Welcome to Ecology 101

Premise of course:

Ecosystems approach

a. Physical attributes
b. Energy flow
c. Productivity

Readings:

Required:
- The Diversity of Life, Edward O. Wilson
- Sand County Almanac, Aldo Leopold
- Ecology: A Bridge Between Science and Society, Eugene P. Odum

Recommended:
- Science Times
- Science
- Nature

Grading

1. Midterm: 50%
2. Final: 50%

Examination format:

Multiple choice, true/false, short answer, essay

Schedule:

September
- Introduction
- Basic Principles I - Evolution of Ecosystems
- Basic Principles II - Species and the Niche Concept
- Basic Principles III - Energy Flow and Trophic Levels
- Biogeochemical Cycles I

October
- Biogeochemical Cycles II
- Rivers
- MIDTERM EXAMINATION

November
- Lakes
- Estuaries and Wetlands
- The Oceans
- Coral Reefs
- Rain forests
- December
- Hardwood and Boreal Forests
- FINAL EXAMINATION

Websites:

Required:


Recommended:

www.medicalecology.org
“Is That All There Is?”

"Right now we can only guess that the correct answer for the total number of species worldwide lies between 2 and 10 million."

“Views Of Early Earth”

"Drifting Apart"

"Still Drifting After All These Years"
Life Without The Sun’s Help

Extremophiles Rule!

GAIA Hypothesis

Some General Ecological Principles

Ecosystem Ecology
Describing Ecosystems

1. Identify a definable geographic region (e.g., grassland, prairie)
2. Identify all plants and animals within that region (i.e., biodiversity index)
3. Study how these disparate groups form associations of food chains and food webs (i.e., form ecosystems)
4. Study the flow of energy through these associations (i.e., measure productivity)

Levels of Complexity
Why is this man sleeping?
We have come a long way in just 20 years

DNA Sequencing Core

What Is A Species?*

Variations on a theme. One snail species, many varieties

How Many Species of Dogs And Cats Are There?

One!

Two Species Or One?

Neandertal

Modern Human

Study: Human DNA Neanderthal-Free

Cro-Magnon vs. Neanderthal
May 12, 2003

— Neanderthals did not contribute to the gene pool of modern humans, according to a recent study that compared the DNA of two ancient Cro-Magnons with that of four Neanderthals.

While Neanderthals and early humans coexisted in Europe for a few thousand years 40,000 years ago, the findings suggest they did not interbreed, an action that would have made Neanderthals a direct ancestor of modern humans.

The study also supports the "Out of Africa" theory, according to which modern humans evolved in East Africa and then spread into Europe and Asia through the Middle East.
Speciation Drives the System

The Concept Of Niche*

"No two species can occupy the same niche."

SPATIAL CONCEPT OF NICHE

G.E. HUTCHINSON (1957), A YALE SCHOLAR: “THE NICHE IS AN ABSTRACTLY INHABITED HYPERVOLUME”

CONCEPT OF DIMENSIONALITY OF CONTROL FACTORS

FUNDAMENTAL VS. REALIZED NICHE

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There Can Be No Ecosystems Without Plant-Animal Interactions

It Takes Two To Tango

General Scheme For Most Life On Earth
The Galapagos Islands

Genetic Relationships Among Darwin’s Finches
Beak Size and Shape

Evolution of Darwin’s Finches

An Early Food Web

Trophic Levels and Food Webs

Trophic Levels and Food Webs: The Complexity of Interactions

Learn more: http://www.talkorigins.org/faqs/wells/finches.html

from Miller, Living In The Environment
Thompson, Pub.
Biogeochemical Cycles:

- Oxygen
- Carbon
- Sulfur
- Nitrogen
- Phosphorous
- Calcium

Oxygen Cycle

Brazil's forests produce 40% of the earth's atmospheric oxygen.
Oxygen Cycle

Depletion of ozone leads to ecosystem health risks

Carbon Cycle

Temperate rainforests store vast amounts of carbon, both above and below ground.

Brazil’s rainforests re-cycle carbon faster than any other ecosystem.

