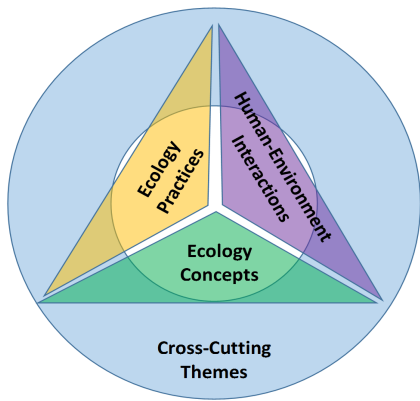


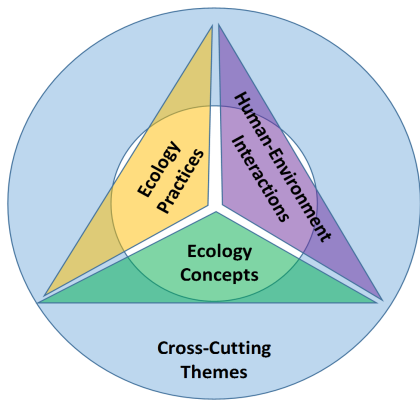
Pam Templer, *Boston Univ.*
Alan R. Berkowitz, *Cary Institute*
Luanna Prevost, *Univ. South Florida*
Amanda Sorensen, *Univ. Nebraska*
Diane Ebert-May, *Mich. State Univ.*

The ESA's Four-Dimensional Ecology Education
Framework (4DEE):
Opportunities and Challenges
January 24, 2019



Our Vision for the Webinar

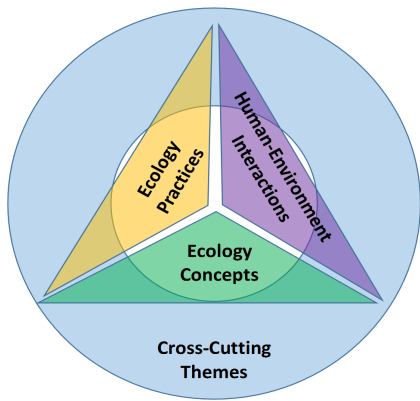
- Leadership in the field of ecology education
 - ESA endorsement of the 4DEE Framework
 - Dissemination of the Framework
- Building on, extending and celebrating the Framework



Importance of ESA-Endorsed Curricular Framework

- ESA: largest professional society in ecology
- Excellent ecology teaching essential for ...
 - effective and diverse ecology workforce
 - environmental decision-making
- Help ESA members incorporate society-relevant content
- Fill gap in college-level resources for ecology teaching
- ESA endorsement validates program enhancement

4DEE Framework can help with all of these goals



Schedule of the Webinar

- Introducing the 4DEE – [Alan Berkowitz](#)
- Engaging non-majors in ecology: Aligning lesson plans using 4DEE – [Luanna Prevost](#)
- 4DEE and Course-Based Undergraduate Research Experiences (CUREs) – [Amanda Sorensen](#)
- How do we assess multiple dimensions of student learning? - [Diane Ebert-May](#)
- Wrap up and next steps – [Pam Templer](#)

Alan Berkowitz – Introducing the 4DEE

Various attempts to define ecological literacy.

ALAN R. BERKOWITZ, MARY E. FORD AND CAROL A. BREWER

BASIC ECOLOGICAL LITERACY: A FIRST CUT

(Published in the *Ecological Society of America Education Section Newsletter*, June 1991, 2 (1): 4-5.)

Kenneth M. Klemow
Department of Biology, [Wilkes University](#)
Wilkes-Barre, PA 18766

Within the past decade, we have all witnessed a dramatic increase in the public's concern over education, especially science education. Of course, this concern has extended to ecology, where ecologists and non-ecologists alike realize the need for ecological concepts to be accurately taught to students in primary and secondary schools, to undergraduates, and to adults. The importance of a sound ecology-education strategy was emphasized in the "Sustainable Biosphere Initiative", published by the Ecological Society of America (Ecology 72: 371-412).

Those people who are responsible for implementing a sound ecology-education program at any level are confronted by several challenges. First, as most ecologists realize, ecology itself is highly interdisciplinary and intergrades into other areas of biology like systematics, physiology, genetics, behavior and evolution, as well as into physical sciences like chemistry, meteorology, physics and earth science. Moreover, ecology relates to many applied areas such as resource management, agronomics, forestry, environmental toxicology, and wildlife biology. Thus, the definition as to what exactly comprises "ecology" is often difficult to delineate from that which is "not ecology".

A second challenge is that the field is rapidly changing and even the most basic concepts are of (a m

CONCEPTS AND QUESTIONS

What should every citizen know about ecology?

Rebecca Jordan¹, Frederick Singer¹, John Vaughan¹, and Alan Berkowitz²

The level of ecological literacy among the general population in the US and other countries is not known, although there is widespread concern that it is too low to enable effective social responses to current problems. Here, we describe a framework for conceptualizing ecological literacy. This framework combines ideas and approaches from the social sciences with content deemed critical by ecology professionals. We conclude with key controversies and questions that should initiate a dialogue aimed at improving ecological literacy among the public. As ecological literacy was the theme of the 93rd Annual Meeting of the Ecological Society of America in 2008, we believe it is time for this discussion to be expanded, increased in priority, and brought to fruition.

Front Ecol Environ 2009, 7(9): 495-500, doi:10.1890/107013 (published online 25 Jul 2008)

Fewer than 20% of Americans are sufficiently literate to read a science article in a major newspaper, understand a science-based television program, or comprehend a popular science book (Miller 2002). That leaves about four-fifths of the population insufficiently knowledgeable about issues that may affect their lives. Literacy in certain areas of science – the environment, for example (Clemen 2001; Corle 2005), or evolution (Miller et al. 2006) – has substantially exceeded expectations for an informed citizenry.

While data are not abundant, there is evidence that the general public is not well versed in ecology (Maguire 2005; Stone and Barlow 2005; Dak and Makiin 2006). Performance of students on the ecology portions of national science assessments is poor (IES 2006) and on international science assessments, US students perform less well than students from many European and Asian nations (Gonzalez et al. 2002).

Ecological literacy is necessary for understanding the

In a nutshell:

- Defining ecological literacy is more difficult than it seems at first glance.
- Questions regarding values and behavior are especially problematic.
- We must recognize that an ecologically literate person will not always act to promote the health of ecosystems.
- A framework of ecological literacy must consider pathways to achieving literacy among citizens, not just the definition of literacy per se.
- The document of ecological literacy should be continued and expanded within the Ecological Society of America.

natural world and human interaction with it (eg Shobkolian 2003; Speth 2004) and for making informed decisions about the conservation and management of resources (Berkowitz et al. 2005). Given the rapid growth and development facing communities, ecological literacy must be part of a citizen's lifetime learning experience, beginning in the primary grades and continuing through informal adult learning experiences. Indeed, the goals of the Ecological Society of America (ESA) Education Section include "to promote and enhance ecology education for students of all ages and for the general public" (ESA 1993). To promote dialogue about ecological literacy, we need some common language, and to measure educational achievement, we need some sort of metric. Here, we therefore pose the question: "What should every citizen know about ecology?"

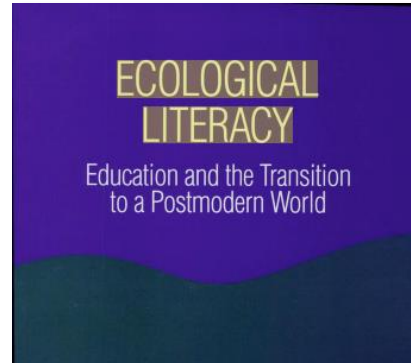
Without expert guidance, formal and informal education cannot determine which concepts are essential for ecological literacy; thus, there is a need for national reform documents (Barber and Alkton 1991; AAAS 1993; NRC 1999; Bernard 2007). While ecologists' voices were heard during the development of general science standards (AAAS 1993; NRC 1999), education need focused guidance to promote ecological literacy. They also need up-to-date information as to the body of knowledge changes. If we are to meet the goals of our own professional society, we need to explicitly define ecological literacy and detail its components. The time for this discussion could not be better, because environmental education and citizen science programs are spreading and national educational standards are being revised (Bernard 2007).

Putting ideas into context

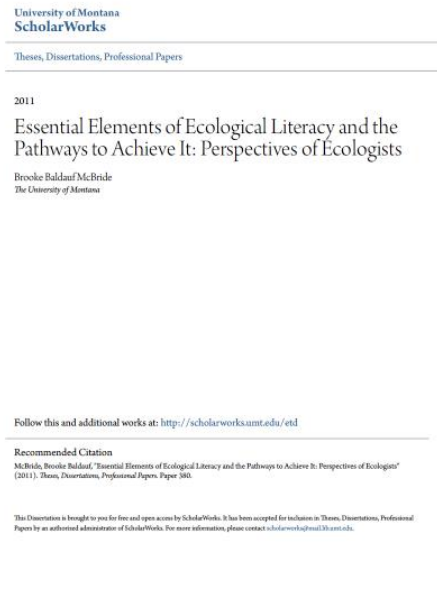
Scholars representing a range of disciplines – philosophy, education, psychology and science – have written extensively about ecological literacy. Although this paper is not a comprehensive review, we highlight key issues and

¹Department of Ecology, Evolution, and Natural Resources, School of Environmental and Biological Sciences, Rutgers University, New Brunswick, NJ (jordan@aesop.rutgers.edu). ²Department of Biology, Ball State University, Muncie, IN. ³Department of Natural Sciences, St. Peterburg College, St. Petersburg, FL. ⁴Education Program, Institute of Ecosystem Studies, Millbrook, NY

Klemow – 1991



Orr – 1992



Jordan et al. 2009

McBride 2011

11

A framework for integrating ecological literacy, civics literacy, and environmental citizenship in environmental education

INTRODUCTION

Environmental education practitioners span all of the natural and social sciences in terms of their training and passion. Practitioners have a range of science backgrounds, from very little science background to science degrees and some view science as a root cause of environmental problems. The matter is made more complicated by the fact that environmental education does not have a professional training dimension in the same way that physics or sociology do. Although such training gives disciplines focus and rigor, some say this leads to a rigidity that environmental education does not require. Thus, there is a diversity of perspectives on the role the science of ecology should play in environmental education.

There are two concerns about ecology in environmental education. First, the ecology can reflect outdated ecological science and



Berkowitz et al. 2005

Essential Elements of Ecological Literacy and the Pathways to Achieve It: Perspectives of Ecologists

Brooke Balduf McBride
The University of Montana

2011

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McBride, Brooke Balduf. "Essential Elements of Ecological Literacy and the Pathways to Achieve It: Perspectives of Ecologists" (2011). Theses, Dissertations, Professional Papers. Paper 383.

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ESAPHERE
SYNTHESIS & INTEGRATION

Environmental literacy, ecological literacy, ecoliteracy: What do we mean and how did we get here?
B. B. McBride,¹ C. A. Brewer,² A. R. Berkowitz,³ and W. T. Borrie³

¹College of Forestry and Conservation, The University of Montana, Missoula, Montana 59712 USA
²Division of Biological Sciences, The University of Montana, Missoula, Montana 59712 USA
³Cary Institute of Ecosystem Studies, Millbrook, New York 12545 USA

Abstract. Numerous scholars have argued that the terms environmental literacy, ecological literacy, and ecoliteracy have been used in so many different ways and/or are so all-encompassing that they have very little useful meaning. However, despite the seemingly arbitrary and, at times, indiscriminate use of these terms, tremendous efforts have in fact been made to explicitly define and delineate the essential components of environmental literacy, ecological literacy, and ecoliteracy, and to firmly anchor their characterizations in deep theoretical and philosophical foundations. A driving purpose behind these ongoing conversations has been to advance complete, pedagogy-guiding, and readily applicable frameworks for these ideals, allowing for standards and assessments of educational achievement to be set. In this manuscript, we review a diversity of perspectives related to the often nuanced differences and similarities of these terms. A classification of the numerous proposed frameworks for environmental literacy, ecological literacy, and ecoliteracy (advanced within the fields of environmental education, ecology, and the broader humanities, respectively) is presented, and used to compare and contrast frameworks across multiple dimensions of affect, knowledge, skills, and behavior. This analysis facilitates close examination of where we have been, where we are, and where we might be headed with respect to these vital conversations. This work also offers points of reference for continued critical discourse, and illuminates a diversity of inspiration sources for developing and/or enriching programs aimed at cultivating these types of literacies.

Key words: ecoliteracy; ecological literacy; ecology education; environmental education; environmental literacy; sustainability education.

Received 5 March 2011; revised 10 April 2011; accepted 12 April 2011; final version received 8 May 2011; published 31 May 2011. Corresponding Editor: C. D'Avanzo.

