NETWORK SCIENCE

Fish Supply

NE STEM 4U

Fish Supply

Objective

The student will understand how being a part of a network (e.g. different roles) influences an individual's decision-making in addition to understanding positions of power within a fish supply network.

The student will be able to identify fish transfer (and money) in a fish supply chain network while seeing how each participant's goals compete with one another and are balanced by the network.

The student will engage with NGSS Crosscutting Concept 4. *Systems/System Models.*

Vocabulary

Networks: 1) are a set of relationships 2) show how things are connected 3) reveal hidden information.

Edge: A line that connects vertices in a network and represents a relationship. Arrows can indicate the direction of the relationship between two parties. The first example below shows an undirected edge where there is no communication between the two parties, but they are connected; the second example shows a directed edge where communication only flows one way; the third example shows a bidirectional edge where communication flows two ways. For this activity, think about the deliberation for selling/buying fish and how these interactions demonstrate these arrow examples.

Background

Scan this QR code to open an explanation of supply chain networks! →

The Fishing Industry has been around for a very long time. Many jobs are tied to the industry, including people who actually catch the fish, sell the fish, and everything in between. This includes marketing, transporting, and even farming the fish. The fishing industry has become very large and generates a lot of revenue globally. This industry has also gained popularity through viewership of reality tv shows (e.g. Wicked Tuna) amongst others, to demonstrate parts of

the supply chain. Within the seafood industry, commercial fishing is a major component that highlights a supply chain.

A supply chain is expressed as the process of making and selling goods. It includes supplies and materials, manufacturers, distributors, and consumers. Supply chains are used for many reasons, and are efficient at providing the 'big picture' of the flow of a good or resource amongst various stakeholders, in addition to the intercollaboration that exists amongst various stakeholders in the supply chain.

This supply chain activity demonstrates the network of the fishing industry as a supply chain. Throughout the activity, students are provided with different scenarios that would mimic the real world and possible situations faced by the industry. In some activities, the fish catchers are limited to the number of fish they can take, mimicked by the fact that people do not always have a good day at sea when catching fish. Also, prices may differ from wild-caught and farm-raised fish or in relation to the availability of the resource (fish). The conversations that develop in the scenarios about prices between the fish market and consumer or the fish catcher and fish market are all elements of the supply chain network at large. The network can branch out many different ways with the introduction of new stakeholders or changes in power, but will always keep the same cycled structure of a supply chain (supplier, distributor, retailers, and consumers).

***Feel free to use some of the video resources in the references section for a deeper overview of supply chains if needed! ***

Materials

For the class (Group size 4-5 students) [We recommend having enough complete sets of money and fish, so each group of four youth has their own set (e.g., 20 youth = 5 groups/sets).]

- Mini whiteboard sets or paper/pencil (to draw individual network)
- 120 paper fish (wild-caught)
- 90 paper fish (farm-raised)
- Fake Money amounts of $10s, $5s, $1s
- Facilitator chooses amount for each role to start with (must be the same)
- Fish "player cards" with rules sheet (in resources)

- Dice
- Timer
- Plastic cups (one for each fish catcher role card)
- Ping-Pong balls (one for each fish catcher role card)

Procedure

Activity – Fishing Market

1. Welcome youth and provide an ice breaker activity to promote community building amongst the students *(e.g. What is your favorite activity to do outside of the school day?)*.
2. Introduce the topic of how the fishing industry and supply chains work together to create a network concept.
3. Provide youth with a quick summary about the roles in the game and that there will be a different scenario each round.
4. Have youth pick a face-down role card. This will be their role for the duration of the activity.
    a. There are four role cards:
        i. Consumers
        ii. Fish market sellers
        iii. Fish catchers
        iv. Fish policy-maker

****Note: Each role starts with 45 dollars of money, or an amount chosen by the facilitator (except for the fish policy-maker, which will have zero). [Larger denominations make the game less interesting – less ability to barter]**

