Conservation Biology 406R/506R

1. Global Climate Change, Research Example

2. Conservation of Aquatic Ecosystems (Van Dyke Chapter 9)

Exam two returned on Thursday
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 Treasures within…
Unanticipated Uses of Biological Collections

Lucinda McDade
Academy of Natural Sciences, Philadelphia
PH: Fatally flawed storage system installed, late 70s

Most of herbarium cabinets went to NYBG

Why bother?

Specimens play major role in making systematics repeatable and thus an empirical science

True whether floristics, revisionary work, higher level phylogenetics
Unanticipated uses of Museum Specimens

not systematic biology

not geographic distributions

not conservation biology

not identification

(these all vital… but anticipated)

1. Phenology

2. DNA (almost conventional)

3. Historical Environmental Conditions
   Amino Acid Enantiomers
   Leaf Stomatal Density
   Carbon Isotope Ratios
Unanticipated uses of Museum Specimens

3. Historical Environmental Conditions
   Leaf Stomatal Density

Beerling and Chaloner 1993
(Annals of Botany)

Stomates on Surface of Leaves

Leaf surface

x-section
Density of Stomates ↓
with ↑ atmospheric CO₂

>3000 years of Olive leaves
(Olea europaea)
1300 BC to present

Funeral Wreaths
King Tut’s Tomb
Herbarium, Kew

Industrial Revolution
Beerling and Chaloner 1993
(Annals of Botany)
Unanticipated uses of Museum Specimens

3. Historical Environmental Conditions
   Carbon Isotope Ratios

   Black Guillemots,
   Long term study (1972-present)
   George Divoky
Divoky’s 25+ year study shows:
Birds arrive at nesting site two weeks earlier now
Laying eggs 10 days earlier
Results led to examination of causes

***climate change***

Island snow free for 80+ days
only beginning in 70s

Other ways birds might document climate change?

Because guillemots feed at edge of
pack ice in winter

Their bodies should reflect
the location of that pack ice

Specifically:
More southerly seas more productive
Translates to higher C13:C12 ratio

Therefore:
If pack ice (and birds) reduced
in southerly expansion over time

Detectable in C13:C12 in birds
(you are what you eat)

C13:C12 should decrease with time

...where to find really old birds?
(Not just old but DATED)
PH Bird Collection:
Second oldest and fifth largest in the US

δ^{13}C in Black Guillemots
1898-2000
Supports hypothesis that birds feeding farther south 100 yrs ago

Consistent with / extends shorter term documentation of reduced extent of winter ice

Also likely exacerbated by increase in atmospheric CO2
Burning fossil fuel adds C12>C13

Divoky continuing project….

Latest Development:
Pack ice retreating farther to North in summer
(away from island)

Unanticipated uses of Museum Specimens

3. Other Chemical Constituents
Carbon Isotope Ratios

PH has essentially all of Merriweather Lewis’ plant specimens

Collected 1804-1806, Lewis & Clark Expedition

Remarkable series of events brought them to PH (see web site)
PH has essentially all Lewis & Clark plant specimens

Mark Teece studied C13:C12 ratios in sample of L&C plants

Burning fossil fuels adds >>C12
Indeed: C13:C12 higher 200 years ago

Obviously no direct measurements of atmospheric C13:C12 data from 200 years ago

Teece’s results provide modern but pre-Industrial Revolution baseline

Extend record far back into time
Confirm secular increase in C12

The Treasures within...
Unanticipated Uses of Biological Collections

Lucinda McDade
Academy of Natural Sciences, Philadelphia
Aquatic Conservation (VanDyke, Chapter 9)

• Marine vs. Freshwater
  (definition of limnology)

• Fisheries
• Mariculture
• Hydrothermal Vents (and other Benthic Examples)

• Wetlands
• Eutrophication

• Ramsar Treaty
  other legislation

• IBI

Threats to marine environments

• Overfishing and
  overhunting
• Alteration of physical
  environment
• Pollution
• Introduction of non-
  native species
• Global climate change
Impact of Fisheries

• 1940’s and 50’s
  – Fish stocks were seen as a renewable resource where management could lead to a continual maximum sustainable yield every year

• Today’s outlook
  – 70% of the world’s marine stocks have been classified as heavily exploited, over exploited, or depleted.
  – 45% of all species are over-harvested

Commercial Fisheries

• MSY

• Destructive fishing techniques
• Habitat destruction (Dredging/trawling)
• By-catch (Driftnets/dredging/trawling)

• Proposed solutions:
  • Banning certain fishing techniques (drift netting)
  • Requiring the use of devices such as TED’s
  • Limiting the area/time of commercial engagement
  • Marine Reserves
“Rapid worldwide decline of predator fish communities”,

What they concluded:
Only 10% of large, predatory fish are left in the world’s oceans.

