Fishbanks

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A brief history of Fishbanks...

Paper version invented by Dennis Meadows, former MIT Sloan Professor of System Dynamics, 1986

Online version developed by MIT Sloan and Forio, deployed through LearningEdge, 2010

Translations in beta test for Chinese, Spanish, Portuguese, with funding from Gustavo Pierini, 2014

Deployment in universities and training programs around the world, including MIT Sloan S-Lab, L-Lab, ExecEd
Fishbanks: A Renewable Resource Management Simulation

DEVELOPERS
Dennis Meadows, John Sterman and Andrew King

ABSTRACT
Fishbanks is a multiplayer web-based simulation in which participants play the role of fishers and seek to maximize their net worth as they compete against other players and deal with variations in fish stocks and their catch. Participants buy, sell, and build ships; decide where to fish; and negotiate with one another. Policy options available to instructors include auctions of new boats, permits, and quotas.

LEARNING OBJECTIVE
To provide the opportunity for students to learn about the challenges of managing resources sustainably in a common pool resource setting, with realistic resource dynamics.

COULD BE TAUGHT IN THE FOLLOWING COURSE(S)
Economics, strategy, negotiations, sustainability, environmental studies, public policy, resource economics; leadership and team-building; and any course in which the dynamics of cooperation and competition, resource management, and negotiation are relevant.

NOW AVAILABLE!
Corporate trainers, consultants, and educators from non-academic institutions can now access our simulations directly from our simulation partner, Forio, here.
Fishbanks

- Intro (almost over)
- Fishbanks!
- Results and Discussion

Winslow Homer, The Herring Net

Fishbanks game by originally developed by Prof. Dennis Meadows. 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.
Your Goal

Maximize your Net Worth at the end of the game.

Net Worth = Bank Balance + Value of Fleet

The winner is the team with the highest Net Worth at game end.
Profit = Income – Expenses

- Fish Sales
- Ship Sales
- Interest Earnings
- Harbor & Operating Costs
- Ship Purchases
- New Ship Orders
- Interest Charges
Income

- **Fish Sales**
  - Catch x Price ($20 per fish)

- **Interest Earnings**
  - 2%/year if Minimum Bank Balance is greater than zero

- **Ship Sales**
  - Price set by auction
Expenses

Harbor & Operating Costs

- Harbor: $50/year per ship
- Coastal Fishery: $150/year per ship
- Deep Sea Fishery: $250/year per ship

Construction

- New Ships: $300 each. Charged at end of current year. Delivered the following year

Ship Purchases

- Buy a ship at auction. Cost: your winning bid per ship * number bought

Interest Charges

- 5%/yr if Minimum Bank Balance is less than zero.
Fishing Fleet

• Initial Fleet = 3 Ships/team

• Fleet Growth
  - Purchase from other teams via auctions
  - Order new ships

• Fleet Reduction
  - Sales to other teams via auctions
Ordering New Ships

Each year you may order the construction of new ships.

The maximum order is half of your current fleet (initial fleet + auction purchases).

If total fleet is an odd number, your maximum order is rounded up to the next whole number.
Catch influenced by:

Number of Ships,
Ship Effectiveness,
Weather
Ship Effectiveness

**Ship Effectiveness (Fish per Ship per Year)**

- **Deep Sea**
- **Coastal**

Graph showing the relationship between fish density and ship effectiveness for coastal and deep sea fishing.
Recent History of the Fisheries

YEAR | CATCH | SHIPS

PRESENT
FishBanks

• One ocean: Atlantic, Pacific
• 5 teams in each ocean, 3-4 people per team
• The oceans are separate
• Fish do not move between oceans
• Ships do not move between oceans
• Conditions identical except for your decisions
Let’s Go Fishing

 Winslow Homer, Fishing Boats, Key West (1903)
Login

• 1 Laptop per team  
  (put all others away please)

