FishBanks Simulation Guide
Lesson Guide and Handouts for Pre-college Audience by Anne LaVigne for the Creative Learning Exchange

OVERVIEW

FishBanks is an online multi-user simulation (Figure 1) to explore the management of a marine fishery. The simulation, created through MIT, is available for educators to use at no cost. Students experience the difficulties of managing a renewable resource, seeing how short-term goals can interfere with long-term success. Each student team makes decisions with a goal of creating success for a fishing company. The tendency is for teams to overfish, not realizing the long-term problem until it’s too late to reverse the diminished fish population in time to save the fish or their companies from bankruptcy. See Additional Resources in the Technical Guide for information about how to access the Introduction Video.

Learning Goals
- Interpret data on line graphs and in tables.
- Identify how decisions impact individual teams and the larger system as a whole.
- Design and justify policies to minimize negative human impacts on the health of the marine ecosystem.

TEAM GOAL

Manage a fishing company, maximizing its total assets while competing with other companies that are working toward the same goal.

LESSON DETAILS

Preparation
1. Follow the instructions in the Technical Guide (Page 16) for registering and setting up classes.
2. Go through the Intro Slideshow to familiarize yourself with the simulation and decisions students make.

Materials:
- One computer for every 2-4 students
- Simulation online at http://bit.ly/fishbanks
- Handouts
- Excel spreadsheet to create users
- Intro. and debrief slideshows
- Technical Guide

Key system dynamics concepts and insights:
- Cause and effect are not closely related in time or space.
- Action is often ineffective due to the application of low-leverage policies.
- Conflicts arise between short-term and long-term goals.
- High-leverage policies are difficult to apply correctly.

Curricular connections*:
- NGSS - Human Impacts on the Environment
- Common Core ELA Standards
* Read more on Page 6.

LESSON DETAILS

Age: Grades 5 through 12
Time (approximate):
Introduction – 30-60 minutes
Community Creation – 1 hour
Simulation – 2 hours
Debrief – 1-2 hours
Assessment – varies

3. Log in as the facilitator and test the simulation with all team computers before the first class period.
As we look out over the landscape here in New England, we see the record-breaking 108” of snow gradually melt. The operative word is gradually. But the light is bright and the days are becoming warmer. Many of you are enjoying the spring season already, and we hope that we too have grass and flowers soon.

Spring and summer have a good deal in store for us. A revival of DynamiQueST is being held on May 29, once again hosted by the System Dynamics Program at WPI. It is always an exciting event, with all generations of system dynamicists—from the very youngest to those who have been in the field since close to its inception—participating. If you are in the area, please join us.

Systems-thinking educators will host/present at two conferences this summer: Camp Snowball in Portland, Oregon (July 13-17), and the System Dynamics Conference the following week in Cambridge, Massachusetts. Again, we would love to see you there.

This issue’s lead article will be a familiar topic to many of you. We have used the on-line FishBanks simulation, based on Dennis Meadows’ FishBanks game, to create a curriculum specifically for middle to high school students as they play the multi-user simulation. We trust that teachers and students will enjoy exploring it and playing FishBanks in this new mode.

I hope you all survive testing season and enjoy the renewal that the warmer weather and sunshine bring.

Take care,
Lees
(stuntzln@clexchange.org)

In 2012, with the support of the System Dynamics Society, we offered many of the CLE materials at a substantial discount and gave attendees at the conference a number of ideas to help them take system dynamics to schools near them. Bill Ryder has given us an example of how he has taken what we offered and run with it, bringing SD to two different sets of children in different ways.

I have done a couple of things to further the cause of K-12 System Dynamics. Thanks to your efforts, I had a spare set of materials, including The Shape of Change, which, last summer, I gave to a fellow who teaches 6th-grade math in Idaho. He’s a real spark plug and potential leverage point. (I also later gave him a set of the Diana Fisher books and an educator subscription to Stella.) He became quite excited and started planning lessons that would use the materials.

More recently, I had the privilege of speaking at “Bill Nye Day,” a science festival for elementary school students (K-5) put on by members of the National Science Honor Society at one of our local high schools. They want to bolster elementary students’ enthusiasm for STEM subjects. The K-5 students circulated among classrooms with demonstrations and showed various hand-on exhibits in the cafeteria. There was a rocket launching outside and a magic show based on science in the auditorium. “Abracadabra” didn’t work any magic there, but “I Love Science” did. Recalling the ingenious use of hand-crunked fuel pumps you demonstrated at the conference last June, I built a similar device for use in my classroom demonstration, “Drawing The Shape of Change.” A photo of the device and a Bill Nye wannabe is attached. Most of the students were 1st and 2nd graders, with a sprinkling of Ks, 3s, and 4s.