5. Have the youth read their cards and then see if they have any questions about their roles.

Scenario One: No Regulation

1. Provide the rules for scenario one to the group:
    a. Fish catchers are allowed to take as many wild fish as they want from the lake. However, they cannot take more than 15 fish at once because that is the LIMIT for how many fish their boat can hold.
        i. Here is the 'catch': For a fish catcher to take from the lake, they must

bounce a ping-pong ball into a cup on the table in front of them (can be as close or as far away from them as facilitator chooses). IF fish catchers are unable to bounce the ping-pong ball into a plastic cup, then they had a bad day of fishing and are unable to take fish from the lake.

b. Fish catchers will sell fish to the fish market at a price they agree upon.
c. Fish markets will sell fish to consumers at a price they agree upon.
d. Fish policy-maker will keep track of how many fish are caught by the fish catcher and how many fish remain in the water. They will make a graph out of this information to report out at the end of scenario one.

2. This scenario is played out for 6-7 minutes.
3. Once complete, ask individuals to draw a network of their transactions, drawing lines to the different roles or people with whom they did business and where the fish traveled through the group.
4. Have students reflect on what happened and what strategies they used.

Scenario Two: When Regulation Happens

1. Rules for scenario two are the same as scenario one, but with one ADDED piece below:
    a. Fish policy-maker rolls dice, making sure the fish catchers do not take extra fish beyond the allotted amount below. There will be 30 seconds for each fish catcher to catch fish under the fish policy. Every 30 seconds the fish policy-maker will roll the dice to determine the 'new policy' for the number of fish the fish catcher can take from the lake per successful ping-pong ball bounced into the cup. This is monitored by the fish policy-maker.
        i. Rolls 1 = Nothing, proceed as normal (can take up to 15 fish at once for a successful ping-pong ball bounced into cup).
        ii. Rolls 2-3 = Fish catcher catches 1 fish per successful ping-pong ball bounced into the cup.
        iii. Rolls 4-5 = Fish catcher catches 2 fish per successful ping-pong ball bounced into the cup.
        iv. Rolls 6 = Fish catcher catches 3 fish per successful ping-pong ball bounced into the cup.

****Note: The fish catcher can only take out fish caught as a result of a successful Ping-Pong ball bounced into the cup and per the policy constraint for the time. This is**

enforced by the fish policy-maker.

2. The scenario is played out for 6-7 minutes.
3. Once complete, ask individuals to reflect on how this scenario was different than the first. Did the network for selling or buying fish change?
4. Have students reflect on what happened and what strategies they used.

Scenario Three: When You Introduce Farm-Raised Resources

1. Rules for scenario three are the same as scenario one, but with one ADDED piece below:
    a. Fish policy-maker rolls dice, making sure the fish catchers do not take extra fish beyond the allotted amount below. There will be 30 seconds for each fish catcher to catch fish. Every 30 seconds the fish policy-maker will roll the dice to determine the 'new policy' for the number of fish the fish catcher can take from the lake per successful ping-pong ball bounced into the cup. This is monitored by the fish policy-maker.
        i. Rolls 1 = Nothing, proceed as normal (can take up to 15 fish per successful ping-pong ball bounced into the cup from either wild-caught OR farm-raised fish)
        ii. Rolls 2-5 = Fish catchers catch 4 farm raised fish from the "farm lake" after a successful ping-pong ball bounced into the cup
        iii. Rolls 6 = Fish catchers catch 2 wild-caught fish from the "main lake" after a successful ping-pong ball bounced into the cup

****Note: The fish catcher can only take out fish caught as a result of a successful Ping-Pong ball bounced into the cup and per the policy constraint for the time. This is enforced by fish policy-maker.**

2. The scenario is played out for 6-7 minutes.
3. Once complete, ask individuals to reflect on how this scenario was different than the first two scenarios. Did the network for selling or buying fish change?
4. Have students reflect on what happened and what strategies they used.

Differentiation/Extension

Encourage students to imagine what happens when there are disruptions in supply chains (e.g. reducing the number of fish) and who has more or less power to set the price

in a supply chain. Encourage youth to think of examples in their own lives where the price may have gone up or supply was short (e.g. Toilet paper at the start of the Covid-19 pandemic; lumber later in the pandemic).