• Go to: http://bit.ly/fishbanks

• Login with the user name and password we hand out

• **STOP** – wait for instructions
Welcome to the Fishbanks Simulation

Student
- Play as individual
- Play as part of a class

Administrators
- Set up a new class
- Register as an administrator
- Administer an existing class
YEAR 1

**Buy**

- **Seller**
  - Number of Ships: 
  - Reserve Price: 

**Sell**

- No. of Ships: 0
- Reserve Price: 

**Current Total Fleet**: 3

**Ship Market Value ($/Ship)**: 300
**Number of Ships (Ships)**: 3
**Value of Ships ($)**: 900
**Bank Balance ($)**: 600
**Total Assets ($)**: 1,500

**Expected Catch per Ship (Fish / Year / Ship)**: 
- **Harbor**: 0
- **Coast**: 15
- **Deep**: 25

**Price of Fish ($/Fish)**: 
- **Harbor**: 20
- **Coast**: 20
- **Deep**: 20

**Expected Revenue per Ship ($/Year/Ship)**: 
- **Harbor**: 0
- **Coast**: 300
- **Deep**: 600

**Operating Cost per Ship ($/Year/Ship)**: 
- **Harbor**: 50
- **Coast**: 150
- **Deep**: 250

**Expected Profit per Ship ($/Year/Ship)**: 
- **Harbor**: -50
- **Coast**: 150
- **Deep**: 250

**Maximum Ship Orders**
- No. of Ships: 2
- Total: 300 each

**Ship Allocation**
- No specific allocation details provided.

**Ship Orders**
- No specific order details provided.
**Fishing Areas**

**Deep Sea**
- Maximum Population: 2000 - 4000 Fish
- Annual Operating Cost: $250 per Ship-Year
- Productivity (Max Ship Effectiveness): 25 (Fish/year)/ship

**Coast**
- Maximum Population: 1000 - 2000 Fish
- Annual Operating Cost: $150 per Ship-Year
- Productivity (Max Ship Effectiveness): 15 (Fish/year)/Ship
### Profit Example

<table>
<thead>
<tr>
<th>1 Ship to Deep Sea</th>
<th>FISH SALES = $20 x 25</th>
<th>$500</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OPERATING COST</td>
<td>- $250</td>
</tr>
<tr>
<td></td>
<td>DEEP SEA SUBTOTAL</td>
<td>$250</td>
</tr>
<tr>
<td>1 Ship to Coastal</td>
<td>FISH SALES = $20 x 15</td>
<td>$300</td>
</tr>
<tr>
<td></td>
<td>OPERATING COST</td>
<td>- $150</td>
</tr>
<tr>
<td></td>
<td>COASTAL SUBTOTAL</td>
<td>$150</td>
</tr>
<tr>
<td>1 Ship to Harbor</td>
<td>HARBOR COST</td>
<td>- $50</td>
</tr>
</tbody>
</table>

**Profit** $350
Develop your Strategy

1. Your goal is to end the game with the maximum possible assets.

2. Discuss within your team what strategies for boat acquisition and allocation you will follow to attain this.

3. Write your strategy down.
### All auctions available

<table>
<thead>
<tr>
<th>SELLER</th>
<th>NO. OF SHIPS</th>
<th>RESERVE PRICE ($/SHIP)</th>
<th>HIGHEST BID ($/SHIP)</th>
<th>YOUR BID ($/SHIP)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bank</td>
<td>3</td>
<td>300</td>
<td>0</td>
<td>-</td>
</tr>
</tbody>
</table>

### Ship Market Values
- Ship Market Value ($/Ship): 300
- Number of Ships (Ships): 3
- Value of Ships ($): 900
- Bank Balance ($): 600
- Total Assets ($): 1,500

### Financial Statistics

<table>
<thead>
<tr>
<th>Harbor</th>
<th>Coast</th>
<th>Deep</th>
</tr>
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<tbody>
<tr>
<td>Expected Catch per Ship (Fish / Year / Ship)</td>
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<td>-50</td>
<td>150</td>
<td>250</td>
</tr>
</tbody>
</table>