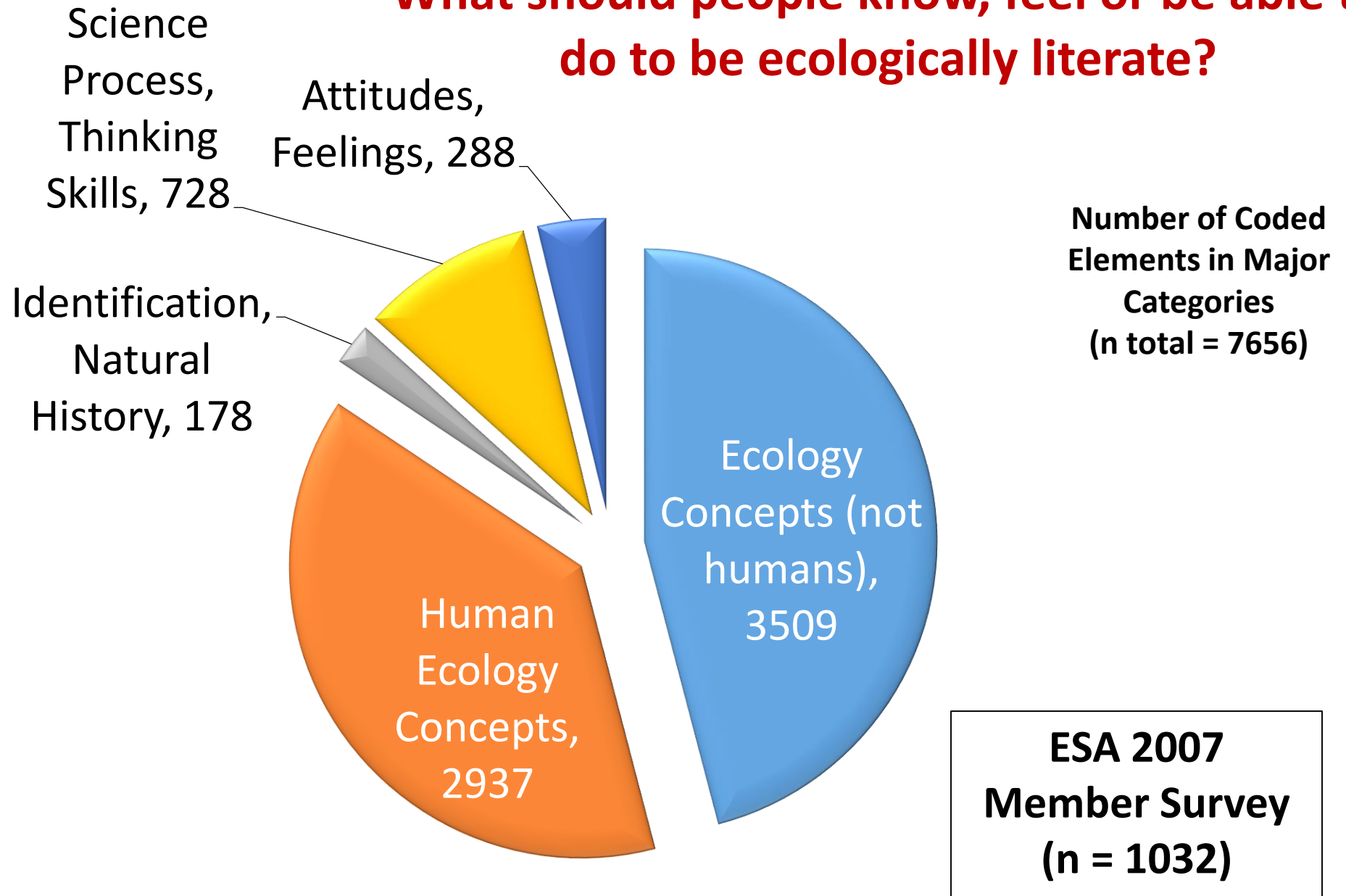
Copyright © 2011 McBride et al. This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited. <http://onlinelibrary.wiley.com/doi/10.1111/j.1523-1739.2011.01701.x>

1 E-mail: brookeb@montana.edu

WHAT IS LITERACY?
Literacy referred only to the ability to read and write; its usage has since been extended greatly in scope, beginning during the Industrial Revolution. In fact, according to the Oxford English Dictionary, the word *literacy* was predicated by the century and then spreading throughout Western Europe and North America, the Industrial Revolution was a period of rapid industrial

ECOSPHERE • www.esajournals.org 1 May 2013 • Volume 4(5) • Article 67

What should people know, feel or be able to do to be ecologically literate?



ESA 2015 ~~Fundamental Concepts~~ / 4DEE Task Force

- **George Middendorf**, Howard University
- **Bob Pohl**, Ferrum College

- **Alan Berkowitz**, Cary Institute of Ecosystem Studies
- **Carmen Cid**, Eastern Connecticut State University
- **Jennifer Doherty**, University of Washington
- **Ken Klemow**, Wilkes University
- **Diane Ebert-May**, Michigan State University
- **Teresa Mourad**, Ecological Society of America



Brewer et al 2011

Two Dimensions:

1. Core Concepts
2. Competencies

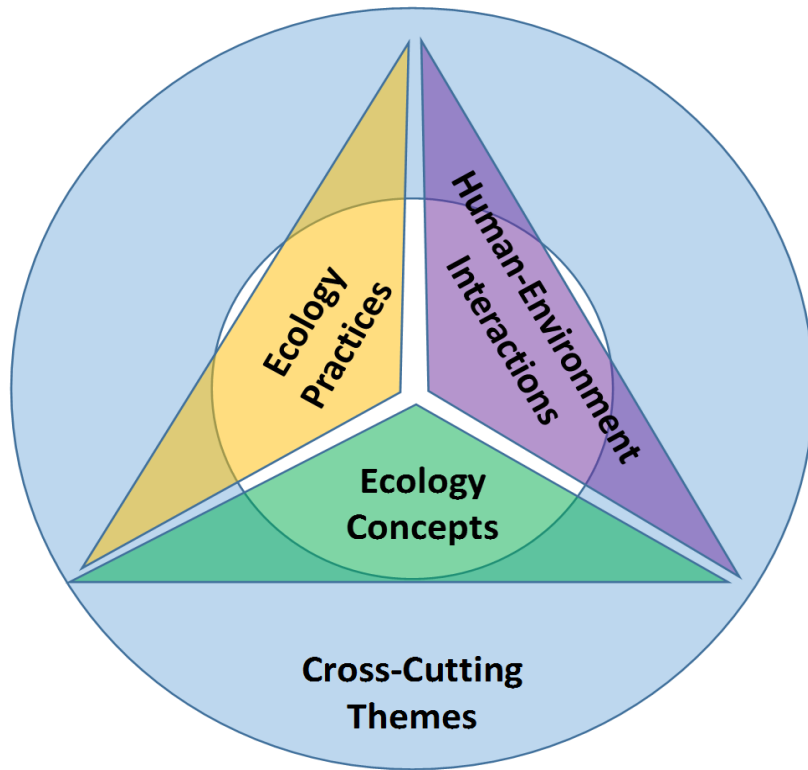


NRC, 2012

Three Dimensions:

1. Disciplinary Core Concepts
2. Crosscutting Concepts
3. Science Practices

4DEE Ecology Education Framework



Core Ecology Concepts

classical ecological hierarchy
e.g., population, ecosystem

Ecology Practices

doing and critiquing ecology
e.g., fieldwork, modeling

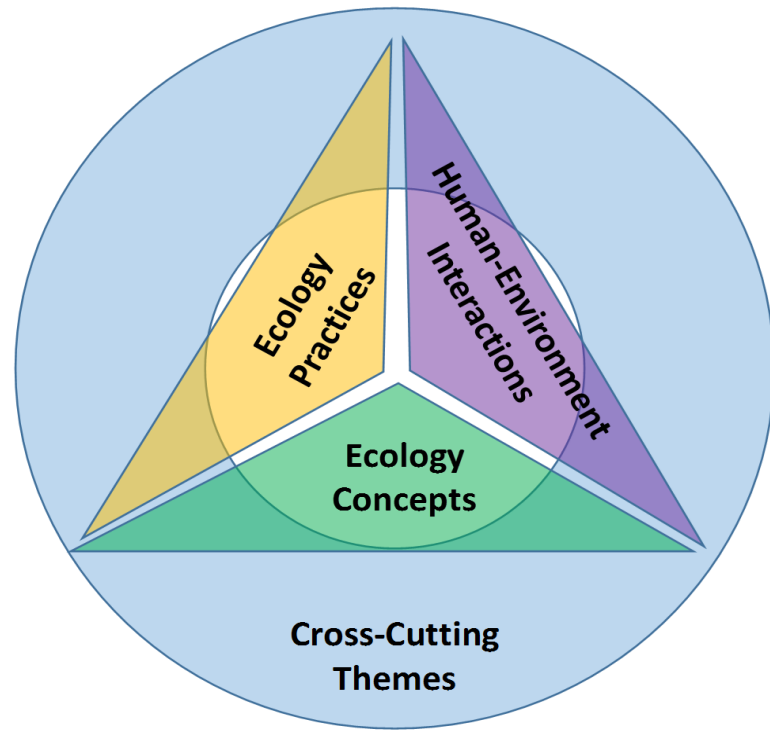
Human-Environment Interactions

human dependency and impact
e.g., climate change, services, ethics

Cross-Cutting Themes

ways-of-thinking, unifying ideas
e.g., evolution, space, structure/
function

Many Challenges for Scientists and Educators



Defining learning outcomes – for each sub-element, and for integration across dimensions.

Exploring effective teaching strategies and course sequences.

Developing useful tools for measuring student progress and attainment.

Luanna Prevost –

Engaging non-majors in ecology:

Aligning lesson plans using 4DEE

Engaging non-majors in ecology : Aligning lesson plans using 4DEE

Causes and Impacts of Declines in Bee Diversity



Course Context

- Non majors introductory biology course
- ~180 students each semester
- Meets in an auditorium with fixed seating
- Activities
 - Small group work
 - Clickers
 - Worksheets
 - Online homework

Major	% enrollment
Arts & Humanities	4
Biomedical & Health Sciences	14
Business	29
Education	5
Engineering	2
Social & Behavioral Sciences	22
Other	23



Causes and Impacts of Declines in Bee Diversity

Case overview

- Students examine causes and impacts of bee decline on the environment and implications for society
- Based on literature: article in *Frontiers in Ecology and the Environment*
- Activities: Worksheets, Clicker questions
- Assessments
 - In Class: Open-ended questions and clicker question
 - Homework: Multiple-choice questions
 - Exam: Multiple-choice questions

The screenshot displays the journal's website interface. At the top, the ESA logo and navigation options like 'Journals' and 'Become a Member' are visible. A search bar is present with the text 'All ESA Journals' and a prompt to 'Enter search terms, e.g. title, author, keyword'. Below this is a green banner for 'Join the ESA. The largest global community of ecologists.' with a globe image. The main content area features the article title 'Interest exceeds understanding in public support of bee conservation' by Joseph S Wilson, Matthew L Forister, and Olivia Messinger Carril. It includes publication details: 'First published: 5 September 2017', 'DOI: 10.1002/fee.1531', and 'Cited by (CrossRef): 0 articles'. A sidebar on the left offers options for PDF, Info, References, and Figures. On the right, there is a 'View Issue TOC' section for Volume 15, Issue 8, October 2017, pages 460-466.

Aligning the lesson plan using 4DEE

**Learning
Objectives**

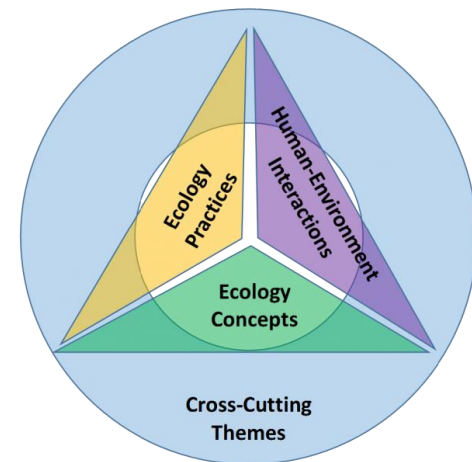
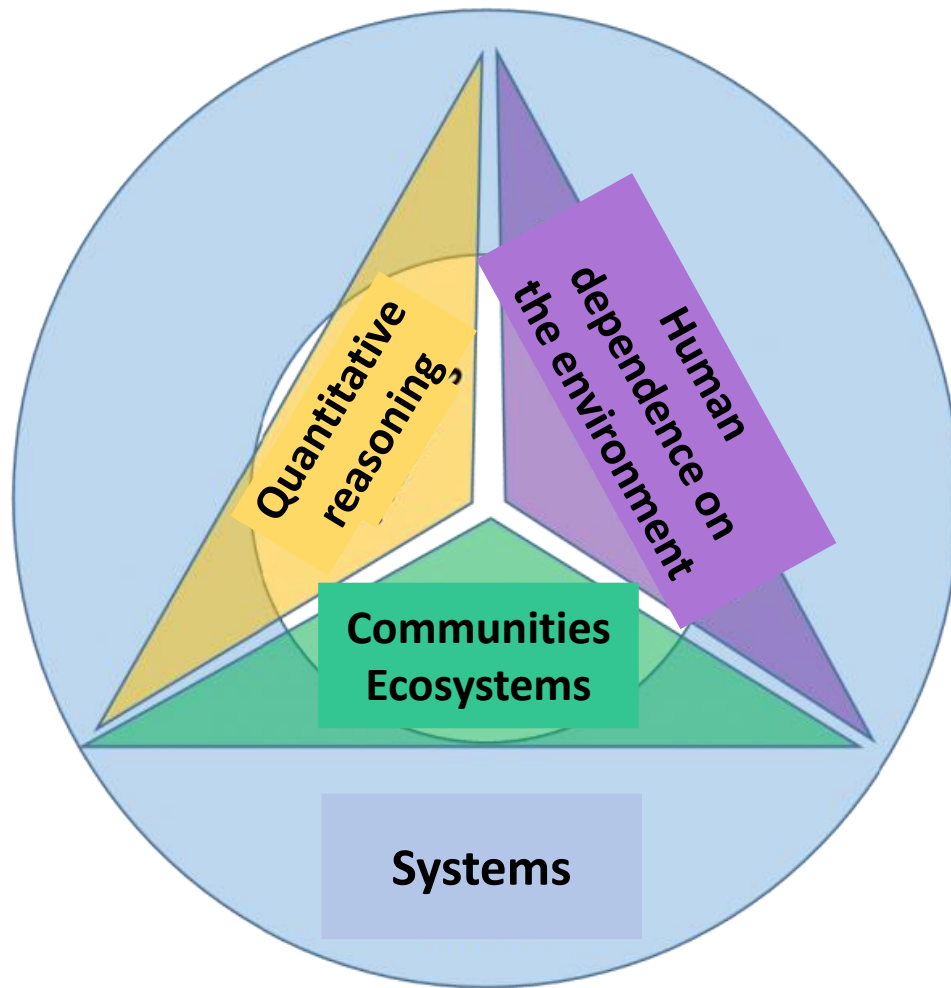
**Instructional
Activity**

Assessment

- Alignment improves learning outcomes

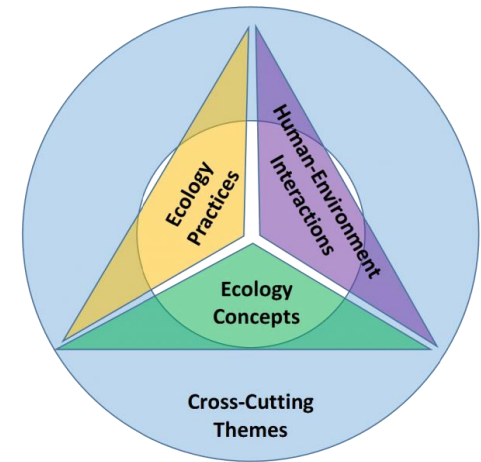
Fink 2003; Wiggins and McTighe 2005;
Momsen et al. 2010 ; Jensen et al 2014

4DEE approach to understanding causes and impacts of a decline in bee diversity



Learning Objectives

- Identify, explain, give examples ecological interactions between organisms
- Interpret data to deduce ecological interactions
- Interpret food webs to determine energy flow with an ecosystem
- Apply the skills and concepts above to describe potentials causes and impacts of a decline in bee diversity



Instructional Activities:

Small groups with reporting out

1. Brainstorming

Setting the Context and Real World Challenge

- Why are bees important to people?
- What are potential causes of bee declines?
- What are potential impacts?
- How can we reduce or stop this decline?

