DISEASE ECOLOGY AND CONSERVATION
GEORGE MASON UNIVERSITY
Fall Semester 2020
3 Credit Hours

EVPP 427-001 (CRN: 75157)/BIOL 417-002 (CRN: 75780)
EVPP 527-001(CRN: 76157)/BIOL 507-002 (CRN: 77471)
Lecture: 4:30–7:10 p.m. Tuesdays
Innovation 209

Instructor: Dr. Esther Peters
Office: David J. King Hall 3050, Fairfax
Office Hours: 3:15–4:15 p.m. Tuesdays (please let Dr. Peters know by e-mail if you are coming) or schedule other times BY APPOINTMENT (send email request to Dr. Peters)
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Prerequisite(s): *Undergraduate students*: EVPP 301 OR BIOL 308 and 60 credit hours; or Instructor's permission.

Graduate Students: Courses on Evolution, Ecology, Zoology and Conservation Biology or Instructor's permission.

Sign up for Mason Alert (e.g., weather closings, emergencies) at **https://alert.gmu.edu**
See Emergency Preparedness Guides at (http://ehs.gmu.edu/guides_EP.html)

Syllabus

Course Description

Conservation of biological diversity faces multiple challenges. The relationship of humans to impacts on terrestrial and aquatic organisms has been recognized, but conservation strategies traditionally have not included investigations of the symbioses and linkages among all organisms and the continuum of environment and health to frame protection policies and educate the public. In the 1990s, conservation medicine emerged as a transdisciplinary field that studies the relationships between human, animal, and ecosystem health and environmental conditions. Biomedical sciences are combined with conservation biology and other disciplines to trace the environmental sources of pathogens and pollutants, develop an understanding of the ecological causes of changes in human, biotic, and ecosystem health and address the consequences of diseases to populations and ecological communities. This advanced course will provide a

framework in which to examine the connections between condition of the planet and health of all species. It will also challenge students in the ecological sciences, health sciences and the natural sciences to think about new, collaborative ways to address ecological health. Understanding infectious and noninfectious diseases, pathogens, processes, impacts, and how to maintain healthy populations of species—and the ecosystem services the species provide—is the key to conservation.

Course Objectives and Student Learning Outcomes

The course will examine health issues from various standpoints, including the emergence and resurgence of infectious disease agents and how they are investigated; the effects of global climate change on health; the increasing impacts of toxic chemicals and hazardous substances; and the health implications of habitat fragmentation, degradation, and loss of biodiversity. Students will participate in individual and team assignments to be able to:

- Explain the difference between health and disease;
- Discuss biotic and abiotic agents causing diseases, the paradigm of disease, factors controlling diseases and how they are investigated;
- Define terms pertaining to health, disease, epidemiology, ecology, and medicine;
- Analyze diverse readings on conservation medicine and its role in conserving species and ecosystems;
- Collect examples of diseases occurring in terrestrial and aquatic organisms;
- Evaluate recent reports on emerging diseases in wildlife, domestic animals, and humans and their effects on ecosystems; and
- Explain how disease investigations can improve conservation projects.

Course Expectations

Each session will combine lectures, class exercises, occasional guest speakers and student discussion. As with any cross-listed course (undergrad/grad) offering, ***this will not be an easy course***. The successful student **must read assignments, study supporting materials, and prepare assignments outside of class**. Self-directed study skills are important. Students need to organize material logically and communicate well orally and in writing.

Class Preparation

"He who hesitates is lost...." Reading, research, and assignments are detailed on the following class outlines. Any concerns about keeping up with assignments should be discussed with Dr. Peters. More students are juggling work, research, internships, shadowing, and families. Please note: "Although many students must work to meet living expenses, employment must not take

priority over academic responsibilities. Students employed more than 20 hours a week are strongly urged not to attempt a full-time academic load. Students employed more than 40 hours a week should attempt no more than 6 credits per semester. Students who fail to observe these guidelines may expect no special consideration for academic problems arising from the pressures of employment." (University catalog, section AP.1.2. Academic Load, see: http://catalog.gmu.edu/content.php?catoid=27&navoid=5365#attendance). Please consider your responsibilities and interests and plan accordingly to protect your health and GPA!

