Lecture 22, 08 November 2005
Conservation in Practice

Conservation Biology
ECOL 406R/506R
University of Arizona
Fall 2005

Kevin Bonine
Kathy Gerst

Conservation Biology 406R/506R

Conservation of Aquatic Ecosystems
(Van Dyke Chapter 9)

Conservation of Terrestrial Ecosystems
(Van Dyke Chapter 10)

Exam two was returned on Thursday (one week)
Thank Bob Steidl
Role Playing on 15 November
Exam 3 on Thursday 17 November
(review sheet later this week)
Return 506 papers

Shifting Baselines?
Linette Ancha

There will be a seminar on Wednesday, November 2.
1pm in BSE 225.

The presenter will be:

Dr. William W. Shaw
School of Natural Resources
University of Arizona

His topic will be:

"The Santa Lucia Preserve: Innovative Conservation of Nature for the Rich and Famous"

Did anyone see this?

Exam 2

3. Fst data and Slatkin's Migration Estimates

9. Density-dependent population over time

10. Effective population size

18 Cryptic species

21. Alleles (haplotype)

Out of 75 (before bonus):

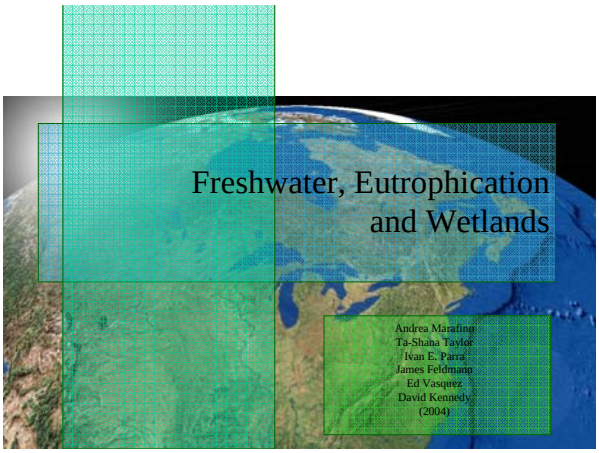
58.6087	mean
68	max
40.5	min
6.692867	s.d.
60.5	median

Aquatic Conservation (VanDyke, Chapter 9)

- Marine vs. Freshwater
  (definition of limnology)
- Fisheries
- Mariculture
- Hydrothermal Vents (and other Benthic Examples)

Today:

- Wetlands
- Eutrophication
- Ramsar Treaty
  other legislation
- IBI



The Center for Limnology was established in July 1982 to plan, conduct, and facilitate inland freshwater research. The Center grew out of almost one hundred years of limnology at the University initiated by E.A. Birge and Chancey Juday, who founded limnology in North America through extensive descriptive and comparative studies. Our roots were further developed by Arthur D. Hasler, who led the way in experimental limnology and facilitated four decades of aquatic studies at Wisconsin. Our present program builds on these approaches and has expanded to include long-term studies, synthesis, modeling, Great Lakes research, and application to resource managment and environmental issues.

The Center Today

Today's Center for Limnology operates two field stations, the Lake Mendota Laboratory located on the University of Wisconsin-Madison campus and the Trout Lake Station in the Northern Highland Lake District at Boulder Junction. Although both facilities operate year round, Trout Lake Station is the most busy during the summer months.

Contact Information:
University of Wisconsin Center for Limnology
680 North Park Street
Madison WI 53706-1492
Phone 608-262-3014
Fax 608-265-2340

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Importance of freshwater environments and wetlands

An acre of wetland can store 1.0 to 1.5 million gallons of floodwater.

Water storage (and release during dry periods) and erosion control

You can drink more than 4,000 glasses of tap water for the price of a packaged beverage (based on price of a six-pack of soda).

Water filtration (improves water quality)

75% of commercially harvested fish are wetland-dependent.
95% when shellfish species are added to this figure.

Up to one-half of North American bird species nest or feed in wetlands.

