

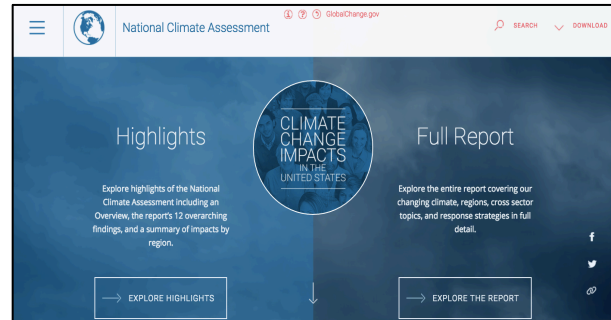


## Quick Guide to Using EcoChains: Arctic Crisis™ with the National Climate Assessment

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**EcoChains: Arctic Crisis** is a fun and educational card game designed to highlight the impacts of climate change on the Arctic marine ecosystem. In this 2-4 player game of strategy and survival, players build an Arctic marine food web, learn about the importance of sea ice, and see the potential impact of future changes on the ecosystem. The game also incorporates climate change solutions and ecosystem-based management options.

The **National Climate Assessment (NCA)** summarizes the impacts of climate change on the United States, now and in the future. The most recent NCA, released in 2014, is an interactive and easily accessible online report that is searchable by region and topic. All components of the report can be downloaded, including graphics. In each section, teachers can click on the “Supporting Evidence” icon for additional information that can be further explored with students.



The NCA focuses on a number of issues highlighted in the EcoChains: Arctic Crisis card game. The game can enhance learning about climate change impacts detailed in the following sections of the NCA report:

### ‘Our Changing Climate’ Section

- Key Message #11: Melting Ice  
<http://nca2014.globalchange.gov/report/our-changing-climate/melting-ice>
  - “Rising temperatures are reducing ice volume and surface extent on land, lakes, and sea. This loss of ice is expected to continue. The Arctic Ocean is expected to become essentially ice free in summer before mid-century.”
- Key Message #12: Ocean Acidification  
<http://nca2014.globalchange.gov/report/our-changing-climate/ocean-acidification>
  - “The oceans are absorbing about a quarter of the carbon dioxide emitted to the atmosphere annually and are becoming more acidic as a result, leading to concerns about intensifying impacts on marine ecosystems.”

### ‘Sectors’ Section

- Ecosystems, Biodiversity and Ecosystem Services chapter  
<http://nca2014.globalchange.gov/report/sectors/ecosystems>
  - Key Message #3: Plants and Animals  
“Landscapes and seascapes are changing rapidly, and species, including many iconic species, may disappear from regions where they have been prevalent or become extinct, altering some regions so much that their mix of plant and animal life will become almost unrecognizable.”
- Indigenous Peoples, Lands, and Resources chapter  
<http://nca2014.globalchange.gov/report/sectors/indigenous-peoples>
  - Key Message #3: Declining Sea Ice  
“Declining sea ice in Alaska is causing significant impacts to Native communities, including increasingly risky travel and hunting conditions, damage and loss to



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settlements, food insecurity, and socioeconomic and health impacts from loss of cultures, traditional knowledge, and homelands.”

### ‘Regions’ Section

- Alaska chapter  
<http://nca2014.globalchange.gov/report/regions/alaska>
  - Key Message #1: Disappearing Sea Ice  
“Arctic summer sea ice is receding faster than previously projected and is expected to virtually disappear before mid-century. This is altering marine ecosystems and leading to greater ship access, offshore development opportunity, and increased community vulnerability to coastal erosion.”
  - Key Message #5: Native Communities  
“The cumulative effects of climate change in Alaska strongly affect Native communities, which are highly vulnerable to these rapid changes but have a deep cultural history of adapting the change.”
- Oceans and Marine Resources chapter  
<http://nca2014.globalchange.gov/report/regions/oceans>
  - Key Message #2: Ocean Acidification Alters Marine Ecosystems  
“The ocean currently absorbs about a quarter of human-caused carbon dioxide emissions to the atmosphere, leading to ocean acidification that will alter marine ecosystems in dramatic yet uncertain ways.”
  - Key Message #3: Habitat Loss Affects Marine Life  
“Significant habitat loss will continue to occur due to climate change for many species and areas, including the Arctic and coral reef ecosystems, while habitat in other areas and for other species will expand. These changes will consequently alter the distribution, abundance, and productivity of many marine species.”



