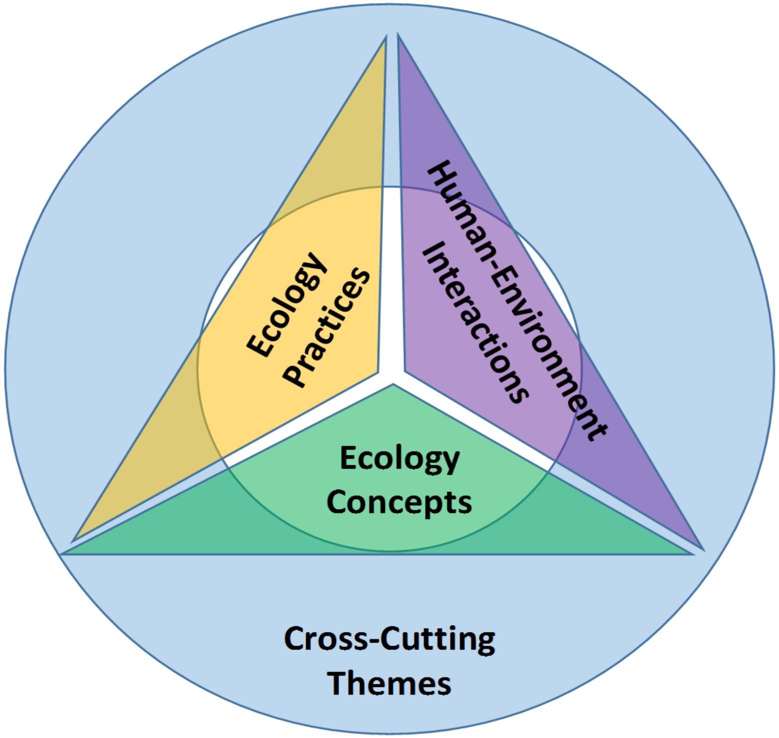
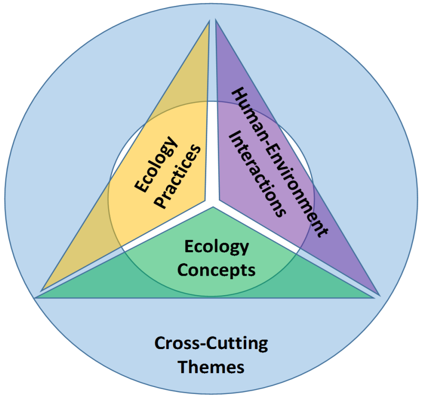


Pam Templer, *Boston Univ.*
Alan R. Berkowitz, *Cary Institute*
Luanna Prevost, *Univ. South Florida*
Amanda Sorensen, *Univ. Nebraska*
Diane Ebert-May, *Mich. State Univ.*

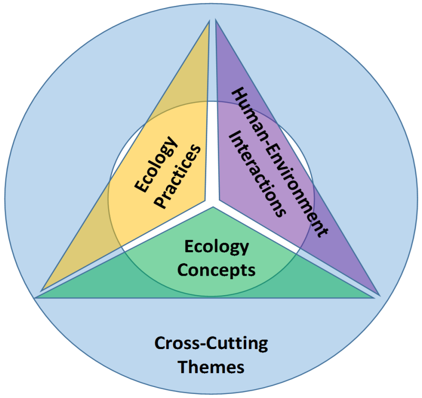
The ESA's Four-Dimensional Ecology Education Framework (4DEE): Opportunities and Challenges

January 24, 2019



Our Vision for the Webinar

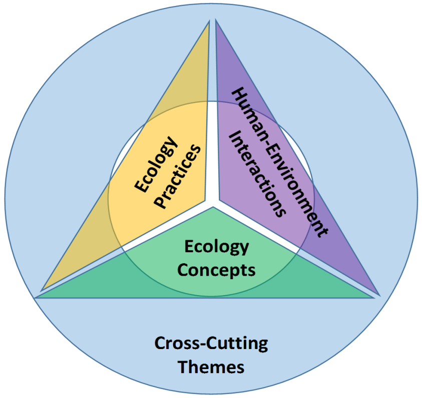
- Leadership in the field of ecology education
  - ESA endorsement of the 4DEE Framework
  - Dissemination of the Framework
- Building on, extending and celebrating the Framework



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.

BASIC ECOLOGICAL LITERACY: A FIRST CUT

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

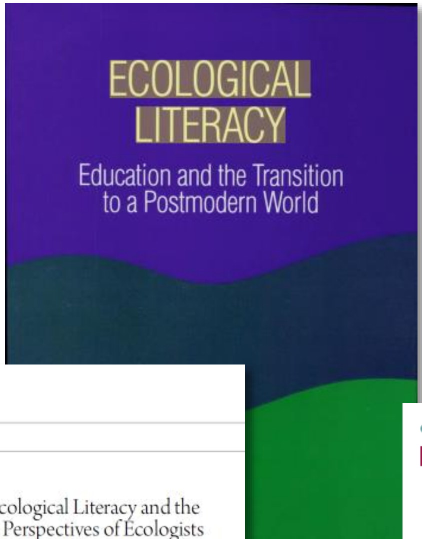
Kenneth M. Klemow
Department of Biology, Wilkes University
Wilkes-Barre, PA 18766

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 ...

Klemow – 1991



Orr – 1992

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

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

CONCEPTS AND QUESTIONS

What should every citizen know about ecology?

Rebecca Jordan, Frederick Singer, John Vaughan, and Alan Berkowitz

Jordan et al. 2009

University of Montana
ScholarWorks

Theses, Dissertations, Professional Papers

2011

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

Brooke Baldauf McBride
The University of Montana

Follow this and additional works at: http://scholarworks.umt.edu/etd

McBride 2011

esa ECOSPHERE

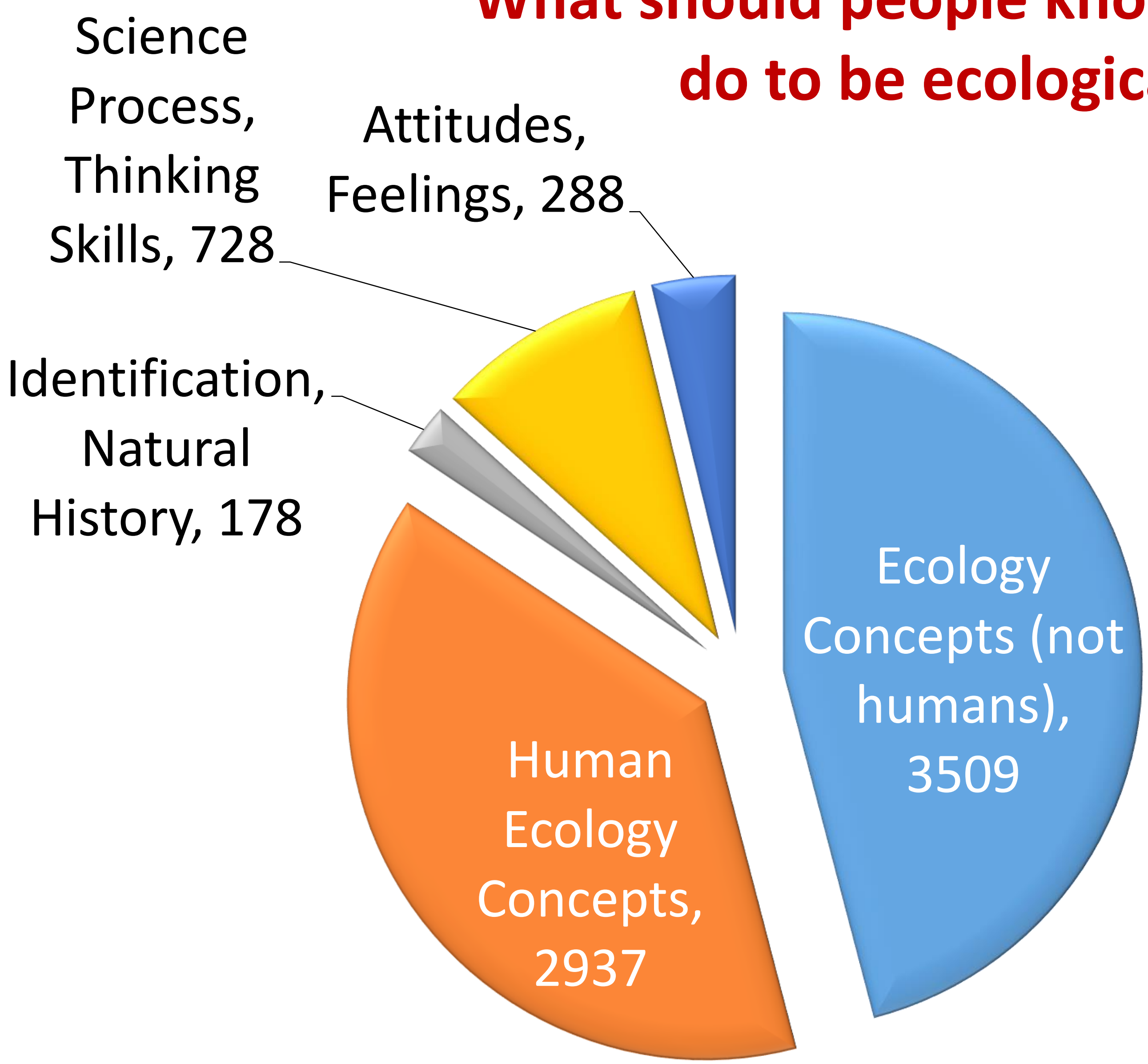
SYNTHESIS & INTEGRATION

Environmental literacy, ecological literacy, ecoliteracy: What do we mean and how did we get here?

