Monday 20 February 2006, 17th class meeting
(Miller Chapter 5; RedSky 1)

Environmental Biology (ECOL 206)
U. Arizona, spring 2006

Kevin Bonine, Ph.D.
Alice Boyle, Kristen Potter, Graduate TAs

1. Human Population and Urbanization (Miller Ch. 5)
2. Red Sky Ch 1

3. Lecture schedule updates on your website
4. 206 Lab Website for handouts and assignments
   Lab 21-24 Feb, Meet S side BSE (4th and Highland)

5. Exam I returned Wed, key posted, 1 week for point ?s

EVOLUTION: A Series of Seven Lectures Exploring our World and Ourselves

Location: Center for Creative Photography Auditorium, 1030 North Olive Road
Parking is available in the Park Avenue Garage
Time: All lectures begin at 7:00 pm

All the sciences, from astronomy to biology, have worked together to discover the processes that create the current state of our universe, our world and ourselves. These evolutionary processes define the origin of the atoms that make up all matter, the origin of stars and planets, and the development of life itself.

The University of Arizona College of Science is proud to present these seven lectures. Each will illustrate this vision of evolution and demonstrate how we know that evolution represents reality.

Tuesday, February 21. Biological Evolution: What It Is and What It Isn't (Joanna Masel, Assistant Professor, EEB)
Tuesday, March 7. Cosmic Evolution: From Big Bang to Biology (Chris Impey, Distinguished Professor, Astronomy)
Tuesday, March 21. Earth Evolution: The Formation of Our Planet (Joaquin Ruiz, Dean of COS and Professor, Geosciences)
Tuesday, March 28. Social Evolution: Cooperation and Conflict From Molecules to Society (Rick Michod, Professor, EEB)
Tuesday, April 11. Animal Evolution: Recycling Ancient Genes For New Uses (Lisa Nagy, Associate Professor, MCB)
Tuesday, April 18. Human Evolution: Tracking Our Origins with DNA (Michael Hammer, Research Scientist, ARL/EEB)
Tuesday, April 25. Disease Evolution: The Example of HIV (Michael Worobey, Assistant Professor, EEB)

Call 520.621.4090 or go to cos.arizona.edu for more information.
To subscribe to the E.C.L.I.P.S.E. list, send an email to listserv@listserv.arizona.edu with the following as the only line in the body of the message:

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subscribe eclipse Firstname Lastname
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Population Size

- Birth, Death, Migration

- Birth rate
  - Crude Birth Rate (per 1,000)

- Death rate
  - Crude Death Rate (per 1,000)

- Rate of Population Change
  = birth rate - death rate

-Migration
  - Immigration
  - Emigration

Figure 14.8 Population age structures of Sweden and Costa Rica in 1997 reflect the history of birth and survival rates. Because Sweden’s population has grown slowly, its population is weighted toward older age classes. Declining birth rates during the Depression (1930s) and the baby boom that followed World War II (1945–1955) were responsible for irregularities in the age structure. Costa Rica’s rapid population growth, caused by a high birth rate, resulted in a bottom-heavy age structure. However, birth rates have decreased over the last two decades. Ricklets 2001

Figure 11-2: Average crude birth and death rates for various groupings of countries in 2001. (Data from Population Reference Bureau)
Birth and Fertility

- **Replacement Level Fertility** = 2.1 – 2.5

- **Total Fertility Rate** (over lifetime of woman)
  1. 6 in developed
  2. 3.1 in developing
  (2.8 global average)

- **Factors that affect birth rates** (p. 80 your text SE2005):
  1. Children in Labor Force
  2. Urbanization
  3. Cost to raise and educate
  4. Female education and employment
  5. Infant Mortality Rate
  6. Age at first reproduction
  7. Availability of pension/social security
  8. Availability of abortions
  9. Birth control availability
  10. Religious and cultural beliefs

- 216,000 new people/day
- 1.4 billion live on <$1/day
- US 288 million to 571 million in 2100
4. Female education and employment

“For poor women the only holiday is when you are asleep.”

