

Manual for FISH 4.0

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Brief Introduction

FISH 4.0 is a microworld exercise designed by University of Victoria professor Dr. Robert Gifford and programmed by Dr. Jorge Aranda for studying the resource management decision-making of individuals and small groups. It is especially useful for conducting studies that examine situations often called commons dilemmas, resource dilemmas, or social dilemmas. These situations focus on valuable, limited, common pool resources in which individuals make decisions whether to cooperate (harvest little, resulting in modest short-term gain but long-term conservation of the resource) or defect (harvest a large amount, resulting in large short-term gains but endangering or even extinguishing the common resource (Gifford & Gifford, 2000). FISH 4.0 can be run with either all human fishers, or both human and computer-simulated fishers. For a brief description of how a typical FISH 4.0 session proceeds, see “How to Fish” on page 5.

Access to FISH 4.0

Access to the FISH 4.0 program is available by request to Dr. Robert Gifford, at no charge. To request a copy, contact him at rgifford@uvic.ca.

FISH 4.0 Quick-Start Instructions

Below are simple instructions for running FISH 4.0 on an internet browser. FISH 4.0 is currently not compatible with Internet Explorer, so Firefox, Safari, or Google Chrome are the best options for running the program.

Once you receive an e-mail with the links to the program, begin by clicking on the FISH 4.0 Administration link. You will be asked to log in with a User ID, which will also be provided to you. Enter this ID and click “Login.”

You will see the following screen:

Fish Administration

Create a new group

Click this button to go to the New Group page:

Simulations in Progress

(loading...)

Simulations Completed

(loading...)

Click on “Create a simulation.” You will then be directed to the following screen, where a variety of parameters such as the number of fishers, the cost per fish, the number of fish, and many others can be modified.

Settings for a new simulation

General settings	Economics
Simulation name <input type="text"/>	Fish value <input type="text" value="3"/>
Total fishers per ocean <input type="text" value="4"/>	Cost to cast <input type="text" value="0"/>
Human fishers per ocean <input type="text" value="1"/>	Cost per departure <input type="text" value="0"/>
Oceans <input type="text" value="1"/>	Cost per second at sea <input type="text" value="0"/>
Fishing seasons <input type="text" value="4"/>	Currency symbol <input type="text" value="\$"/>
Season length in seconds <input type="text" value="60"/>	
Initial delay seconds <input type="text" value="10"/>	
Season delay seconds <input type="text" value="10"/>	
Allow client to pause? <input checked="" type="radio"/> Yes <input type="radio"/> No	
Allow early season end? <input checked="" type="radio"/> Yes <input type="radio"/> No	

The first step on this screen is to enter a name into the “Simulation name” text box. You will need to make note of this name, as your participants will use it to log in to the simulation. Simulation names are case sensitive, and do not allow for spaces.

For a Quick-Start run, simply leave the other parameters as they have been set by default. However, you may wish to vary the number of fishers or oceans, as well as the number of human fishers per ocean, to suit the needs of your study. Each ocean is a separate (independent) set of fishers, with the same simulation name and the same settings. For example, if you plan to have 5 participants, 5 oceans will be required in the simulation.

Scroll down to the bottom of the screen, and click “Create This Group.”

Your job is to consider all these factors, and the other fishers, and make your own decisions about how to fish. Fish however you wish.

Please ask if anything is unclear. We want you to fully understand the rules before you start fishing.

If you are sure you understand all the above, you are ready to fish. Click on the Go Fishing button on the right when you are ready. Once all the fishers have clicked this button, the first season will begin. (You may have to wait briefly for all the others fishers to click the button.)

Create this Group

To begin the simulation with your participants, open the participant view screen on each participant's computer; the link will be provided to you. Each participant will see the following screen:

Welcome to FISH, and thanks for participating!

Before proceeding, please wait for the experimenter to explain the next steps. When you are ready, enter the name of your group, and your participant ID.

