

Learning Progressions: It's All About Fused Knowledge (Content + Practices + Crosscutting Concepts)

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NGSS and Fused Knowledge

“The standards are written as student performance expectations...These statements each incorporate a **practice**, a **disciplinary core idea**, and a **crosscutting concept**. The performance expectations are the assessable components of the NGSS architecture.” (Achieve draft, May 2012)

How Do We Use Learning Progressions?

- 1. Framing scientific knowledge and goals
 - e.g., Identify what knowledge is important

Last Update 2008.09.12

There are other interactions besides eating, interactions + actors make ecosystems

6th Grade

Organisms interact by eating each other

- C8. Patterns of shared characteristics reveal the evolutionary history of groups (e.g., the shared characteristics of birds and crocodiles supports the relationships of birds to reptiles and their grouping into "Reptalia").
- C7. Classification is important for communication, and it helps us make educated guesses about organisms. If we know enough about an organism to classify it, then we can predict that it will have other characteristics of the organisms in its group, even if we don't observe them directly.
- C6. Classification is hierarchical. (similar species are grouped into one genus, similar genera into one family, similar families into one order, etc.)
- C5. Organisms are grouped based on the structures they have in common. This is called classification.

4th Grade

- C4. Organisms (animals) have different features that they use to survive in different habitats. There are observable internal and external differences (some fly, some have scales, fur, wings, live in the water, etc.). Some of these differences are used to distinguish major groups.
- C3. Plants and animals differ in the types of observable structures they have and what function those structures have.
- C2. Animals and plants are both alive. (Plants and animals grow, breathe, move, reproduce, need energy, have cells.)
- C1. There are observable features of living things (grow, breathe, move, reproduce, need energy, have cells), once living things, and non-living things.

- E13. Because many animals rely on each other, a change in the number of one species can affect many different members of the web.
- E12. The network, the organisms, their relationships, and the non-living environment in which they live, is called an ecosystem.
- E11. The web of relationships has many links between plants and animals. Most animals need plants for food, sometimes shelter, sometimes water. Plants need decomposers to convert dead organisms into nutrients they need, plants sometimes need animals to help them reproduce or help transport their offspring.
- E10. Some organisms help others survive, this is called mutualism. We can add these relationships to food webs, but now it's not really just a food web any more, it's a web of different kinds of relationships.
- E8. Sometimes organisms compete with other organisms for food, or for other things they need to survive or reproduce. Plants may compete for light, water or nutrients; animals may compete for food or shelter.

E6 (repeated). You can connect the plants and animals in a habitat into a web of eating relationships, a food web.

5th Grade

- E7 Only a small fraction of the energy at each level of a food chain is transferred to the next level. Most of the food energy made by plants is not eaten by herbivores and most of the energy in herbivores is not eaten by carnivores. We can diagram this as an energy flow model, with most of the energy in the plants, a smaller amount in herbivores, and an even smaller amount in carnivores.
- E6. You can connect the plants and animals in a habitat into a web of eating relationships, a food web. Because many animals rely on each other, a change in the # of one species (especially the elimination of one species) can affect many different members of the web.
- E5. Trophic relationships between organisms can be diagrammed as a food chain, a linking of predators and prey.
- E4. An animal that eats another organism is a predator; the organism that it eats is called its prey. A parasite eats only a part of another organism and doesn't kill it. The organism (plant or animal) that a parasite feeds on is the host.
- E3. Most animals use particular kinds of organisms for food. Some general groups are herbivores, carnivores, omnivores, and decomposers.
- E2. Organisms can be divided into producers (those that make their own food) and consumers (those that use other organisms or their remains as food).
- E1. Every organism needs energy to live and gets it from food.

- B11. Human activity and other factors affect biodiversity of ecosystems (introduced species, changing habitat qualities, food web disruptions).
- B10. Biodiversity helps to buffer ecosystems against change and to provide other benefits to humans. Biodiversity can be used as a way to measure the "health" of an ecosystem.
- B9. Natural changes in ecosystems (succession, natural disturbance) affect biodiversity and species composition.
- B8. Ecosystems change naturally over time (succession) in response to changes in non-living environment (climate, geological events) and because of changes in the relationships between species present.
- B7. Biodiversity differs in different areas. It is a useful way of characterizing habitats; it tells you something about the quality of the habitat as a whole for a number of different organisms.

