

# **Assessing Science Knowledge that Inextricably Links Core Disciplinary Ideas and Practices**

Nancy Butler Songer

Professor of Science Education and Learning Technologies

Director, *Center for Essential Science*

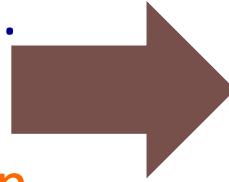
The University of Michigan

# Example of Tri-Dimensional Fused (Inextricably Linked ) Knowledge

## Core Disciplinary /Crosscutting

Because many animals rely on each other, a change in the number of one species can affect different members of the web.

**Practice** Students build a complete scientific explanation consisting of a claim, two pieces of evidence and reasoning



## Fused Knowledge

Students construct scientific explanations to address the question, How have recent changes in the Detroit River affected yellow perch populations?

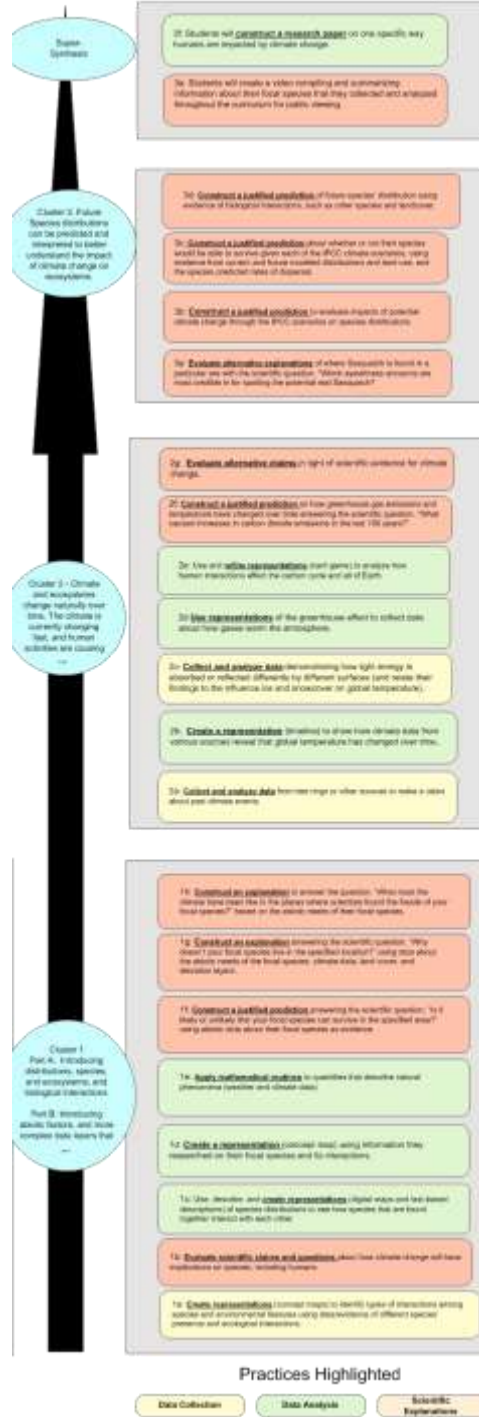
# Two Samples of Fused Knowledge from a Learning Progression Focused on Climate Change

Students *construct a scientific explanation* based on evidence about how greenhouse gas emissions and temperature have changed over time.



Students *construct a explanation* to address the question, Is there evidence that climate change will impact the distribution of the Red Squirrel?

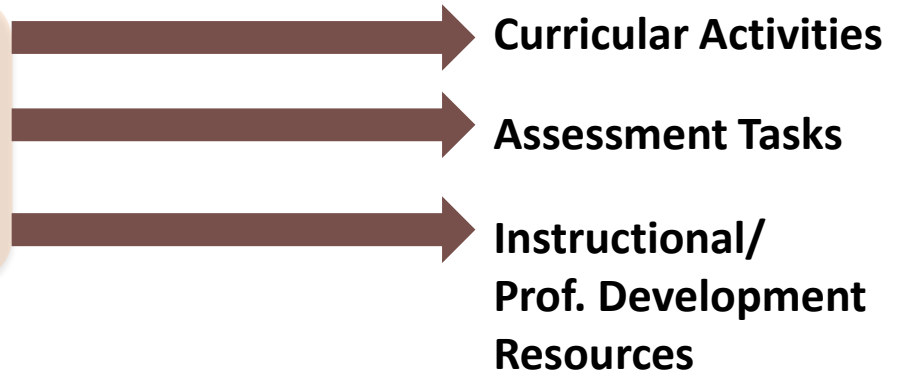
# Tri-Dimensional Fused Knowledge Learning Progression



# Fused Knowledge Learning Goals are the Template for Curricular Units, Assessment, and Instruction

## Fused Knowledge 3b. From Learning Progression

3b. Students *construct a explanation* to address the question, Is there evidence that climate change will impact the distribution of the Red Squirrel?



