MDC DISCOVER nature SCHOOLS

Conserving Missouri's AQUATIC ECOSYSTEMS

CONSERVATION DEPARTMENT MISSOURI

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Teacher Guide

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Conserving Missouri's Aquatic Ecosystems

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Alignment to Missouri Standards

Conserving Missouri's Aquatic Ecosystems is designed to be taught at any middle school grade level (6–8). Teachers can use *Conserving Missouri's Aquatic Ecosystems* to teach required content because all instructional activities have been correlated to the Missouri Department of Elementary and Secondary Education (DESE) science Grade-Level Expectations (GLEs). Please note, however, that the unit was developed based on the assumption that students have learned what is indicated in GLEs through 5th grade. The Teacher Guide contains plans for teaching each chapter in the Student Guide.

Missouri Science Concepts Addressed

EC.1.A.	All populations living together within a community interact with one another and with their environment in order to survive and maintain a balanced ecosystem.
EC.1.B.	Living organisms have the capacity to produce populations of infinite size, but environments and resources are finite.
EC.1.D.	The diversity of species within an ecosystem is affected by changes in the environment, which can be caused by other organisms or outside processes.
EC.2.A.	As energy flows through the ecosystem, all organisms capture a portion of that energy and transform it to a form they can use.
EC.3.C.	Natural selection is the process of sorting individuals based on their ability to survive and reproduce within their ecosystem.
ES.1.B.	The hydrosphere is composed of water (a material with unique properties), gases and other materials.
ES.1.D.	Climate is a description of average weather conditions in a given area over time.
ES.2.E.	Changes in the form of water as it moves through Earth's systems are described as the water cycle.
ES.3.A.	Earth's materials are limited natural resources affected by human activity.
IN.1.A.	Scientific inquiry includes the ability of students to formulate a testable question and explanation, and to select appropriate investigative methods in order to obtain evidence relevant to the explanation.
IN.1.B.	Scientific inquiry relies upon gathering evidence from qualitative and quantitative observations.
IN.1.C.	Evidence is used to formulate explanations.
IN.1.E.	The nature of science relies upon communication of results and justification of explanations.
IS.1.C.	Technological solutions to problems often have drawbacks as well as benefits.
IS.3.B.	Social, political, economic, ethical and environmental factors strongly influence, and are influenced by, the direction of progress of science and technology.

Many GLEs are addressed in several chapters. For brevity's sake only the code is given here. In the chapter guides, when a GLE is first addressed the code and language of the GLE are given. When a GLE is addressed again in a subsequent chapter, the GLE is indicated by code only. Teachers must use their discretion to determine whether the referenced GLE has been mastered by their students.

Content Aligned to Science Grade-Level Expectations

Chapter	Grade-Level Expectations
1—Water Is Life	ES.3.A.6.a, ES.1.B.6.a, ES.3.A.6.b, IS.1.C.6.a, IN.1.A.6.b, IN.1.A.6.c, IN.1.B.6.a, IN.1.B.6.b, IN.1.B.6.c, IN.1.B.6.d, IN.1.B.6.e, IN.1.C.6.a, IN.1.C.6.b, IN.1.E.6.a
2—The Ultimate Recyclable	ES.2.E.7.a., ES.1.D.7.a., ES.3.A.6.b., ES.3.A.7.b., IS.1.C.6.a., IN.1.A.6.a., IN.1.B.6.a., IN.1.B.6.b.
3—What's Your Watershed Address?	ES.3.A.6.b., ES.3.A.6.c., IS.1.C.6.a., IN.1.B.6.a., IN.1.E.6.a.
4—Living in the Water	EC.3.C.6.a., EC.3.C.6.b., IN.1.A.6.a., IN.1.A.6.b., IN.1.A.6.c., IN.1.B.6.a., IN.1.B.6.b., IN.1.B.6.c., IN.1.B.6.d., IN.1.B.6.e., IN.1.C.6.a., IN.1.C.6.b., IN.1.E.6.a.
5—From Sun to Sunfish	EC.1.B.6.a., EC.1.B.6.b., EC.2.A.6.a., EC.2.A.6.b., EC.1.B.6.c., EC.1.D.6.a., IS.1.C.6.a.
6—Missouri's Aquatic Ecosystems	EC.1.A.6.a., EC.1.D.6.a., EC.1.D.6.b., EC.1.D.6.c., IS.1.C.6.a.
7—Rivers and Streams	EC.1.A.6.a., EC.1.B.6.a., EC.1.B.6.b., EC.1.B.6.c., EC.2.A.6.a., EC.2.A.6.b., EC.1.D.6.a., EC.1.D.6.b., EC.1.D.6.c., IS.1.C.6.a.
8—Lakes and Ponds	EC.1.A.6.a., EC.1.B.6.a., EC.1.B.6.b., EC.1.B.6.c., EC.2.A.6.a., EC.2.A.6.b., EC.1.D.6.a., EC.1.D.6.b., EC.1.D.6.c., IS.1.C.6.a.
9—Swamps and Marshes	EC.1.A.6.a., EC.1.B.6.a., EC.1.B.6.b., EC.1.B.6.c., EC.2.A.6.a., EC.2.A.6.b., EC.1.D.6.a., EC.1.D.6.b., EC.1.D.6.c., IS.1.C.6.a.
10—Fishing for Answers	EC.1.B.6.a., EC.1.B.6.b., EC.1.B.6.c., EC.1.D.6.a., EC.1.D.6.b., EC.1.D.6.c., EC.2.A.6.a., EC.2.A.6.b., EC.3.C.6.a. , EC.3.C.6.b. , IS.1.C.6.a., IS.3.B.6.a.
Field study day	IN.1.A.6.a, IN.1.A.6.b, IN.1.A.6.c, IN.1.A.6.e, IN.1.B.6.a, IN.1.B.6.b, IN.1.B.6.c, IN.1.B.6.d.
Unit wrap-up	IN.1.A.6.d, IN.1.B.6.e, IN.1.B.6.f, IN.1.C.6.a, IN.1.C.6.b, IN.1.E.6.a.

Science Grade-Level Expectations Continuum

In *Conserving Missouri's Aquatic Ecosystems*, students develop the science Grade-Level Expectations (GLE) listed in the "Targeted learning" column below. While supporting students in the development of these skills, teachers should consider students' prior learning and keep in mind their future learning. Although the following table lists each GLE in its entirety for the concept, the bold type denotes the specific parts of a GLE that are addressed in this unit.

Prior learning	Targeted learning	Future learning
EC.1.A.4.a. Identify the ways a specific organism may interact with other organisms or with the environment (e.g., pollination, shelter, seed dispersal, camouflage, migration, hibernation, defensive mechanism) b. Recognize that different environments (i.e., pond, forest, prairie) support the life of different types of plants and animals	**EC.1.A.6.a. Identify the biotic factors (populations of organisms) and abiotic factors (e.g., quantity of light and water, range of temperatures, soil composition) that make up an ecosystem**	EC.1.A.9–11.a. Explain the nature of interactions between organisms in different symbiotic relationships (i.e., mutualism, commensalism, parasitism) b. Explain how cooperative (e.g., symbiosis) and competitive (e.g., predator/prey) relationships help maintain balance within an ecosystem c. Explain why no two species can occupy the same niche in a community
Not assessed at this level	**EC.1.B.6.a. Identify populations within a community that are in competition with one another for resources** **b. Recognize the factors that affect the number and types of organisms an ecosystem can support (e.g., food availability, abiotic factors such as quantity of light and water, temperature and temperature range, soil composition, disease, competitions from other organisms, predation)** **c. Predict the possible effects of changes in the number and types of organisms in an ecosystem on the populations of other organisms within that ecosystem**	EC.1.B.9–11.a. Identify and explain the limiting factors that may affect the carrying capacity of a population within an ecosystem b. Predict how populations within an ecosystem change in number and/or structure in response to hypothesized changes in biotic and/or abiotic factors