B. B. McBride, C. A. Brewer, A. R. Berkowitz, and W. T. Borrie

McBride et al. 2013

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



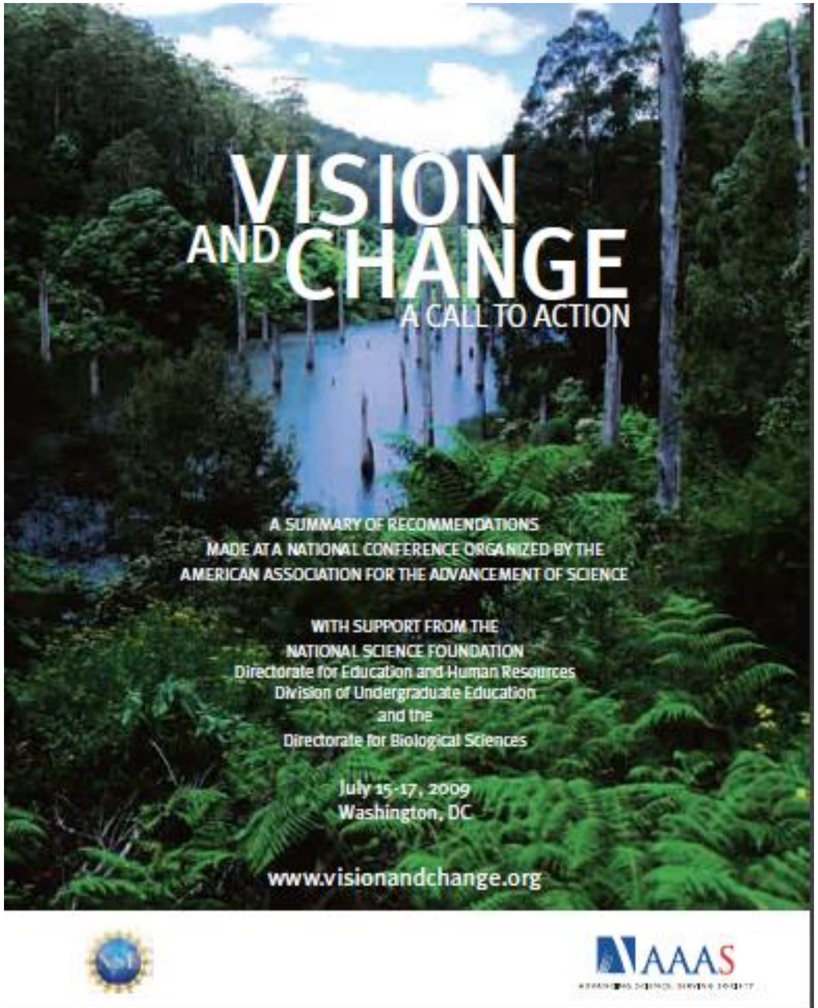
Number of Coded Elements in Major Categories (n total = 7656)

ESA 2007 Member Survey (n = 1032)

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

- **George Middendorf**, Howard University
- **Bob Pohlad**, 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

NEXT GENERATION
SCIENCE
STANDARDS
For States, By States

NRC, 2012

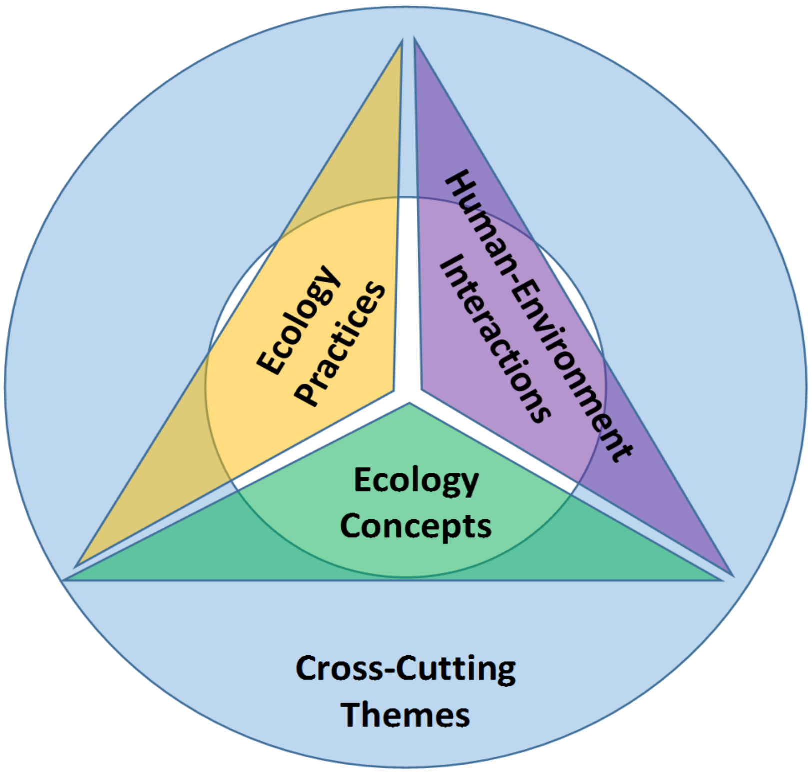
Two Dimensions:

1. Core Concepts
2. Competencies

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

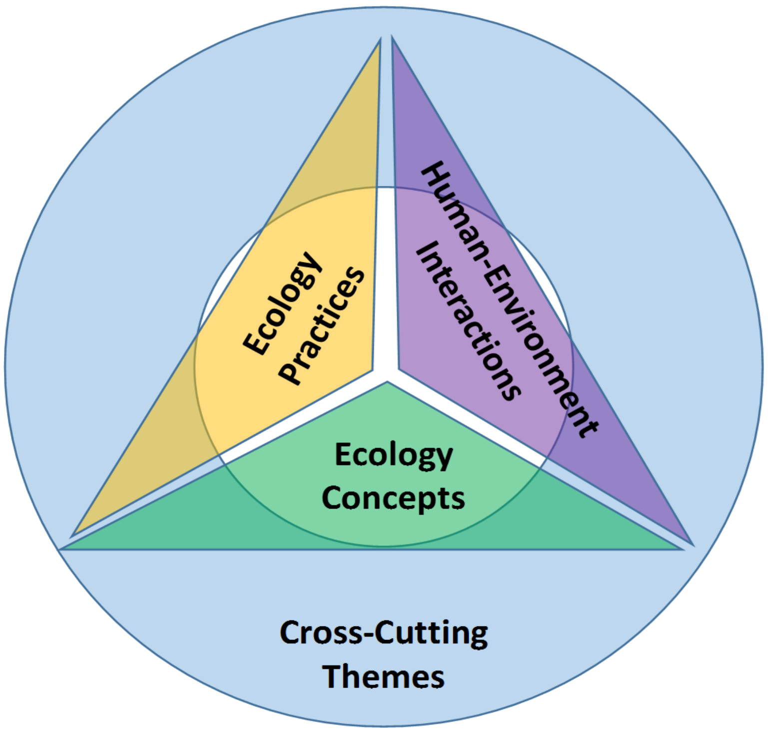
Human-Environment Interactions

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

Aligning the lesson plan using 4DEE

Learning Objectives

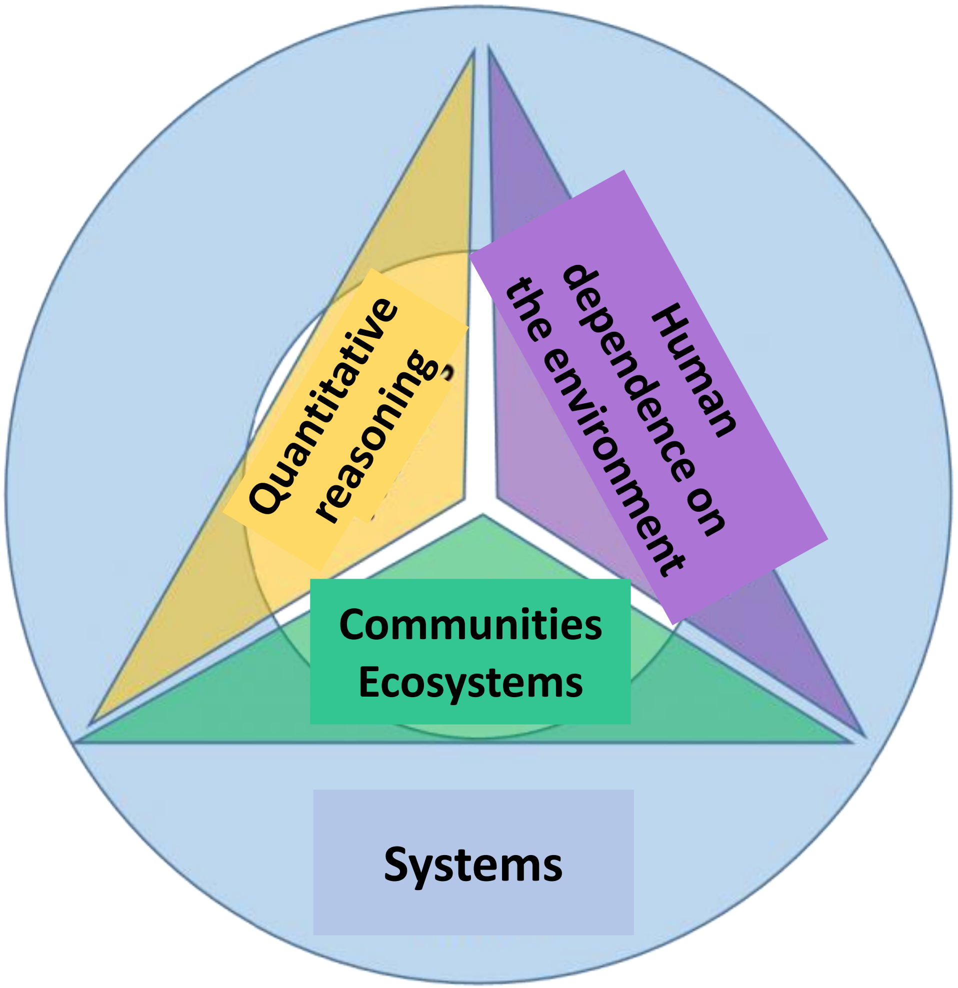
Instructional Activity

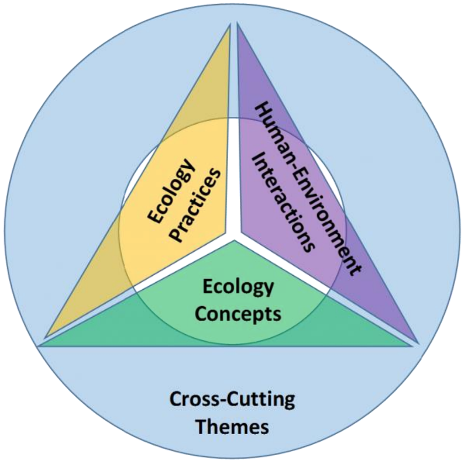
Assessment

- Alignment improves learning outcomes

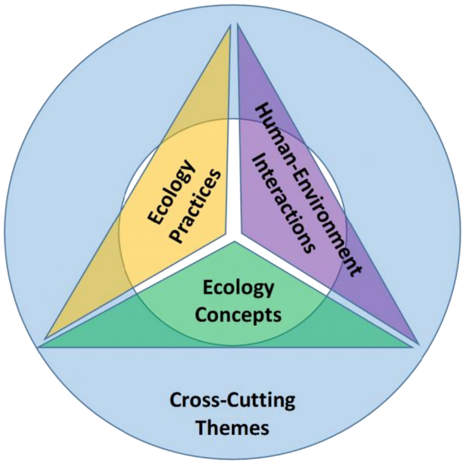
Fink 2003; Wiggins and McTighe 2005; Momsen et al. 2010 ; Jensen et al 2014