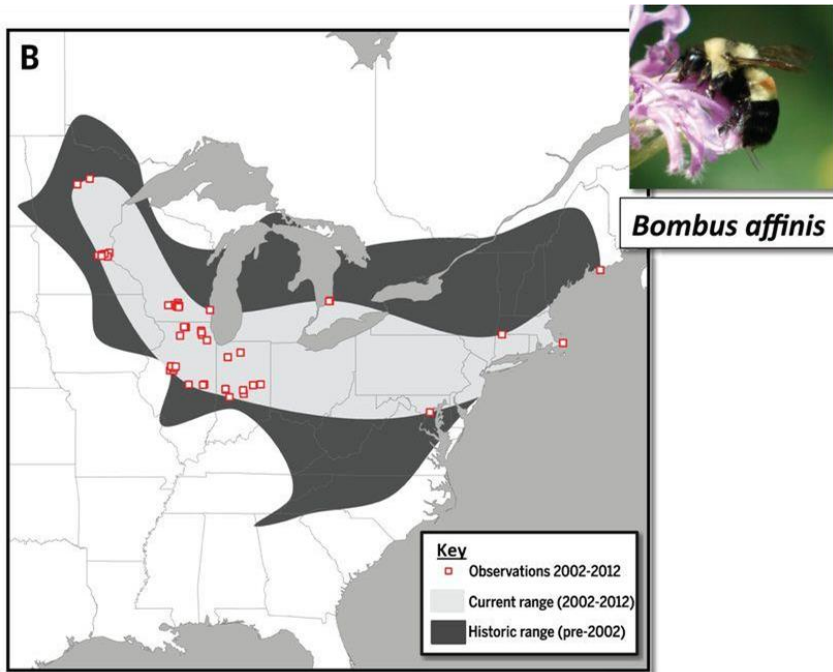
2. Data interpretation

3. Integration of data

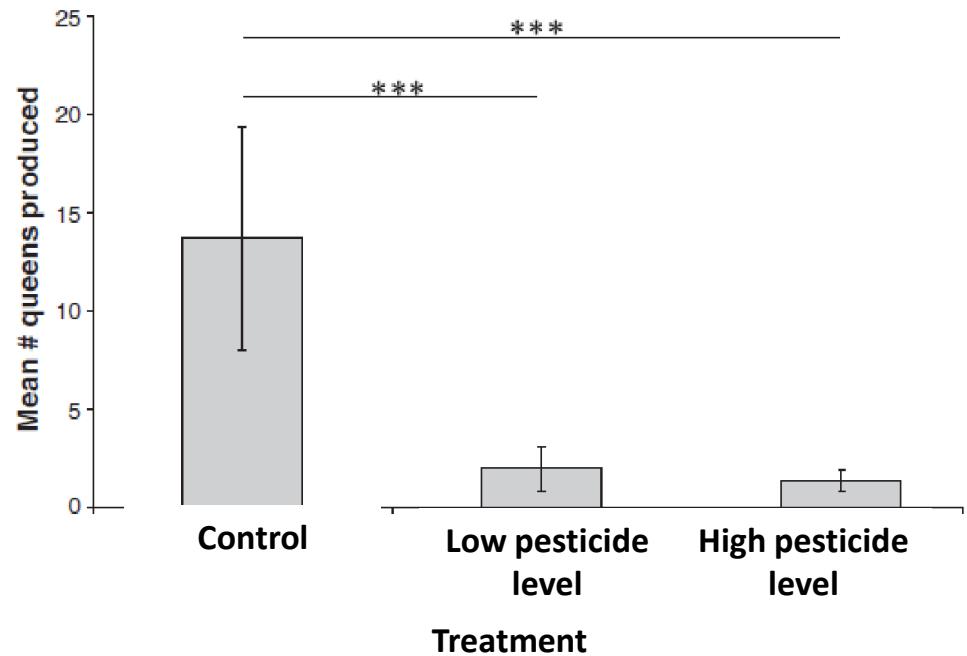
4. Making predictions and recommends (using content knowledge and data)

2. Interpret data from primary literature

What does the map tell you about the distribution of *Bombus affinis*?



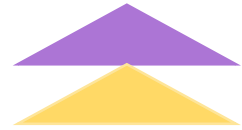
How do pesticides affect queen bee production? What impact can this have on bee populations?



Dave Goulson et al.
Science 2015;347:1255957

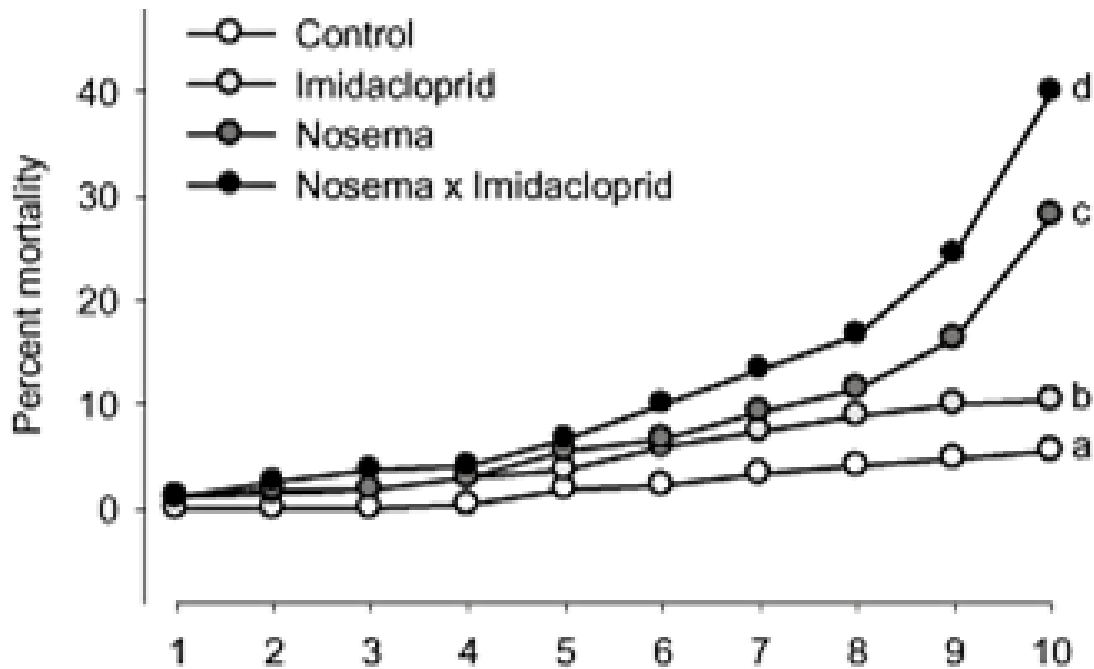
Whitehorn, P. R., S. O'Connor, F. L. Wackers, and D. Goulson. 2012. Neonicotinoid pesticide reduces bumble bee colony growth and queen production. Science 336:351–352.

3. Integration of data:



Small group discussion: What happens when bees face multiple stressors?

Clicker question: Bee mortality when both fungus and pesticides are present is _____ than when either fungus or pesticide alone is present.



A. lower than

A. higher than

A. the same as

4. Making predictions and recommendations (using content knowledge and data)

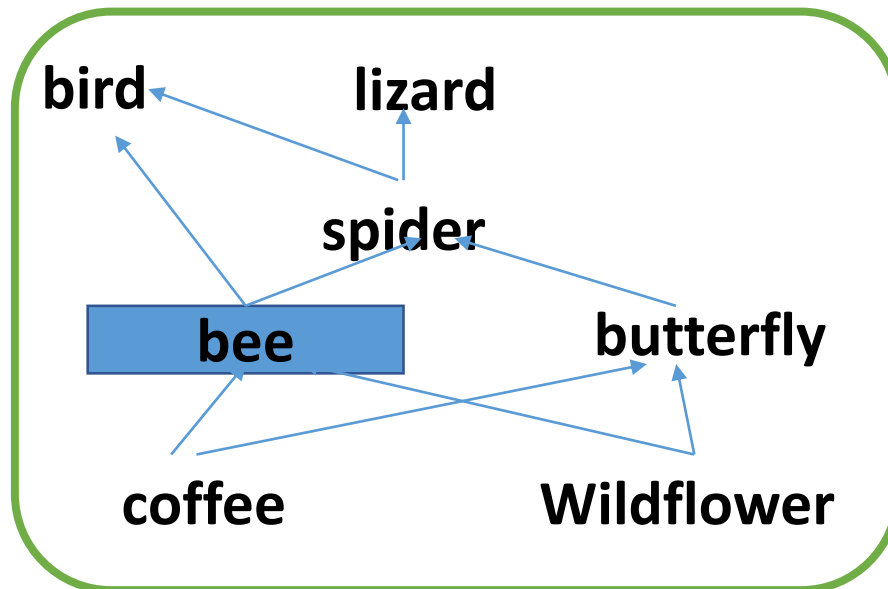


Based on your readings, can you describe the interaction between bees and

- a) spiders?
- b) birds?
- C) coffee plants?

Describe the impact of the removal of bees on

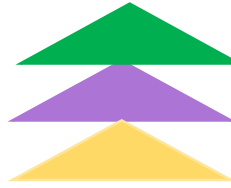
- a) spider populations?
- b) lizard populations?
- C) coffee plant populations?



Assessment

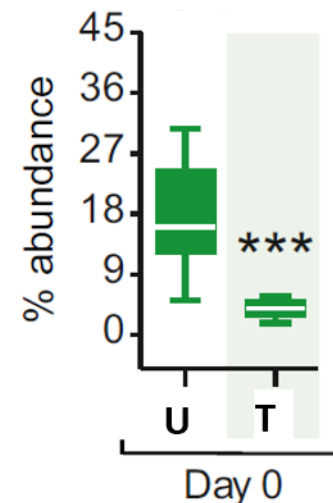
- Assessments directly related to bee diversity
 - Open ended responses
 - Clicker questions
 - Exam multiple-choice questions
- Application to a similar context – Coral Diversity
 - Homework and Exam multiple-choice questions

- A study published in **2018 examined the effects of glyphosate, on bees**. Glyphosate is one of the main herbicide used for weed control around the world. It works by inhibiting the function of some enzymes found in plants and microorganisms, like bacteria.
- Thus, glyphosate has the potential to affect the microbes that live in the guts of bees.
- Scientist wanted to find out the effect of glyphosate on the bacteria in young worker bees. They treated one group of bees with glyphosate (T)but did not treat the other group (U).
- One of the bacteria studied was *S. alvi* (**Figure 1**). Which statement best describes the change in **relative abundance** of *S. alvi*?



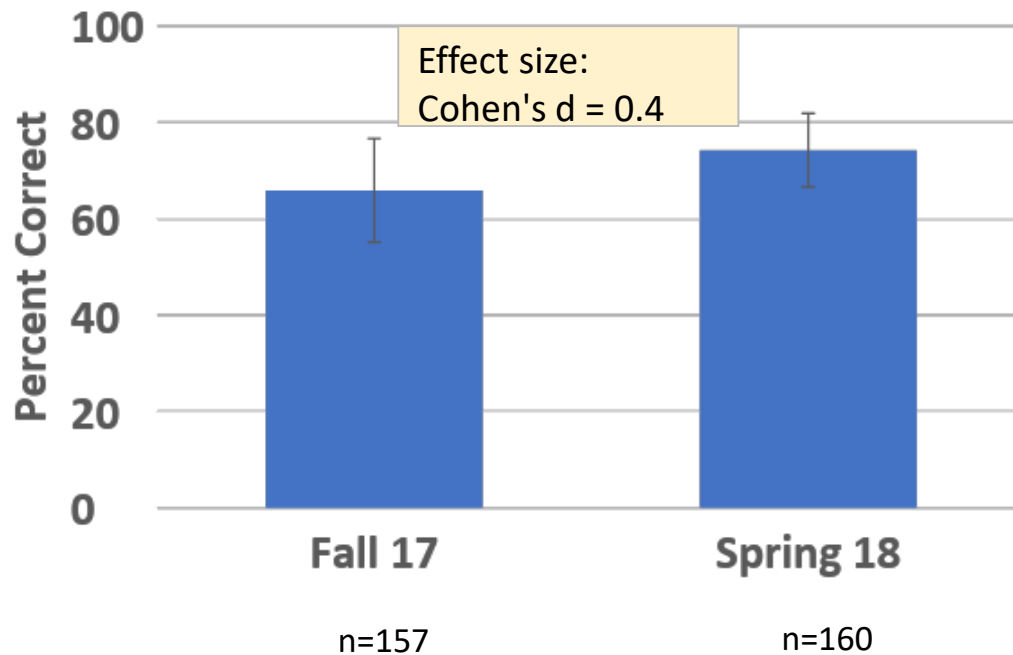
- S. alvi* bacteria became less resistant
- There was less *S. alvi* bacteria compare to other types of bacteria found.
- The total number of *S. alvi* bacteria decreased.
- There were fewer species of *S. alvi* bacteria.

