not lab). Bring a #2 pencil with you to each exam. Cell phones must be turned off and stowed during the exam period. Grades will be posted on *Webcourses* and I will inform the class when they are posted.

Late for the exam policy - If you arrive late for any exam you will be allowed to take the test if no one has yet turned in an exam. However, you must turn in the exam at the regular scheduled end of the test. You will not be allowed extra time unless a documentable emergency has occurred.

Makeup Exam Policy – There will not be any make up exams due to unauthorized absence. If you miss an exam for other than an acceptable absence (see above) your score will be a zero. Makeup exams will not be given to accommodate travel plans.

Labs - Labs are an integral - and FUN! - part of this course and should be taken seriously. The University of Central Florida provides access to a tremendous diversity of prepared slides, preserved specimens and skeletons and supplies vans for field trips at considerable expense. Attendance is mandatory for ALL labs. Be on time for lab. For field labs we will leave promptly. Don't be late or you will miss your ride! Absolutely, positively no personal vehicles are allowed on field trips.

Labs will consist of both indoor and outdoor (field) labs.

Indoor - Students will observe preserved, skeletal and slide specimens and dissect representative specimens within each of the major vertebrate groups. Students will learn the key characteristics used to identify and differentiate groups (e.g. Families) with emphasis being placed on characteristics useful to their identification in the field or museum collections.

Lab Exams – There will be 2 lab exams counting 18% each for a total of 36%. Lab exams will be in a “practical” exam format consisting of 25 stations with 2 questions at each station. You will have 2 minutes to answer the questions and then must move to the next station. At the end you will have 5 minutes to briefly return to any desired stations. At each station there will be preserved specimens, dissected specimens, slides, etc. similar to those observed during labs. Questions may ask you to identify the taxonomic group (YES spelling counts so practice, practice, practice!), name which of the specimens shown are most closely related, identify a labeled structure or its function, or something about the ecology of the organism (e.g. its preferred habitat or food). Answers will generally consist of 1 or 2 words. As there is a good amount of material and a need for near instant recall of the information, it is essential that you spend a substantial amount of time reviewing the material prior to the lab exam.

Outdoor: Field labs will include observational trips and the collection of data. Students will learn techniques used by field ecologists to learn where vertebrates occur, what controls their abundance, and how they interact with each other and their environment. This will include both capture and observation. For all outdoor labs please wear long pants, long sleeves, socks and close toed shoes that can get wet and dirty since you are likely to encounter waist high vegetation, poison ivy, rain, mud, etc. and may be wading in the water. If you have something to do after this lab you may want to bring a change of clothes. Labs will occur rain or shine unless the weather is severe. So, please bring a rain coat on rainy days. Please take care with all lab equipment so that it remains in good shape for your peers.

List of recommended equipment to bring to each outdoor lab:

1. **Water** - bring plenty (i.e. not just 1 small bottle) as we will be outdoors in the sun for many hours.
2. **Long** pants, long sleeves, socks and close toed shoes that can get wet and dirty
3. Hat
4. Sunblock
5. Insect repellent
6. First aid kit - band-aids, antibiotic ointment, tweezers and alcohol swabs
7. Bee sting kit if allergic to bee stings
8. Other personal medications – allergy, headache etc.
9. Lunch and snack
10. Your field notebook and pencils
11. Camera and binoculars (each student will be issued binoculars but bring your own if you have a preferred set)
12. Watch
13. Hand towel
14. Backpack

Field notebook: Detailed field notes are an extremely valuable part of natural history collections. They are used extensively for museum research, conservation, and management. For example, the distribution and abundance of plants and animals changes over time, due to natural causes as well as human-mediated impacts on the environment. By looking back at field notes from 100 years ago, we can accurately document the changing status of biodiversity in a given area.

You should maintain a field notebook in which you make notes before, during, and after field labs. Include instructions, notes, data, results, descriptions, pictures, graphs, sketches, and anything else that may act as a detailed record of all you observe or think while in the field. At first when you're learning to identify animals, you won't know what you're looking at. In that case, you should describe the animal as best you can. Once you've learned to positively identify a species, it isn't necessary to repeat the description each time you make a new account of that species. All results and observations should be written directly in the notebook and temporary notes should not be made on random pieces of paper. Mistakes in the lab notebook should be crossed out with a single line. You may find that this information is needed at a later time and if scribbled or whited out will be unreadable.