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

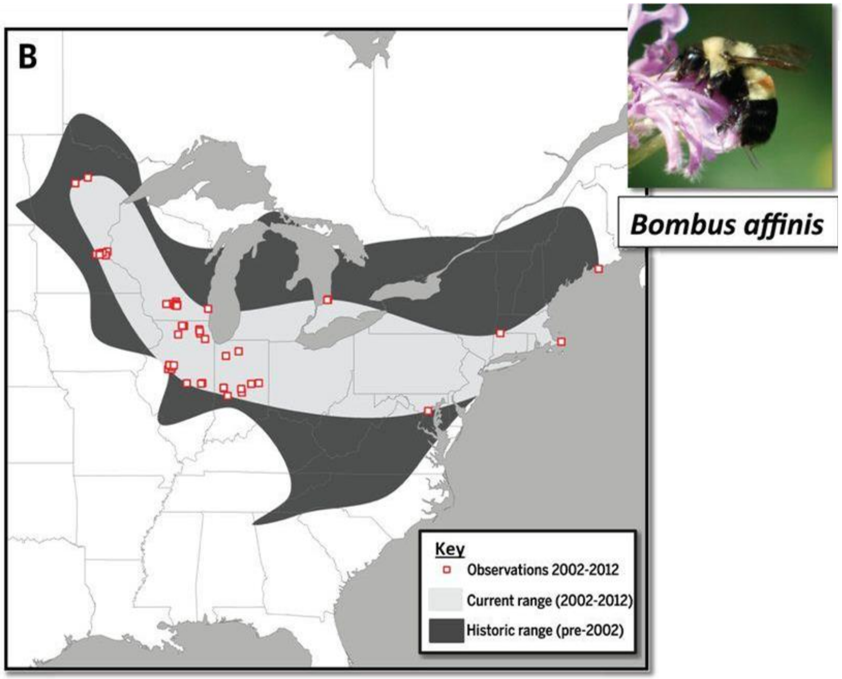
1. Brainstorming

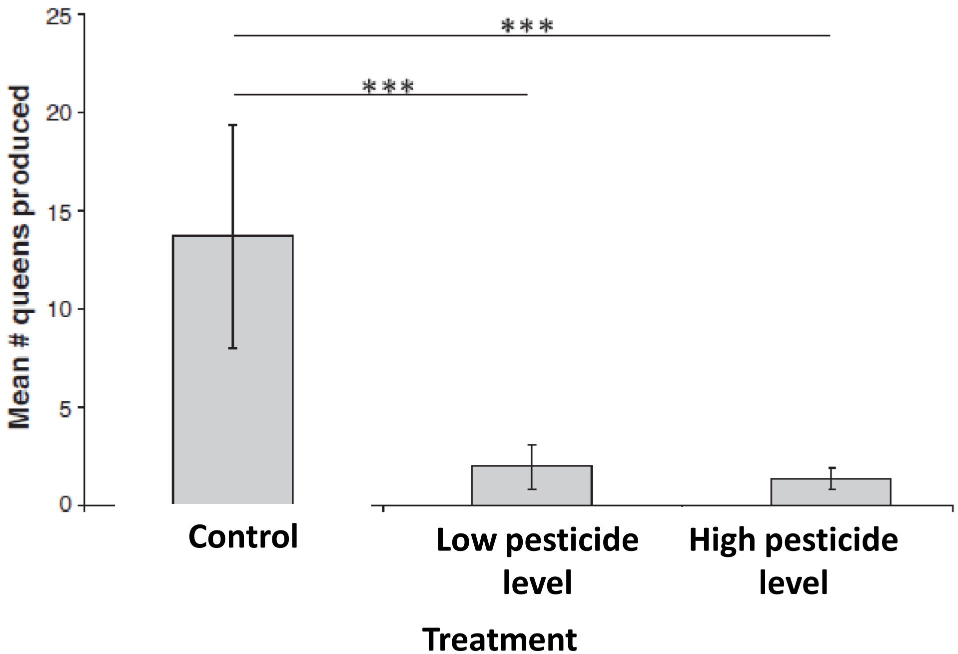
   Setting the Context and Real World Challenge
   - Why are bees important to people?
   - What are potential causes of bee declines?
   - What are potential impacts?
   - How can we reduce or stop this decline?
2. Data interpretation
3. Integration of data
4. Making predictions and recommends (using content 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?





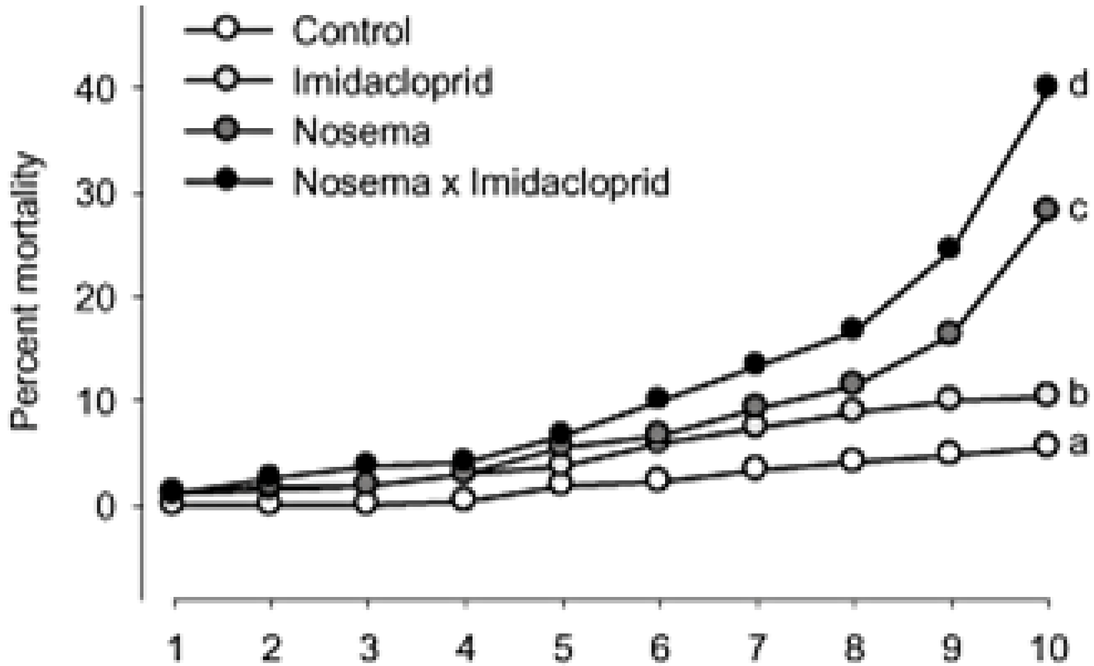
Dave Goulson et al.
Science 2015;347:1255957

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

Alaux, C., Brunet, J.-L., Dussaubat, C., Mondet, F., Tchamitchan, S., Cousin, M., Brillard, J., Baldy, A., Belzunces, L. P. and Le Conte, Y. (2010), Interactions between *Nosema* microspores and a neonicotinoid weaken honeybees (*Apis mellifera*). Environmental Microbiology, 12: 774–782. doi:10.1111/j.1462-2920.2009.02123.x

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?

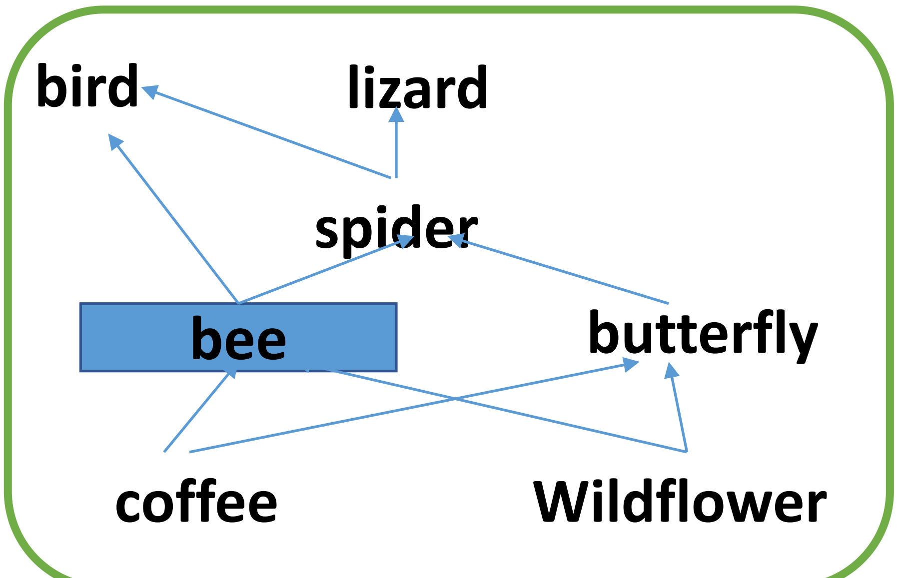
C) coffee plants?

Describe the impact of the removal of bees on

a) spider populations?

b) lizard populations?

C) coffee plant populations?

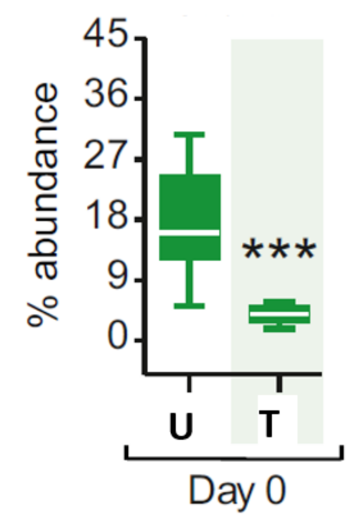


Assessment

- 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 (T).
- One of the bacteria studied was *S. alvi* (**Figure 1).** Which statement best describes the change in **relative abundance** of *S. alvi*?

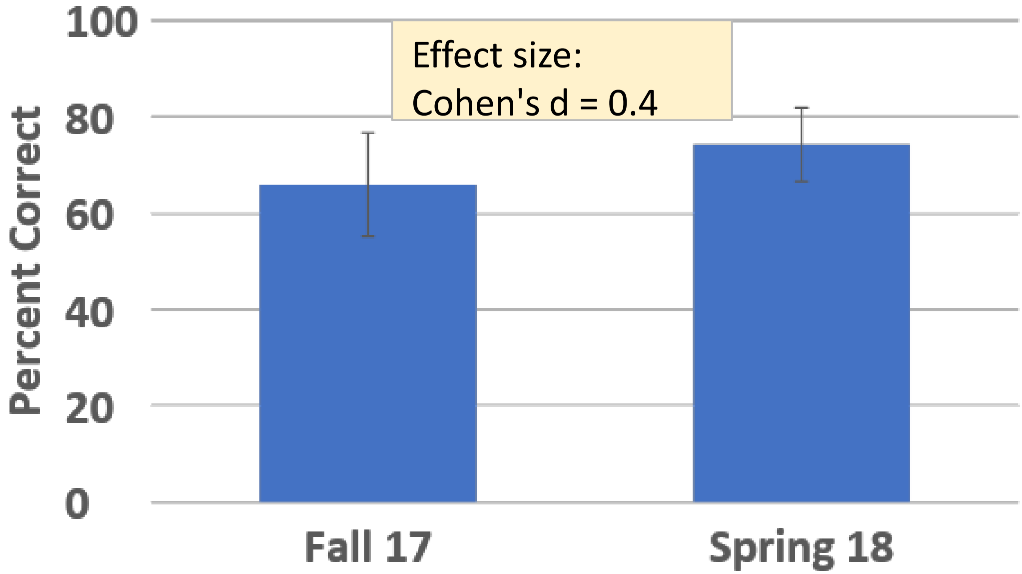
Figure 1. Abundance of *S. alvi* bacteria