Figure 1. Abundance of *S. alvi* bacteria



Outcomes

5 multiple-choice questions on ecological interactions and food webs



“I have NEVER understood science and have always done poorly in science classes until this semester”

“..relates to my every day life in the food i eat”

Amanda Sorensen –
4DEE and Course-Based
Undergraduate Research Experiences
(CUREs)

Context

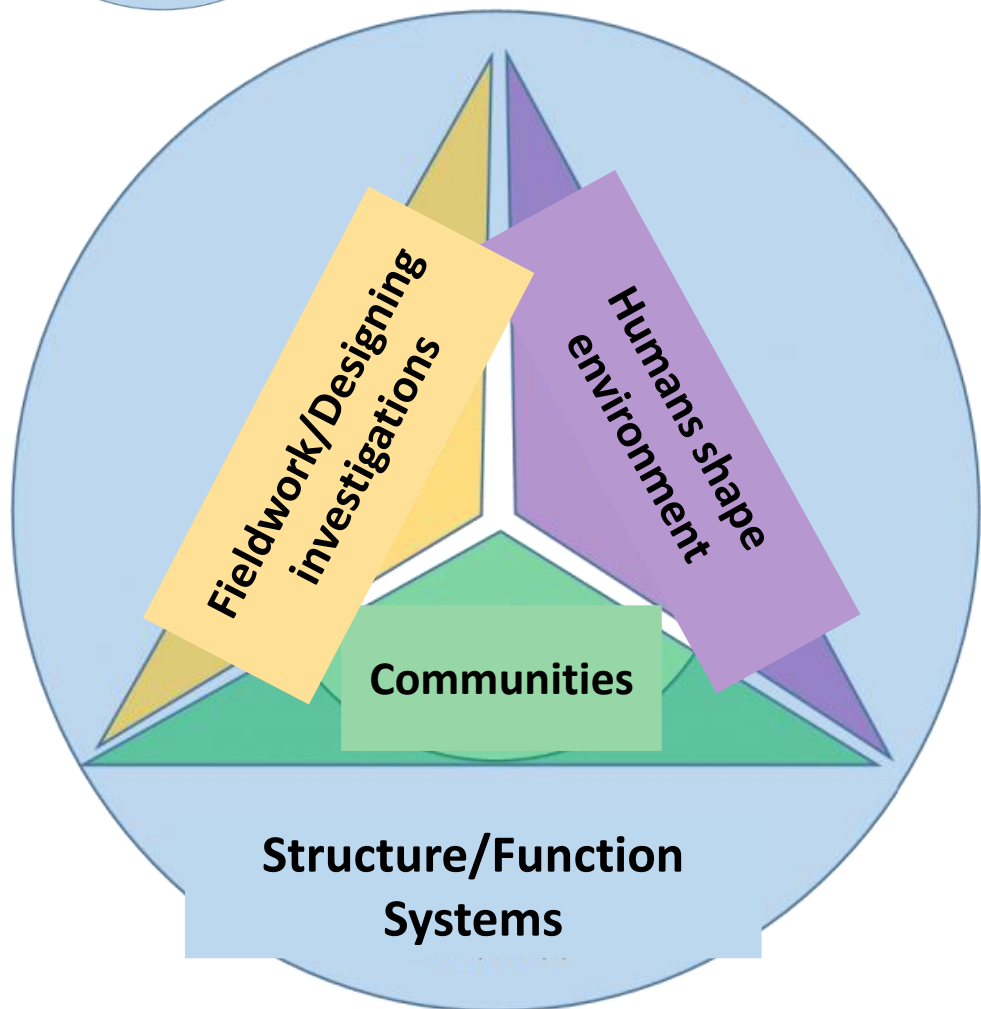
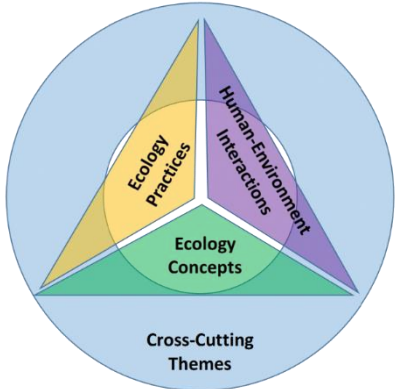
- Fall 2017
 - 4 class sessions (3 hours each)
 - 4 week independent research time
- 30 Students
 - Freshman-Senior level
- Majority Natural Resource Majors
 - Mathematics, Hospitality, English



Photo credit: World Wildlife Fund

CURE-Auchincloss et al. 2014





Learning Objectives

- Identify and explain human influence in prairie canid communities
- Develop and implement research protocol
- Interpret data to inform model of prairie system
- Generate and use model to explain impact of canid + human interactions on swift fox

Models as Classroom Supports

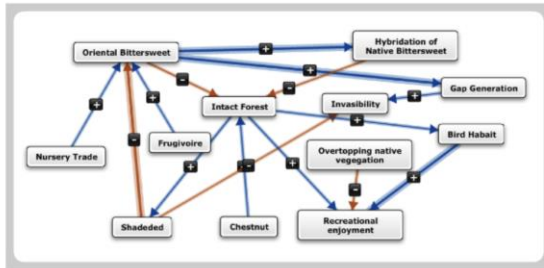
MentalModeler

01 HOME 02 SOFTWARE 03 WHAT IS FCM? 04 RESOURCES 05 ABOUT

01 HOME

What is *Mental Modeler*?

Mental Modeler is modeling software that helps individuals and communities capture their knowledge in a standardized format that can be used for scenario analysis.



Based in Fuzzy-logic Cognitive Mapping (FCM), users can easily develop semi-quantitative models of environmental issues, social concerns or social-ecological systems in *Mental Modeler* by:

- 1 Defining the important components of a system
- 2 Defining the relationships between these components
- 3 Running "what if" scenarios to determine how the system might react under a range of possible changes.

PMC-2E Conceptual Framework:

P- Phenomenon

M- Mechanism

C- Components

E- Evidence

E- Explanation

*Based on SBF Models

Gray et al. 2013

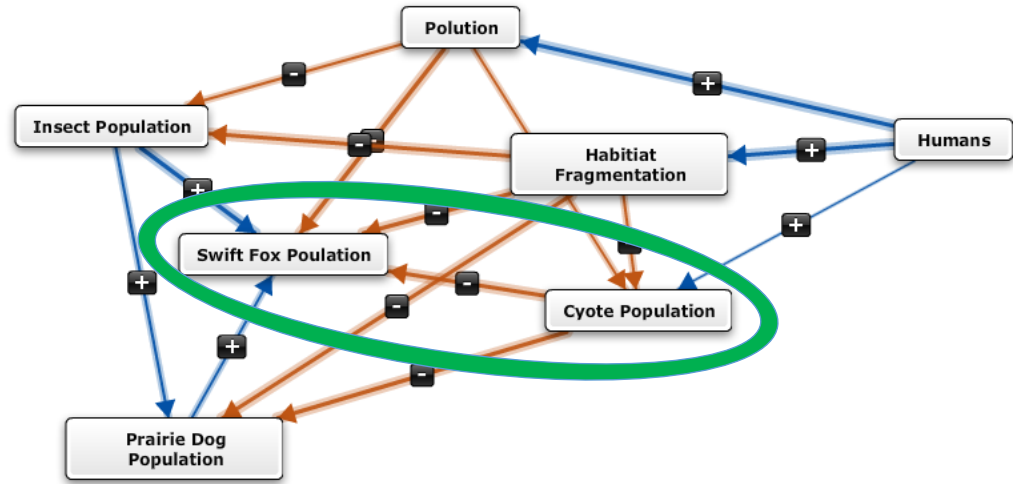
Jordan et al. 2014

Models as Assessments

1. Open-ended reflection
 - Explain relationships (mechanisms) between components in their models
 - Describe predicted impact on system before running a scenario

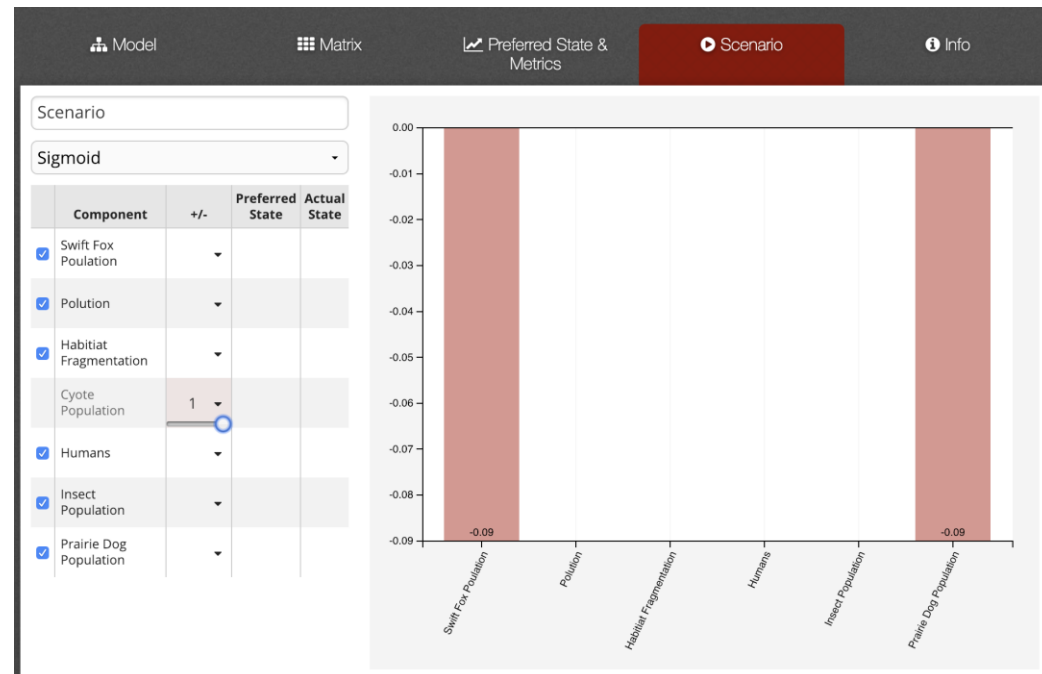
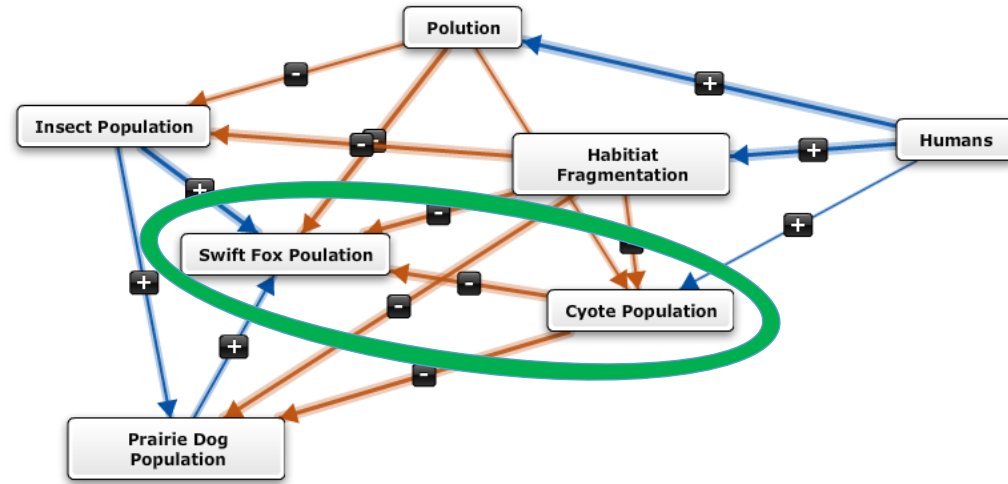
Models as Assessments