Simulation name

Participant ID

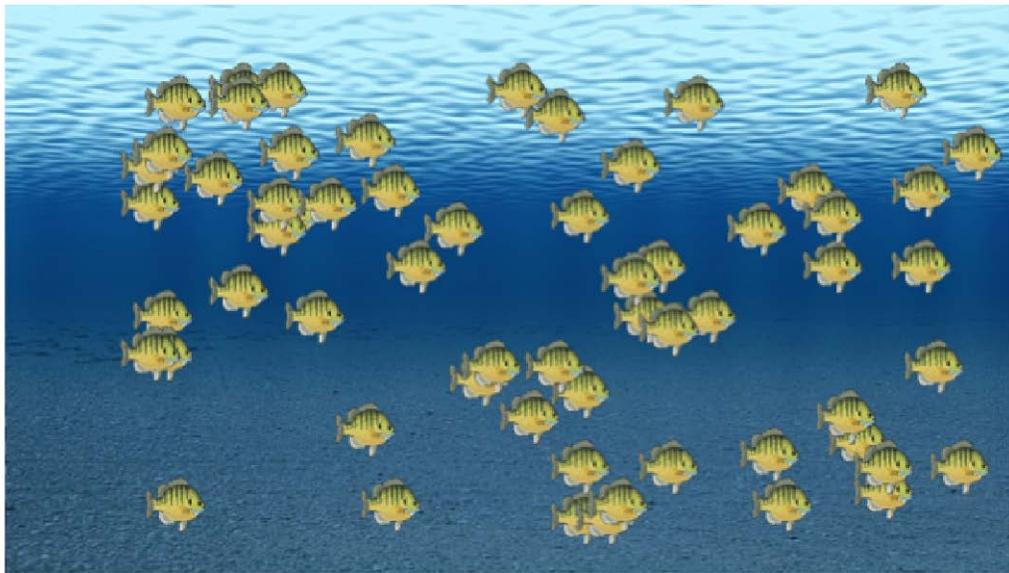
Get Started!

Here, the participants must enter the simulation name you chose, as well as their Participant ID. Each participant will have a unique Participant ID, and any participant ID code can be used; whatever works for your experiment.

Participants will now be ready to fish.

Participant View

Below is an image of the participant's screen, that is, what the fishers see on their screen.



Each fish earns you \$0.10

Fisher	Location	Fish caught season	Overall	Profits season	Overall
You		1	1	\$ 0.10	\$ 0.10
Participant 1		0	0	\$ 0	\$ 0
Participant 2		0	0	\$ 0	\$ 0
Participant 3		0	0	\$ 0	\$ 0

How to Fish

All choices are made with the grey rectangular buttons across the middle of the screen. To begin a fishing season, participants must click on the “Go out to sea” button. Only after all the fishers in that ocean have hit the “Go out to sea” button will the fishing season begin. This is true for all fishing seasons.

To cast for one fish, the fisher clicks on the “cast for one fish” button.

Ending the Fishing Session

When a fisher decides to stop fishing for the season, he or she clicks the “Return to port” button. Each fishing season ends when all the fishers in each ocean have returned to port or when all the fish have been harvested. You can also have a time-based season exclusively. That is, you can force the simulation to run through its full time, even though all fishers may have returned to port.

When the season ends, the fishers wait for the remaining fish (if any) to spawn in order to begin the next fishing season. The session can go on for multiple fishing seasons. The maximum number of seasons is set by you, on the “Settings for a new simulation” page.

For further instruction on how participants are to proceed in the simulation, view the YouTube tutorial video here:

<http://www.youtube.com/watch?v=9PGam-zTKcY>

Retrieving Data

Once all of the participants have completed the simulation, either because all the fish have been caught or all the seasons are complete, the data for the simulation will be available for you to view. Simply return to the administration page, enter the login, and scroll down to “Simulations Completed.”