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

Outcomes

5 multiple-choice questions on ecological interactions and food webs



n=157

n=160

"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

CURE-Auchincloss et al. 2014

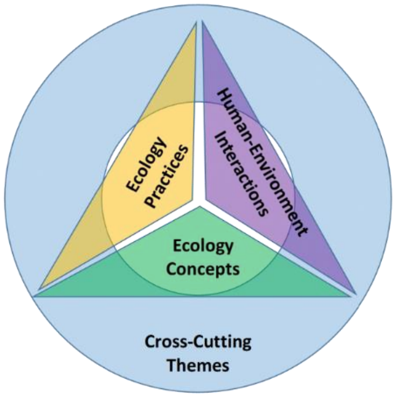
Nebraska Canid Project

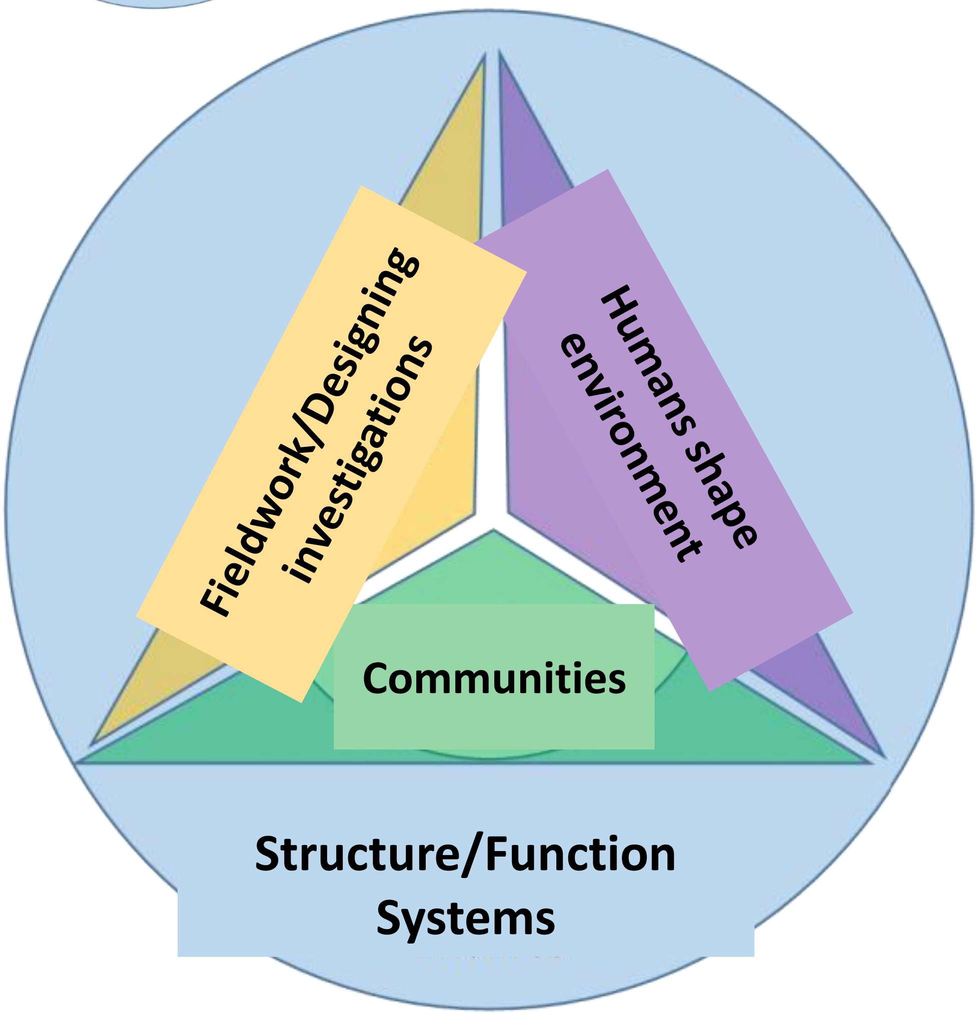
Nebraska Environmental Trust

A CHECK FOR WILDLIFE — Nebraska Game and Parks Commission

NEBRASKA GAME PARKS

NEBRASKA COOPERATIVE FISH & WILDLIFE RESEARCH UNIT

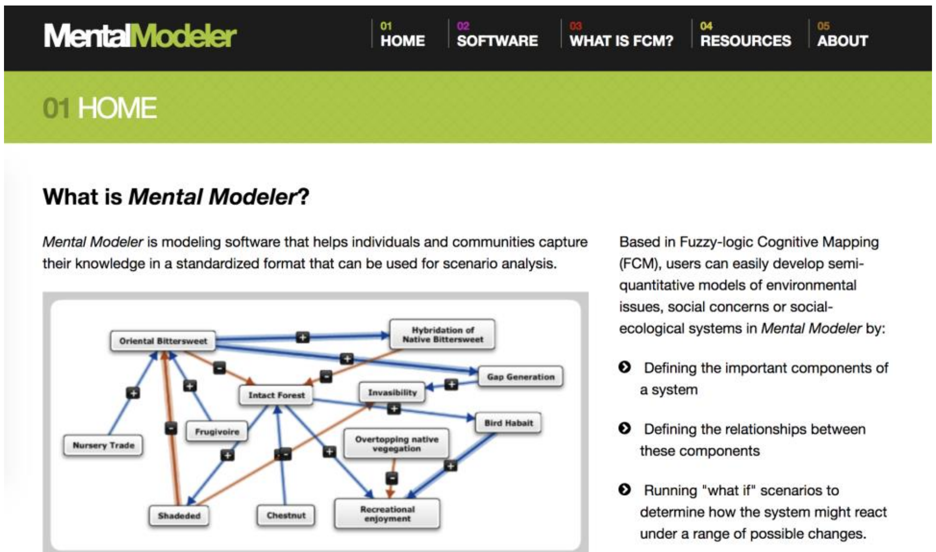




Learning Objectives

- 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



PMC-2E Conceptual Framework:

P- Phenomenon

M- Mechanism

C- Components

E- Evidence

E- Explanation

*Based on SBF Models

Gray et al. 2013

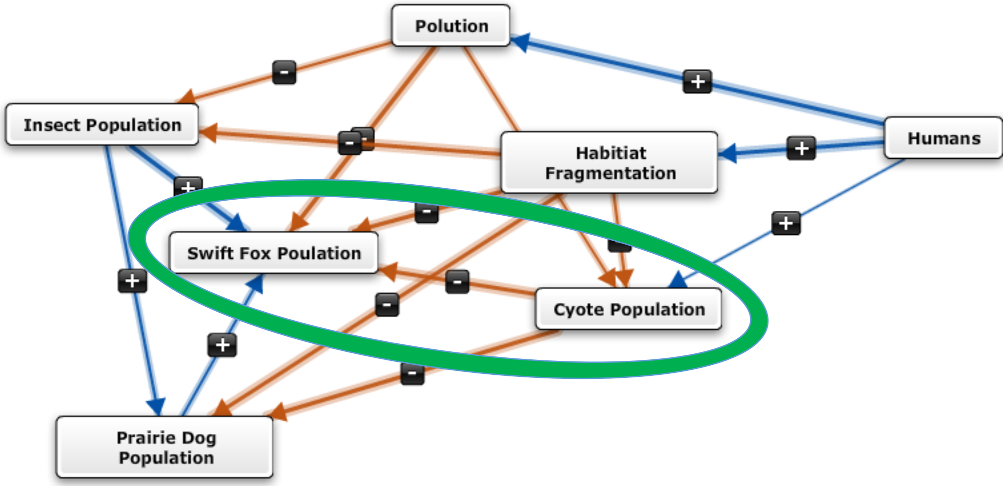
Jordan et al. 2014

Models as Assessments

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

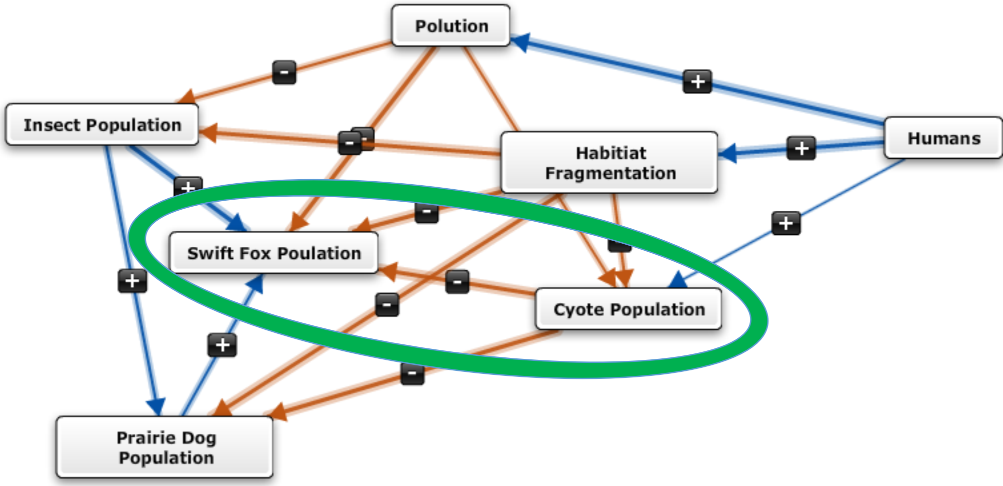
Models as Assessments

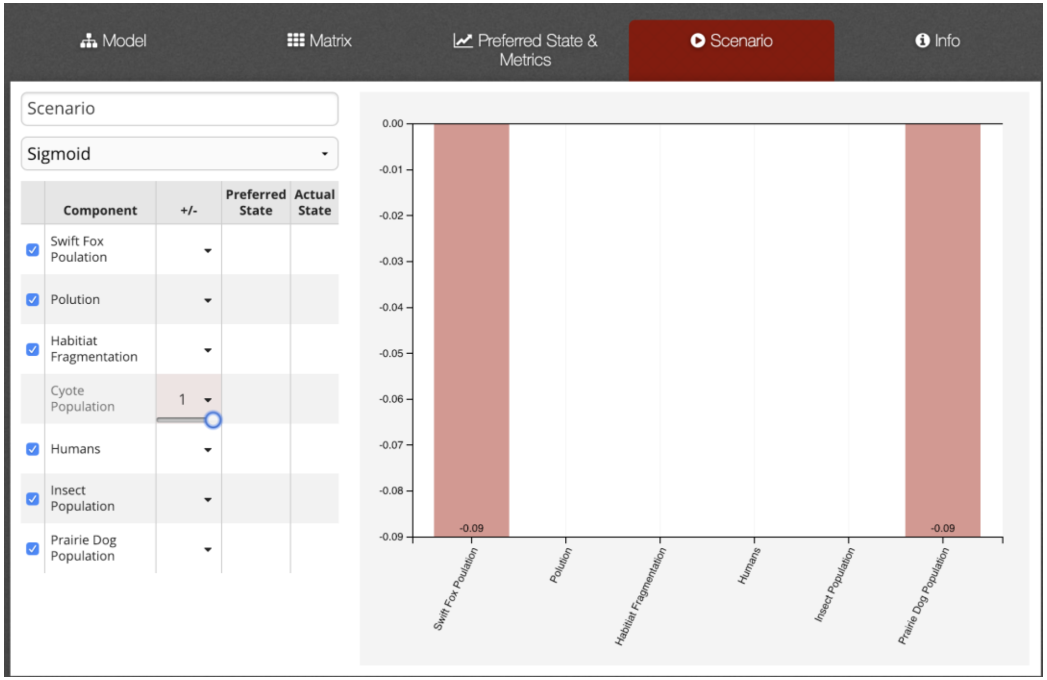
1. Open-ended reflection
   - Explain relationships (mechanisms) between components
   - Describe predicted impact on system before running a scenario