Class Participation

Students should come to class ready to participate in all activities (assignments completed prior to class). They should behave in a mature and professional manner and abide by the GMU honor code. **Please turn off cell phones before class begins.**

Absenteeism should be limited to illness or emergencies, or discuss concerns with the instructor.

Students should notify Dr. Peters before class if they must miss a class. **Multiple missed classes will affect student grades** as class exercises are given in almost every lecture. PowerPoint TEXTS will be posted so you have the highlights of each lecture. However, you need to make every effort to attend. Students should contact classmates to obtain lecture notes and assignments as quizzes and exams will be based on the lectures and other reading materials.

Students may record the lectures (sound) but may not take photographs or videos. Instead, they should take notes, which will help them study for the quizzes. If using electronic devices (such as laptops, notebooks, tablets) please be respectful of your peers and instructor and do not engage in activities unrelated to class. Such disruptions show a lack of professionalism and can affect your grade.

If you are a student with a disability and you need academic accommodations, please notify Dr. Peters and contact the Office of Disability Services (ODS) at 993-2474. All academic accommodations must be arranged through the ODS.

E-mail Communications

Dr. Peters will send e-mail messages only to your GMU e-mail account. Students must use their Mason email accounts— "MASONLIVE" account—to receive important University information, including messages related to this class. See http://masonlive.gmu.edu for more information. Please be sure you check it often and respond to queries from Dr. Peters! If you are not getting messages (e.g., MasonLive issues), please send Dr. Peters an alternate e-mail address.

Required Textbook

Aguirre, A. A., R. S. Ostfeld and P. Daszak. 2012. *New Directions in Conservation Medicine: Applied Cases of Ecological Health,* Oxford University Press, New York, 646 pp.

Course Assignments

Definitions of Terms

Each student is expected to identify and define 100 common terms related to conservation medicine and disease ecology and submit them ***written by hand***. This is a way to expose you to common terminology used in conservation medicine, and to help you remember some of these definitions by writing them. Terms must be selected from class materials and may not be copied from Internet word searches. Terms must be numbered and written legibly on lined paper (notecards will not be accepted). Terms are not required to be in alphabetical order, but if they are not in alphabetical order they must demonstrate organizational thought such as grouped by theme (e.g., types of surveillance, emerging infectious diseases, disease and translocation) or field (i.e., disease ecology, conservation, climate change, fragmentation). If you choose to define THEORIES, HYPOTHESES or POSTULATES, you MUST cite the original publication, AND thoroughly explain the premise.

Written Assignments

In addition to reading and studying the textbook, other books, and journal papers, **undergraduates will prepare one written assignment and graduate students will prepare two written assignments** of 400 words not including references drafted as commentaries. These single-spaced assignments may compare, contrast, or critique a **technical (scientific) article recently published (2018 or later) on a disease ecology issue** (e.g., anthrax outbreak in bison; dolphins stranding on the Virginia coast; global Ebola outbreak; Zika virus spreading in the Americas). Follow the style and formatting guidelines for *Letters to Science* (https://science.sciencemag.org/ and scroll down to LETTERS in the latest edition to review examples.

> **YOU MUST ATTACH THE PAPER YOU ARE REVIEWING TO YOUR SUBMISSION** Attachments can be .doc, .pdf, or other downloadable files. Attachments may NOT be in the form of a hyperlink.

Identify ***specific*** issues/critiques you have with **the article**. This can be something that you found problematic, interesting, ridiculous, missing, etc. Compare and support your arguments with other sources in the literature, **citing a minimum of 4 other sources** and a maximum of 8 other sources. You are **encouraged** to search articles from all sources. Use Web of Science or other journal databases to do additional literature searches, or http://scholar.google.com. You do not need to attach or provide any of the supporting papers.

Make your critiques **explicit and clear**, e.g.: "I find three main critiques in the way this argument was presented." Then explain them in paragraphs 1, 2, 3. You should critique a piece of **primary** literature from a journal, popular magazine. or even a TV news report. Do not critique a review paper or book chapter.