# How Do We Design Assessment Tasks Focused on Fused Knowledge ?

Students *construct a explanation* to address the question, Is there evidence that climate change will impact the distribution of the Red Squirrel?



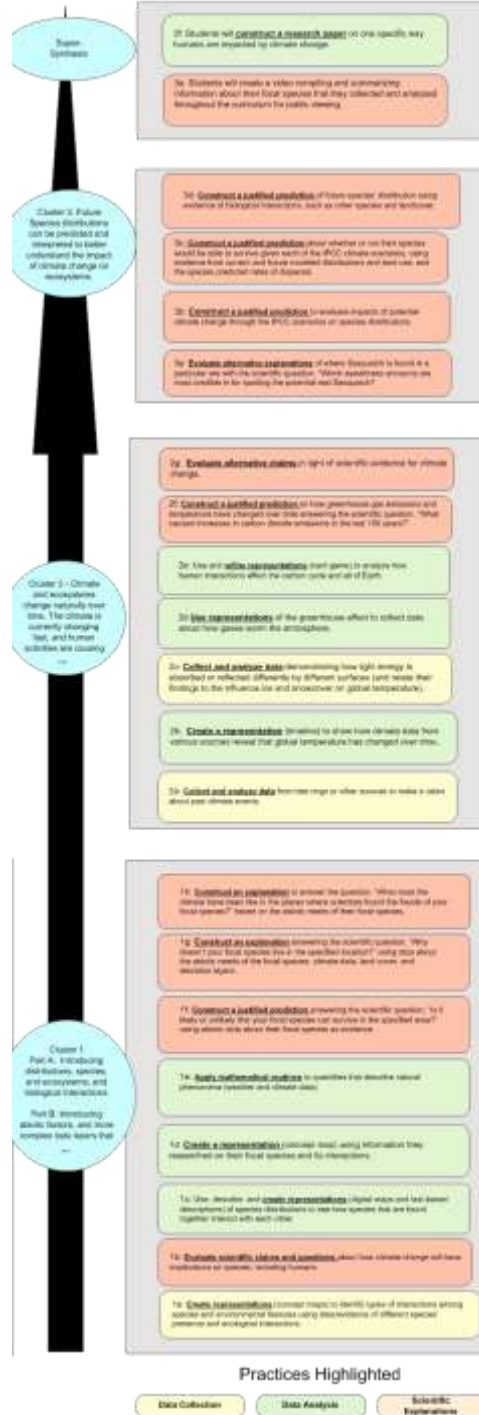
**Assessment  
Task**

## Summative Assessment >

## Embedded Assessment >

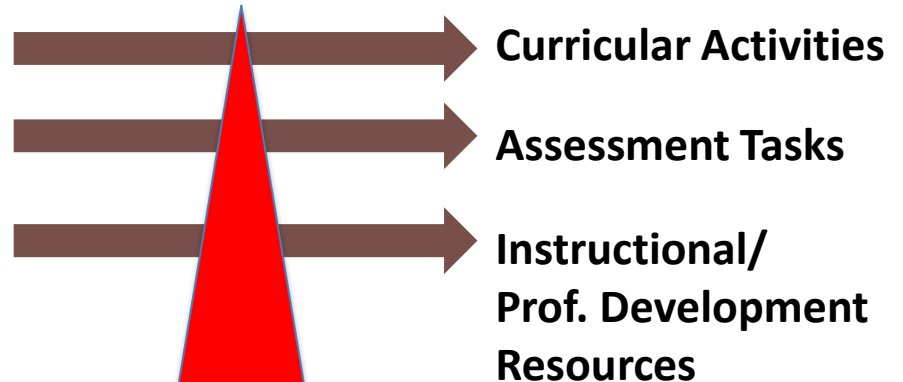
## Embedded Assessment >

## Embedded Assessment >



# Step One: Cognitive Analysis and Strategic Simplification

Students *construct a explanation* to address the question, Is there evidence that climate change will impact the distribution of the Red Squirrel?

