Econauts Curriculum Framework

The contents of this framework are intended to help educators use *Econauts* as a tool for engaging learners in scientific discovery. It is not designed to support scripted teaching approaches, rather to leverage the elements of the video game to support educators in linking game content to local contexts. Have fun playing and learning!

Econauts can be played online here:

gamesportal.gameslearningsociety.org

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Curriculum / Game Overview

Games and Learning

Games are growing in popularity as powerful learning tools and viable vehicles for supporting 21st century curricula. Researchers and game developers at the University of Wisconsin-Madison and the Morgridge Institute for Research are using video games and new media to move scientific discovery from the laboratory to the broader community. Led by games scholar and researcher Dr. Kurt Squire, and incorporating research and theoretical models from UW – Madison Ecologist Robert Bohanan, *Econauts* has been designed to support civic scientific literacy and provide a game experience that can connect virtual worlds and scientific concepts with real-world issues and local practices.

<u>Econauts</u>

Econauts is an online unity-based computer adventure game in which the player takes the stylized role of an ecologically based industry. The avatars for the industries are depicted as personified woodland creatures. Through game play, the creatures must compete with each other for resources to increase their production of goods. Within the virtual world of Econauts, players actions can either positively or negatively affect each other and the environment. Players must develop a strategy to increase their earnings, by working together (with other players) or alone.

Econauts encourages students to connect ecology content to action. It is designed to introduce questions like, "How do the actions of a one group affect the environment?" and "How can small changes in industry change the environmental impact on bodies of water?" The purpose of *Econauts* is to help players develop a conceptual understanding of ecology while giving them experiences of confronting pressing ecological issues, conducting scientific inquiry to address these issues, and taking action in the (virtual) world to affect change. By focusing on the ecological needs of the surrounding virtual community, the game is able to bring together real-world issues and scientific practices.

Research and Applications

The curricular applications of *Econauts* are flexible and interdisciplinary and can link to standards related to water ecology, biology, environmental studies, social studies, language arts, technology, and civic engagement. As a flash-based online game, there is no content to download, and students are able to save their progress across multiple play sessions. Whether implemented as part of several lessons or an extended community investigation, educators are encouraged to integrate the game in ways that best serve local educational goals. While early studies show great promise for the use of *Econauts* as a learning tool, they also point to the importance of creating productive interplay between in-game and out-of-game experiences. The research around *Econauts* is particularly interested in the interactions between the game, the local environment, government regulations and civic action.

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Big Ideas and Essential Questions

As defined in Wiggins' and McTighe's *Understanding by Design* (2005), "a big idea is a concept, theme, or issue that gives meaning and connection to discrete facts and skills." The big ideas in *Econauts* relate across pillars in the Framework for K-12 Science Education (2011), including learning goals in scientific practices, crosscutting concepts, and domain-specific core ideas.

Big Ideas:

- The costs and benefits of economic choices on the environment.
- Using and manipulating models to investigate scientific principles.
- Understanding long range planning.
- The role of government on environmental interactions.
- To understand the ecological indicators of the eutrophication process.

The big ideas encountered in *Econauts* to connect players to content in a variety of contexts. At the simplest level, teachers can use the game to introduce or reinforce content that's already part of an existing curriculum and set of learning activities. At a more deeply integrated level, *Econauts* can be used as a part of an interdisciplinary set of activities that become locally contextualized.

Essential Questions:

The essential questions that drive the content in *Econauts* are intended to spark curiosity and more questions and foster critical thinking. They are thoughtful questions to drive the spirit of inquiry for experts and novices alike.

How can the environmental actions of one industry affect other uses of the lake/water shed?

How can industries work together to lessen the environmental stressors which impact the water shed as a result of human interaction?

What role should government play in regulating industrial behavior in an effort to lessen the impact human interaction has on the environment?

The kinds of learning activities designed to surround the game will determine the kinds of frames students can use to investigate the larger essential questions.

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Walkthrough

General Gameplay

Players begin by selecting whether to play the game as taking the role as member of an industry (logging, mining or farming) which has an ecological impact on natural environments. The industry avatars are constructed with male or female characteristics. Once confirmed, the player begins exploration in a mapped area of woodlands and lakes. The object of the game is to explore the relationships between people, land and water. The game does this by allowing the player control over their industry – the amount of resources they obtain, the placement of these resources and their use. As play progresses, they learn how the environmental impact of one industry can affect others as well as the environment.

