**Roanoke Valley Governor’s School for Science and Technology AP Environmental Science Competency List**

(Last updated: June, 2022)

AP Environmental Science is an interdisciplinary course equivalent to an introductory college course for science majors. There is an emphasis on data collection and analysis both outdoors and in the lab. The major themes include the connection between living organisms and their environment, the flow of energy and chemicals through ecosystems, and human impact on the environment. Students are expected to obtain a qualifying score of 3, 4, or 5 on the AP environmental science exam at the end of this course.

This course is taught using best practices in gifted education. Each competency is aligned with Hockett’s five principles of gifted education:

**Gifted Education Principles:** ( Hockett, J.A. (2009) “Curriculum for Highly Able Learners That Conforms to General Education and Gifted Education Quality Indicators.” *Journal of Education for the Gifted***.** Vol. 32, No. 3, p. 394-440)

**1.** High-quality curriculum for gifted learners uses a conceptual approach to organize or explore content that is discipline based and integrative.

**2.** High-quality curriculum for gifted learners pursues advanced levels of understanding beyond the general education curriculum through abstraction, depth, breadth, and complexity.

**3.** High-quality curriculum for gifted learners asks students to use processes and materials that approximate those of an expert, disciplinarian, or practicing professional.

**4.**  High-quality curriculum for gifted learners emphasizes problems, products, and performances that are true to life, and outcomes that are transformational.

**5.** High-quality curriculum for gifted learners is flexible enough to accommodate self-directed learning fueled by student interests, adjustments for pacing, and variety.

External standards from the [AP Environmental Science Course and Exam Description](https://apcentral.collegeboard.org/pdf/ap-environmental-science-course-and-exam-description.pdf?course=ap-environmental-science) were referenced when reviewing these competencies. To the right of each Enabling Objective is notation indicating alignment with external standards and a relative priority/proficiency rating from A (highest) to D (lowest).

COMPETENCY I

**Define and describe the science of ecology and apply the scientific method to the study of ecology and environmental science.**

*Enabling Objectives:*

|  |  |
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| 1. Distinguish between biotic and abiotic factors in an ecosystem. | AP 1.1 |
|  |  |
| 2. Describe the hierarchy of ecosystem structure. | AP 1.1,1.9-11 |
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| 3. Relate the major components of the scientific method to laboratory investigations. | AP SP4 |
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| 4. Construct hypotheses. Design and carry out individual and group investigations to test hypotheses. | AP SP4 |
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| 5. Design tests to answer questions from previous investigations. | AP SP4,SP5 |
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| 6. Organize data and observations from lab and field settings into appropriate forms for analysis. | AP SP5, SP6 |
|  |  |
| 7. Interpret experimental results. | AP SP4, SP5 |
|  |  |
| 8. Draw appropriate conclusions from observations and experimental results. | AP SP4, SP5, SP1, SP7 |
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| 9. Identify and analyze sources of error inherent in experimental designs. | AP SP4 |
|  |  |
| 10. Integrate mathematics, graphing, and statistics into the analysis of experimental data. | AP SP2, SP6 |
|  |  |
| 11. Use computer-interfaced probes and other sophisticated lab equipment for data collection and analysis. | AP SP5 |
|  |  |
| 12. Select and utilize appropriate resources for research ideas and background information. | AP SP3 |

COMPETENCY II

**Understand that biological evolution is a unifying concept that provides the foundation for linking the patterns and processes of ecology.**

*Enabling Objectives:*

|  |  |
| --- | --- |
| 1. Describe the process of natural selection. | AP 2.1,2.6 |
|  |  |
| 2. Explain the role of heredity and genetics in natural selection. | AP 2.6 |
|  |  |
| 3. Discuss geographic variation within species. | AP 2.1,2.3,2.4 |
|  |  |
| 4. Discuss how adaptations reflect trade-offs and constraints. Apply this concept to studies of plants, animals, life history patterns, intraspecific interaction, interspecific interaction, ecological succession, energy acquisition in the ecosystem, and conservation. | AP SP1  2.1, 2.4-7, 3.1-5, 9.8 |

