The Salton sea wetlands: A guidebook of curriculum based lessons

Etta Margo Ligman-McCormick

Follow this and additional works at: https://scholarworks.lib.csusb.edu/etd-project

Recommended Citation
https://scholarworks.lib.csusb.edu/etd-project/2292

This Project is brought to you for free and open access by the John M. Pfau Library at CSUSB ScholarWorks. It has been accepted for inclusion in Theses Digitization Project by an authorized administrator of CSUSB ScholarWorks. For more information, please contact scholarworks@csusb.edu.
THE SALTON SEA WETLANDS: A GUIDEBOOK OF CURRICULUM BASED LESSONS

A Project
Presented to the Faculty of California State University, San Bernardino

In Partial Fulfillment of the Requirements for the Degree Master of Arts in Education: Environmental Education

by
Etta Margo Ligman-McCormick
June 2003
THE SALTON SEA WETLANDS: A GUIDEBOOK OF CURRICULUM BASED LESSONS

A Project
Presented to the Faculty of California State University, San Bernardino

by Etta Margo Ligman-McCormick
June 2003

Approved by:

Darleen K. Stoner, Ph.D., First Reader
Date May 13, 2003

Caroline Conway, M.A., The Living Desert, Second Reader
ABSTRACT

Using Coachella Valley's Salton Sea ecosystem as a model, several multidisciplinary wetland activities for grades three to six were developed. A resource guide for educators is included.

Lessons target issues relating to the health of wetlands, the important ecological niche for plants and wildlife that wetlands provide, and recharging and filtering the water supply. These lessons promote environmental awareness, encourage use of scientific processes, practice building higher-level critical thinking skills, encourage positive environmental attitudes, and emphasize decision-making actions about environmental issues.
ACKNOWLEDGMENTS

I would like to thank my husband, Patrick and my children, Sarah, Zachary, and Amanda for their love, patience, and understanding in my quest to complete this project. I would also like to thank my parents and friends for their unconditional support and guidance.

A special thank you goes to Dr. Darleen Stoner for her tremendous expertise and support. Her love of the environment continues to inspire me! My deepest gratitude goes to Sharon Marks and Debi Gummer who kept me focused and on task. Finally, I would like to thank Anne Copeland for being the catalyst and mentor committed to seeing this project succeed.
TABLE OF CONTENTS

ABSTRACT ................................................................. iii
ACKNOWLEDGMENTS ................................................... iv
CHAPTER ONE: INTRODUCTION ........................................ 1

CHAPTER TWO: REVIEW OF THE LITERATURE
              Rationale of Environmental Education
              Attainment of Awareness ...................................... 4
              Acquiring Environmental Knowledge ...................... 6
              Development of Environmental Critical
              Thinking Skills ................................................ 8
              Cultivating an Environmental Attitude .................... 10
              Responsible Environmental Behavior ....................... 12
              Development of Actions Relating to
              Environmental Issues ........................................... 13

CHAPTER THREE: GOALS AND OBJECTIVES ......................... 16
CHAPTER FOUR: DESIGN OF PROJECT ............................. 17
CHAPTER FIVE: IMPLICATION FOR EDUCATORS .................... 20
APPENDIX A: TEACHER BACKGROUND INFORMATION .............. 23
APPENDIX B: INTERDISCIPLINARY LESSONS ...................... 28
APPENDIX C: RESOURCE GUIDE ...................................... 131
REFERENCES ................................................................. 144
CHAPTER ONE
INTRODUCTION

Wetlands are considered one of the most valuable ecosystems on Earth. In the Coachella Valley, the Salton Sea and its surrounds are classified as one of these key areas. "Wetlands are places where water saturates, or floods, the soil much of the time so that only plants especially adapted to wetness can survive" (Vileisis, 1997, p. xi).

For some the Salton Sea is seen very differently. Seen as a dumping ground for waste with no regard to the environment. Other see it as a vanished recreational, for bird migration along the Pacific flyway it is a necessary habitat.

Pesticides from farmers use in the Coachella and Imperial Valleys, waste from the New and Alamo rivers, factory toxins from the “Maciadores” (American owned factories in Mexicali), illegally dumped medical waste, human waste, and dead animals are but a few of the items found “dumped” into the Salton Sea (Polakovic, 1993).

Salinity level is so high that few fish species are viable, thus a decrease in recreational fishing industry occurred. The food chain has been compromised, thereby
affecting the wetlands habitat (University of Redlands, 2002, p. 42).

Although many scientists have called it "California's Crown Jewel of Avian Biodiversity" (Salton Sea Authority, 2000, p. 1), others view the Salton Sea as one of the world's most productive fisheries. Decisions and policies made today about this fragile wetland ecosystem will undoubtedly affect future generations for years to come: environmentally, aesthetically, and financially. With education and knowledge of the Salton Sea wetland environment students will be a productive part of the community decision making process with regard to the water transfer negotiations.