Gameplay in Econauts is linear, meaning that the player must follow a set progression through game events. The player must complete tasks in sequential order to obtain skill points that allow them to progress through the game. Play begins with the player having the most limited resources with which to function in their chosen field. As in life, as the player becomes more adept at controlling their resources, they earn the ability to upgrade and obtain more objects. As they continue to successfully operate their designated machines, they are able to earn more skill points. However, sometimes their actions may have a detrimental effect on other players or the environment. When this happens, the player may decide to make changes to the way the play continues.

The player controls objects by clicking locations where he or she would like the objects to be placed. The player can also click on other objects and locations within the game world, to purchase additional resources with which to interact in the virtual world. As the player continues to gain experience and skill, he or she is able to possess resources only confined by the physical space of the virtual world.

Starting The Game

There are 3 different ways in which the game can be played:

- in a TUTORIAL (or short practice mode to learn how to play the game)
- as a LOCAL game (meaning one player on their own computer)
- in group play over a network. When playing over a network, the player can either HOST the game, or JOIN the game.

These options are presented as choices when the player first starts the game.

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The first time that students have a chance to play the game, the tutorial is a good way to familiarize them with the game mechanics: how to move, create buildings, how to earn points, etc.

Playing through the tutorial is a relatively quick way to familiarize students with the game. It will take most students between 5 and 10 minutes to complete.

When playing the game (not the tutorial), there will be 3 different careers to choose from:

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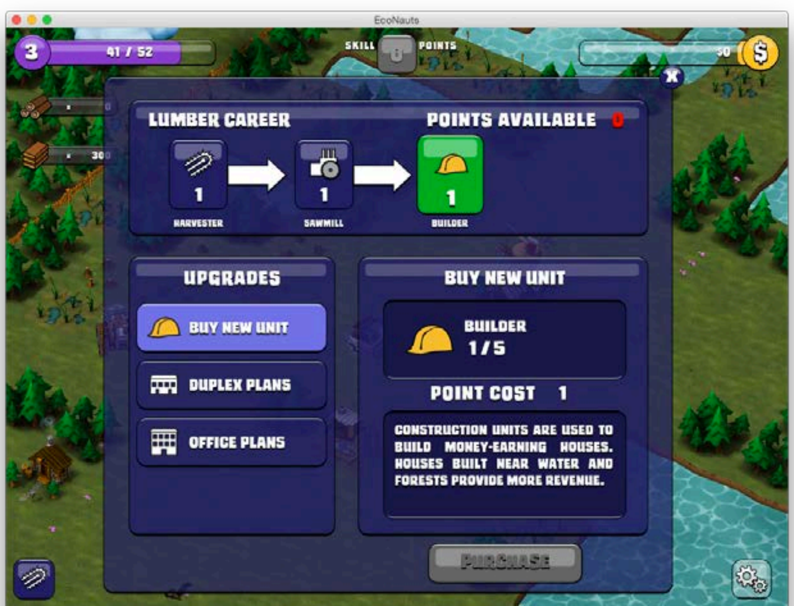
Each career follows a similar path. You start with a factory that you can use to make other items.

LUMBERJACK

These characters use HARVESTERS to cut down trees. SAWMILLS turn those trees into planks. BUILDERS drive around and can build HOUSES, DUPLEXES, and OFFICES (each of which make more or less money depending on their location and type).



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When buildings are placed adjacent to water, there are bonuses: those properties earn money more quickly.

After a while, the impact of humanity on the surrounding environment starts to appear. In the case of the lumberjack, the lake develops ALGAE BLOOM

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The presence of algae detracts from the value of buildings as seen below.

The game ends when a player reaches $8,000.