Do not spend too many words describing the intro, methods, conclusions, etc., of the article or report that you are critiquing. Try to give a very **brief** overview of the important points or methods and spend the rest of your paper giving **your own** "two-cents"! A good idea is to end

with what you think needs to be done in the future based on your critique. **Don't be repetitive** with your points, you only have up to 400 words, therefore be concise and clear. Make every word count (this may be one of the big challenges of the assignments and will train you for real manuscript writing with editor-imposed word limits).

Proofread: Review your spelling and grammar before handing your work in! Avoid run-on or ambiguous sentences.

Each paper should be neatly prepared and proofread, especially checking for consistency, completeness, and correctness (Help: The Writing Center, OWL/On-line Writing Lab). Many online grammar resources are now available. This book might help when writing:

Ross-Larson, B. 1996. *Edit Yourself: A Manual for Everyone Who Works With Words.* W.W. Norton & Co., New York, NY.

All statements of fact in your paper need to be referenced to the original research. You can of course access that material electronically, BUT the use of web sites as a primary source of information is discouraged. You should be using primary literature (e.g., peer reviewed journal articles) and reports for your authority. Limit web citations to no more than about 25% of the total. Full references (all author names) should be provided in the References and Notes section of your paper. As for citation style, use *Letters to Science*, but include all authors and the full title of the article. Footnotes are reserved for limited explanatory material only. In the body of the text use numbers in boldface and in parentheses, then list the citations in numerical order. Please use Zotero or EndNote as your reference manager as this will be very useful in your future research. But please "disconnect" the link to Zotero or Endnote before submitting.

Use **proper reference structure**, numbered reference (to save words), e.g. "Nipah virus was isolated from pigs [1]".

References and Notes

1. S. AbuBakar, L.-Y. Chang, A.R.M. Ali, S.H. Sharifah, K. Yusoff, Z. Zamrod, Isolation and molecular identification of Nipah virus from pigs. *Emerging Infectious Diseases*, 2004. 10(12): p. 2228-2230.

2. A. Authorlastname, B. Authorlastname, Title of paper. *Journal Title in Italics*, **Vol**(Issue), startpageno (YEAR).

Please use Word (either .doc or .docx files only) and email your paper to Dr. Peters before or on the due date at 11:59 p.m. DO NOT CONVERT TO PDF!

Final PowerPoint Presentation

Not for Undergraduates!
This assignment is optional for undergraduate students to improve their grades, however.

Undergrads will listen to the presentations and participate in the Q&A session for each talk.

Graduate students are required to give a 10–12-min presentation (+5 min Q&A) using PowerPoint slides on a *contemporary* issue/topic relevant to Conservation Medicine. These presentations are worth *20% of your grade*. The issues/topics (*but not the contents*) for the presentations are not limited to those covered in the textbook. *Choose your favorite infectious disease, in a terrestrial or marine species or ecosystem from a newspaper, magazine article, or scientific journal article*. In your presentation, provide a brief background of the problem; describe the impacts of this disease to wildlife, domestic animals, humans and ecosystems and concerns from an economic, cultural, environmental, and conservation medicine perspective. Impacts can be considered from species to ecosystems and from molecular to global. Management implications may include discussion of mechanisms of control, prevention measures and proactive intervention to control impacts of the pathogen. Presentations will be **15 minutes total.**

The slide presentation "rule of thumb" is 1 slide per minute, so plan accordingly.
Your first slide should be a title slide with your name and title of the talk. Next should be an introduction and overview of the topic followed by more specifics. Next you should discuss the implications of your infectious disease and management issues related to conservation medicine. Finally, you should provide conclusions and highlight the main points.

Presentations will be graded on the clarity of the presentation, the professionalism of the slides, the content of the material presented and your ability to answer questions posed by classmates and instructor.

Each topic below will get a score ranging from **1** (poor), **2** (good), **3** (very good) **4** (excellent).

Literature Review- Scope of information gathering.

Scientific knowledge- How accurate is the information presented.

Management Implications- all presentations should address *at least* 3 of the following areas:

a) Effects of an infectious disease in species and ecosystems from the molecular to the global, including human health.
b) Economic perspectives.
c) Cultural perspectives.
d) Socioeconomic perspectives.
e) Environmental policy angle.
f) Perspectives from both the development, agriculture and conservation.
g) Public health angles.
h) Solutions to the problems outlined.