### Other NCA-related teaching resources

National Climate Assessment: Americans on the Front Lines of Climate Change video series

- Indigenous Peoples, Lands and Resources chapter  
<https://vimeo.com/100528198>
- Alaska chapter  
<https://vimeo.com/92563357>

National Climate Assessment Learning Pathways

- Alaska region  
<https://www.climate.gov/teaching/alaska-region>



## Quick Guide to Using EcoChains: Arctic Life™ In Your Middle School Classroom

**EcoChains: Arctic Life** is a fun and educational card game designed to highlight the impacts of climate change on the Arctic marine ecosystem. In this 2-4 player game of strategy and survival, players build an Arctic marine food web, learn about the importance of sea ice, and see the potential impact of future changes on the ecosystem. The game also incorporates climate change solutions and ecosystem-based management options.

**Using Games in Teaching and Learning:** Educational games offer an active and engaging method of introducing complex concepts and reinforcing instruction. Games are increasingly used in educational settings to help inspire curiosity, creativity, collaboration, optimism, and problem-solving skills among a wide variety of audiences. Serious games address real-world challenges, compress time and space, encourage systems thinking, and promote active engagement, making them particularly well suited to teaching complex topics such as climate change. Emerging research also suggests that using gameplay to introduce new concepts results in longer lasting knowledge retention when compared to more traditional instruction methods.

With game-based learning, it is critical to allow time for students to reflect and debrief after gameplay in the classroom. Debriefing helps ensure that game-based learning experiences are meaningful by allowing students to explore and express what knowledge they have gained, how it connects to prior learning, and how it can be applied in the classroom and beyond.

**Extension:** One way to expand on game-based learning is to encourage students to design their own variant of the game by modifying existing game play and/or content. Students should report back during debrief on the specific learning objectives they included and how their game design improved learning.



**Learning Goals:** Students will understand the nature of the Arctic marine food web and the impact of a warming climate.

**Note:** Sea ice is a critical underpinning to the Arctic marine food web. Depending on your class, you may wish to introduce the role of sea ice in the Arctic prior to the students playing the game, or to encourage critical thinking in your students, you might wish to play the game without introduction, allowing them to arrive at this during the gameplay debrief.

**Objectives:** The students will be able to:

- 1) Classify organisms by their roles in the food chain (primary producer versus consumer)
- 2) Organize a list of organisms into a food chain
- 3) Predict how an event at one level of the food chain will impact the entire chain
- 4) Recognize the dependence of key Arctic marine species on sea ice
- 5) Describe the impacts (positive and negative) of human activities on the Arctic marine ecosystem

### Classroom Tips:

**Space:** This game builds out into a large web so allocating enough space is critical. Students will not be able to play it at their desks unless multiple desks are pushed together; if available playing at a lab table is a great idea.

**Time:** The game can be played in a 40-minute class period. We recommend you allocate 5 minutes for directions and game set up, 25 minutes for gameplay, and 10 minutes for debriefing with the students after gameplay.

**Players:** A typical game is played with 2-4 players, however, a single game can accommodate up to 8 players if students are teamed up into pairs.



## Quick Guide to Using EcoChains: Arctic Life™ In Your Middle School Classroom

### Connecting to Curriculum:

Middle School science includes a wide-ranging rotation of topics with EcoChains fitting comfortably into areas covered in *ecology, biodiversity, food webs, energy flow and climate*.