COMPETENCY III

**Examine features of the physical environment that directly influence its habitability by living things.**

*Enabling Objectives:*

|  |  |
| --- | --- |
| 1. Explain how climate determines the availability of heat and water on the Earth’s surface and influences the amount of solar energy that plants can harness. | AP 1.8,4.7,4.8 |
|  |  |
| 2. Contrast climate and weather. | AP 4.4-5, 4.7-8 |
|  |  |
| 3. Describe the causes of air and water currents and how they affect climate. | AP 4.4-8 |
|  |  |
| 4. Describe the El Niño Southern Oscillation and its global effects. | AP 4.9 |
|  |  |
| 5. Describe how geographic variations in climate govern the large-scale distribution of plants and therefore the nature of terrestrial ecosystems. | AP 1.2 |
|  |  |
| 6. Explain how urban areas can create their own microclimates. | AP 5.10 |
|  |  |
| 7. Relate the effect of urban heat islands to air quality. | AP 7.1,7.2,5.10 |
|  |  |
| 8. Use air sampling techniques to evaluate the air quality in the Roanoke Valley. | AP 7.1,7.4,7.6,7.7 |

COMPETENCY IV

**Understand how the physical features of the aquatic environment set the constraints for life.**

*Enabling Objectives:*

|  |  |
| --- | --- |
| *1.* Describe how water cycles between earth and the atmosphere and discuss ways human activity affects this cycle. | AP 1.7, 4.6, 5.1,5.2,5.4,5.5,5.12,5.13,5.17 |
|  |  |
| 2. Discuss the importance of groundwater resources to people and evaluate the threats to the sustainability of these resources. | AP 4.6, 5.4, 5.12,5.13, 8.9 |
|  |  |
| 3. List and describe the unique physical properties of water. | Exceeds standards |
|  |  |
| 4. Describe how abiotic factors such as light, depth, acidity, turbidity, temperature, dissolved oxygen and water movements affect organisms that live in water. | AP 1.3,4.6,9.6 |
|  |  |
| 5. Describe how different types of pollution affect organisms that live in the water. | AP 7.7, 8.1-8, 9.7 |
|  |  |
| 6. Experimentally determine the LD-50 of a toxin on a suitable subject organism. | AP 8.12, SP4, SP5 |
|  |  |
| 7. Monitor the health of Murray Run using a biotic index as well as water chemistry analysis. | AP SP5, SP7 |
|  |  |
| 8. Create a habitat assessment of the Murray Run sampling area. | AP 1.1, 2.1, 2.2, SP 5 |
|  |  |
| 9. Describe how the rapid changes experienced by intertidal zones and estuaries affect life in those places. | AP 1.3,8.4 |

COMPETENCY V

**Describe how the physical features of the terrestrial environment set the constraints for life.**

*Enabling Objectives:*

|  |  |
| --- | --- |
| 1. Explain how plant cover influences the vertical distribution of light. | AP 1.2 |
|  |  |
| 2. Discuss the importance of soil to terrestrial life. | AP 1.2,1.5,1.6 |
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| 3. Describe the formation of soil, including how difference processes produce different soils. | AP 4.2,4.3 |
|  |  |
| 4. List and describe the physical characteristics used to distinguish soils. | AP 4.3 |
|  |  |
| 5. Describe the four commonly recognized horizons of soils. | AP 4.3 |
|  |  |
| 6. Relate the role of ion exchange to soil fertility. | AP 4.3 |
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| 7. Discuss how land use and soil salinization affect human life. | AP 5.1-2, 5.4-5, 5.15,5.17 |
|  |  |
| 8. Experimentally determine the physical and chemical characteristics of soil samples from the Roanoke Valley. | AP 1.2,4.3, SP4, SP5 |
|  |  |
| 9. Experimentally demonstrate the effect of acid rain on organisms and their physical environment. | AP SP4,5,7.7 |