Prior learning	Targeted learning	Future learning
EC.1.D.4.a. Identify examples in Missouri where human activity has had a beneficial or harmful effect on other organisms (e.g., feeding birds, littering vs. picking up trash, hunting/conservation of species, paving/restoring greenspace)	**EC.1.D.6.a. Describe beneficial and harmful activities of organisms, including humans (e.g., deforestation, overpopulation, water and air pollution, global warming, restoration of natural environments, river bank/coastal stabilization, recycling, channelization, reintroduction of species, depletion of resources), and explain how these activities affect organisms within an ecosystem** **b. Predict the impact (beneficial or harmful) of a natural environmental change (e.g., forest fire, flood,** volcanic eruption**, avalanche) on the organisms in an ecosystem** **c. Describe possible solutions to potentially harmful environmental changes within an ecosystem**	EC.1.D.9–11.a. Predict the impact (beneficial or harmful) a natural environmental event (e.g., forest fire, flood, volcanic eruption, avalanche) may have on the diversity of different species in an ecosystem b. Describe possible causes of extinction of a population
EC.2.A.4.a. Classify populations of organisms as producers, consumers, decomposers by the role they serve in the ecosystem b. Differentiate between the three types of consumers (herbivore, carnivore, omnivore) c. Categorize organisms as predator or prey in a given ecosystem	**EC.2.A.6.a. Diagram and describe the transfer of energy in an aquatic food web** and a land food web **with reference to producers, consumers, decomposers, scavengers, and predator/prey relationships** **b. Classify populations of unicellular and multicellular organisms as producers, consumers, and decomposers by the role they serve in the ecosystem**	EC.2.A.9-11a. Illustrate and describe the flow of energy within a food web b. Explain why there are generally more producers than consumers in an energy pyramid c. Predict how energy distribution and energy use will be altered due to changes in a food web
EC.3.C.4 a. Identify specialized structures and describe how they help plants survive in their environment (e.g., root, cactus needles, thorns, winged seed, waxy leaves) b. Identify specialized structures and senses and describe how they help animals survive in their environment (e.g., antennae, body covering, teeth, beaks, whiskers, appendages) c. Recognize internal cues (e.g., hunger) and external cues (e.g. changes in the environment) that cause organisms to behave in certain ways (e.g., hunting, migration, hibernation) d. Predict which plant or animal will be able to survive in a specific environment based on its special structures or behaviors	**EC.3.C.6.a. Relate examples of adaptations (specialized structures or behaviors) within a species to its ability to survive in a specific environment (e.g.,** hollow bones/flight, hollow hair/insulation, dense root structure/compact soil, seeds/food, protection for plant embryo vs. spores**, fins/movement in water)** **b. Predict how certain adaptations, such as behavior, body structure, or coloration, may offer a survival advantage to an organism in a particular environment**	EC.3.C.9-11.a. Describe how variation in characteristics provides populations an advantage for survival. b. Identify examples of adaptations that may have resulted from variations favored by natural selection (e.g., long-necked giraffes, long ears on jack rabbits) c. Explain how genetic homogeneity may cause a population to be more susceptible to extinction (e.g., succumbing to a disease for which there is no natural resistance) d. Explain how environmental factors (e.g., habitat loss, climate change, pollution, introduction of non-native species) can be agents of natural selection e. Given a scenario describing an environmental change, hypothesize why a given species was unable to survive

Prior learning	Targeted learning	Future learning
ES.1.B.5.a. Classify major bodies of surface water (e.g., rivers, lakes, oceans, glaciers) as fresh or salt water, flowing or stationary, large or small, solid or liquid, surface or groundwater b. Relate the type of water body to the process by which it was formed	**ES.1.B.6.a. Recognize the properties of water that make it an essential component of the Earth system (e.g., its ability to act as a solvent, its ability to remain as a liquid at most Earth temperatures)**	ES.1.B.9-11.a. Recognize the importance of water as a solvent in the environment as it relates to karst topography (cave formation), acid rain, and water pollution
Not assessed at this level	**ES.1.D.7.a. Differentiate between weather and climate** b. Identify factors that affect climate (e.g., latitude, altitude, prevailing wind currents, amount of solar radiation)	ES.1.D.9-11.a Provide evidence (e.g., melting glaciers, fossils, desertification) that supports theories of climate change due to natural phenomena and/or human interactions b. Explain how climate and weather patterns in a particular region are affected by factors, such as proximity to large bodies of water or ice/ocean currents, latitude, altitude, prevailing wind currents, and amount of solar radiation
ES.2.E.5.a. Describe and trace the path of water as it cycles through the hydrosphere, geosphere, and atmosphere (i.e., the water cycle: evaporation, condensation, precipitation, surface run-off/ groundwater flow) b. Identify the different forms water can take (e.g., snow, rain, sleet, fog, clouds, dew) as it moves through the water cycle	**ES.2.E.7.a. Explain and trace the possible paths of water through the hydrosphere, geosphere, and atmosphere (i.e., the water cycle: evaporation, condensation, precipitation, surface run-off/ groundwater flow)**	Not assessed at this level

Prior learning	Targeted learning	Future learning
ES.3.A.5.a. Explain how major bodies of water are important natural resources for human activity (e.g., food, recreation, habitat, irrigation, solvent, transportation) b. Describe how human needs and activities (e.g., irrigation, damming of rivers, waste treatment, sources of drinking water) have affected the quantity and quality of major bodies of fresh water c. Propose solutions to problems related to water quality and availability that result from human activity	**ES.3.A.6.a. Relate the comparative amounts of fresh water and salt water on the Earth to the availability of water as a resource for living organisms and human activity** **b. Describe the affect of human activities (e.g.,** landfills**, use of fertilizers and herbicides, farming, septic systems) on the quality of water** **c. Analyze the ways humans affect the erosion and deposition of soil and rock materials (e.g., clearing of land, planting vegetation, paving land, construction of new buildings, building or removal of dams)**	ES.3.A.9-11.a. Distinguish between renewable and nonrenewable energy resources b. Recognize the finite availability of fresh water for use by living organisms c. Identify human activities that adversely affect the composition of the atmosphere, hydrosphere, or geosphere d. Predict the effect of change on the other sphere when given a scenario describing how the composition of the atmosphere, hydrosphere, or geosphere is altered e. Recognize how the geomorphology of Missouri (i.e., different types of Missouri soil and rock materials such as limestone, granite, clay, loam; land formations such as karst (cave) formations, glaciated plains, river channels) affects the development of land use (e.g., agriculture, recreation, planning and zoning, waste management) f. Recognize the limited availability of major mineral deposits in the United States (e.g., lead, petroleum, coal, copper, zinc, iron, gravel, aluminum) and the factors that affect their availability g. Recognize the economic, political, social, and ethical constraints associated with obtaining and using natural resources (e.g., mining and use of different types of Missouri mineral resources such as lead mining, gravel dredging, strip mining, coal burning, production of fertilizers and explosives; use of fossil fuels versus renewable resources) (Assess Locally)

Prior learning	Targeted learning	Future learning
ES.3.A.4.a. Identify the ways humans affect the erosion and deposition of Earth's materials (e.g., clearing of land, planting vegetation, paving land, construction of new buildings) b. Propose ways to solve simple environmental problems (e.g., recycling, composting, ways to decrease soil erosion) that result from human activity ES.3.A.5.a. Explain how major bodies of water are important natural resources for human activity (e.g., food, recreation, habitat, irrigation, solvent, transportation) b. Describe how human needs and activities (e.g., irrigation, damming of rivers, waste treatment, sources of drinking water) have affected the quantity and quality of major bodies of fresh water c. Propose solutions to problems related to water quality and availability that result from human activity	ES.3.A.7.a. Distinguish between renewable (e.g., geothermal, hydroelectric) and nonrenewable (e.g., fossil fuel) energy sources **ES.3.A.7.b. Provide examples of how the availability of fresh water for humans and other living organisms is dependent upon the water cycle**	ES.3.A.9–11.a. Distinguish between renewable and nonrenewable energy resources b. Recognize the finite availability of fresh water for use by living organisms c. Identify human activities that adversely affect the composition of the atmosphere, hydrosphere, or geosphere d. Predict the effect of change on the other sphere when given a scenario describing how the composition of the atmosphere, hydrosphere or geosphere is altered e. Recognize how the geomorphology of Missouri (i.e., different types of Missouri soil and rock materials such as limestone, granite, clay, loam; land formations such as karst (cave) formations, glaciated plains, river channels) affects the development of land use (e.g., agriculture, recreation, planning and zoning, waste management) f. Recognize the limited availability of major mineral deposits in the United States (e.g., lead, petroleum, coal, copper, zinc, iron, gravel, aluminum) and the factors that affect their availability g. Recognize the economic, political, social, and ethical constraints associated with obtaining and using natural resources (e.g., mining and use of different types of Missouri mineral resources such as lead mining, gravel dredging, strip mining, coal burning, production of fertilizers and explosives; use of fossil fuels vs. renewable resources) (Assess Locally)