1. Open-ended reflection
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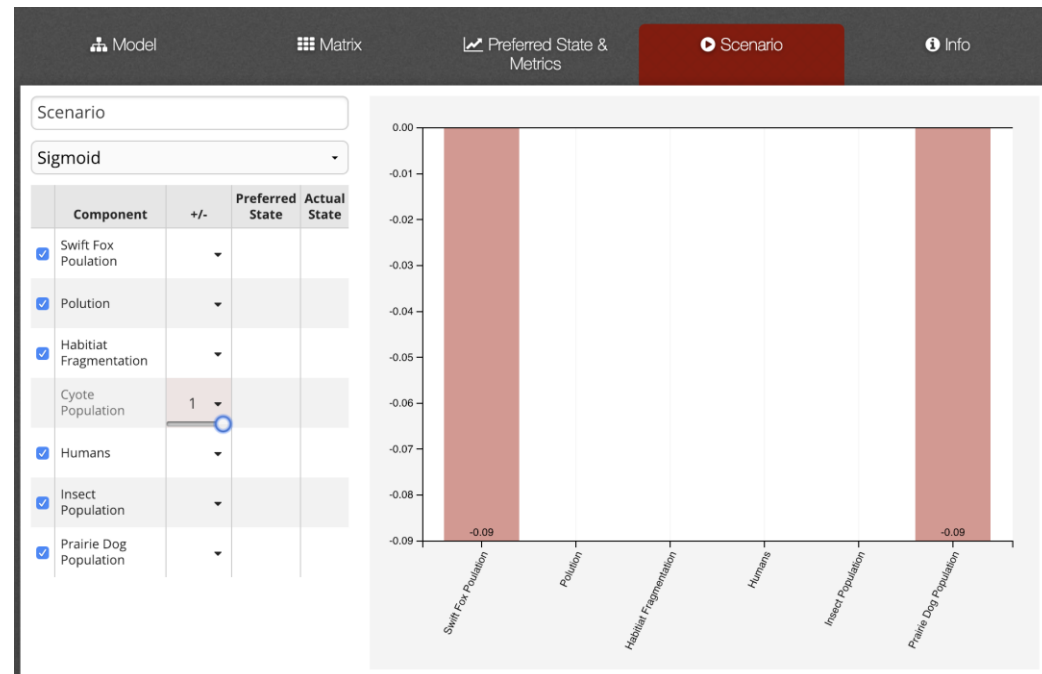
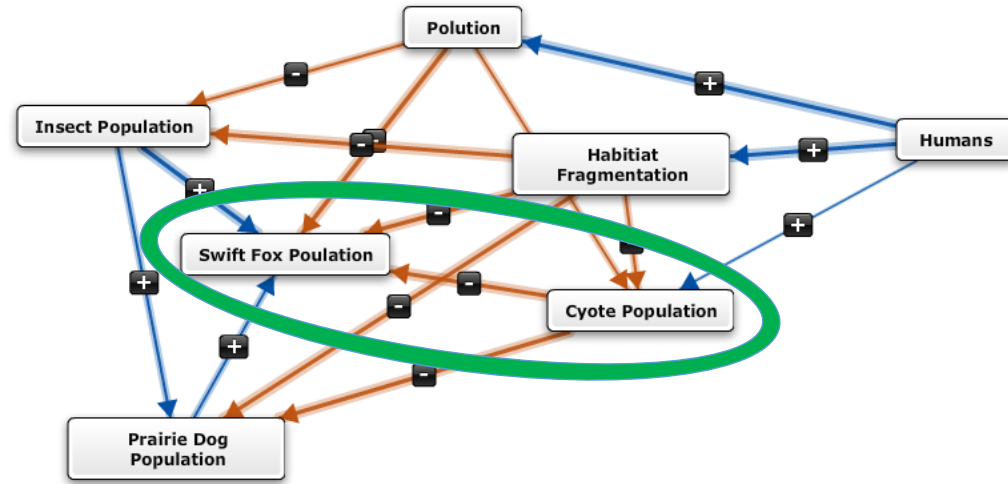
Models as Assessments

1. Open-ended reflection
 - Explain relationships (mechanisms) between components
 - Describe predicted impact on system before running a scenario
2. Run a scenario

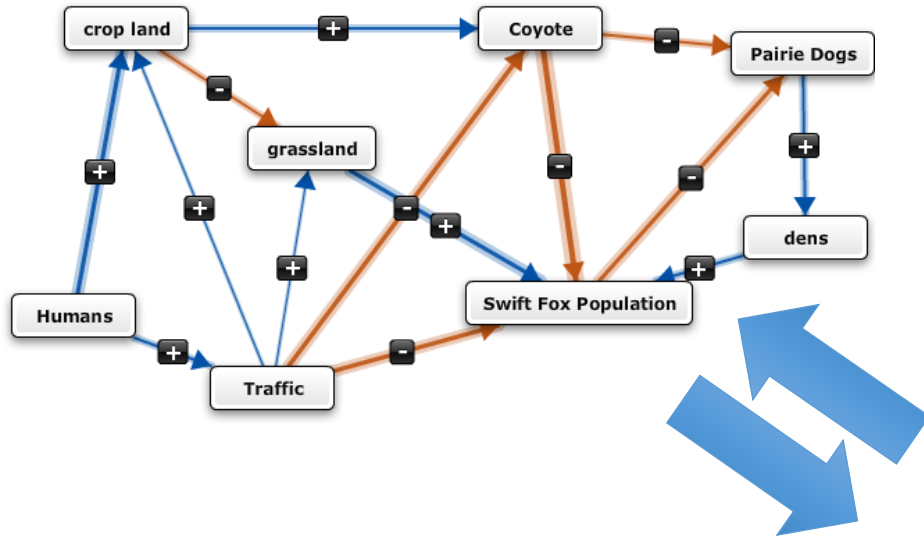


Models as Assessments

1. Open-ended reflection
 - Explain relationships (mechanisms) between components
 - Describe predicted impact on system before running a scenario
2. Run a scenario
3. Open-ended reflection
 - Identify direct and indirect relationships
 - Justify scenario output

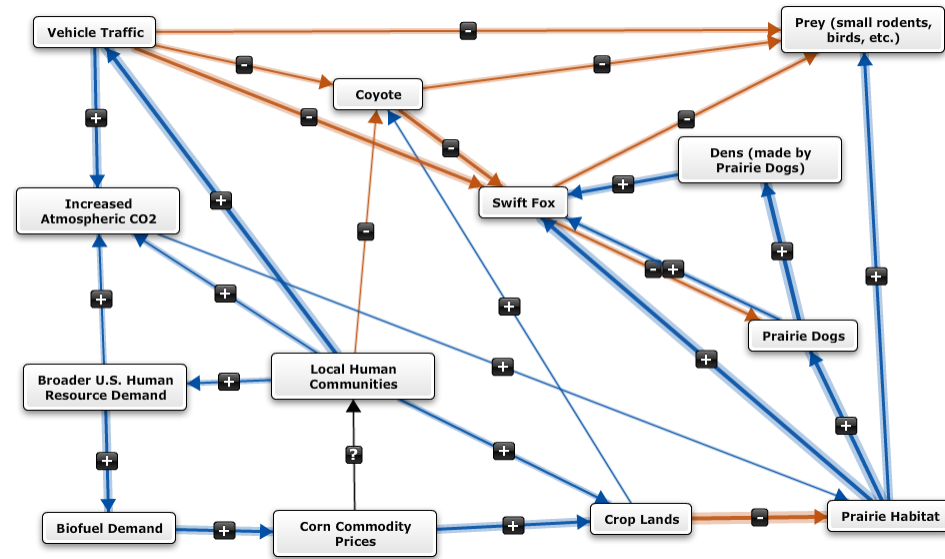


Models as Assessments

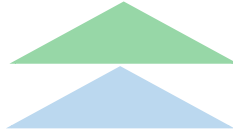


Wildlife Biologists Model

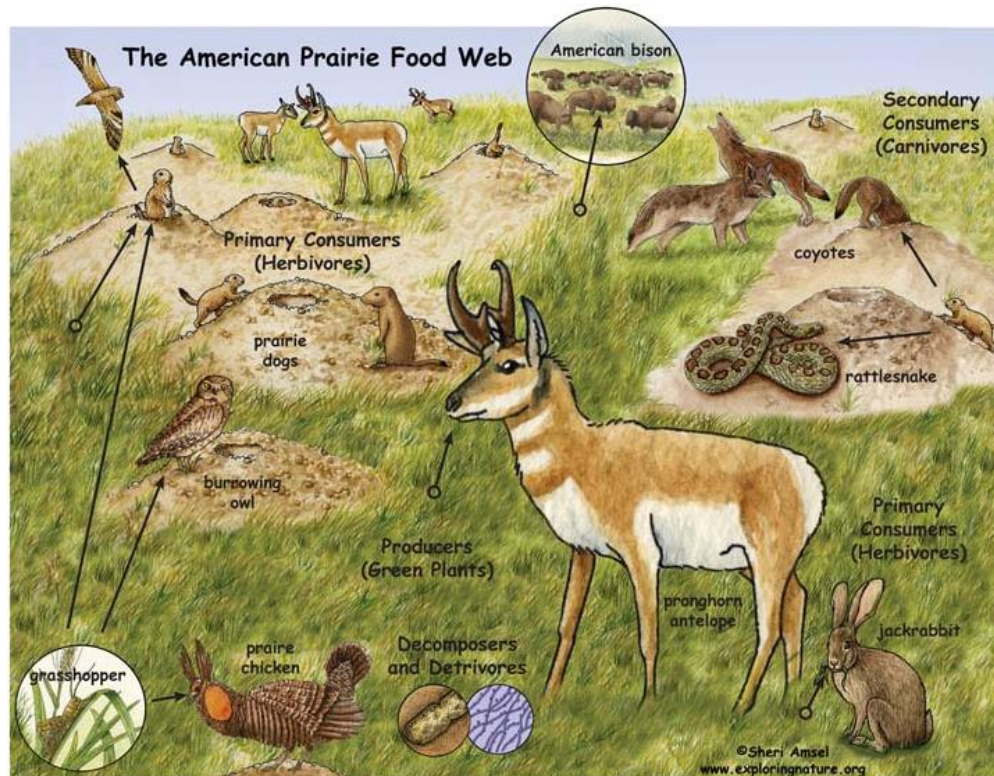
Student Individual + Group Models



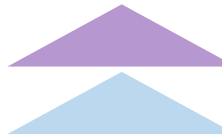
Class 1



Topic	Activity	Assessment
Community Ecology- prairie systems	-Lecture -Model Building	-Multiple Choice Quiz -Student Models



Class 2



Topic	Activity	Assessment
Anthropogenic Influences	-Primary Literature -Group Discussion -Model Revisions	-Open-Ended Reflection -Student Models

Journal of Mammalogy, 84(3):989–995, 2003

HABITAT USE, HOME RANGES, AND SURVIVAL OF SWIFT FOXES IN A FRAGMENTED LANDSCAPE: CONSERVATION IMPLICATIONS

JAN F. KAMLER, WARREN B. BALLARD,² FERNST B. FISH, PATRICK R. LEMBO, CELINE C. PERKELLETT

¹Department of Range, Wildlife, and Fisheries Management, Box 42125, 7 Lubbock, TX 79409, USA (JFK, WB, LBF, CFP)
²Texas Parks and Wildlife Department, 321 Nacatoche Court, Pilot Point, Texas
Present address of JFK: Missouri Research Institute, Polish Academy of Sciences, 17-230 Białowięzka, Poland

Habitat (velox) is 42 swift lands of juvenile (Cons) (10.8 grass pr types, North A for their)

Key word

CAUSES AND RATES OF MORTALITY OF SWIFT FOXES IN WESTERN KANSAS

MARGHA A. SOVADA,¹ U.S. Geological Survey, Northern Prairie Wildlife Research Center, 8711 37th Street SE, Jamestown, ND 58401, USA
CHRISTIANE C. POY,¹ Kansas Department of Wildlife and Parks, Emporia, KS 66801, USA
J. B. BRUGHART,¹ U.S. Geological Survey, Northern Prairie Wildlife Research Center, 8711 37th Street SE, Jamestown, ND 58401, USA
JAMES R. GILLIS, U.S. Geological Survey, Northern Prairie Wildlife Research Center, 8711 37th Street SE, Jamestown, ND 58401, USA

Abstract: Knowledge of mortality factors is important for developing strategies to conserve the swift fox (*Vulpes velox*), a species being considered for listing under the Endangered Species Act. We used radiotelemetry techniques to examine and causes of mortality of swift fox populations in 2 study areas in western Kansas. One predominantly cropland, the other rangeland. Mortality rates, calculated using Kaplan-Meier techniques in a staggered entry design, were 0.55 ± 0.08 (± SE) for adult and 0.67 ± 0.08 for juveniles. We did not detect differences between study areas in mortality rates for adults or juveniles by coyotes (*Canis latrans*) was the major cause of mortality for adult and juvenile swift fox areas, and which collision was an important mortality factor for juveniles in the cropland mortality was attributed to starvation or disease.

JOURNAL OF WILDLIFE MANAGEMENT

Key words: *Canis latrans*, coyote predation, interspecific competition, Kansas, mortality rates, swift fox, *Vulpes velox*.