The Imperial Irrigation District negotiated with the San Diego County Water Authority to transfer a portion of the water from the Colorado River that would normally flow into the Salton Sea to other Southern California urban areas, beginning January 1, 2003 (San Diego Water Authority, 2002). If water is not available for the Salton Sea to keep its water level stable, the shoreline will recede, birds and other animals will lose their habitat, and the newly uncovered shoreline will release great clouds of dust particles into the atmosphere for miles. Migrating birds on the Pacific Flyway will lose an
important stop and the general economy of the area will suffer. Provisions must be made for the Salton Sea to maintain its current water level or California will lose one of its most valuable resource and recreation areas. If these resource and recreational areas are lost, they will impact individual, business, community, and government decisions.

This project is intended to educate third through sixth grade teachers and their students about this very important resource, the Salton Sea. Through content-based lessons, students will gain historical background and knowledge about the Salton Sea wetlands. These lessons encourage development of positive environmental attitudes and problem-solving skills, along with practice in making observations and formulating decisions about the future of the Salton Sea.

The goal for the students is to gain a greater appreciation for this environmental treasure by forming a foundation of wetland knowledge and a contextual understanding of the Salton Sea and its influences. As potential voters, their decisions will impact the future of the Coachella Valley area.
CHAPTER TWO

REVIEW OF THE LITERATURE

Rationale of Environmental Education
Attainment of Awareness

When considering the Salton Sea’s future, the definition of environmental education must be considered. Stapp defined environmental education as “environmental education is aimed at producing citizenry that is knowledgeable concerning the biophysical environment and its associated problems, aware of how to help solve those problems, and motivated to work towards their solutions” (as cited in Wilke, 1997, p. 35).

The Salton Sea wetland is a starting place to model positive real world experiences by combining academic disciplines with the local environment in defining and assessing issues. Environmental education can be woven into the curriculum to help understand human interactions within the context of the Salton Sea Wetlands environment.

Education is environmental when it increases the understanding of native culture, technology, people, ideas and feelings about the environment. Environmental education is interdisciplinary and relevant in each subject area from kindergarten to college. Environmental education provides unique contributions for educators to
contribute significantly to a person's ability to function effectively in society (California Department of Education, 2002).

Most people in the United States live in urban communities. The daily contact with basic natural resources that once characterized rural living is no longer prevalent. With urbanization, people tend to become less aware of their interdependence with the environment. Considering solutions to today's environmental problems from air pollution to overpopulation requires citizens who are knowledgeable about their interdependence with the environment. A critical need exists for an educational approach that includes experience in a natural environment (Klein, & Merritt, 1994, p. 14).

In the world of education in California today, students struggle to learn the basic skills of reading, writing, and math. Their future is determined by how well they do in the classroom and on test driven standards. Society forgets that it is not simply the "3 R's"; rather their future is a broader more complex network of environmental issues, actions, and responsibilities. Within these sets of networks are intricate relationships of interdependent societies, economies, governments, and environments. In Education and the Environment, we are
reminded that, "Much of California’s economic prosperity has depended on how we have used our environment. In the future it will depend on how we understand our environment. In its broadest definition, our environment is the Now that joins our Past to our Future. It is not just ancient redwoods; it’s the bush in your backyard; it’s you and I. Our environment links everyone and everything" (California Department of Education, 2002, p. 1).

Knowledge of issues is required before environmental actions can be made. This knowledge leads to attitudes, behavioral changes, and skill development by applying that knowledge to a given local environmental issue (Wilke, 1997, p. 49). The Salton Sea wetland is a starting place to model positive real world experiences by combining academic disciplines with the local environment defining and assessing issues.

Acquiring Environmental Knowledge

"Knowledge is primarily conceptual," according to Volk (in Wilke, 1997, p. 49), but Volk suggested that a part of knowledge contains a skills component. One of the skills necessary for environmental literacy is a knowledgeable analysis of environmental issues.
Individuals must possess knowledge of the courses of action that are available and which ones will be most effective in a given situation. Individuals benefit from skills development by appropriately applying knowledge of an action strategy to a given issue (Hoody, 1995, p.6).

This approach is based on the Hines Model of Responsible Environmental Behavior which stated that "changing environmental behavior with increased knowledge leads to favorable attitudes which in turn lead to actions promoting better environmental quality" (Hoody, 1995, p. 6).

Hungerford and Volk (in Wilke, 1997, p. 47) suggested that responsible behavior might be actualized through knowledge gained through environmental education. Using the framework objectives: awareness, sensitivity, attitudes, skills, knowledge and participation for environmental education as defined by the 1977 Tbilisi Intergovernmental Conference on Environmental Education, this framework provides the perfect vehicle to integrate environmental knowledge, skills, and education across the curriculum (California Department of Education, 2002, p. 5).

A knowledgeable teacher, teaching about the environment, provides a positive learning experience for
students and helps them become enthusiastic about their learning. The teacher needs to make certain the difference between problems and issues is understood, be nonjudgmental, and yet give students opportunities for depth and equality of learning.