Women:
- Do 2/3 of the work
- 10% of the income
- own 0.01% of the property
- 70% of the world’s poor
- 2/3 of the world’s illiterate
(page 87 your text, SE 2005)

Decreased Death Rates

- Big contributor to population growth

1. Increased food supplies
2. Better nutrition
3. Medical Technology
   - immunizations, antibiotics
4. Sanitation and Hygiene
5. Safer Water

| Infant Mortality Rate | 60/1,000 vs. 7/1,000 |
| Life Expectancy      | 65 vs. 76 (67 avg.) |

(ex. India, China, Thailand p. 87 your text, SE 2005)
Life Table

Table 14.4  Life table of the grass Poa annua

<table>
<thead>
<tr>
<th>Age (x)</th>
<th>Number alive</th>
<th>Survivorship ($l_x$)</th>
<th>Mortality rate ($m_x$)</th>
<th>Survival rate ($s_x$)</th>
<th>Fecundity ($b_x$)</th>
</tr>
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<tbody>
<tr>
<td>0</td>
<td>843</td>
<td>1.000</td>
<td>0.143</td>
<td>0.657</td>
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<td>1</td>
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<td>8</td>
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Number of 3-month periods, in other words, 3 = 9 months.


Summary of life-table variables:

$l_x$: Survival of newborn individuals to age $x$

$s_x$: Fecundity at age $x$

$m_x$: Proportion of individuals of age $x$ dying by age $x + 1$

$b_x$: Proportion of individuals of age $x$ surviving to age $x + 1$

Ricklefs 2001

U.S. Population Example (baby boom)

Figure 11-9: Total fertility rates for the United States between 1917 and 2001. (Data from Population Reference Bureau and U.S. Census Bureau)  
Miller, 2003

Figure 11-10: U.S. population growth, 1900-2000, and projections to 2050. (Data from U.S. Census Bureau)  
Miller, 2003
Demographic Transition

![Graph of demographic transition]

Hall et al. 1994.
The environmental consequences of having a baby in the United States.
Population and Environment 15(6):505-524

Ecological Footprint

Assumptions:
One child, to age 75, average American consumption, born 1990s

Looked at 100 impacts in 5 categories,

1. Waste
2. Mineral consumption
3. Energy consumption
4. Ecosystem alteration (Forest, Wetlands, Water)
5. Food consumption
(as well as extinction of species and indigenous cultures)

Environment and human quality of life
Lifetime per capita:

WASTE:
- 1,000,000 kg atmospheric
- 10,000,000 kg liquid
- 1,000,000 kg solid

CONSUME:
- 700,000 kg minerals
- 4,000 barrels of oil (energy equivalent)
- 25,000 kg major plant foods
- 28,000 kg animal products (2,000 animals)
- 162,000 cubic m water
- 0.84 hectares of forest
- 5,430 kg of fertilizer; 18,675 eggs; 1,654 chickens
- 95 Liters of liquid waste per roll of film used
- Each dollar spent results in 0.5 L oil extracted and burned

Killing the Natives, Chapter 3

U.S.:
- 4% global population
- 25% fossil fuels
- >25% cars
- 50% advertising spending

Goods vs. Bads

$80 billion on shoes, jewelry, watches
$65 billion on higher education

Americans since 1950 have consumed more than all in history preceding

# indivs/house dropping in US

Jimmy Carter – malaise speech, reduce consumption...Reagan
Killing the Natives, Chapter 3

U.S.: 19% believe in top 1% income bracket
      20% believe they will make it to top 1%

Overconsumption leading to 25 million deaths/year

Corporate PR campaigns, think tanks, spin?
- often debunk science

Media: Liberal, Conservative, Corporate

Real Simple?

“We cling to things because they don’t die and we do.”
  (but in doing so we cause untimely deaths)

Speth
Red Sky at Morning
Chapter 1, A World of Wounds

Human Population x4 in past century, Economic Output x20

Local → Global pollution and effects

5-6 billion pounds of pesticides applied each year in world
75% Marine Fisheries in bad shape

We can no longer view nature as a force independent of humans
  (“end of nature”)

Late this century ~50% land in U.S. will not be able to support the
  biota currently living there
Speth
Red Sky at Morning
Chapter 1, A World of Wounds

In Past 20 years:

- Global Population up 35%
- World Economic Output up 75%
- Global Energy Use up 40%
- Global Meat Consumption up 70%
- World Auto Production up 45%
- Global Paper Use up 90%
- Advertising around World up 100%

World Economy May Quadruple by 2050 (to about $180 trillion)

Urbanization (area with > 2,500 people)

19 megacities (with > 10 million)

Figure 11-20: Major urban areas throughout the world based on satellite images of the earth at night that show city lights. Currently, the 46% of the world’s people living in urban areas occupy about 4% of the earth’s land area. Note that (i) most of the world’s urban areas are found along the coasts of continents and (ii) most of Africa and much of the interior of South America, Asia, and Australia is dark at night. The figure also shows the population of the world’s 16 megacities with 10 million or more people and their projected population in 2015. (National Geophysical Data Center, National Oceanic and Atmospheric Administration, and United Nations)
Figure 11-22 Major urban regions in the United States. About 75% of Americans live in urban areas occupying about 3% of the country’s land area. Nearly half (46%) of Americans live in consolidated metropolitan areas with 1 million or more people. (Data from U.S. Census Bureau)