Thinking Prompts/Guiding Questions

Scenario 1: No Regulation

- What interactions did you have where there was two-way communication for setting a price? Who did you feel like had the most power in their role?
- How many fish were left in the lake? Would this method be sustainable to a wild population or a resource without control?

Scenario 2: When Regulation Happens

- What happened to the fish population when the fish policy-maker controlled the fishing?
- How did the interactions change based on the number of available fish for setting the price? Who did you feel like had the most power in this scenario?

Scenario 3: When You Introduce Farm-Raised Resources

- Why would a farm-raised fish population be important for the wild fish population?
- How did your original network and communication change from the first scenario to the second and then to this final scenario? Did anything change? Did you communicate buying/selling the fish differently? How so?
- What happens with non-renewable resources?
- In what ways could the supply chain be "cheated?"
- Example: Fish catcher pays off the fish policy-maker to 'look the other way' or the consumer decides to just go fishing themselves and cut out all the other people.

Career/Future Application

Environmental scientists or Fisheries scientists would be interested to know about processes that can influence overfishing, while someone involved in marketing might be interested in how different transactions take place. In healthcare, supply chain experts plan for the dissemination of vaccines to reach the people who, if vaccinated, can save the most lives. Supply chain experts use computer software and data to solve challenges such as how to get all of the equipment necessary for hospitals during disasters. It is possible to major in Supply Chain Management in college.

Job Description:

Nike Supply Chain experts ensure that every year 1.3 billion pieces of footwear, apparel, and equipment arrive at the right destination on time. That is no easy task. The complex process involves more than 60 distribution centers, a network of thousands of accounts, and more than 100,000 retail stores around the world. Supply Chain professionals constantly push for ways to make Nike's supply chain faster, more efficient and more responsive to Nike's always-changing consumer needs.

References

- 1:27 minute video and brief write up on the "power of the network" for supply chains on this web page – useful background for facilitators:

- 7-minute video by a business consultant looking at good shapes of networks and what factors influence them:

Academic Articles

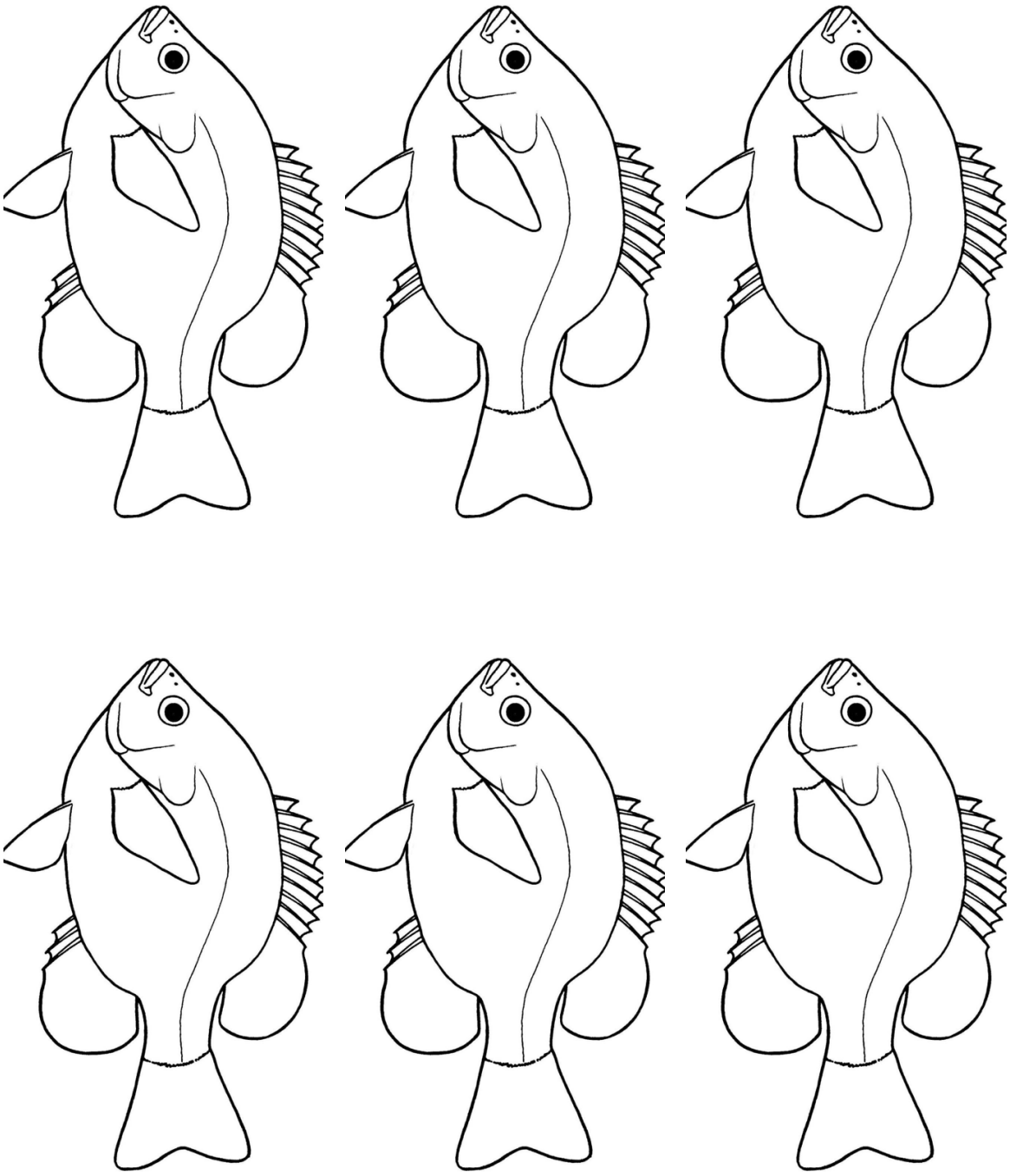
Bellamy, Marcus A. and Rahul C. Basole. 2013. Network Analysis of Supply Chain Systems: A Systematic Review and Future Research. Systems Engineering. 16:2:235-249. DOI 10.1002/sys.21238

