Course No. S 870

Orange Unified School District

ENVIRONMENTAL SCIENCE

Year Course

GRADE LEVEL: 9-12

PREREQUISITES: Completion of high school **Earth Science** and **Biology or Life Science**

INTRODUCTION TO THE SUBJECT:
Environmental Science is designed to emphasize the use of an ecosystem concept in the study of environmental problems. This will be accomplished by learning basic information regarding interrelations of the ecosystem and applying this information in problem solving. The importance of conservation and preservation will be discussed within the constraints dictated by human development and human needs. Environmental Science is an interdisciplinary science including geology, biology, earth science, environmental science -and geography.

This course will develop students' abilities to think critically and to clearly and logically express ideas, both orally and in written form.

COURSE OBJECTIVES:

BY THE END OF THE COURSE THE STUDENT WILL BE ABLE TO:

Define and describe various ecological systems, both open and closed.

Identify biotic and abiotic factors of an ecosystem.

Understand basic principles of photosynthesis and respiration and apply these models of energy flow, including the concepts of trophic levels and food webs.

Describe the main material cycles of nitrogen, carbon, oxygen, and phosphorous.

Utilize the concepts of succession in real and modeled ecological systems.

Describe factors of population growth and regulation.

Demonstrate an understanding of how human population growth and dynamics function in our biosphere.

Identify and understand humankind's impact on atmosphere, soils, and hydrological cycles.

Identify renewable and nonrenewable resources.

Assess quantitatively humankind's impact on terrestrial and marine ecosystems.

Demonstrate how to record, graph, and interpret experimental data.

Apply environmental principles in designing, setting-up, and monitoring both field and laboratory experiments.

Demonstrate competency in written and oral presentations of research data.

Understand the interrelationships of environment, economics, and politics in humankind's impact on the biosphere.

Research employment opportunities in environmental fields.

Understand environmental regulations.

Understand recycling principles and practices.

Demonstrate safe lab procedures.

COURSE OVERVIEW AND APPROXIMATE UNIT TIME ALLOTMENTS:

WEEKS

I. Interdependence of Earth's Systems: Fundamental Principles and Concepts 9

- A. The flow of energy (Earth Science Standards 4 a-c)
  1. Forms and quality of energy.
- B. The cycling of matter (Biology Standard 6d)
  1. Water
  2. Carbon
  3. Major nutrients
     a. Nitrogen
     b. Phosphorous
- C. The solid earth (Earth Science Standards 3 a-f)
  1. Earth history and the geological time scale
  2. Earth dynamics: plate tectonics, volcanism, the rock cycle
- D. The atmosphere (Earth Science Standards 6a, 8a- c)
  1. Atmospheric history: origin, evolution, composition, and structure
  2. Atmospheric dynamics: weather and climate
- E. The biosphere (Biology Standards 6b, 7d, 8b)
  1. Organisms: adaptations to their environments
  2. Populations and communities: exponential growth, carrying capacity.

II. Human Population Dynamics (Biology Standards 6b, 6d) 3

- A. Evolution of life: natural selection, extinction

B. History of global distribution
   1. Numbers
   2. Demographics, such as birth and death rates
   3. Patterns of resource utilization
C. Carrying capacity - local, regional, global
D. Cultural and economic influences

III. Ecosystems and Change 4

A. Aquatic (Earth Science Standard 9c)
   1. Fresh water: agricultural, industrial, domestic
   2. Oceans: fisheries, industrial
   3. Wetlands
B. Terrestrial Ecosystems (Biology Standards 6a-c)
   1. Grasslands
   2. Forests
   3. Deserts

IV. Renewable and Nonrenewable Resources: Distribution, Use and Conservation 3

A. Energy Resources
   1. Conventional sources
   2. Alternative sources
B. Land Resources
   1. Residential and commercial
   2. Agricultural and forestry
   3. Recreational and wilderness

V. Environmental Quality (Biology Standards 6a-b) 7

A. Major pollutants – Air/Water/Soil
   1. Types, such as SO_2, NOx, and pesticides
   2. Thermal pollution
   3. Point and nonpoint sources (domestic, industrial, agricultural)
B. Effects of pollutants on
   1. Aquatic systems
   2. Vegetation
   3. Natural features, buildings and structures
   4. Wildlife
   5. Soil
C. Solid waste, remediation, and control **WEEKS**
   1. Types, sources, and amounts
   2. Current, disposal methods and their limitations
   3. Alternative practices in solid waste management
D. Impact on Human Health
   1. Agents: chemical and biological
   2. Effects: acute and chronic

3. Relative risks: evaluation and response

VI. Global Changes and Their Consequences (Earth Science Standards 4c,5a, 5c,5g, 6a-d; Biology Standards 6a-b) 6

A. First order effects (changes)
   1. Atmosphere: CO_2, CH_4, stratospheric O_3
   2. Oceans: surface temperatures, currents
   3. Biota: habitat destruction, introduced exotics, over harvesting
B. Higher-order interactions (consequences)
   1. Atmosphere: global warming, increasing ultraviolet radiation
   2. Oceans: increasing sea level, long-term climate change,
   3. Impact on El Niño
   4. Biota: loss of biodiversity

VII. Environment and Society: Trade-Offs and Decision Making 3

A. Economic forces
   1. Cost-benefit analysis
   2. Marginal costs
   3. Ownership and externalized costs
B. Cultural and aesthetic considerations
C. Environmental ethics
D. Environmental laws and regulations (international, national and regional)
E. Issues and options (conservation, preservation, restoration, remediation, sustainability, mitigation)