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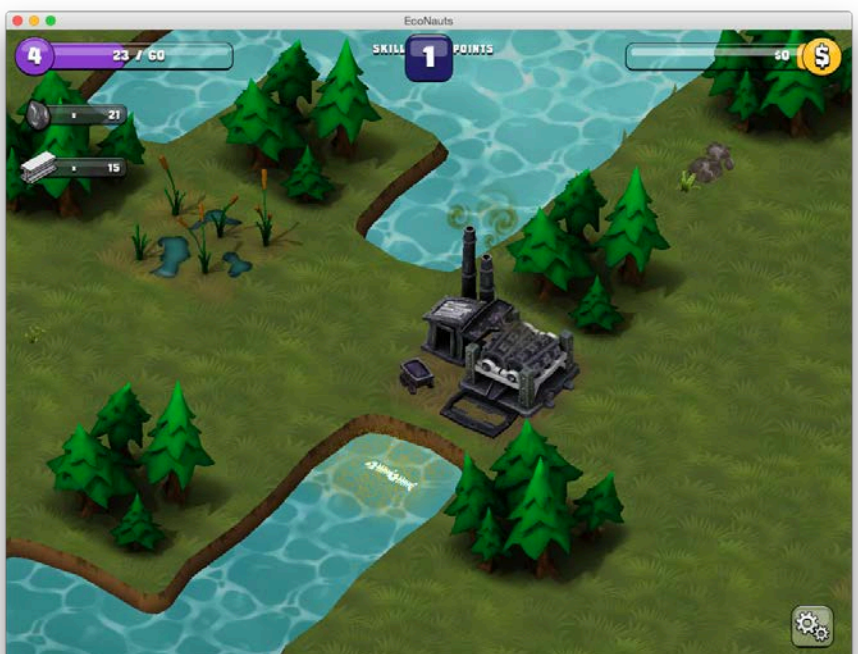
MINER

The story proceeds very similarly. Instead of harvesting TREES, your job is to harvest IRON ORE (shown in the picture below)

In order to find the IRON ORE, your harvester must scan the surrounding area, which it does automatically as it moves.

Once you have found IRON ORE, you must convert it into STEEL to make cars. STEEL MILLS are used to perform this task, and they perform best when placed near water. As they work, you see their impact on the environment almost immediately.



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CAR FACTORIES are built to turn the STEEL into cars, which are sold at CAR LOTS to earn money. CAR LOTS make more money when placed close to living spaces (houses, duplexes, office buildings), but less when they are near industrial sites (STEEL MILLS & CAR FACTORIES).

Again, the game ends when the player reaches $8,000.

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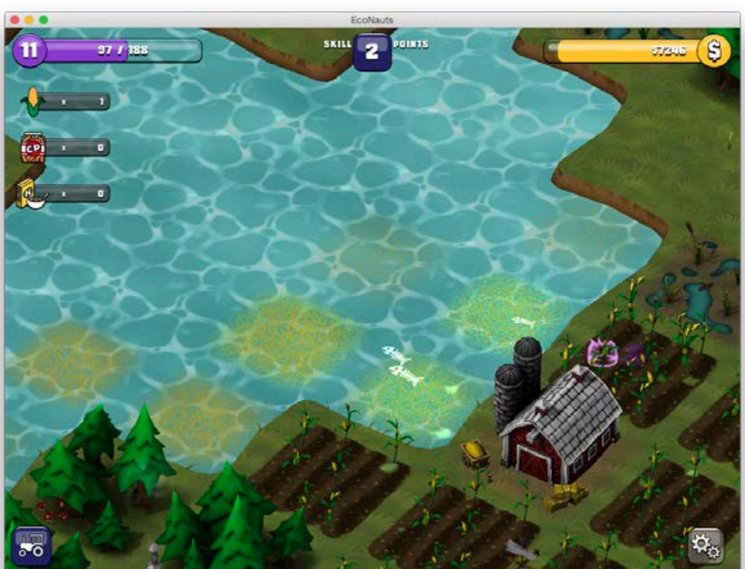
FARMER

The path to a farmer is similar to the other two careers, but instead of finding resources like iron or wood, you build FARMS and fields will surround them automatically. To harvest these fields, you must also build a TRACTOR. Once you start to accumulate corn, you'll need to build a FOOD PLANT to process the corn you've grown.

As in the other careers, certain types of buildings work best when close to water. The crops from FARMS will grow more quickly when those farms are adjacent to WATER. Again, the environmental impact is represented by the colored patches in the lake and the fish skeletons.



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Analysis

National Standards Alignment

This section focuses specifically on the alignment of game-based content to national standards. It is important to note that *Econauts* was designed to have utility in multiple disciplines, from civics and social studies to sciences. *Econauts* may be used as a catalyst for myriad types of learning activities, and may therefore to be used to address any number or combination of national standards and learning goals. The alignment specified in this section, however, relates most directly to the in-game content, and the activities and performance of the students as players of the game.

The concepts addressed in *Econauts* can be used across multiple grade levels, whether repeated in multiple years for various purposes (changes in specific content applications/focus, use of peer mentoring, etc.), or can be used as part of a learning trajectory for players between 3rd and 8th grade.