The swift fox once occupied most of the Great Plains of North America from westcentral Texas to the prairies of Alberta (Carbyn et al. 1994). Settlement of the prairies led to declines in swift fox numbers; by 1900, rare throughout much of its range (Sharps 1978, Zimmling and 1994). Many factors likely were responsible, including inadvertent poisoning wolves (*Canis lupus*), in

Journal of Wildlife Diseases, 43(3): 406–410, 2007
© Wildlife Disease Association 2007

Possible Vector Dissemination by Swift Foxes following a Plague Epizootic in Black-tailed Prairie Dogs in Northwestern Texas

Brady K. McGee,¹ Matthew J. Butler,¹ Danny B. Pence,² James L. Alexander,¹ Janet B. Nissen,³ Warren B. Ballard,¹ and Kerry L. Nicholson¹

¹Department of Range, Wildlife, and Fisheries Management, Texas Tech University, Box 42125, Lubbock, Texas 79409, USA; ²Department of Pathology, Texas Tech University Health Sciences Center, 3901 41st Street, Lubbock, Texas 79430, USA; ³Texas Department of State Health Services, Molecular and Cell Biology Laboratory, Austin, Texas 78756, USA; *Corresponding author (email: [email address])

increase as host mortality increases (Ulrico et al., 1988). Some fleas will use alternative mammalian hosts if their primary host is not available (Casper and Watson, 2001). Sick and dead prairie dogs attract carnivores and raptors that could potentially disseminate fleas, possibly spreading *Y. pestis* to other areas (Ulrico et al., 1988). Calkins and Williams (2001) suggested that

J. Zool., Lond. (2005) 289, 1–5 © 2005 The Zoological Society of London. Printed in the United Kingdom. DOI: 10.1017/S0022292X05002625

Home range and habitat use of the kit fox (*Vulpes macrotis*) in a prairie dog (*Cynomys ludovicianus*) complex

Rink List^{1,2} and David W. Macdonald^{1*}

¹Wildlife Conservation Research Unit, Department of Zoology, South Parks Road, Oxford OX1 3PS, UK; ²Present address: Instituto de Biología y Geología, Universidad Nacional Autónoma de México, Ciudad de México, D.F., México (e-mail: [email address])

Abstract
The kit fox remains a black-tailed prairie dog (*Cynomys ludovicianus*) complex in North America, where they coexist with the kit fox *Vulpes macrotis*, providing a unique opportunity to study the relationship between these threatened species. We hypothesized that the presence of prairie dogs would positively affect the kit fox population in our study areas in north-western Mexico, and that their influence would be manifest in home-range size, density and habitat selection. We estimated five densities, fluctuating from 0.52/m² to 0.84/m², and radiotelemetry revealed minimum core-polygon home range averaging 11 km². These values are within the bounds of estimates from study areas elsewhere. Home range measure varied less than expected, but prairie dogs were than expected in relation to availability. Other habitats, including prairie dog towns, were used at random. Most (65.1% of 32) fox dens were in grassland, and were collocated with prairie dog towns (34.9%) or prairie dog (34.9%) burrows. The kit fox tends to select grassland unless prairie dog towns are nearby, particularly at prairie dog densities known to be a major component of kit fox diet. Home range may reduce the amount of time they spend in prairie dog towns to avoid coyotes, which can be responsible for significant swift fox mortality. In our study area, coyotes were more active in prairie dog towns than in the grassland, where they were regularly shot. However, grassland used by kit foxes in a short-lived pocket of prairie dog poisoning, which is quickly eradicated by coyotes, a habitat favoured by coyotes. We conclude that kit fox conservation initiatives in north-western Mexico should be closely linked to re-generation of the prairie dog ecosystem.

Use of U.S. Croplands for Biofuels Increases Greenhouse Gases Through Emissions from Land-Use Change

Timothy Searles^{1,2}, Nisha Halder¹, M. A. Whitham¹, Fenglai Gong¹, Anang Tiabot¹, Justin Falkow¹, Sami Selgas¹, Dennis Hayes¹, Yun-Hsiang Yu¹

Most prior studies have found that substituting biofuels for gasoline will reduce greenhouse gases because biofuels sequester carbon through the growth of the feedstock. These analyses have failed to count the carbon emissions that occur as farmers worldwide respond to higher prices and convert forest and grassland to new cropland to replace the grain for cropland devoted to biofuels. By using a worldwide agricultural model to estimate emissions from land-use change, we found that cropland changed instead of producing a 29% savings, nearly doubling greenhouse emissions over 10 years and increasing greenhouse gases for 147 years. Biofuels from wheatgrains, if grown in U.S. corn lands, increase emissions by 20%. This result raises concerns about large biofuel production and distribution.

Journal of Zoology

REVIEW ARTICLE

Big city life: carnivores in urban environments

P. W. Bateman¹ & P. A. Fleming²

¹Department of Zoology and Entomology, University of Exeter, Exeter, Devon, UK
²School of Zoology and Botany, Murdoch University, Murdoch University, Perth, Western Australia

Abstract
Cities represent one of the most challenging environments for carnivorous mammals. For example, cities have a dearth of vegetation and other natural resources, coupled with increased habitat fragmentation and an abundance of rubbish as well as altered climate (e.g. temperature, light, rainfall and water runoff). It is therefore interesting that several carnivore species have become established in cities across the globe. Mediterranean climates such as the red fox, coyote, Eurasian badger and raccoon not only survive in cities but also have managed to expand into urban areas. We review the factors that may be influencing carnivore success in cities, such as urban sprawl, human density and human-derived significant benefits from living adjacent to urban areas. In this review, we examine the history of urban adaptation by mammalian carnivores, explore where they are living, what they eat, what kills them and the behavioural consequences of living in urban areas. We review the biology of urban carnivores, explore areas such as body size and dietary flexibility. Finally, we consider the consequences of having populations of carnivores in urbanised areas, both for humans and for these charismatic mammals. In conclusion, as a time of massive environmental change across the globe, the continuing establishment of urbanisation opens wilderness areas is substantially reducing the availability of natural habitats for many species; there fore, understanding the biology of any taxon that is able to adapt to and exploit anthropogenically disturbed systems will aid us in both conserving and developing suitable conservation reserves for the future of such species.

Recent land use change in the Western Corn Belt threatens grasslands and wetlands

Christopher K. Wright¹ and Michael C. Wimberly

¹Geographic Information Science Center of a Flagler, South Dakota State University, Brookings, SD 57007
E-mail: [email address]

ann. 02, and approved January 15, 2013 (received for review September 5, 2013)

annually prices has increased the cost and via from the National Center for Grassland Research in the Corn Belt (NCRB)

conversion of grass-land and wetland areas to cultivated cropland (2). Since 2008, however, there has been no regional-scale accounting of grassland conversion in the Corn Belt.

The present study addresses knowledge gaps evident in previous research by assessing very recent grassland conversion

Ecological Modelling

Volume 35, 1991, Pages 205–248

Simulation model for the effects of climate change on temperate grassland ecosystems

H. H. Van't Hof, M. J. Tong, P. F. Redfern, J. C. Moore, J. K. Deling, A. T. G. Kröber, D. E. Waller, & M. C.

Journal of Zoology

REVIEW ARTICLE

Big city life: carnivores in urban environments

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Abstract
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Student Research



Topic	Activity	Assessment
Research Planning and Data Collection	-Research Planning Framework -Discussion with professional ecologist -Camera Trapping	-Data collection -Research Plan Justification

- supported by literature and models
- reviewed by professional ecologist
- revisions + justification

Plan for camera trap deployment and data collection.
5 points – due at the beginning of class, Sept 25th for Monday section or 27th for Wednesday section

Name: _____

1) Cameras should be deployed between September 29th and November 26th, 2017. Cameras should be deployed for at least 10 nights, but can be out for 14 days.

Dates of camera trap deployment: _____

Date to obtain the cameras: _____

Date to return the cameras: _____

Before you pick up the cameras, please email Jessie Hall, halljr93@gmail.com, to confirm the camera pick up. Cameras will be picked up and dropped off in 200 Hardin Hall.

2) **Location of camera trap deployment:** _____
Please be as specific as you can.

GPS coordinates of the property: _____
(You can use Google Maps to find coordinates <http://www.gps-coordinates.net/> or the “compass” app on an iPhone, or other similar app, when you are on the property.)

3) Draw a map of your property. Use Google Maps in “map” view and “earth” view to sketch out the property. Label each section of the property with the associated land cover (tall grass, mowed grass, short grass, grass & shrubs, tree cover, corn crop etc), being as specific as you can. Label any road, structure or waterway. Draw in any fences, telephone or electric posts or any structures present that you could attach the camera to. Add an indicator of scale. See the back of the page for an example. When you visit the land, “prove” the map by validating that the vegetation cover that exists in various locations on your map. (*When you are collecting the camera trap data, you will need to be more specific about the vegetation around the camera trap.*)

4) A. Decide where to place the camera traps. Where do you think canid species might be found on your property (your hypothesis)? Why?

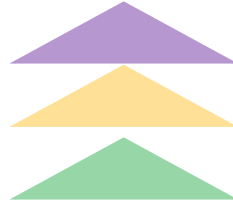


CAMERA TRAP STATION RECORD FORM

Date:		Data collector(s) name(s):			
Station ID ^a :		Start date:		Start time:	
Camera ID ^b :		End date:		End time:	
UTM Coordinates: Easting		Northing		Camera mounted on:	
Proximity to road/trail (m):	Type of road:	<input type="checkbox"/> 2 Lane paved	<input type="checkbox"/> Unpaved/Gravel	<input type="checkbox"/> 2 Track trail	<input type="checkbox"/> Other:
Vegetation height (average height in 5 m circle around the camera) ^c :		<input type="checkbox"/> < 30 cm (12 in)		<input type="checkbox"/> > 30 cm (12 in)	
Vegetation type or dominant cover 5 m (~16 ft) around the camera ^d :					
<input type="checkbox"/> Grass:		<input type="checkbox"/> Crop:			<input type="checkbox"/> Sand sage
<input type="checkbox"/> Mixed grass	<input type="checkbox"/> Alfalfa	<input type="checkbox"/> Fallow (no-planted)	<input type="checkbox"/> Sorghum/milo	<input type="checkbox"/> Sunflower	<input type="checkbox"/> Other:
<input type="checkbox"/> Shortgrass	<input type="checkbox"/> Corn	<input type="checkbox"/> Soybeans	<input type="checkbox"/> Wheat		
<input type="checkbox"/> Tallgrass					
Dominant cover ~ 0.5 mi around the camera station ^e :		<input type="checkbox"/> Crop		<input type="checkbox"/> Grass	<input type="checkbox"/> Other:
Comments/Observations:					

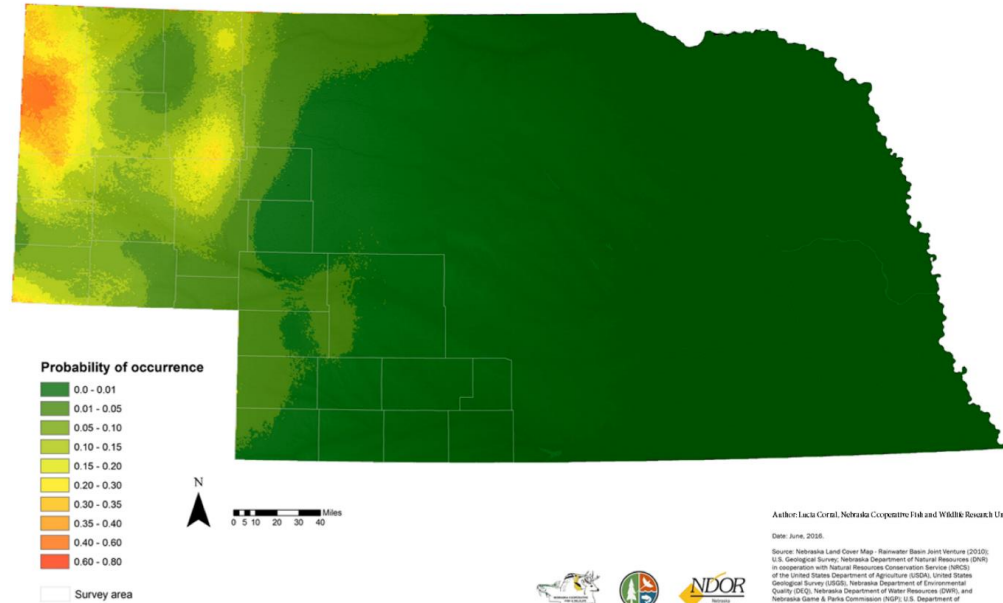
Class 3

Topic	Activity	Assessment
Data Analysis	-Data crunching session with wildlife biologist -Model Revisions	-Brief report on findings from research -Open-Ended Reflection -Student Models



	A	B	C	D	E	F	G	H	I	J	K	L	M
1	Folder	CAFA	CALA	LYRU	MEME	PRLO	TATA	VUVE	VUVU	CYLU	DIOR	LECA	Lepus
2	ADK-1	3	0	0	24	80	3	0	0	0	0	0	
3	ADK-2	0	0	0	0	0	0	0	0	0	23	0	
4	ADK-3	0	3	0	29	178	0	0	0	0	0	12	
5	ADK-4	0	2	0	24	66	0	0	0	0	0	0	
6	ADK-5	0	0	0	0	24	0	0	0	0	0	25	
7	ANDE-1	0	0	0	0	0	0	0	0	0	0	0	
8	ANDE-3	0	0	0	0	0	0	0	0	0	0	0	
9	BAH-1	0	12	0	0	6	0	0	0	0	0	0	
10	BAH-2	0	0	0	0	0	20	0	0	0	0	0	
11	BAH-3	0	0	0	0	16	0	0	0	0	0	0	
12	BAH-1	0	4	0	0	0	0	0	0	0	0	0	
13	BAH-2	0	0	0	0	0	0	0	0	0	0	0	
14	BAH-3	0	0	0	0	0	0	0	0	0	0	0	
15	BAH-4	0	0	0	0	0	0	0	0	0	0	0	
16	BAH-5	0	0	0	0	0	0	0	0	0	0	0	
17	BAH-6	0	0	0	0	0	0	0	0	0	0	0	
18	BAR-1	0	0	0	0	0	0	0	0	0	0	0	
19	BAR-2	0	0	0	0	0	0	0	0	0	0	0	
20	BAR-3	0	0	0	0	0	0	0	0	0	0	0	
21	BAR-4	0	0	0	0	0	0	0	0	0	0	0	
22	BAR-5	0	0	0	0	0	0	0	0	0	0	0	
23	BAR-6	0	0	0	0	0	0	0	0	0	0	0	
24	BOB-1	0	0	0	0	0	0	0	0	0	0	0	
25	BOB-1-RE	0	0	0	0	0	0	0	0	0	0	0	
26	BOB-2	0	0	0	0	0	0	0	0	0	0	0	
27	BOB-3	0	0	0	0	0	0	0	0	0	0	0	
28	BOT-1	0	0	0	0	0	0	0	0	0	0	0	
29	BOT-2	0	0	0	0	0	0	0	0	0	0	0	
30	BOT-3	0	0	0	0	0	0	0	0	0	0	0	
31	BR-1	0	0	0	0	0	0	0	0	0	0	0	
32	BR-2	0	0	0	0	0	0	0	0	0	0	0	
33	BR-3	0	0	0	0	0	0	0	0	0	0	0	
34	BR-4	0	0	0	0	0	0	0	0	0	0	0	
35	BRE-1	0	0	0	0	0	0	0	0	0	0	0	
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37	BRE-3	0	0	0	0	0	0	0	0	0	0	0	