Development of Environmental Critical Thinking Skills

Liberman and Hoody (1998) surveyed forty schools that used the environment as integrated concept (EIC) for learning to support thinking skills across the curriculum and to incorporate Bloom’s ‘taxonomy of the cognitive domain’, into the educational setting. When these approaches were used in the educational setting, the cognitive abilities of students appeared to grow more rapidly. The teachers of EIC students reported that their students synthesized information using a higher level of creative and critical thinking skills along with higher level thinking processes that are key to identifying, investigating, and analyzing issues, and formulating and evaluating alternative solutions. Other EIC benefits include measured academic achievement in standardized tests in Mathematics, Reading, and Science as well as reduction in student discipline and attendance issues (Liberman & Hoody, 1998, p. 1).
"Environmental education builds the capacity of learners to work individually as well as cooperatively to improve environmental conditions" (North American Associates for Environmental Education, 1998, p. 2). Environmental education is not a separate subject but a framing that provides students with a comprehensive view of the world and moves them beyond the boundaries of traditional education. Framing allows students to inquire about and examine, explain, interpret, explore, manage, discover and be able to take action and ownership of local issues. The student will learn and develop critical thinking, problem solving, research and decision making skills through environmental education (Trisler, 1993).

Students and educators alike recognize environmental issues of global concern. If asked to identify issues, most would be able to identify several issues: global climate change, ozone depletion, acid rain, deforestation, and ocean dumping, to name a few. The challenge of environmental education is to make these global issues meaningful to learners by focusing on individual contributions to the issues, and then using problem-solving, decision-making strategies to develop, refine and re-direct the thinking and learning (Trisler, 1993).
Cultivating an Environmental Attitude

Attitude is defined as "manner, disposition, feeling, position, etc., toward a person or thing" (Lindana, 1980, p. 87). Students create their own environmental attitude when they make sound discussion regarding environmental issues. Providing a positive attitude for learning about the environment in elementary grades is essential. Research tells us that from ages 9 to 12 years a significant amount of a child’s attitude toward the environment tends to be formed (Jaus, 1982). The development of a positive attitude towards the environment is strongly correlated with the extent of environmental evidence received (Cohen, 1977). Volk (1993, p. 37) stated that attitude affects people’s awareness of consciousness about their environment.

Hoody (1995, p. 7) examined the affective domain, which explored the student reaction to a given subject, in this case environmental education. In Hoody’s study a national inventory of over 15,000 students was done. The outcome indicated that students had a poor grasp of factual environmental knowledge; however they tended to express positive responses and environmental attitudes to affective questions. This study concluded that even though students lacked prior environmental knowledge, when they
were questioned after the study, they were sympathetic towards environmental issues.

Blum’s study (in Hoody, 1995, p. 7) found that open-ended inquiry environmental instructional methods tended to have positive impacts on students’ attitude changes. Hepurn’s 1978 study (in Hoody, 1995, p. 7) found that the greatest environmental impact and changes in attitude were associated with interdisciplinary teaching approaches.

In a case study by Jaus, 53 fifth grade students were divided into two groups (as cited in Hoody, 1995, p. 8). One group was given 40 minutes of environmental education instruction for 15 consecutive school days. Each lesson included lecture, discussion, laboratory activities and homework. The second group was the control group of fifth graders at another school site; they received no environmental education instruction. The investigator developed a 25 Point Likert scale instrument to measure environmental attitudes. The environmental experimental group was found to express 22% more “positive” environmental attitudes than the control group. Jaus concluded that environmental education programs aim at providing citizens to understand and appreciate their relationship to the environment while developing their
critical thinking skills and commitment to constructive actions. While applying easy to understand concepts, students develop a holistic respect and appreciation and concern for the environment and responsible behavior.

Responsible Environmental Behavior

The ultimate goal of environmental education is the development of environmentally responsible citizens (Hungerford & Volk, 1990). Behavior is considered environmentally responsible when the actions of an individual or group advocates the sustainable or diminished use of natural resources (Hungerford & Volk, 1990). "There is a growing development among environmental educators to develop a citizenry that both behaves responsibly and is actively working to protect the environment" (Hoody, 1995, p. 9).

According to Hines, Hungerford, & Tomera (1987), an important factor in whether or not an individual emerges with an environmentally responsible behavior or attitude is the person's development of locus of control or feeling of effectiveness.

An important part of developing one's responsible environmental behavior is the evolvement of the internal locus of control (Hines, 1987). Disinger (1993, p. 51)
suggested that a person with an internal locus of control feels a personal stronger measure of control over events that occur.

One’s own locus of control may be influenced by what is learned and applied to one’s immediate surroundings. More importantly, as one is demonstrating actions and skills in the community, the locus of control becomes internalized. Once internalized, the locus of control enables students to forge an emotional attachment to their surroundings and the environment.

Culen discovered that overt environmental behavior improved with two levels of environmental instruction. Culen did a study of wetland issues with three experimental middle school treatment groups. Group one received four levels of environmental instruction. Group two received two levels of environmental instruction. Group three, or the control group, received traditional science instruction. The most significant results were from experimental group one, which received four levels of environmental education (Culen, 1994).

Development of Actions Relating to Environmental Issues

The 1977 "Tbilisi Declaration" on environmental education outlined five objectives for environmental
education. One of the objectives was to provide societies and individuals opportunities to be active participants in working towards the resolution of environmental issues and problems (California Department of Education, 2002, p. 5).

When students are actively participating in environmental education, they are inspired to take actions, and through follow-up activities have continued cycles of growth and action. The result of research also shows that changes occur because society and individuals have ownership of the issues and problems that are familiar to them (California Department of Education, 2002, p. 3). Using environmental activities allows students to practice, participate and eventually be responsible voters in local, state, national, and global issue problems (California Department of Education, 2002, p. 3).