The device turned out to be a godsend. Not only did it speed up comprehension of the relationship between stocks and flows, but it allowed us to do experimental measurements and make plots rapidly enough to keep everybody’s attention for the several half-hour sessions. We ran one session of the In And Out Game using people as the changing entity, then switched to the water-stock with cranked flows for the rest of the experiments in the first chapter. To make the graphs quickly, we used a sliding panel of 1” square graph grid that we moved horizontally behind the water column. Student volunteers would operate the cranks a specified number of turns according to the

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FishBanks

continued from page 1

4. Copy handouts. Note: All handouts are optional. However, having students record information and reflections before, during and after the simulation can help them think more deeply about the dynamics experienced.

5. Divide students into teams of two to four students each. The maximum number of teams is 10. Note: Small teams tend to stay engaged since it’s easier for all to see the data.

Introduction and Community Creation

1. Describe the project in which students will take on the role of managing a fishing company. Use the project requirements and rubric (Handout 1) if desired.

2. Show the Intro Slideshow (Slides 1-7) to introduce students to simulation goals and logistics (Figure 2).

3. Have the teams meet to set up their company/town (Handouts 2 and 3). Although in reality multiple companies may be based in the same town, the handout assumes that each company is in a different town. All these towns/companies rely on success in the same ocean.

Preparation for Running the Simulation (See the Technical Guide for more information.)

1. Before students arrive to run the simulation, have all the computers ready to go.

2. Have the simulation administrator computer on, with the simulation started and ready for Year 1.

3. Have log-in information for teams up on a board or written on slips of paper, so teams can easily log onto the simulation.

Running the Simulation

1. Give students their record-keeping sheets (Handout 4). They’ll use these as soon as they are logged into the simulation to record their total assets for the starting point (Year 1).

2. Have teams place their company’s table tent in front of the group on the table/desk.

3. Project the Intro Slideshow from the second “teacher computer” and go to Slide 8 to show the log-in procedure.

4. After all teams have successfully logged in, continue going through the Intro Slideshow, as students complete the first round from the main Dashboard (Figure 3) and submit their decisions. Refer to Running the Simulation in the Technical Guide as needed.

5. After a couple of rounds, make sure that students are accessing all the tabs near the top of the main screen to view available data (Figure 4) as they make decisions.

6. Continue running the simulation until the fish populations are depleted in both the coastal area and the deep. This typically takes about 10-15 years (rounds) in the simulation, usually 1.5-2 class periods. Refer to the Technical Guide as needed.

Debrief the Simulation

1. Have students complete their graphs to show their assets over time. They’ll need to determine an appropriate scale for the y-axis, based on the table data.

2. Debrief the simulation experience using data from the simulation and the debrief slideshow. See also the Debrief Questions to Consider and Assessment Ideas on the next pages.

3. One highly recommended aspect of debriefing is to allow students to
run the simulation again, using policies that they designed on Handout 5. The class can vote to decide what policy(s) to implement in the second run. Running it a second time can go very quickly since they are testing a very specific policy.

4. See examples for completing Handout 5 below.

**Connection Circle and Loop Examples**

Handout 5 provides one way for students to illustrate cause and effect relationships they note during the simulation. Each element around the circle is a key variable in the simulation. Each arrow they draw shows how one element causes a change in another element. For example, the more fish there are, the more fish they will likely catch. Note the blue arrow from the fish population to the fish that are caught (Figure 5). This diagram is meant to serve as an example only. Students may see different relationships than those shown here.

Conversely, a red arrow in the diagram indicates that an increase in the first variable causes the second variable to decrease. For example, the more fish that are caught, the more fish that are removed from the fish population.

From there, students can look for loops within their connection circle and draw them out separately. Figure 6 shows an example with two loops that are embedded in the full connection circle.

For additional information about how to create connection circles, see Lesson 10 in *The Shape of Change*, available on the CLE website at [http://www.clexchange.org/cleproducts/shapeofchange_lessons.asp](http://www.clexchange.org/cleproducts/shapeofchange_lessons.asp).