A waterproof Write-in-the-rain notebook will be supplied for you. You must supply a pencil with which to write. Notebooks must be kept up to date and should be completed while in the field. Lab notebooks will be collected periodically following lab and

considered as part of your participation grade. (Warning – Be sure to only use a pencil since upon collection all notebooks may “accidentally” be dropped in a bucket of water and it would be a shame if all your writing was washed away!).

While the exact style and entries of a field notebook vary substantially between individuals, each day’s work should include:

- A. Date – I prefer the format DD MMM YYYY (e.g. 12 Jan 2012) since 1/6/12 could mean Jan 6 or June 1.
- B. Times – I prefer 24 hour format (e.g. 13:00 to 15:30 h) rather than am and pm.
- C. Researchers names
- D. Location – Precise description or GPS coordinate if available.
- E. Weather – temp, cloud cover, rain etc.
- F. Intended activities
- G. General location description (e.g. habitat, topography, important features, etc.)
- H. Data – either directly written into notebook or transcribed from datasheets (indicate if transcribed).
 - a. A list of individuals and species seen
 - b. Time (e.g. 14:35 h)
 - c. Where each was located (GPS point if possible)
 - d. Habitat description (e.g. on trunk of slash pine tree, 1 m off ground in oak/pine forest w/ dense palmetto)
 - e. What it was doing or how it sounded (e.g. was eating an acorn).
 - f. Measurements taken (e.g. body dimensions or weight)
 - g. Description (e.g. color, pattern, external parasites observed etc.)
- I. Other observations and descriptions
- J. Specimen and/or location sketches (optional)

For more hints on keeping a field notebook see the attachment at the end of this syllabus.

Lab Participation: I expect you to have a good attitude and to be active participants in the learning process. This not only means that you are present in all labs but that you are prepared and actively work to improve your understanding of the subject. Ask questions and seek answers both alone and in conjunction with your classmates. In the field you will quickly discover that working outdoors trying to collect ecological data is a challenging endeavor that is generally enjoyable but can at times be uncomfortable, exhausting and monotonous. Please try to keep a good attitude and help your classmates whenever possible. In addition to the learning benefits that active participation will bestow upon you, it will also be reflected in your grade. Dr. Klowden and the TA will observe and evaluate your preparedness, general attitude, and enthusiasm in all labs and this will account for a portion of your grade.

Journal Article Reviews – From the list at the end of the syllabus, choose 3 journal articles to review (unless you choose to do the oral presentation (see below)). Each review should be **750-1000** words in length, no more, no less. Each review will be worth 2% of your final grade. All reviews are due by 11:59 pm on the dates shown in the schedule below. You may however turn them in earlier if you choose. Reviews should be submitted via the appropriate link on Webcourses. Late assignments will incur a penalty of 10% for each late day.

Summaries must be entirely your own work. All reviews will be submitted to Turn-it-in to check for plagiarism so be certain that ALL words are your own. When taking notes it is recommended to place any copied material in quotes to be sure you avoid using other people’s writing in your final summary. Unless absolutely essential, quotations should be avoided. You are encouraged to discuss the articles with classmates however discussion is where it should end. In other words be sure each of you writes a completely original review. **Plagiarism will not be tolerated and will result in a failing grade for the course or expulsion from UCF.**

The structure of your reviews should include:

- an initial identification of the article (author, title of article, title of journal, year of publication, and an indication of the major aspects of the article you will be discussing.
- a brief summary of the range, contents and argument of the article. You may summarize section by section but since the review is short it may better to pick up the main themes only. This section should not normally take up more than a third of the total review.
- a critical discussion of 2-3 key issues raised in the article. This section is the core of your review. You need to make clear the author’s own argument before you criticize and evaluate it. Also you must support your criticisms with evidence from the text or from other writings. You may also want to indicate gaps in the author’s treatment of a topic; but it is seldom useful to criticize a writer for not doing something they never intended to do.
- a final evaluation of the overall contribution that the article has made to your understanding of the topic (and maybe its importance to the development of knowledge in this particular area or discipline, setting it in the context of other writings in the field).

Optional assignments – Optional assignments are not extra credit however like extra credit can boost your grade. As opposed to extra credit, which can be neutral or help your grade, optional assignments can benefit your grade **IF you do a good job** but could hurt your grade if you do a poor job. I design it this way as a way to encourage you to take the assignment seriously and to do a good job and to avoid you turning in a hastily prepared assignment in hopes of getting a point or two. However, do not be dissuaded from doing this in fear of receiving poor credit. If you take the assignment seriously, you will receive full credit and it will benefit you. Just be sure to take it seriously and do a good job.

There are 3 possible optional assignments. You may do zero, one, two, or all three.