Ecosystems change over time, and biodiversity patterns reflect those changes

- B6. There are many different habitats.
- B5. An area has high biodiversity if it has both high richness (taxon or species diversity) and high abundance.
- B4. Biodiversity is a measure of the number and variety of different organisms in a particular area (habitat, ecosystem, or biome, so scale dependent). Biodiversity combines abundance and richness.
- B3. Richness and abundance are two different measures of the amount of animal life in a habitat or area. Abundance is the total number of each kind of animal in the habitat; richness is the number of kinds of animals in an area. (You need a classification system to be able to measure the variety of organisms)
- B2 (same as C4). Organisms (animals) have different features that they use to survive in different habitats. There are observable internal and external differences (some fly, some have scales, fur, wings, live in the water, etc.). Some of these differences are used to distinguish major groups.
- B1. A habitat is a place that provides food, water, shelter, and space for living things.

Upper Anchor

2008: Three Year Content Learning Progression in Ecology and Biodiversity

Lower Anchor

Focal Knowledge We Care About = Knowledge That Fuses **Content** + **Practices**

- **Content**: Because many animals rely on each other, a change in the number of one species can affect different members of the web.
- **Science Practice *Explanations***: Students build a complete scientific explanation consisting of a claim, two pieces of evidence and reasoning
- **Fused C+P CC**: Students construct scientific explanations to address the question, How have recent changes in the Detroit River affected yellow perch populations?

Learning Progression, Climate Change Impacts

Content Highlighted

SSa. Create representations to document how human activity in your community has positive or negative affects on climate change.

5c. Construct a representation of an explanation to address the scientific question: What does Future 1 look like for my species?

5b. Construct a justified prediction using data to address the scientific question, does Future 1 predict affects on predator-prey interactions for my focal species?

5a. Use a representation of a prediction to analyze the future impact of climate change on the Pike and on a focal species' distribution.

4d. Construct an explanation (using climate data) to address the scientific question, is there scientific evidence to show that human activities have an effect on climate?

4c. Use a video representation as evidence to justify their answer to the question, does human activity have an effect on the climate?

4b. Construct several justified predictions of how human activities influence the rate of future carbon dioxide production and temperature increases using knowledge of the carbon cycle and human activities.

4a. Use a representation (Carbon Card Game) to tell a story about human activities and their associated carbon production.

3c. Construct an explanation to address the scientific question, is there a relationship between carbon dioxide and changing climate?

3b. Create a representation to describe the greenhouse effect.

3a. Create a representation (Carbon Cycle) of the movement of Greenhouse gases through the environmental system.

2d. Construct an explanation to address the scientific question, is there a difference between weather and climate?

2c. Analyze data to identify patterns of average temperature rates over the last 100 years?

2b. Apply mathematical routines (averages) to historic and current temperatures and create representations to compare historic and current average temperatures (climate).

2a. Analyze data of species distribution and abiotic conditions (temperature and precipitation), to identify patterns in abiotic conditions that influence where a focal species lives.

1e. Construct an explanation to address the scientific question, why doesn't my focal species distribution completely overlap with the distribution of its prey?

1d. Analyze data in the form of two species distributions to compare the locations of predator-prey habitats.

1c. Use representations in the form of a food web to address the question, what does my species eat and what eats my species?

1b. Analyze data to show where a focal species lives.

1a. Collect data to show how things in the school yard serve as a species' habitat.



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Practices Highlighted



Learning Goals Highlighted by Content

3c. Construct an explanation to address the scientific question, is there a relationship between carbon dioxide and changing climate?

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3a. Create a representation (Carbon Cycle) of the movement of Greenhouse gases through the environmental system.

Abiotic

Biotic

**Fusion:
Abiotic + Biotic**

Learning Goals Highlighted by Science Practices

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**Scientific
Explanations**

Data Analysis

Data Collection

How Do We Use Learning Progressions?

- 2. Formative and summative assessment
 - e.g., Identify what knowledge to assess

Assessment Emphasizing Fused Knowledge

Beth wrote this explanation below to answer the scientific question, **Is there evidence that climate change will affect where plants and animals can live in the future?**

A. Is there anything you would change about Beth's explanation?

"Yes."

B. If you would change something, what would you write instead?

" Instead of talking about what she saw on the maps I would use real life evidence. Like the example about polar bears and ice caps."