Research has indicated that environmental based education has a plethora of outcomes: students and academic performance and test scores improve, classroom discipline and attendance problems decrease, and students increase their ability to transfer knowledge to new situations environment and surroundings (2002, p. 3). Environmental actions are an incorporation of attainment of awareness, acquiring environmental knowledge,
development of environmental thinking skills, cultivating an environmental attitude, and responsible environmental behavior.

In the collection of studies by Emmons, Hungerford, Ramsey, Mardock, and Kransy, (Emmons, 1997, p. 35) it was suggested that positive social and environmental change is the underlying purpose of environmental education. Local environmental issues provide the connection between education and the natural system in real world context, links the classroom with the environment, and provides the venue for action, social transformation, and environmental change on a local, state, national, or global environmental issues.
CHAPTER THREE

GOALS AND OBJECTIVES

The goal of this project is to provide a guide for classroom teachers who wish to promote and implement environmental education about the Salton Sea wetland ecosystem. Lessons are designed for use by Coachella Valley students in grades three through six.

The primary objective of this endeavor was the development of a manual for educators that includes lesson plans, activities, community resources, references, and literature guides.

The secondary objective was to field test lessons through the educational system of Desert Sands Unified School District, the Coachella Valley Wild Bird Center, and the Salton Sea Recreation Area.

The ultimate goal is to produce an ever increasing group of informed and productive citizens who will internalize the importance of wetlands and who will take the necessary actions to protect them.
CHAPTER FOUR
DESIGN OF PROJECT

This project was developed for use by the Coachella Valley Wild Bird Center and the Salton Sea Recreation Center, as well as for implementation by classroom teachers in the Desert Sands Unified School District. The curriculum guide contains lessons relating to the Salton Sea Wetland Ecosystem.

There are ten 40 to 60 minute lessons designed for grades three to six. Each lesson meets a learning concept as prescribed by the California Department of Education’s Content Area Standards in Language Arts, Science (Earth & Life), Social Studies, Geography, Math, and Visual Arts. The author created most of the activities herein, while some were adapted from other environmental lessons to make them more appropriate to this particular geographic region. Additional lessons are used in original form, with permission from the authors noted in the lesson.

Each lesson is appropriate for upper primary and older elementary students. Students in this age group are beginning to develop an environmental consciousness, which can be further promoted by hands-on activities and lessons involving the Salton Sea wetlands. The teacher can pick
and choose lessons at random to meet specific educational goals and objectives for a particular lesson or unit.

The lessons included in this project (see Appendix B), are intended to be used as a springboard for developing an understanding of the Salton Sea wetlands and habitat. This knowledge can later be used for further investigations of other wetland environments. The lessons may be used individually, or as part of a thematic unit, incorporating language arts, mathematics, science, social science, art, and writing.

Field-testing was accomplished at three educational sites: Lyndon Johnson Elementary School, John F. Kennedy Elementary School, and Indio Middle School, all in the Desert Sands Unified School District. Each was diverse in student population, ethnicity, academic abilities, geographic locations, and socio-economic backgrounds. The student population ranged from ages nine through eleven years of age. The teacher’s experience ranged from new interns through master teachers. There were 30 teachers and their classes involved in field testing the lessons. Eight of the twelve lessons were field tested by 25 teachers in the fourth and fifth grades. The same eight lessons were field tested by five third grade teachers. The third grade teachers felt that the materials they
tested could be used at their grade level but were more applicable for the fourth and fifth grade students due to the curriculum content and expectations.

Background information on wetlands and the Salton Sea is provided in the Appendix A for additional teacher support, primarily for those teachers new to the area and/or teaching wetlands and science. Resources for education include relevant community agencies, a literature list, and field trip information.
CHAPTER FIVE
IMPLICATION FOR EDUCATORS

Currently in the public school system, education concerning the environment and, in particular, awareness of wetlands has been lacking. Yet it is vitally important. Environmental education is academic in nature. "Learning in context makes for better retention, and since the best context is one that is local and meaningful, then education rooted in the local environment is the soundest" (California Department of Education, 2002, p. 5).

Environmental education’s inclusion in the K-12 curriculum is a conduit to all disciplines: physical and social sciences, math, arts, and the humanities. It is, therefore, an ideal curricular methodology for meeting the California’s State standards in content areas.

As discussed in Education and the Environment, connecting to local issues is important (California Department of Education, 2002). One of the major issues in Southern California involves the Salton Sea. Students educated about wetlands learn to respect them as critical habitats and natural water purification systems. When students gain wetland knowledge, it enables them to see their local wetlands, such as the Salton Sea, as an
integral part of the planet’s connected ecosystems. When educators utilize curriculum that students can relate to, the lessons are not forgotten. The information becomes pertinent, meaningful, and internalized.

If we, as educators, develop curriculum that enables students to take pride and ownership in their local environment, the students will remember the lessons. These lessons assist students in forming a respect for their environment, formulating decisions, and taking responsible actions towards saving the wetlands. Ultimately, it is hoped that these students will become informed voters making responsible choices to sustain the environment.