Simulations Completed

- [t13-001.txt](#)
- [fish_post-009.txt](#)
- [fish_post-003.txt](#)
- [fish_pre-014.txt](#)
- [actest-002.txt](#)
- [stock-030.txt](#)
- [Fish-Testetx3-007.txt](#)
- [Fish-Testetx4-002.txt](#)
- [fishA-013.txt](#)
- [thais2-001.txt](#)
- [stock-017.txt](#)
- [teste99-001.txt](#)
- [t9-001.txt](#)
- [Fish-Testetx4-004.txt](#)
- [fishA-053.txt](#)
- [actest-001.txt](#)

Here you will find your simulation name. Click on the link and the details of the simulation will be available for viewing. The data can also be downloaded as a .txt file.

These Quick Start Instructions show how to create and run a basic FISH 4.0 simulation. However, many parameters for varying FISH 4.0 conditions can be set, and this will be explained in the following section of this manual.

FISH 4.0's Features

FISH 4.0 is a fully interactive environment. That is, the computers logged into each simulation actually interact with one another in such a way that when a fisher takes fish from the ocean, those fish disappear from the screens of the other fishers in the same ocean.

Many different scenarios are possible with FISH 4.0. Specifically, by varying the parameters on the “Settings for a New Simulation” screen, FISH 4.0 allows investigators to define:

- the initial and maximum size of the fish stock in each ocean (the limit is several hundred)
- the number of seasons (replenishment trials) for the session (no limit set)
- the regeneration rate of the fish stock (a multiplier, i.e., 2 doubles the fish remaining at the end of a season during spawning)
- the computer fishers' level of greediness (as a decimal number from 0 = not greedy at all to 1 = entirely greedy)
- the degree of uncertainty in the fish stock (as a maximum number of “uncertain” or “mystery” fish displayed as outlines in the ocean)
- the probability that each cast will be successful (a decimal number from 0 = never to 1 = always)
- the information displayed or not about the other fishers (e.g., number of fish caught, profit made, whether they are out fishing or have returned to port)
- the profits from and expenses of fishing (all are in dollars by default, thus 5 = 5 dollars), including:
 - the cost of leaving port to begin each fishing season, the cost per

second of being out on the ocean, fishing, the profits made while fishing

- the message that appears as instructions before the session begins
- the initial profit and expense balances of all fishers

The messages that are shown after the session ends (e.g., either that all fish have been taken and the resource is depleted or that the number of seasons of this particular session are over) can also be changed.

Note: Costs, expenses, and profits may be in hypothetical money, or in real money that fishers actually get paid by the researcher at the end of the session. If real money is used, it increases the mundane realism of the study because most real-world resource-sharing situations offer the opportunity for personal profit.

The “Settings for a new simulation” page contains definitions of the various microworld settings, such as how many seasons the session should last, remuneration per fish caught, and how many fish are in the ocean at the beginning. Many details are specified below.

FISH 4.0 Simulation Parameters

By modifying the parameters in different ways, through the “Settings for a new simulation” screen, one can create many variations of simulations. The following table explains many of the commonly varied factors.

GENERAL SETTINGS

Number of Oceans	The number of simulations that exist with the same simulation name and settings. If 10 people are participating individually with the same simulation settings, 10 oceans are required.
Fishers per Ocean	The number of human and computer fishers in each ocean.
Human Fishers per Ocean	The number of human fishers per ocean; human fishers will be distributed evenly across oceans.
Number of Seasons	The number of seasons fishing will last for before the simulation ends, provided that all fish are not harvested first.
Initial Delay	The number of seconds to pause while supposedly waiting for other fishers. Adds realism.
Season Delay	The number of seconds between seasons. Time for the participants to reflect on the state of the fishery.

ECONOMICS

Fish Value	The amount each fish that is caught is worth to the fisher.
Currency Symbol	The default is in dollars, but can be changed to any currency symbol.

FISH STOCKS AND FISHING

Certain Fish	The number of fish that will definitely be available in the first season of fishing.
Potential Mystery Fish	How many mystery fish the participants are told there could be
Available Mystery Fish	How many mystery fish actually exist in the simulation

Spawn Factor	The multiplier by which the remaining fish in each season will generate or spawn new fish. A spawn factor of 3 means the remaining fish will triple for the next season.
Chance of Catch	A decimal number between 0 and 1, where 1 means all casts are successful, and 0 means that each cast is never successful; 0.5 indicates that half are successful on a random basis.