Models as Assessments

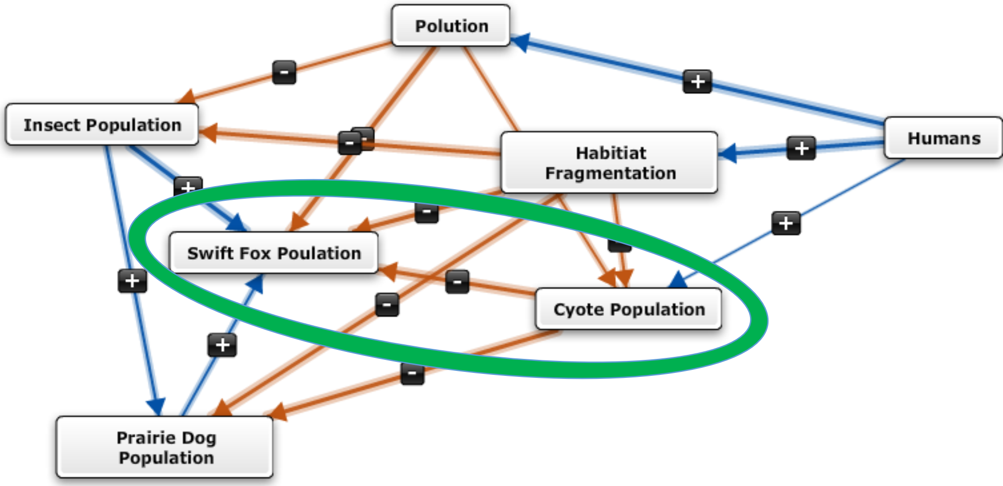
1. Open-ended reflection
   - Explain relationships (mechanisms) between components
   - Describe predicted impact on system before running a scenario
2. Run a scenario

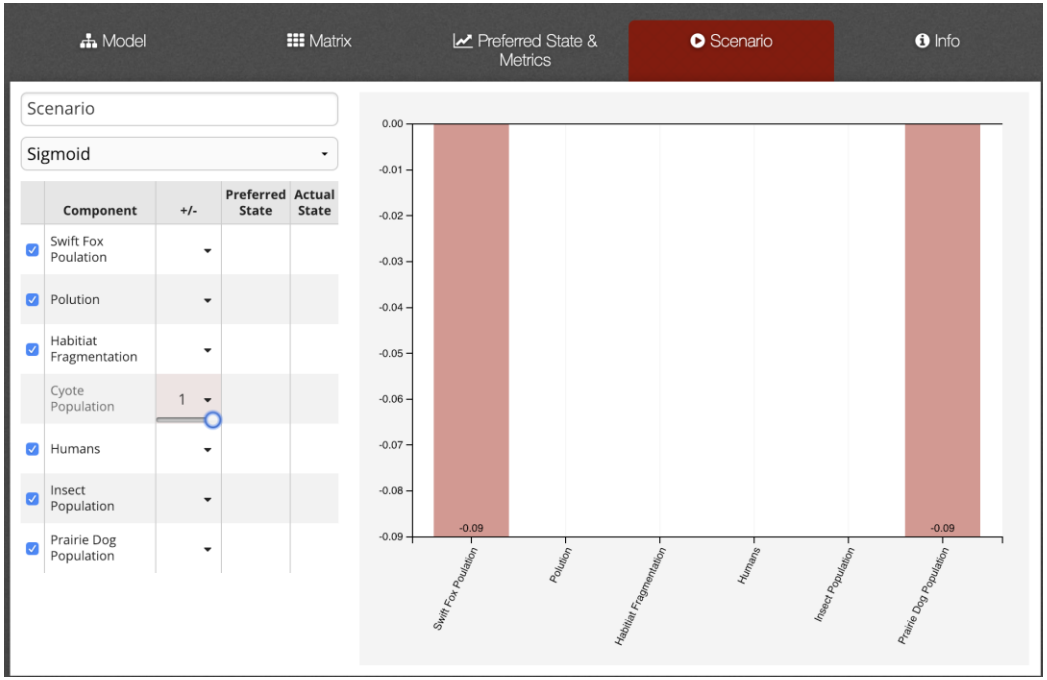




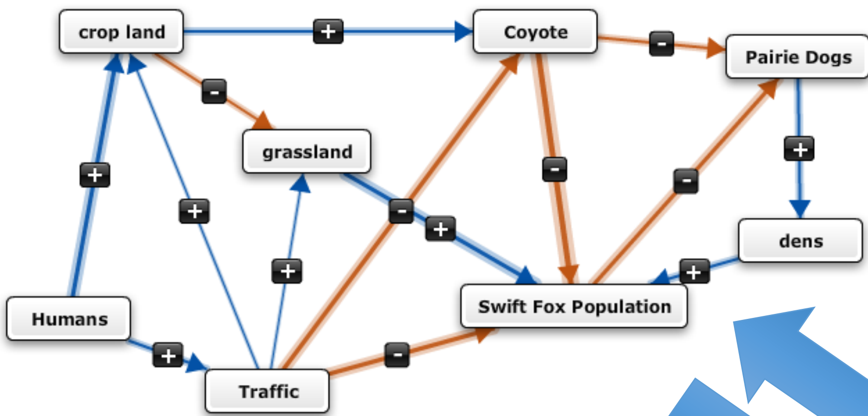
Models as Assessments

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

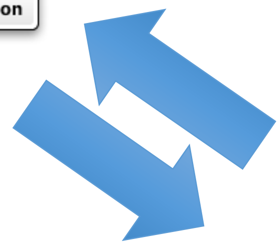


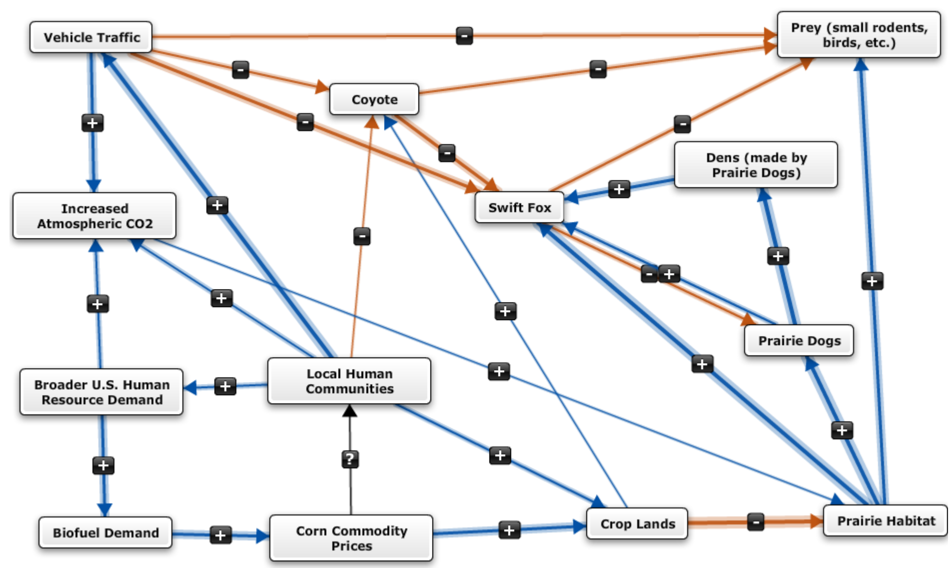


Models as Assessments



Student Individual + Group Models

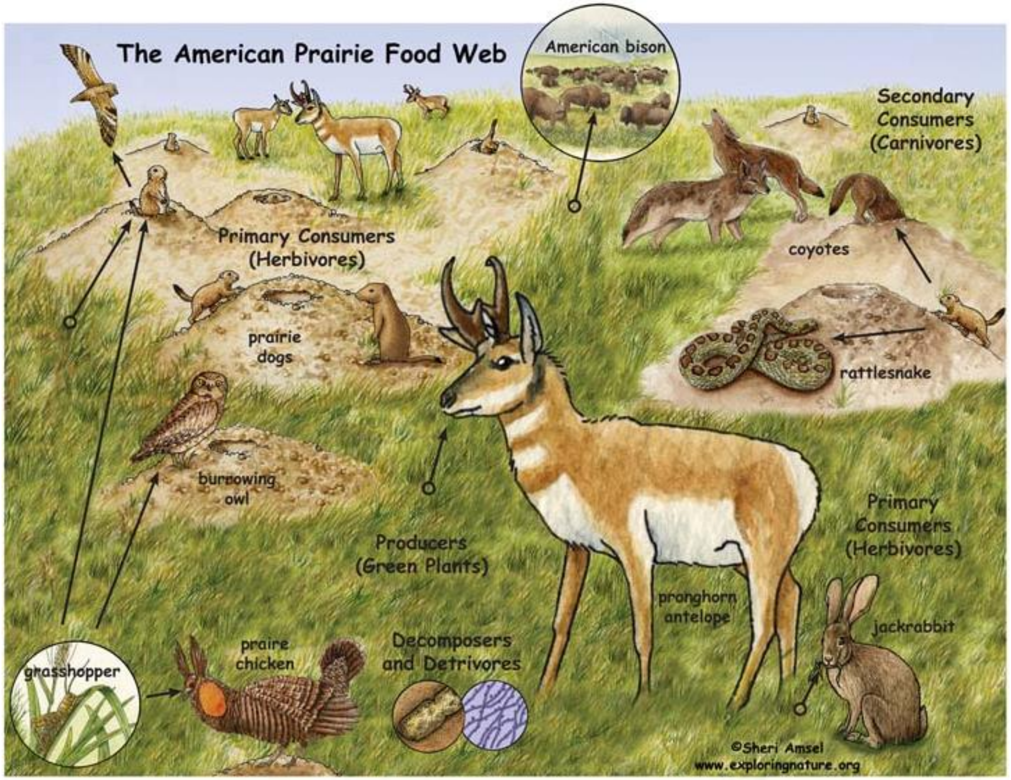




Wildlife Biologists Model

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**

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: ________________________________

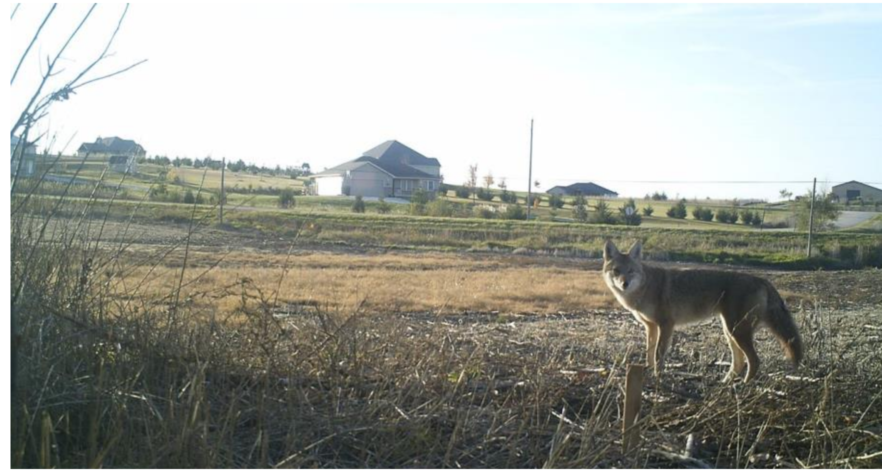
Before you pick up the cameras, please email Jessie Hall, halljr93@gmail.com, to confirm the camera pick up. Cameras will be picked up and dropped off in 200 Hardin Hall.

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?