Biological productivity (plant and animal habitat)

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Source: EPA

Importance of freshwater environments and wetlands

Regulation Functions
Storage and recycling of nutrients
Storage and recycling of human waste
Storage and recycling of organic waste
Groundwater recharge
Groundwater discharge
Natural flood control and flow regulation
Erosion control
Salinity control
Water treatment
Climatic stabilization
Carbon sequestration
Maintenance of migration and nursery habitats
Maintenance of ecosystem stability
Maintenance of integrity of other ecosystems
Maintenance of biological and genetic diversity

Information Functions
Research, education and monitoring
Uniqueness, rarity or naturalness and role in cultural heritage

Carrier Functions
Agriculture, irrigation
Stock farming (grazing)
Wildlife cropping/resources
Transport
Energy production
Tourism and recreation
Human habitation and settlements
Habitat and nursery for plant and animal species

Production Functions
Water
Food
Fuel wood
Medicinal resources
Genetic resources
Raw materials for building, construction and industrial use

Wetlands alone have an economic value of $70 billion per year (World Conservation Union)

$4.8 trillion overall economic value (Costanza, et al)

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What is a freshwater aquatic environment?

- **Lotic Systems:** flowing water environments such as streams and rivers.
- **Lentic Systems:** lake, pond environments.
- **Wetlands:** areas where the land transitions from aquatic to terrestrial, such as marshes, swamps, bogs and fens. Very difficult to define.

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How is a wetland defined?

A wetland is defined by the EPA by the:

1. Hydrology – it is covered by water during part of the growing season or the soils are saturated.
2. Vegetation – it has at least 50% obligate and facultative plants.
3. Hydric soils – soils that are saturated long enough to have low oxygen levels

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How Much Wetland Area Has Been Lost??

(since pre-settlement ~ 1600's)?

- **Nationwide** – 53% (in lower 48)
- **Great Lakes Basin** – 70%
- **Michigan**
  - 50% of total wetlands lost
  - 70% of coastal wetlands

- 75% of Michigan wetlands in private ownership.

(from *Living With Michigan Wetlands: A Landowner's Guide*)

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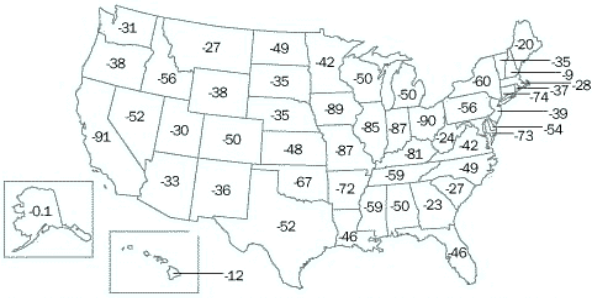
Percentage of Wetlands Acreage Lost, 1780's-1980's



Twenty-two states have lost at least 50 percent of their original wetlands. Seven states—Indiana, Illinois, Missouri, Kentucky, Iowa, California, and Ohio—have lost over 80 percent of their original wetlands. Since the 1970's, the most extensive losses of wetlands have been in Louisiana, Mississippi, Arkansas, Florida, South Carolina, and North Carolina.

Source: Mitch and Gosselink, Wetlands, 2nd Edition, Van Nostrand Reinhold, 1993

Major Effects of Wetland Losses

- loss of spawning grounds for fish
- loss of waterfowl habitat
- loss of flood control capability
- loss of erosion control and sediment-trapping capability

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Why So Much Wetland Loss?

- Perception of wetlands as "wastelands" and "swamps" (= ignorance)
- Economic incentives for development and urban sprawl

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Removal of riparian vegetation next to stream due to residential development.

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Farming up to edge of stream.

