AZ Science Standards:

Including Ecology Explorers in your science curriculum may help you to fulfill many of the requirements as outlined in the Arizona Department of Education Science Standards. Since ecology is the study of the interactions between living and non-living components in the biosphere, it is one field of scientific study that easily combines the life sciences, physical sciences and earth sciences. The study of urban ecology makes your schoolyard an easily accessible scientific laboratory. Urban ecology also touches on human interactions with the environment and students will be able to see the interplay between science and society as they ask questions about their local environment.

The following are selected standards taken directly from the Arizona Department of Education Science Standards that may be met by incorporating Ecology Explorer into your curriculum. The fulfillment of some of these standards, while not directly addressed by this Ecology Explorer Web site are logical extensions that teachers will make while teaching ecological concepts.
Science as Inquiry:

Participation in Ecology Explorers fulfills many of the requirements for the Inquiry Process (Strand 1), History and Nature of Science (Strand 2) and Science in Personal and Social Perspectives (Strand 3) because this program is designed to allow students to be active participants in on-going and active research projects at ASU.

Ecology Explorer Project can fulfill:

**K-4**

S1C1-K-4: observe, ask questions, and make predictions
S1C2-K-4: participate in planning and conducting investigations and recording data
S1C3-K-4: organize and analyze data; compare to predictions
S1C4-K-4: communicate results of investigations

**5-8**

S1C1-5-8: formulate predictions, questions, or hypotheses based on observations; locate appropriate resources
S1C2-5-8: design and conduct controlled investigations
S1C3-5-8: analyze and interpret data to explain correlations and results; formulate new questions
S1C4-5-8: communicate results of investigations

**HS**

S1C1-HS: formulate predictions, questions, or hypotheses based on observations; evaluate appropriate resources
S1C2-HS: design and conduct controlled investigations
S1C3-HS: evaluate experimental design, analyze data to explain results and to propose further investigations; design models
S1C4-HS: communicate results of investigations

S2C2-HS: understand how scientists evaluate and extend scientific knowledge

S2C1-HS: identify individual, cultural, and technological contributions to scientific knowledge
S3C1-HS: describe the interactions between human populations, natural hazards, and the environment
S3C2-HS: develop viable solutions to a need or problem
S3C3-HS: analyze factors that affect human populations
Students participating in Ecology Explorers will meet many of the AZ Life Science Standards through learning ecology in cities. Ecology is the branch of biology that studies interactions among living things as well as interactions of living things and their physical environment. We have mapped how the major concepts in ecology relate to the Arizona state science standards and the concepts emphasized in Ecology Explorers are highlighted in the maps. The maps are shown below.
5-8: Life Science Standards

Strand 4, Concept 1:
5-8: Structure and function in living systems: understand the relationships between structures and functions of organisms

PO-1: Explain the importance of water to organisms

Strand 4, Concept 2:
5-8: Populations of organisms in an ecosystem: analyze the relationships among various organisms and their environment

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PO-1: Explain that sunlight is the major source of energy for most ecosystems
PO-2: Describe how the following environmental conditions affect the quality of life: water quality, climate, population density, smog
PO-1: Compare food chains in a specified ecosystem and their corresponding food web
PO-2: Explain how organisms obtain and use resources to develop and thrive in niches, predator/prey relationships
PO-3: Analyze the interactions of living organisms with their ecosystems: limiting factors, carrying capacity
PO-4: Evaluate data related to problems associated with population growth (e.g., over-grazing, forest management, invasion of non-native species) and the possible solutions
PO-5: Predict how environmental factors (e.g., floods, droughts, temperature changes) affect survival rates in living organisms
PO-6: Create a model of the interactions of living organisms within an ecosystem

Strand 4, Concept 3:
5-8: Diversity, adaptation, and behavior: identify structural and behavioral adaptations

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PO-1: Explain how an organism's behavior allows it to survive in an environment
PO-2: Describe how an organism can maintain a stable internal environment while living in a constantly changing external environment
PO-3: Determine characteristics of organisms that could change over several generations
PO-4: Compare the symbiotic and competitive relationships in organisms within an ecosystem (e.g., lichen, mistletoe/tree, clownfish/sea anemone, native/non-native species)
PO-5: Analyze the following behavioral cycles of organisms: hibernation, migration, dormancy (plants)
PO-6: Describe the following factors that allow for the survival of living organisms: protective coloration, beak design, seed dispersal, pollination
HS: Life Science Standards

Strand 4. Concept 3:
HS: Interdependence of organisms: analyze the relationships among various organisms and their environment
PO-1: Identify the relationships among organisms within populations, communities, ecosystems, and biomes.
PO-2: Describe how organisms are influenced by a particular combination of biotic and abiotic factors in an environment.
PO-3: Assess how the size and rate of growth of a population are determined by birth rate, death rate, immigration, emigration, and carrying capacity of the environment.