NRC Framework for K-12 Science Education

Econauts addresses the following areas of knowledge as described by the Framework for K-12 Science Education:

Guiding Scientific and Engineering Practices	Crosscutting Concepts	Disciplinary Core Ideas
Developing and Using Models **Science** often involves the construction and use of models and simulations to help develop explanations about natural phenomena. ***Constructing Explanations and Designing Solutions*** In **science**, students are expected to construct their own explanations as well as apply standard explanations they learn about from their teachers or reading. ***Obtaining, Evaluating, and Communicating Information*** **Science** cannot advance if scientists are unable to communicate their findings clearly and persuasively or learn about the findings of others.	***Cause and Effect*** Events have causes, sometimes simple, sometimes multifaceted. A major activity of science is investigating and explaining causal relationships and the mechanisms by which they are mediated. Such mechanisms can then be tested across given contexts and used to predict and explain events in new contexts. ***Systems and System Models*** Defining the system under study – specifying its boundaries and making explicit a model of that system – provides tools for understanding and testing ideas that are applicable throughout science and engineering. ***Stability and Change*** For natural and built systems alike, conditions of stability and determinants of rates of change or evolution of a system are critical elements of study.	***Life Sciences*** LS2: Ecosystems: Interactions, Energy, and Dynamics ***Earth & Space Sciences*** ESS3: Earth and Human Activity ***Engineering, Technology, and Applications of Science*** ETS2: Links among Engineering, Technology, Science, and Society

As is described in the Framework, a core idea for K-12 science instruction should:

- Have broad importance across multiple sciences or engineering disciplines or be a key organizing principle of a single discipline.
- Provide a key tool for understanding or investigating more complex ideas and solving problems.

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- Relate to the interests and life experiences of students or be connected to societal or personal concerns that require scientific or technological knowledge.
- Be teachable and learnable over multiple grades at increasing levels of depth and sophistication. That is, the idea can be made accessible to younger students but is broad enough to sustain continued investigation over years.

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NextGen Science Standards

The following NextGen Science Standards are addressed by playing *Econauts*, and may be covered in greater depth through the use of out-of-game conversations and expansion activities. These performance expectations are based on the May 2012 release of the standards. For updates, details, and clarification statements for use in assessment and expansion activity design, educators should visit http://www.nextgenscience.org/.

#	Performance Expectation	Description of Game Alignment
Life Sciences - Interdependent Relationships in Ecosystems		
MS-LS2-2	Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems.	• Players obtain information about the impact different actions have on financial and environmental resources. • The player is able to foresee the effect an action will have on the environment. • The player uses game resources to determine the most profitable and environmentally sound actions. • The player is able to explain the impact that an action will have in the virtual world prior to taking it.
MS-LS2-5	Evaluate competing design solutions for maintaining biodiversity and ecosystem services	• Big game ideas include building near water to increase property values and decrease transportation costs. • Conflict between industries – logging and building can be negatively affected by farming when pollution gets into the water.
Life Sciences - Matter and Energy in Organisms and 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.	• Interacting with other players as the competing industries' actions affect one another • Interpreting the affect that the player's actions have on the ecosystem – physical, biological, economic and social
MS-LS2-4	Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.	• Given various constraints of different game sessions, the players is able to determine how the manipulation of multiple variables affects game outcomes •
Earth Sciences – Human Impacts		
MS-ESS3-2	Analyze and interpret data on natural hazards to forecast future catastrophic events and inform the development of technologies to mitigate their effects.	• Through participation in additional wrap-around assignments, players are able to predict the affect natural disasters may have on an ecosystem.
MS-ESS3-3	Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.	• By varying the amount and location of the player's physical resources, the player can manipulate their impact on the environment.
MS-ESS3-4.	Construct an argument supported by evidence for how increases in human	• As player's interact with the environment, they are able to see how

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	population and per-capita consumption of natural resources impact Earth's systems.	their actions impact other industries and the ecosystem as a whole.
Engineering, Technology, and Applications of Science – Engineering Design		
MS-ETS1-2	Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.	• Through multiple game plays, the player in able to determine how the manipulation of multiple variables affects the ecosystem
MS-ETS1-1.	Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.	• Players use evidence from game play to support any changes they might suggest, either with placement of resources or the amount of resources in order to maintain a balance between economic gain and environmental health.

