

EcoNet

A web-based software for
ecological modeling,
simulation and analysis

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What does EcoNet do?

What is EcoNet?

Why EcoNet?

Features

User base

Interface

Model structure

Model format

Flow types

EcoNet structure

How to use?

Feature

- Creates a network diagram of the model

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- Creates a network diagram of the model
- Converts the model into:
 - ◆ An Ordinary Differential Equation (ODE)
 - ◆ A Stochastic Differential Equation (SDE)
 - ◆ A Discrete Stochastic Process (Gillespie)

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- Solves the appropriate equations numerically
- Plots a time course diagram of stock values

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- Plots a time course diagram of stock values
- Performs Ecological Network Analysis, based on the final state of the system.

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- Current simulation and analysis methods and high performance algorithms are hidden behind a simple interface.

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 - ◆ An educational tool or a research software?
 - ◆ eg. Stochastic simulations, Large models.
- Brings the thought process and results closer.

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- Easy to learn and use

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- **Easy** to learn and use
- **Fast** and efficient.

Advantages of EcoNet

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- **Server-side** web application (not client side)

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- Modular and flexible structure.

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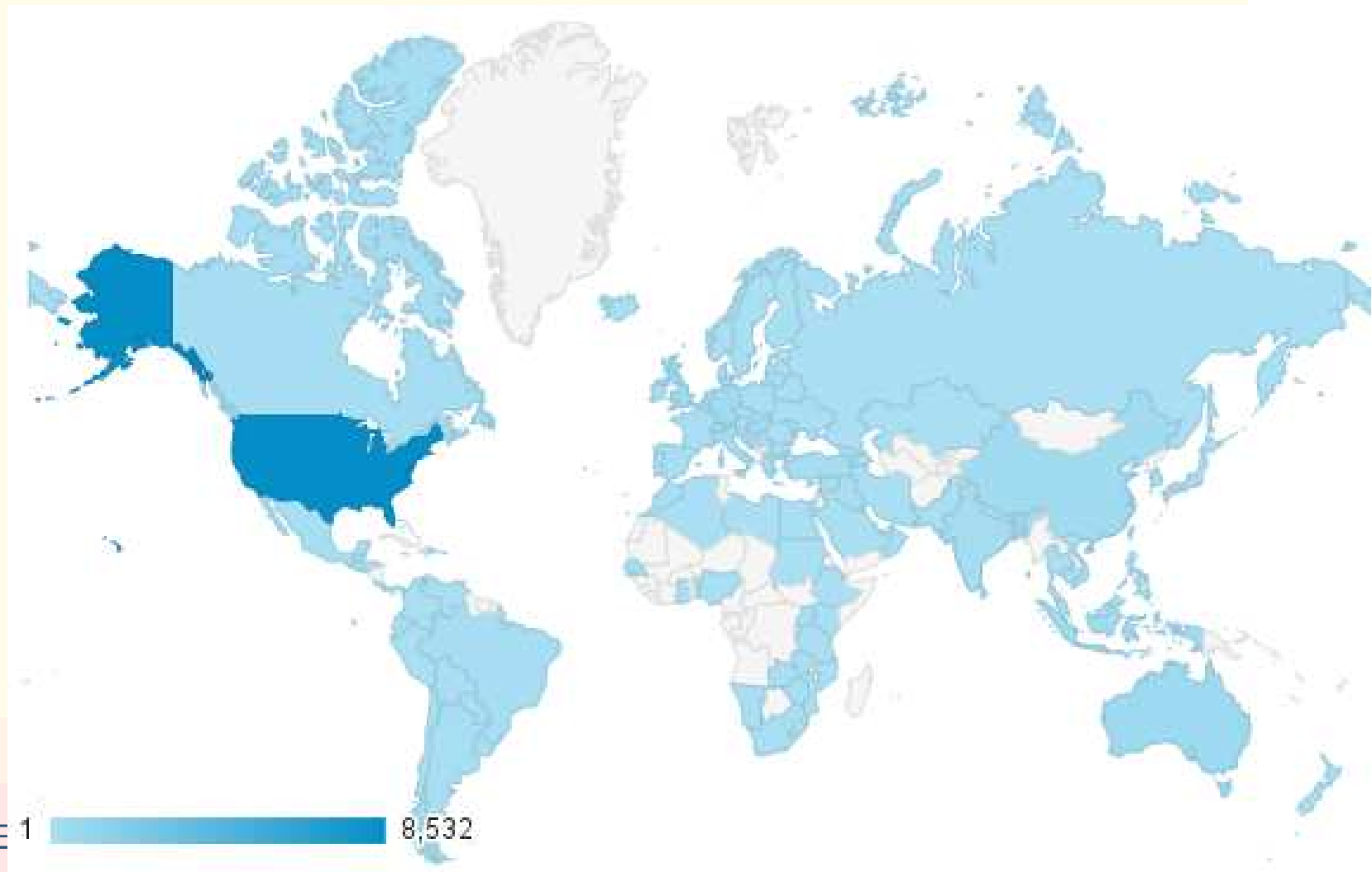
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- Publication quality figures.
- Modular and flexible structure.
- **Free!**

Who uses EcoNet?