Prior learning	Targeted learning	Future learning
IN.1.A.5.a. Formulate testable questions and explanations (hypotheses) b. Recognize the characteristics of a fair and unbiased test c. Conduct a fair test to answer a question d. Make suggestions for reasonable improvements or extensions of a fair test	**IN.1.A.6.a. Formulate testable questions and hypotheses** **b. Recognize the importance of the independent variable, dependent variables, control of constants, and multiple trials to the design of a valid experiment** **c. Design and conduct a valid experiment** **d. Evaluate the design of an experiment and make suggestions for reasonable improvements or extensions of an experiment** **e. Recognize different kinds of questions suggest different kinds of scientific investigations (e.g., some involve observing and describing objects, organisms, or events; some involve collecting specimens; some involve experiments; some involve making observations in nature; some involve discovery of new objects and phenomena; some involve making models)**	IN.1.A.9–11.a. Formulate testable questions and hypotheses b. Analyzing an experiment, identify the components (i.e., independent variable, dependent variables, control of constants, multiple trials) and explain their importance to the design of a valid experiment c. Design and conduct a valid experiment d. Recognize it is not always possible, for practical or ethical reasons, to control some conditions (e.g., when sampling or testing humans, when observing animal behaviors in nature) e. Acknowledge some scientific explanations (e.g., explanations of astronomical or meteorological phenomena) cannot be tested using the standard experimental "scientific method" due to the limits of the laboratory environment, resources, and/or technologies f. Acknowledge there is no fixed procedure called "the scientific method," but that some investigations involve systematic observations, carefully collected and relevant evidence, logical reasoning, and some imagination in developing hypotheses and other explanations g. Evaluate the design of an experiment and make suggestions for reasonable improvements
IN.1.C.5.a. Use quantitative and qualitative data as support for reasonable explanations b. Use data as support for observed patterns and relationships, and to make predictions to be tested	**IN.1.C.6.a. Use quantitative and qualitative data as support for reasonable explanations (conclusions)** **b. Use data as support for observed patterns and relationships, and to make predictions to be tested** c. Recognize the possible effects of errors in observations, measurements, and calculations on the formulation of explanations (conclusions)	IN.1.C.9–11.a. Use quantitative and qualitative data as support for reasonable explanations (conclusions) b. Analyze experimental data to determine patterns, relationship, perspectives and credibility of explanations (e.g., predict/extrapolate data, explain the relationship between the independent and dependent variable) c. Identify the possible effects of errors in observations, measurements and calculations, on the validity and reliability of data and resultant explanations (conclusions)

Prior learning	Targeted learning	Future learning
IN.1.E.5.a. Communicate the procedures and results of investigations and explanations through: – oral presentations – drawings and maps – data tables – graphs (bar, single line, pictograph) – writings	**IN.1.E.6.a. Communicate the procedures and results of investigations and explanations through:** – **oral presentations** – **drawings and maps** – **data tables (allowing for the recording and analysis of data relevant to the experiment, such as independent and dependent variables, multiple trials, beginning and ending times or temperatures, derived quantities)** – **graphs (bar, single line,** pictograph**)** – **writings**	IN.1.E.9–11.a. Communicate the procedures and results of investigations and explanations through: – oral presentations – drawings and maps – data tables (allowing for the recording and analysis of data relevant to the experiment, such as independent and dependent variables, multiple trials, beginning and ending times or temperatures, derived quantities) – graphs (bar, single line, pictograph) – equations – writings b. Communicate and defend a scientific argument c. Explain the importance of the public presentation of scientific work and supporting evidence to the scientific community (e.g., work and evidence must be critiqued, reviewed and validated by peers; needed for subsequent investigations by peers; results can influence the decisions regarding future scientific work)
IS.1.C.6.a. Identify how the effects of inventions or technological advances (e.g., complex machinery, technologies used in space exploration, satellite imagery, weather observation and prediction, communication, transportation, robotics, tracking devices) may be helpful, harmful, or both (Assess Locally)	**IS.1.C.6–8.a. Describe how technological solutions to problems (e.g., storm water runoff,** fiber optics, windmills, efficient car design, electronic trains without conductors, sonar, robotics, Hubble telescope**) can have both benefits and drawbacks (e.g.,** design constraints**, unintended consequences, risks) (Assess Locally)**	Not assessed at this level

Prior learning	Targeted learning	Future learning
Not assessed at this level	**IS.3.B.6.a. Describe ways in which science and society influence one another (e.g., scientific knowledge and the procedures used by scientists influence the way many individuals in society think about themselves, others, and the environment; societal challenges often inspire questions for scientific research;** social priorities often influence research priorities through the availability of funding for research) b. Identify and evaluate the physical, social, economic, and/or environmental problems that may be overcome using science and technology (e.g., the need for alternative fuels, human travel in space, AIDS)	IS.3.B.9–11.a. Analyze the roles of science and society as they interact to determine the direction of scientific and technological progress (e.g., prioritization of and funding for new scientific research and technological development is determined on the basis of individual, political and social values and needs; understanding basic concepts and principles of science and technology influences debate about the economics, policies, politics, and ethics of various scientific and technological challenges) b. Identify and describe major scientific and technological challenges to society and their ramifications for public policy (e.g., global warming, limitations to fossil fuels, genetic engineering of plants, space and/or medical research) c. Analyze and evaluate the social, political, economic, ethical and environmental factors affecting progress toward meeting major scientific and technological challenges (e.g., limitations placed on stem-cell research or genetic engineering, introduction of alien species, deforestation, bioterrorism, nuclear energy, genetic counseling, computer technology)

Connections to Missouri GLEs from Other Content Standards

Connections to Missouri Grade-Level Expectations from other content standards
(Note: Learning of these Grade-Level Expectations is reflected within activities. Corresponding activities are listed at the end of each GLE. They are not assessed in the summative assessments.)

CA.W.2.E.6 In writing, use (All Activities)
- correct spelling of grade-level frequently used words
- classroom resources and dictionary to verify correct spelling

CA.W.3.C.6 Write expository and persuasive
- paragraphs (including cause/effect) with (Activity 4.5, Field Study Report)
  - a strong controlling idea
  - supporting and concluding sentences
  - appropriate logical sequence
  - relevant details, facts and/or examples from one or more sources
- multi-paragraph essays (Activity 4.5, Field Study Report)

Connections to Missouri Show-Me Performance Standards

(Note: Learning of these performance standards is reflected within activities. They are not assessed in summative assessments.)

Goal 1: Students in Missouri public schools will acquire the knowledge and skills to gather, analyze and apply information and ideas. Students will demonstrate within and integrate across all content areas the ability to:		
1.1.	Develop questions and ideas to initiate and refine research	Activities 1.8, 2.5, 2.6, 3.2, 3.3, 4.4, 4.5, 4.6, 5.4, 5.6, 5.8, 6.3, 6.7, 6.8, 7.2, 7.4, 8.2, 8.4, 9.2, 9.4, 10.3, 10.4, Field Study, Field Study Report
1.2.	Conduct research to answer questions and evaluate information and ideas	Activities 1.4, 1.5, 1.7, 2.3, 2.5, 3.2, 3.3, 4.4, 4.5, 4.6, 5.3, 5.4, 5.5, 5.6, 6.3, 6.4, 6.7, 7.3, 8.3, 9.3, 9.7, 10.4, 10.5, Field Study
1.3.	Design and conduct field and laboratory investigations to study nature and society	Activities 1.5, 1.7, 3.2, 3.3, 4.6, 6.7, 9.7, Field Study
1.4.	Use technological tools and other resources to locate, select and organize information	Activities 2.3, 2.5, 3.6, 4.4, 4.5, 5.4, 5.6, 6.3
1.5.	Comprehend and evaluate written, visual and oral presentations and works	Activities 1.2, 1.3, 1.6, 1.8, 2.2, 2.3, 2.4, 3.4, 3.5, 3.6, 4.2, 4.3, 4.4, 4.5, 5.3, 5.4, 5.5, 5.6, 5.7, 5.8, 6.1, 6.2, 6.3, 6.4, 6.5, 6.6, 7.2, 7.3, 7.4, 7.5, 8.2, 8.3, 8.4, 8.5, 9.2, 9.3, 9.4, 9.5, 10.1, 10.3, 10.4, 10.5, Field Study Report
1.6.	Discover and evaluate patterns and relationships in information, ideas and structures	Activities 1.2, 1.3, 1.8, 2.2, 3.2, 3.4, 3.5, 3.6, 4.2, 4.3, 4.4, 4.5, 4.6, 5.2, 5.3, 5.4, 5.5, 5.6, 5.7, 5.8, 6.1, 6.2, 6.3, 6.4, 6.5, 6.6, 6.8, 7.2, 7.3, 7.4, 7.6, 8.2, 8.3, 8.4, 8.6, 9.2, 9.3, 9.4, 9.6, 9.7, 9.8, 10.3, 10.4, Field Study, Field Study Report
1.8.	Organize data, information and ideas into useful forms (including charts, graphs, outlines) for analysis or presentation	Activities 1.5, 1.7, 1.8, 2.3, 2.6, 3.7, 4.4, 4.5, 4.6, 5.4, 5.6, 5.8, 6.3, 6.7, 6.8, 7.1, 8.1, 9.1, 9.7, 9.8, 10.3, Field Study, Field Study Report