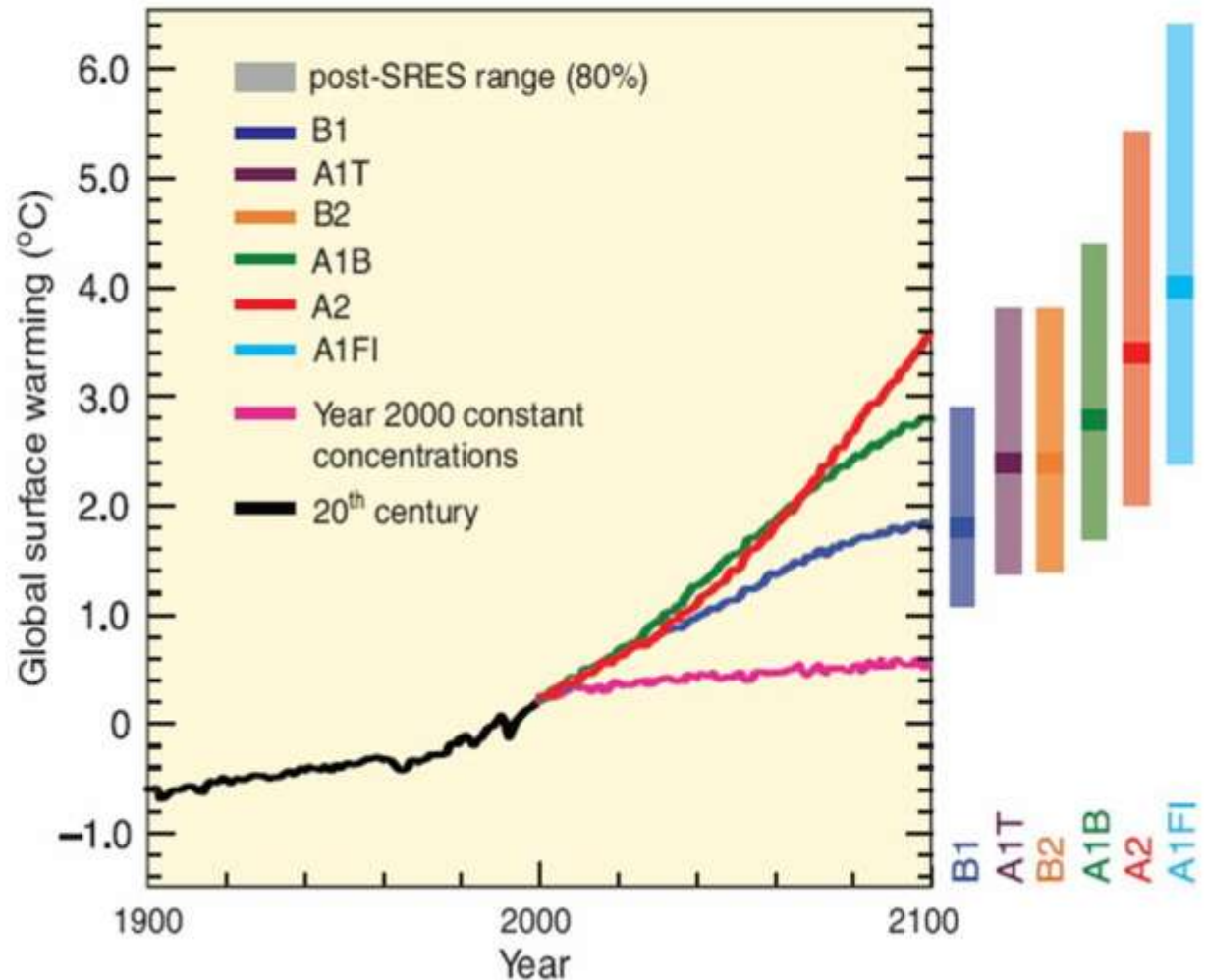
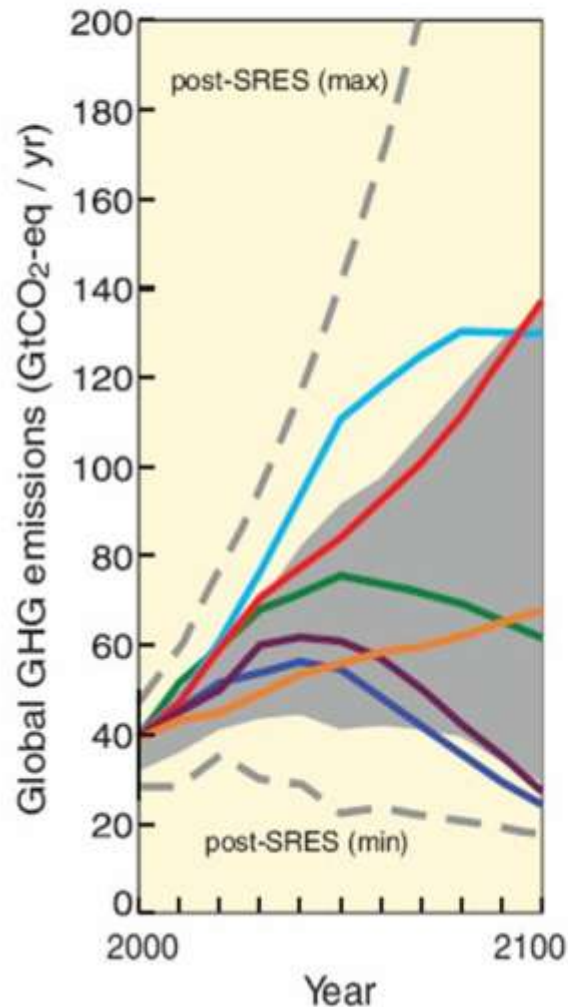