- Over 15000 unique visits from over 127 countries
- Around 500 people have accessed EcoNet more than a hundred times.

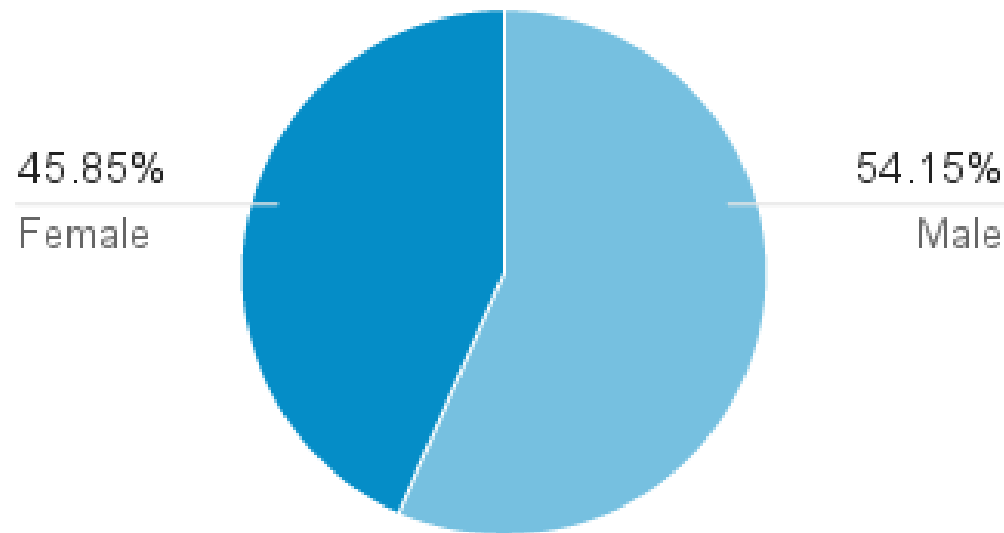


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Gender

100% of total sessions



What is EcoNet?

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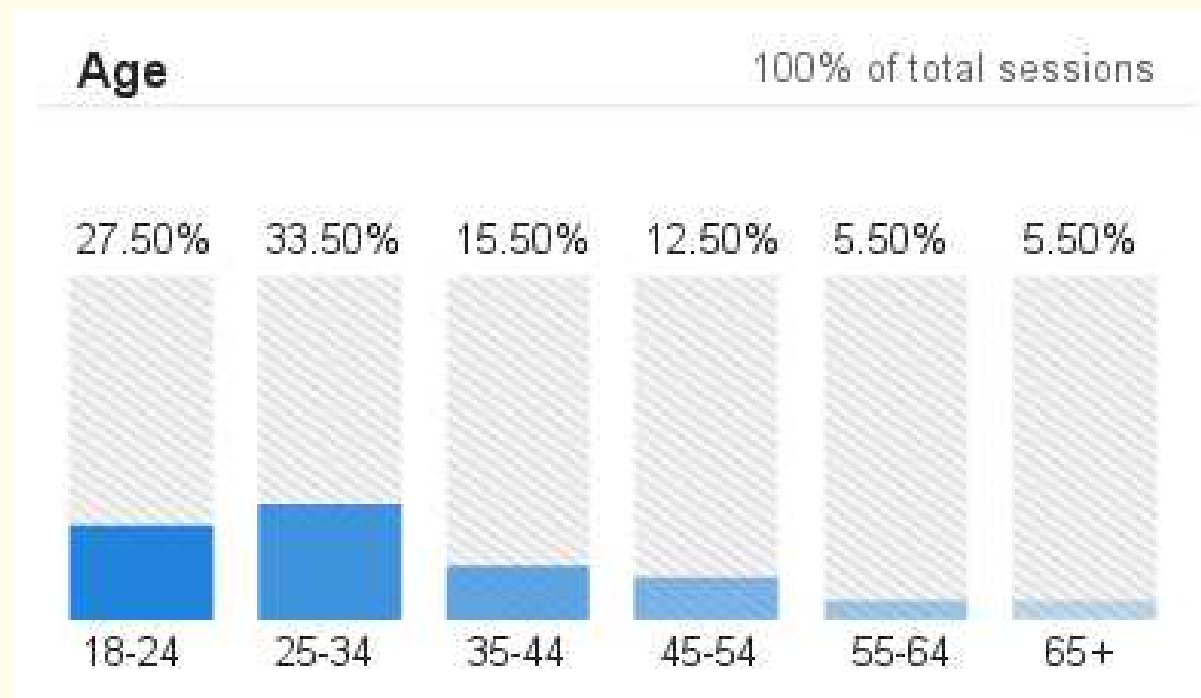
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The screenshot shows the EcoNet web interface. At the top, the browser address bar displays 'http://eco.engr.uga.edu/'. The page has a navigation menu with links: 'Run EcoNet!', 'What is EcoNet?', 'Examples', 'Support', and 'Contact'. The main heading is 'Welcome to EcoNet!'. Below this, there is a text area for entering a model. The model text is as follows:

```
# Below is a simple model example
* -> Detritus      c=10      # input to Detritus

Detritus -> Microbiota  c=0.15 # flows
Detritus -> Meiofauna  c=0.2  # among
Microbiota -> Meiofauna c=0.5  # compartments

Meiofauna -> *      c=.23      # outputs
Microbiota -> *      c=.01

Detritus  = 100      # initial stock values
Microbiota = 50
Meiofauna = 10
```