Goal 2: Students in Missouri public schools will acquire the knowledge and skills to communicate effectively within and beyond the classroom. Students will demonstrate within and integrate across all content areas the ability to:		
2.1.	Plan and make written, oral and visual presentations for a variety of purposes and audiences	Activities 2.1, 4.2, 4.4, 4.5, 5.4, 5.6, Field Study Report
2.3.	Exchange information, questions and ideas while recognizing the perspectives of others	Activities 1.1, 1.2, 1.6, 2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 3.1, 3.2, 3.5, 3.6, 3.7, 4.1, 4.2, 4.3, 4.6, 5.1, 5.2, 5.3, 5.5, 5.7, 6.1, 6.2, 6.3, 6.4, 6.5, 6.6, 6.7, 7.1, 7.3, 7.4, 8.1, 8.3, 8.4, 9.1, 9.3, 9.4, 9.7, 9.8, 10.1, 10.4, Field Study, Field Study Report
2.7.	Use technological tools to exchange information and ideas	Optional for multiple activities, Field Study Report
Goal 3: Students in Missouri public schools will acquire the knowledge and skills to recognize and solve problems. Students will demonstrate within and integrate across all content areas the ability to:		
3.1.	Identify problems and define their scope and elements	Activities 1.5, 1.8, 2.6, 3.3, 3.7, 4.5, 4.6, 5.2, 5.6, 5.7, 5.8, 6.2, 6.3, 6.5, 6.6, 6.8, 7.2, 7.4, 8.2, 8.4, 9.2, 9.4, 9.8, 10.3, Field Study, Field Study Report
3.2.	Develop and apply strategies based on ways others have prevented or solved problems	Activities 1.5, 1.8, 2.6, 3.7, 4.6, 5.8, 6.5, 6.8, 7.6, 8.6, 9.6, 9.8, 10.1, 10.2, 10.3, 10.4, Field Study, Field Study Report
3.3.	Develop and apply strategies based on one's own experience in preventing or solving problems	Activities 1.5, 1.8, 2.6, 3.7, 4.6, 5.8, 6.5, 6.8, 9.8, 10.2, Field Study, Field Study Report
3.4.	Evaluate the processes used in recognizing and solving problems	Activities 2.5, 3.3, 6.6, Field Study Report
3.6.	Examine problems and proposed solutions from multiple perspectives	Activities 1.5, 3.3, 5.2, 5.7, 6.2, 6.3, 6.5, 10.4, Field Study Report
3.8.	Assess costs, benefits and other consequences of proposed solutions	Activities 1.5, 3.3, 5.2, 5.7, 6.2, 6.3, 6.5, Field Study Report
Goal 4: Students in Missouri public schools will acquire the knowledge and skills to make decisions and act as responsible members of society. Students will demonstrate within and integrate across all content areas the ability to:		
4.1.	Explain reasoning and identify information used to support decisions	Activities 1.7, 2.2, 3.3, 4.5, 5.6, 6.2, 6.3, 6.5, 6.6, 10.1, Field Study Report
4.4.	Recognize and practice honesty and integrity in academic work and in the workplace	Entire unit
4.6.	Identify tasks that require a coordinated effort and work with others to complete those tasks	Activities 1.6, 1.7, 1.8, 2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 3.5, 3.7, 4.3, 4.6, 5.2, 5.3, 5.5, 5.7, 5.8, 6.2, 6.4, 6.5, 6.6, 6.7, 6.8, 7.3, 8.3, 9.3, 9.8, 10.4, Field Study, Field Study Report
4.7.	Identify and apply practices that preserve and enhance the safety and health of self and others	Activities 1.5, 1.7, 2.3, 2.5, 3.2, 3.3, 3.5, 3.7, 5.2, 5.7, 6.5, 10.1, 10.2, 10.3, 10.4, 10.5, Field Study
4.8.	Explore, prepare for and seek educational and job opportunities	Activities 1.6, 2.4, 3.5, 4.3, 5.3, 5.5, 6.4, 7.3, 8.3, 9.3, 10.4

Discover Nature Schools

Outdoors is the best place for students to learn how nature works. This premise shapes the Missouri Department of Conservation's statewide conservation education program, Discover Nature Schools. Teachers helped us develop this, so we're confident that it will meet their needs, both in the classroom and in the field. After a year of testing the curriculum and its field activities, one Missouri middle school teacher wrote, "MDC resources are great, a teacher's best friend."

Get your students excited about nature now, and they'll be conservationists for life. Key elements of the program include free instructional units that meet current testing needs, as well as grants for field trips and teaching materials. Our Discover Nature Schools program gives you the tools to inspire students ranging from preschool through grade 12. The program helps teachers deliver hands-on, place-based learning, helps school administrators meet funding and testing challenges, and helps students connect with nature close to home.

Instructional units include *Nature Revealed* (preschool), *Nature Unfolds* (grades K–2), *Nature Unleashed—The Untamed World of Missouri Ponds, Forests and Prairies* (grades 3–5), *Conserving Missouri's Aquatic Ecosystems* (grades 6–8) and *Nature Unbound—The Impact of Ecology on Missouri and the World* (grades 9–12). To launch a Discover Nature Schools program in your class, visit ***mdc.mo.gov/teacher/contacts*** to find your local education consultant. He or she can introduce you to the units, register you for training and help you get started.

How to Use *Conserving Missouri's Aquatic Ecosystems*

"Is my local stream polluted?"
"What is the condition of that marsh?"
"Is our neighborhood pond healthy?"

These are questions that many of us have asked in one form or another. When we wonder whether it is safe to eat the fish we caught in the river, drink the water from our taps or swim in our favorite lakes, we are really wondering about the ecological status of those waters. Our children and our students have the same questions. In fact, almost two-thirds of all Missourians worry "a great deal" about pollution of rivers, streams, lakes and drinking water. Good water quality is important to all Missourians. It also is essential to the health of the state's plants and animals. The Missouri Department of Conservation is committed to protecting clean and healthy waters, to educating Missourians about fish, forest and wildlife resources and to preserving Missouri's outdoor recreation heritage. This unit is intended to address and begin to fulfill these commitments.

Is it safe to swim in/drink from/eat fish from a particular body of water? *Conserving Missouri's Aquatic Ecosystems* helps students answer this question for themselves. To do so, students first must learn what the components of an ecosystem are, and what constitutes ecological "health." Students then must discover how those components may be measured or observed. They must figure out how to make, record and quantify their observations. Finally, students must evaluate those observations in the context of their original question. In this way they will develop a deeper understanding of aquatic ecosystems and of how natural processes and human actions affect them.

Each chapter of *Conserving Missouri's Aquatic Ecosystems* prepares students for a hands-on activity to make, record, quantify and evaluate observations about an aquatic ecosystem. Students must identify, describe and apply principles of aquatic ecology. On the field study day they use this knowledge to gather data. In the unit summation, students analyze their data, draw conclusions and create their own solutions to environmental problems. Students will develop an understanding of ecological concepts by direct contact with and observation of the natural world. Students will understand the processes by which scientists form and evaluate hypotheses about the natural world by doing those things themselves. Science understanding is developed through the use of science process skills, scientific knowledge, scientific investigation, reasoning and critical thinking.

Chapter Structure and Instructional Strategy

The first activity in each chapter explores students' current understanding of the chapter's essentials. It gets students talking to one another and asking questions about the topics to be addressed. These simple advance organizers provide teachers with information about what students already know. At the same time, students link their prior knowledge to the new material.

Once students are engaged with the subject and prepared to learn, they explore the chapter's main ideas through hands-on demonstrations, watching short video segments or playing games that model concepts. Some of these activities include data gathering or self-directed research; others generate notebook entries or group discussions.

The middle activities in each chapter provide students with formal explanations of concepts. Readings in the Student Guide and cooperative learning activities centered on the chapter's **Questions to Consider** make up this phase of the process. The **Questions to Consider** provide teachers with a mid-chapter check for student understanding. Enrichment activities, including activities from Project WET and Project WILD Aquatic, guest speakers and demonstrations are suggested for firming up student understanding of key concepts.

More hands-on activities, self-directed research, short video segments and games that model concepts develop and deepen student understanding. Activity 4.4, for example, starts the students on a comparison matrix to which they add in several later activities. Other activities include water chemistry testing, line transect plant sampling on school grounds and a formal writing assignment.

The last activity in each chapter challenges students to apply what they have learned in the preceding activities to decide the best way to make and record observations in the field. Students then create data tables or other recording systems for use on the field study day. These data record pages become part of their science notebooks.

A formal summative assessment is provided at the end of each chapter, along with an answer key. These include multiple-choice questions and open-ended constructed-response questions.

Field Study and Unit Summation

Each chapter of *Conserving Missouri's Aquatic Ecosystems* anticipates a field study activity. Students learn and practice simple water chemistry tests in Chapter 1, observe and record weather conditions in Chapter 2 and learn to look for potential sources of pollution by observing land uses and site conditions in Chapter 3. Students not only learn to fish, but use the experience to collect data about fish. A wildlife walk provides an opportunity for direct visual and auditory observation of wildlife and teaches students to look for animal signs such as tracks and scat. Students practice simple line transect plant sampling in Chapter 6 and learn invertebrate sampling techniques in Chapters 7, 8 and 9. Classes that study wetland sites also examine soil for signs of saturation and anaerobic conditions. Depending on which chapters the class has completed, the equipment resources available, time constraints, number of adult assistants and other considerations, teachers will have many field day activity options from which to choose.

