Wa-Tor for Windows

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The following help topics are available:

Introduction

Welcome to Wa-Tor, the sharks and fish game for Microsoft Windows.   This program allows you to create your own world, populated with tasty fish and hungry sharks, and watch how the population changes through time.

You can change parameters that determine how often the sharks and fish breed and how soon the sharks will starve if they can't eat a fish.   If you get the settings right, the populations will live for a long time. Get them wrong, however, and the sharks might eat up all the fish, then starve to death.   They might also all die off before finding any fish to feed on.

It is fun to cheer on the sharks and fish as they battle it out, but this game is also a simulation of some ideas from population ecology, although it is a very simplistic model.

The idea for this game comes from A.K. Dewdney's "Computer Recreations" column in the December 1984 issue of *Scientific American*.

Starting Wa-Tor

When you first start Wa-Tor, you will see the blank <u>game board</u> and the <u>population graph</u>.   You can first change the initial parameters through the <u>Options menu</u>, then start or stop the simulation through the <u>Game menu</u>.   You can view other types of graphs through the <u>Graphs menu</u>.

The game board can be cleared and a new game started by choosing "New" from the <u>Game menu</u>.

Changes made to the <u>parameters</u> in the middle of a run take effect immediately.

Game Board

Wa-Tor is a toroidal (doughnut-shaped) planet completely covered by an ocean.   The game board shows a map of the planet flattened out into a square.   If a fish or shark moves off one edge of the map, it will reappear on the other side.

At the start of the game, fish   and sharks   are placed randomly around the board.   You control how many are there at the start through the options menu.   When the game starts, each fish and shark moves once during a chronon (time unit). Fish move onto the next adjacent space, chosen randomly.   Sharks will first look around to see if a fish is within snapping distance; if not it too will move onto an unoccupied space.

After all fish and sharks have moved once, the scoreboard will be updated to show the current population. The movements for the next chronon will then begin.

Population Ecology

Population ecology is the study of assemblages of individuals of one species and the interactions between these groups.   A group of organisms can be considered a population when they occur in a well defined region.   For example, the golden eagles of western Scotland comprise one population, whereas those of the Rocky Mountains in North America are another.   The individuals within each of these populations are likely to interact with each other, but not with those of the other population.

Of particular interest to population biologists are the factors involved in the variability, stability, and density of these populations.   To learn more about these factors, they will study various aspects of populations. These include their birth and death rates, the numbers of organisms of different ages in the population, the relationship between the organisms and those that they feed on (or that feed on them), and the various degrees of competition and co-operation within the population.   Much of the work depends on developing mathematical models that simulate what is seen in the real world.

The game Wa-Tor mainly focuses on providing a simplistic model of predator-prey relationships.   The rate at which sharks eat fish depends on the density of the two populations, which   is in turn affected by the rates of predation.   This relationship can fall into a cyclic pattern if the birth and death rates (which you set through the Options menu) are well balanced.   The graphs provided with Wa-Tor can demonstrate this cyclic pattern, as well as showing the fluctuations in the individual populations and the age structure of the populations.

Game Menu

The options on this menu allow you to control the running of the simulation.   After you have set the initial parameters you can choose "Start" to set up the game board and begin the simulation.   At any time during the run you can choose "Stop" to pause.   The fish and sharks will continue moving until the chronon is finished, then the action will stop while you examine the board.

You can restart the run by choosing "Start" again, or you can choose "New" to clear the board and start over at chronon 0.   Choosing "Exit" at any time will terminate the program.

Options Menu

This allows you to change the parameters that control the simulation.

Fish

Breeding age: The age interval at which a fish will produce a new fish.   They can only breed if there is an adjacent empty space, onto which the parent fish moves after giving birth.   These fish breed parthenogenetically; that is they don't need to mate with another fish before breeding.   Thus a single remaining fish can repopulate the world.

Initial #: This parameter controls how many fish are created at the start of the game.   The maximum initial number is 960.

Sharks

Breeding age: The age at which a shark will produce a new shark.   They can only breed if there is an adjacent empty space, or a space with a fish, which is eaten while the shark is giving birth.   The sharks also breed parthenogenetically.

Initial #: This parameter controls how many sharks are created at the start of the game.   The maximum initial number is 960.

Starvation time: This controls how long a shark can live without eating a fish.   A shark will move one last time, looking for a fish, before it starves.

Save results to file

The results of a Wa-Tor run can be saved to a file for further analysis.   For each chronon, the fish and shark populations are saved.   The results are saved in comma-delimited (.CSV) format so that they can easily be imported into a spreadsheet for graphing and analysis.

If this box is checked when you press "Ok", you will be prompted for a filename.   If you wish to stop saving results in the middle of a run, just call up the Options dialog box again and uncheck this option.

Graphs Menu

This menu allows you to choose which graphs you want to see while the simulation is running.   Each type of graph can be toggled on or off; and a check mark indicates which are being shown at the moment.

The three types of graphs available are <u>Population Graph</u>, <u>Predator/Prey Graph</u>, and <u>Age Structure Graph</u>.

Population Graph

This graph shows the fluctuations through time of the fish and shark populations.

The horizontal axis represents time in chronons (with a maximum of 100 chronons shown on the graph) while the vertical axis indicates the population of each type of organism at that time, ranging from 0 to 961.

These curves will generally show smoothly rising and falling populations, with the maximum shark population trailing behind the peak fish population.   This pattern emulates the result of one of the basic tenets of population ecology, the Lotka-Volterra equation, which models the changes in populations of predators and prey in real life.

