Environmental Science and Biocomplexity

A case-based approach to learning about complex systems

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Biocomplexity overview

- Capstone Course for Grades 11-12
- Interdisciplinary
- Consistent with the vision and goals of NGSS

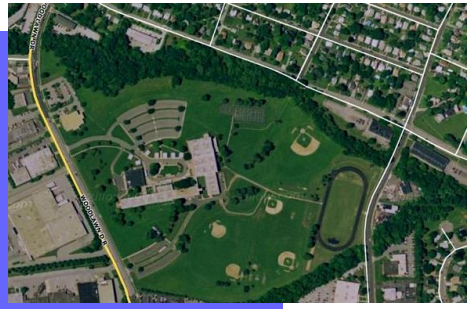
Biocomplexity R&D

- Extensively implemented and revised
- Piloted with 13 teachers
- Field-tested with 33 teachers (650+ students)
- Significant learning gains
- Available from Its About Time publishers

Case-based learning

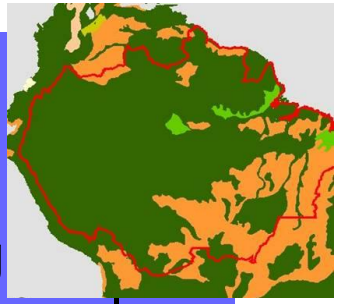
- **Real world scenarios**
- **Real data**

URBAN:
Local school decision about building a new sports field



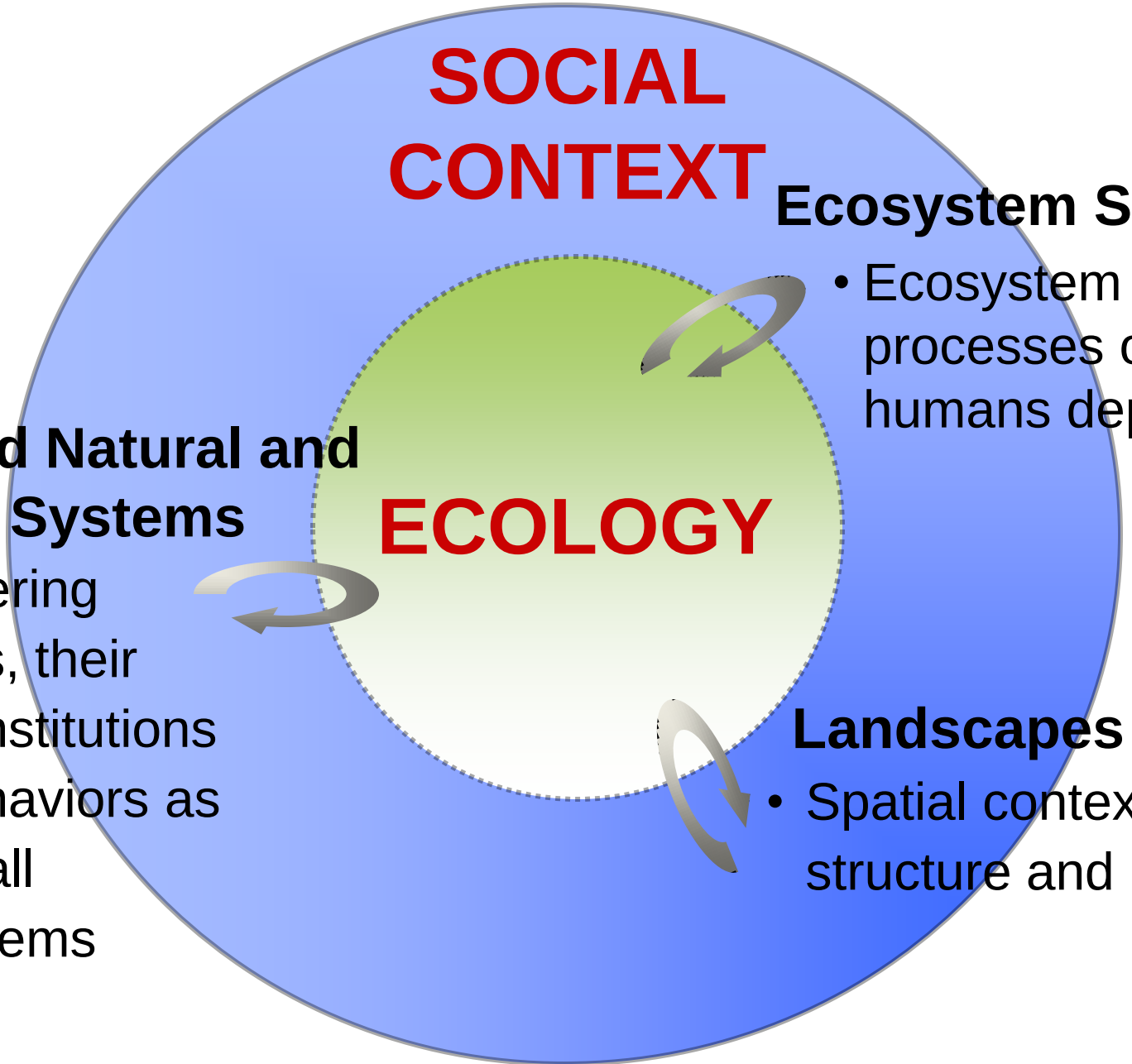
ARCTIC:
Local species conservation in light of global climate change impacts

SPRAWL:
Regional land use plan for farm land, housing development, conservation



AMAZONIA:
Biome-wide land use plan considering rights of indigenous peoples, rainforest conservation, and ranching

What is Biocomplexity?