VIII. Careers in the Field 1

SUGGESTED LABORATORY EXPERIMENTS

1. Introductory Environmental Journal
2. The Dynamic of Plate Tectonics: Earthquakes and Volcanic Activity
3. The Rock Cycle and Soil Formation
4. Environmental Influences on Population Distribution
5. Human Population Demographics
6. Soil Analysis
7. Carbon footprint
8. Air Pollution
9. Water-Quality Testing
10. Water/Wastewater Treatment
11. The Greenhouse Effect

DATE OF CONTENT REVISION: February 2009

DATE OF BOARD APPROVAL: February 12, 2009

STATE CONTENT STANDARDS

BIOLOGY/LIFE SCIENCES

Ecology

6. Stability in an ecosystem is a balance between competing effects. As a basis for understanding this concept:
   a. *Students know* biodiversity is the sum total of different kinds of organisms and is affected by alterations of habitats.
   b. *Students know* how to analyze changes in an ecosystem resulting from changes in climate, human activity, introduction of nonnative species, or changes in population size.
   c. *Students know* how fluctuations in population size in an ecosystem are determined by the relative rates of birth, immigration, emigration, and death.
   d. *Students know* how water, carbon, and nitrogen cycle between abiotic resources and organic matter in the ecosystem and how oxygen cycles through photosynthesis and respiration.

Evolution

7. The frequency of an allele in a gene pool of a population depends on many factors and may be stable or unstable over time. As a basis for understanding this concept:
   d. *Students know* variation within a species increases the likelihood that at least some members of a species will survive under changed environmental conditions.
8. Evolution is the result of genetic changes that occur in constantly changing environments. As a basis for understanding this concept:
   b. *Students know* a great diversity of species increases the chance that at least some organisms survive major changes in the environment.
   c. *Students know* the effects of genetic drift on the diversity of organisms in a population.

EARTH SCIENCES

Dynamic Earth Processes

3. Plate tectonics operating over geologic time has changed the patterns of land, sea, and mountains on Earth's surface. As the basis for understanding this concept:
   a. *Students know* features of the ocean floor (magnetic patterns, age, and sea-floor topography) provide evidence of plate tectonics.
   b. *Students know* the principal structures that form at the three different kinds of plate boundaries.
   c. *Students know* how to explain the properties of rocks based on the physical and chemical conditions in which they formed, including plate tectonic processes.
   d. *Students know* why and how earthquakes occur and the scales used to measure their intensity and magnitude.
   e. *Students know* there are two kinds of volcanoes: one kind with violent eruptions producing steep slopes and the other kind with voluminous lava flows producing gentle slopes.
   f. *Students know* the explanation for the location and properties of volcanoes that are due to hot spots and the explanation for those that are due to subduction.

Energy in the Earth System

4. Energy enters the Earth system primarily as solar radiation and eventually escapes as heat. As a basis for understanding this concept:
   a. *Students know* the relative amount of incoming solar energy compared with Earth's internal energy and the energy used by society.
   b. *Students know* the fate of incoming solar radiation in terms of reflection, absorption, and photosynthesis.
   c. *Students know* the different atmospheric gases that absorb the Earth's thermal radiation and the mechanism and significance of the greenhouse effect.
5. Heating of Earth's surface and atmosphere by the sun drives convection within the atmosphere and oceans, producing winds and ocean currents. As a basis for understanding this concept:
   a. *Students know* how differential heating of Earth results in circulation patterns in the atmosphere and oceans that globally distribute the heat.
   c. The origin and effects of temperature inversions.
   g.* *Students know* features of the ENSO (El Niño southern oscillation) cycle in terms of sea-surface and air temperature variations across the Pacific and some climatic results of this cycle.
6. Climate is the long-term average of a region's weather and depends on many factors. As a basis for understanding this concept:
   a. *Students know* weather (in the short run) and climate (in the long run) involve the transfer of energy into and out of the atmosphere.
   b. *Students know* the effects on climate of latitude, elevation, topography, and proximity to large bodies of water and cold or warm ocean currents.
   c. *Students know* how Earth's climate has changed over time, corresponding to changes in Earth's geography, atmospheric composition, and other factors, such as solar radiation and plate movement.
   d.* *Students know* how computer models are used to predict the effects of the increase in greenhouse gases on climate for the planet as a whole and for specific regions.

California Geology

9. The geology of California underlies the state's wealth of natural resources as well as its natural hazards. As a basis for understanding this concept:
   a. Students know the resources of major economic importance in California and their relation to California's geology.
   b. Students know the principal natural hazards in different California regions, and the geological basis of those hazards.
   c. Students know the importance of water to society, the origins of California's fresh water, and the relationship between supply and need.
   d.* Students know how to analyze published geologic hazard maps of California and use the map information to identify evidence of geological events of the past and predict geological changes in the future.

INVESTIGATION AND EXPERIMENTATION

1. Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept and addressing the content in the

other four strands, students should develop their own questions, and perform investigations. Students will:

a. Select and use appropriate tools and technology (such as computer-linked probes, spreadsheets, and graphing calculators) to perform tests, collect data, analyze relationships, and display data.
d. Formulate explanations by using logic and evidence.
g. Recognize the usefulness and limitations of models and theories as scientific representations of reality.
k. Recognize the cumulative nature of scientific evidence.
l. Analyze situations and solve problems that require combining and applying concepts from more than one area of science.
m. Investigate a science-based societal issue by researching the literature, analyzing data, and communicating the findings. Examples of issues include irradiation of food, cloning of animals by somatic cell nuclear transfer, choice of energy sources, and land and water use decisions in California.