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

EcoChains Arctic Crisis is an educational card game developed around the impacts of climate change on the marine Arctic food web, and includes adaptation & solutions.

Using Games in Teaching & Learning: Games offer active and engaging methods of introducing new concepts and reinforcing instruction. Emerging research is showing that concepts introduced through gameplay are more enduring than concepts introduced through more traditional instruction. In using games in the classroom be sure you allow time for dialog and debriefing with the students after play. Additionally, encourage breaks during gameplay to encourage discussion between the players on topics such as the development of ecosystem energy cycling, predictions from changes to the physical or biological elements in the ecosystem, or a discussion on maintaining biodiversity in the Arctic.

Extension: One way to expand the game learning is to encourage the students to modify the game play, designing their own variant of the game. 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 marine Artic food web and the impact of a warming climate.

Note: Sea ice is a critical base for the Arctic 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. Alternatively, in order to encourage critical thinking in your students, you might wish to play the game without an introduction, allowing them to arrive at their own understanding of the role of sea ice during the de-brief.

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 the marine Arctic ecosystem on sea ice;
5) Describe the impact on the Arctic ecosystem from human choices.

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; a lab table is ideal if available.

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 play and 10 minutes for debriefing with the students after game play.

Players: Game play can be structured with 2 to 4 players.

Connecting to Curriculum:

The following is a suggestion of High School courses and curriculum topics:

- **Biology:** *Ecology (relation of species to their natural environment); Composition, distribution, biomass, and changing state of organisms in an ecosystem. Human impacts with nature, human pressure on natural environments. Perpetuation of species. Understand the development in energy patterns, and the development of the ecosystem. Interpret current issues in biology such as population growth, ecological intervention.*

- **Environmental Sciences:** *Ecosystem Ecology; Population ecology; Energy; Human systems and consumption and natural resources; Effects of natural resource consumption; Non-renewable/renewable energy sources; Human use of energy; Solutions to problems; Climate Change; Protecting Biodiversity.*

- **AP Environmental Sciences:** *Ecosystem Structure – Biological populations and communities; Ecological niches; Interactions among species; Energy flow – Food webs & trophic levels, ecological pyramids; Natural Ecosystem Change – Species movement; Climate change; Energy Resources & Consumption – Fossil fuel Resources & Use; Energy Conservation & efficiency; Renewable Energy; Global Change – Global Warming; Loss of Biodiversity.*

Environmental Science & Living Environment Optional Activity: Assign students 'species card' research (see examples on the website). Students will collect data on Predator and Prey, Sea Ice & Climate, Adaptive Features for the Arctic, Lifecycle and Distribution. There are 4 samples on the website – Beluga Whale, Polar Bear, Narwhal and Walrus.

CONNECTING TO NGSS

DISCIPLINARY CORE IDEAS	
HS-Life Sciences (LS)	
Standard 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.	Through EcoChains students build a web of predator/prey relationships. As they build out their chain they can see how balance is maintained by the structure of a larger number of producers than predators in the system. Players will see how loss of sea ice dependent species in the Arctic ecosystem shifts the entire ecosystem from being able to support larger marine mammals to being unable to provide that support, thus changing the overall structure of the ecosystem.
HS-LS2-7 Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.	Humans form the major input from the terrestrial ecosystem in this activity. They can cause both the collapse of, or can contribute to the rebuilding of, parts of the food web. Using the Event and Action cards students can see the effects of negative impacts on the environment from human behavior, and opportunities to mitigate and alleviate some of these impacts through a change in practice. This is a great discussion to have post game as a wrap up.
Standard 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,	Ecochains visually demonstrates the predator prey balance. (1) If there is no food for a specific species, or their sea ice platform disappears, they will no longer be able to sustain themselves in the system. This drop in one species population very clearly demonstrates how a niche opens for another population to expand. (3) Multiple species depend on the same prey and as that prey is depleted competition will become more intense.
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.	As events in the game cause sea ice to disappear, the impact on ice dependent species is swift and visible. Species that are not ice dependent, or require only a small amount of ice will continue to be successful and a more significant part of the food supply. Those higher on the food chain will be negatively impacted by the loss of sea ice, and can even become extinct.
Standard 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.	The most obvious changes to physical and biological components come from changes in sea ice cover and impacts from the Action and Event cards, and both are driven by human choices and behavior. Play a hand of the game without the inclusion of these two types of cards to test the influence of humans in the system.

HS- Earth Sciences (ESS)	
ESS3-4 – Evaluate or refine a technological solution that reduces impacts of human activities on natural systems	Students can review each of the Action cards to consider what types of technological solutions are being considered. An extension for this could be to have the students do outside research, and then either set up a presentation to the class on whether they feel the suggested solution is viable, or students could be set up in a debate with the students taking opposing sides. This aligns nicely with the practice of "Arguing from Evidence."
ALIGNMENT WITH SCIENCE & ENGINEERING PRACTICES	
NOTE* - The after-gameplay debriefing works well with the *NGSS Practices	
Constructing Explanations and Designing Solutions	The players in the game are constantly finding solutions to changes in the food web due to shifts in sea ice, available species to incorporate into the food web, and to deal with events that appear suddenly in the game play.
Obtaining, Evaluating and Communicating Information	Each card carries information on predator/prey, their roles in the ecosystem and species requirements and information that players are evaluating as they build their web. As events impact the food web, players will need to communicate with each other in order to plan for successful migration of any displaced species.
Engaging in Argumentation from Evidence	Students can 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, and the role of migration in survival.
CROSS CUTTING CONCEPTS	
Cause & Effect	Cause and effect are visible in the changes in sea ice (both loss and gain) from both manmade and natural events.
Systems and System Models	The entire game is built as a system model. The Marine Arctic food web is a system that links together physical and biological impacts, with changes in one part of the system directly impacting other parts of the system. EcoChains is a very visual way to teach system science.
Stability and Change	The food web can be relatively stable without outside influences, but impacts from human initiated events, or changes in the number of top predators in the system (which students could experiment with by testing small changes to the deck) bring about immediate instability and change.
Influence of Engineering, Technology and Science on Society and the Real World	The Action and Event cards introduce the influence of engineering, technology and science in the Arctic marine ecosystem. Each one brings in a new technology or influence, which provides an opportunity for discussing such topics as geo-engineering, energy use and production and sustainability.