Carbon Cycle

Today, the earth’s atmosphere is accumulating CO₂ faster than it can be sequestered.
**Carbon Sinks:**

1. Marine viruses and phytoplankton
2. Forests
3. Coral reefs

**Carbon Cycle**

*Image obtained from [http://www.agnr.umd.edu/users/agron/nutrient/Factshee/sulfur/Sulfur.html]*

**Sulfur Cycle**

*Image obtained from [http://www.agnr.umd.edu/users/agron/nutrient/Factshee/sulfur/Sulfur.html]*
Most energy generating systems that utilize fossil fuels put significant amounts of SO$_2$ into the atmosphere.
Nitrogen Cycle

Corn is not a legume

No clouds
Ecozones

River Ecology

Lotic Ecosystems

Limnology, The Science Of Lakes
New York City Drinks Lake Water

So Does Northern New Jersey

Lentic Ecosystems

Classification Of Large Lakes

<table>
<thead>
<tr>
<th>Range in area (km²)</th>
<th>Total number</th>
<th>Total area (km²)</th>
<th>Mean area (km²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>500–1,000</td>
<td>113</td>
<td>76,350</td>
<td>675</td>
</tr>
<tr>
<td>1,000–2,000</td>
<td>63</td>
<td>84,643</td>
<td>1,343</td>
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<tr>
<td>2,000–3,000</td>
<td>23</td>
<td>50,152</td>
<td>2,190</td>
</tr>
<tr>
<td>3,000–4,000</td>
<td>9</td>
<td>30,907</td>
<td>3,434</td>
</tr>
<tr>
<td>4,000–5,000</td>
<td>13</td>
<td>58,543</td>
<td>4,503</td>
</tr>
<tr>
<td>5,000–10,000</td>
<td>13</td>
<td>103,764</td>
<td>6,951</td>
</tr>
<tr>
<td>10,000–50,000</td>
<td>5</td>
<td>291,478</td>
<td>22,421</td>
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<tr>
<td>50,000–400,000</td>
<td>1</td>
<td>331,910</td>
<td>66,382</td>
</tr>
<tr>
<td>&lt;100,000</td>
<td>1</td>
<td>374,000</td>
<td>374,000</td>
</tr>
<tr>
<td>Total</td>
<td>253</td>
<td>1,400,771</td>
<td></td>
</tr>
</tbody>
</table>

Factors Affecting The Trophic Status Of Lakes

[Diagram showing relationships of factors affecting trophic status of lakes]
Energy Considerations

Food Pyramids

Oligotrophic lakes

Temperature Profile, Summer

Temperature Profiles Throughout The Seasons In An Oligotrophic Lake

Circulation Patterns
Thermal Profiles Of An Oligotrophic Lake Over A 12 Hour Period

Energy Flow In An Oligotrophic Lake

Accumulation Of Strontium\textsuperscript{90} In A Lake

Langmuir Circulation

Eutrophic Lakes

All Lake Undergo Eutrophication And Eventually Fill In With Detritus And Dry Up

From Miller, Living In The Environment
Unusual Lakes

Pitcher Plant Bog

Lake Baikal From Space

Lake Baikal, Siberia

Bathymetry

Courtesy NASA
Lake Baikal, Siberia

http://www.livinglakes.org/baikal/

Baikal has more endemics than any other lake in the world. Its great age—more than 25 million years—also sets it apart from any other freshwater lake as a living laboratory of evolution. During its life, 30 species of sculpins (above) have evolved. In comparison, 10,000-year-old Lake Superior has but four species.

