





Ecology vs. Ecological Engineering

Ecological Engineering (ENV 4005/6307) Week 2

David Kaplan, Ph.D. (<u>dkaplan@ufl.edu</u>) UF Environmental Engineering Sciences www.watershedecology.org

Announcements

1. Quiz Time!

Ecologists vs. Engineers...



http://www.environmentalscience.org/career/aquatic-ecologist



Ecologists vs. Engineers...



http://www.environmentalscience.org/career/aquatic-ecologist







Ecologists and Engineers...



http://www.environmentalscience.org/career/aquatic-ecologist





https://shrutithakkar.wordpress.com/tag/engineering/



http://www.budgetdumpster.com/blog/profiles-in-environmentalism-nerds-for-nature/

Ecology: "The scientific study of the processes influencing the **distribution and abundance** of organisms, the **interactions among organisms**, and the **interactions between organisms**, and the **interactions between organisms**, and the **transformation and flux of energy and matter**." (Cary Institute)





Engineering:



Engineering: "The application of mathematics, empirical evidence, and scientific, economic, social, and practical knowledge to invent, design, build, maintain, research and improve machines, tools, systems, components, materials and processes." (Wikipedia...)

Ecology: "The scientific study of the processes influencing the **distribution and abundance** of organisms, the **interactions among organisms**, and the **interactions between organisms**, and the **interactions between organisms**, and the **transformation and flux of energy and matter**." (Cary Institute)

Ecological Engineering: "The design of *sustainable* ecosystems that integrate human society with its natural environment *for the benefit of both.*" (M&J 2003)

Engineering: "The application of mathematics, empirical evidence, and scientific, economic, social, and practical knowledge to invent, design, build, maintain, research and improve machines, tools, systems, components, materials and processes." (Wikipedia...)

The Challenges:

- Population growth (9 billion by 2050)
- Pollution, water quality & quantity
- Global-scale land degradation, loss of biodiversity and habitat
- Climate change, energy supplies









Traditional Engineering Approaches:

- Helped create the world we live in (\$, health, literacy, infrastructure...)
- Extremely efficient, but with unintended consequences
- Apply technological, resource-intensive approaches
- At best, ignores ecosystem function...at worst degrades nature
- Moves pollutants from one phase (solid/liquid/gas) to another

Trading H₂O pollution for solid waste?





- Ecology not included in engineering, even for Environmental Engineers.
- Ecologists and environmental scientists miss important training in quantitative skills and problem solving.
- "These two problems could be solved in the integrated field of ecological engineering."







Available online at www.sciencedirect.com

ECOLOGICAL ENGINEERING

Bill Mitsch (top) and Sven Jørgenson

Ecological Engineering 20 (2003) 363–377

www.elsevier.com/locate/ecoleng

Ecological engineering: A field whose time has come

William J. Mitsch^{a,*}, Sven E. Jørgensen^b

^a Olentangy River Wetland Research Park and School of Natural Resources, The Ohio State University, Columbus, OH 43210, USA ^b Environmental Chemistry, Royal Danish School of Pharmacy, Copenhagen, DK, Denmark

Received 10 May 2002; received in revised form 14 December 2002; accepted 1 May 2003

NERDS FOR NATURE



I DIDN'T CHOOSE THE

ENGINEERING LIFE

THE ENGINEERING LIFE

skills and problem solving.

- "These two problems could be solved in the
 - integrate NUL Poplogical engineering



^b Environmental Chemistry, Royal Danish School of Pharmacy, Copenhagen, DK, Denmark

Received 10 May 2002; received in revised form 14 December 2002; accepted 1 May 2003

To Recap: What is Ecological Engineering?

Ecological Engineering: "The design of *sustainable* ecosystems that integrate human society with its natural environment *for the benefit of both.*" (M&J 2003)

"It is engineering in that it involves the design of the natural environment through quantitative approaches..."

"It is **biology and ecology** in the sense that the components [of the design] are all of the biological species of the world"

To Recap: What is Ecological Engineering?

Ecological Engineering: "The design of *sustainable* ecosystems that integrate human society with its natural environment *for the benefit of both.*" (M&J 2003)

Two Goals:

- "The <u>restoration</u> of ecosystems that been substantially disturbed by human activities..." (an engineer might say "fix")
- "The <u>development of new</u>
 <u>sustainable ecosystems</u> that have both human and ecological value" (*engineer: "design and build"*)



History of Ecological Engineering



- Coined the term in the 1960s
- Focus on renewable energy and resources
- Self-organization as primary structuring force
 - "...the management of nature is ecological engineering...an endeavor supplementary to those of traditional engineering. A partnership with nature is a better term."

History of Ecological Engineering



- Coined the term in the 1960s
- Focus on renewable energy and resources
- Self-organization as primary structuring force
- "...the management of nature is ecological engineering...an endeavor supplementary to those of traditional engineering. A partnership with nature is a better term."
- Parallel efforts by Ma Shijun in the 1960s
- "...a specially designed system of production in which...the cycling and regeneration of substances... are applied to make a multi-step use of a substance"
- Derived (in part) from cultural focus on balance



- 1. It is the based on the self-designing capacity of ecosystems
- 2. It can be the acid test of ecological theories
- 3. It relies on system approaches
- 4. It conserves non-renewable energy sources
- 5. It supports biological conservation.

- 1. It is the based on the self-designing capacity of ecosystems
- 2. It can be the acid test of ecological theories
- 3. It relies on system approaches
- 4. It conserves non-renewable energy sources
- 5. It supports biological conservation.

<u>Self-organization</u>: the property of ecosystems (and systems in general) to organize themselves in an unstable and heterogeneous environment...to evolve diversity and resilience (contrast with imposed organization)

<u>Self-design</u>: application of the idea of selforganization in the design of ecosystems (contrast with 'designer ecosystems')



- 1. It is the based on the self-designing capacity of ecosystems
- 2. It can be the acid test of ecological theories
- 3. It relies on system approaches
- 4. It conserves non-renewable energy sources
- 5. It supports biological conservation.

"Ecological engineering emphasizes...the need to consider the entire ecosystem [or process]..."



- 1. It is the based on the self-designing capacity of ecosystems
- 2. It can be the acid test of ecological theories
- 3. It relies on system approaches
- 4. It conserves non-renewable energy sources
- 5. It supports biological conservation.





- 1. It is the based on the self-designing capacity of ecosystems
- 2. It can be the acid test of ecological theories
- 3. It relies on system approaches
- 4. It conserves non-renewable energy sources
- 5. It supports biological conservation.

"Nature conservation is so important that it needs to become a **goal of engineering**, not just one of its possible outcomes."

"...ecological engineering offer[s] additional means for coping with pollution problems by recognizing the **self-designing properties of natural ecosystems**. The prototype machines for ecological engineers are the ecosystems of the world."

A note: Ecological Engineering, aka

- synthetic ecology
- restoration ecology
- bioengineering
- sustainable agroecology
- habitat reconstruction
- ecohydrology
- ecosystem rehabilitation
- biospherics

- biomanipulation
- river and lake restoration
- wetland restoration
- reclamation ecology
- nature engineering
- ecotechnology
- engineering ecology
- solar aquatics

Coming Up

<u>Now:</u> Forest Structure Lab (Lab 2) <u>Wednesday</u>: Ecology and the Ecosystem Concept (Read Ricklefs Ch. 9) <u>Next Week</u>: MLK, then Ecosystem Services (Read MEA 2005)