Cramer, Mary E., Ozgur M. Araz, and Mary J. Wendl. 2017. Social Networking in an Agricultural Research Center: using Data to Enhance Outcomes. Journal of Agromedicine. 22:2:170-179. http://dx.doi.org/10.1080/1059924X.2017.1282905

Frerichs, Leah, Ozgur M. Araz, Larissa Calancie, Terry T-K Huang, and Kristen Hassmiller Lich. Dynamic Empirically Based Model for Understanding Future Trends in US Obesity Prevalence in the Context of Social Influences. Obesity (2019) 0, 1-11. doi:10.1002/oby.22580

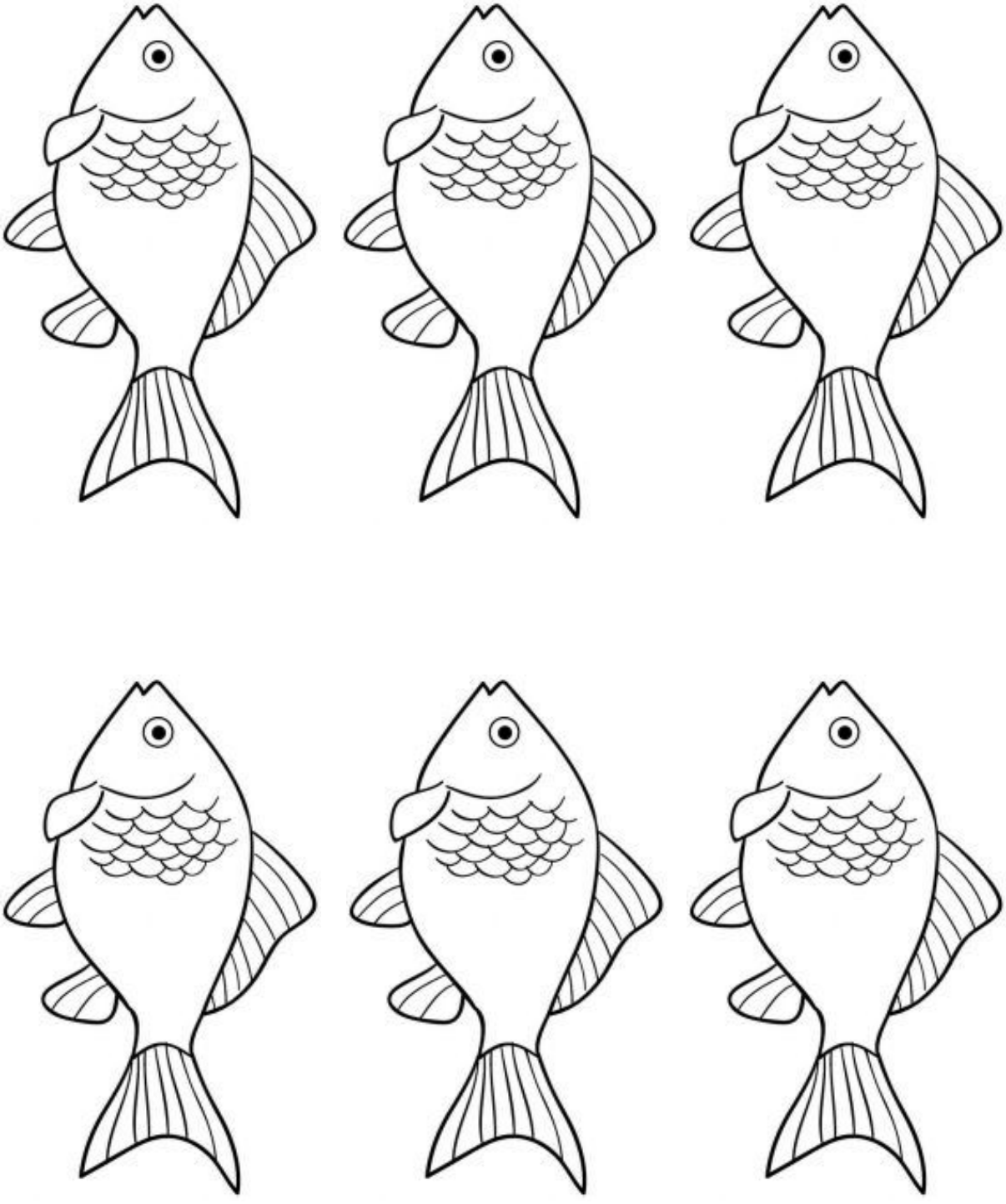
Nooy, W.D., Mrvar, A., & Batagelj, V. (2005). Exploratory social network analysis with Pajek. Cambridge: Cambridge University Press.

Rastogi, Aditya P., John W. Fowler, W. Matthew Carlyle, Ozgur M. Araz, Arnold Maltz, and Burak Burke. 2011. Supply network capacity planning for semiconductor manufacturing with uncertain demand and correlation in demand considerations. International Journal of Production Economics. 134. 322-332. doi:10.1016/j.ijpe.2009.11.006



Wild-Caught Fish Printout (20 sheets)

Farm-Raised Fish Printout (15 sheets)



The Fish Catcher:

Goal is to catch fish and make money selling fish to fish market.

Fish Fun Fact: *Operations in the Alaskan fisheries have generated a gross earning of around $455 million in one year.*

Important Rules for the Game

- *Overall Rules/ Scenario One*
    - Your boat is only so large, so you can grab a maximum of 15 fish at one time from the wild fish lake.
    - In order to grab fish, you must bounce a Ping-Pong ball into a plastic cup.
        - When you successfully do this, then you had a 'good day' of fishing and can grab fish from the lake.
        - IF you are unable to bounce the Ping-Pong ball into a plastic cup, then you had a bad day of fishing and are unable to take fish from the lake.
    - Once you catch fish successfully, you must sell the fish to the fish market role.
        - It is up to you to decide on a price with the fish market role.