Students should not only be aware of their environment or its issues. Students also need to develop a life-long love for their home environment, indeed the planet. A teacher needs to provide a wide range of environmental based hands-on experiences to supply opportunities to develop this kind of passionate awareness. Steven Gould reminded us (in Orr, 1994, p. 45) that, “We cannot win this battle to save our species and environments without forging an emotional bond between ourselves and nature as we will not fight to save what we do not love.”
Research based information has suggested that when students have a positive environmental experience they develop a higher internal "locus of control" (Volk, 1993, p. 57). Thus, students become better able to deal with environmental issues facing the community as they apply classroom acquired knowledge to real-world issues.

The sustainability of our planet’s ecosystem is the ultimate goal of any environmental education project. That goal will be achieved in this project by introducing environmental knowledge and awareness, developing critical thinking skills, and demonstrating positive attitudes and action toward environmental problems and issues in a familiar and local setting.

The Salton Sea curriculum guide can be used by educators to teach thousands of students the wonders of wetlands and the respect to which they are entitled.
APPENDIX A

TEACHER BACKGROUND INFORMATION
The Salton Sea And Other California Wetlands

Wetlands can generally be described as transitional areas between land and deepwater habitats. California has several different kinds of wetlands, and they can be found in almost every habitat from forests to deserts. Some are maintained by saltwater, others by freshwater.

The value of wetlands is often unappreciated. Wetlands cleanse the environment, sponge up excess water, strain trash and silt, filter impurities, oxygenate and add nutrients to the water, provide a nursery for young wildlife, act as bed and breakfast to millions of migrating birds. Wetlands in the United States provide critical habitat for more than 150 kinds of birds and 200 kinds of fish. Approximately one-third of all endangered plant and animal species depend upon wetlands for survival (University of Redlands Institute, p. 130).

Two hundred years ago, there were in excess of 220 million acres of wetlands. The amount has dwindled to approximately 100 million acres today (Vileisis, p. 63).

Here is a collection of wetland facts that may surprise the reader:

- The first state in the United States to develop water quality standards for wetlands was Wisconsin (Vileisis, p. 4).

- The Canaan Valley of West Virginia has the largest wetland complex in the central Appalachian Mountains (Vileisis, p. 230).

- In the mid-1800s Florida received more acreage under Swamp Land Acts than any other state with 20 million acres. Louisiana was second with 9.5 million acres (Vileisis, p. 74).

- Arkansas has lost more inland acres of wetlands than any other inland state (Vileisis, p. 131).

- Alaska has more wetland acres than all of the other 49 states combined (Vileisis, p. 43).
In the 1800s in California there were about 450,000 acres of wetland habitat. By the year 2000, the calculated loss of wetlands was 91%, or about 410,000 acres (Vileisis, p. 85), leaving 40,000 acres.

Water sources for wetlands are surface and ground water. According to the Coachella Valley Water District (CVWD), the "designated wetland" for Coachella Valley is the Whitewater River/storm water channel that collects water from storms, surface runoff and farm drainage (CVWD website, 2002). This channel is a combination of constructed channel in a natural riverbed. The entire habitat could be carried into the Salton Sea during one of the desert's rare flash floods (CVWD website, 2002).

Small farm-to-sea drains flow directly into the Salton Sea, providing habitat for the federally endangered desert pupfish. In farm-to-sea drains, CVWD removes plants and detritus on one side of the channel at a time. The desert pupfish simply set up housekeeping on the other side of the drain and then move back when their current habitat is cleaned up. This action, disruptive as it seems to us, has provided the best pupfish habitat outside of its natural desert environment (CVWD website, 2002).

The Salton Sea, an important wetland on the Pacific Flyway, is fed by the Coachella Valley designated wetland and about one million acre feet of drain water from Imperial Valley. Each year the tremendous salt load contained in drain water collects in the sea. However, the drain water that has collected dissolved salts from desert soils contributes even more salt to the sea. Without huge storms diluting the salt concentration each year, the 36 mile long lake continues to become more briny. The sea is currently about 25% more salty than the ocean, and is expected to reach critical salinity in the next few years unless help is provided. Solutions to the salinity problem are being explored by several agencies at this time. (Salton Sea Authority, in conjunction with the Federal Government, California State Department of Parks, Coachella Valley Water District, and Imperial Irrigation). The final solution will depend upon adequate funding.
Salton Sea Water

Because water flowing into Salton Sea is rich in nitrogen and phosphorus, it provides a highly productive system. The small microorganisms reproducing in it cause a dark color in the sea. When they die, the process uses up all the oxygen in their area. Fish may also die off from lack of oxygen. The die-off causes a bad odor giving fuel to the rumor that the sea is dying or polluted when actually the die-off process is a normal consequence of any body of water when conditions are right (University of Redlands Institute, year, p. 46-47).

Geothermal Activity

Mud pots at the Salton Sea are one of the most intriguing indications of geothermal activity. Within the boundaries of the Sonny Bono National Wildlife Refuge is an alkali field. Several dozen active mud pot formations can be found there. Some mud pots look like giant anthills. The hills are made of mud that has splattered around the mud pot and then dried.

Carbon dioxide gas rising from sediments thousands of years old causes the bubbling. Calcium carbonate in silt that the Colorado River was eroding from the Grand Canyon makes the gas. The river flowed into the Salton Sea Basin many times in the past building up these silts. Geothermal heat beneath the Salton Sea area causes the calcium carbonate to liberate carbon dioxide gas.