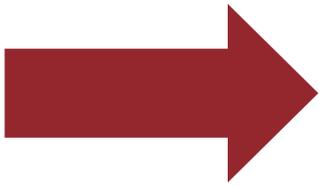
"Her reasoning and evidence isn't legit. It only states the warmth which isn't enough to say climate change will affect where plants and animals can live."

How Do We Use Learning Progressions?

- 3. Scaffolding students' practices fused to core science content
 - e.g., Provide guidance on how to guide learning through “the messy middle” towards upper anchor

LP Section: Impact of Climate Change on Species

5c. Construct a representation of an explanation to address the scientific question, "what does Future 1 look like for my species?"



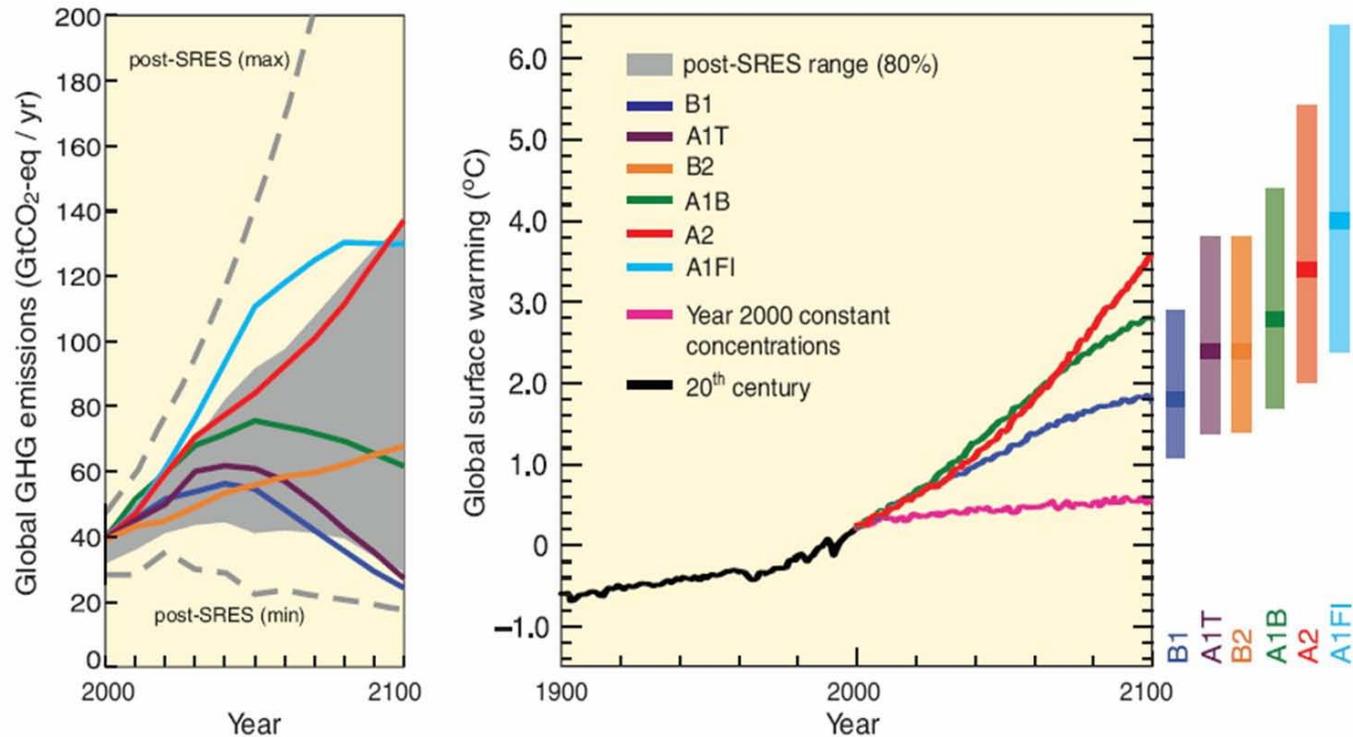
5b. Construct a justified prediction using data to address the scientific question, "does Future 1 predict effects on predator-prey interactions for my focal species?"

5a. Use a representation of a prediction to analyze the future impact of climate change on the northern pike (the fish species) and on a focal species' distribution.