In the unit summation, students analyze their data, draw conclusions and propose their own solutions to environmental problems. Instructors will have to decide for themselves on a class-by-class basis how much and what kind of direction students need in analyzing their data. Students may write a formal report on their field study. Alternatively, the field study report could take the form of a science notebook entry. A class presentation and discussion of findings ensures that students understand the importance of communication and dialog in the scientific process.

Teaching about conservation helps students develop into young adults who are aware of the world around them and are able to make good choices. When our students understand what the components of an ecosystem are, what constitutes ecological health and how that health is maintained or impaired, they become able to envision solutions. For students to accept responsibility for the environment they must begin to imagine themselves as a part of the solution. They must feel ownership of the resources and the issues and feel empowered to do something about those issues. *Conserving Missouri's Aquatic Ecosystems* offers educators the opportunity to help students understand the issues and challenge them to create their own solutions.

For Further Information

Hungerford, H.R. "The Development of Responsible Environmental Citizenship: A Critical Challenge." Journal of Interpretation Research, Volume 1, Number 1.

Using Science Notebooks

A journal records observation and reflection while log books record data. A science notebook records both. *Conserving Missouri's Aquatic Ecosystems* is structured around keeping a science notebook.

Guiding Inquiry

Using science notebooks develops and strengthens students' thinking, and at the same time deepens their understanding of the science concepts they investigate. Science notebooks help build both science content and process skills. Writing in science notebooks is one of the most immediate points of integration with inquiry-based science. We want students to do science as scientists do; scientists write their observations, reflections and conclusions in their notebooks. They illustrate and label these illustrations, collect data, and make charts and graphs to organize the data before analyzing it. With appropriate guidance, students can do the same.

Each chapter of *Conserving Missouri's Aquatic Ecosystems* prepares students for a hands-on activity to be performed on the field study day. Depending on which chapters the class has completed, the equipment resources available, time constraints and other considerations, teachers will have many field study options from which to choose. The last activity in each chapter asks students to apply what they have learned in the preceding activities to decide the best way to make and record observations in the field. Students then create data tables or other recording systems for use on the field study day. These data record pages become part of their science notebooks.

After guiding students through a data-gathering method in the classroom, give students time to think about how they want to organize data they gather in the field. Ask students to share how they organized their information. Encourage students to make predictions based on prior knowledge and what they learned in the classroom. After the field study experience, students will need to refer to their notebooks to understand how they can better organize them and represent the information. Ask students to refer to their notebooks when discussing their findings. This will help them analyze and ultimately draw conclusions from their observations.

Encouraging Reflection and Heightening Awareness

Another reward of notebook keeping is its ability to heighten awareness of the natural world. Successfully identifying one wildflower, mushroom or tree opens up a whole new world of natural objects to explore and to get to know. After discovering one object, students may be surprised at how many times they encounter it in their daily lives.

Give students time for reflection and notebook writing after activities and investigations. Use this opportunity to make connections between what students have observed and their prior experiences. Ask students to explain what they have learned. Ask what questions they now want to ask. Encourage students to add to their notebooks what others have been saying. Also allow them to add their personal feelings and questions.

Improving Observation and Description Skills

Science notebooks provide opportunities for students to practice using their senses to make detailed observations. All of us are occasionally stumped by something we can't identify. Relying on memory alone to later identify a newly encountered object can be extremely frustrating. If it's a wildflower, recording written observations about the site on which it was found—habitat type, topography of the land, direction of the slope—combined with the date and notes about the size, color and shape will all aid in later identification. These kinds of detailed notes, combined with a field sketch of the flower, will help with identification.

Drawing an object forces the student to slow down, observe it carefully and see it as it really is. Drawing compels more accurate observation. This better enables students to identify things in nature. Science notebooks appeal to different learning styles and connect learning to the real world.

Integrating Science and Literacy

Science notebooks improve skills in thinking, drawing and writing. When students explain in writing what they have seen and why they think this occurs, they are forced to clarify their thoughts and organize their ideas in ways that others can understand. Using notebooks in guided or structured inquiry gives students opportunities to use language in the context of solving meaningful problems and, as a result, engage in genuine, purposeful communication.

Using Science Notebooks for Formative Assessment

Science notebooks are best used for formative assessment. They serve as tools for informing teachers of student progress. Teachers can collect and review notebooks throughout the unit. They can also observe and listen to class discussions generated from the notebooks. Look at what kind of organizers students are using, whether they are drawing, labeling, etc. In doing so, teachers can check developing misconceptions, find evidence of student learning and plan instruction based on what students know. Feedback should move students' understanding to a higher level and create opportunities for students to respond to that feedback. Teachers also can pose questions to help students clarify their thinking. Comments can be written on Post-it notes and placed on the notebook's pages.

Notebooks may be used for summative assessment or to check for student mastery, but it may be easier and better to do these using work generated from the notebook. Have students create informational writing and presentations to the class. As a vessel for the data and observations made on the field study day, the science notebook is the jumping-off point for unit wrap-up projects based on the notebook.

For Further Information

Britsch, Susan and Daniel P. Shepardson. " The Art of Reviewing Science Journals." Science and Children, Nov-Dec 2004. pgs 43–45.

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Campbell, Brian, and Lori Fulton. "Student-Centered Notebooks" Science and Children, Nov-Dec 2004. pgs 26–29.

Calhoun, Jeri and Ellen Mintz. "Project Notebook." Science and Children, Nov-Dec 2004. pgs. 30–34.

Leslie, Clare Walker and Charles E. Roth. Nature Journaling, Vermont: Storey Books, 1998.

Worth, Karen, Robin Moriarty and Jeff Winokur, "Capitalizing on Literacy Connections," Science and Children, Feb 2004. pgs. 35–39.

Young, Jocelyn, Science Interactive Notebooks in the Classroom. Science Scope, v26 n4 pgs 44–47, Jan 2003.

Guidelines for Keeping a Science Notebook

1. Keeping a good record of your work in science is as important as anything else you do.

2. Use one 3-ring notebook for your science work. Put all your class notes, assignments, notes from reading and other material in this notebook. Use sectional dividers.

3. Date each page and handout. Write neatly and legibly so that you can read what you have written. Label all drawings and diagrams so that they mean something to you long after you have made them.

4. Get in the habit of writing complete sentences for all your notes. Only then will the notes mean something to you when you read them later. Make sure that your sentences express complete thoughts.

5. Begin each new topic on a new page. Leave spaces between topics so that new materials can be added if you want to.

6. In writing your notes try to put all ideas in your own words. If you copy materials from books put quotations marks in the proper place. This is the way all scientists work.

7. Developing the habit of keeping a good notebook is the same as developing any other habit. As you practice doing the job the right way, you will improve in your skill and it will be easier and less burdensome for you. Before long you will be doing your work automatically.

8. The notebook should be a complete record of everything you have done in connection with your science work. It should include the results of your work in class, your reading, experiments and projects performed, observations, and all drawings and diagrams that illustrate your work.

Cooperative Learning

As the term suggests, cooperative learning involves students working in groups to help each other learn. Cooperative learning encourages development of problem solving skills and can be used with students of different levels of ability. Each group member is responsible for learning what is taught and for helping others learn. Students work through the assignment together so that all group members understand and complete the lesson successfully. Cooperative learning techniques honor individual strengths through remediation of student weaknesses and providing enrichment through interaction with others. Some commonly used cooperative learning techniques are summarized here.

Carousel Brainstorming—Have students work in small groups. For each group, display a poster board with a quote, question or concept related to the lesson. Provide each group a different color marker and assign each group to a poster. Give each group two or three minutes to write on the poster its ideas about the quote, question or concept. Answers might compare one thing to another, form an opinion, list characteristics or state an issue. Have groups then move to the next poster in the rotation. Have each group review the previous entries and quickly compose a response. Continue until all groups have contributed to all the posters. Conclude by reviewing the information for each poster.

Jigsaw—Have students work in small groups. Assign each student in the group some portion of the material to learn and then teach to the other students in the group. Have students working on the same portion of the material first work together to decide how to teach it to the others. After these "expert" groups have practiced, re-form the original groups and have students teach one another each portion of the material in turn.

Numbered Heads—Divide students into small groups. Give each student in every group a number (or numbers) that correspond to all the assigned questions. Call out a number and ask one of the questions. Ask each student assigned that number to give an answer.

Round Robin Brainstorming—Have students work in small groups. Assign a question or problem and give students time to think about answers. Designate one student in each group as recorder and tell students to take turns sharing their responses with the group. Each group then appoints another student as reporter to share the group's responses with the class.

Team-Pair-Solo—Have students work on problems or questions first in small groups, then in pairs, and finally on their own.

Think-Pair-Share—Assign a question or problem for the class. Allow time for individuals to think silently about it, then have students pair up and exchange thoughts. Have the pairs share their responses with the class.