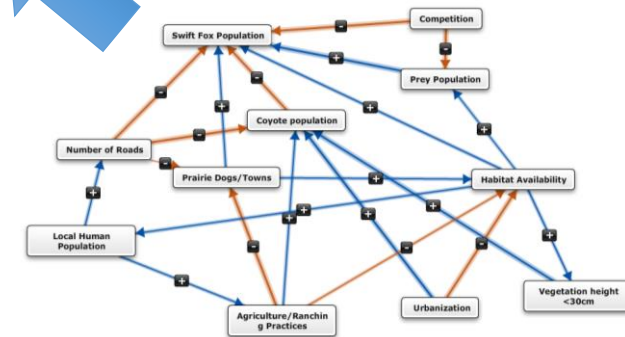
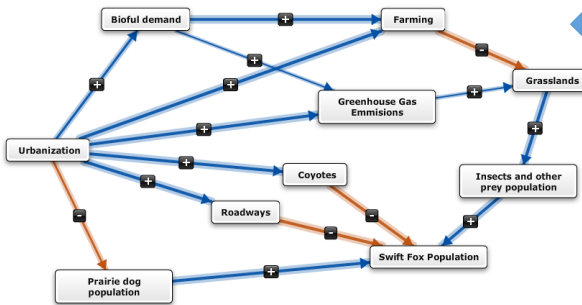
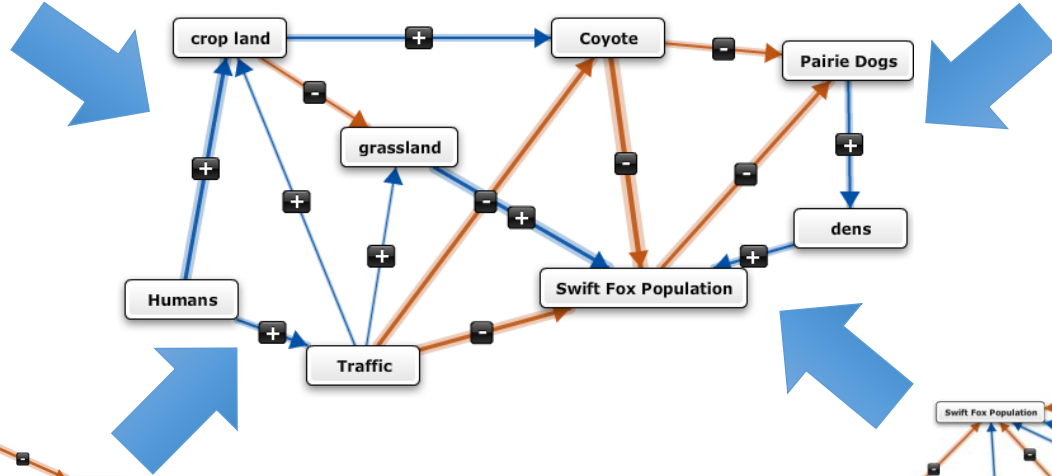
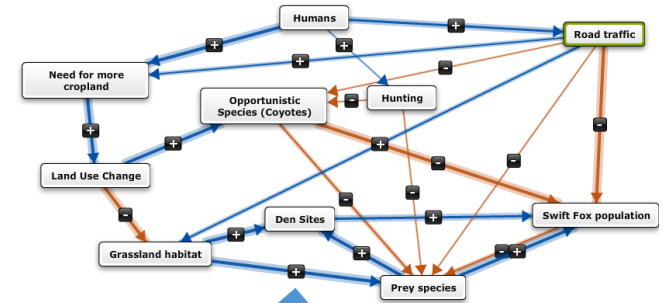
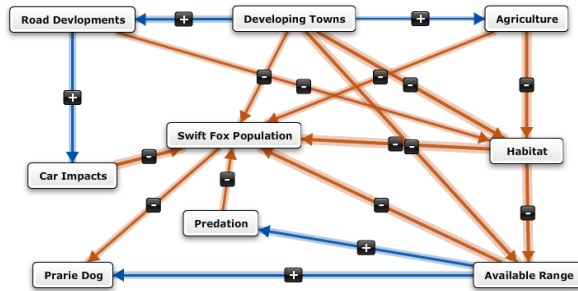
	A	B	C	D	E	F	G	H	I	
1		CALA	LYRU	MEME	PRLO	TATA	VUVE	VUVU		
2	CALA	1								
3	LYRU	-0.04107	1							
4	MEME	0.012244	0.010037	1						
5	PRLO	0.016951	0.084372	0.212116	1					
6	TATA	0.071748	0.010675	0.094721	0.09862	1				
7	VUVE	0.005846	-0.01372	0.148324	-0.01026	-0.02336	1			
8	VUVU	-0.01743	-0.0135	0.132222	0.011482	0.007487	-0.00854	1		
9									1	
10										
11										
12										
13										
14										
15										



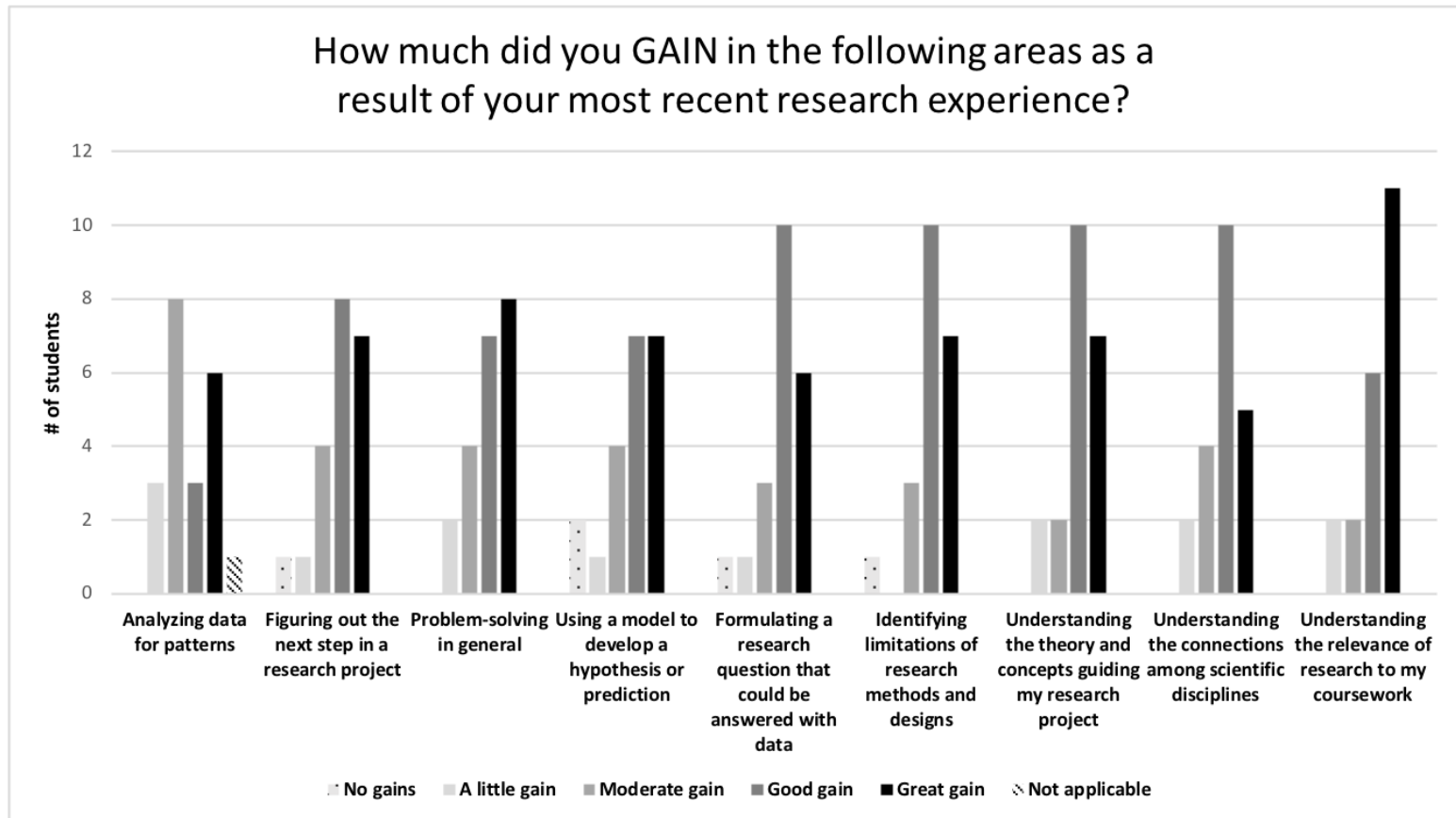
Student Data -> Swift Fox Distribution Model

Class 4

Topic	Activity	Assessment
Group Consensus Model	-Model Building	-Open-Ended Reflection -Student Models




Student Perceptions



Undergraduate Research Student Self-Assessment (URSSA) (Weston and Laursen 2015)

Diane Ebert-May –

How do we assess multiple dimensions of student learning?



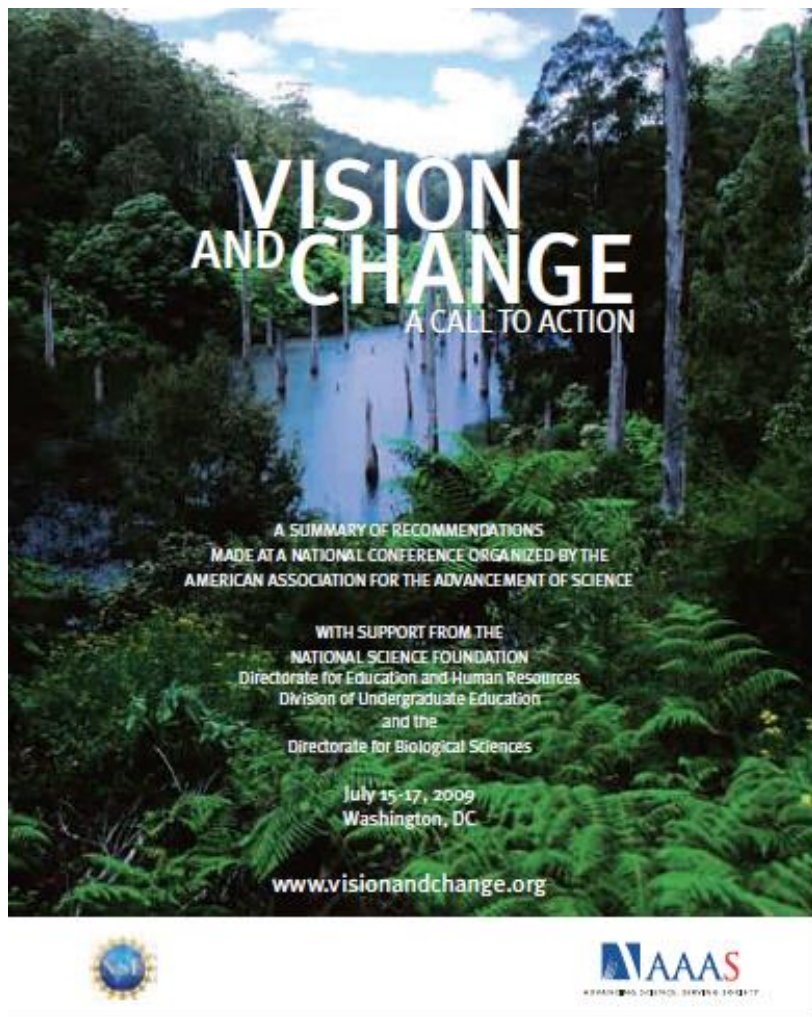
How do we assess multiple dimensions of student learning?