COMPETENCY VI

**Describe plant adaptations to the environment.**

*Enabling Objectives:*

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| 1. Describe photosynthesis and the factors that affect the rate of photosynthesis in plants and algae. | AP 1.4, 1.8 |
|  |  |
| 2. Trace the movement of carbon through terrestrial and aquatic plants. | AP 1.4 |
|  |  |
| 3. Discuss and describe adaptations to light availability, water demand, temperature, and nutrient availability. | AP 2.1,5.15,5.17 |
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| 4. Discuss the possible effects of global warming on different types of plants. | AP 9.5,9.8 |

COMPETENCY VII

**Examine the life history patterns of plants and animals.**

*Enabling Objectives:*

|  |  |
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| 1. Relate reproductive strategies to resources, time, and energy. | AP 3.1-3 |
|  |  |
| 2. Compare and contrast different parental investment strategies and relate to conservation priority and endangered species. | AP 3.2,3.3, 9.9,9.10, SP7 |
|  |  |
| 3. Discuss how environmental conditions influence the evolution of life history characteristics. | AP 3.2-5 |
|  |  |
| 4. Evaluate how humans have altered the life history patterns of plants and animals for agricultural purposes. Cite the pros and cons of the mass production of monocultures such as corn. | AP 5.2-5.4, 7.8, SP7 |

COMPETENCY VIII

**Explore the dynamics of natural populations.**

*Enabling Objectives:*

|  |  |
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| 1. Examine how birth, death, and migration govern the dynamics of local populations. | AP 3.5 |
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| 2. Determine the density of a local population. | AP SP5, SP6 |
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| 3. Practice sampling a population. | AP SP5, SP6 |
|  |  |
| 4. Examine factors, both environmental and behavioral, that function to regulate the growth of populations. | AP 3.1,3.4,3.5 |
|  |  |
| 5. Compare exponential and logistic growth mathematical models. | AP 3.5 |
|  |  |
| 6. Demonstrate logistic growth of an organism in the laboratory. | AP 3.5, SP4, SP5 |
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| 7. Experimentally examine factors that affect population growth. | AP SP4, SP5 |
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| 8. Relate principles of population growth to the human population. | AP 3.6-3.9 |
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| 9. Analyze the impact of the human population on the environment in terms of number of people as well as the ecological footprint of peoples from different parts of the world. | AP 5.1-17, 9.1-10, SP7 |
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| 10. Discuss factors that may lead to extinction. | AP 9.8-10 |
|  |  |
| 11. Contrast density-dependent and density-independent effects on population growth. | AP 3.2, 3.5 |
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| 12. Describe different types of competition within and between plant and animal populations. | AP 1.11, 2.4, 2.6, 3.5 |
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| 13. Explore the processes that influence the interactions among local subpopulations and the dynamics of the larger regional population. | AP 2.3,2.5, 9.9, 9.10 |
|  |  |
| 14. Research the impact of invasive species on the native populations of plants and animals in Southwest Virginia. | AP 9.8 |

COMPETENCY IX

**Examine the diversity of species interactions, their influence on demographic processes, and their role as agents of natural selection.**