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Lesson Plans

At its most fundamental level, the practice of science is to create, test and revise **models** that describe and explain the world around us. Models and reasoning about models and with models is what unites the disparate disciplines of science. Econauts is an interactive game that explores the relationships of land, water and people. Ultimately students develop their understanding of **ecosystems** by changing the ecosystem via human activities (food production, home/office building, car production). In the initial stages of these activities, students convert existing land for other uses **(land use, habitat loss)** through farming, logging and mining. Econauts is a map-based game whose spatial boundaries delineate the ecosystem. The current ecosystem represents a typical ecosystem in the **Temperate Mixed Forest Biome** and includes forests, grassland and streams, lakes, ponds and wetlands.

Econauts fits nicely into a spiral of lessons/curriculum that uses model-based reasoning to construct explanations and to make predictions of ecosystem changes based on choices of human activity. Econauts can be effectively situated at multiple points in a sequence of learning affording repeated iterations of game play to test evolving strategies. Econauts as an ecosystem model integrates **biological, earth, social and economic systems**.

Because Econauts is a map-based game, we suggest that map reading, construction and navigation provide an accessible entry point.

1. **Where does our water come from and where does our water go?**
   Objective: Use a map or create a map to trace the pathways of water in a place.
   Activity Using an Existing Map:
2. Locate the school on the map.
3. Locate lakes, ponds, wetlands and streams on the map.
4. Where does water (rain or snow) that would fall on the school and playground go? Draw arrows showing the path.
5. Explain why you drew the path that you made.
6. Where does the water that students drink or wash their hands with in this school come from? Hint you may need to explore a bigger map of the city or town.
   Activity Constructing a Map:
   1. Starting with your school walk to the nearest place that you find a lake, pond, wetland or stream.

2. What path will water (rain or snow) at your school and playground follow to get to this body of water? Does all of the rain or snow at your school go to this body of water?
3. Are there other sources of water for this body of water?
4. Does water from this body of water go to other bodies of water? How does it get there?
5. What is the biggest body of water in your school or town? Where does the water come from and where does it go?
6. Where does the water that you drink or use to wash your hands at your school come from? Where does it go?

Putting it together: The map that you just drew that connects water from your school/a school to bodies of water around your school is sometimes called a **watershed** and a watershed map that includes land, water and people is an **ecosystem**.

Now that we know where our water comes from and where it goes, let's explore what affects how water moves in our ecosystem?

Think about the last big rainstorm in your area. Some of the water might have just soaked in to the soil or earth **(infiltration)** and some it might have moved from the school across sidewalks and parking lots to the street **(run-off).**

1. Take the map that you just drew and now think about what might affect whether water soaks in **(infiltrates)** or leaves the school to go to sidewalks, parking lots and streets **(runs off)**.
2. Where is the water the most likely to infiltrate? Where is the water most likely to run-off? Why?
3. It might help us to answer this if we add **habitat** to our map. Note whether areas of land on the map are lawns, parks, farm fields, woodlands or forests, **prairies** or areas with tall grasses and flowers, **wetlands** or areas with tall plants standing in water or usually wet and soggy soils. List all of the different habitats and rank them from the habitat with the most run-off to the habitat with the least run-off or most infiltration.
4. Does your ecosystem have more infiltration land or more run-off land?
5. You also know that buildings, houses, sidewalks, driveways, streets and roads always run-off. How much of your ecosystem is covered by **impermeable or run-off land**?
6. Do you know what besides water would be in run-off? Find a storm drain near your school and look what is around the drain. That is some of what is run-off. What thing might be in run-off that would be too small to see?

In ecosystems living (biotic) and non-living (abiotic) parts of the environment interact and influence each other.

Think about the watershed map that you just worked with. What are the **biotic** parts of your watershed? What are the **abiotic** parts of the watershed?

1. Identify and list all of the biotic parts of your watershed and for each of these explain what they do in the ecosystem.
2. Identify and list all of the abiotic parts of your watershed and for each of these explain what they do in the ecosystem?
3. Analyze your list of biotic and abiotic factors and rank these in order from most important for a healthy ecosystem to least important.
4. Which abiotic and biotic factors might influence each other the most or when one changes the other changes?
5. Now let's use the Lake Globe in Citizen Science http://citizenscience.gameslearningsociety.org/node/23 to test some **hypotheses** about relationships among **variables**.