### Ship Allocation
- Maximum Ship Orders: 2
  - No. of ships: 2
  - Total: 0
- Ship allocation:
  - 0 (Lobster)
  - 0 (Tuna)

### Ship Orders
- Maximum Ship Orders: 2
  - No. of ships: 2
  - Total: 0
- Ready for next year? Yes
DATA DEBRIEF – WHAT HAPPENED?
CONCEPTUAL DEBRIEF – WHAT CAN WE LEARN?
Fishbanks Debrief

Winslow Homer, Fishing Boats, Key West (1903)
The Iceberg
A Metaphor for Systems Thinking

- Events
- Patterns of Behavior
- Systemic Structure
- More Leverage
Event level: the Headlines

Fishing banned at Georges Bank
Local fishermen fear overcrowding

Hearing casts fishery as sinking ship

Codfish depleted off Maine
Restrictions could hurt local fishermen

Lobstermen snag record 38m pounds

Loopholes found in fishing rules

N.E. lawmakers seek boat buyback ideas

Canada’s Gunboat Diplomacy
Chrétien to protect Atlantic fish stocks

Limits may follow as cod diminishes in Gulf of Maine

Feds approve boat buyback program
Hope to thin fishing fleet with $2m in incentives
The Iceberg
A Metaphor for Systems Thinking

- Events
- Patterns of Behavior
- Systemic Structure

More Leverage
Typical Game Behavior

INDEX

YEAR

Fish

Catch

Ships
Typical Game Behavior - Fleet

![Graph showing the increase in ships with the total fleet over the years.](image-url)
Typical Game Behavior - Catch

Deep Sea Catch

Coastal Catch

Fish per Year

YEAR

0 1 2 3 4 5 6 7 8

0 200 400 600 800 1000 1200

YEAR

0 1 2 3 4 5 6 7 8

0 200 400 600 800 1000 1200
Typical Game Behavior - Fish Stocks

YEAR

FISH

Deep Sea

Coastal
Pattern #1: Overshoot and Collapse

Atlantic Swordfish Catch

Pacific Bluefin Tuna Catch

Thousand Metric Tons/year


North Sea Herring Catch

Consider the Cod

• Northern or Atlantic Cod
  – Long-lived, slow to mature
  – Once immensely abundant
  • Early fishers (e.g., Basque) claimed fish so dense you could walk from Spain to the New World on their backs.
  • John Cabot, exploring Newfoundland in 1497, noted fish so thick they practically blocked his ship.

  – Harvest $\approx 250,000$ metric tons/yr through 1950s
  – Vital in feeding the Old World, in the development of the New World, and of Massachusetts:
The Sacred Cod
Massachusetts State House
“Probably all the great fisheries are inexhaustible; that is to say that nothing we do seriously affects the number of fish.”

– Thomas Henry Huxley, 1883
US Atlantic Cod Commercial Landings
(Metric Tons/Year)

Source: US National Marine Fisheries Service
Estimated Cod Stocks, Scotian Shelf (000 Metric Tons)

Rosenberg et al., Frontiers in Ecology, 2005
Overshoot and Collapse

Why the pervasive pattern of overshoot and collapse of fisheries?

Where are the leverage points for creating a sustainable fishery?

Where are they not?
The Iceberg
A Metaphor for Systems Thinking

![Image of an iceberg with labels: Events, Patterns of Behavior, Systemic Structure, More Leverage]
“Common Pool Resources”

- Limited Stock
- Limited Rate of Renewal
- Easily Appropriable (Low barriers to access)
- Rival (What you use, I can’t use)

**EXAMPLES:**

- Pastures
- Fish
- Forests
- Irrigation
- Clean Air & Water
- Climate

- Roads and Highways
- Parking Spaces
- Views
- Server Resources
- Trust among consumers
“The Tragedy of The Commons”
The Tragedy of the Commons

“Each man is locked into a system that compels him to increase his herd without limit—in a world that is limited. Ruin is the destination toward which all men rush, each pursuing his own best interest…”

“No technical solution can rescue us….”