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Livestock corral adjacent to stream

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Invader Species

- Major threat to wetland diversity
- Reduction in the abundance and species-richness of native macrophytes and associated invertebrate communities
- Alteration of nutrient cycles and biochemical processes
- Invasive exotic species tends to increase as ecosystems become degraded

Introduced weeds and non-native plants, i.e. purple loosestrife

need to be controlled through biological, chemical and/or mechanical means

or prevented by proper land management, i.e. minimize disturbance.

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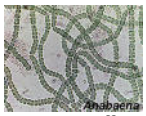
Eutrophication – enrichment of aquatic ecosystems by inorganic nutrients (mostly P & N), causing increased primary productivity

- **Cultural eutrophication - The usual suspects: sewage, agriculture, land clearance… fisheries mgmt. practices?**
- **Did reclamation pollute Black Pond? (Stager, 2001)**
- ***Anabaena* blooms: Rotenone fish kills and/or fish stocking?**
- **Sediment core evidence: diatoms and organic matter**



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"Natural" Eutrophication - a Paleo Perspective

- **Forest fires, droughts, climate shifts**
- **Insect infestations? Hemlock Decline ~ 4,800 yrs. BP – van Nostrand Lake, Ontario (St. Jaques et al., 2,000).**
- **Die-off = nutrient inputs, erosion**
- **Sediment cores: pollen, diatoms, organic matter**

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Acidification

- **H_2S & NO + atm. moisture = sulfuric and nitric acid pecip.**
- **Mortality and fecundity: inverts., amphibians, fish**
- **Mobilization of heavy metals e.g. Al, Hg**
- **Watershed factors: buffering capacity, climate patterns, elevation, seasonal snow cover (key)**
- **Big Moose Lake, Herkimer Co. NY: vulnerable in all categories**

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Are Eutrophication and Acidification "Good" or "Bad"?

- **Mid 1900s: "oligotrophic lakes are 'wasted resources' – fertilize them!"**
- **1970s – 1980s: "eutrophic lakes are scummy and 'polluted' – ban phosphates!" (so acid precipitation must be good because it makes nice, clear oligotrophic lakes?!)**
- **Human activity vs. non-human processes**
- **Perspectives: human (many), organisms, ecosystems**

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Point vs. Nonpoint

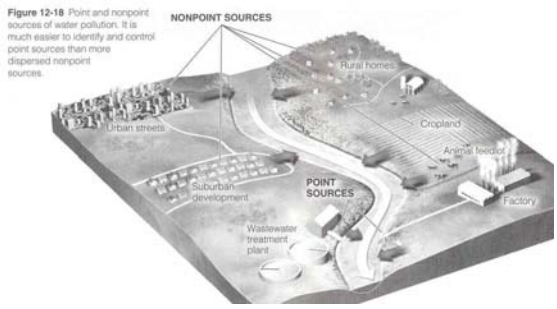

Figure 12-18 Point and nonpoint sources of water pollution. It is much easier to identify and control point sources than more dispersed nonpoint sources.

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Factory Farms and Water Pollution

Factory Farms and Water Pollution

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Approaches in Protecting Freshwater and Wetlands

Conservation Issue	Remedial Management	Preventative Management
Wetlands	Coordinated Management	Buffer strips
Acidification	Liming	Education
Sedimentation and Eutrophication	•Removal of fertilizers •Dredging •Chemical manipulation •Biomanipulation	• Reduce the use of fertilizers • Reduce erosion on agricultural lands • Education
Invasive Species	Intervention •Manual Removal •Mechanical Control •Chemical Control •Biological Control •Environmental Manipulation •Direct use of invasive species	• Protection • Restoration • Education
Groundwater Depletion	Reclaimed water	• Conservation • Regulation • Education

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Legislation and Management for Freshwater Environments

- International Legislation
  - Ramsar Convention on Wetlands
  - Global International Water Assessment (GIWA)
- The Wild and Scenic Rivers Act
- The Clean Water Act
  - Index of Biotic Integrity (IBI)

"a thing is right when it tends to preserve the integrity, stability, and beauty of the biotic community. It is wrong when it tends otherwise."