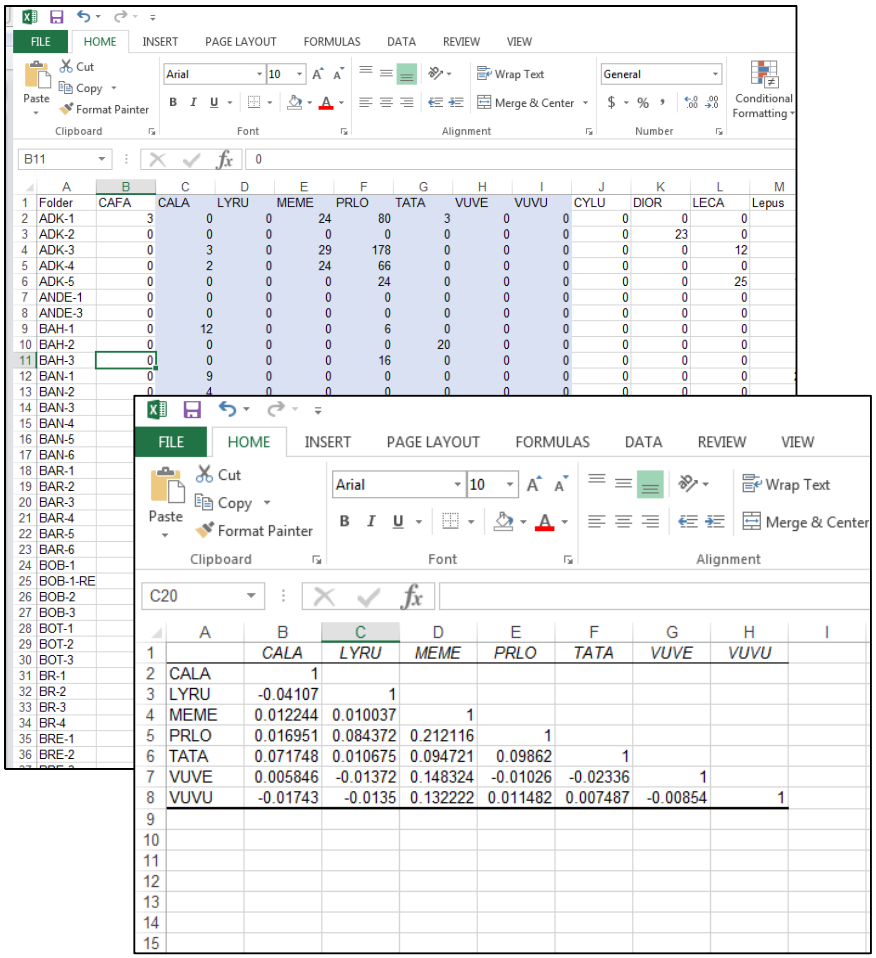


CAMERA TRAP STATION RECORD FORM

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:** ☐ 2 Lane paved	☐ Unpaved/ Gravel	☐ 2 Track trail	☐ Other:
Vegetation height (average height in 5 m circle around the camera)[c]:			☐ < 30 cm (12 in)	☐ > 30 cm (12 in)
Vegetation type or dominant cover 5 m (~16 ft) around the camera[d]:				
☐ **Grass:**	☐ **Crop:**			☐ **Sand sage**
☐ Mixed grass ☐ Shortgrass ☐ Tallgrass	☐ Alfalfa ☐ Corn	☐ Fallow (no-planted)	☐ Sorghum/milo ☐ Soybeans	☐ Sunflower ☐ Wheat ☐ **Other:**
Dominant cover ~ 0.5 mi around the camera station[e]:		☐ Crop	☐ Grass	☐ 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



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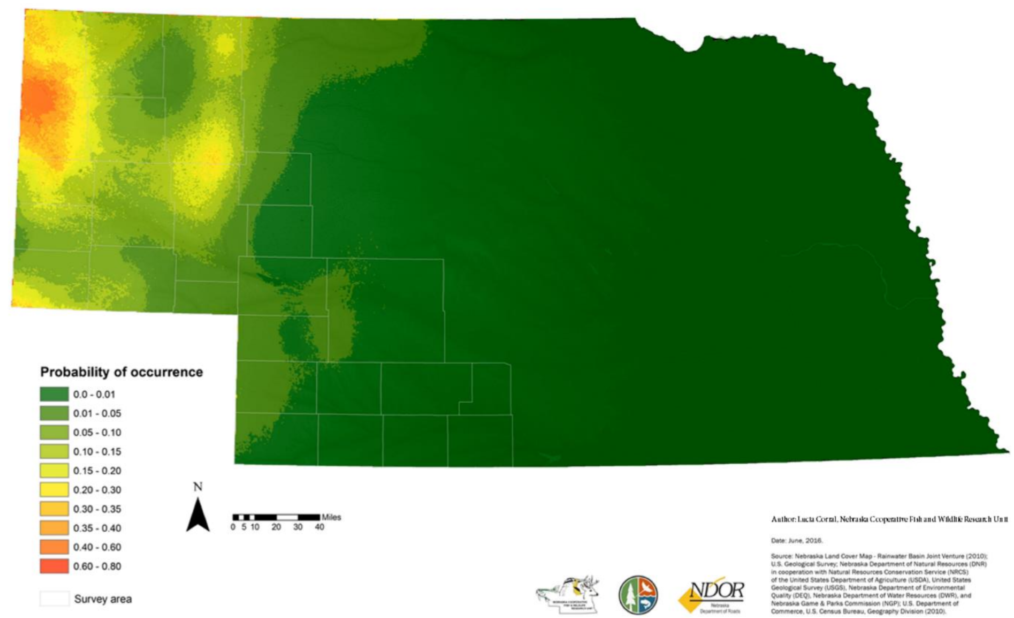
3	ADK-2	0	0	0	0	0	0	0	0	0	23	0	
4	ADK-3	0	3	0	29	178	0	0	0	0	0	12	
5	ADK-4	0	2	0	24	66	0	0	0	0	0	0	
6	ADK-5	0	0	0	0	24	0	0	0	0	0	25	
7	ANDE-1	0	0	0	0	0	0	0	0	0	0	0	
8	ANDE-3	0	0	0	0	0	0	0	0	0	0	0	
9	BAH-1	0	12	0	0	6	0	0	0	0	0	0	
10	BAH-2	0	0	0	0	0	20	0	0	0	0	0	
11	BAH-3	0	0	0	0	16	0	0	0	0	0	0	
12	BAN-1	0	9	0	0	0	0	0	0	0	0	0	

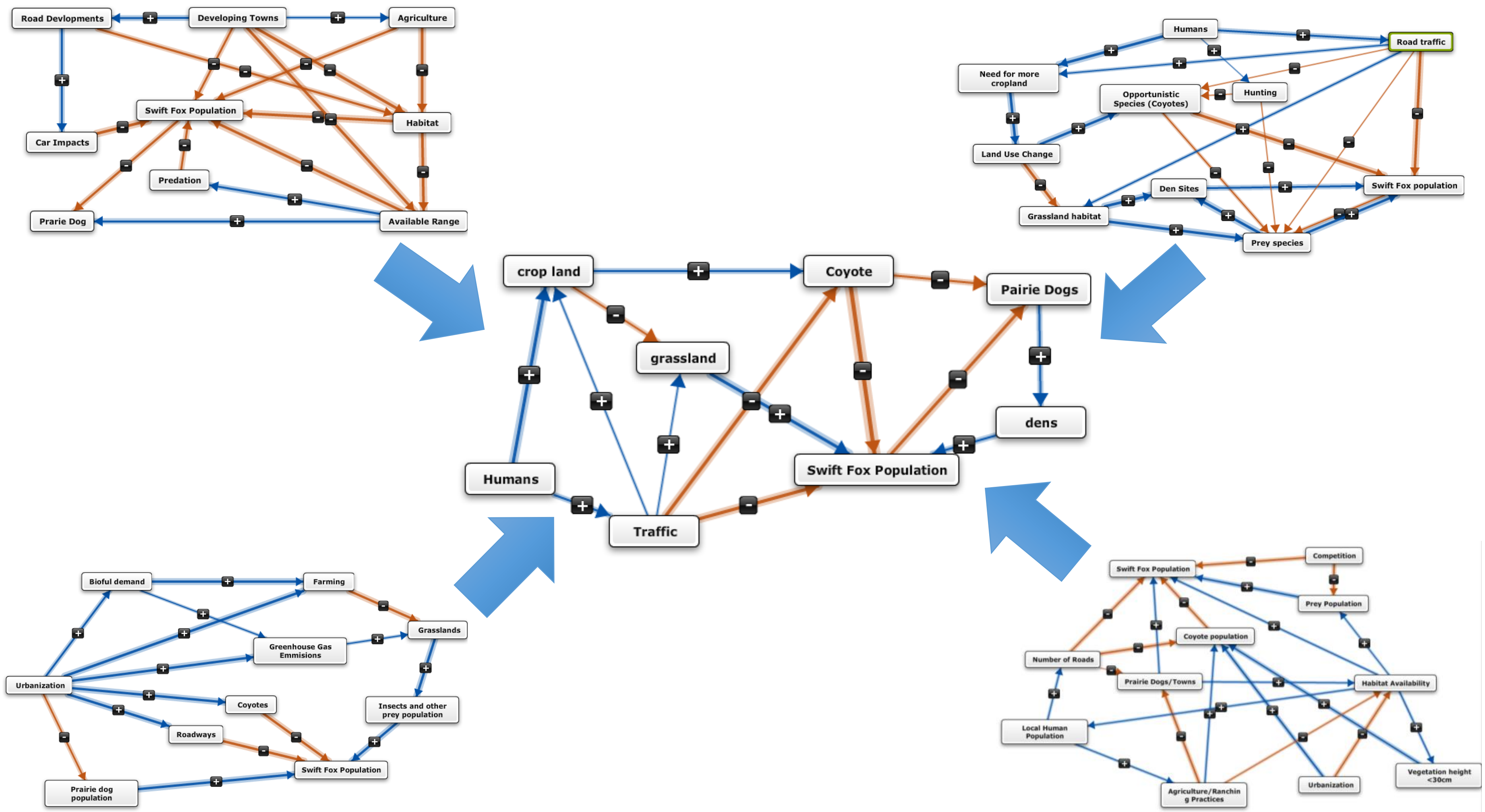
	CALA	LYRU	MEME	PRLO	TATA	VUVE	VUVU
CALA	1						
LYRU	-0.04107	1					
MEME	0.012244	0.010037	1				
PRLO	0.016951	0.084372	0.212116	1			
TATA	0.071748	0.010675	0.094721	0.09862	1		
VUVE	0.005846	-0.01372	0.148324	-0.01026	-0.02336	1	
VUVU	-0.01743	-0.0135	0.132222	0.011482	0.007487	-0.00854	1