When the pressure of carbon dioxide gas becomes great enough to force a path through the clay to the surface from about 600 feet deep, a mud pot is sometimes formed. As the pressurized gas nears the surface, the shallow groundwater that's in its path is forced up, soaking the surrounding soil creating mud. If there is little or no groundwater, the gas vents through cracks in the surface sometimes causing farmers' fields to bubble when irrigated (University of Redlands Institute, 2002, p. 68).
Kinds Of Wetlands

Inland wetlands are not affected by tides. The water can be either fresh or salt. Inland marshes and wet meadows are covered with shallow water much of the time. Vegetation includes grasses, sedges, bulrushes and cattails. Pintail ducks, bullfrogs, dragonflies, and mosquitoes utilize these low-lying depressions. Forested wetlands can be dry in summer but are usually waterlogged in winter and early spring. Naturally, trees such as black spruce in the north and bald cypress in the south are prevalent. You would expect to see raccoons, opossums and alligators in the southern states, and woodpeckers, wood ducks, moose and snowshoe hares in the northern states. Shrub wetlands are freshwater areas with woody vegetation less than 6 meters high. Black willow is common. Red-winged blackbirds, mice and muskrats inhabit them. The United States has widespread shrub wetlands along rivers and streams, lakes and reservoirs (National Wildlife Federation, year, p. 4).

Estuarine wetlands are affected by tides. The water may be fresh or salt. These wetlands are nursery habitats for many kinds of fishes and birds. In this class are salt marshes vegetated with black ash, pickleweed and spartina. Blue heron, salmon smolt and fiddler crabs make their homes here. On Florida coasts and in Puerto Rico are mangrove swamps. There the stilt-like roots of trees give them stable footing. Egrets and ibis nest here (National Wildlife Federation, year, p. 46).

Other wetlands are shallow-water habitats or unvegetated wetlands that may be in rivers, lakes and reservoirs. Located there are water lilies, duckweed, underwater plants, water striders, beavers, shrews, red-winged blackbirds and osprey (National Wildlife Federation, 2001, p. 33).
APPENDIX B

INTERDISCIPLINARY LESSONS
INTERDISCIPLINARY LESSONS

TABLE OF CONTENTS

Lesson One: WHERE ARE THE WETLANDS? .................................................. 30
Lesson Two: WETLAND SIMILIS ...................................................................... 32
Lesson Three: WETLAND DIAMONTE POETRY .............................................. 38
Lesson Four: AQUATIC PLANT EXAMINATION ............................................ 41
Lesson Five: WETLAND BIOSPHERE .............................................................. 48
Lesson Six: MAPPING THE PACIFIC FLYWAY .............................................. 64
Lesson Seven: A POND ENVIRONMENT ......................................................... 72
Lesson Eight: CANADIAN GEESE ON THE PACIFIC FLYWAY ................. 77
Lesson Nine: WETLANDS FOOD CHAIN CARD GAME ............................... 82
Lesson Ten: A MINI FIELD GUIDE ............................................................... 110
Lesson Eleven: WONDERFUL, WATERFUL WETLANDS ............................ 113
Lesson Twelve: HOME, WET HOME ......................................................... 119
Lesson Thirteen: Understanding the concepts of parts per million and parts per billion ........................................................................... 123
Extra: SIMPLE CAPTURE DEVICES FOR WETLAND STUDY INVESTIGATIONS .................................................................. 126
Lesson One
WHERE ARE THE WETLANDS?

Purpose: To introduce and reinforce the geographical locations and types of wetland habitats.

Objectives: Students will identify and locate wetland sites statewide.

Materials:
California Geological Survey maps
Markers
Sticky notes
Journals

Standards Addressed:
History/Social Studies:
4.1 Use of maps and other geographic representations.
4.5 Use of maps, charts, and pictures to describe California communities.
Language Art:
3.0 Reading Comprehension.
3.1 Writing Strategies.
Science:
6e Construct and interpret graphs.

Background: It's estimated that more than 90% of the wetlands in the continental United States have been altered or destroyed. For example, only 30% of Florida's Everglade Wetlands remain. Additional California wetland information can be found in Appendix A.

Procedure:
1. Prior to the lesson, teacher will gather background information about wetlands. Sources include:
   A. Local yellow pages or local commercial dealers that sell California state maps.
   B. Earth Science information centers (ESIC) for earth science information in a variety of formats. 1(800) USA-MAPS.
   C. U.S. Environmental protection agency's wetlands protection hotline. 1(800) 832-7828.
D. U.S. Fish and Wildlife Service and State Department of Natural Resources.
E. Appendix C of this resource guide.

2. Students gather information about functions of wetland found in California.
3. Students locate and label California wetland sites.
4. Students estimate the percentage of functioning wetlands found in California.
5. Students create graphs to display acreage of wetland areas in the state.

Assessment: Student created graphs, journals, and student discussion.

Extension: Students create graphs comparing the percentage of wetlands in California together with the states of Florida, Texas, and Ohio (see background information Appendix A).

After students discover the location of local wetlands they can learn even more by visiting any national wildlife refuge or nature center in their local.
Lesson Two
WETLAND SIMILIS

Purpose: Through identifying and describing the uses for a number of common household objects, students will draw parallels in wetland functions using the word "like." For example, a wetland is like a coffee filter because it filters out the impurities from water.