Future Scenarios from (IPCC) = COMPLEX

Future **climate change** depends on future greenhouse gas emissions
Future **greenhouse gas emissions** depend on socio-economic choices

Scenarios for GHG emissions from 2000 to 2100 (in the absence of additional climate policies)
and projections of surface temperatures



Prediction-Making using Models of Simplified Climate Change Scenarios for Middle/High Schoolers

Future **climate change** depends on future greenhouse gas emissions
Future **greenhouse gas emissions** depend on socio-economic choices

Population growth rate



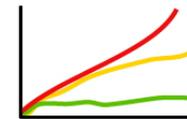
Energy use per person



Proportion clean energy



Total CO₂ emissions by 2100 (gigatons)



Future 1

Fast

Low

Low

1862

Future 2

Slow

High

High

1499

Future 3

Slow

Low

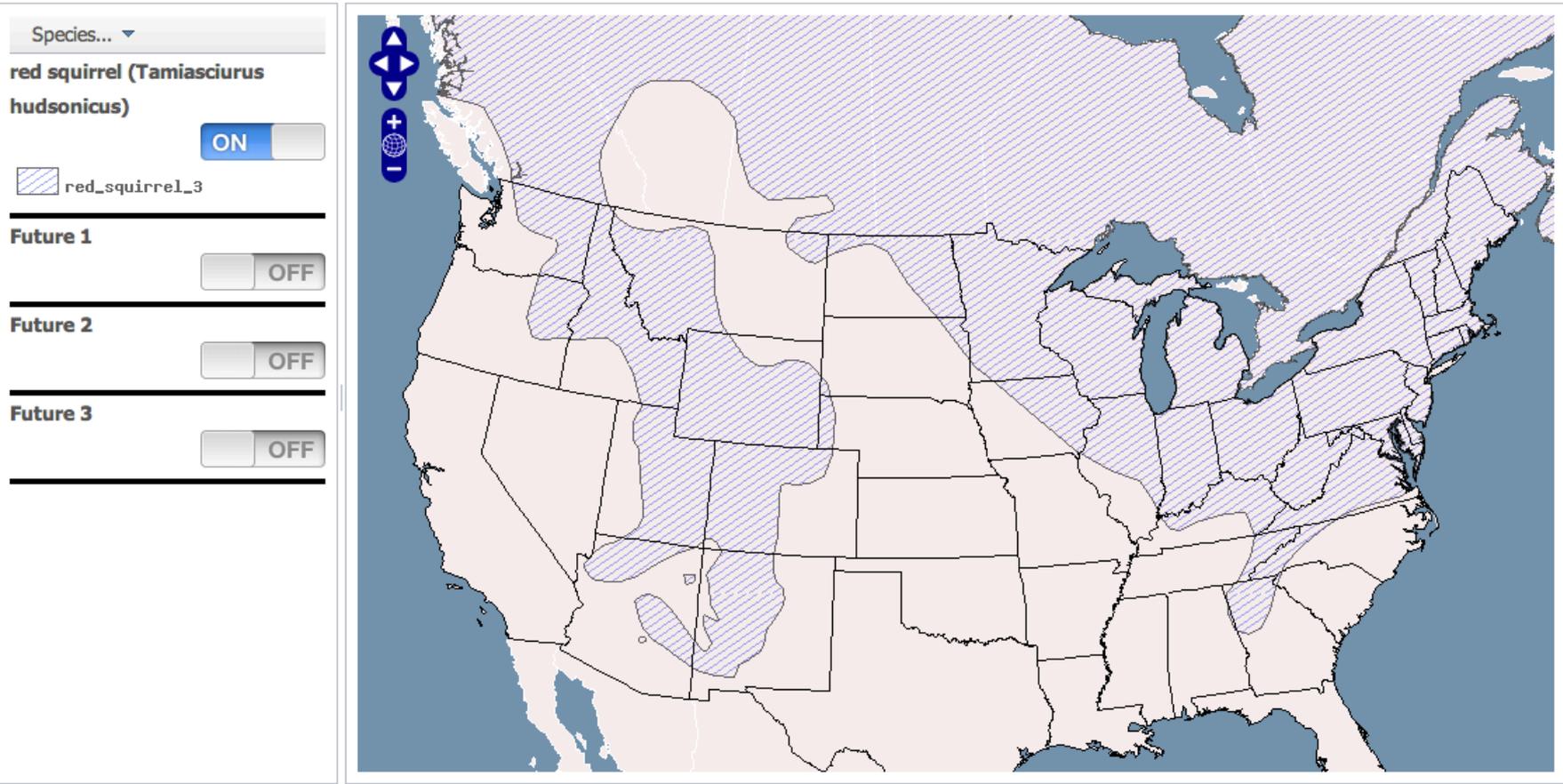
High

983

Simplified Modeled Predictions

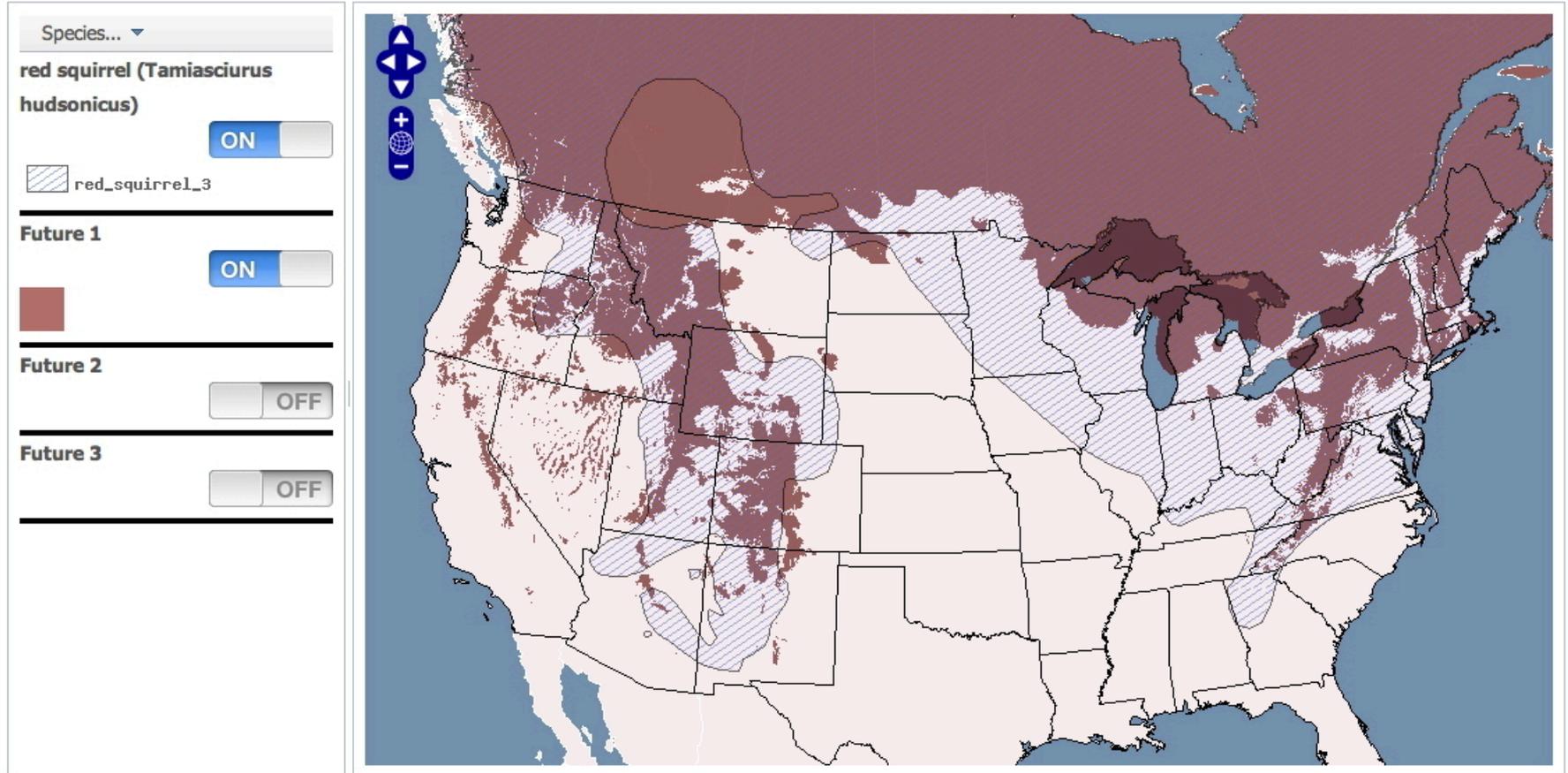
Is there evidence that climate change will impact the distribution of my species, Red Squirrel?