**Curricular Connection Examples**

See the complete FishBanks lesson at the CLE website, [www.clexchange.org](http://www.clexchange.org) for curricular connection examples for Next Generation Science Standards (April 2013 Release) and Common Core ELA Standards.
Debrief Questions to Consider

Processing What Happened
• What happened to the fish and the companies over time? Consider financial success, health of the fishery, etc.
• Which team had the highest total assets at the end? Why?
• Did any teams have a negative balance? Why?
• If the fish population crashed, whose fault was it?
• What were benefits and tradeoffs of different strategies for fishing and boat ownership?
• How were company goals seemingly in conflict with sustaining the fish population?

Considering Leverage Action
• How could you improve results for the fish?
• To what degree are those ideas reasonable within a real-world context?
• How could you save the fish and create economic success for the fishing companies?

Handout 1

FishBanks Simulation Requirements
1. Complete a self-assessment (this handout).
   • Use the rubric below to assess how you feel you did for each of the areas below.
   • Attach a separate explanation, justifying your self-assessment.
2. Assemble all team handouts.
   • Community Creation – Handouts 2 and 3 (one per team)
   • Simulation Record-Keeping – Handout 4 (one per team)
   • Finding Connections – Handout 5 (one per team member)
   • Leverage Plan – Handout 6 (one per team member)

Project Assessment Rubric

<table>
<thead>
<tr>
<th></th>
<th>Novice</th>
<th>Basic</th>
<th>Proficient</th>
<th>Advanced</th>
</tr>
</thead>
<tbody>
<tr>
<td>Community Creation</td>
<td>Community materials were missing entirely or very little was included.</td>
<td>We created a community, but a couple of components were missing or minimal.</td>
<td>We created a community with all the required components that have clear, logical explanations.</td>
<td>In addition, our community as a whole painted a strong image of what it would be like to live within that community.</td>
</tr>
<tr>
<td>Participation and Teamwork</td>
<td>I participated minimally, letting others on my team complete the required components.</td>
<td>I participated somewhat, helping with decisions.</td>
<td>I participated and worked well with my team throughout the intro, simulation, and debrief.</td>
<td>In addition, I took a leadership role, making sure that everyone on my team felt like they had a strong role on our team.</td>
</tr>
<tr>
<td>Simulation Record-Keeping</td>
<td>We didn't keep any records.</td>
<td>We recorded results that were mostly accurate.</td>
<td>We recorded results that were accurate and explained what happened.</td>
<td>In addition, we were able to analyze why our company did or did not meet its goal.</td>
</tr>
<tr>
<td>Leverage Plan</td>
<td>I didn't have a leverage plan or it was minimal.</td>
<td>My leverage plan was confusing or incomplete.</td>
<td>My leverage plan had specific strategies explained clearly.</td>
<td>In addition, my plan included realistic consequences, both now and into the future.</td>
</tr>
<tr>
<td>Team Assessment</td>
<td>My team members did not work well together.</td>
<td>Some of the team members worked together but one or more did little to nothing.</td>
<td>We worked well together to accomplish the tasks. Everyone had an equal role.</td>
<td>This was a great team, one of the best team experiences I’ve ever had.</td>
</tr>
</tbody>
</table>

FishBanks continued on page 6
**Handout 2**

**Community Creation Tasks**

Create a community that includes your company and the town where it is based. As a group, complete the first four tasks together. Divide the remaining tasks among members of your team. If you have fewer than three members, some individuals will have more than one job. Use all of the talents of your team to accomplish these tasks. In addition, complete the attached form as a summary of your work.

1. Name your company.
2. Select a board of directors.
3. Create a company mission statement that reflects the purpose and goals for your company.
4. Name your town.
5. **Town Map**
   - Create a map of the town, drawing important places (businesses, including your company; docks; marina; school; library; parks; government offices; homes; etc.) in your community.
   - Write a summary describing how your town relies on the fishing industry and how the fishing industry relies on the town resources. Include specific examples from the map.
6. **Company History**
   Write your company’s history, making sure to include answers to the following:
   - When was your company founded?
   - Who founded your company?
   - How is your company important to the local town?
   - What service does your company provide for your town?
7. **Company Logo and Sign**
   - Design your company’s logo.
   - Create a free-standing, table tent (using a sheet of 8.5” x 11” paper) that displays your company’s name and logo on one side and names of team members on the other side.

There are 6 handouts included in the lesson. We have included the first two here. The other handouts are:
- Handout 3 – Community Creation Summary
- Handout 4 – Simulation Record-Keeping
- Handout 5 – Finding Connections
- Handout 6 – Leverage Plan


**FishBanks Resources:**

FishBanks game originally developed by Prof. Dennis Meadows, Emeritus Professor of Systems Management, University of New Hampshire.