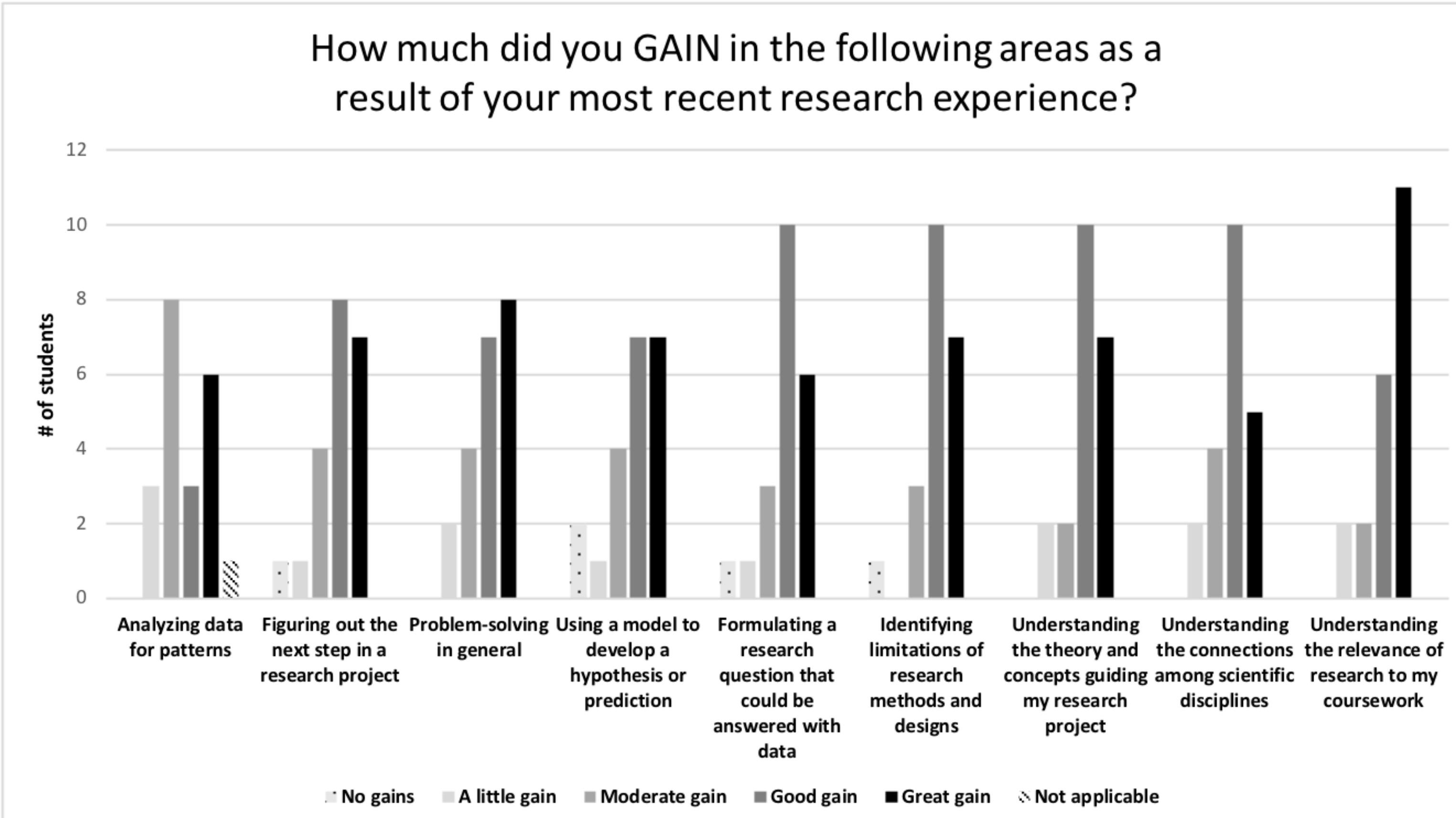
Student Data -> Swift Fox Distribution Model

Class 4

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



Student Perceptions



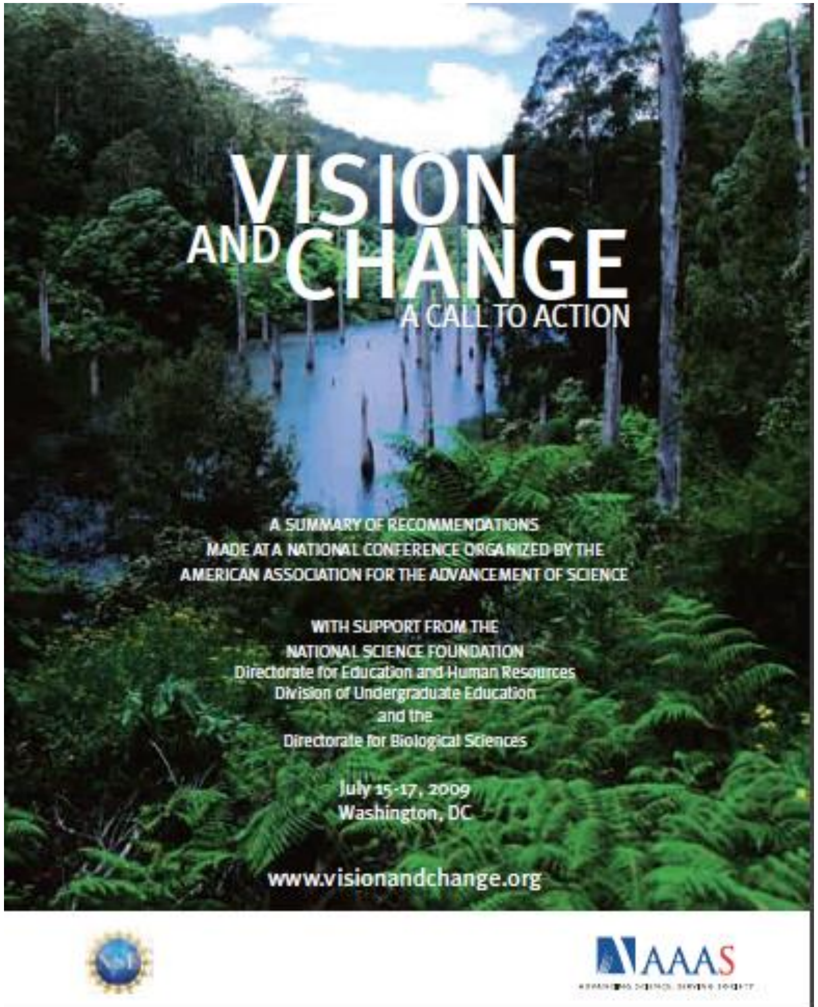
Undergraduate Research Student Self-Assessment (URSSA) (Weston and Laursen 2015)