Miller, 2003
your Fig 5-14

Pull:
- jobs and income
- education
- innovation, culture
- health care

Push:
- poverty
- lack of land, work
- famine, war

- 400 cities > 1 million
- 50% world’s population
- poverty and slums
- fast urbanization in developing world

Figure 11-21 Two megalopolises: Bowash, consisting of urban sprawl and coalescence between Boston and Washington, D.C., and Chipitts, extending from Chicago to Pittsburgh.
Unsustainable Urban Areas...

Figure 11.24: Urban areas rarely are sustainable systems. The typical city is an open system that depends on other areas for large inputs of matter and energy resources and for large outputs of waste and heat. Large areas of nonurban land must be used to supply urban areas with resources. For example, according to an analysis by Mathis Wackernagel and William Rees, 58 times the land area of London is needed to supply its residents with resources. They estimate that meeting the needs of all the world’s people at the same rate of resource use as London would take at least three more earths.

Urban Heat Island

Figure 5-21: Profile of an urban heat island showing how temperature changes as the density of development and trees changes. Urban areas with few trees and large areas of heat-absorbing paved streets, roofs, and other dark surfaces that absorb and release heat are hotter than surrounding suburban and rural areas with more trees and less heat-absorbing surfaces. Cities can save money and partially counteract the heat island effect by (1) instituting tree planting programs, (2) using lighter-colored paving, building surfaces, and rooftops to reflect heat away, (3) reducing inputs of waste heat into the atmosphere by establishing high energy-efficiency standards for vehicles, buildings, and appliances, and (4) establishing gardens on the roofs of large buildings.
Reining in Urban Sprawl  
Stoel, 1999

- Sprawl, suburbs, city center
- greenspace, pollution, traffic, erosion, water
- more highways do not help
- wealth vs. quality of life
- fossil fuels
- gov’t subsidies
- divided jurisdictions
- Portland, Oregon  
success attracts people!
- antisprawl legislation  
developers and property rights advocates opposed
- last sentence about need to tax fossil fuels

(Buying larger pants to deal with weight problem)

Travel delays cost DC area residents >$1,000/year

- Travel delays
cost DC area residents
>$1,000/year

= Tortoise Population

= Urban buffer

Phoenix

Tucson

0
90
180 Kilometers

咙 = Urban buffer
● = Tortoise Population
Urbanization and Sprawl
Role of the automobile?

- U.S. 4.6% population
- ~33% of world's cars

Bicycles!!
Mass transit

Sprawl and Cars...

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<tr>
<th>Land and Biodiversity</th>
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<tbody>
<tr>
<td>Loss of cropland</td>
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<tr>
<td>Loss of forests and grasslands</td>
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<tr>
<td>Loss of wetlands</td>
</tr>
<tr>
<td>Loss and fragmentation of wildlife habitats</td>
</tr>
<tr>
<td>Increased wildlife roadkill</td>
</tr>
<tr>
<td>Increased soil erosion</td>
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</tbody>
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<tr>
<th>Human Health and Aesthetics</th>
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<tbody>
<tr>
<td>Contaminated drinking water and air</td>
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<td>Noise pollution</td>
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<tr>
<td>Sky illumination at night</td>
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<td>Traffic congestion</td>
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<th>Water</th>
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<td>Increased runoff</td>
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<td>Increased surface water and groundwater pollution</td>
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<td>Increased use of surface water and groundwater</td>
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<td>Decreased storage at surface water and groundwater</td>
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<td>Increased flooding</td>
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<td>Decreased natural sewage treatment</td>
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<th>Energy, Air, and Climate</th>
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<td>Increased energy use and waste</td>
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<tr>
<td>Increased air pollution</td>
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<tr>
<td>Increased greenhouse gas emissions</td>
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<tr>
<td>Enhanced global warming</td>
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<td>Warmer microclimates (heat island effect)</td>
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<thead>
<tr>
<th>Economic Effects</th>
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<tr>
<td>Higher taxes</td>
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<tr>
<td>Decline of downtown business districts</td>
</tr>
<tr>
<td>Increased unemployment in central city</td>
</tr>
<tr>
<td>Loss of tax base in central city</td>
</tr>
</tbody>
</table>

Figure 11-20: Some of the undesirable impacts of urban sprawl and car-dependent development.
“Cars Rule”

75% Americans drive to work alone
5% commute on public transit
0.5% bicycle to work

In US we drive 2.5 trillion miles/year
(same as all other people combined)

China and others aspiring...