Strand 4. Concept 4:
HS: Biological evolution: understand the scientific principles and processes involved in biological evolution
PO-1: Identify the following components of natural selection, which can lead to specialization: potential for a species to increase its numbers; genetic variability and inheritance of offspring due to mutation and recombination of genes; finite supply of resources required for life; selection by the environment of those offspring better able to survive and produce offspring.
PO-2: Explain how genotypic and phenotypic variation can result in adaptations that influence an organism’s success in an environment.
PO-3: Describe how the continuing operation of natural selection underlies a population’s ability to adapt to changes in the environment and leads to biodiversity and the origin of new species.
PO-4: Predict how a change in an environmental factor (e.g., rainfall, habitat loss, non-native species) can affect the number and diversity of species in an ecosystem.
PO-5: Analyze how patterns in the fossil record, nuclear chemistry, geology, molecular biology, and geographical distribution give support to the theory of organic evolution through natural selection over billions of years and the resulting present-day biodiversity.
PO-6: Analyze, using a biological classification system (i.e., cladistics, phylogeny, morphology, DNA analysis), the degree of relatedness among various species.

Strand 4. Concept 5:
HS: Matter, energy, and organization in living systems (including human systems): understand the organization of living systems, and the role of energy within those systems.
PO-1: Compare the processes of photosynthesis and cellular respiration in terms of energy flow, reactants, and products.
PO-2: Describe the role of organic and inorganic chemicals (e.g., carbohydrates, proteins, lipids, nucleic acids, water, ATP) important to living things.
PO-3: Diagram the following biogeochemical cycles in an ecosystem: water, carbon, nitrogen.
PO-4: Diagram the energy flow in an ecosystem through a food chain.
PO-5: Describe the levels of organization of living things from cells, through tissues, organs, organ systems, organisms, populations, and communities to ecosystems.
Physical Science (Strand 5)

Although the physical sciences are used extensively to understand ecosystems, these standards are specific to understanding the underlying structure of matter. In Ecology Explorers, students need to be comfortable with many of the characteristics of chemical compounds, but they are not part of this curriculum. For example, understanding conservation of energy and matter are key components to understanding ecosystems. Ecology Explorers is a way for students to see how these basic physical concepts are applied in biological systems.
Earth and Space Science (Strand 6)

Since Ecology is the interaction between the living and non-living components, knowing something about the earth is very important. Ecology Explorer project can fulfill:

K-4
S6.C2.G1.PO1: Identify evidence that the Sun is the natural source of heat and light on the Earth (e.g., warm surfaces, shadows, shade).
S6.C3.GR1.PO1: Identify the following characteristics of seasonal weather patterns: temperature, type of precipitation, wind.
S6.C3.GR1.PO2: Analyze how the weather affects daily activities.
S6.C3.GR2.PO1: Measure weather conditions (e.g., temperature, precipitation).
S6.C3.GR2.PO2: Record weather conditions (e.g., temperature, precipitation).
S6.C5.GR4.PO1: Identify the sources of water within an environment (e.g., ground water, surface water, atmospheric water, glaciers).
S6.C5.GR4.PO6: Compare weather conditions in various locations (e.g., regions of Arizona, various U.S. cities, coastal vs. interior geographical regions).

5 - 8
S6.C2.GR7.PO3: Explain the following processes involved in the formation of the Earth’s structure: erosion, deposition, plate tectonics, volcanism.
S6.C2.GR7.PO4: Describe how the rock and fossil record show that environmental Conditions have changed over geologic and recent time.
S6.C2. GR4.PO1: Identify the earth processes that cause erosion.
S6.C2. GR4.PO4: Compare rapid and slow processes that change the Earth’s surface, including: rapid – earthquakes, volcanoes, floods; slow – wind, weathering.
S6.C2. GR4.PO5: Identify the earth events that cause changes in atmospheric conditions (e.g., volcanic eruptions, forest fires).
S6.C2. GR4.PO6: Analyze evidence that indicates life and environmental conditions have changed (e.g., tree rings, fish fossils in desert regions, ice cores).
S6.C2. GR6.PO1: Explain how water is cycled in nature.
S6.C2. GR6.PO-3: Analyze the effects that bodies of water have on the climate of a region.
S6.C2. GR6.PO 4. Analyze the following factors that affect climate: ocean currents, elevation, location.
HS

S6.C1.HS.PO1: Identify ways materials are cycled within the earth system (i.e., carbon cycle, water cycle, rock cycle).