Ecosystem Services

- Ecosystem processes on which humans depend

Coupled Natural and Human Systems

- Considering humans, their social institutions and behaviors as part of all ecosystems

Landscapes

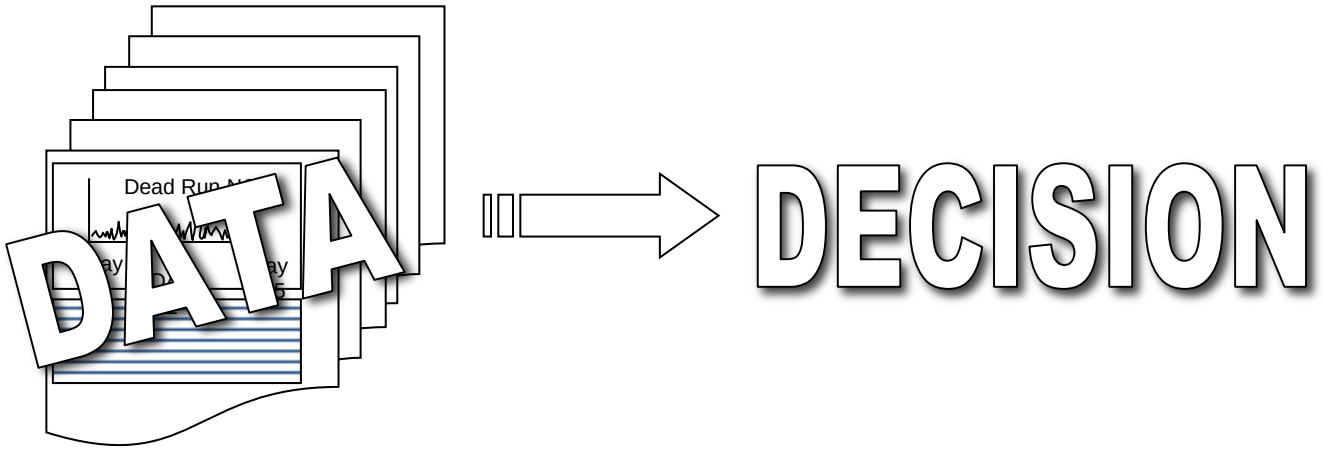
- Spatial context and its structure and patterns

Storyline

All Units are organized to address a Guiding Question.

Example: Should the school replace the streamside woodland on the school grounds with an additional athletic field?

Real world scenarios



NGSS 3 dimensions: Sprawl unit

Crosscutting Concepts

- Scale
- Systems
- Patterns

Practices

- Planning/carrying out investigations
- Analyzing/interpreting data
- Developing/using models
- Using data as evidence
- Communicating results

Core Ideas

- Cycles of energy and matter
- Ecosystem dynamics
- Biodiversity
- Ecological succession
- Climate change

NGSS 3 dimensions: Sprawl unit

Practices

- Ask questions
- Plan and conduct investigations
- Analyze data

Disciplinary core ideas

- Organization for matter and energy flow in organisms

Crosscutting Concepts

- Energy and matter

NGSS 3 dimensions: Sprawl unit

Practices

- Constructing and using models

Disciplinary core ideas

- Cycles of matter and energy flow in ecosystems

Crosscutting concepts

- Using mathematics and computational thinking
- Energy and matter

NGSS 3 dimensions: Sprawl unit

Practices

- Constructing and using models

Disciplinary core ideas

- Cycles of matter and energy flow in ecosystems
- Human impacts on Earth systems

