AP Environmental Science Syllabus

Course Description:
This AP course is designed to give junior and senior high school students an in-depth understanding of environmental science. Included in this is the specific goal of enhancing their awareness of, their roles in, and their responsibilities to local, regional, national and global environmental issues.

Summer Assignment:
All students enrolled in the class are required to complete a summer assignment prior to starting the course. This assignment consists of textbook readings and research papers on well-known environmental tragedies. In addition the students are required to develop a glossary of basic terms and concepts fundamental to the understanding of Environmental Science. This assignment is due on the first day of the new school year.

Application of Mathematical Principles to Environmental Science:
Students are instructed in and must apply various mathematical skills during the course of the school year. Each student receives instruction in, and are expected to master; a) basic statistical analysis, b) modeling, c) application of mathematical problem solving using chemical formulas and laws, and d) solving word based problems. In addition, each student is expected to be able to apply metric unit conversions in problem solving.

Student Enrollment:
Enrollment in AP Environmental Science is generally open to all interested students. Pre-requisites are Freshman Biology, Sophomore Chemistry and Algebra II. All students enrolled in the class are required to take the AP test in May of each year.

Outside Activities:
All AP Environmental Science students are provided with the opportunity to join and participate in the school’s Earth Club. This club is student driven and is instrumental in instituting various environment-based activities and projects at school.

Schedule:
1st Semester

Chapter 1: Introduction
General Topics:
What is Environmental Science?
History of the environmental movement
  Case Study: Migratory waterfowl
Conservation of land and wildlife
Toxic substances and wastes
Important figures in the environmental movement
Assessing environmental literature
Scientific Method
Experimental design
  Field experiments
  Lab experiments
  Modeling
  Controlled experiments
  Statistical analysis
Justifications for protecting the environment
Terms and Concepts
Developing skills in writing free response answers
Labs:
  Observations in the Field
  Experimental Design
Research Project: Case Studies (Summer Assignment)
  Love Canal, N.Y.
  Bhopal, India
  Chernobyl, USSR
  Three Mile Island, Penn.
  Minamata, Japan

Chapter 2: Organisms and Environment
Topics:
  Biomes, Ecosystems, Organism, Species, Genome
  Systematic nomenclature
  Population, community, niche, habitat
Interactions: (Includes case studies of each)
  Predator/Prey
  Commensalism
  Parasite/Host
  Mutualism
    Symbiosis
    Non-symbiotic mutualism
    Endosymbiosis
    Obligate mutualism
    Non-obligatory mutualism
    Mutualistic Anachronisms
  Herbivory w/ plant defensive strategies
  Allelopathy
  Competition
  Competitive Exclusion Principle
  Exotic Species
  Adaptation
  Coevolution
  Evolution
    Evolution by Natural Selection
    Darwin and Wallace
    Mechanisms for Evolution
Labs:
- Identifying Interrelationships in the Field
- Termite Microorganisms

Research Project:
- Case studies of interactions (optional)

Chapter 3: Biological, Chemical and Geological Cycles

Topics:
- Biological Cycles
- Law of Conservation of Matter
- Laws of Thermodynamics
- Ecosystems
  - Producers, consumers, decomposers
- Trophic levels
- Efficiency of energy transfer
- Food chains
- Food webs
- Ecological pyramids
- Keystone species
- Photosynthesis and respiration
- Chemical cycles
  - Carbon cycle
  - Carbon-silicate cycle
  - Nitrogen
    - Nitrogen fixation
    - Nitrification
    - Denitrification
    - Eutrophication
- Phosphorus
- Sulfur
- Calcium

Geological Time and Time Scale
- Radiometric dating
- Relative dating

Tectonic cycle
- Tectonic plate boundaries
- Environmental impact of the tectonic cycle
- Earthquakes
- Focus and epicenter
- Seismic waves
  - p-waves
  - s-waves
- Surface waves
- Seismographs and seismograms
- Richter and Modified Mercalli scales
- Environmental impacts of earthquakes
- Tsunamis
Rock types and the rock cycle

Labs:
- Biomass and Trophic Levels in the Field
- Nitrogen Fixation (optional)
- The Rock Cycle