**1. Strategic  
Simplification**

# Example:

## Intergovernmental Panel on Climate Change (IPCC) Future Scenarios

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



# Strategic Simplification of Aspects of (Content) Necessary to Support Students' Ability to Construct Explanation or Prediction

Population  
growth rate



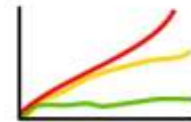
Energy use  
per person



Proportion  
clean energy



Total CO<sub>2</sub> emissions  
by 2100 (gigatons)



**Future 1**

Fast

Low

Low

1862

**Future 2**

Slow

High

High

1499

**Future 3**

Slow

Low

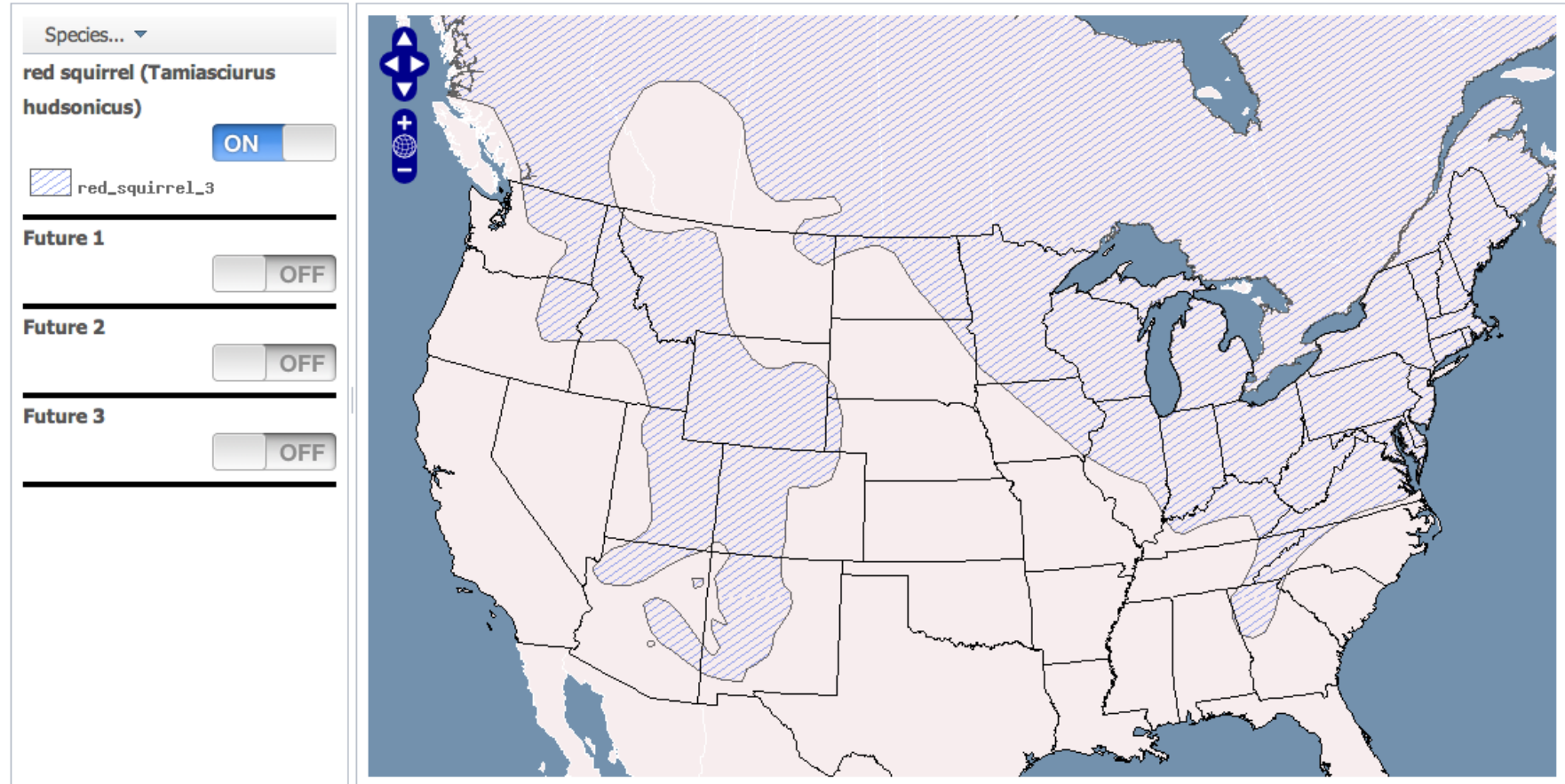
High

983

## Step 2: Create Stimulus Materials

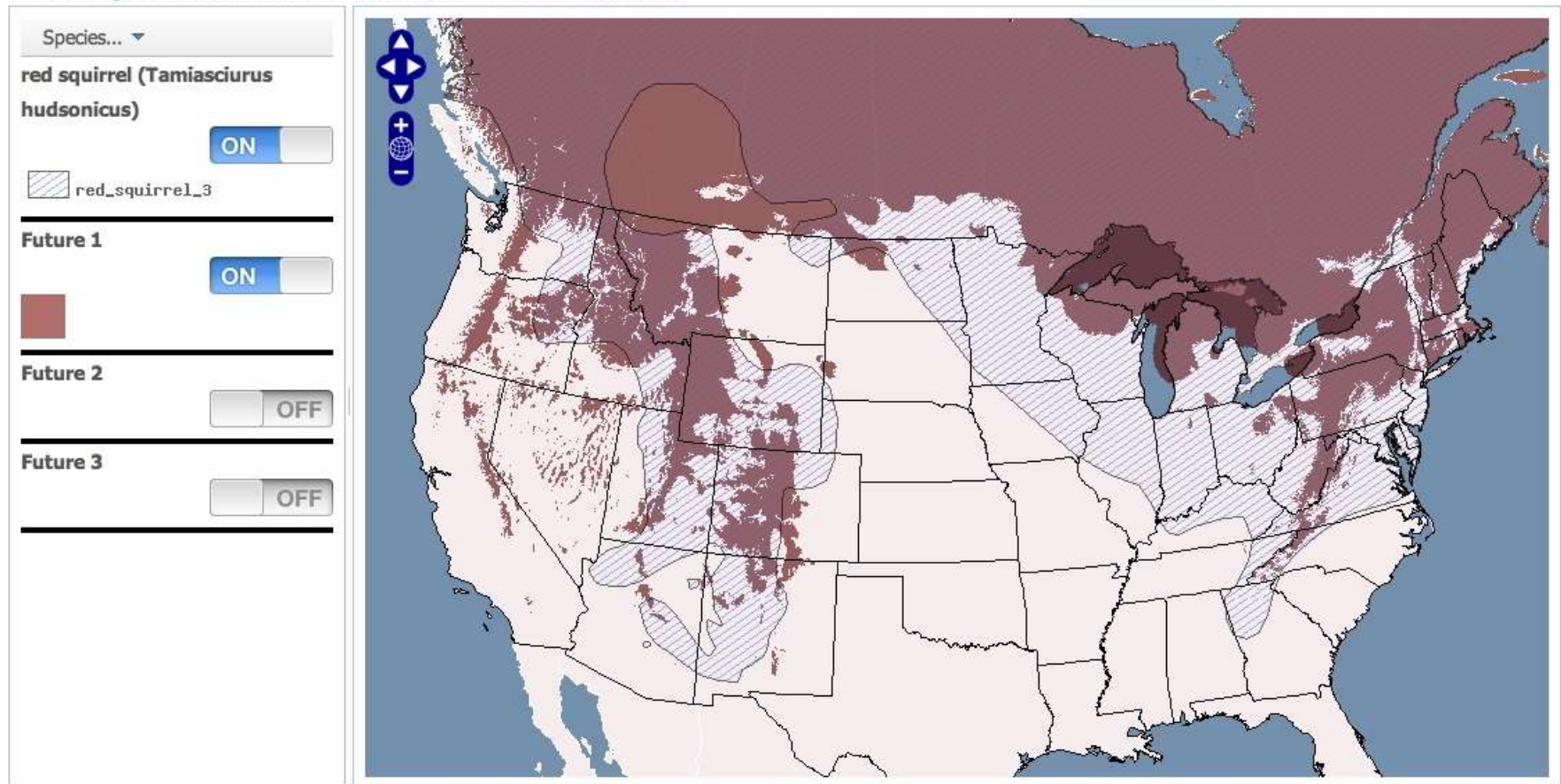
### Current Distribution of the Red Squirrel (real data)

