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

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.

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: The 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.

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.

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

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