Crosscutting concepts

- Using mathematics and computational thinking
- Energy and matter
- Scale

NGSS 3 dimensions: Sprawl unit

Practices

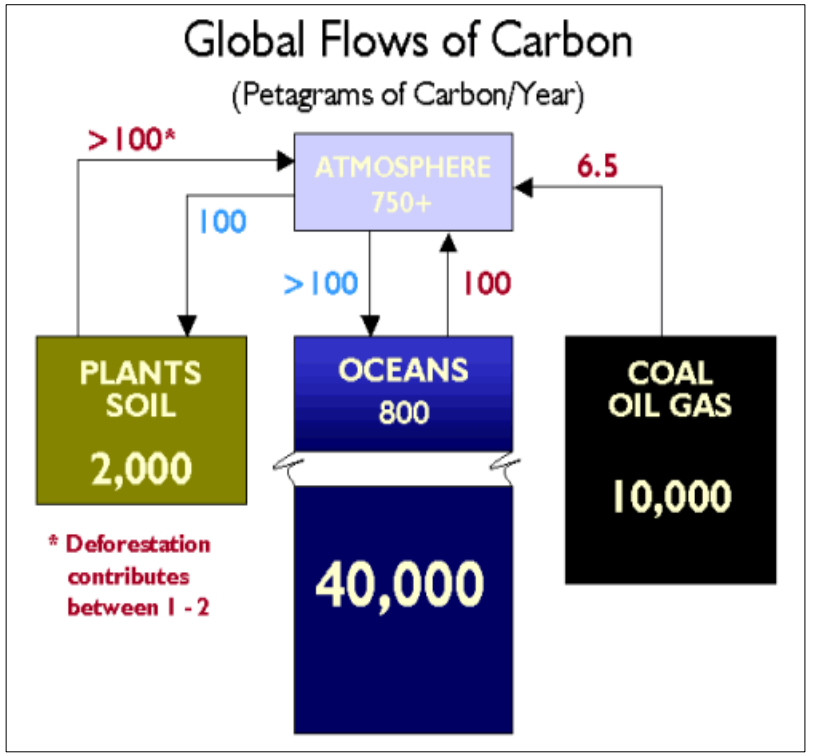
- Using models
- Analyzing/interpreting data
- Math/comp. thinking

Disciplinary core ideas

- Global climate change
- Earth and human activity

Crosscutting concepts

- Energy and matter
- Scale
- Stability and change



NGSS 3 dimensions: Urban unit

Practices

- Ask questions
- Plan and conduct investigations
- Analyze data

Disciplinary core ideas

- Cycles of matter and energy flow in organisms
- Ecosystem Dynamics, Functioning, and Resilience
- Earth and human activity

Crosscutting Concepts

- Energy and matter
- Patterns
- Systems and systems models

NGSS 3 dimensions: Urban unit

Practices

- Ask questions
- Plan and conduct investigations
- Analyze data

Disciplinary core ideas

- Cycles of matter and energy flow in organisms
- Ecosystem Dynamics, Functioning, and Resilience
- Biodiversity and humans
- Earth and human activity

Crosscutting Concepts

- Energy and matter
- Patterns

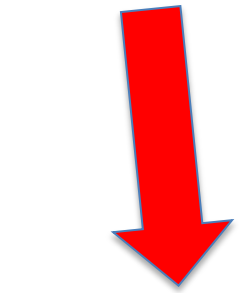
NGSS 3 dimensions: Urban unit

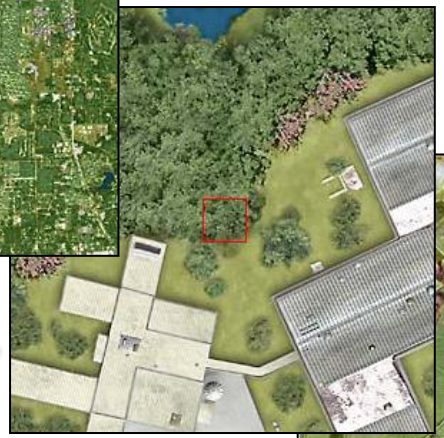
Practices

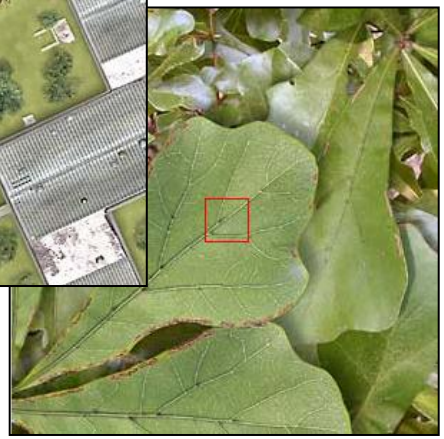
- Asking questions and defining problems
- Obtaining, evaluating and communicating information

Disciplinary core ideas

- Matter and energy flow
- Ecosystem Dynamics, Functioning
- Biodiversity and humans
- Earth and human activity