Oral Presentation – This assignment is OPTIONAL (see above). Oral presentations can be on any topic related to the conservation of vertebrates. It may be on a specific species or on a broader topic. All topics must 1st be approved by Dr. Klowden. Presentations should be in PowerPoint format and should be 15-20 minutes in length. You will be graded on both content (quality not quantity) and presentation (e.g. eye contact, volume, effectiveness of slide use, etc.) so practice, practice, practice. If you would like to do an oral presentation talk to Dr. Klowden ASAP so a date can be arranged.

Book Review – This assignment is OPTIONAL (see above). Due April 21 at 11:59 pm submitted via a link on Webcourses. If you choose to do this, it will replace 3% of the value of your lowest lecture or lab exam (thereby reducing it from 18% to 15% of your grade). If you choose, pick an ecology themed book of at least 250 pages or more to read and write a **750-1000 word** summary report demonstrating that you read the entire book and your understanding and opinions of the book. This should be similar in style to the journal articles reviews (see above). Approved books are listed below. Other books must 1st be approved by Dr. Klowden. Reviews should be for this class only and not a book used in another class. Summaries must be entirely your own work. Plagiarism will not be tolerated and will result in a failing grade for the course or expulsion from UCF. All reviews will be submitted to Turn-it-in to check for plagiarism so be certain that ALL words are your own. Unless absolutely essential, quotations should be avoided. I reserve the right to orally quiz you about the book if I suspect you have not read it.

Books approved for review are:

The Beak of the Finch by Jonathan Weiner
Voyage of the Beagle by Charles Darwin
On the Origin of Species by Charles Darwin
Diversity of Life by E.O. Wilson
Song of the Dodo by David Quaman (excellent!)
The Reluctant Mr. Darwin by David Quammen
Boilerplate Rhino by David Quammen
How and Why Species Multiply by P. Grant and R. Grant
A Stillness in the Pines by Robert McFarlane

Ever Since Darwin by Stephen Jay Gould
What Evolution Is by Ernst Mayr
The Selfish Gene Richard Dawkins
The Greatest Show on Earth Richard Dawkins
The Extended Phenotype by Richard Dawkins
Evolution's Rainbow Joan Roughgarden
Amazon Expeditions by Paul Colinvaux
Your Inner Fish by Neil Shubin
Winter World by Bernd Heinrich

Additional Journal Article Review – This assignment is OPTIONAL. Due April 21 at 11:59 pm submitted via a link on Webcourses. If you choose to do this, it will replace 2% of the value of your lowest lecture or lab exam (thereby reducing it from 18% to 16% of your grade). From the list at the end of the syllabus, choose a journal article to review that you did not review for the regular review assignments. Format should be the same as for the regular review assignment (see above). Late assignments will NOT be accepted.

Ethics - UCF faculty supports the UCF Creed. Integrity - practicing and defending academic and personal honesty - is the first tenet of the UCF Creed. This is in part a reflection of the second tenet, Scholarship: - I will cherish and honor learning as a fundamental purpose of membership in the UCF community. - Course assignments and tests are designed to have educational value; the process of preparing for and completing these exercises will help improve your skills and knowledge. Material presented to satisfy course requirements is therefore expected to be the result of your own original scholarly efforts.

Plagiarism and cheating - presenting another's ideas, arguments, words or images as your own, using unauthorized material, or giving or accepting unauthorized help on tests - contradict the educational value of these exercises. Students who attempt to obtain unearned academic credentials that do not reflect their skills and knowledge can also undermine the value of the UCF degrees earned by their more honest peers.

UCF faculty members have a responsibility for your education and the value of a UCF degree, and so seek to prevent unethical behavior and when necessary respond to infringements of academic integrity. Penalties can include a failing grade in an assignment or in the course, the issuance of a 'Z' grade on your transcripts or suspension or expulsion from the university. See <http://www.osc.sdes.ucf.edu/> for more information about UCF's Rules of Conduct.

Dr. Klowden will issue a failing grade of "F" for the entire course for anyone caught cheating and will send notice to the University where more serious action may be taken..

"I'm a great believer in luck, and I find the harder I work the more I have of it."
-Thomas Jefferson

The professor reserves the right to modify the syllabus as needed.
Students will be informed of any changes.