Research Project:
- Keystone Species case studies
- Map: Tectonic plates

Chapter 4: Types of Ecosystems

Topics:
- Primary and secondary succession
- Succession and chemical cycles
- Biomes
- Ecosystems
  - Desert
  - Grasslands
  - Savanna
  - Chaparral
  - Tundra
  - Alpine
  - Boreal Forest
  - Deciduous Forest
  - Tropical Rainforest
  - Tropical Seasonal Forest
  - Temperate Forest
  - Vertical transitions of terrestrial ecosystems
  - Ponds and Lakes (+seasonal turnover)
  - Streams and Rivers (+ riparian zone)
  - Wetlands (swamps, wetlands, bogs, fens, prairie potholes)
  - Estuary
  - Salt marsh
  - Intertidal
  - Coral reef
  - Carbonate bank
  - Mangrove
  - Continental shelf
  - Deep (open) ocean
  - Hydrothermal vents and cold seeps
- Ecosystem productivity
- Ecosystems and human impact
- Ecosystem edge effect
- Landscape ecology
- Patchiness and heterogeneity
- Restoration ecology
- Human intervention and natural processes
- Ecosystem management
Labs:

Succession in the Field
Pond Ecosystem
Coal Forming Ecosystems (optional)
Determining Environments from Sand Samples (optional)

Research Projects:
Map: Global distributions of ecosystems
Selected Ecosystems

Chapter 5: Water Resources

Topics:
Distribution of water
World’s estimated water supply
Distribution of water in the U.S.
Properties of water
Origin of water
Hydrological cycle
Water budget
Human impacts on the hydrological cycle and water budget
Average use of water in the U.S.
Water shortages and water wars
Misuse of water case studies
  Aral Sea
  Colorado River
  Nile River and Tushki Canal
Environmental problems created by dams w/ case studies
  Aswan Dam
Benefits of wetlands
Groundwater
Porosity and permeability
Groundwater flow
Aquifers and aquifer distribution
Types of aquifers; unconfined, confined, perched and karst
Overexploitation of aquifers
  Ogallala Aquifer
Water rights in the U.S.
Water sustainability
Ownership of oceans
Ocean resources
Fishing methods: bottom trawling, long line, drift net, purse seine
Aquaculture

Labs:
Porosity and Permeability (either demo or lab)
Aquifers of Hamilton County

Research Projects:
China’s Three Gorges Dam
Free Response: Georges Bank Groundfish Harvest
Chapter 6: Water Pollution

Topics:

- Point source and non-point source
- Types of pollutants
  - Pathogens
  - Organic matter
  - Organic chemicals
  - Inorganic chemicals
  - Physical agents
  - Radioactive wastes
- Methods for determining water pollution
  - Bioassay
  - Basic water quality testing
- Toxicology
  - Synergistic interactions
  - Bioaccumulation
  - Biological magnification
  - Response to toxins
  - Variability of toxins
  - Determining toxicity
    - Dose/response curves
- Types of damage caused by toxins
- How toxins work
- Organohalogenens
- Production of synthetic chemicals
- MSDS
- Risk analysis, risk assessment, risk communication
- Drinking water standards
- Safe Drinking Water Act
- Clean Water Act
- Other Federal regulations for water
- Freshwater pollution: Rivers and streams
  - Oxygen Sag Curve
- Vernal pools
- Freshwater pollution: Ponds and lakes
  - Eutrophication
  - Seasonal turnover
  - Case study: Great Lakes
- Freshwater pollution: Groundwater
  - Contaminate plume
- Groundwater well design
- Sources of groundwater pollution
- Acid mine drainage
- Ocean pollution
  - Dead zones
- Wastewater treatment
  - Septic systems
Municipal wastewater treatment plants
Primary treatment
Secondary treatment
Advanced treatment
Solids processing
Failures of wastewater treatment plants

Labs:
Assessing Toxins Using a Bioassay
Basic Water Quality Testing: Macroinvertebrates, DO, BOD, FC, Turbidity,
   Total Solids, Nitrates, Phosphates, pH, Temperature
LD 50 w/ copper sulfate
The Effects of Heavy Metals on Enzyme Activity (optional)
Remediating Contaminated Surface/Groundwater (optional)