Crosscutting Concepts

- Energy and matter
- Patterns
- Scale

NGSS 3 dimensions: Arctic unit

Practices

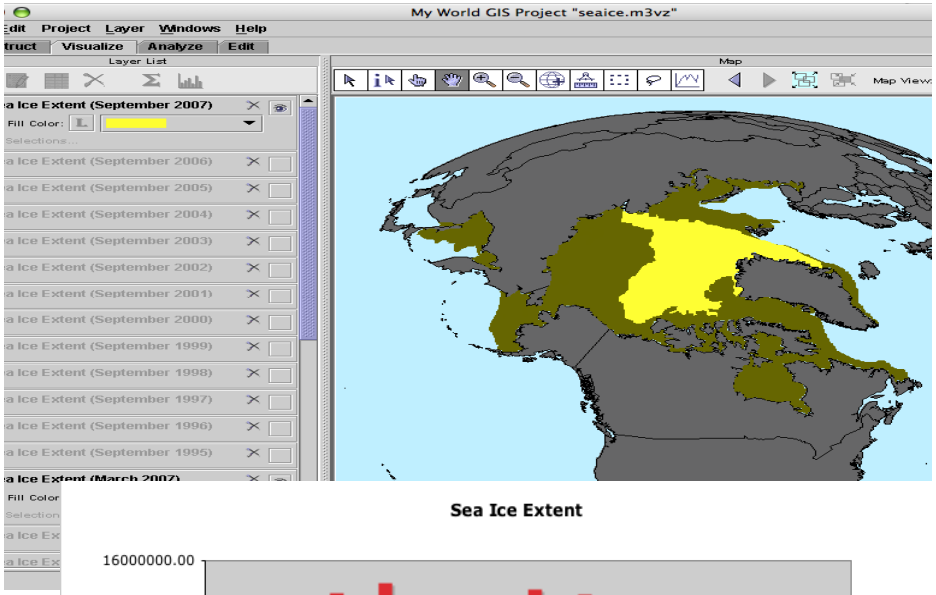
- Developing and using models
- Using mathematics and computational thinking
- Analyzing and interpreting data

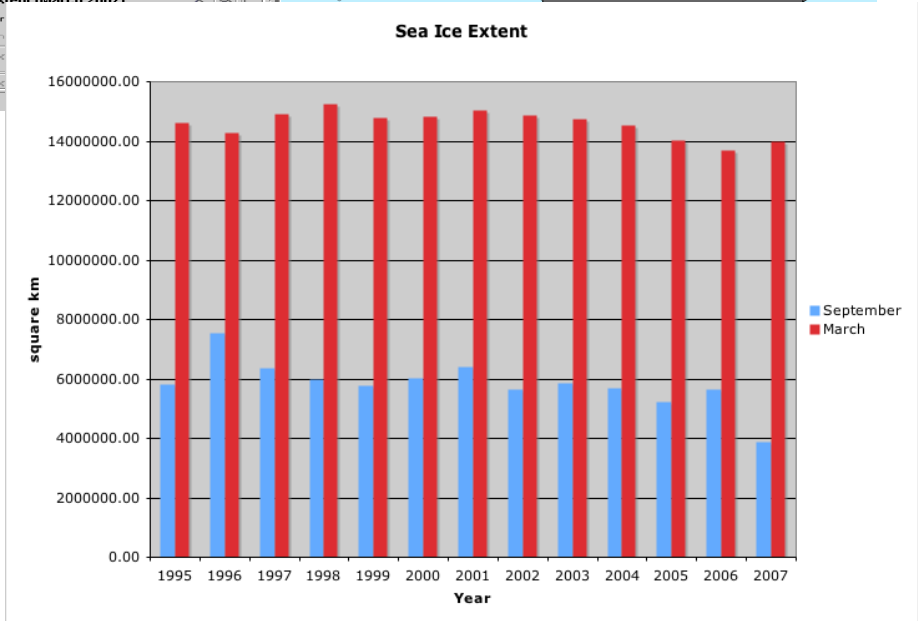
Disciplinary core ideas

- Global climate change
- Human impact on Earth systems
- Cycles of matter and energy transfer in ecosystems

Crosscutting Concepts

- Cause and effect
- Systems and system models
- Energy and matter
- Stability and change





Practices

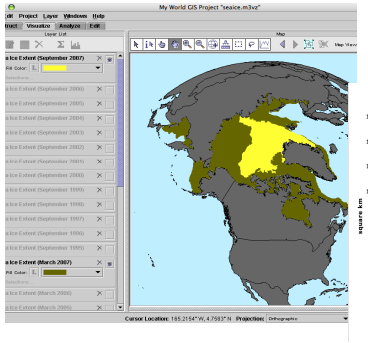
- Develop and use models
- Use mathematics and computational thinking
- Analyze and interpret data