Conclusions-Conclusions are sound and supported by data.

Slides-Slides are well organized, logical, and easy to read and to interpret.

Style-Delivery is clear, audible, with proper elocution and eye contact with audience.

Time-Speaker adheres strictly to time limit.

Grading Criteria

The total grade received for this course will be based on the following assignments and assessments:

Activity	EVPP427/BIOL417 Contribution to Total Grade	EVPP527/BIOL507 Contribution to Total Grade
Definitions of Terms	10%	10%
Class participation	8%	5%
Extra readings	-	5%
Written commentaries	20% (one only)	20% (10% each)
5 Quizzes, lowest grade dropped	40% (10% each)	20% (5% each)
Mid-term Exam	20%	20%
PowerPoint presentation	2% (listen, question)	20%
TOTAL	**100%**	**100%**

The final grade for undergraduate students will be based on this scale: A = 100–93%, A- = 92-90%, B+ = 89-86%, B=85-83, B- = 82-80%, C = 79–70%, D = 69–60%, F < 59%.

The final grade for graduate students will be based on this scale: A= 100–90%, B= 89-80, C = 79–70%, D= 69–60%, F < 59%.

A CURVE WILL NOT BE APPLIED.

Academic Integrity

GMU is an Honor Code university; please see the University Catalog for a full description of the code and the honor committee process. The principle of academic integrity is taken very seriously and violations are treated gravely. What does academic integrity mean in this course? Essentially this: when you are responsible for a task, you will perform that task. When you rely on someone else's work in an aspect of the performance of that task, you will give full credit in the proper, accepted form. Another aspect of academic integrity is the free play of ideas. Vigorous discussion and debate are encouraged in this course, with the firm expectation that all aspects of the class will be conducted with civility and respect for differing ideas, perspectives, and traditions. When in doubt (of any kind) please ask for guidance and clarification. Students are expected to complete the work on their own or as a team, depending on the assignment.

All exams will be completed by individuals in the classroom or as a team outside the classroom (those registered for the course).

Unless otherwise noted, these assessments will be taken without the use of study aids, memoranda, textbooks, other books, data, or other information available. The purpose of these assessments is to evaluate the student's progress in understanding the material.

It is important to note that materials produced for this course, particularly for the commentaries, require creativity in organization and presentation, but that the information presented within the paper or other product must be properly acknowledged as to its source. Statements of a general nature or that synthesize information from several sources need not be attributed to a specific source; however, statements of specific details or direct quotations ("between quotation marks") from books, journals, newspaper or other media articles, Internet web pages, or other authorities must be identified by number in the text and the full citation provided in the References and Notes section at the end of the paper.

Other Useful Campus Resources

WRITING CENTER: Robinson Hall B213; 703-993-1200; http://writingcenter.gmu.edu

UNIVERSITY LIBRARIES: "Ask a Librarian" http://library.gmu.edu/mudge/IM/IMRef.html

COUNSELING AND PSYCHOLOGICAL SERVICES (CAPS): 703-993-2380; http://caps.gmu.edu

LEARNING SERVICES: 703-993-2999; http://caps.gmu.edu/learningservices/; offer many good study skills workshops!

ACADEMIC COUNSELING PROGRAM: 703-993-2380: http://caps.gmu.edu/learningservices/academiccounseling.php

UNIVERSITY POLICIES
The University Catalog, http://catalog.gmu.edu, is the central resource for university policies affecting student, faculty, and staff conduct in university academic affairs. Other policies are available at http://universitypolicy.gmu.edu/. All members of the university community are responsible for knowing and following established policies.