SCHEDULE (subject to change as necessary)

| Week | Dates | Lecture Topics | Text Chapter | Lab | Due Dates |
|-------------------|---------------|--|--------------|---------------------------|-------------------------|
| 1 | JAN 13 | Diversity, Classification & Evolution of Vertebrates Vertebrate Relationships and Basic Structure | 1 2 | Introduction / Bird id | |
| | JAN 15 | Early Vertebrates | 3 | -- | |
| 2 | JAN 20 | Field Trip to Merritt Island National Wildlife Refuge | - | Field Trip | |
| | JAN 22 | Living in Water | 4 | -- | |
| 3 | JAN 27 | Radiation of the Chondrichthyes Major Radiation of Fishes | 5 6 | Fishes | |
| | JAN 29 | Major Radiation of Fishes (cont) | 6 (cont) | -- | |
| 4 | FEB 3 | LECTURE EXAM 1 (Chapters 1-6) | -- | Amphibians | Lecture Exam 1 |
| | FEB 5 | Living on land / Origin and Radiation of Tetrapods | 8 / 9 | -- | |
| 5 | FEB 10 | LAB EXAM 1 (Fishes and Amphibians) Lecture – catchup? | | Lab Exam 1 | Lab Exam 1 |
| | FEB 12 | Salamanders, Anurans and Caecilians | 10 | -- | |
| 6 | FEB 17 | ----- | | Field Research | Article 1 due |
| | FEB 19 | Salamanders, Anurans and Caecilians (continued) | 10 (cont) | -- | |
| 7 | FEB 24 | ----- | -- | Field Research | |
| | FEB 26 | Salamanders, Anurans and Caecilians (continued) | 10 (cont) | -- | |
| 8 | MAR 3 | The Lepidosaur: Tuatara, Lizards, and Snakes | 13 | Non-avian Reptiles | |
| | MAR 5 | Lepidosaur (cont) | 13 (cont) | | Article 2 due |
| | MAR 9-14 | Spring Break - No Classes | -- | -- | |
| 9 | MAR 17 | ----- | -- | Field Research | |
| | MAR 19 | Turtles | 12 | -- | |
| 10 | MAR 24 | LECTURE EXAM 2 (Chapters 8-10, 12-13) | -- | Birds | Lecture Exam 2 |
| | MAR 26 | Mesozoic Diapsids: Crocodillians, Dinosaurs, Birds | 16 | -- | |
| 11 | MAR 31 | Avian specializations | 17 | Mammals | |
| | APR 2 | Avian specializations | 17 | -- | |
| 12 | APR 7 | LAB EXAM 2 (Non-avian reptiles, birds, mammals) Lecture – catchup? | -- | Lab Exam 2 | Lab Exam 2 |
| | APR 9 | The Synapsida and the Evolution of Mammals Mammalian Diversity and Characteristics | 18 20 | -- | |
| 13 | APR 14 | ----- | -- | Field Research | Article 3 due |
| | APR 16 | Guest lecturer Ariel Horner – Topic TBA | -- | -- | |
| 14 | APR 21 | ----- | -- | Field Research | Optional Book Review |
| | APR 23 | Mammalian Specializations | 21 | -- | |
| Final Exam | MAY 5 | FINAL EXAM (Chapters 16-18, 20-21 & guest lecture) Tuesday MAY 5 at 1:00-3:50 pm in BSFS 105 | -- | -- | Final exam |

Journal Articles

Choose 3 of these to review. Assignment details are above.

Aguirre, Windsor E., Kaitlyn E. Ellis, Mary Kusenda And Michael A. Bell. 2008. Phenotypic variation and sexual dimorphism in anadromous threespine stickleback: implications for postglacial adaptive radiation. *Biological Journal of the Linnean Society* 95:465–478.

Burke AC, CE Nelson, BA Morgan, and C Tabin. 1995. Hox genes and the evolution of vertebrate axial morphology. *Development* 121:333-346.

Estes, JA, et al. 2011. Trophic Downgrading of Planet Earth. *Science* 333:301-306.

Grant, Peter R. and B. Rosemary Grant. 2002. Darwin's Finches Unpredictable Evolution in a 30-Year Study of Darwin's Finches. *Science* 296:707-711.

Grant, Bruce W. 1990. Trade-offs in activity time and physiological performance for thermoregulating desert lizards, *Sceloporus merriami*. *Ecology* 71: 2323-2333.

Holland, Nicholas D. and Junyuan Chen. 2002. Origin and early evolution of the vertebrates: new insights from advances in molecular biology, anatomy, and palaeontology. *BioEssays* 23:142-151.

Lamb, Trevor D., Shaun P. Collin, and Edward N. Pugh, Jr. 2007. Evolution of the vertebrate eye: opsins, photoreceptors, retina and eye cup. *Nature Reviews Neuroscience* 8:960-976.

MacArthur, Robert H. 1958. Population ecology of some warblers of northeastern coniferous forests. *Ecology* 39:599-619.