S6.C1.HS.PO2: Demonstrate how dynamic processes such as weathering, erosion, sedimentation, metamorphism, and orogenesis relate to redistribution of materials within the earth system.

S6.C1.HS.PO5: Describe factors that impact current and future water quantity and quality including surface, ground, and local water issues.


S6.C2.HS.PO3: Distinguish between weather and climate.

S6.C2.HS.PO9: Explain the effect of heat transfer on climate and weather.

S6.C2.HS.PO12: Describe the conditions that cause severe weather (e.g., hurricanes, tornadoes, thunderstorms).

S6.C2.HS.PO14: Analyze how weather is influenced by both natural and artificial earth features (e.g., mountain ranges, bodies of water, cities, air pollution).

S6.C2.HS.PO15: List the factors that determine climate (e.g., altitude, latitude, water bodies, precipitation, prevailing winds, topography).

S6.C2.HS.PO16: Explain the causes and/or effects of climate changes over long periods of time (e.g., glaciation, desertification, solar activity, greenhouse effect).

S6.C2.HS.PO17: Investigate the effects of acid rain, smoke, volcanic dust, urban development, and greenhouse gases, on climate change over various periods of time.

S6.C3.HS.PO6: Investigate scientific theories of how life originated on Earth (high temperature, low oxygen, clay catalyst model).

S6.C3.HS.PO7: Describe how life on Earth has influenced the evolution of the Earth’s systems.

S6.C3.HS.PO8: Sequence major events in the Earth’s evolution (e.g., mass extinctions, glacial episodes) using relative and absolute dating data.

Teacher’s Guide

Ecology Explorers and the AZ Standards (other than Science)

Reading, Writing, Listening & Speaking: Language Arts Standards & CAP LTER

Arizona Standards stress the interdependency or reading, writing, listening and speaking. Interdisciplinary projects such as CAP LTER protocols and their associated extensions (reading science information, interpreting keys, presenting and sharing data) offer a cross disciplinary method for integration of many language arts skills.

**Reading**
- Comprehension: identifying cause and effect (R-F3, PO4)
- Structural analysis skills: identify root words, infer meaning from knowledge of prefixes and suffixes, and confirm meaning by context clues (R-E1, PO1,2,3)
- Evaluate an instructional manual: identify components in the manual, incorporate information from illustrations, identify the sequence of activities needed to carry out a procedure (R-E5, PO1,2,4)

**Writing**
- Gather, organize and accurately, clearly and sequentially report information gained from personal observations and experiences such as science experiments, field trips and classroom visitors: record observations, write an introductory statement, report events sequentially, write a concluding statement (W-F4, PO1 – 4)
- Locate, acknowledge and use several sources to write an informational report in their own words: use resources (W-F5,PO1)
- Write a persuasive essay (W-P2)

**Listening and Speaking**
- Prepare and deliver an oral report: grades 4 – 8
- Communicate information expressively, informatively, and analytically through a variety of media to audiences inside or outside of the school: grades 9 -12.

**Viewing and Presenting**
- Plan, develop and produce a visual presentation, using a variety of media such as videos, films, newspapers, magazines and computer images: grades 4 – 8.
Mathematics Standards and CAP LTER

Arizona Mathematics Standards Rationale

“Whenever possible, mathematical learning should be placed in a broader, problem-solving context and evaluated through performance assessments. In this setting, students discover questions involving numbers or equations from a real-world context which lead to answers that have meaning. Ultimately, all problems should be application problems; more ideally, problems should be presented in the broader context of an investigation or project. This way the students use problem solving, reasoning, communication and connections in every mathematical activity. The spirit of these four goals is a mathematical apprenticeship in which the students solve problems on a daily basis, much as mathematics is used in the real world.”

CAP LTER projects offer students real world applications of numerous problem-solving and computational skills required by the Arizona Department of Education.