NAMES AND PHONE NUMBERS OF CLASSMATES:

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Course Schedule*

Week	***Date***	***Book Chapters***	***Topic***
1	08/25	The following readings should be done BEFORE CLASS EACH WEEK	Introductions. Syllabus. Course expectations. General concepts & definitions Conservation Medicine: Ecological Health in Practice
2	09/1	Foreword, Preface Chapter 1	Health and disease: Concepts and models
3	09/8	Chapter 37	Eco-epidemiological approaches to infectious disease
4 **Quiz 1**	09/15	Chapter 6	Disease, biodiversity, and species extinction
5	09/22	Chapters 5 & 10	Habitat fragmentation/loss and disease ecology and Lyme disease and the dilution effect
6	9/29	Chapter 15	Movie night: "*Contagion"*
7 **Quiz 2**	10/6		Principles of emerging infectious diseases (EIDs)
8	10/13	***No class***	**Columbus Day Recess**
9 **Quiz 3**	10/20	Chapters 16 & 23, Readings	***Written Commentary 1 due – Email to Dr. Peters*** ***Definitions due – submit printed copy to Dr. Peters in class***
			EIDs: terrestrial and marine ecosystems ***Take Home Midterm Exam - Provided***
10	10/27	***No class***	***Work on Exam***
11	11/3	Chapters 20 & 21, Readings	Disease ecology of plants and invertebrates
12	11/10	***No class***	***Take Home Midterm Exam Due –*** Email Exam to Dr. Peters by the start of class
13 **Quiz 4**	11/17	Chapter 29**, Readings	Disease ecology, bioterrorism and environmental security
14	11/24	Chapters 11 & 12, Readings	***Written Commentary 2 due - Email to Dr. Peters***
			The wildlife trade, bushmeat and the spread of disease
15 **Quiz 5**	12/1	Chapter 42, Readings	Prediction and prevention of the next epidemic
16	12/8		**Final PPT Presentations**

*** In addition to the chapters for each session, ALL GRADUATE STUDENTS are required to read *extra preselected, refereed papers/chapters* listed below that they will discuss in class.**

** Chapter 29 from Aguirre et al. 2002 will be provided as a PDF.

Required Readings for Graduate Students:

Be ready to report on the highlights from the following textbook and papers during class for the weeks indicated (e.g., the Week 2 assigned readings must be read before class in Week 2).

Week 2:

Textbook: Chapters 2, 3, and 38

DeCandia A.L., A.P. Dobson and B.M. vonHoldt. 2018. Toward an integrative molecular approach to wildlife disease. Conservation Biology 32:798-807.

Week 3:

Textbook: Chapter 9

Burge C. A., C. M. Eakin, C. S. Friedman, B. Froelich, P. K. Hershberger, E. E. Hofmann, L. E. Petes, K. C. Prager, E. Weil, B. L. Willis, S. E. Ford, and C. D. Harvell. 2014. Climate change influences on marine infectious diseases: implications for management and society. Ann Rev Mar Sci 6:249-277.

Rohr J.R., A.P. Dobson, P.T.J. Johnson, A.M. Kilpatrick, S.H. Pauli, T.R. Raffel, D. Ruiz-Moreno, and M.B. Thomas. 2011. Frontiers in climate-change-disease research. TREE 26:270-277.

Week 4:

Heard M.J, K.F. Smith, K.J. Ripp, M. Berger, J. Chen, J. Dittmeier, M. Goter, S.T. McGarvey, and E. Ryan. 2013. The threat of disease increases as species move towards extinction. Conservation Biology 27:1378-1388.

Keesing, F., L.K. Belden, P. Daszak, A. Dobson, C.D. Harvell, R.D. Holt, P. Hudson, A. Jolles, K.E. Jones, C.E. Mitchell, S.S. Myers, T. Bogich, and R.S. Ostfeld. 2010. Impacts of biodiversity on the emergence and transmission of infectious diseases. Nature 468:647-652.

Week 5:

Randolph, S.E., and A.D.M. Dobson. 2012. Pangloss revisited: a critique of the dilution effect and the biodiversity-buffers-disease paradigm. Parasitology 139(7):847-863. doi: dx.doi.org/10.1017/S0031182012000200

Ostfeld, R.S. 2013. A Candide response to Panglossian accusations by Randolph and Dobson: biodiversity buffers disease. Parasitology doi:10.1017/S0031182013000541

Week 6:

No readings. Movie night.

Week 7:

Chapter 28

Tompkins, D.M., S. Carver, M.E. Jones, M. Krkošek, and L.F. Skerrat. 2015. Emerging infectious diseases of wildlife: a critical perspective. Trends in Parasitology 31:149-159.