Research Projects:
LD 50 Free Response

Chapter 7: Air Pollution
Ambient air
Classification of air pollutants
   Physical
   Origin
   Sequential
   Location
History of air pollution
   Case studies
Thermal inversions
Sources and health effects of particulates
Source and health effects of gases
   Sulfur dioxide, carbon monoxide, nitrogen oxide, carbon dioxide, hydrocarbons,
   CFC’s, and ozone
Photochemical smog
Ozone and damage caused by ozone w/ EPA maps from Airnow
Clean Air Act
Attainment and non-attainment areas
Air Quality Index
Global air pollution
   Case studies: China, India, Asian Brown Cloud
Grasshopper Effect
Hazardous Air Pollutants
Combustion reaction
   Vehicle emission testing
Acid Rain
   Effects of acid rain on aquatic ecosystems
   Effects of acid rain on terrestrial ecosystems
   Effects of acid rain on architecture
   Effects of acid rain on human health
   Trends in acid rain
Methyl mercury
Indoor air pollution
Sources of indoor air pollution
Health risks of indoor air pollution
Sick Building Syndrome
Formaldehyde, mold, radon, asbestos
Noise pollution

Labs:
Vehicle Emissions Testing and calculations using the Ideal Gas Law
Microbiology of Indoor Air (optional)
Indoor Air Pollution (Particulates)

Research Projects:
Ozone (optional)
Acid Rain (optional)
Coal Power Plants (optional)

2ND SEMESTER
Chapter 8: Atmosphere and Climate
Topics:
Composition of the atmosphere
Principle functions of the atmosphere
Early atmosphere
Layers of the atmosphere
Weather and climate
Weather maps
Weather fronts
Atmospheric pressure
Air masses
Pressure gradient force
Coriolis force
Jet stream
Climate
Latitude
Seasonal variations
Atmosphere and air circulation patterns
Ocean currents
Case Study: Gulf Stream
Local geography: rain shadows
Air cells
Changes in climate
Cyclic changes: Sun spots and Milankovitch cycle
Irregular changes: El Nino and La Nina
Characteristics of El Nino and La Nina
Global impacts
El Nino and La Nina and diseases
Catastrophic events
Impacts, volcanic activity, hurricanes
Hurricanes
Global distribution
Classification
Formation
Anatomy
Frequency
Changes in climate through geological history
Cambrian to recent
Last 800,000 years
Last 140,000 years
Last 18,000 years
Greenhouse Effect and Global Warming
Greenhouse gases
Carbon dioxide
Ice core data and deep sea sediment data
Kyoto Summit
Methods to reduce carbon dioxide
Impacts of Global Warming
Stratigraphic Ozone Layer
CFC cycle
CFC products
Thinning Ozone Layer
Effects of ozone depletion
Efforts to reduce ozone depletion
Labs:
Design an Experiment to Test the Properties of Greenhouse Gases
Research Projects:
El Nino and La Nina (optional)
Causes and Effects of Hurricanes (optional)
Climate Changes Through Geological History (optional)

Chapter 9: Land Use
Topics:
Current land use in the U.S.
Urban areas, infrastructure, urbanization and urban crisis
Suburban sprawl, why cities sprawl
Land use and planning
Burgess Model
Smart Growth
Wedge and Corridor Model
Fundamentals of Smart Growth
Federal regulations:
CERCLA
SARA
Brownfields
NEPA
EPA Model Ordinances
Soils

Factors of Soil Formation
Soil profiles
Soil types
  - Prairie
  - Boreal forest
  - Desert
  - Rainforest
  - Deciduous forest
Soils and development
  - Ranking soils and agricultural usages
  - History of American agriculture and population
  - Environmental impact of agriculture
  - Global soil loss and degradation
  - Desertification
  - Salinization
Agriculture
  - Green Revolution
  - Soil conservation and farming practices
  - Conventional vs. No-till
  - Conservation practices
  - Farm Act
  - Pesticides
  - Integrated Pest Management
  - Food and food supply
Genetically modified foods
  - Current GMO’s
  - GMO distribution and traits
  - How crops are modified
  - What foods contain GMO’s
  - Benefits and controversies of GMO’s
Forestry
  - Sustainable forestry
  - Causes of deforestation
Mineral resources and mining
  - Basic mining practices
  - Environmental impacts of mining
  - Formation of ore bodies
Government lands
  - Distribution
  - Agencies involved in government lands
  - Wilderness Act
  - National Landscape Monuments
  - Federal Mining Act

Labs:
  - Soil Profiles in the Field
  - Characteristics of Local Soils
  - Soil Texture (optional)
Basic Soil Testing
Microbiology of Soils (optional)
Soil Invertebrates (optional)
Ohio Minerals (optional)
Ores and Minerals (optional)

Research Projects:
The Debate Over Smart Growth and Urban Sprawl (optional)
The Urban Development of SW Ohio (optional)
Model Ordinances to Protect Local Resources (optional)
Ores and Mining (optional)
National Parks (optional)