A shrimping crew culls the by-catch, Gulf of Mexico Commercial marine fisheries in the U.S. alone toss away up to 20 billion pounds of by-catch each year--twice the commercial and recreational catch combined


Bycatch

Sorting catch and by-catch on a shrimpboat deck, Georgia, 1986
Shrimpers tow nets that collect shrimp, and many other animals in their path. Red snapper, croaker, mackerel, sea trout, spot, drum, and other fishes--up to nine times more than the shrimp catch--are dumped overboard, already dead or dying

Turtle Excluder Devices

Destruction of Habitats

Dynamite fishing destroys reefs
Trawling damage

• Most destructive fishing method that is widely used

• Endangers species that may not even be known yet
Chesapeake Bay

Figure 14-29 Chesapeake Bay, the largest estuary in the United States, is severely degraded as a result of water pollution from point and nonpoint sources in six states and from deposition of air pollutants.

http://www.cbf.org/site/PageServer?pagename=cbf_homepage

Oxygen Depletion
Gulf of Mexico

'Dead Zone'

Figure 14-28 A large zone of oxygen-depleted water forms for half of the year in the Gulf of Mexico as a result of oxygen-depleting algal blooms. It is created by huge inputs of nitrate (NO₃⁻) and phosphate (PO₄³⁻) plant nutrients from the massive Mississippi River Basin.
Oxygen Depletion

Mariculture, A part of the solution?

- **Benefits**: efficient and effective, reduced need to disturb natural systems, perhaps more sustainable

- **Concerns**: Many of the same problems associated with terrestrial agriculture, e.g., concentrated pollution and disturbance

- Increased supply could mean increased demand

- Pearl and oyster farming has been successful for centuries

- Loss of wild populations of cultural & historical importance
Examples

- Fish production
  - Salmon
  - Tilapia (aquatic chicken)
- Oysters
- Giant Clam

Salmon: A Case Study

- Change chemistry of water

- Escape into wild populations:
  - Compete with wild populations (and win)
  - Contaminate gene pool
**Giant Clams**, a mariculture example

- Includes **nine species** of marine clams often found on coral reefs
- Heavily **exploited**
- Large size means high **demand** as food
- Early life stages (egg, larval, juvenile) are raised in outdoor **tanks**, eventually moved into **containers** in the ocean
- **Large adults are then grown in the open sea**
- No apparent environmental harm, increased fish diversity around clam colonies
- Efforts to include locals in mariculture helps to **avoid poaching** of wild clams

**Giant Clam: A Case Study**

- Symbiotic relationship with zooxanthellae.
- No deleterious environmental effects
- **Big Success -> Increased Demand -> Exploitation of Wild Population -> Ban on International Trade**
Marine Protected Areas (MPA)

- World Conservation Union:
  "any area of the intertidal or subtidal terrain, together with its overlying water and associated flora, fauna, historical and cultural features, which has been reserved by law or other effective means to protect part or all of the enclosed environment" (IUCN, 1988; Kelleher, 1999).

Objectives

- Increase biodiversity
- To protect a representative sample of some or all of the habitats found within a region.
- To reduce or prevent impacts from fishing, including population decline, ecological impacts and habitat destruction.
- Establish undisturbed areas as control or reference sites for scientific research and fishery assessment.
- Prevent marine pollution by prohibiting industrial activities, like oil drilling and mining.
- Protect culturally important seascapes, sites and artifacts.
Protected Marine Areas in the World

Benthic Communities and Hydrothermal Vents

Modified from: Bob Seaman, Laura Marshall, Dan Post, Nicole Hallmark
(ECOL 406/506, 2004)
• First one discovered east of the Galapagos in 1977
Hydrothermal Life

- chemosynthesis instead of photosynthesis

- Bacteria—
  primary producers, synthesize sugars from chemoautotrophy
Hydrothermal Life and Conservation

- Areas of **High Biodiversity**
  - Giant Worms, Clams and Crabs live off Archaea (**chemosynthesis**)
- Possible **metapopulation**?
- Habitat for “relict” species:
  - less affected by extinction events
  - stable habitat
- Potential impacts (**mining, energy conversion**)

Benthic Community

- **Ocean Floor**
  - Neritic
  - Continental Shelf
  - Continental Slope
  - Benthic
  - Abyssal benthic
  - Bathypelagic
  - Mesopelagic
  - Eupelagic
  - Pelagic

Depth, m
Benthic Ecosystem

- Nutrient cycling
- Marine Snow
- Estimates of marine benthic species: 500k – 10million

- Habitats-
  - Sea grass (breeding grounds)
  - Extreme environments (high biodiversity)