BOTS (Computer Fishers)

Greediness	Value from 0 to 1; 0 causes bots to take no fish, 0.5 causes them to fish at an exactly sustainable rate, and 1 causes them to take all fish possible
“Should Bots be Erratic”	If yes, bots behave non-deterministically. They may or may not act at any given moment of the simulation. Adds to realism.
Hesitation Factor	Determines the likelihood that the bots will act; a higher hesitation factor value makes it more likely that the bot will act.

General Settings

Under “General Settings” you can vary the number of oceans, the **number of seasons** for which fishing will occur, and the **time in seconds** that each season will last.

The server automatically divides fishers into equal groups for the **number of oceans** specified. For example, if you indicate that there are twelve fishers and three oceans, there will automatically be four fishers in each ocean.

If the total number of fishers does not evenly divide into the desired amount of oceans, new participants will be placed in the next ocean in the queue. Once an ocean has all the participants it needs, its simulation will start. Any participants that log in afterwards will be assigned into the next ocean available.

The number of fishers per ocean is the total number of human and computer (bot) fishers. If there are 2 **human fishers per ocean**, participants will be assigned to an ocean randomly. Their simulation will begin when the required number of human fishers (in this case 2) have been assigned to that ocean, and the remaining number of fishers per ocean will be made up of computer fishers.

Initial delay is the number of seconds that will pass before the first season of the simulation begins, and **season delay** is the number of seconds that will pass in between seasons.

Allow client to pause? asks you to choose whether you would like to allow your participants to pause the simulation or not, and **Allow early season to end?** asks whether you would like a season of fishing to end either when all fishers have gone to sea and returned to port at least once, and when all fishers are inactive for three seconds.

Economics

In the following column, labeled “Economics,” you can vary:

- the value of each fish caught
- the cost to cast for a fish
- the cost to depart and go out to sea
- the cost per second at sea
- the symbol for the currency used. The default is in dollars.

Fish Stocks and Fishing

Mystery Fish

You can choose to include stock size uncertainty as a factor in the study, meaning there are “mystery fish.” These “mystery fish” may or may not exist because the exact number of fish is unknown to the fisher. Those that do exist may be caught and can spawn. The mystery fish are used to manipulate the degree of uncertainty about the number of fish in the ocean.

Mystery fish can be manipulated in the third column labeled “Fish stocks and fishing.” **Potential mystery fish** is how many mystery fish participants are told there could be; **available mystery fish** is how many there actually are. **Certain Fish** indicates the number of fish that will definitely be available at the beginning of the first season of the simulation.

For example, if there are:

- 40 certain fish
- 10 available mystery fish
- 20 potential mystery fish

participants would be told there are "between 40 and 60 fish". In reality, there are exactly 50 fish.

The **spawn factor** is the multiplier by which the remaining fish in each season will generate or spawn new fish. The default spawn factor is set to 2.0; this means that if 20 fish remain at the end of a season, they will spawn by a factor of 2.0 and 40 fish will be available for the following season. If the spawn factor were 3.0, 60 fish would be available for the following season. However, the total number of fish will not exceed the original number of fish. This is for ecological validity (oceans can only support so many fish.)

Chance of catch is the probability that each cast will be successful; this number is a decimal, with 0 meaning each cast is never successful, and 1 meaning that each cast is always successful.

Information Display

Under “Information Display” you can decide what information each fisher will be able to view about the other fishers. You can choose whether all fishers will be shown, whether their names will be shown, whether their location, in port or at sea, will be shown, as well as the number of fish they’ve caught and the total money they’ve earned.