Web version developed by Prof. John Sterman (MIT Sloan School of Management), with help from Prof. Andrew King (Tuck School of Business), Dennis Meadows, Keith Eubanks, and Forio.com. Available from: [https://mitsloan.mit.edu/LearningEdge/simulations/fishbanks/Pages/fish-banks.aspx](https://mitsloan.mit.edu/LearningEdge/simulations/fishbanks/Pages/fish-banks.aspx)

Simulation screen shots from web version of FishBanks.

Original introduction slideshow developed by Dennis Meadows, Andrew King and John Sterman is available from Learning Edge.

Lesson, handouts, and slideshows adapted for middle/high school audience by the Creative Learning Exchange and distributed with permission from John Sterman, MIT.
DynamiQueST: A showcase of student projects

DynamiQueST is a showcase of student projects that utilize critical thinking skills to analyze complex dynamic systems in a relaxed environment, free from “winner/loser” constraints. Students ages 8-18 will showcase their work using their ability to analyze and to clearly communicate critical thinking using the tools and methods of system thinking and system dynamics.

WHAT ARE THE GOALS OF DYNAMIQUEST?

• Give students the experience of being coached on their projects by experts in the systems field, teachers, and other students, in a helpful and supportive manner.

• Permit teachers from different schools to see evidence of student work communicating critical thinking using systems thinking and system dynamics (ST/SD).

• Provide a venue for teachers and kids to network and learn from each other.

• Showcase student work for the wider community.

• Have some fun and celebrate with kids!

DO STUDENTS NEED A LOT OF EXPERIENCE TO PARTICIPATE?

No! DynamiQueST creates a venue for celebrating what has been done, informing those who wish to start, and providing encouragement for all!

WHO ARE THE COACHES?

• Professionals well versed in analyzing complex systems using the tools and methods of ST/SD

• Teachers who have used ST/SD in their classrooms for years

• Other participating students

JOIN US!

• Students and teachers with projects/presentations

• Educators who wish to see what students are capable of thinking and communicating

• Community members who are curious about better ways to help students learn about the complex systems that are everywhere.


• Identify project(s) about topics that change over time. Look at the Rubrics for Projects and Tips on Using System Dynamics Tools or email Lees Stuntz for a free copy of Communicating Critical Thinking: Visual Tools for Student Projects.

• Check the Creative Learning Exchange website for information or email the director, Lees Stuntz. If you are new to learning systems thinking, get in touch with the CLE. We have both the resources and the willingness to help you get ready for DynamiQueST.

• If you are new to thinking critically about systems and don't have any projects this year, just come and join us to experience the day, and mostly enjoy what students can do. But, please register, so we know who will be there!

For more information, visit DynamiQueST.
On July 13-17, 2015, join teams of educators, students, and business and community leaders at Camp Snowball to explore how to build everyone’s capacity for learning and leading in the 21st century. We can provide opportunities for learning how to enable all students to think deeply and critically, manage high complexity, work collaboratively, communicate effectively, and achieve academically, in short, to prepare them for their future. Deepen your own learning in this fun, engaging, and practical professional development opportunity.

Co-hosted by Peter Senge, author of The Fifth Discipline: The Art and Practice of the Learning Organization—and a team of experienced faculty and staff—we’ll work together to prepare students—our future leaders—for the roles they will step into in tomorrow’s organizations and world.

A growing number of school systems have found that by integrating the tools and techniques of systems thinking, organizational learning, and education for sustainability, they can accelerate the development of leadership, teaching, and learning capacities. At Camp Snowball, young people and adults will participate together in a rich array of workshops. And because adults interact with students at camp, they can see how valuable and relevant students find these tools and approaches directly. The energy and enthusiasm is snowballing! Don’t miss out. Register now at www.campsnowball.org!

Teachers Learning Together for Student Success with Systems Thinking:
A Thoughtful Approach to the Common Core

This booklet contains lesson plans in early reading, middle school math, and high school non-fiction texts. Learn more at at soledpartnership.org.