6. Global Inputs in the game represent variables that humans control and Results represent the response of the ecosystem to changes. You can change one or more Global Inputs variables at a time to test hypotheses about change in an ecosystem. You can change the Global Input variables to 'more' or to 'less'.
7. Let's first make some predictions to test. Which of the Global Inputs would effect how water moves in a watershed such as runoff? Why?

8. How would you decide if a Global Input changed runoff? (Hint: would you change one variable or many variables at a time?).
9. Do any of the Global Inputs that you changed also affect Results other than just runoff? Can you think of an explanation why?
10. Are there any Global Inputs that don't affect any of the Results?

Let's play Econauts. In the lesson about ecosystem variables and interactions, you learned about how some variables affect things like runoff, pollution, algae, fish (piscivore and planktivore), etc. Choose a career and avatar. You may want to play the tutorial to see how to move around the map and to make money with your career. Play Local first to learn more about your career and the ecosystem. You may want to play Local a few times to try different strategies. As you play notice what strategies help you make the money quickly. You might think about where on the map you are farming, logging or mining. You might think about how many tractors, harvesters or dredges you have operating at a time or how many factories or lumber mills or how many grocery stores, car lots or they types of buildings you are building and where you place these. Even though your goal is to make money, you may want to notice how the environment responds.

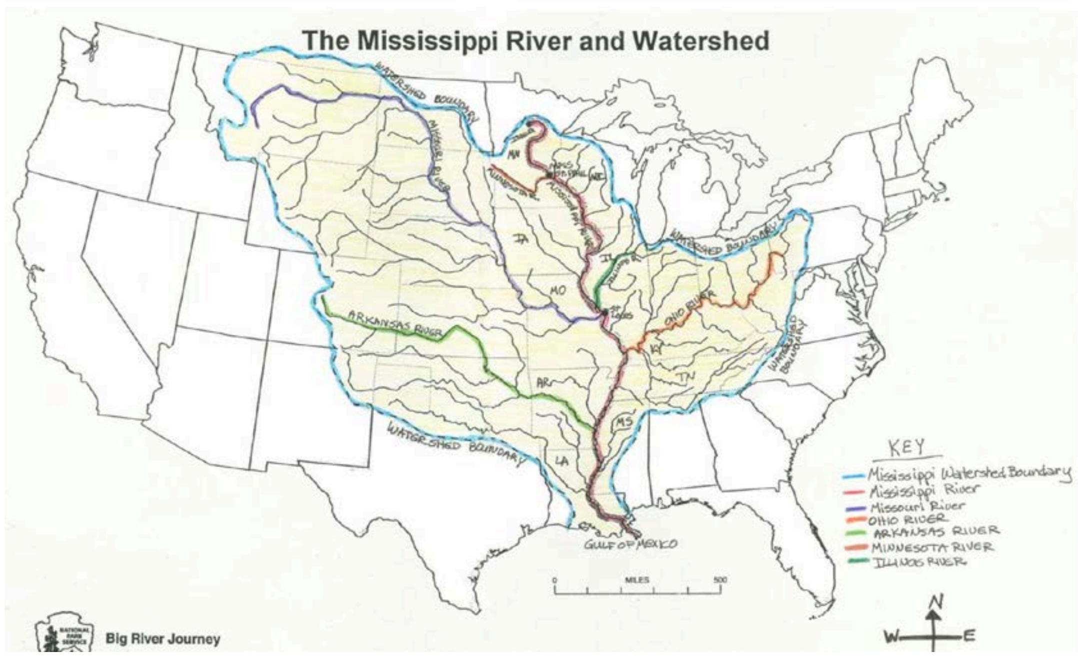
1. Let's list the different strategies that people tried.
2. Which of these were successful? How would you decide what successful means?
3. Were there any strategies that were not successful? Why?
4. What were some of the ways that the ecosystem responded? Were some of these positive? Were some negative?
5. Were their some of the ecosystem responses that did not happen right away? These are called **time lags**.
6. Do you have some hypotheses about why you may have seen the ecosystem respond as it did? When you saw a time lag what do you predict was happening? Sometimes time lags happen because there is a **threshold** or a critical amount of some substance like phosphates or toxins that take time to build up. Were there any warning signs or indicators that a threshold was nearing? This is sometimes called an **indicator or bioindicator** if it is biotic or living.
7. Would you change your strategy? How? Why?
8. When we evaluate strategies sometimes it is useful to make a table of pluses (**benefits)** and minuses **(costs)**.

Now let's play multi-player games. Remember strategies that worked for you in the Local game. Remember the costs and benefits. Do you think that this strategy will work as well in a multi-player game? Why? Will you modify your strategy? How?