#### Focal Species Current and Future Distributions



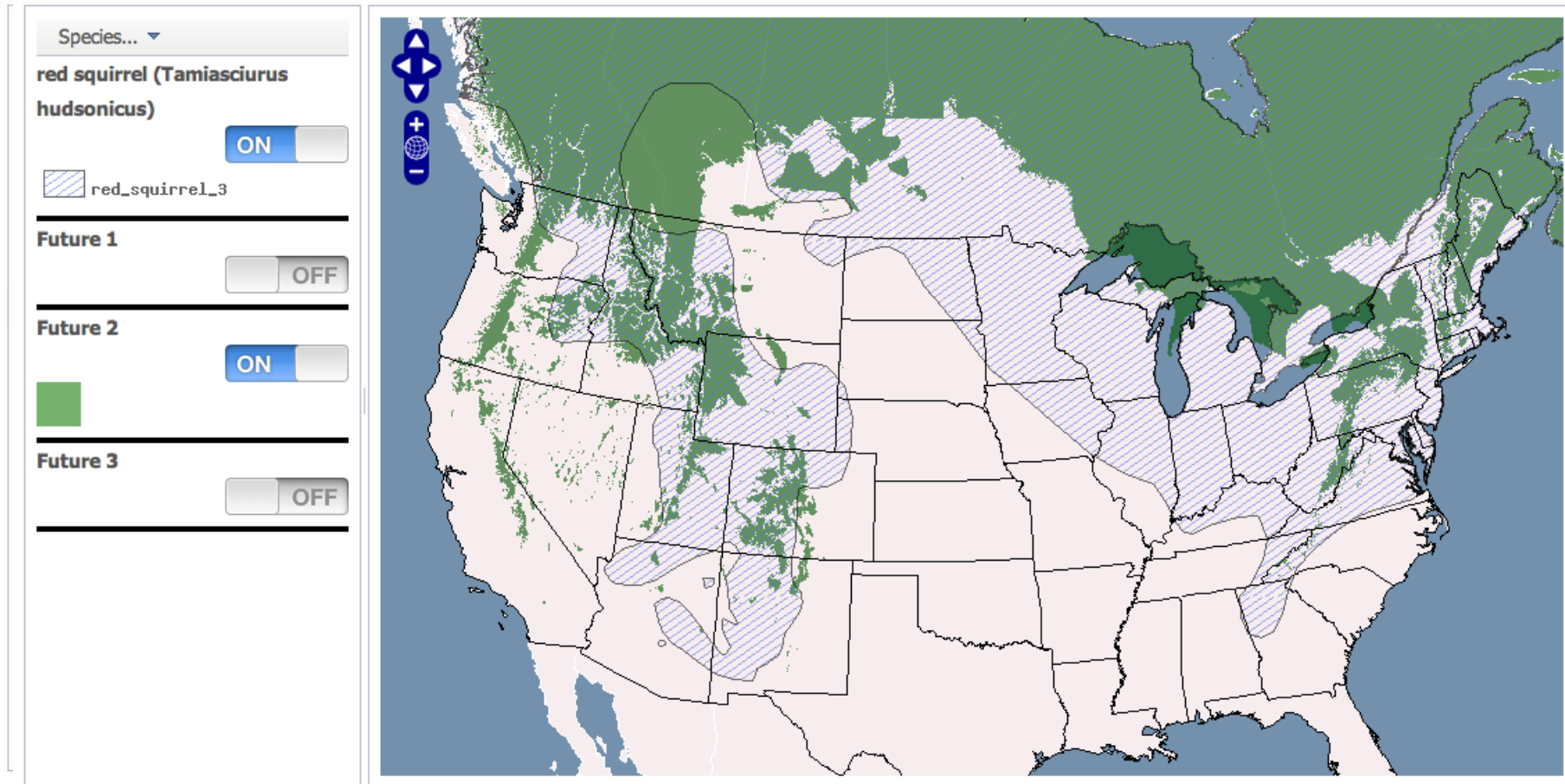
# Red Squirrel Distribution Under IPCC Scenario Future 1 (modeled data)