Week 8:

No Class - Columbus Day Recess

Week 9:

Chapter 18

Aguirre, A. A. and E. S. Weber III. 2012. Living Ocean, an Evolving Oxymoron. *In* R.A. Meyers (ed.), Encyclopedia of Sustainability Science and Technology, Springer, New York, pp. 6179-6202.

Peters E. C. 2015. Diseases of coral reef organisms. In C. Birkeland (ed.). Coral Reefs in the Anthropocene. Springer Science+Business Media, Dordrecht DOI 10.1007/978-94-017-7249-5_8.

Week 10:

No Class – Work on mid-term exam

Week 11:

The *Journal of Invertebrate Pathology* is an excellent resource for information on insect diseases. Select 2 articles from the list below:

Anderson, P.K., A.A. Cunningham, N.G. Patel, F.J. Morales, P.R. Epstein, and P. Daszak. 2004. Emerging infectious diseases of plants: Pathogen pollution, climate change and agro technology drivers. Trends in Ecology and Evolution 19(10):535-544.

Boyd, I.L., P.H. Freer-Smith, C.A. Gilligan, and H.C.J. Godfray. 2013. The consequence of tree pests and diseases for ecosystem services. Science 342: 1235773

Manley R., M. Boots and L. Wilfert. 2015. Emerging viral disease risk to pollinating insects: ecological, evolutionary and anthropogenic factors. Journal of Applied Ecology 52:331-340.

Sweet M.J. and K.S. Bateman. 2015. Diseases in marine invertebrates associated with mariculture and commercial fisheries. Journal of Sea Research 104:16-32.

Week 12:

No class, take home midterm due to Dr. Peters via e-mail by the start of class

Week 13:

Chapter 28

Altizer, S., R. Bartel, and B.A. Han. 2011. Animal migration and infectious disease risk. Science 331:296-302.

Pruvot M., M. Lejeune, S. Kutz, W. Hutchins, M. Musiani, A. Massolo and K. Orsel. 2016. Better alone or in ill company? The effect of migration and interspecies comingling on *Fascioloides magna* infection in elk. PLoS ONE 11(7): e0159319. doi:10.1371/journal.pone.0159319

Blancou J. and J.E. Pearson. 2003. Bioterrorism and infectious animal diseases. Comp Immunol Microbiol Inf Dis 26:431-443.

Robinowitz P., Z. Gordon, D. Chudnov, M. Wilcox, L. Odofin, A. Liu and J. Dein. 2006. Animals as sentinels of bioterrorism agents. Emerg Infect Dis 12:647-652.

Week 14:

Gomez, A. and A.A. Aguirre. 2008. Infectious diseases in the illegal wildlife trade. Animal Biodiversity and Emerging Diseases. N.Y. Acad. Sci.1149:16-19.

Smith, K.F., Behrens, M.D., Schloegel, L.M., Marano, N., Burgiel, S. and Daszak, P. 2009. Reducing the risks of the wildlife trade. Science 324: 594-595.

Week 15:

Gortazar C., L.A. Reperant, T. Kuiken, J. de la Fuente, M. Boadella, B. Martínez-Lopez, F. Ruiz-Fons, A. Estrada-Peña, C. Drosten, G. Medley, R. Ostfeld, T. Peterson, K. C. VerCauteren, C. Menge, M. Artois, C. Schultsz, R. Delahay, J. Serra-Cobo, R. Poulin, F. Keck, A.A. Aguirre, H. Henttonen, A.P. Dobson, S. Kutz, J. Lubroth and A. Mysterud. 2014. Crossing the interspecies barrier: opening the door to zoonotic pathogens. PLoS Pathogens 10(6): e1004129. doi:10.1371/journal.ppat.1004129.

Suzán G., G. E. García-Peña, I. Castro-Arellano, O. Rico, A. V. Rubio, M. J. Tolsá, B. Roche, P. R. Hosseini, A. Rizzoli, K. A. Murray, C. Zambrana-Torrelio, A. A. Aguirre, P. Daszak, A.-H. Prieur-Richard, J. N. Mills, and J.-F. Guégan. 2015. Metacommunity and phylogenetic structure determine wildlife and zoonotic infectious disease patterns in time and space. Ecology and Evolution doi: 10.1002/ece3.1404