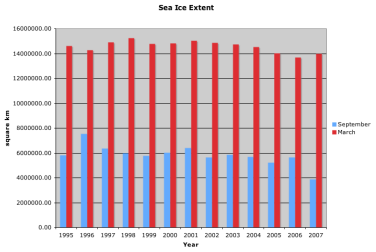
Disciplinary core ideas

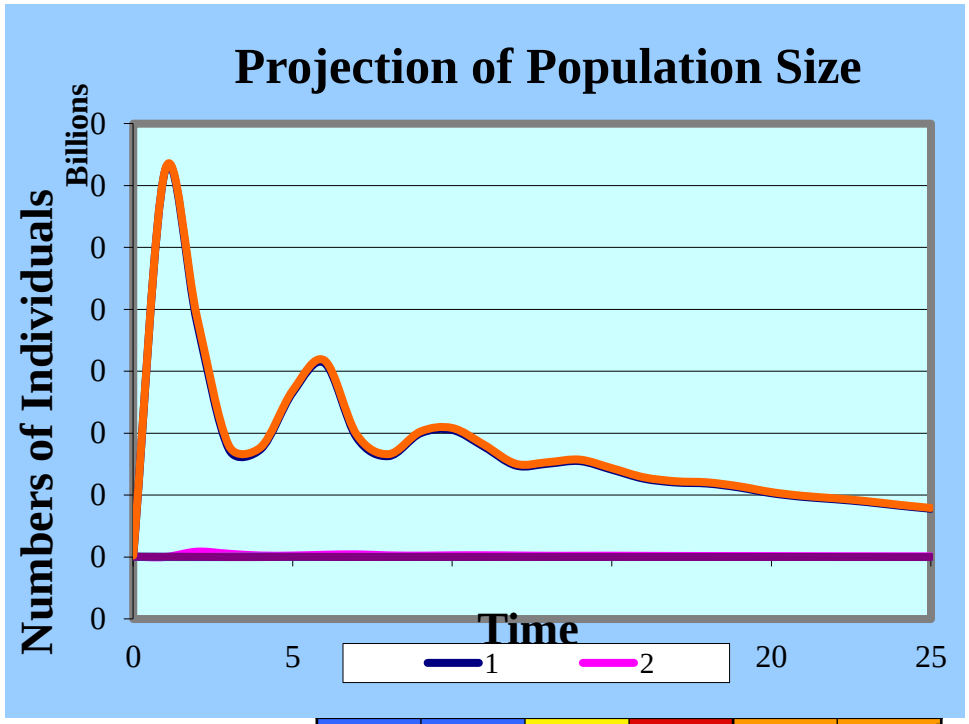
- Ecosystem Dynamics, Functioning, and Resilience

Crosscutting Concepts

- Cause and effect
- Stability and change
- Patterns







Age Class	Number Indivs	ReproOutput	GradProb	TIME	Total Population
1	10	0	0.014	0	50
2	10	0	0.058	5	5380
3	10	325	0.8	10	4170
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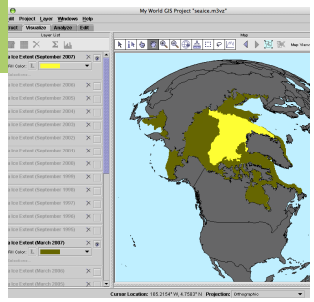
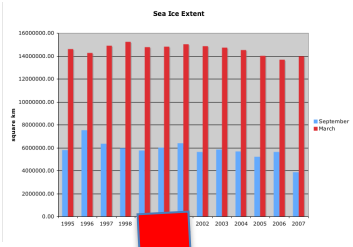
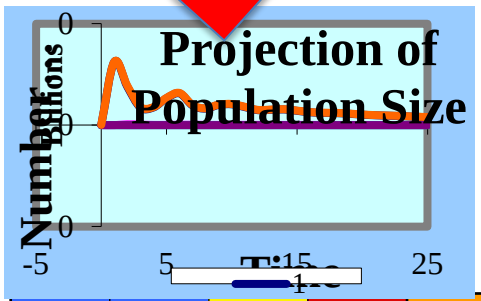
5	10	514	0	20	2098

NGSS 3 dimensions: Arctic unit







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Practices

- Developing and using models
- Using mathematics and computational thinking
- Analyzing and interpreting data

Disciplinary core ideas

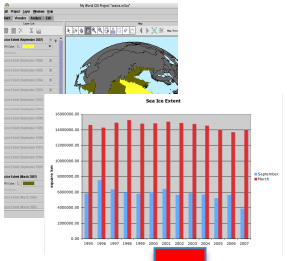
- Variation in traits
- Natural selection