“We may well call it ‘the tragedy of the commons,’ using the word ‘tragedy’ as the philosopher Whitehead used it: ‘The essence of dramatic tragedy is not unhappiness. It resides in the solemnity of the remorseless working of things.’
Collective Action

Elinor Ostrom: Winner, 2009 Nobel Memorial Prize in Economic Sciences
Elinor Ostrom’s Optimism

“I would rather address the question of how to enhance the capabilities of those involved to change the constraining rules of the game to lead to outcomes other than remorseless tragedies…”
Rule-Base for Alanya

- List of eligible fishers each September
- List all usable fishing spots
- Assign spots by lottery – one per fisher
- September – January: Each day each fisher moves east to next spot
- January – May: Each day each fisher moves west to next spot
Design Principles for “Governing the Commons”

- Individuals know the boundaries and limits
  - Of the resource ("Common Pool Resource")
  - Of the community of users ("Appropriators")
- Rules are locally made and adapted to context
- Decisions are made together
- Active measurement and monitoring
- Effective, graduated sanctions
- Accessible mechanisms for conflict resolution
- Latitude from higher authorities to act locally

Leadership question: how do we enroll and mobilize people to create these conditions?
LearningEdge

A free learning resource for management educators and students

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The case studies available on LearningEdge are teaching case studies, narratives that facilitate class discussion about a particular business or management issue.

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Overview

The teaching case studies available on LearningEdge, which fall under the headings of entrepreneurship, leadership/ethics, operations management, strategy, sustainability, and system dynamics, are narratives that facilitate class discussion about a particular business or management issue. Teaching cases are meant to spur debate among students rather than promote a particular point of view or steer students in a specific direction.

Some teaching cases featured on LearningEdge highlight the decision-making process in a business or management setting. Other cases are descriptive or demonstrative in nature, showcasing something that has happened or is happening in a particular business or management environment.

Whether decision based or demonstrative, teaching cases give students the chance to be in the shoes of a protagonist. With the help of context and detailed data, students can analyze what they would and would not do in a particular situation, why, and how.
Management Flight Simulations

“Deep actionable knowledge and decision-making skills develop when people have the chance to apply classroom theory in the real world, with its messy complexity, time pressures, and irreversible consequences.”

– John Sterman, Jay W. Forrester Professor in Computer Science

Role-playing games provide real-world lessons

MIT Sloan has long been a pioneer among business schools when it comes to action learning—creating real-world applications of classroom knowledge. Management flight simulations are the latest such application. These innovative and interactive tools create a virtual world in which students explore and participate in the critical management issues facing a range of industries and organizations.

Management flight simulations bring an experiential aspect to learning about complex systems. This type of action learning has more impact on students than simply listening to a lecture or engaging in a case study discussion. Students who participate in a simulation can see the immediate consequences of their decisions and learn what it’s truly like to juggle competing priorities amidst a constant influx of information.

Each management simulation offers video user guides and online instructions for students. Registered educators can access video teaching notes and slides that introduce and debrief all aspects of the simulation.
Featured Simulations

- CleanStart: Simulating a Clean Energy Startup
- Eclipsing the Competition: The Solar PV Industry Simulation
- Fishbanks: A Renewable Resource Management Simulation
  - en Español: Fishbanks: una simulación de gestión de recursos renovables
  - em Português: Fishbanks: uma simulação de gerenciamento de fontes renováveis
  - 简体中文版本: Fishbanks（鱼行）：可再生资源管理模拟游戏
- Platform Wars: Simulating the Battle for Video Game Supremacy
- Salt Seller: A Commodity Pricing Simulation
- World Climate: Negotiating a Global Climate Change Agreement
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