1. Let's list the different strategies that people tried.
2. Let's make a table or a graph of how frequently each career won.
3. Which of these were successful? How would you decide what successful means?
4. Were there any strategies that were not successful? Why?
5. What were some of the ways that the ecosystem responded? Were some of these positive? Were some negative? Did the ecosystem respond differently in multi-player than in local?
6. Each game or each map has a finite set of **resources** these can be thought of as the **carry capacity** for all of the plants and animals in the game. Each player **competes** for these. One resource is land or space. What are some other resources? Which of these might be the most competed for even though each career needs slightly different things?
7. Usually in **competition** there are winners and losers. There are other ways that we see competition. Sometimes one player interferes or negative affects another player. Were there some careers that had more of a negative effect on others? Were there any careers that had a positive effect on others? Do you have a hypothesis? Could you test that hypothesis in a new game/
8. One way to reduce negative effects or costs either on the ecosystem or on especially affected careers is to make rules or create policies. Are there any rules or policies that you predict would reduce the negative impact on the ecosystem or other players while at the same time allowing for competition?
9. Play a new game with your new rules or policies. How did your new rules or policies work?
10. Let's make another table or graph of how frequently each career won. Is it possible for any of the careers to win or have a similar probability or likelihood of winning?
11. If Econauts were the real world, all three careers would need and depend on each other **(sustainability)** rather than just compete against each other using resources without regard for other careers with the sole purpose of winning **(tragedy of the commons).**
12. What rules or policies would be necessary for all three careers to be **sustainable**?
13. Play Econauts again with your new sustainability rules or policies. How well did they work? Did it make Econauts more sustainable? Is it possible to have a truly sustainable game where each career has an equal likelihood or probability of winning with each career not only do less harm and actually benefit others?

Watersheds connect to other watersheds. Let's explore how what happens in one watershed may affect another watershed. Look at the map below showing the Mississippi River Watershed. The Mississippi River starts in Lake Itasca in Minnesota and flows from north to south across the United States ending at the Gulf of Mexico. All of the land

highlighted in yellow is the watershed. On this map there are rivers that connect to other rivers that connect to other rivers. What you don't see on this map are all of the lakes, ponds and wetlands that also connect to the Mississippi River by other rivers. So all of the land, water and people in the yellow area of this map are part of the Mississippi River Watershed. The maps in Econauts are part of this watershed. So that means that what is happening the land and water in Econauts represents something that is part of the Mississippi River Watershed and don't forget, the Gulf of Mexico!



1. How many different watersheds can you find in Econauts?
2. How are they connected?
3. How far away do the effects of Farming, Logging or Mining reach?
4. Does Farming, Logging or Mining only affects lakes that are adjacent or very nearby?
5. As you play notice which lakes are affected first and if some lakes are affected even though no activity is happening nearby?
6. What kinds of effects did you notice? Was there a predictable sequence of effects (green algae to cyanobacteria to fish kill)?
7. If you lived downstream or down watershed from a farm/factory, logging site/construction or mining/car lot how would you be affected? What would you do about it? What new rules/policies would you want to include in the game to protect where you live?

Drought: A Climate Disturbance Summative Assessment

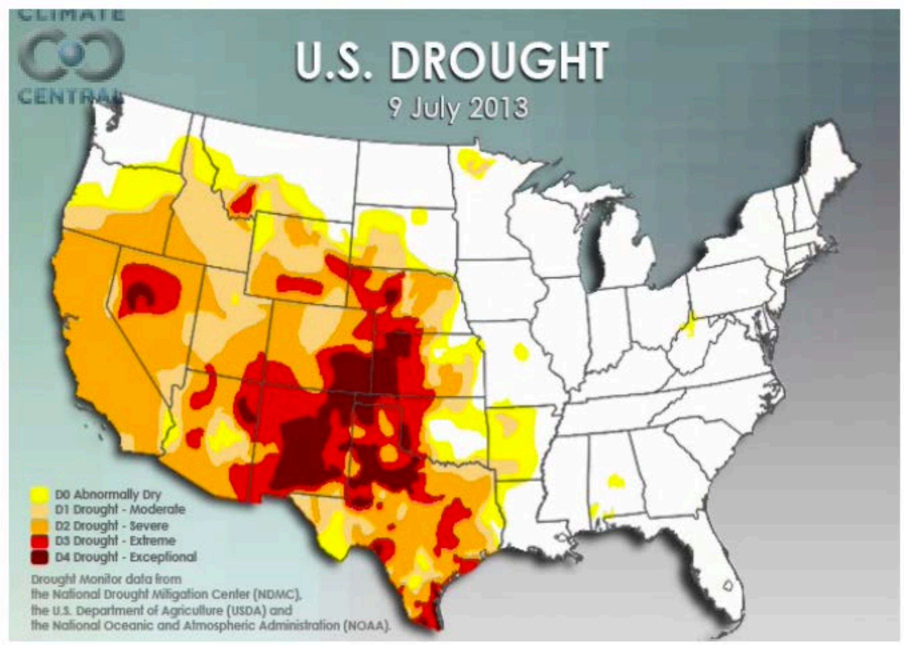
Drought is an abiotic factor affecting ecosystems and life on earth. Drought can occur even in some of the wet biomes like those in temperate zones. Drought is one of several abiotic factors that ecologists call *disturbances.*