Diane Ebert-May
Department of Plant Biology
Michigan State University

24 January 2019



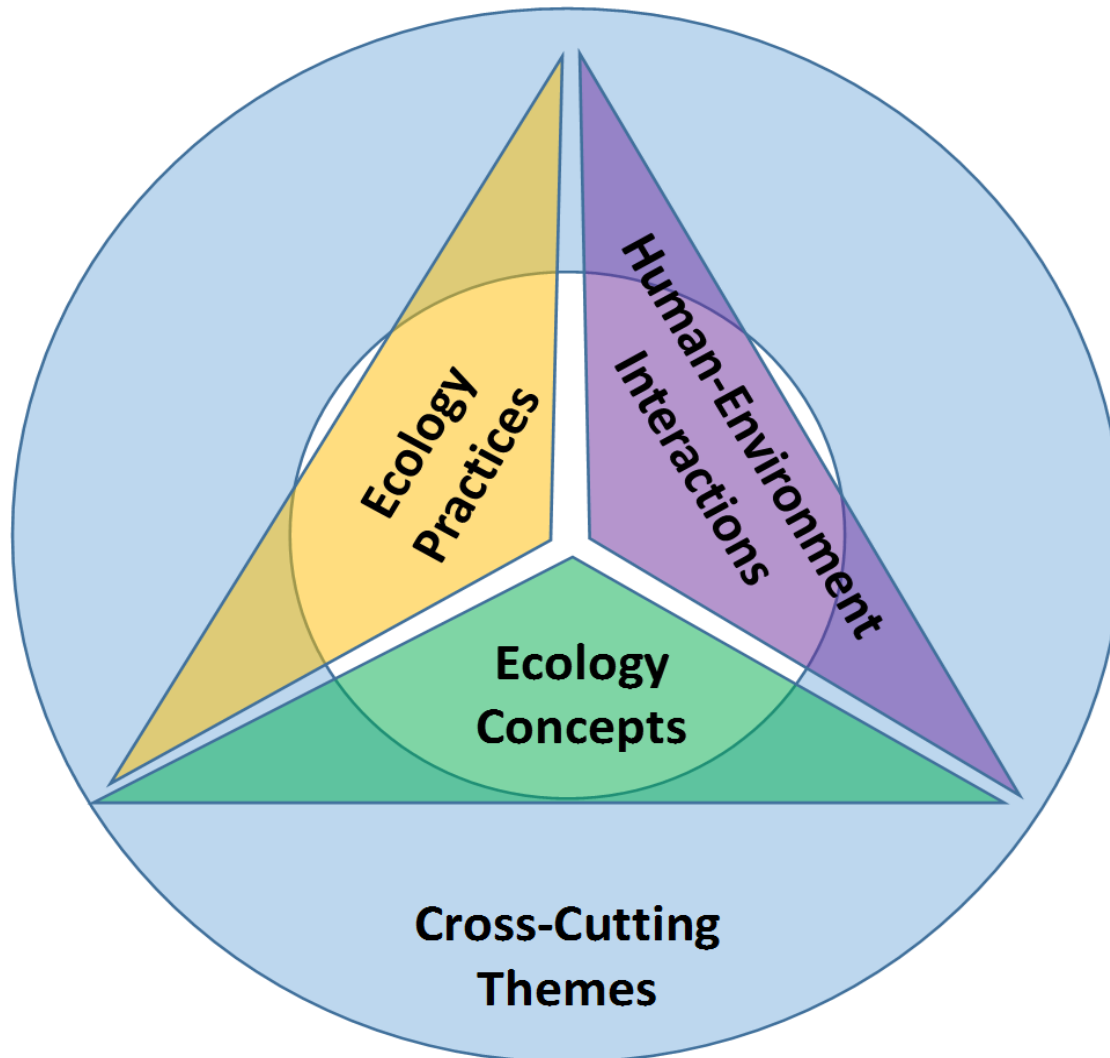


Brewer et al 2011



NRC, 2012

4-Dimensional Ecology Education

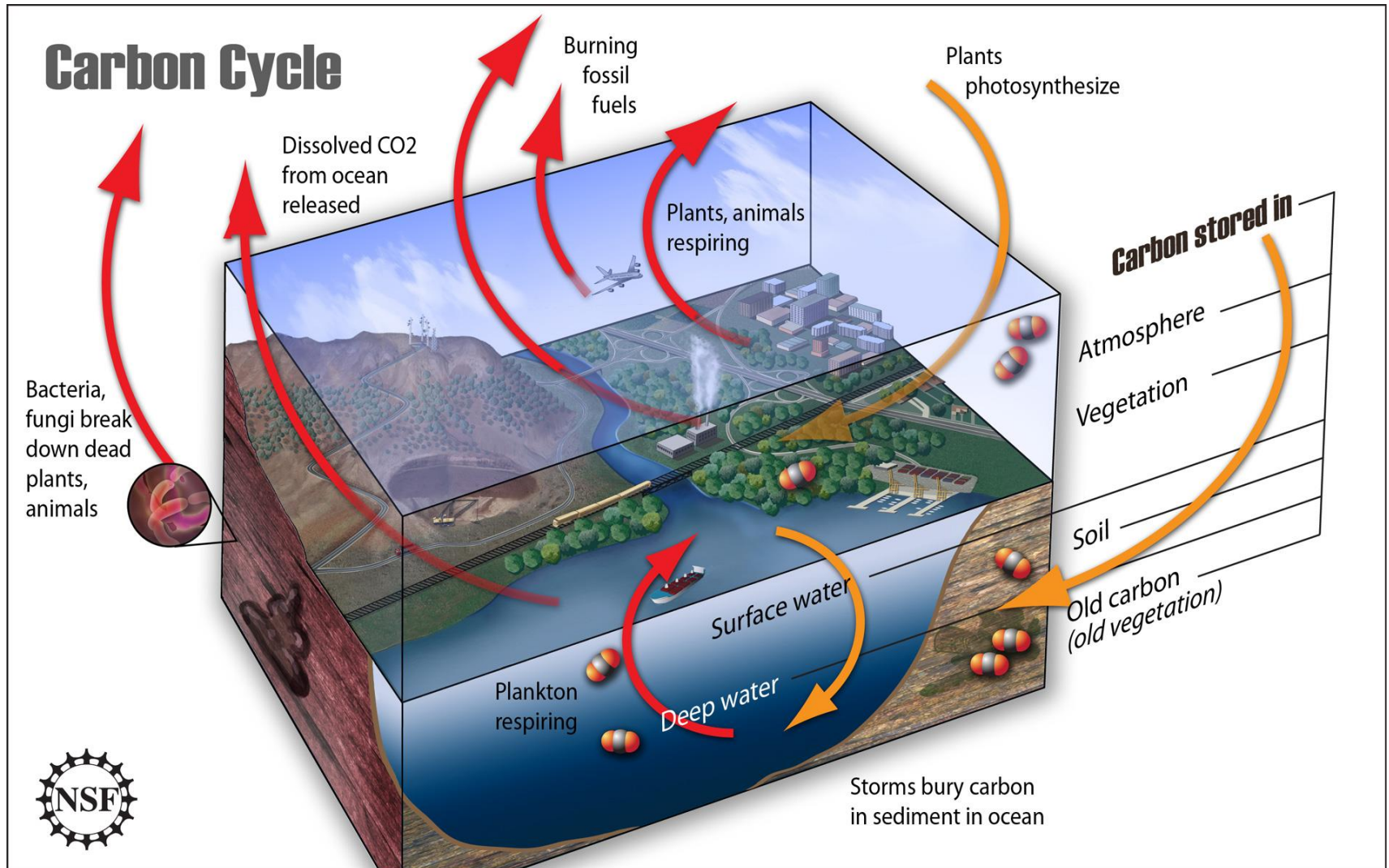


Where do we start?



Core Concept in Ecology

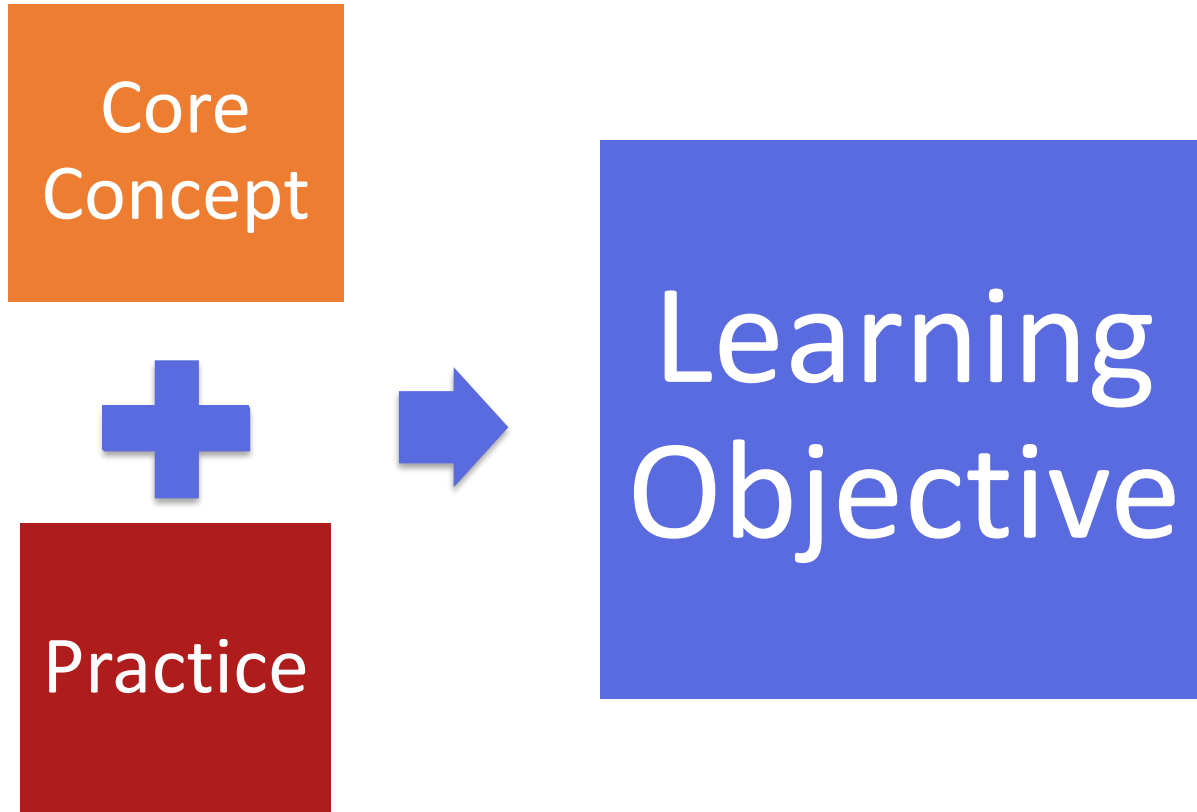
Energy Flow – Nutrient Cycling



What should students do with this Big Idea?



Create Learning Objectives that Use Science Practices and Core Concepts





Ecosystems



Models

Model the flow of carbon through a ecosystem and use the model to predict the consequences of increased temperature on primary productivity.

Three-Dimensional Learning Assessment Protocol: 3D – LAP

Laverty JT, Underwood SM, Matz RL, Posey LA, Carmel JH, Caballero MD, Fata-Hartley CL, Ebert-May D, Jardeleza SE, Cooper MM. 2016. Characterizing College Science Assessments: The Three-Dimensional Learning Assessment Protocol. PLoS ONE 11(9): 0162333. doi:10.1371.

Three-Dimensional Learning Assessment Protocol: 3D – LAP

1. Characterize assessment questions
2. Develop/modify assessments

3D-LAP Developing and Using Models: *Constructed Response*

1. Question gives an event, observation, or phenomenon for the student to explain or make a prediction about.
2. Question gives a representation or asks student to construct a representation.
3. Question asks student to explain or make a prediction about the event, observation, or phenomenon.
4. Question asks student to provide the reasoning that links the representation to their explanation or prediction.

Case based exam: Global warming and the arctic food web

Kahru et al. 2016. Effects of sea ice cover on satellite-detected primary production in the Arctic Ocean. *Biology Letters* 12: 20160223.

Zimmer, 2016. <http://www.nytimes.com/2016/11/22/science/global-warming-alters-arctic-food-chain.html>

The Arctic Ocean is home to a diverse community of organisms, supported by primary producers - algae – that use sunlight (energy) and carbon dioxide to produce carbohydrates (matter) through photosynthesis, just like plants. This ecosystem is seasonal, with high levels of primary productivity (NPP) during the summer, when sea ice melts and liquid ocean water is exposed to the air, and low NPP during the rest of the year, when the ocean surface is frozen as sea ice....



What do we know about students' thinking from these two questions?

1a. Draw a species interaction model for the Arctic ocean food web described in this case. Connect names of species that interact directly with each other using lines and indicate on the lines how each species' fitness is impacted, with +/-/0 next to the species name. Be sure to include all appropriate primary producers, competitors, predators in the case.

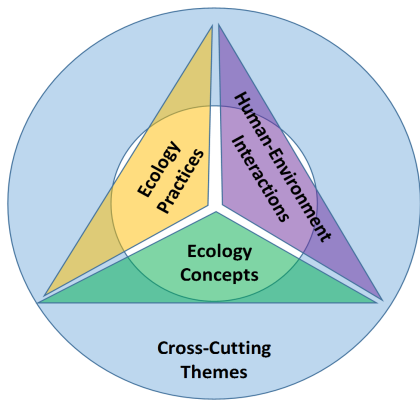
Q1b. Now, draw another species interaction model for this Arctic Ocean food web following extinction of polar bears. Predict how primary productivity may be affected and explain your reasoning.

3-DLAP Tool to Assess 4DEE

- The 3D-LAP can help us create and modify assessments.
- The 3D-LAP can help us characterize assessments for “what” is assessed.

Pam Templer –

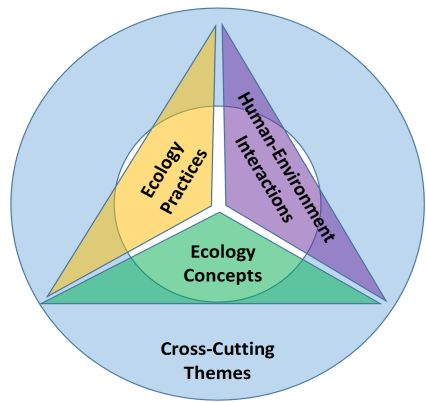
Discussion, Next Steps and Wrap-up



Next Steps for 4DEE: How Can ESA Help You?

- Course syllabi examples
- Lesson plans
- Lecture (powerpoint) examples
- Assessment tools and sample exam questions
- Workshops at ESA meetings
- Workshops at Life Discovery Conference
- Research publications showing that utilization of 4DEE improves learning outcomes

For more information or to get involved with 4DEE



Website: <https://www.esa.org/4DEE/>

ESA 4DEE
Task Force

- **George Middendorf** - gmiddendorf@gmail.com
- **Bob Pohl** - bpohl@ferrum.edu
- **Alan Berkowitz** - berkowitz@caryinstitute.org
- **Carmen Cid** - cid@easternct.edu
- **Jennifer Doherty** - doherty2@uw.edu
- **Diane Ebert-May** - ebertmay@msu.edu
- **Ken Klemow** - kenneth.klemow@wilkes.edu

Webinar
Presenters

- **Luanna Prevost** - prevost@usf.edu
- **Amanda Sorensen** - asorensen8@unl.edu

ESA Educ.
Staff & VP

- **Teresa Mourad** - Teresa@esa.org
- **Pam Templer** - ptempler@bu.edu

Thank you!