**Early Reading**

**Lesson 1**: The Great Kapok Tree: A Tale of the Amazon Rain Forest by Lynne Cherry. Designed by Lindsay Rondeau, Tahoma School District, Maple Valley, Washington

**Lesson 2**: A House for Hermit Crab by Eric Carle. Designed by Cindy Hanson, Tahoma School District, Maple Valley, Washington

**Middle School Mathematics**

**Lesson 3**: Patterns in Algebra. Designed by April Knippen, Gridley Middle School, Tucson Unified School District, Tucson, Arizona

**Lesson 4**: Habits of Mathematical Thinking. Designed by Middle School Math Cohort, Hewlett Deeper Learning and the Common Core

**High School Non-Fiction Texts**

**Lesson 5**: Financial Planning Life Scenarios. Designed by Cheryl Jolly-Luster, Ritenour High School, Ritenour, Missouri

**Lesson 6**: Focus on the Pivotal Year 1964. Designed by Brett Goble, City High School, Tucson Unified School District, Tucson, Arizona

“To be a teacher is to be a prophet. You are not preparing children for today’s world, but for the world of the next 50-75 years—a world we can barely imagine.”

Gordon Brown, former Dean, MIT School of Engineering
As the teacher moves about the room from a supply station to a concept drawn on a board to a table on which is displayed a long-term experiment, students move as well, working on physical projects, observing, and participating in the discussion which never really ceases even after its allotted time.

The lessons and projects range in type and direction from the actual construction of a model to the perusal and discussion of a video. For example, students built models illustrating the principles of heating systems and exploring the most effective way to store heat. To simulate the task of actually designing and building a heating system that would be sent into space, students were given a budget and a list of prices for a wide variety of materials. After watching a few videos, running various experiments, and discussing some rules of heat, they built their models and tested them to find out the most effective method.

Other planned modeling activities include the construction of a Mars rover, which student Joe says is the project he is most excited about.

In developing the curriculum for this class, Think Tank partnered with Creative Learning Exchange, a nonprofit organization with the goal of encouraging “systems-thinking” in education. I had the opportunity to speak with Lees Stunz, executive director of CLE who has several times joined us in teaching this class. Essentially, she views knowledge as an iceberg, with the surface, protruding layer being Events, the lower but still shallow layer being Patterns, and the deepest, most important layer being Systems. She believes that the condition of our society and world would be immeasurably improved if everyone took the time to learn and apply the simple methodology which arises from this understanding. I encourage you to check out the CLE’s website and explore some of its ideas. (They develop curricula, which could provide some inspiration to those of you who homeschool).

I was so impressed by the quality of student input in the discussions that I feel compelled to note my personal astonishment in this piece. Their ability to swiftly intuit the nature of the scientific concepts introduced to them and as quickly describe how that knowledge could be practically applied was simply incredible; I would never have believed that students of such a young age were capable of it. It seems that if you give a child the opportunity to interact with ideas on their own terms rather than feeding them both facts and conclusions, the limit of their ability will be no less than the depth of their curiosity, which is boundless.
POPULATION DYNAMICS
Connecting Past, Present and Future
A Four-Part Curriculum by Jeff Potash & Jennifer Andersen

The four simulations of the Population Dynamics series are designed to supplement existing high school history curricula. Each of the four examines an important period of development in American history.

A. Settlement of New England (1620-1630)
B. New England’s Colonial History (1630-1776)
C. U.S. Urbanization (1820-1920)
D. America’s Baby Boom and Global Youth Bulges (1945–present)

Parts A and B of Population Dynamics were featured in the Winter issue of The Exchange. The entire unit of all 4 parts is available on the CLE website at http://clexchange.org/curriculum/complexsystems/populationdynamics/.

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in-out rules. A third student would mark dots on the graph next to the water to record the water’s height. They would then connect the dots with straight line segments once the dots were completed. The discussions about the graphs were quite rich and stimulating, especially when we suggested that the water column could represent CO$_2$ in the atmosphere. What really impressed me was that the adults seemed to be just as interested as the students.

I really do owe you and the rest of the conference attendees a huge thank you for the terrific ideas presented there. They gave me the foundation for a demonstration that even Bill Nye would have enjoyed!

Invest in Education!

Your financial support of our effort here at The Creative Learning Exchange is always appreciated. You may donate any amount you wish; perhaps $50.00 is a reasonable amount for a year. All contributions are tax-deductible.

Enclosed is _________________ to The Creative Learning Exchange to help invest in the future of K-12 systems education.

Name_____________________________________________________

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________________________________________________________________________

E-mail_________________________________________________________

THANK YOU!
The Creative Learning Exchange, 27 Central Street, Acton, MA 01720