Three-Minute Review—Stop any time during a lesson and give students working in small groups three minutes to review what has been said, ask clarifying questions or answer assigned questions.

Three-Step Interview—Have pairs of partners take turns interviewing one another about the assigned material. Each student then shares their partner's response with the class.

For Further Information

Hill, J. D. & Flynn, K. M. (2006). Classroom instruction that works with English language learners. Association for Supervision and Curriculum Development (ASCD), Alexandria, VA.

Marzano, R. J., Pickering, D. J., & Pollock, J. E. (2001) Classroom instruction that works: Research-based strategies for increasing student achievement. Association for Supervision and Curriculum Development (ASCD), Alexandria, VA.

Pollock, J. E. (2007). Improving student learning one teacher at a time. ASCD, Alexandria, VA.

Tovanni, C. (2004). Do I really have to teach reading? Content comprehension, grades 6–12. Stenhouse Publishers. Portland, Maine.

Wormeli, R. (2005). Summarization in any subject: 50 techniques to improve student learning. ASCD, Alexandria, VA.

Planning a Successful Field Trip

Setting a Date

Contact your Missouri Department of Conservation education consultant or outdoor skills specialist for assistance in planning and implementing your field trip. A field trip requires advanced planning to select and reserve a site that will fit your objectives. Determine a program date at least four months in advance. Having a Plan B in case of rain is always wise. Late spring and early fall provide the greatest variety of plant and animal life around aquatic areas. For a spring field trip, make arrangements in the fall. Contact your education consultant or outdoor skills specialist in the spring to arrange a fall field trip. These are good times for aquatic studies and for catching fish.

Selecting a Site

Choose a location with an aquatic feature, such as a stream, lake or wetland. Make sure there is some shade. This can be a stand of trees, a shelter or an awning. If restrooms are not available at the site, determine if some are close by. If none are nearby, you may need to arrange to have portable toilets available. Try to find a suitable place not too far from your school. This will reduce gas consumption and ensure adequate funds for the field trip. Moreover, students may feel more comfortable with and take more ownership of a location that is not too far from home.

If the site is a public site, check with the area manager to determine if a permit is needed and if any special rules apply to fishing or other activities at the site. Obtain permits if needed. If the site is on a private landowner's property, contact the owner, obtain permission and discuss any restrictions. Discuss with the manager/owner dates and times for the trip, the perimeter of the designated area, bathroom facilities, bus parking, etc.

Getting Help

Recruit adult volunteers to help on the trip. One volunteer for every 5–10 students is ideal. If you have more than 100 students, spread the trip over two days with half the students going each day. This may increase your adult-to-student ratio and make for a more rewarding and less stressful field trip. Having enough volunteers and knowledgeable help is essential. Parents, local fishing clubs, Rotary Clubs, etc., are potential sources of volunteers. Your Missouri Department of Conservation education consultant or outdoor skills specialist may be able to help with professional staff or trained volunteers. Contact other agencies such as the Department of Natural Resources, Natural Resources Conservation Service and Soil and Water Conservation District. Demand for these services is very high—staff availability depends on advanced planning. Keep in mind that those you have asked to assist may not be able to set aside another day in case of rain.

Finding a Location for a Fishing Event

Your Missouri Department of Conservation education consultant or outdoor skills specialist will need the following information:

- Who—the teacher's name, phone number, e-mail and other contact information
- When—the date of the event
- Where—if you have a specific body of water in mind for the event, or if not, how far the class can travel
- How long—length of time of the fishing event
- Ages of the students
- How many students will be fishing
- Whether the students will harvest fish or release them all

With this information, the education consultant or outdoor skills specialist will contact the regional fisheries supervisor and make arrangements for a successful and enjoyable fishing experience. In many cases, a fisheries biologist will be able to recommend nearby suitable waters. For situations where stocking is required, significant lead times are needed to work out stocking logistics. Rods, reels and other fishing tackle may be available if your school does not have equipment. Be sure to let your education consultant or outdoor skills specialist know if you need to borrow equipment.

Arranging Transportation

Contact the school district's transportation service to secure busses for your desired date. Ask for a cost estimate for the bus mileage and the driver. The transportation service may not be familiar with your field trip location or how to get there. Make sure you are and be prepared to provide a map.

Planning for Emergencies

Compile a list of all students participating in the trip and provide a copy to the school office. Let your principal know where the students are going and what they will be doing, and invite the school nurse to come along. On the day of the field study, post on the classroom door or other conspicuous location a sign indicating the destination of the class trip and departure and return times. Have a cell phone, two-way radio, etc. to contact the school should an emergency arise. Have a plan in case of sudden changes in weather, such as rainstorms. Do not seek shelter around water or under trees in lightening storms. In case of violent weather, the bus may be a vital refuge. Insist that the bus and driver remain in the immediate vicinity during the entire event. Should an emergency arise, finding the driver and waiting for him or her to return to the area could result in an unacceptable delay. Of course, a first-aid kit and life preserver or reach pole are musts for field trips around water.

Obtaining Permission

Send out a permission slip form (use copy page or create your own form) to get parents/guardians permission for the field trip. Permission slips should be sent home with the students at least a month in advance of the field trip with a reminder two weeks prior to the event. Permission slips must be returned before the field trip date. If some students are not given permission to participate in the field trip, make arrangement for the students to stay at school with a designated teacher or classroom. Make appropriate arrangements with the special education staff, school nurse, and/or parents for students with special needs.

Preparing Adult Volunteers

Be sure volunteers understand what is expected of them. The adult volunteers will need a list of students they will oversee and their responsibilities. Usually adult volunteers are tasked with keeping their students in designated areas, monitoring student behavior and assisting with fishing or other equipment, bait and fish. Be sure volunteers know what the students are supposed to be doing and what the volunteer should do to maintain order.

Safety Precautions and Concerns

Safety procedures are essential to successful hands-on science investigations, whether the activity takes place within the school laboratory or in the outdoors. Schools should have science lab safety guidelines such as those developed by the Council of State Science Supervisors. Visit *csss-science.org/safety.shtml* or *scienceaware.com/genlabsf.htm* for more information about school lab safety. Both teachers and their students should be familiar with and understand these guidelines before conducting hands-on science activities.

Using Chemicals and Equipment Safely

Teachers should familiarize themselves with chemicals and equipment that students will use to perform pH, dissolved oxygen and other chemical water quality tests. This includes a complete understanding of test procedure steps, material safety data and acceptable disposal methods for used chemicals. A thick polyethylene plastic container with closable lid, such as a rinsed-out bleach bottle can be used to collect used chemicals in field situations for eventual proper disposal back in the laboratory. When handling any type of chemical, teachers and students should wear protective eyewear. Long hair and loose clothing should be tied back. Always have a first-aid kit containing a buffered eye wash solution on hand.

All equipment including laboratory glassware, water sampling equipment and fishing gear should be inspected regularly. Equipment that is worn or broken should be repaired or discarded and replaced. Teachers also need to ensure that the students know how to use the equipment properly and appropriately. This is particularly true when casting with baited hooks.

Learning Outdoors Safely

Be alert to environmental hazards that may arise in outdoor situations. These include poisonous plants, biting and stinging insects and wild animals. Teach students to identify and avoid poison ivy. Remind students and parents to provide sunscreen and insect repellant as appropriate. Avoid conditions that could cause students to fall, such as steep terrain, slippery or unstable rocks, or animal burrows or holes. Minimize the risk of sun-, heat- and cold-related injuries by insisting that students come properly dressed for outdoor activity, including wearing closed-toed shoes. Do not tolerate running or horseplay with equipment or around water. Tell students to stay out of the water except as instructed and never to wade into water more than knee deep. A life preserver or reach pole is a must for field trips around water.

For the most part, using common sense will ensure that hands-on science investigations can be conducted safely and without incident. Common sense also dictates the need to be prepared for the unexpected by having an action plan, a first-aid procedure and ready method of contacting emergency help if necessary. Teach students that, by taking appropriate precautions and using common sense, the outdoors is a safe and wondrous place to learn.

Assessment Opportunities

The unit pre-test serves as a formative assessment and provides important baseline data for unit development. Re-deploying the pre-test as a unit post-test helps the Missouri Department of Conservation's education and curriculum development team by providing important before and after data.

Each chapter provides multiple assessment opportunities. The first activity in each chapter provides formative assessment data while keeping the focus on what is to come. Throughout the unit students design data sheets, develop experiments, create graphs, research and write. Teachers may use each chapter's **Questions to Consider** as discussions prompts, for cooperative learning activities, for formative assessment or for science notebook writings.

Formal summative assessments and answer keys are included in each chapter. These assessments allow students to practice answering the type of questions used on standardized tests such as *TerraNova* and the Missouri Assessment Program (MAP) test. They include multiple-choice questions and open-ended constructed-response questions. Open-ended constructed-response questions may have many correct answers. Answers in the keys are meant to provide guidance or examples of correct answers. They do not exhaust all possibilities.