Objectives: Students will begin to understand the importance of wetland habitats.

Materials:
Sponge..............absorbs excess water caused by runoff, retains moisture
Pillow or bed...a resting place for migratory birds
Eggbeater..........mixes nutrients and oxygen into water
Cradle............provides a nursery that shelters, protects/feeds young wildlife
Strainer...strains silt and debris from water to keep it clean
Coffee filter...filters smaller impurities from water, excess nutrients and toxins
Antacid (tums)...neutralizes toxic substances
Breakfast cereal...provides nutrient-rich foods for wildlife and humans
Soap..............helps cleanse the environment
Picture of a zoo...habitat for diverse wildlife
Picture of resort or hotel...a resting or wintering place for migrating waterfowl
A box to hold all items

Standards Addressed:
Science:
2.6 Students will understand concepts of producer and consumers and the relationships to food chains and food webs.
2.0 Plants and animals meet their needs in different ways.
Language Arts:
1.0 Listening and speaking strategies and responding to oral communication.
2.0 Understanding structural features in informational test.
Background: Wetlands are often unappreciated and yet provide critical benefits to plants, animals, humans, and the environment. At the beginning of these lessons in the section Appendix A, you may read about the importance of wetlands. Many of the books listed in teacher resources discuss about the importance and beauty of wetlands. One way to begin the lesson is by reading aloud Pond Year by Kathryn Lasky. Similes are figures of speech comparing two unlike things that are often introduced by like or as. For example: cheeks like roses or a wetland soaks up water like a sponge.

Procedure:
1. Take out the prepared container and tell students that a “wetland is contained in this box; but the items are similes for real wetland attributes or characteristics.”
2. Give several examples of similes as needed. Divide the class into groups of four or less. Give each group an item from the box and let them know what they have is “like” a wetland in some ways.
3. Spend a few minutes in group discussion before asking them to present their similes. One helpful strategy would be to ask, “what does this item do” to create a greater understanding of how the item can be a simile for a wetland.

Assessment: Informal class discussion, teacher observation, and student journal.

Extension: At various times in the unit you may recall this activity when students begin to look at different plants, animals, and attributes of wetlands.
Extension for older students: Read the Purpose of a Wetland and complete wetlands worksheet.

Adapted from Project WILD Aquatic, "Wetland Mephaphors."
Wetlands are low areas that are soaked with water. They can consist of freshwater or salt water. They can be found on the coast or inland. Wetlands include marshes, swamps, lagoons, bogs, and prairie potholes.

Wetlands are often thought of as soggy pieces of ground that are good for nothing except mosquito breeding. About half million acres per year are destroyed for agricultural use, malls, or housing developments. Since scientists have discovered that wetlands are a very valuable resource, today many people are trying to protect them from further destruction.

Wetlands provide shelter for many different animals including fish, birds, amphibians, reptiles, and mammals. Many of these animals could be left homeless and face extinction without wetlands. Because plants provide good covers, wetlands are a great breeding and nesting ground for animals.

Migratory birds use wetlands for a resting place as they travel back and forth between summer and winter habitats. As these birds follow the same route year after year, they depend on the wetlands their ancestors have used for centuries. Can you imagine what would happen if they were ready to stop and rest for the night and found a mall instead of their wetlands?

The plants growing in a wetland area are an important part of the food web. They provide nutrient-rich food for all the herbivores and omnivores that live there. They, in turn, provide food for the carnivores.

Wetlands help prevent flooding. They provide a place for excess water to spill out and be soaked up like a sponge. In times of heavy rains, wetlands provide a place for the excess water to sit until it can flow out into streams.

These natural sponges act as strainers to sift mud and other debris from the water. They trap sewage waste and silt to settle. The streams that flow out of wetlands are cleaner than the water first arrived there.
Wetlands act as a filter to clean toxins from the water. They help in the decomposition of many harmful substances. The plants in the wetlands help keep nutrient concentrations from reaching toxic levels. In some areas where wetlands have been filled, too many nitrates are entering the water making it unsafe to drink. Because plants produce oxygen in the process of photosynthesis, plants in the wetlands also mix oxygen into the water.

Wetlands are a very valuable resource. Let's do all we can to preserve them.
Wetlands Worksheet

Each picture in the web below represents one of the attributes of the wetlands. On or next to each picture, write a phrase describing the main reason that picture represents a wetland.
Wetlands Vocabulary

absorb
air pockets
algae
aquatic
birds
blackbird
bog
brackish
bulrushes
calm
cattails
clapper rail
cleanse
cool
creek
critical habitat
desert pupfish
dragonfly
ducks
duckweed
edible
egret
emergent
endangered
evolve
feeding
fens
filter
fish
floating
flowing
flyway
food web

fresh
frog
geese
habitats
harvester mouse
hawk
heron
ibis
insects
lake
larvae
Mangrove
marsh
meandering
migrating
mosquito
muddy
muskrat
neutralize
nursery
nutrient
oxygen
pickleweed
pollen
pollutants
pond
raccoon
rail
resting place
river
salt
Salton Sea
shade

shoots
shore
slow moving
spoon
snake
snail
stabilize
still
strain
stream
submerge
sun
swamp
swim
tadpole
tide
toxic
turtle
underwater
wade
water hyacinth
water lettuce
water lily
water strider
water boatman
winding

Keep adding to this list. Try a
wetlands pictionary or wetlands
alphabet book with younger
children to insure their
understanding of wetlands.
Lesson Three:
WETLAND DIAMONTE POETRY

Purpose: Write a diamante poem that will compare streams and ponds.