This pattern is produced as follows: as the fish population increases, the sharks find that there is an abundance of food. Therefore the chances of a shark starving are reduced and they can increase in numbers.   Soon, however, the fish are eaten faster than they can breed and the fish population begins to fall.   When this happens the shark population will also begin to decrease within a few chronons.

Predator/Prey Graph

This graph type plots the population of fish (horizontal axis) against that of sharks (vertical axis).   It is designed to show you the relationships between the population levels of the predators (the sharks) and their prey (the fish).

This graph clearly shows the cyclic nature of the population fluctuations, as the curve inscribes a counterclockwise path around an equilibrium point.

Vertical and horizontal lines can be drawn through this central point, dividing the graph into four regions. When the shark population falls below the horizontal line, the fish population begins to increase due to decreased predation.   Likewise, when the fish population rises above the vertical line, the shark population increases, since food has become abundant.

Age Structure Graph

This graph shows the distribution of ages of individuals in a population at any one time.   The horizontal axis indicates the percentage of the population, while the vertical axis represents age.   Each bar thus shows what percentage of the population is of a certain age.

Populations that are growing slowly will show a relatively even distribution of ages, slowly decreasing upwards.   Rapidly expanding populations will exhibit a bottom-heavy pattern, with a high percentage of individuals being relatively young.

One curiosity of this graph in the Wa-Tor simulation occurs when the fish population expands rapidly and fills the board at the beginning of a run.   When the population is close to its maximum, there are no more spaces available for new fish, so breeding stops due to "overcrowding".   You will then see a group of bars representing similarly aged individuals moving up the graph, with very small bars near the bottom. Eventually this cohort of elderly fish will be eaten by the expanding shark population and the graph will settle down into a more even pattern.

Further Reading

There are numerous books about ecology that provide more information about population biology.   Your local library should have some.   I can recommend two books that I have used.   R.E. Ricklefs' *Ecology* (1979, Chiron Press, New York) is a classic book covering all fields of ecology in great detail, with many examples.   It discusses population ecology very thoroughly.   *Population Ecology: A Unified Study of Animals and Plants, 2nd edition* by M. Begon and M. Mortimer (1986; Blackwell Scientific Publications, Oxford) focuses on this field.   It is well written and is geared towards a wider audience than Ricklef's book.

Registration

Wa-Tor is a shareware game.   This means that you can freely copy it and give it to friends and colleagues.   A charge may be made for distribution to cover costs, so long as you make it clear to the recipient that a payment must also be made to the author for continued use.   See the file VENDOR.DOC that accompanies this program for details.

You may use this program on a trial basis for up to 30 days.   If you like the program and wish to continue using it, a registration fee of UK£10 plus shipping & handling must be paid.   The registration may also be paid in the equivalent amount of US dollars; in May 1993 the exchange rate was 1.55 $/£, giving a registration price of $15.50 plus shipping and handling.   In return, you will be sent a disk with the latest version and you will be notified of any updates to Wa-Tor, as well as of <u>other programs</u> produced by Kovach Computing Services.

If you wish to use the program for teaching, then you must register.   A copy of Wa-Tor must be purchased for each machine it is used on.   Discounts are available for purchases of multiple copies of Wa-Tor, according to the following table:

Copies	Price per copy
1-10	£10
11-20	£8
21-50	£6
51-100	£4

Payment may be made by credit card (Visa, MasterCard, Access, or Eurocard), cheque in UK pounds or US dollars (drawn on a UK or US bank), international money order in pounds or dollars, Eurocheque in pounds, or (if you want to risk it) by sending banknotes through the post.   Cheques should be made payable to *Kovach Computing Services*.   If paying by credit card, please be sure to include the card expiration date and your billing address.   Credit cards will be charged in UK pounds; your card company will bill you in your local currency.

To register, please print out and complete the order form in the accompanying file REGISTER.DOC and send it with your payment to:

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Other Products
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Kovach Computing Services specializes in developing easy to use scientific software at reasonable prices.   We also doing consulting in data analysis, particularly using multivariate methods.

Current products from KCS include:

MVSP - A MultiVariate Statistical Package.
MVSP is a program for the IBM-PC and compatibles that performs a variety of ordination and cluster analyses.   It provides an inexpensive yet easy means of analysing your data in fields ranging from ecology and geology to sociology and market research.   MVSP is in use at hundreds of sites in over 45 countries.   The results of analyses using MVSP have been published in numerous journals, including Science,
Nature, Ecology, Journal of Petroleum Geology, and Journal of Biogeography.

MVSP performs several types of eigenanalysis ordinations: principal components (PCA), principal coordinates (PCO), and correspondence/detrended correspondence analyses (CA/DCA).   It can also perform cluster analysis, using eighteen different distance or similarity measures and seven clustering strategies.   Diversity indices may be calculated on ecological data; these include Simpson's, Shannon's, and Brillouin's indices.   Data matrices up to 750x750 may be analysed.   Scatterplots and dendrograms can be produced and printed on a variety of printers and plotters.

Price: UK£65 + shipping & handling

Oriana for Windows - Orientation Analysis
(to be released Autumn 1993)
Oriana calculates a variety of statistics on angular data, measured in degrees.   It is written for Microsoft Windows and, unlike most Windows statistics programs, follows the Windows conventions so that it is easy to use and intuitive.

Oriana calculates the mean angle, length of the mean vector, and mean angular deviation for each sample.   In addition, sample means and data distributions may be compared and tested using F-tests and Chi-square tests.   Circular histograms (or rose diagrams) may be plotted for each samples and printed on any Windows printer.

Price: TBA

Other developments
Other statistical programs for Windows are under development.   If you wish to be placed on our mailing list for news about future releases, please write to us at the address listed in the Registration section or in the "About" box in the program.