- *Specific to Scenario Two:*
    - If the fish policy-maker rolls a 1 then no policy change, so proceed as normal (can take up to 15 wild fish at once for a successful Ping-Pong ball bounced into the cup).
    - If the fish policy-maker rolls a 2 or 3, then the policy is enforced that you can only catch 1 fish per successful Ping-Pong ball bounced into the cup.
    - If the fish policy-maker rolls a 4 or 5, then the policy is enforced that you can only catch 2 fish per successful Ping-Pong ball bounced into the cup.
    - If the fish policy-maker rolls a 6, then the policy is enforced that you can only catch 3 fish per successful Ping-Pong ball bounced into the cup.
    - **Pay attention** to what the fish policy-maker SAYS in relation to the current policy!

- *Specific to Scenario Three:*
    - If the fish policy-maker rolls a 1 then no policy change, so proceed as normal (can take up to 15 fish at once for a successful Ping-Pong ball bounced into the cup).
    - If the fish policy-maker rolls a 2, 3, 4, or 5, then the policy is enforced that you can only catch 4 farm-raised fish per successful Ping-Pong ball bounced into the cup

- If the fish policy-maker rolls a 6, then the policy is enforced that you can only catch 2 wild-caught fish from the main lake per successful Ping-Pong ball bounced into the cup
- **Pay attention** to what the fish policy-maker SAYS in relation to the current policy!

The Fish Market:
Goal is to buy fish from fish-catcher and sell to consumer and make as much money as possible.

Fish Fun Fact: *Seattle is home of one of the oldest public farmers market in the US that is still up and running.*

Important Rules for the Game

- *Overall Rules*
    - During each scenario it is up to you to decide on a price to buy fish from the fish catchers.
        - Be aware, they may have had a bad day fishing or may not have much to sell!
    - You must then look to sell for a profit to the fish consumer.
        - Work with the fish consumer to decide on a price to sell the fish to the fish consumer.
    - Collect as much money as possible!

The Fish Consumer:
Goal is to buy fish as cheaply as possible.

Fish Fun Fact: *Through calculations of different fisheries, the approximate global demand for fish consumption is around 144 Million tons per year. One ton is approximately 2,000 pounds…That's a lot of seafood!!*

Important Rules for the Game

- *Overall Rules*
    - During each scenario, it is up to you to decide on a price to buy from the fish market. You are a hungry customer, so you don't want to buy too expensive!
    - Be aware, there may not be a lot of fish up for sale if the fish catchers had a bad day out on the lake.
    - Look to get the best deal possible and buy the fish as inexpensively as possible from the fish market.

The Fish Policy-Maker:
Goal is to keep fish supply from being depleted.

Fish Fun Fact: *According to Marine Biologist Enric Sala, around 70 percent of fisheries are overfished. This is why it is important to have these policy-makers, to make sure these wild fish populations don't get overfished and depleted to a point that they cannot recover.*

Important Rules for the Game

- *Specific to Scenario One*
    - Keep a detailed log of how many fish are caught by the fish catcher and how many fish are remaining in the lake
    - Jot the information down on a sheet of paper and make a graph to share with the class after scenario one.
    - Who is taking the most fish?

- *Specific to Scenario Two*
    - As the fish policy-maker, you also have to ensure the population of wild fish does not run out, so you will roll the dice to determine the policy to deliver to the fish catchers.
    - Start a timer and every 30 seconds roll the dice, announce the rule to the fish catchers every 30 seconds.
        - If you roll a 1, nothing happens, have the fish catchers proceed as normal.
        - If you roll a 2 or 3, fish limit of 1!
        - If you roll a 4 or 5, fish limit of 2!
        - If you roll a 6, fish limit of 3!

- *Specific to Scenario Three*
    - As the fish policy-maker, you also have to ensure the population of wild fish does not run out, so you will roll the dice to determine the policy to deliver to the fish catchers.
    - Start a timer and every 30 seconds roll the dice, announce the rule to the fish catchers every 30 seconds.
        - If you roll a 1, nothing happens, have the fish catchers proceed as normal.
        - If you roll a 2, 3, 4, or 5, fish catchers can use the farm-raised fish and can catch 4!
        - If you roll a 6, fish limit of wild-caught fish is 2!