-Aldo Leopold

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IBI

Table 1. Index of biotic integrity metrics as originally developed (modified from Karr and others, 1986).

Category	Metric
Species richness and composition	1. Total number of fish species 2. Number and identity of darter species 3. Number and identity of sunfish species 4. Number and identity of sucker species 5. Number and identity of intolerant species 6. Proportion of individuals as green sunfish (tolerant species)
Trophic composition	7. Proportion of individuals as omnivores 8. Proportion of individuals as insectivorous cyprinids (minnows) 9. Proportion of individuals as top carnivores
Fish abundance and condition	10. Number of individuals in sample 11. Proportion of individuals as hybrids 12. Proportion of individuals with disease, tumors, fin damage, or skeletal anomalies

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Freshwater Legislation

Wild & Scenic Rivers Act (1968, USA)

- "Stream or section thereof designated as wild or scenic river is protected from any action by any federal agency that would adversely affect its water quality."
- Sections of rivers can also be designated

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Freshwater Legislation

Clean Water Act & Amendments (1972, USA)

- "restore & maintain integrity"
- "enhance aquatic life"

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Wetlands Legislation

1971 Ramsar Convention (international)

- Protection of ecosystem instead of species
- Canada
- United States – Table 9.3, p.246
- United States – Wetlands Reserve Program

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Wetlands Legislation

1982 Commission on Conservation of Antarctic Marine Living Resources (CCAMLR)

- Established marine life conservation; allows for "rational use" of resources
- Regulated harvesting - may not cause population to diminish below number that allows stable recruitment

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Problems Associated with Marine Environmental Law and Policy

- "Present management of marine ecosystem is based on a series of regimes that are directed at the various parts rather than the whole and that are… ineffectual" (W.M. von Zharen)
- National jurisdiction does not usually coincide with the movement of fish populations
- Pollution from one country often affects waters and marine ecosystems of other countries
- Discharged waters may introduce non-native species to coastal waters that destroy local species
- International and national laws conflict with the conservation of marine resources

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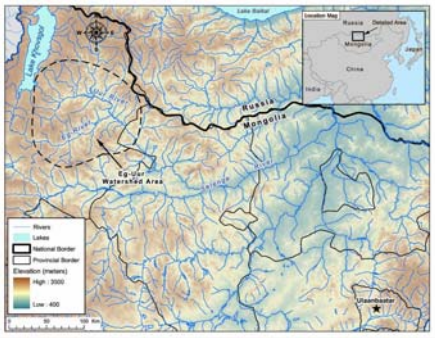
http://limnology.wisc.edu/mongolia/



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Biologist Zeb Hogan, Monk Gantulga and Fishing Outfitter, Dan Vermillion partner to save taimen

The University of Wisconsin-Madison, the University of Nevada-Reno, and the University of California-Davis, and the Mongolian Institute of Geoecology have partnered as a research team in a conservation effort to sustainably protect Mongolia's giant salmon, Hucho taimen, through operation of fishing concessions. This 5-year program will be the most extensive study of Hucho taimen ever conducted. The study will assess population status, migrations, and threats to healthy populations of taimen, and the role of taimen as a part of the broader ecosystem. Information produced by the science team will be used to develop a natural resource management plan for the region.

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Zeb Hogan

Traditional cultures are coming into direct conflict with modern mining, which also threatens local ecology.

Mongolia's environment undermined by gold fever

http://pubs.acs.org/subscribe/journals/esthag-w/2004/may/science/pt_goldfever.html

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Figure 10.13
The northern spotted owl (*Strix occidentalis caurina*), a species that can be effectively preserved only with an ecosystem management approach to its obligate habitat, old-growth conifer forests.