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



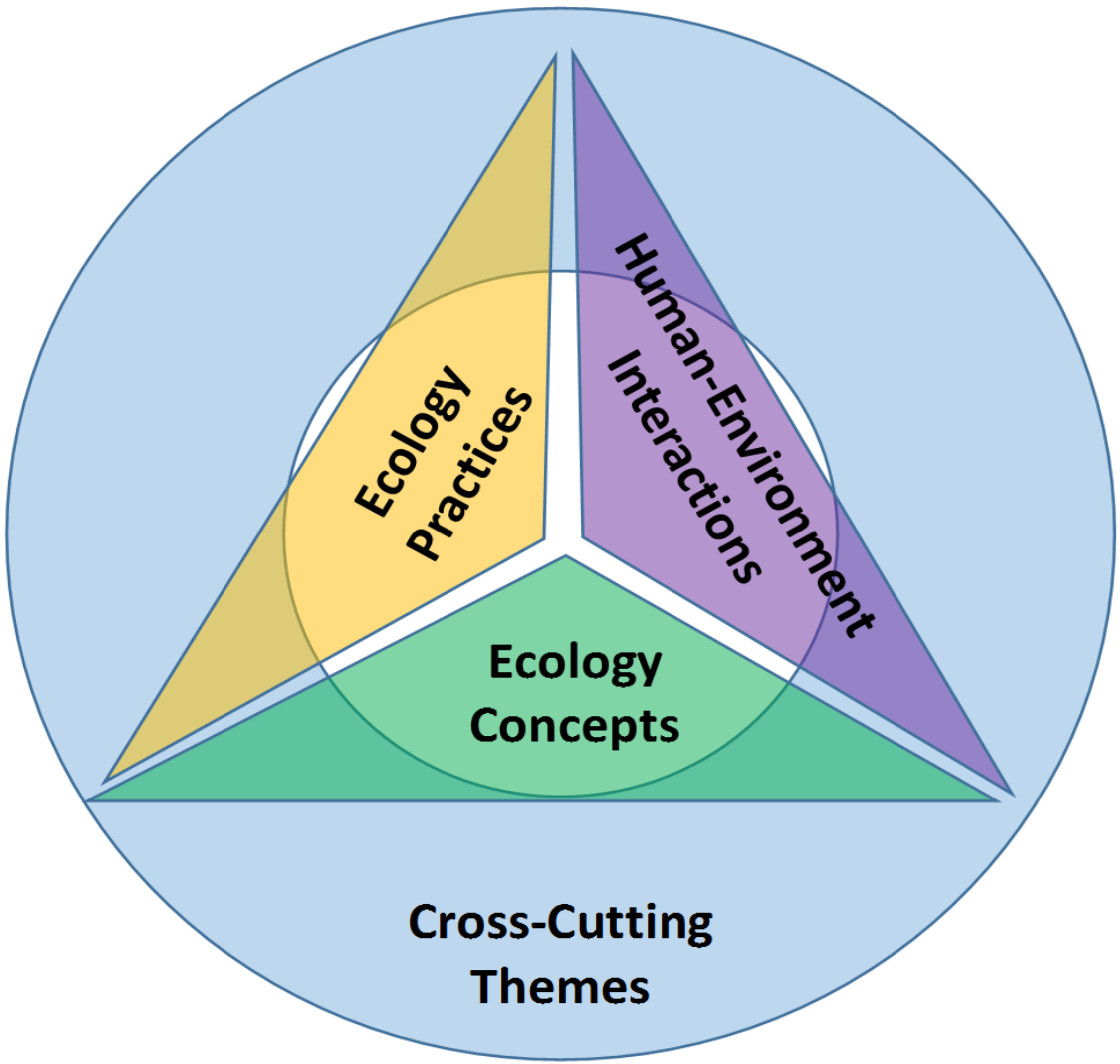
Brewer et al 2011

NEXT GENERATION SCIENCE STANDARDS

For States, By States

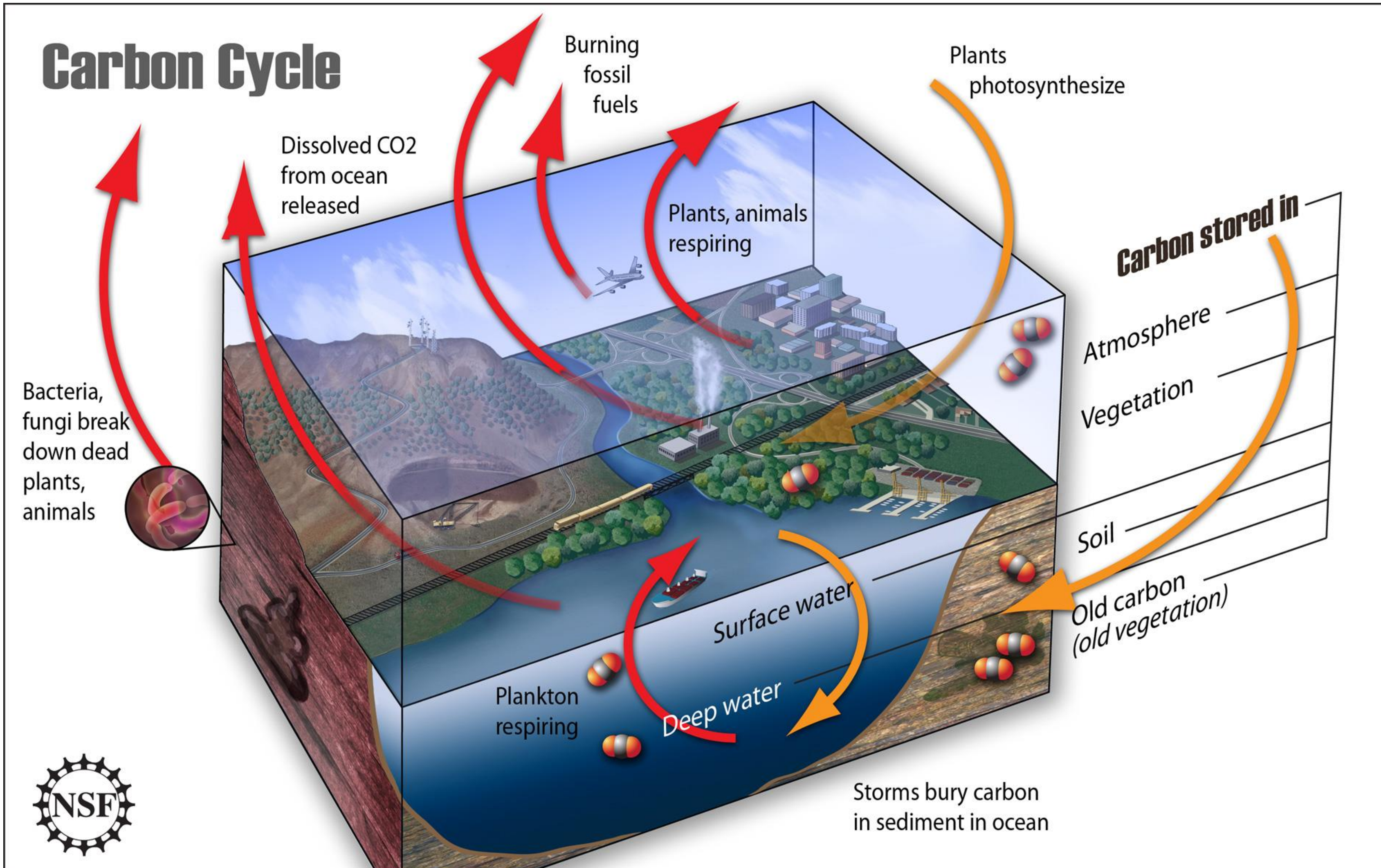
NRC, 2012

4-Dimensional Ecology Education



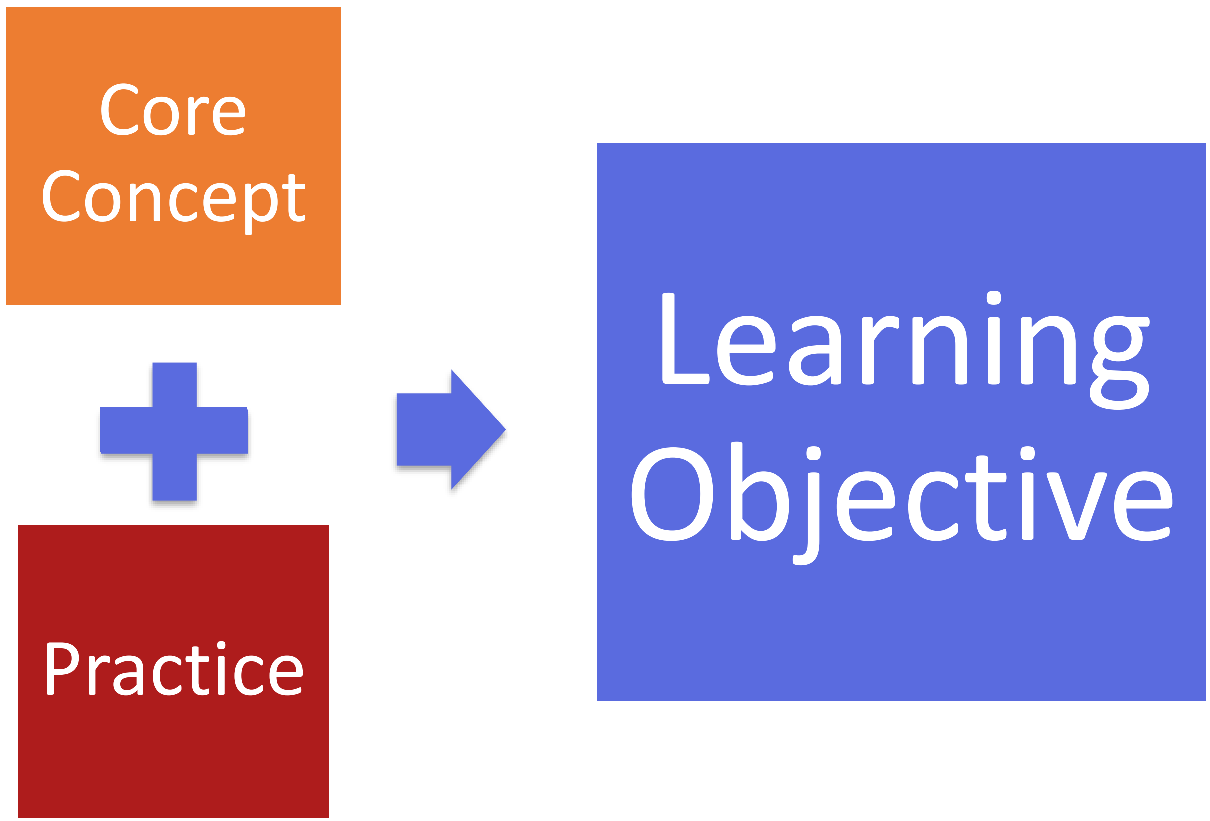
Where do we start?

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?

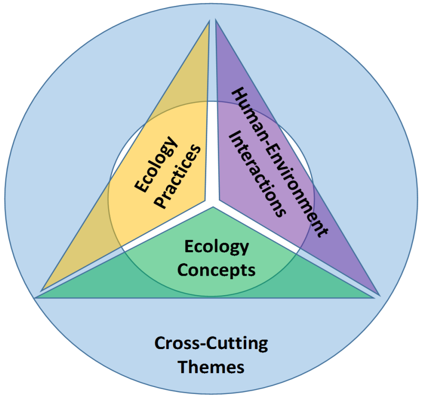
1a. Draw a species interaction model for the Arctic ocean food web described in this case. Connect names of species that interact directly with each other using lines and indicate on the lines how each species' fitness is impacted, with +/-/0 next to the species name. Be sure to include all appropriate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

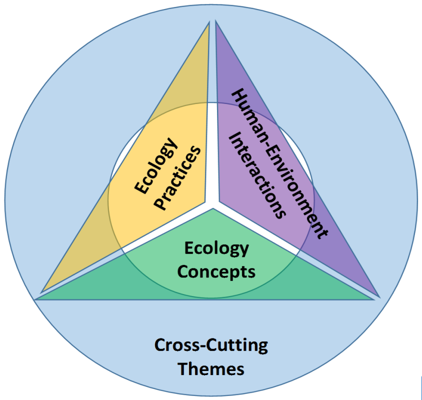
- The 3D-LAP can help us create and modify assessments.
- The 3D-LAP can help us characterize assessments for “what” is assessed.

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/

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ESA Educ. Staff & VP

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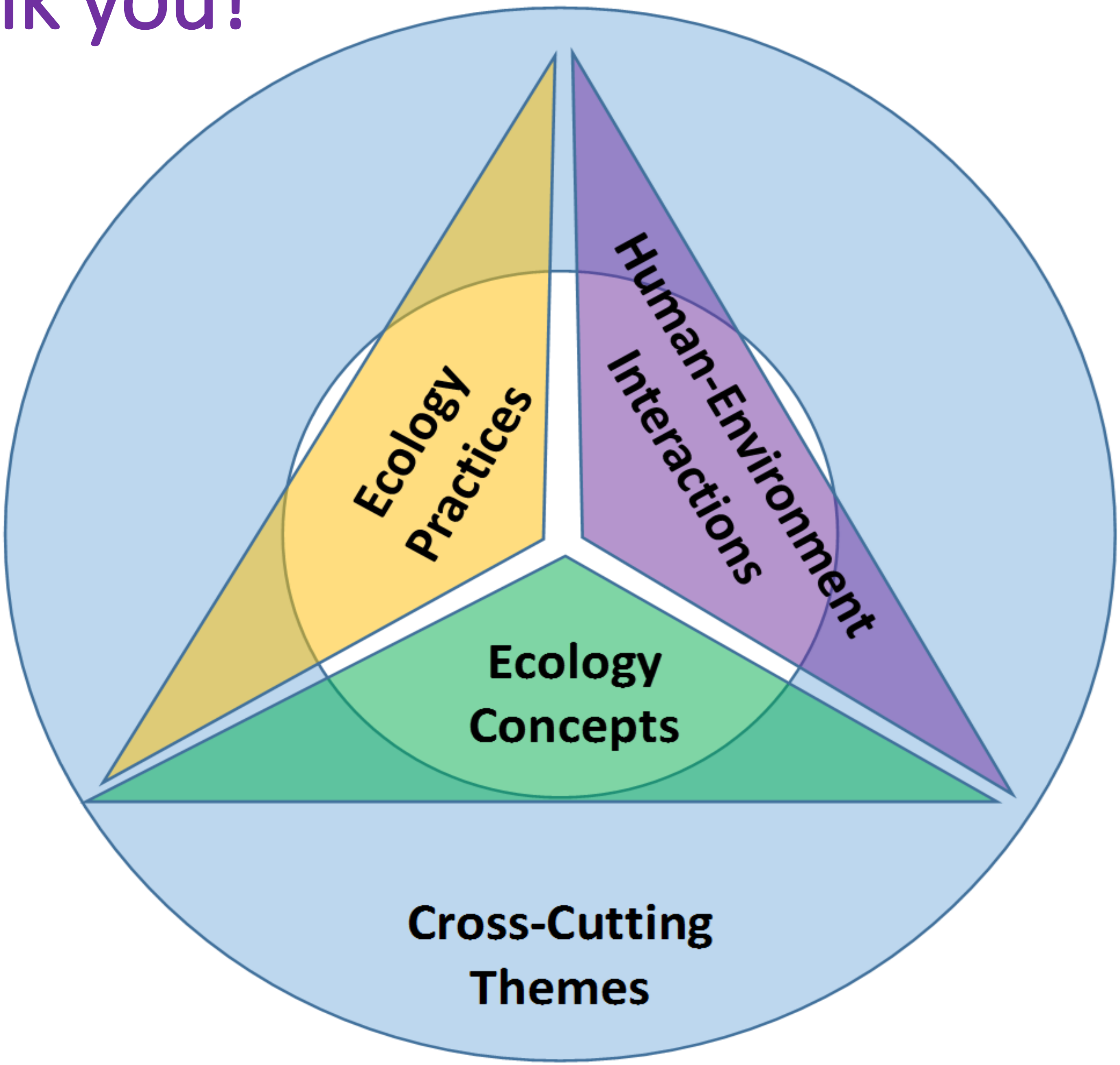
- **Pam Templer** - ptempler@bu.edu

Thank you!


Ecology Practices
Human-Environment Interactions
Ecology Concepts
Cross-Cutting Themes