As mentioned earlier, computer fishers, called “bots” can be manipulated as well. **Greediness** of the bots can be varied within a range of 0 to 1, where 0 causes them to take no fish, 0.5 causes them to take fish at an exactly sustainable rate, and 1 causes them to take every fish possible. Greediness can be kept constant across bots and across time, or can be varied for various bots, and can increase or decrease with time. Each individual bot’s greediness can be altered in the “Bots” column, if you choose to have individual greediness levels vary across bots. In this column, the names of the bots can also be changed.

The erratic option and hesitation factor give the bots more natural-seeming behaviour. When the **erratic** option is set to “Yes,” the bots behave non-deterministically; they may or may not act at any given time during the simulation.

The **hesitation factor** determines the likelihood that the bots will act. Note: the higher the hesitation factor is, the likelier it is that a bot will act at any particular time.

Setting the erratic option to “Yes” and the hesitation factor to a very low value will yield bots that take a long time to do anything.

Messages to Participants

At the very bottom of the screen, you will see the preparatory text, the end of simulation message, and the depleted fish stock text. Each of these texts can be changed by simply clicking on the text box and typing a new message. Currently, the program is available in English, Portuguese, and Spanish.

The **preparatory text** is seen by participants before the first season, the **end of simulation message** is seen after each season after fishing, and the **depleted fish stock text** is seen by participants if all fish are harvested in a season.

Once you have varied the parameters to meet the needs of your study, you are ready to click “Create this simulation” and invite participants to begin the simulation.

Suggestions for Using FISH 4.0 in Research

You may wish to watch the tutorial video:

<http://www.youtube.com/watch?v=Yx9mjLgPa2s>

Run a Practice Session

It is a good idea to allow fishers to engage in a practice session at the beginning of their participation. The practice session need only be two or three seasons long so that fishers can see how the program works and how the fishing conditions change from one season to the next. You want their choices to reflect their values, not their learning about how FISH 4.0 works.

To create different experimental conditions, enter the values you desire for the various parameters and simply click “Create this simulation.”

Output Files

FISH automatically collects, aggregates, and stores information about each fisher’s harvesting behavior in each season. It also computes four different cooperation formulae that measure both harvest restraint and harvest efficiency at both the individual and group levels for each season and over all seasons (cf. Hine & Gifford, 1996 and the next section of this manual). From this information, rates of defection (harvesting a large amount, resulting in large short-term gain but endangering or even extinguishing the common resource) and cooperation (harvesting little, resulting in modest short-term gain but long-term conservation of the resource) can be determined. This is the information (dependent variables) that researchers use to analyze the individual or group behavior of participants during the session.

Collecting and Saving the Output from FISH 4.0 Sessions

Transferring the Output into a Statistical Package for Analysis

The output is organized so that the individual data for each fisher,

as well as the group data of each separate ocean are easily displayed. The numbers produced in the output file can be transferred into statistical packages such as SPSS or Excel for statistical analysis.

To transfer the output into a statistical program such as SPSS, make sure that it is saved as a text (.txt) document (this can be done in Notepad). Then edit the document so that it is single-spaced with at least one space between each number on each row. Check that the rows and columns of data are set up the same as you would like them in the SPSS spreadsheet and then save the document.

Once the text document is edited and saved, open SPSS and choose “File”--“Open”--“Data” and in the box that says “Files of Type” choose “Text” or “All files”. Then find the text document that you saved the data as and click “Open”. When the “Text Import Wizard” box comes up click “Next” for all options (unless you wish to modify how the data will be imported) until you get to the screen that says “Finish” at the bottom and click on “Finish”. The data should then be automatically transferred into SPSS’s database.

Note that the data are produced for each season separately. This is useful for examining behavior during each season or identifying behavioral patterns across seasons. However, an average across all seasons for individual or group data may be calculated by hand or in the statistical package in order to examine behavior patterns across all seasons for the entire session (FISH 4.0 does not do this).

The Cooperation Formulae for FISH 4.0

Cooperation may be measured for each individual fisher, or for the group. It also may be measured in terms of harvest restraint in an absolute sense (i.e., x fish taken), or in the context of current stock size, that is efficiency (AKA conservationism or sustainability, i.e., x fish taken when y fish were available). This implies four

different measures of cooperation, as follows.