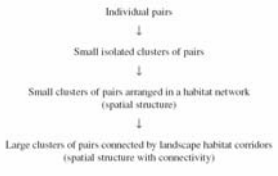
Van Dyke 2003

Northern Spotted Owl

-Old Growth Forests

-Thomas Report 1990

-towards an Ecosystem Approach



Ecosystem Management

Ch10 Van Dyke text

"...land management system that seeks protect viable populations of all native species, perpetuates natural disturbance regimes on the regional scale, adopts a planning timeline of centuries, and allows human use at levels that do not result in long-term ecological degradation"

Ecosystem:

-energy and nutrient processing system with physical structure and function that circulates matter and energy.

Definitions are debatable...

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Table 10.1 Some Definitions of Ecosystem Management from U.S. Federal Agencies

AGENCY	DEFINITION	
Department of Agriculture	The integration of ecological principles and social factors to manage ecosystems to safeguard ecological sustainability, biodiversity, and productivity.	...production
Department of Commerce, National Oceanic and Atmospheric Administration	Activities that seek to restore and maintain the health, integrity, and functional values of natural ecosystems that are the cornerstone of productive, sustainable economies.	
Department of Defense	The identification of target areas, including Department of Defense lands, and the implementation of a "holistic approach" instead of a "species-by-species approach" in order to enhance biodiversity.	DOD!
Department of Energy	A consensual process based on the best available science that specifically includes human interactions and management and uses natural instead of political boundaries in order to restore and enhance environmental quality.	DOE!
Department of the Interior: Bureau of Land Management	The integration of ecological, economic, and social principles to manage biological and physical systems in a manner safeguarding the long-term ecological sustainability, natural diversity, and productivity of the landscape.	
Fish and Wildlife Service	Protection or restoration of the function, structure, and species composition of an ecosystem, recognizing that all components are interrelated.	
National Park Service	A philosophical approach that respects all living things and seeks to sustain natural processes and the dignity of all species and to ensure that common interests flourish.	NPS - ????
U.S. Geological Survey	Ecosystem management to emphasize natural boundaries, such as watersheds, biological communities, and physiographic provinces, and bases management decisions on an integrated scientific understanding of the entire ecosystem.	
Environmental Protection Agency	To maintain overall ecological integrity of the environment while ensuring that ecosystem outputs meet human needs on a sustainable level.	Sustainable?
National Science Foundation	An integrative approach to the maintenance of land and water resources as functional habitat for an array of organisms and the provision of goods and services to society.	

Compiled from U.S. Congressional Research Service 1994.

Van Dyke 2003

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Ecosystem Management (Ch10 Van Dyke text)

Why?
-erosion, pollution, waste disposal, sedimentation
-small or uncharismatic species, recreation, intrinsic value
-single species approach very expensive
(SDCP model)

-driven by CAPACITY to deliver goods, services, functions; NOT Demand for them
(forest as an ecosystem, not just a tree farm)

-management experimental and adaptive (SDCP)
-monitoring

-cooperation, stakeholders

"Managers recognize the need for human communities to utilize some ecosystem resources" (VanDyke p.272)

-Define "some"
-Where do we draw the line?
-Human population increase?

Unit of ecosystem management?
-watershed?
-make sure include important components
(Everglades and Lake Okeechobee)

Ecosystem Processes: Necessary vs. Sufficient
-Hawaii missing 90% native vertebrates
-fire, water, herbivory, predation

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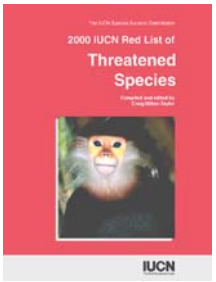
Red list
(International Union for Conservation of Nature and Natural Resources)

Categories of Threat in the IUCN Red List system:
1 *Extinct,*
2 Extinct in the Wild,
3 Critically Endangered,
4 Endangered,
5 Vulnerable,
6 Near Threatened,
7 Least Concern,
8 *Data Deficient*, and
9 *Not Evaluated*.

A species is listed as threatened if it falls in the Critically Endangered, Endangered or Vulnerable categories.



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