In US, $1 of every $4 related to automobile

Globally: 1.2 million killed each year, 15 million injured

Cars: 25% of CO₂ emissions
Urban areas: 33-50% car related

Externalities accounted: + $5-8 / gallon gasoline

Tax Incentives for Hybrids vs. Large SUVs

$3,150 hybrid
Up to $25,000 for large SUV

depreciation
Curitiba, Brazil

- Cost of implementing the bus system in Curitiba was $2.0 million (U.S.) per mile.

- 10 percent of yearly income on transport.

- As a result, despite the second highest per capita car ownership rate in Brazil (one car for every three people), Curitiba's gasoline use per capita is 30 percent below that of eight comparable Brazilian cities.
Curitiba has 26 parks of well-preserved environment, with rich and diversified fauna and flora. The city has a green area of **55m² for each resident** and is known as the Ecological Capital of Brazil.

Curitiba has doubled in size in just 25 years and now has a population of 1.6 million.
Curitiba, Brazil

• During 1950s and 60s, cities across Brazil experienced rapid population growth due to agricultural mechanization. Curitiba had one of the highest population growths, 6% a yr.

• demanded effective city planning in areas ranging from social services, housing and sanitation, to the environment and transportation

• By the 1960s, officials were working on a Master Plan (1966) to meet these demands, which included a consolidated bus transit system
Curitiba, Brazil

• 340 routes
• 2,000 buses transport 2 million passengers daily
• 700 miles of bus routes; 40 miles dedicated to bus use only
• 25 terminals, 200+ bus tubes
• 30 routes and buses designed for specific use by the disabled
• 50-second deadhead (period between buses) at peak times, and 2 to 3 minutes at other times at the central station
• first city in Brazil to use less polluting fuels; 89.4% diesel, 8% anhydrous alcohol, and 2.6% soybean additive
• The resulting fuel is less polluting and cuts the emissions of particles to the air by up to 43 per cent.
Fossil Fuels and Cars

auto industry

inner city transportation

mass transit

http://www.thethirdrail.net/9905/agt1.htm

UAW

+ 

Sierra Club

??

THE NEW YORK TIMES NATIONAL WEDNESDAY, NOV. 1

Proposal to Change Car Rules Brings 2 Adversaries Together

By DANNY BARDIN

The United Auto Workers union and the Sierra Club, long at odds over fuel economy regulations, are meeting to oppose a Bush administration plan to exempt small cars.

In an article today on the Op-Ed page of The New York Times, leaders of the two groups say the administration proposal, which would weaken the nation's fuel economy and increase pollution, is a threat to all Americans. They claim that millions of Americans are being displaced from their homes by the increased production of small cars.

"United States manufacturing is already in depression," said the article, signed by Ron Gettelfinger, the U.A.W. president, and Carl Pope, the executive director of the Sierra Club.

"The Bush administration should not approve the plan." Federal rules divide new auto-maker's annual fleet of new vehicles into two categories: passenger cars and light trucks, which include sport-utility vehicles, and pickup trucks and minivans. Car fleets are required to average 22.7 miles per gallon and light trucks, 18 miles per gallon.

But if the Bush plan is approved, it would mean that all new vehicle fleets, including utility vehicles and busses, must average 20 miles per gallon in the light truck category and 23 miles per gallon in the average fleet category. The average fuel economy for new vehicles sold in the light truck category would be 23 miles per gallon.

The Sierra Club is concerned that the administration's proposal would be a "double hit" to the environment and the economy. "We're concerned that if the administration's proposal is approved, it will further weaken the nation's fuel economy standards," said Pope.

The proposal would also mean that car manufacturers would have to increase the production of small cars, which would likely displace millions of Americans from their homes.

The Sierra Club is concerned that the increase in production of small cars will further weaken the nation's fuel economy standards. "We're concerned that if the administration's proposal is approved, it will further weaken the nation's fuel economy standards," said Pope.
Subsidized!

> $300 billion/year

Costs not included:

> $300 billion/year

- Foreign military intervention
- Terrorism
- Habitat destruction
- Oil spills
- Health care (smog, accidents, poor fitness)
- Climate change (sea level, global warming)

= $600 billion/year

Energy (Ch 6)

- Solar 99% (not in market place)
- Commercial 1% (82% nonrenewable)
  (incl. indirect solar: wind, water, biomass)