Crater Lake, Oregon

http://craterlake.wr.usgs.gov/bathymetry.html

Biological studies include the discovery of bacterial colonies associated with hydrothermal fluids. These yellow-orange mats consist of thousands of Gallionella and Leptothrix bacteria. Golden-colored bacteria were found surrounding Llao’s Bath. A thick band of moss, Drepanocladius aduncus, encircles the lake at depths from 26-140 m (85-460 ft). It hangs like icicles on vertical cliffs and forms thick, lush fields on the gentler slopes around Wizard Island. A fascinating discovery is the animals living in the deepest basin of Crater Lake (589 m, or 1,932 ft). These animals which withstand such high water pressure include flatworms, nematodes, earthworms, copepods, ostracods, and the midge fly Heterotrissocladius.
Mono Lake, California: Ecology

- Brine Shrimp
- Alkali Flies
- Bacteria: Desulfonatronum thiadismutans, Spirochaeta americana, Bacillus arsenicoselenatis
- Pluvial lake (no outlet)
- Carbonates (CaCO3), chlorides, sulfates
- pH: 9.8
- Salinity: 76-90 g/L
- Halophilic green algae: Nannochloris sp. dominates
- Primary productivity: 340-540 g C/yr

Mono Lake, California: Remediation

Tropical Lakes Of Africa

Lake Nakuru
- Surface area [km²]: 40
- Volume [km³]: 0.082
- Maximum depth [m]: 2.8
- Mean depth [m]: 2.3
- Water level: Unregulated
- Length of shoreline [km]: 27
- Catchment area [km²]: 1,100** Including the lake area

Lake Malawi

World Lakes Database

[Link to World Lakes Database]
Tropical Lakes Of Africa: Lake Tanganyika

- Surface area [km²]: 32,000
- Volume [km³]: 17,800
- Maximum depth [m]: 1,471
- Mean depth [m]: 572
- Water level - Unregulated
- Length of shoreline [km]: 1,900
- Catchment area [km²]: 263,000

Lake Victoria, East Africa

Tropical Lakes Of New York City

Cichlids Unlimited

Some Attributes Of Three African Lakes

<table>
<thead>
<tr>
<th>Lake</th>
<th>World Rank</th>
<th>Area [km²]</th>
<th>Depth [m]</th>
<th>Clarity [m]</th>
<th>Age [Years]</th>
<th>Cichlid Species</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tanganyika</td>
<td>7th</td>
<td>24,000</td>
<td>(3,000)</td>
<td>22</td>
<td>6 million</td>
<td>300</td>
</tr>
<tr>
<td>Malawi</td>
<td>9th</td>
<td>31,600</td>
<td>(1,000)</td>
<td>27</td>
<td>1-2 million</td>
<td>500</td>
</tr>
<tr>
<td>Victoria</td>
<td>3rd</td>
<td>68,600</td>
<td>(95)</td>
<td>1-8</td>
<td>12,400</td>
<td>400</td>
</tr>
</tbody>
</table>

Temperature And Oxygen Profiles Of A Tropical Lake

Lakes Malawi And Tanganyika: Speciation Of Cichlids
Speciation of Cichlids

Phylogenetics Of Lake Malawi Cichlids

Lake Victoria Has Cichlids, Too

That Is Until Someone Stocked It With Nile Perch!
New York City Drinks Lake Water

So Does Northern New Jersey

Two Approaches To Watershed Management*

New York City
Northeast New Jersey

*Which water would you rather drink?

Beavers Alter The Landscape
In favor Of Wetlands

Most Significant Cause Of Pollution
World-wide: Agricultural Runoff

Zebra Mussels and Lake Erie

Lake Erie dead zone may be due to zebra mussels
September 2003
U.S. Water News Online
Researchers think zebra mussels may be
causing a low-oxygen “dead zone” in the
central basin of Lake Erie.
St. Lawrence Seaway
The seaway was officially opened on June 26th, 1959 and cost 470 million US dollars.

Host, Predators, And Parasites

Lake Trout
Lamprey Eel
Lake Trout

Lake Trout With Wounds
Inflicted By Lamprey Eels

How The Lamprey Eel
Got Into The Great Lakes

How The Lamprey Eel Gained Entrance Into The Great Lakes:
The Welland Canal

Controlling Lamprey Populations
1. Lampricides - TMF (3-trifluoromethyl-4-nitrophenol)
2. Adult lamprey trapping
Lake Trout in the Great Lakes

Lake trout (*Salvelinus namaycush*) populations in the Great Lakes collapsed catastrophically during the 1940s and 1950s because of excessive predation by the sea lamprey (*Petromyzon marinus*) and exploitation by fisheries.