Science notebooks are best used for formative assessment. They serve as tools for informing teachers of student progress. Teachers can collect and review notebooks throughout the unit. Notebooks may be used for summative assessment or to check for student mastery, but it may be easier and better to do these using work generated from the notebook. Science notebook assessment may be holistic or analytic, but no scoring rubric is provided in the Teacher Guide.

Field study activities may form the basis of performance assessments. However, no scoring guide is provided. While students are provided the opportunity to practice techniques before the field study day, it is not the intention of *Conserving Missouri's Aquatic Ecosystems* to develop student mastery of these techniques. Rather, introducing students to scientific techniques for studying the natural world is intended to deepen students' understanding of ecological concepts. Science understanding is developed through the use of science process skills, scientific knowledge, scientific investigation, reasoning, and critical thinking.

The unit summation provides other opportunities for assessment. Students may write a formal report on their field study. Alternatively, the field study report could take the form of a science notebook entry. A class presentation and discussion of findings ensures that students understand the importance of communication and dialog in the scientific process.

Permission Slip for Field Trip

Dear Parent/Guardian,

Students in ____________________ (teacher's name) class are studying Missouri's aquatic ecosystems. A field study day is planned for ________________ (date of trip). We will leave from the school at ____________ (leaving time) and will return by _____________ (returning time).

Activities will include: soil and water quality testing, observation of weather conditions and land uses in the watershed, plant and invertebrate sampling, a wildlife walk and fishing. Procedures and safety rules have been reviewed and practiced at school for this event. Students will be divided into groups with an adult volunteer to ensure safety.

Students should dress for the weather, as we will be outside all day. See the checklist at the bottom of the page to see what students should bring. A school lunch will be provided for students who receive lunches from the cafeteria. Students may bring their own lunch if desired. Coolers will be provided for beverages if students want to bring them. Students will need to put their name on their beverage.

Please sign the permission slip below to indicate that your child does or does not have permission to participate in this field trip.

Permission granted or denied

My child ________________________________ (print child's name) does or does not (circle one) have my permission to participate in the field trip on ________________ (date of trip).

____ ______________________________________

Parent/guardian printed name Phone number

____

Parent/guardian signature

Cut here

- -

Checklist for parents and students

- Blanket, towel, or tarp to sit on at lunch
- No swimsuits! Only school-appropriate clothes that can get wet and dirty.
- Wear shoes that can get wet and dirty, such as old tennis shoes.
  Closed-toed shoes are mandatory. No sandals or flip flops!
- Sunscreen
- Insect repellent
- Lunch

Chapter Components

Estimated Time—Indicates approximate number of 50-minute class sessions for the chapter.

Vocabulary—Listed terms are the same as the bolded terms in the Student Guide. They are defined in the glossary of the Student Guide and in this guide.

Essential Concept for the Chapter—The main idea of the chapter.

Chapter Objectives—Lists student objectives addressed in the chapter.

Targeted Grade-Level Expectations—Lists GLEs targeted for learning in the chapter. Many GLEs are addressed in several chapters. The chapter in which a GLE is first addressed provides the code and language of the GLE. When a GLE is addressed again in a subsequent chapter, the GLE is indicated by code only. Teachers must use their discretion to determine whether the referenced GLE has been mastered by their students.

Technology Tools/Skills Used in the Chapter— Indicates connections made to technology such as the Internet, scientific or other special equipment in the chapter.

Reference Materials for Teacher Background—Lists recommended references for teacher background in the chapter.

Safety Precautions/Concerns—Indicates specific safety precautions, if any, applicable to the chapter.

Required Materials—Lists items supplies and equipment needed for completing the activities in the chapter, including copies of handouts, transparencies, materials for teacher demonstrations, and materials for student activities.

Activities—These sections contain several components: **Estimated time, required materials** and step-by-step **procedures** for each activity. **Transparency masters** and student **copy pages** are provided.

Assessments—Summative assessments and answer keys are provided for every chapter to be used at the teacher's discretion.

Enrichments—Optional activity ideas appropriate to the chapter, including Project WET and Project WILD Aquatic activities, additional video clips, guest speaker, demonstration, service learning and field trip suggestions.

Unit Time Frame

The Estimated Time section suggests how much time it may take to teach each chapter in 50-minute class sessions. Actual time will be affected by the following factors:

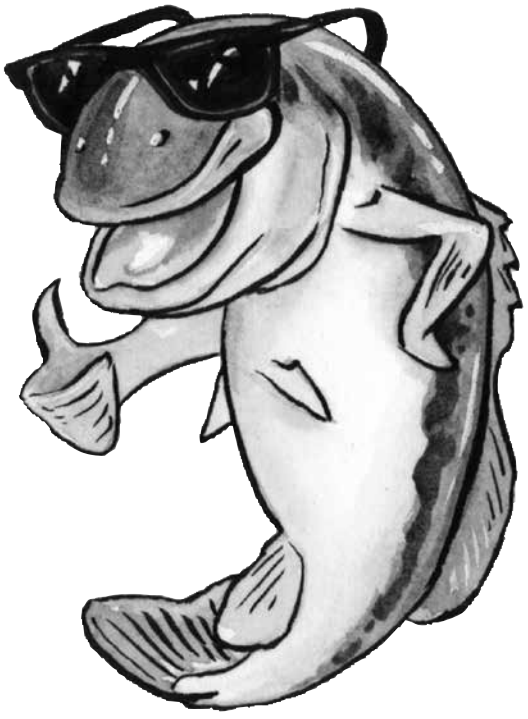
- daily schedule of the school (50-minute periods, block scheduling, etc.)
- need for review or re-teaching of previous learning based on extent of students' prior knowledge
- teacher's additional resources and knowledge
- time allotted for cooperative learning activities
- number of activities given as homework rather than in-class activities
- availability of resources for student use
- number and type of field study experiences
- number and type of enrichment activities used
- number of summative assessments used

Chapter Title	Estimated Time (50-minute class sessions)*
1—Water Is Life	4–5 sessions
2—The Ultimate Recyclable	3 sessions
3—What's Your Watershed Address?	3–4 sessions
4—Living In The Water	3 sessions
5—From Sun To Sunfish	5 sessions
6—Missouri's Aquatic Ecosystems	4 sessions
7—Rivers And Streams	3 sessions
8—Lakes And Ponds	3 sessions
9—Swamps And Marshes	3 sessions
10—Fishing For Answers	2–3 sessions
Field Study	1–2 full days
Unit Wrap-Up	2 sessions
All Chapters	35–38 sessions plus 1–2 full field study days

*Excluding time needed to administer summative assessments

Materials Funded by Grant

Please refer to the current *Conserving Missouri's Aquatic Ecosystems* Grant Agreement or Grant Guidelines for the list of these materials.



Conserving Missouri's Aquatic Ecosystems
Materials Order Form

Teacher Name: _____ **School:** _____

School Address: _____ **Phone #** _____

The items listed below are free publications that support the *CMAE* unit. Posters are sent in sets of two to allow access to information on both sides. Any of these publications or parts thereof may be reproduced for classroom use. Some items may be out of stock or under revision.

✓	Quantity	Inventory No.	Title
	1		*CMAE* DVD: Instructional Enrichment Video
	1		*Golden Guide to Pond Life* (160 pages)
	1	01-0250	*Crayfishes of Missouri* (152 pages)
	2	E00002	Missouri Pond Life (poster)
	2	E00003	Exploring Missouri Wetlands (poster)
	2	E00016	Missouri Stream Life (poster)
	2	E00115	Wetlands & Waterfowl (poster)
	2	E00509	Rivers and Streams: Missouri Currents (poster)
	1	FIS013	Zebra Mussels: Missouri's Most Unwanted (brochure)
	1	FIS034	Life Within the Water (brochure)
	1	FIS049	Volunteer Water Quality Monitoring (brochure)
	1	FIS056	Pond Handbook (68-page booklet)
	1	FIS110	Nuisance Aquatic Plants in Missouri Ponds and Lakes (brochure)
	1	FIS182	Form a Missouri Stream Team (brochure)
	1	FIS192	Understanding Streams (brochure)
	1	FIS193	Stream Team Inventory Guide (16-page brochure)
	1	STR250	Stream Insects & Crustaceans (2-sided sheet)
	1	SCI013	African Clawed Frogs (brochure)
	1	E00112	Teacher Request Form (free MDC publications for educators)
The following items are available in classroom sets.			
✓	**Classroom Qty**	**Inventory No.**	**Title**
		E00430	Missouri Toads and Frogs (brochure)
		E00468	Missouri Turtles (brochure)
		E00606	Fishing Regulations Summary
		FIS011	Introduction to Crayfish (brochure)
		FIS020	Introduction to Missouri Fishes (39-page brochure)
		FIS152	Introduction to Fishing (brochure)
		FIS273	What's In Your Water? (watershed placemat)

7/2010

MAIL TO : Distribution Center
Missouri Department of Conservation
P.O. Box 180
Jefferson City, MO 65102-0180

Pre- and Post-test

Directions: Select the best answer for each of the following multiple-choice questions.