Below the text area, there is a 'Select Method' dropdown menu set to 'Adaptive Runge-Kutta-Fehlberg'. Below that are two input fields: 'Maximum Time (t):' with the value '100' and 'Sensitivity:' with the value '0.001'. At the bottom, there is a 'Run Model' button and a note: '<-- To try EcoNet now, simply click here.'.

Red callout boxes with arrows point to the following elements:

- 'Model is entered here' points to the model text area.
- 'Simulation method choices' points to the 'Select Method' dropdown.
- 'Simulation Parameters' points to the 'Maximum Time (t):' and 'Sensitivity:' input fields.

EcoNet Model Structure

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Feature

```
* -> Detritus
```

```
Detritus -> Microbiota
```

```
Detritus -> Meiofauna
```

```
Microbiota -> Meiofauna
```

```
Meiofauna -> *
```

```
Microbiota -> *
```

-> : Flows

* : Environment

Flows among compartments

EcoNet Model Structure

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```
* -> Detritus          c=10
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Microbiota -> *          c=.01
```

Flow types and rates

EcoNet Model Structure

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Detritus    = 100
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```

Initial conditions

EcoNet Model Structure

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Comments (ignored by EcoNet)

EcoNet Model Structure

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```

```
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```

```
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Detritus -> Microbiota
```

```
c=0.15
```

```
# flows
```

```
Detritus -> Meiofauna
```

```
c=0.2
```

```
# among
```

```
Microbiota -> Meiofauna
```

```
c=0.5
```

```
# compartments
```

```
Meiofauna -> *
```

```
c=.23
```

```
# outputs
```

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Microbiota -> *
```

```
c=.01
```

```
# initial stock values
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```
Detritus = 100  
Microbiota = 50  
Meiofauna = 10
```

Flows

Flow type and coefficients

Comments

Initial storage values

EcoNet Model Structure

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```
Detritus    = 100
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```
Detritus -> Meiofauna
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```
c=0.2
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```
Microbiota = 50, Meiofauna = 10
```

```
Detritus -> Microbiota    c=0.15
```

```
Microbiota -> Meiofauna, Meiofauna -> *, Microbiota -> *  
c=0.5, c=.23, c=.01
```

Flexibility

What is EcoNet?

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How to use?

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EcoNet uses a flexible text format for model representation..

Because:

- Quick and easy to enter.
- Human readable.
- Easy to manipulate.

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EcoNet uses a flexible text format for model representation..

Because:

- Quick and easy to enter.
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- Portable.
- Can be automated easily.

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- **Donor controlled flow: $A \rightarrow B$ $c=3$**
Flow rate from A to B is proportional to the storage of A.
 $(\text{Flow rate } A \rightarrow B) = 3 \times (\text{Storage of } A)$

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(Flow rate $A \rightarrow B$) = $3 \times$ (Storage of A)
- **Donor-Recipient controlled flow: $A \rightarrow B$ $r=3$**
Flow rate from A to B is proportional to the storages of both A and B.

$$(\text{Flow rate } A \rightarrow B) = 3 \times (\text{Storage of } A) \times (\text{Storage of } B)$$

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Flow rate from A to B is proportional to the storages of both A and B.

$$(\text{Flow rate } A \rightarrow B) = 3 \times (\text{Storage of } A) \times (\text{Storage of } B)$$

- **Michaelis-Menten type flow: $A \rightarrow B$ $v=3,5$**

$$(\text{Flow rate } A \rightarrow B) = \frac{3 \times (\text{Storage of } A) \times (\text{Storage of } B)}{5 + (\text{Storage of } A)}$$

(Michaelis Menten is not implemented as of August 2015)

What is EcoNet made of?

What is EcoNet?

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How to use?

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- A set of interacting modules based on:
 - ◆ **C++ codes**: Resource intensive processes
 - ◆ **CGI**: Web interface
 - ◆ **Graphviz**: Network diagram
 - ◆ **GNU plot**: Time course figure
 - ◆ **Python**: Network Flux Decomposition
 - ◆ **Linux shell scripts**: Communication among separate modules

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To use EcoNet for your own model:

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To use EcoNet for your own model:

- Search for “econet software”.
- Write your model in the textbox.
- Choose a numerical solution method (optional).
- Change default parameters if need be.
- Hit “**Run Model**” to see the results.

EcoNet 3.1 *Beta*

- New ENA measures (coding finished, not implemented)
 - ◆ Trophic level, keystone index, centrality measures, connectivity distribution, etc.

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Pytho \rightarrow Zoo $c=2$

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Pytho → Zoo
$$k=2 * [Phyto] * [Zoo] / (12 + [Zoo]) * [1 + \sin(23 * t)]$$