## Focal Species Current and Future Distributions



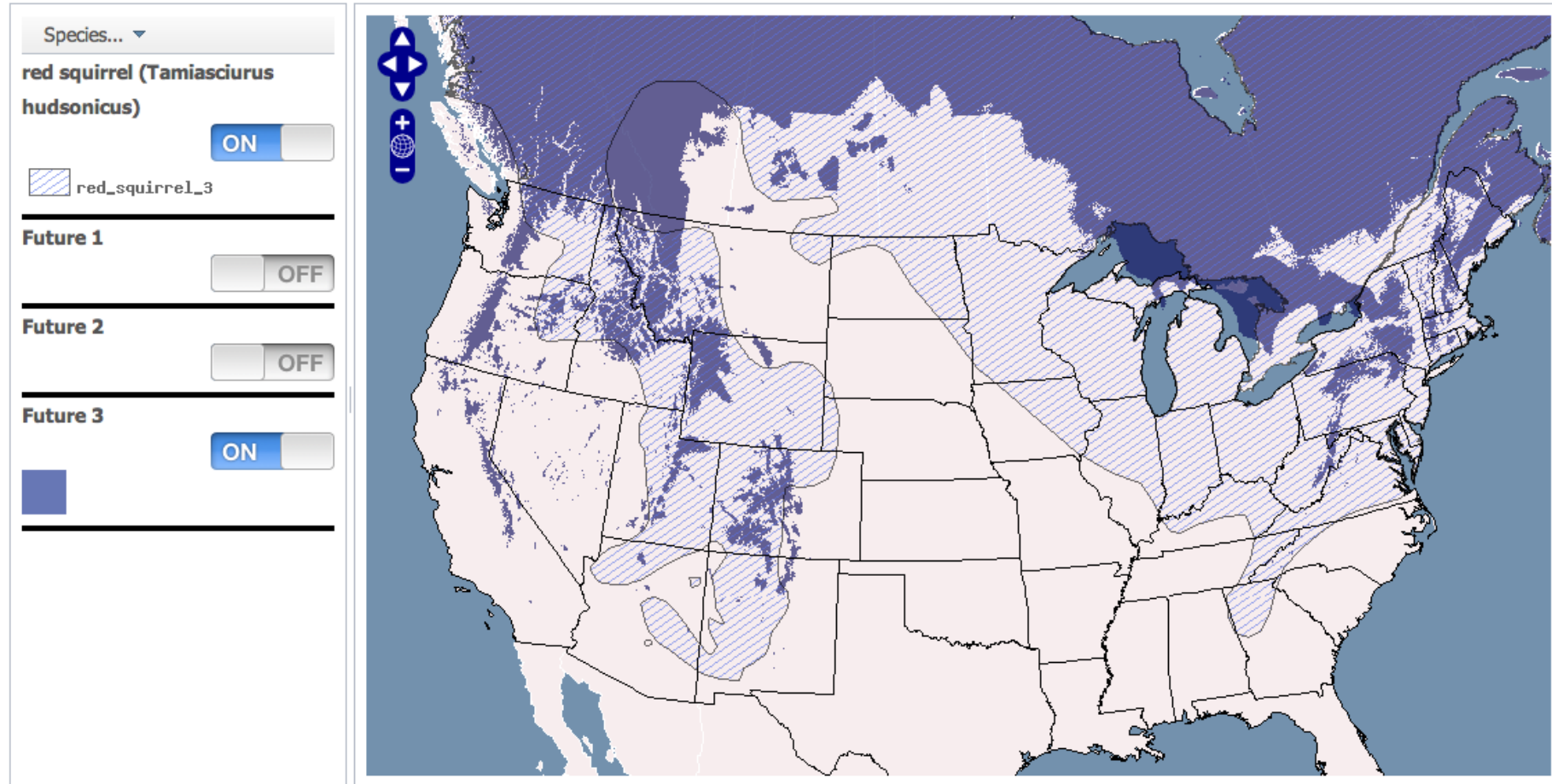
# Red Squirrel Distribution Under IPCC Scenario Future 2