McCollum, S.A. and J.D. Leimberger. 1997. Predator-induced morphological changes in an amphibian: predation by dragonflies affects tadpole shape and color. *Oecologia* 109:615-621.

Murphy, William J., Eduardo Eizirik, Warren E. Johnson, Ya Ping Zhang, Oliver A. Ryderk, and Stephen J. O'Brien. 2001. Molecular phylogenetics and the origins of placental mammals. *Nature* 409:614-618.

Rayner, Jeremy M. V.. 1988. The evolution of vertebrate flight. *Biological Journal of the Linnean Society* 34:269-287.

Satoh, Noriyuki and William R. Jeffery. 1995. Chasing tails in ascidians: developmental insights into the origin and evolution of chordates. *Trends in Genetics* 11:354-359.

Schwenk, Kurt. Why Snakes Have Forked Tongues. *Science* 263:1573-1577.

Vitt, Laurie J., Eric R. Pianka, William E. Cooper, Jr., and Kurt Schwenk. 2003. History and the global ecology of squamate reptiles. *The American Naturalist* 162:44-60.

Keeping a Field Notebook

Excerpt from: "Practical Field Ecology: A Project Guide" by C. Philip Wheeler, Penny A. Cook, James R. Bell

Use a field notebook to write down data, ideas, observations, tentative conclusions and hypotheses as you do your fieldwork to create an immediate and faithful history of your research. Produce comprehensive, clearly organized notes as a reference and so that you can reconstruct the research time-line and follow the development of your thoughts and ideas. Although you may use other collection sheets (e.g. pre-printed data collection forms to ensure data are collected consistently in different locations and at different times), your field notebook should provide the context for data collection and help resolve ambiguities or inconsistencies when preparing for analysis. After data analysis, reference to your notebook may generate further hypotheses and suggest further lines of enquiry.

What should be recorded?

The first page should include contact details in case of loss, the subject of your research and the start and end dates of the period covered by that notebook. Include any conventions used, for example 'All times are recorded as local time'. Number the pages and ideally add a contents table to make searching for information easier. Write on the right hand page only so the left hand page can be used for ideas generated by reading about similar observations or relevant research papers. Leave a few lines between observations for comments to be inserted later (e.g. 'No bark damage here 23 June, see p39'). Add a 2 cm margin to write the time, location (e.g. from a GPS reading) or other identifying labels. Create lists of codes, acronyms, specialist terminology, etc. at the back include any emergency numbers (e.g. those of field buddies). Other useful notes about equipment (how to use, limitations of instruments etc.) and any numerical information you might require in the field (simple formulae for calculations, random numbers, etc.) can also be added here.

Before starting each work day, write down the date, weather, general location, nature of the habitat and purpose of the day's work. Write down any changes in weather or habitat that occur during the day, for example 'At 15.00 hours snow began to fall and visibility was reduced to 20 m'. When observing behavior note the sampling method, how animals were chosen for observation and the recording method (e.g. whether you noted all occurrences or used a time-sampled method). If animals or start times are chosen at random, note how this was done.

Note the type and model number of any equipment (e.g. GPS receiver type Garmin 12). Some instruments need calibrating at intervals, so record the time of calibration and any raw data and subsequent calculations so that any arithmetic errors can be identified and corrected later. Use your notebook to create rough species accumulation curves, etc so you can tell when you should stop collecting data. Along with observations, note the time and if possible, the location from a GPS receiver. Although notes should be made at the time observations are made, it may be difficult to observe and write at the same time, but if you do rely on memory, you should note this. Write exactly what you see or hear, for example when describing behaviour do not ascribe a function to it in the guise of a description (i.e. do not write that a goose was vigilant when you mean that the bird was in a standing posture with an elongated neck and raised head).

Sketches enhance any photographs you take of your study sites and you will have a sketch available in your notebook the next time you visit the area. Sketches can be added subsequently (annotating any changes with the date of the amendment). The value of sketches can be increased by explanatory labels. A careful sketch can aid species identification and will help to jog your memory when you encounter a species in the future; such sketches are more valuable if labeled with the diagnostic feature(s) you use (e.g. 'two spots on forewing' or 'sepals reflexed'). Landscapes change over time and maps may not reflect this. In some cases no map of a suitable scale may be available and a sketch map can be made using compass and tape, or by pacing out distances using a pedometer. This may be adequate to note the locations of those animals or plants of interest.

It is also useful to record any notes and actions from supervisory team meetings both as a reminder and to ensure that any designated actions have been completed as planned.