Chapter 10: Energy

Topics:
History of energy
Energy consumption in the U.S. and globally
Energy units
Energy loss
Non-renewable resources
Oil
  Geological settings and exploration
  Resource depletion curve
  Reserves vs. resources
  Estimating resources, oil window, recovery
  Projected global oil depletion curve and impacts
  Energy usage and population
  Products and fractional distillation
  Environmental impacts
Natural Gas
  Usage, reserves and resources
  Global distribution
  Recovery
  Environmental impacts
Coal
  Formation and types
  Global distribution
  Environmental impacts
Nuclear
  Fission vs. fusion
  Isotopes of uranium
  Fission reactors and chain reaction
  Burner and breeder reactors
  Global distribution of nuclear power
  Fusion reactors
Renewable resources
  Biomass
    Types and fuels
Biodiesel
Hydropower
   Dams
   Tidal
   Wave
   Thermal-Electric generation
Geothermal
   High temperature
   Low temperature
Solar
   Photovoltaic cells
   Low temperature
      Passive
      Active
      Solar ponds
   High temperature
      Power tower
      Parabolic trough
Advantages and disadvantages of solar power
Wind
Fuel Cells and batteries
   Basics of electric current
   Voltaic cells
   Rechargeable batteries
   Fuel cells
      Half cells
      Liquid fuel cell
      Hydrogen fuel cell
      Fuel production
Labs:
   Electric Generation and Energy Loss (demo)
   Biomass Distillation and Use
   Alternative and Non-Conventional Energy and Fuels
Research Projects:
   The Environmental Impact of Petroleum Exploration and Production (optional)

Chapter 11: Solid and Hazardous Waste
Topics:
   History of waste
   Waste types
   Classifying wastes
      Non-Hazardous and Hazardous
   Federal regulations
      RCRA
      CERCLA
      SARA
Chapter 12: Populations

Topics:
- Populations and population dynamics
- Population growth
- Population variations
- Carrying capacity
- Exponential growth
- Doubling time
- Logistic growth
Population vs. carrying capacity
Overshoot and reduced carrying capacity
Fluctuations in carrying capacity
Population density and population growth
Population curves
Predator-prey interactions
Population strategies
  r-select
  K-select
Survivorship curves
Human impacts on wildlife populations
Global warming on wildlife populations
Human population
  Growth of human population
  Thomas Malthus
  Population change
  Fertility rates
  Growth and birth rates
  Trends in birth rates
  Mortality rates
  Infant mortality
  Human diseases
    Pandemics
  Population age structure
  Demographic transition
  Global carrying capacity

Labs:
  Population growth in *Lemna minor* (optional)
  Factors affecting population growth in *Escherichia coli* (optional)

Research Projects:
  Free Response Question: Gypsy Moths and Lyme Disease
  Selected Invasive Species (optional)
  Trends in Human Population (optional)

**Chapter 13: Ethics and Economics**

Topics:
  Economic forces
  Economy
  Economic decisions
  Economic resources
  Types of economies
    Environmental economics
    Command economic system
    Free market
    Capitalistic market economy
    Survival economy
  Measuring economics
Problems with GDP and GNP
Supplementing GDP and GNP

World Bank
Economic forces
Cost-benefit analysis
Internal costs
Externalized costs
Marginal costs
Economic models
Unsustainable vs. Sustainable

Limits to growth
Environmental ethics
Evolution of ethics
The Land Ethic
Conservation ethic
Environmental treaties and laws
GATT
NAFTA
CITES
Kyoto Accord
Federal regulations
CFR
Regional, state and local regulations

Reading Assignments:
A Sand County Almanac, Part IV, A. Leopold
The Steady State Economy in Outline
China Growth Unstable on All Counts, AFP, 2006
Does Globalization Help or Hurt the World’s Poor, Scientific American, 2006

Video Reviews:
Borderline Cases
China From The Inside: Episode 3: Shifting Nature
ABC News: Land Grab (optional)

Assessments:
Combined with Chapter 14.

Chapter 14: Biodiversity Through Time

Topics:
Biodiversity and number of species
Factors that influence biodiversity
Estimating past biodiversity
Review of Geologic Time
Extinctions in the fossil record
Causes of mass extinctions
Human causes of extinctions
Types of extinctions
Extinction and speciation
Periodicity of extinctions and speciation
Evolutionary rebounds after extinctions
Lifespan of species
Susceptibility to extinction
Extinction rates
Co-extinctions
Endangered species
ESA

Research Projects:
   Selected Endangered Species