## Focal Species Current and Future Distributions



# Red Squirrel Distribution Under IPCC Scenario Future 3

## Focal Species Current and Future Distributions



# Is there evidence that climate change will impact the distribution of the Red Squirrel?

**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. **×** Are they going 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. **×**

**Hint** What kind of evidence is used to describe climate?

Cancel Save

# Online Assessment Information Available for Teachers and Students in Real or Near Time

The image shows two side-by-side browser windows from the SPECIES platform.

**Left Window: SPECIES | Columbia Prep - Bess**  
 URL: [animaldiversity.ummz.umich.edu/changethinking/species/manager/workbook/report](http://animaldiversity.ummz.umich.edu/changethinking/species/manager/workbook/report)  
 This window displays a table of course content for 'Climate Change Biology - High School Spring 2012'.

Item	Count
Climate Change Biology - High School Spring 2012	0
Welcome to SPECIES!	0
Learning Set 1	0
Lesson 1 - What is climate change?	0
Lesson 1 - Teacher Information Part 1	1
Lesson 1 - Teacher Information Part 2	1
Lesson 1 - Part 1	10
Lesson 1 - Part 2	4
Lesson 1 - Part 3	1
Lesson 1 - Homework	1
Lesson 2 - How are weather and climate different?	0
Lesson 2 - Teacher Information Part 1	1
Lesson 2 - Teacher Information 2	1
Lesson 2 - Teacher Information Part 3	1
Lesson 2 - Introduction	2
Lesson 2 - Part 1	7
Lesson 2 - Part 2	8
Lesson 2 - Part 3	7
Lesson 3 - How does climate limit where your focal species lives?	0
Lesson 3 Teacher Notes	1
Lesson 3 - Part 1	4
Lesson 3 - Part 2	6
Lesson 3 - Part 3	9
Learning Set 2	0
Lesson 4 - How do we know that ecosystems change over time?	0
Lesson 4 - Teacher Notes, Part 1	1

**Right Window: SPECIES | Honey Creek 2 :: Lesson 2 :: Variables**  
 URL: [animaldiversity.ummz.umich.edu/changethinking/species/manager/workbook/report](http://animaldiversity.ummz.umich.edu/changethinking/species/manager/workbook/report)  
 This window displays a list of student responses for 'Lesson 2 :: Variables'.

Student	Response	Date
JillianB	Weather is talking about current weather, like saying what the temperature is like right now, but climate is talking about weather, but in a certain area, over a long period of time. In this case, we were looking at climate for three different decades.	2012-04-09 11:45:27
JonathanS	Weather is daily temp that goes on climate is an average temp recorded over a period of time	2012-04-09 11:23:05
KateM	The difference between weather is change. Weather always changes and is a day to day thing. Climate is the average temperature for an area and is a year round thing.	2012-04-09 11:38:32
KeeganP	-	2012-04-09 11:33:33
KristineM	Weather is what is happening in the near future or the present. Climate is what is expected to happen.	2012-04-09 11:42:19
MayaK	Long period of time for climate and what's happening NOW for weather	2012-04-09 11:32:21
NatalieK	Weather is what is happening now. It is what is going on in the sky. Climate is the change of the earth over time. It is how the earth changes.	2012-04-12 14:59:08
NyahS	Weather is what is going on right now, but climate is what usually happens in that specific area.	2012-04-09 11:38:30
RitaH	Weather is what is happening at one instant. Climate is the overall average temperature of a specific area.	

# Summary Ideas

- 1. Our learning progressions are a series of fused knowledge statements organized into one of several possible sequences**
- 1. Our assessment constructs are fused knowledge statements**
- 1. Cognitive analysis leading to strategic simplification of some or all of the three dimensions of knowledge is necessary so that target audience can focus on generating fused knowledge**
- 1. Our curricular activities and our assessment tasks always focus on fused knowledge even as they variously provide support and fading of support appropriate for target audience**
- 1. Assessment items can be coded for either core disciplinary ideas, practices and/or fused knowledge (when appropriate)**