IR: Individual Restraint

IR ranges from 1 (if this harvester was totally restrained i.e., took no fish) to 0 (if this harvester took $1/N$ th of the entire pool), to $1 - N$ (a negative number, if this harvester took 100% of the pool), where N is the number of fishers. If this harvester has a score of 0, and all others did the same, the pool was exhausted and all harvesters had equal harvests; the fishers are thinking only of the present, with no thought of conservation. Scores less than 0 indicate very little restraint – this harvester was taking enough fish to rapidly deplete the pool by him- or herself. The lowest possible score depends on the number of fishers, because the formula reduces to $1-N$ when the fisher takes all the fish to him or herself. IR says nothing directly about sustainability, but a sustainable harvest pattern will receive a score between 0 and 1, depending on the spawning rate. IR is also the proportion of fish that would be left in the pool if all harvesters acted exactly as this one did.

GR: Group Restraint

GR ranges from 1 (no harvester in the group took any fish) down to 0 (if the harvesters as a group extinguished the resource by taking $1/N$ of the fish each). No restraint is 0, up to full restraint, which is 1. GR cannot fall below 0, because if it takes $1/N$ across all fishers, no fish are left.

IE: Individual Efficiency (No-Danger and In-Danger Forms)

Efficiency (both individual and group) is computed in one of two ways, depending on whether the stock (in any given season) was endangered or not (see Hine & Gifford, 1996 for details. Please also note that the formula for IE_{ND} is incorrect in the Gifford & Hine 1997 publication; however, the formula is correct within the

FISH 4.0 program and calculations done based from the program are correct).

IE_{ND} is the value for an individual fisher when the resource could regenerate to its original level, with enough harvester restraint, that is, OSS is less than or equal to $R*S$, where OSS is the original stock size, R is the regeneration rate, and S is the initial stock size at the beginning of the current season. Perfect efficiency or sustainability (i.e., this harvester took just enough fish so that, once spawning occurs, the resource would regenerate to its original size – ignoring what other harvesters do) receives a score of 1. Scores above 1 mean that the harvester took less than the most efficient amount (i.e., he or she was following a preservationist strategy rather than an efficiency or sustainability strategy, which could be called inefficient: not taking fish that would have been replenished naturally). Scores below 1 indicate the other kind of inefficiency – taking so much of the resource that the fish will be unable to regenerate to their original level when spawning occurs. A score of 0 means the harvester took $1/N$ th of the whole existing pool, far too much for the pool to regenerate. Scores below 0 indicate even greater inefficiency or greed.

IE_D is the value for an individual fisher when the resource cannot regenerate to its original level even if all harvesters take nothing. That is, the original stock size (OSS) is greater than the regeneration rate times the initial stock size ($R*S$). The ideal harvest when the stock is in danger is no fish, so as to build up the stock to its original level. IE_D ranges from 1 (full restraint – no fish taken) to negative numbers, exactly like IR does.

GE: Group Efficiency (No-Danger and In-Danger Forms)

GE_{ND} scores will be 1 when the group as a whole harvests exactly enough to allow full resource regeneration, no more and no less; thus, perfect efficiency. Scores greater than 1 indicate group

harvesting that reflects preservationism or under-harvesting. More of the resource could have been taken and full regeneration would still occur. Scores smaller than 1 indicate some greed-based inefficiency at the group level; a score of 0 indicates the group exhausted the resource, leaving none to regenerate for the next season.

GE_D can range from 1, when the group engages in maximum restraint (i.e., takes none of the resource) to 0, when the group takes all the resource.

Questions or Comments

Questions or comments about the program's concept and design should be directed to Dr. Robert Gifford (at rgifford@uvic.ca). Questions about the software implementation and usage should be directed to Dr. Jorge Aranda (at jorge.aranda@cuevano.ca)

References

Gifford, J., & Gifford, R. (2000). FISH 3: A microworld for studying social dilemmas and resource management. *Behavior Research Methods, Instruments, & Computers*, 32, 417- 422.

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