*Enabling Objectives:*

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| 1. Describe four possible outcomes of interspecific competition. | AP 3.1,3.4,3.5, 9.8 |
|  |  |
| 2. Discuss experimental evidence for the competitive exclusion principle. | AP SP1, SP4, SP5, 3.1 |
|  |  |
| 3. Explain how interspecific competition may shape the niche of a species. | AP 3.1,2.4,2.5 |
|  |  |
| 4. Cite examples of how interspecific competition influences natural selection. | AP 2.6,3.2 |
|  |  |
| 5. Use mathematical models to express the effects of competition and predation on population growth. | AP 3.5, SP6 |
|  |  |
| 6. Discuss how modern agricultural practices work to limit crop competition and predation. Discuss the positive and negative consequences of using chemical products to control pest species. Discuss the positive and negative environmental consequences of using biotechnology in agriculture. | AP 5.3-6, 5.14-15, SP7 |
|  |  |
| 7. Describe some survival strategies (both for predator and prey) that have resulted from co-evolution | AP 2.6 |
|  |  |
| 8. Describe some different survival strategies used by parasites and their hosts. | AP 2.5,2.6, 8.15 |
|  |  |
| 9. Discuss the impact of parasites on human life in the past and present. | AP 8.15 |
|  |  |
| 10. Discuss how parasites may regulate host survival and reproduction. | AP 3.2,3.4,3.5,8.15 |
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| 11. Define and give examples of mutualism and commensalism. | AP 2.2, 2.6 |
|  |  |
| 12. Investigate a symbiotic relationship in the laboratory. | AP 1.4,2.2,2.6 |
|  |  |
| 13. Explain how mutualism may affect population dynamics. | AP 2.7,3.5 |

COMPETENCY X

**Describe the interactions that occur in ecological communities and how those interactions can lead to changes in the communities.**

*Enabling Objectives:*

|  |  |
| --- | --- |
| 1. Examine the factors that influence the structure of ecological communities. | AP 1.9,1.10.1.11,2.3 |
|  |  |
| 2. Use food webs to describe species interactions | AP 1.11 |
|  |  |
| 3. Demonstrate how adaptations to the physical environment influence the distribution and abundance of populations of a species. | AP 2.6,1.2,1.3,2.4 |
|  |  |
| 4. Examine how the interactions that occur among species function to modify the potential distribution and abundance of a species within an area. | AP 2.6,2.7 |
|  |  |
| 5. Discuss how the relative abundance of species changes through time. | AP 2.7 |
|  |  |
| 6. Evaluate the succession patterns of local fields/forests. | AP 2.7 |
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| 7. Examine how patterns in the physical environment, agents of disturbance, and biotic processes interact to create a mosaic of communities and how the spatial arrangement of these communities influences their dynamics. | AP 2.4,2.5,2.7, 9.10 |
|  |  |
| 8. Correlate the changes in Southeastern forests in the last 250 years to the biological diversity in our area. | AP 2.1,2.7,9.5,9.8,9.10 |

COMPETENCY XI

**Integrate the understanding of adaptation, populations, communities, and the physical environment to explore ecosystems.**

*Enabling Objectives:*

|  |  |
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| 1. Relate the laws of thermodynamics to energy flow in the ecosystem. | AP 1.10 |
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| 2. Discuss primary productivity in both terrestrial and aquatic ecosystems. | AP 1.8 |
|  |  |
| 3. Contrast the grazing food chain and the detrital food chain in ecosystems. | AP 1.10, 1.11 |
|  |  |
| 4. Quantify energy flow through trophic levels. | AP 1.10, SP6 |
|  |  |
| 5. Describe the role of decomposition in nutrient cycling. | AP 1.4-6, 1.9, 1.11 |
|  |  |
| 6. Describe factors influencing the rate of nutrient cycling. | AP 1.4-7 |
|  |  |
| 7. Contrast nutrient cycling in terrestrial and open-water aquatic ecosystems. | AP 1.4-6, 1.8 |
|  |  |
| 8. Describe the major biogeochemical cycles and discuss ways in which human activity has altered these cycles. | AP 1.4-7,8.5 9.4,9.7 |