1. What proportion of the water on the earth is fresh water?
   a. 3 percent
   b. 25 percent
   c. 75 percent
   d. 97 percent

2. Water is a unique substance. It can be found in all three states on Earth—solid, liquid and gas. Which of the following are other properties of water?
   a. Exhibits surface tension
   b. Acts as a solvent
   c. Is transparent
   d. All of the above

3. How does water pollution affect aquatic life?
   a. Cloudy water blocks light and slows plant growth
   b. Too much fertilizer causes overgrowth of algae
   c. Toxic chemicals are poisonous to living things
   d. All of the above

4. What is conservation?
   a. Careful use
   b. Thinking very hard
   c. Taking anything we want
   d. Taking water for granted

5. How does water's temperature affect the amount of oxygen in it?
   a. Cold water floats
   b. Liquid water turns to gas
   c. Cold water holds more oxygen
   d. Oxygen is vital for life

6. How does the water cycle purify water?
   a. Water flows through underground aquifers
   b. Every time water evaporates it becomes pure again
   c. Water vapor condenses to form raindrops
   d. All of the above

7. What is climate?
   a. Hot, damp summers and cold, dry winters
   b. The movement of water from soil through plant roots and stems, and out the leaves into the atmosphere
   c. Average atmospheric conditions in an area over many years
   d. All of the above

8. Where does water go when it runs off a street?
   a. To wastewater treatment plants for processing before being returned to the environment
   b. To drinking water treatment plants, then through pipes to our taps
   c. To pick up air pollution, forming acid rain
   d. Through storm drains and ditches, then directly into streams, lakes and wetlands without being cleaned or processed

9. What is non-point pollution?
   a. A stream that empties into a particular body of water
   b. Water pollution that comes from a broad area or a number of sources
   c. The movement of solid material such as rock, soil or mud
   d. Contamination that can be traced to a single source

10. What is a watershed?
   a. A stream that empties into a particular body of water
   b. The area where precipitation first collects in tiny trickles too small to create a permanent channel
   c. A stream that flows all year long
   d. All the land that drains water into a particular body of water

11. What is sediment?
   a. Any bit of rock or soil that is suspended or carried in water
   b. Water pollution that comes from a broad area or a number of sources
   c. The movement of solid material such as rock, soil or mud
   d. None of the above

12. Which of the following statements about adaptations is true?
   a. Creatures can choose adaptations that will provide them with survival advantages.
   b. Species adaptations provide them with survival advantages in a particular environment.
   c. All aquatic species have the same adaptations.
   d. Both b and c

13. What is a species?
   a. A group of individuals sharing some common characteristics or qualities
   b. Animals with a backbone
   c. A particular kind of creature
   d. Both a and c

14. Complete this analogy: Individual is to population as
   a. Water is to surface tension.
   b. Fish is to gills.
   c. Niche is to habitat.
   d. Population is to community.

15. Which of the following statements about competition is true?
   a. Individuals within a population may compete with other individuals of the same species.
   b. Individuals within a population may compete with individuals of different species.
   c. A population within a community may compete with other populations within the community.
   d. All of the above

16. Carrying capacity is the result of the fact that:
   a. Different populations living in the same place interact with one another.
   b. Within a community every species has a particular niche.
   c. While living organisms have the capacity to produce populations of infinite size, environments and resources are limited.
   d. Most energy pyramids can continue for only four or five trophic levels and can support only a few top-level consumers.

17. Which of the following statements about invasive species is true?
   a. The invasive species may compete with native species for habitat or food.
   b. Invasive species are not subject to natural selection.
   c. Invasive species play an important role by keeping populations of prey species below their carrying capacity.
   d. None of the above

18. What is the biggest threat to aquatic communities?
    a. Predator/prey relationships
    b. Natural selection
    c. Human-caused habitat destruction
    d. All of the above

19. Why can most energy pyramids continue for only four or five trophic levels and support only a few top-level consumers?
    a. Most of the available food energy is lost moving up each trophic level.
    b. Animals lose energy doing tasks such as hunting and keeping their bodies warm.
    c. Only a little of the sun's energy passes from one trophic level to the next.
    d. All of the above

20. Why do scientists use sampling?
    a. To create new habitat
    b. Because each part of an ecosystem is connected to and depends on all the others
    c. Because ecosystems may change in response to natural or human-caused events
    d. To estimate things without having to count each organism

21. What is an endangered species?
    a. A type of plant or animal no longer in existence, having died out leaving no living representatives
    b. A type of plant or animal with a variety and number of different organisms and populations
    c. A type of plant or animal whose numbers are so small that it is at risk of extinction
    d. Both a and c

22. What does it mean for a species to be extinct?
    a. A type of plant or animal no longer in existence, having died out leaving no living representatives
    b. A type of plant or animal with a variety and number of different organisms and populations
    c. A type of plant or animal whose numbers are so small that it is at risk of extinction
    d. Both a and c

23. What is biodiversity?
    a. A complex web of relationships between living and non-living things
    b. The variety and number of different organisms and populations, and the way they live together
    c. The kinds of aquatic ecosystems found in Missouri
    d. None of the above

24. What kinds of aquatic ecosystems do we have in Missouri?
    a. Ozarks, Prairie, Lowland and Big River
    b. Rivers, lakes and wetlands
    c. Swamps, marshes and bogs
    d. Streams, oceans and ponds

25. Predict the impact of flooding on the organisms in a stream ecosystem.
    a. Some fish, plants or other aquatic life could be washed downstream.
    b. There would be no long-term damage.
    c. Fresh nutrients would be brought in.
    d. All of the above

26. Which of the following statements is true:
    a. In a straight stretch of river, the main force of the current is in the middle. The deepest water is also in the middle.
    b. When there is a sharp bend in the river, the strongest current and deepest water is at the outside edge of the bend.
    c. In flowing water, there is less current near the bottom.
    d. All of the above

27. Predict the impact of sediment and nutrients brought by storm water runoff on the organisms in a lake or pond ecosystem.
    a. Temperature changes would cause the layers to mix, bringing decaying organic matter from the bottom up to the surface
    b. There would be no long-term damage
    c. Pond succession would speed up
    d. All of the above

28. Predict the oxygen level in a pond.
    a. The amount of oxygen dissolved in the water stays pretty even over a 24-hour period.
    b. The water is too deep for plants to grow on the bottom, making it oxygen poor.
    c. Oxygen levels are high each day while the sun is shining and plants are photosynthesizing, but they can drop dramatically at night.
    d. None of the above

29. What three factors are required for a place to be considered a wetland?
    a. Saturated soil, diverse plant and animal community, standing water
    b. Saturated soil, diverse plant and animal community, plants specially adapted to live in saturated soil
    c. Saturated soil, wet for a major part of the growing season, plants specially adapted to live in saturated soil
    d. Standing water, wet for a major part of the growing season, plants specially adapted to live in saturated soil

30. What is detritus?
    a. A complex web of relationships between living and non-living things
    b. The variety and number of different organisms and populations, and the way they live together
    c. Dead plant and animal matter in the process of decay
    d. None of the above

31. Aquatic resource conservation is
    a. Best left to professionals
    b. Limited to certain times of the year
    c. Unnecessary because Missouri has plenty of water
    d. Everyone's responsibility

Apply your knowledge of these species' adaptations and their roles in the transfer of energy in Missouri aquatic food webs to predict the best bait or lure to use to catch:

32. Largemouth bass
    a. Live minnow
    b. Bare treble hook
    c. Plastic worm dipped in stinkbait
    d. Artificial fly that mimics a mayfly

33. Channel catfish
    a. Live minnow
    b. Bare treble hook
    c. Plastic worm dipped in stinkbait
    d. Artificial fly that mimics a mayfly

Apply your knowledge of these species' adaptations and habitat needs to predict where to find:

34. Largemouth bass
    a. Shallow marsh
    b. Below a riffle in weeds near a stream bank
    c. Muddy bottom of a pond
    d. Open water zone of a lake

35. Bluegill
    a. Shallow marsh
    b. Below a riffle in weeds near a stream bank
    c. Muddy bottom of a pond
    d. Open water zone of a lake

Pre- and Post-test Answer Key

1. **a**
2. **d**
3. **d**
4. **a**
5. **c**
6. **b**
7. **c**
8. **d**
9. **b**
10. **d**
11. **a**
12. **b**
13. **d**
14. **d**
15. **d**
16. **c**
17. **a**
18. **c**
19. **d**
20. **d**
21. **c**
22. **a**
23. **b**
24. **b**
25. **d**
26. **d**
27. **c**
28. **c**
29. **c**
30. **c**
31. **d**
32. **a**
33. **c**
34. **d**
35. **b**