Focal Species Current and Future Distributions



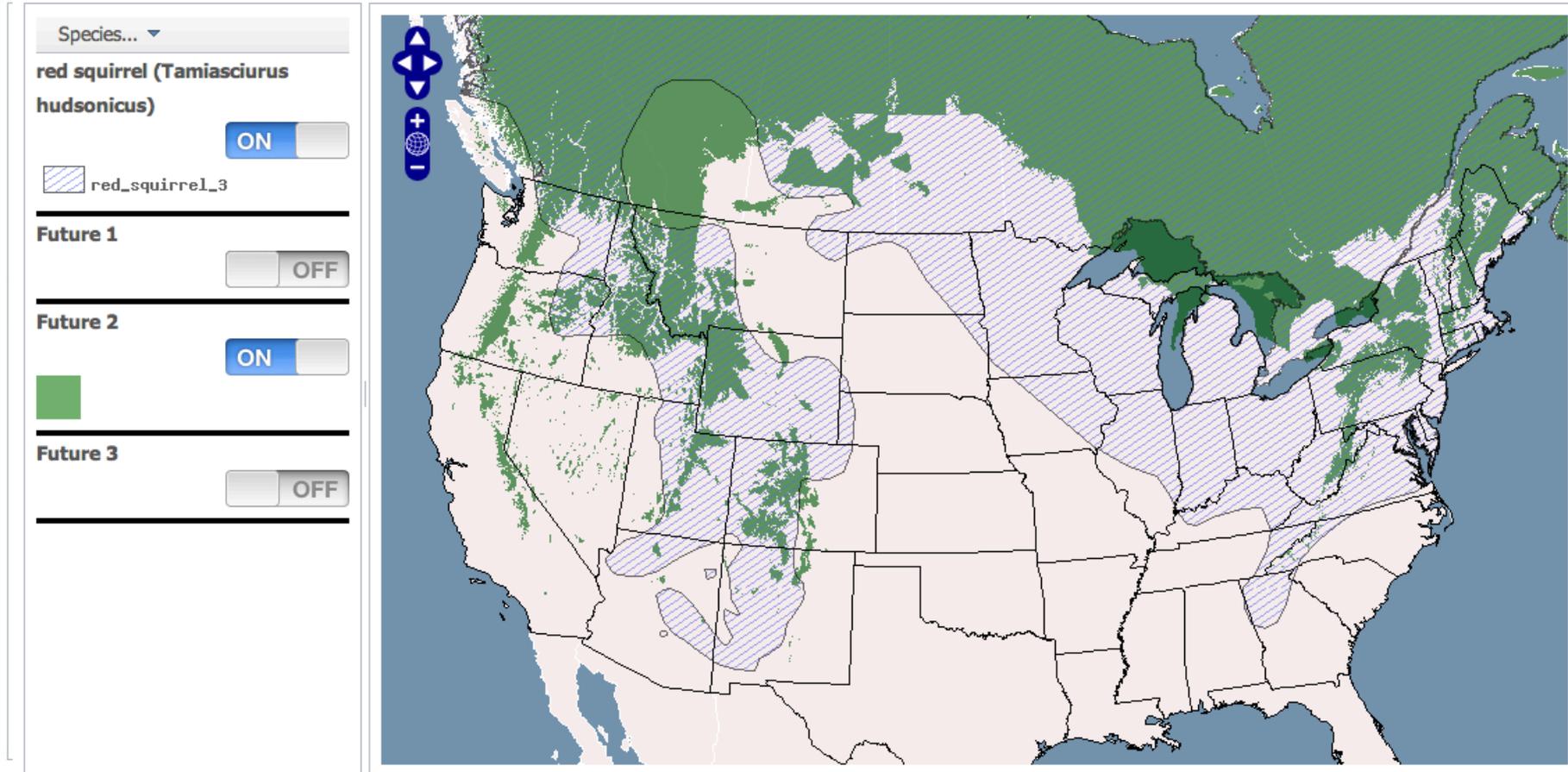
Red Squirrel: Future 1

Focal Species Current and Future Distributions



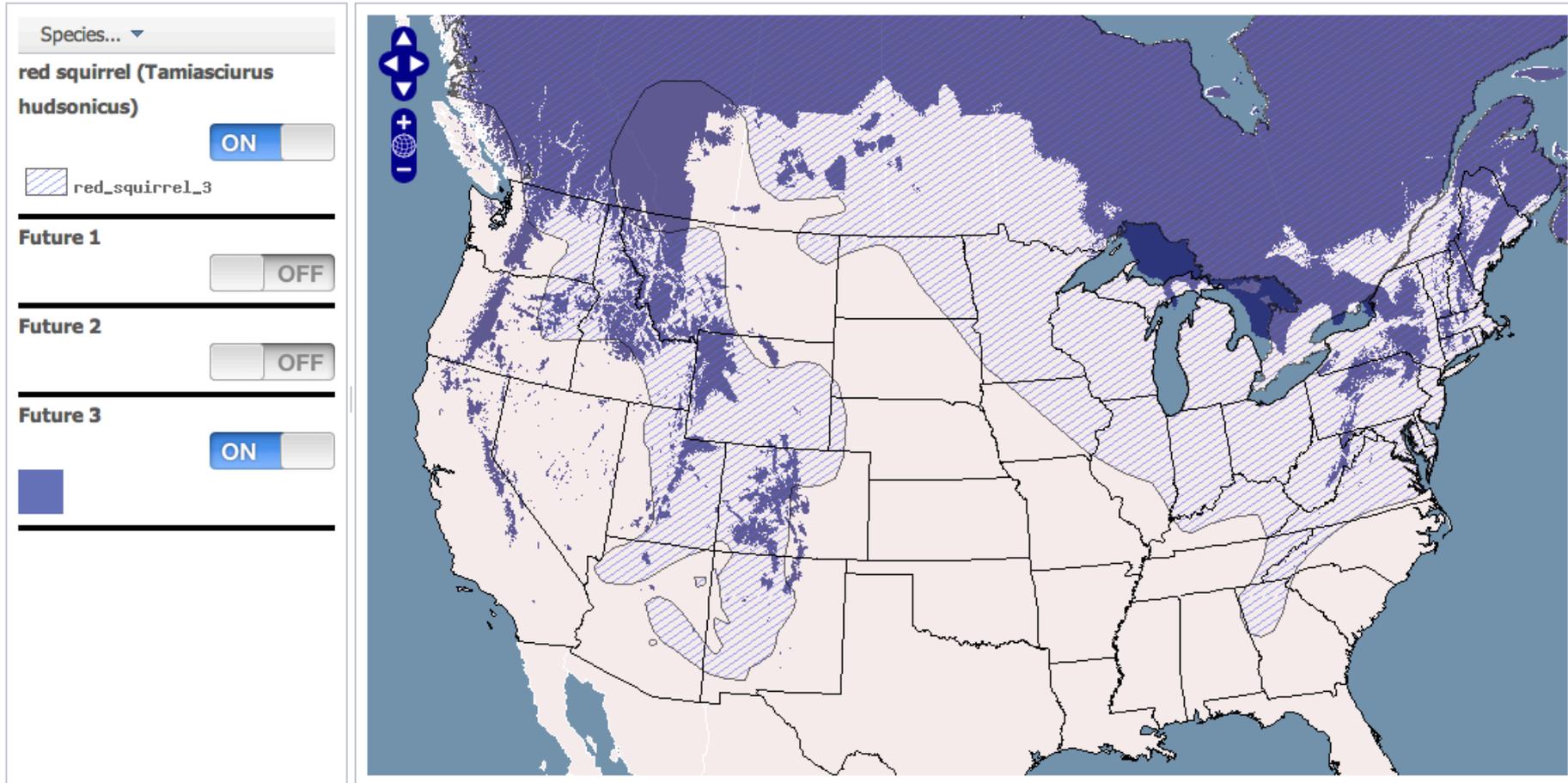
Red Squirrel: Future 2

Focal Species Current and Future Distributions



Red Squirrel: Future 3

Focal Species Current and Future Distributions



Guided Reflection in **Constructing Explanations** to address question, Is there evidence that climate change will impact the distribution of my focal species?

My Scientific Explanation

My claim is:

Science practice scaffold

Hint A claim is your answer to the question. It is a statement that describes how particular evidence supports a scientific claim. For example, you can use scientific definitions, scientific concepts or ideas to explain why you choose the evidence you did. **x** Are they going to go up, down, or stay the same?

My reasoning is:

Science content scaffold

Hint What is the difference between weather and climate?

Evidence Evidence are observations, data, or information that helps you answer the scientific question. **x**

Hint What kind of evidence is used to describe climate?

Cancel Save

Conclusions

- Largest gap in current research on learning progressions is in the area of assessment design and assessment evaluation
- Second priority: Discussions about use of LPs and representing the knowledge we (and NGSS) care about :
- Fused **content** + **practices** + **crosscutting concepts**