1. What are some other types of ecological disturbances? How many can list? **(*Fire, Hurricanes, Tornadoes, Floods, Lightning Strikes, Earthquakes).***
2. Are these naturally occurring or not caused directly by humans? What about Fire? It could be both!
3. What are some ecological disturbances that are directly caused by humans? ***(Fire, Farming, Construction, Logging, Mining).***
4. Can you think of biotic ecological disturbances? ***(Invasive species, Removal of top predators, Spread of Infectious Diseases)***
5. Let's explore and investigate drought some more to see what we can learn about drought .
6. Read the following excerpt:

By Climate Central
http://www.climatecentral.org/news/ongoing-coverage-of-historic-drought-in-us

In 2012, a warm and dry spring followed by a scorchingly hot summer plunged the U.S. into one of its 10 worst drought events on record. At its peak in late summer 2012, the drought extended from Delaware to California, with the most intense drought conditions centered in the nation's heartland. This made it the most widespread drought since 1956 and drew comparisons to the 1930s Dust Bowl era. Although conditions have since eased for the eastern half of the country, severe drought continues to linger for a large swath of the U.S. west of the Mississippi River.

Overall, the drought has caused at least $30 billion in damages to crops, cattle and commerce across the U.S. and left a wide swath of the wheat belt declared a disaster area. It also serves as a lesson of what we can expect in a warming world where droughts are likely to become more extreme.



this is actually a movie. This site also has regional maps and data so that we can tailor it regionally.

7. What is drought?
8. What causes drought?
9. How does drought affect ecosystems?
10. How would drought affect Econauts? Which careers would be affected first? Why? How? How would it change your strategy for playing? If there was a drought in Econauts, would you make any new rules for playing?

Additional Resources

Vocabulary

Model - Econauts is a model of how people, land and water interact. Models may be conceptual, descriptive and predictive. Econauts includes elements of all that may be explored in a variety of ways. At its simplest form a scientific model is an evidence-based explanation.

System - Econauts contains a variety of systems; ecosystem, economic, social and political to name a few. A system at its simplest form is a set of interacting elements that influence each other to varying degrees. Systems have input and output. Input is processed to generate output.

Variables - Econauts contains a number of variables. Some of the variables provide input that generate other variables or output. A variable is an element that can vary. Players make choices about some variables (career choice, where to locate activity) that affect other variables (personal income, income of others, pollution, ecosystem damage).

Ecosystem - Econauts is an ecosystem scale game. The maps create boundaries in which activities take place. An ecosystem in its basic form is a definable unit with boundaries that incorporate physical and biological activity that interact to influence the system. It includes: biological, physical (water and earth/soil), social, economic and political systems.

Biological System - the living components of the system including the survival, growth and reproduction of plants and animals.

Physical System - primarily earth systems with geology and soils. Topography influences runoff and subsequent ecological effects. Proximity to water affects the lakes and streams. Water includes lakes and streams with some lakes isolated in the landscape and others connected by streams.

Trophic System - food webs that describe the movement of nutrients and organic matter.

Watershed - the area around a body of water that drains into it. Watershed show scale effects with watersheds nested within watersheds. Lakes downstream for other lakes may be affected by the upstream activities.

Scale - space and time. An example of spatial scales is that of nested watersheds where a variable may act over distance. Temporal scales often show up as time lags where little to no effects are observed for some time period until a threshold is reached resulting in an a response such as an algae bloom.