### Connecting with NGSS:

#### **Disciplinary Core Ideas**

#### **MS-LS2.A: Interdependent Relationships in Ecosystems**

**MS-LS2-1** Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.

**MS-LS2-2** Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems.

#### **MS-LS2.B: Cycle of Matter and Energy Transfer in Ecosystems**

**MS-LS2-3 Lesson Plans:** Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.

#### **MS-LS2.C: Ecosystem Dynamics, Functioning, and Resilience**

**MS-LS2-4** Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.

**MS-LS2-5** Evaluate competing design solutions for maintaining biodiversity and ecosystem services.

#### **MS-ESS3.C: Human Impacts**

**MS-ESS3-4** Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems

#### **MS-ESS3.D: Global Climate Change**

**MS-ESS3-5** Ask questions to clarify evidence of the factors that have given rise in global temperatures over the past century

### **Practices**

**The post-gameplay debriefing works well with the NGSS Practices:**

- Constructing Explanations and Designing Solutions
- Obtaining, Evaluating and Communicating Information
- Engaging in Argumentation from Evidence – to debate the role of humans and energy use, energy efficiency, whether sea ice is critical for the continuation of the Arctic food web, alternative energy, geo-engineering, role of migration in survival

### **Cross Cutting Concepts**

- Cause & Effect
- Systems and System Models
- Stability and Change
- Influence of Engineering, Technology and Science on Society and the Real World





## Quick Guide to Using EcoChains: Arctic Crisis™ In Your High School Classroom

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## Quick Guide to Using EcoChains: Arctic Crisis™ In Your High School Classroom

### Connecting to Curriculum:

Suggestions for High School courses and curriculum topics:

- **Biology:**
  - *Ecology: Relation of species to their natural environment*
  - *Biologic Communities: Aquatic Ecosystems ->Marine Ecosystems*
    - *Ecosystems: Composition, distribution, biomass, and changing state of organisms in an ecosystem, predator and prey interactions*
  - *Perpetuation of Species*
  - *Energy Flow: Development in energy patterns, and development of the ecosystem, i.e., food webs, food chains, energy pyramid, trophic levels*
  - *Population Ecology: Population growth model, i.e. carrying capacity, dependent factors; Ecological intervention*
  - *Human Impacts: Human pressure on natural environments*
- **Environmental Sciences:**
  - *Ecosystem Ecology*
  - *Population Ecology*
  - *Solutions to environmental problems*
    - *Climate Change*
    - *Protecting Biodiversity*
    - *Energy*
  - *Human Systems and Consumption, and Natural Resources*
    - *Human use of energy*
    - *Effects of natural resource consumption*
    - *Non renewable/renewable energy sources*
- **AP Environmental Sciences:**
  - *Ecosystem Structure: Biological populations and communities, ecological niches, interactions among species*
  - *Energy Flow: Food webs and trophic levels, ecological pyramids*
  - *Natural Ecosystem Change: Species movement, climate change*
  - *Energy Resources and Consumption: Fossil fuel resources and use, energy conservation and efficiency*
  - *Renewable Energy*
  - *Global Change: Global warming*
  - *Loss of Biodiversity*

### Connecting with NGSS:

#### **Disciplinary Core Ideas**

#### **HS-Life Sciences (LS)**

##### **HS-LS2.A - Interdependent Relationships in Ecosystems**

**HS-LS2-6** Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem.

**HS-LS2-7** Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.



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### **HS-LS4.B - Natural Selection & Evolution**

**HS-LS4-2** Construct an explanation based on evidence that the process of evolution primarily results from four factors: (1) the potential for a species to increase in number...(3) competition for limited resources,

**HS-LS4-5** Evaluate the evidence supporting claims that changes in environmental conditions may result in: (1) increases in the number of individuals of some species;... (3) the extinction of other species.

### **HS-LS4.D - Biodiversity & Humans: Interdependent Relationships in Ecosystems**

**HS-LS4-6** Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity.

### **HS- Earth Sciences (ESS)**

#### **ESS3.C - Earth and Human Activity**

**ESS3-4** – Evaluate or refine a technological solution that reduces impacts of human activities on natural systems

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