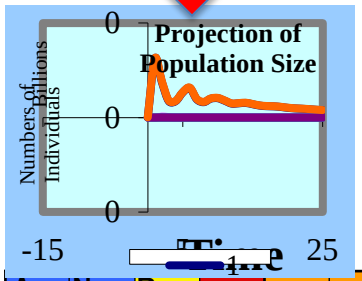
Crosscutting Concepts

- Cause and effect
- Stability and change
- Patterns

NGSS 3 dimensions: Arctic unit

Sea ice





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Population model

Practices

- Construct explanations and design solutions
- Engage in argument from evidence

Disciplinary core ideas

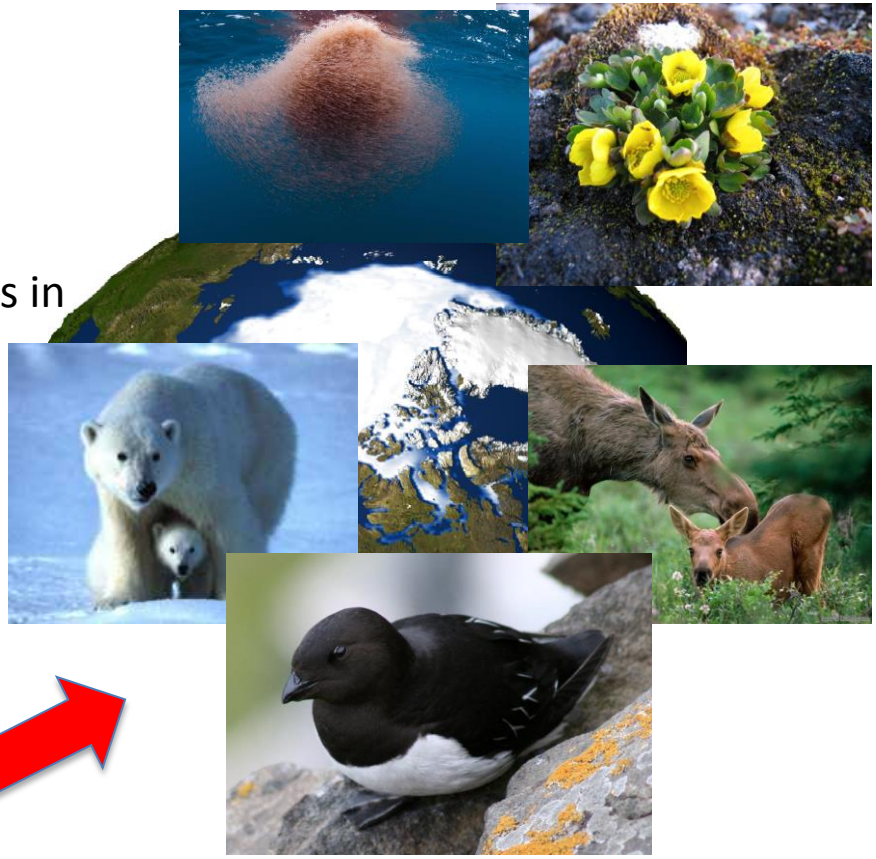
- Natural selection
- Adaptation
- Biodiversity and humans Interdependent relationships in ecosystems
- Biodiversity and Humans

Crosscutting Concepts

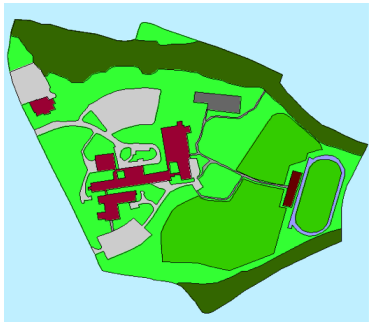
- Cause and effect
- Stability and change
- Patterns

Fast plants

Evolution



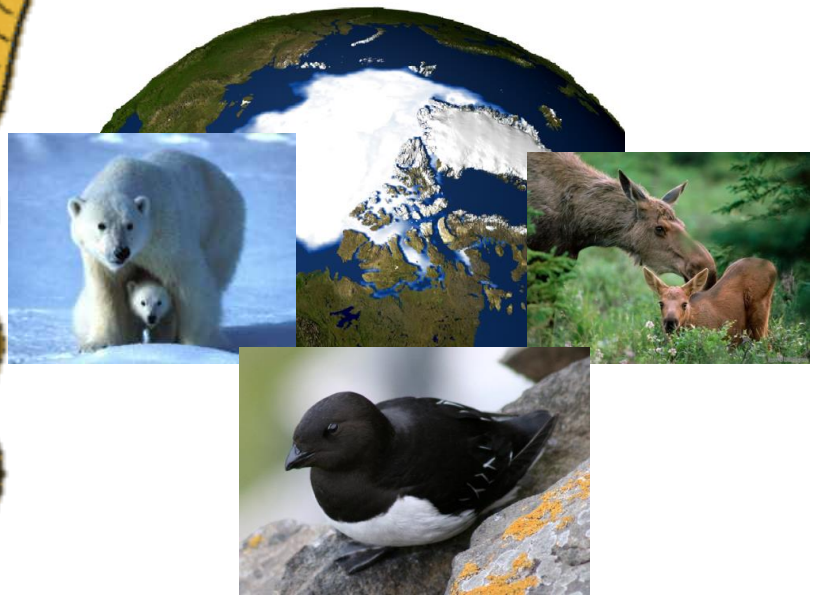
NGSS 3 dimensions: Sprawl unit



Crosscutting Concepts

Practices

Core Ideas



First steps towards alignment: Analyzing a single lesson

1. Core ideas

- *identify learning goals*
- *identify learning experiences that align with the target core ideas*
- *eliminate learning experiences that don't*

2. Questions that drive student learning

- *identify questions that frame activities in the lesson*

3. Evidence (highlighting practices)

- *identify what evidence students will need to develop explanations*
- *consider what classroom activities will allow students to collect evidence*

3. Student opportunities to make meaning

- *identify opportunities for students to communicate and explain – to share their thinking and reasoning, arguing from evidence*