COMPETENCY XII

**Describe the distribution of contemporary organisms (biogeographical ecology).**

*Enabling Objectives:*

|  |  |
| --- | --- |
| 1. Describe the factors that define the major terrestrial biomes (tropical forests, savannas, deserts, temperate shrublands, temperate forests, grasslands, conifer forests, and arctic tundra). | AP 1.2 |
|  |  |
| 2. Discuss plant and animal adaptations to each of the major terrestrial biomes. | AP 1.2 |
|  |  |
| 3. Explain how the nature of life varies with the different zones of a lake. | AP 1.3 |
|  |  |
| 4. Discuss the role of nutrients in a lake ecosystem. | AP 1.3, 1.5,1.6, 8.5 |
|  |  |
| 5. Describe how streams are organized into watersheds. State the watershed in which Roanoke, VA is located. State the ocean into which our watershed river feeds. | AP 4.6 |
|  |  |
| 6. Describe how life is adapted to flowing water. | AP 4.6,1.7 |
|  |  |
| 7. Evaluate the impact of dams on river ecosystems. | AP 4.6,1.7,6.9,8.2 |
|  |  |
| 8. Describe the zones and strata of the ocean ecosystem. | AP 1.3 |
|  |  |
| 9. Discuss the structure and importance of coral reefs. | AP 1.3 |
|  |  |
| 10. List and describe the transition areas between water and terrestrial ecosystems. | AP 1.3, 8.4 |
|  |  |
| 11. List the different types of wetland ecosystems. | AP 1.4 |
|  |  |
| 12. Analyze the causes and consequences of the decline of wetlands in the United States. | AP 8.4, 5.16 |
|  |  |
| 13. Describe how the earth’s biological diversity has changed through geologic time. | AP 2.6, 4.1 |
|  |  |
| 14. Correlate species richness with ecosystem climate and productivity. | AP 1.2,1.3, 1.8, 4.8 |

COMPETENCY XIII

**Analyze human interaction with our environment and propose solutions to our current environmental problems.**

*Enabling Objectives:*

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| 1. Define environmental sustainability. Describe actions an individual may take to live more sustainably. | AP 5.12 |
|  |  |
| 2. Discuss the value of biodiversity and healthy ecosystems. | AP 1.1,2.1,2.2,9.10 |
|  |  |
| 3. Evaluate the sustainability of modern agribusinesses. | AP 5.15, 5.16,5.7 |
|  |  |
| 4. Compare and contrast sustainable forestry with other forms of forestry commonly used today. | AP 5.1, 5.2, 5.17 |
|  |  |
| 5. Discuss the need for management in the fisheries industry in terms of maximum sustainable yield. | AP 3.4, 3.5, 5.8, 5.16 |
|  |  |
| 6. Describe the threats that human activity poses in terms of species extinction and what steps humans may take to reduce the chances of extinction. | AP 9.8,9.9,9.10, SP7 |
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| 7. Evaluate the pros and cons of using pesticides such as DDT to control disease-carrying insects. | AP 5.6, 5.14, 8.15, 8.7, 8.8, 9.10 |
|  |  |
| 8. Discuss the influence of greenhouse gases on the earth’s climate. | AP 9.3-9.6 |
|  |  |
| 9. Discuss the role of human activity in the increase of carbon dioxide levels. Explain how global warming may affect ecosystems, agricultural production, and human health. | AP 9.3-9.6 |
|  |  |
| 10. Discuss mountain-top removal coal mining in our region with respect to: advantages and disadvantages of using coal as an energy resource, human disturbance, landscape ecology, succession, biodiversity, sustainability, watersheds, economics, and environmental justice. | AP 5.9, 6.3-6.5 |
|  |  |
| 11. Evaluate alternative (to fossil fuels) energy resources in terms of their sustainability. Focus on specific alternatives (such as wind and geothermal energy) that would be viable in our region of Southwest Virginia. | AP 6.1-6.13 |
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| 12. Evaluate waste disposal methods and the effects of pollutants on air, soil, water, and organisms (including humans). | AP 7.1-8, 8.1-15 |
|  |  |
| 13. Explain the causes and effects of ozone depletion and how to prevent it. | AP 9.1, 9.2 |
|  |  |
| 14. Examine issues of environmental racism and social justice. | Exceeds standards |
|  |  |
| 15. Analyze the factors that lead to or inhibit public policy concerning environmental issues. | AP SP 1-7, exceeds stds |