Strand One: Number Sense and Operations
S1C1 (GR 3-12): Understand and apply numbers, ways of representing numbers, the relationships among numbers and different number systems
S1C2 (GR K-12): Understand and apply numerical operations and their relationships to one another
S1C3 (GR 3-12): Use estimation strategies reasonably and fluently

Strand Two: Data Analysis, Probability, and Discrete Mathematics
S2C1 (GR K-12): Understand and apply data collection, organization and representation to analyze and sort data

Strand Three: Patterns, Algebra and Functions
S3.C2.GR8.PO4: Identify independent and dependent variables for a contextual situation.
S3.C2.HS: Describe and model functions and their relationships

Strand Four: Geometry and Measurement
S4C1.HS.PO14: Solve contextual situations using angles and side length relationships
S4C4 (GR 3-12): Understand and apply appropriate units of measure, measurement techniques, and formulas to determine measurements

Strand Five: Structure and Logic
S5C1 (GR 1-12): Use reasoning to solve mathematical problems in contextual situations
Human interactions play a large role in Urban Ecology and are an integral component of the research being done as part of CAP LTER. Studying Urban Ecology with your students not only addresses science standards, but social studies as well. The following are selected standards taken directly from the Arizona Social Studies Standards that may be met by incorporating Ecology Explorer into your curriculum.

**Standard 1: History**

“Students analyze the human experience through time, recognize the relationship of events and people, and interpret significant patterns, themes, ideas, beliefs, and turning points in Arizona, America, and world history.”

**Essentials**

1SS-E1: Understand and apply basic tools of historical research, including chronology and how to collect, interpret, and employ information from historical materials.

1SS-E8: Demonstrate and apply the basic tools of historical research, including how to construct timelines, frame questions that can be answered by historical study and research, and analyze and evaluate historical materials offering varied perspectives, with emphasis on:

- **PO 1.** constructing and interpreting graphs and charts using historical data
- **PO 3.** framing questions that can be answered by historical study and research
- **PO 8.** recognize the difference between cause and effect and a mere sequence of historical events

**Proficiency**

1SS-P1: Apply chronological and spatial thinking to understand the meaning, implications, and import of historical and current events.

1SS-P2: Demonstrate knowledge of research sources and apply appropriate research methods, including framing open-ended questions, gathering pertinent information, and evaluating the evidence and point of view contained with primary and secondary sources.

1SS-P3: Develop historical interpretations in terms of the complexity of cause and effect and in the context in which ideas and past events unfold.

1SS-P12: Analyze the development of the American West and specifically Arizona, with emphasis on:
PO 2. the development of resources and the resulting population and economic patterns, including mining, ranching, and agriculture.

Standard 3: Geography
“Students analyze locations, regions, and spatial connections, recognizing the natural and cultural processes that impact the way in which people and societies live and interact with each other and their environment.”

Essentials
3SS-E1: Demonstrate understanding of the physical and human features that define places and regions in Arizona, including the geographic tools to collect, analyze, and interpret data…
3SS-E2: Describe the impact of interactions between people and the natural environment on the development of places and regions in Arizona, including how people have adapted to and modified the environment….
3SS-E4: Demonstrate understanding of the characteristics, purposes, and use of geographic tools to locate and analyze information about people, places and environments….
3SS-E6: Describe the economic, political, cultural, and social processes that interact to shape patterns of human populations, interdependence, and cooperation and conflict….
3SS-E7: Explain the effects of interactions between human and natural systems, including the changes in meaning, use, and distribution of natural resources….
3SS-E8: Use geographic knowledge, skills, and perspectives to explain past, present, and future issues…

Proficiency
3SS-P1: Acquire, process, and analyze geographic information about people, places, and environments by constructing, interpreting, and using geographic tools…
3SS-P2: Analyze natural and human characteristics of places in the world studied to define regions, their relationships, and their patterns of change…
3SS-P3: Analyze how economic, political, cultural, and social processes interact to shape patterns and characteristics of human populations, interdependence, and cooperation…
Technology Standards & CAP LTER

The technology standards are designed to “help students live, learn and work successfully and responsibly in an increasingly complex, technology-driven society.”

Technology Standard 3: Productivity Tools
“Students use technology tools to enhance learning, to increase productivity and creativity, and to collaboratively construct technology-enhanced models, prepare publications, and produce other creative works”

Using technology tools for data collection and analysis including spreadsheets and data probes (3T-F2, 3T-E2, 3T-P2)

Technology Standard 4: Communication Tools
“Building on productivity tools, students will collaborate, publish, and interact with peers, experts and other audiences using telecommunications and media”

Using technology to access remote information and online resources and collaborate with peers, and experts (4T-E1, 4T-E3, 4T-P1, 4T-P3)

Technology Standard 6: Tool for Problem Solving and Decision Making
“Students use technology to make and support decision in the process of solving real-world problems”

Determine when technology is useful and select and use the appropriate tools and technology resources to solve problems (6T-E1, 6T-P2)