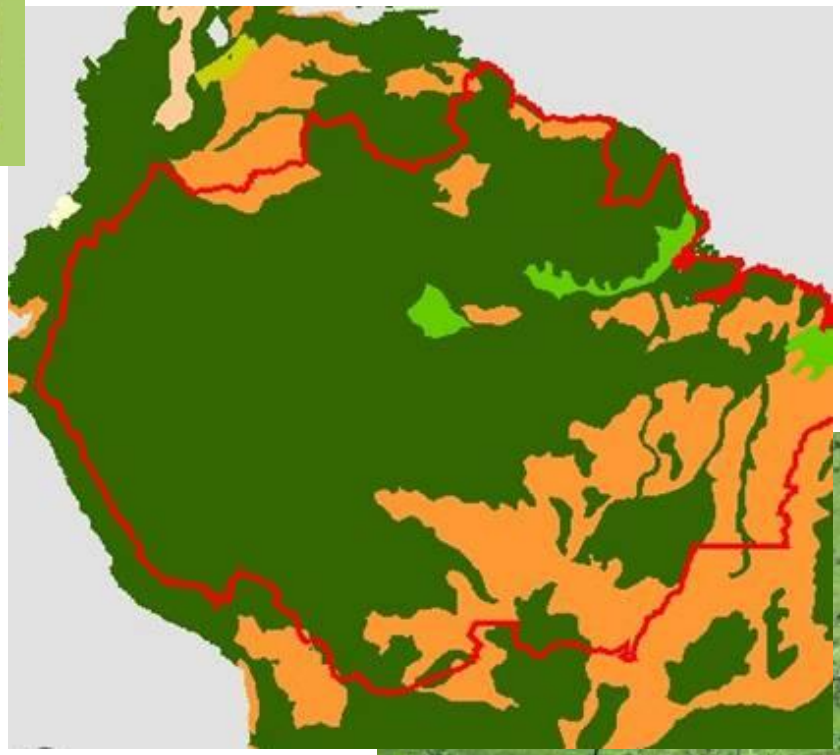
Biocomplexity curriculum

- Accompanying “educative” Teacher Guide
  - Background science information
  - Examples of student work
  - Formative and summative performance assessments
  - Additional resources online

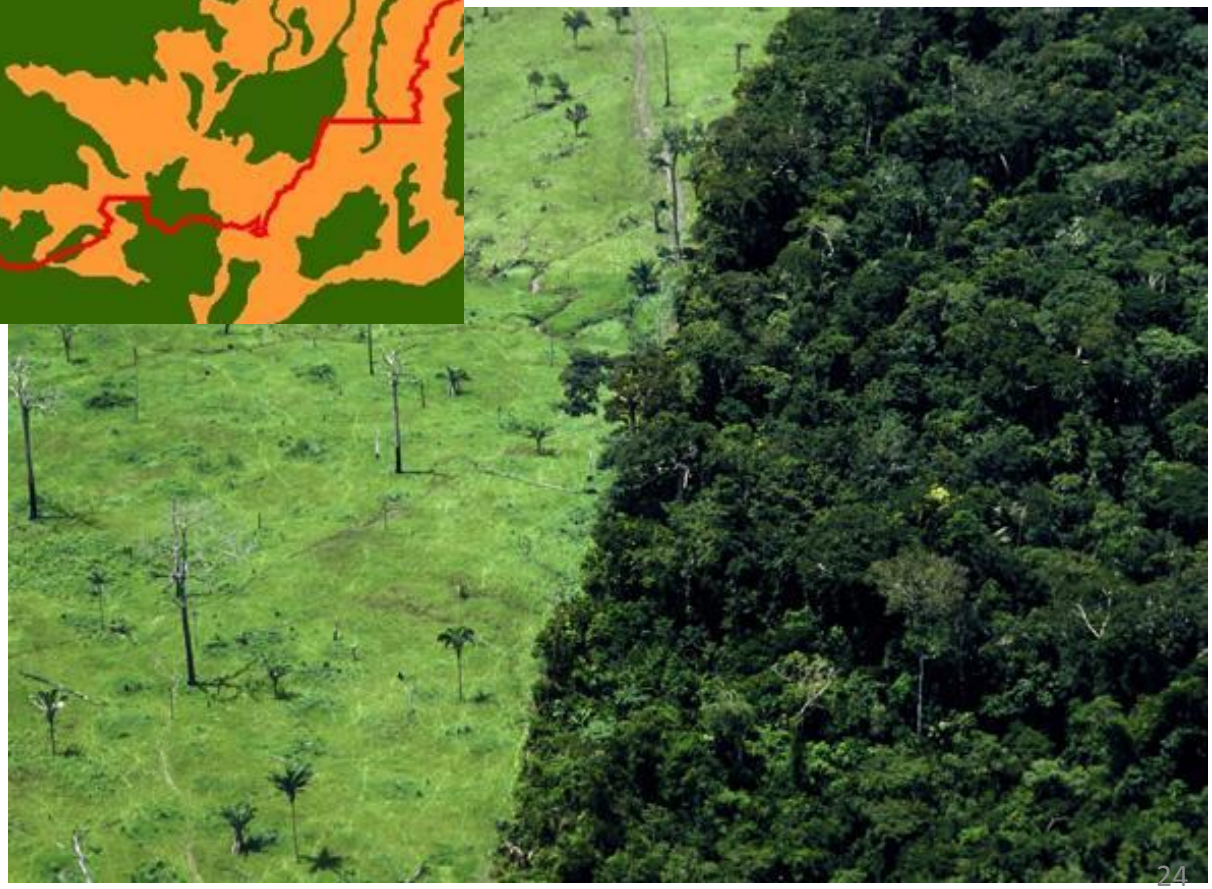
Biocomplexity Teacher Guide

- The instructional approach
  - “Flipped classroom”
  - 3 types of questions

Disciplinary Core Ideas



What are *human impacts on Earth systems* in Amazonia?



Land uses in Amazonia:

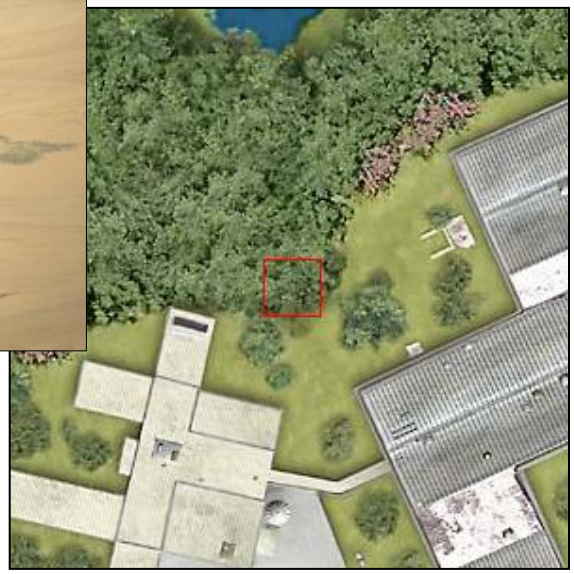
- Soy farming
- Cattle ranching
- Ecotourism
- Conservation
- Development

Cycles of energy and matter

Carbon

Energy

Nitrogen
+ Water



Disciplinary Core Ideas

Ecosystem dynamics and resilience…

Biodiversity…

…contrasting prairie and agriculture

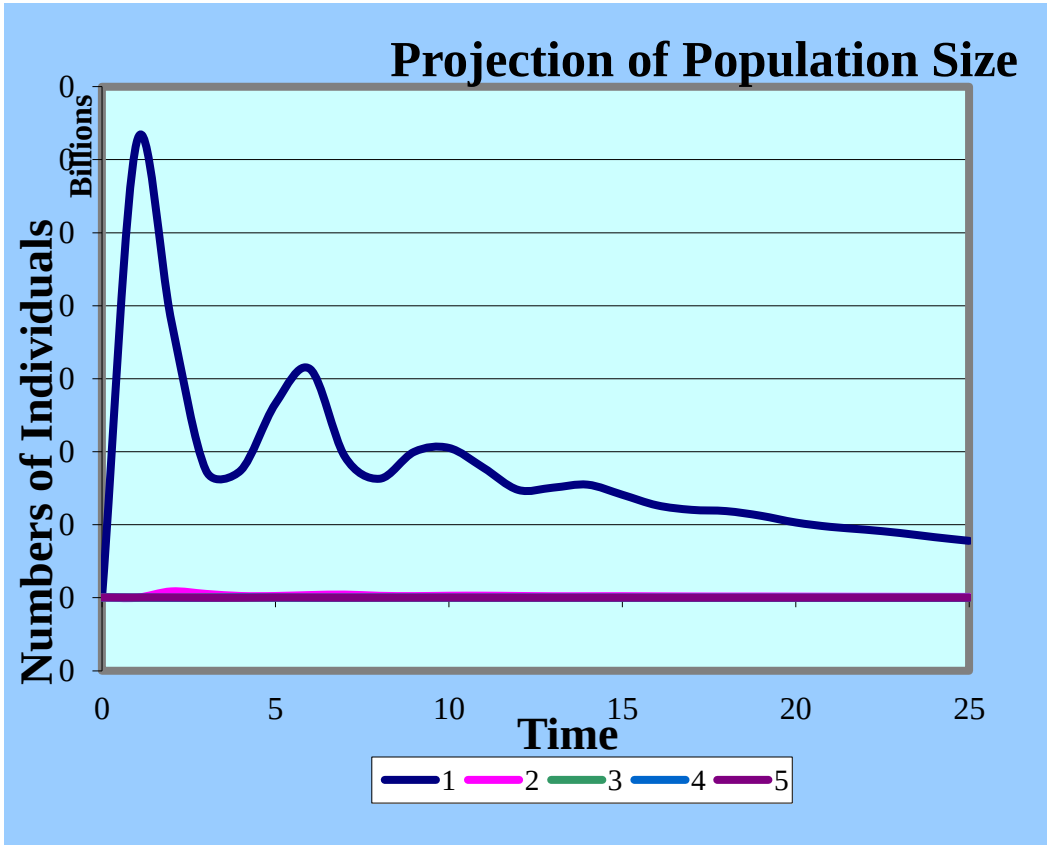
Scale - Time

15-20 year life span

1-1.5 month life span

http://www.ars.usda.gov/Main/site_main.htm?modecode=12-75-41-00
http://www.ars.usda.gov/is/graphics/photos/jun02/k5680-1.htm

NGSS 3 dimensions: Arctic unit



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http://www.nrri.umn.edu/worms/forest/ecosystems.html