Objectives: Students will describe the difference between the moving water of a stream and the calm still water of a pond.

Materials:
Diamante writing form (duplicate one per student)
Pencils
Reference and literature books about wetlands
Word list

Standards Addressed:
Language Arts:
1.0 Written and oral English language identifying verbs, nouns, and adjectives properly in writing or speaking.
Life Science:
3.0 All living things adapt to their environment.

Background: A diamante poem usually indicates change. The beginning and last line of the poem are opposites or contrasting words. The poem shows gradual change from the first line to the last line as it forms the shape of a diamond. When beginning this lesson, the poem should be written as a group project with a model on the board. Review the pond river characteristics using books such as: Pond and River by Steve Parker.
Procedure:

1. Model example on the board:

<table>
<thead>
<tr>
<th>Stream</th>
<th>Tadpole</th>
</tr>
</thead>
<tbody>
<tr>
<td>clear, narrow, sparkling, bubbling, meandering, habitat, purifier, home, calm, comforting, slowing, nourishing, green, muddy, pond</td>
<td>newborn, tiny, eating, growing, changing, swimmer, gills, hopper, lungs, croaking, sunning, leaping, spotted, bug-eyed, frog</td>
</tr>
</tbody>
</table>

2.0 Pass out 2 diamante writing forms to each student.

3.0 Give each student a graphic organizer representing proper diamante format. Line 1: one noun
   Line 2: two adjectives
   Line 3: three participles (words ending in -ing)
   Line 4: four nouns
   Line 5: three participles
   Line 6: two adjectives
   Line 7: one noun

4.0 Brainstorm lists of wetland words.

5.0 Write one diamante together. Students will copy that diamante onto one of their forms.

6.0 Students will create their own diamante using the graphic organizer.

7.0 Students will share their work with the class.

Assessment: Student poem, teacher observation, student discussion.

Extension: Use diamante form to create tadpole/frog, wetland/desert, or any of the hundred contrasting animals and plants living within the wetland environment.
Diamonte Writing Form

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---
Lesson Four
AQUATIC PLANT EXAMINATION

Purpose: Students will observe and illustrate leaf and root structures of aquatic plants.

Objectives: Students will recognize that certain adaptations in aquatic plants enable them to survive and float in the water.

Materials:
Class set of magnifiers
Aquatic plant examination worksheet- water hyacinth (duplicate one per student)
Aquatic plant examination worksheet- duckweed (duplicate one per student)
Aquatic plant examination worksheet- water lily (duplicate one per student)
Aquatic plant examination worksheet- water lettuce (duplicate one per student)
Water lettuce
Aquatic plants
Scissors/plastic knife
Pencils/pens
Plastic bowls to hold plants
Paper towels

Standards Addressed:
Life Science:
5.0 All living systems have structure and function.
2.0 All organisms need energy and matter to live and grow.
7.0 Select and use appropriate tools and technology to perform tests, collect and display data.

Background: Duckweed is the only plant too small to cut. It has tiny air pockets called lacunae within the leaf that allows it to float in water. The blossom of the duckweed is one of the tiniest in nature. A water lily leaf is waxy and curls up around the edge so that it can repel water and float.
The stem goes into the mud at the bottom of the pond and it is hollow... again allowing better floatation. Water hyacinths have bulbs that are filled with a white substance that looks like Styrofoam. The air pockets are visible without a magnifier. Water lettuce has graceful leaves that funnel off water. The leaves have a very fuzzy covering on them that repels water.

*Note: All plants in this activity are commonly found at nurseries or pet stores. Grouping students will cut down on the number of plants needed for this activity. The uncut plants may be observed and saved in a small aquarium for several days if there is a good light source available.

Procedure:
1. Group students around tables.
2. Pass out student work sheets for plant observations.
3. Begin duckweed observation by reading the text box on their worksheet.
4. Students should observe plant first and then move to using magnifiers.
5. Students will begin the water lily observation by reading the text box on their worksheet.
6. Students will then observe and illustrate the water lily.
7. Students will carefully cut across the stem of the water lily with a plastic knife or scissors.
8. Students will record their observations.
9. Student will begin the water hyacinth observation by reading the test box on their worksheet.
10. Students will begin observing the water hyacinth and record/illustrate their information.
11. Student will carefully cut across the bulb and record their findings.
12. Students will begin the water lettuce observation by reading the text box on their worksheet.
13. Students will observe, record, and illustrate their plant information.
14. Students will cut across the base of the water lettuce leaf and record their findings.

Assessment: Student worksheets, teacher-student discussions.
Extension: Students will research and find their own wetland plant to observe, record, and illustrate information.
Duckweed is a very tiny plant that is found floating on the water's surface. It lives in fresh water all around the world. The roots provide a place for very small animals to hide. This plant is very important in the food chain because ducks love to eat it.

Today's questions: How did duckweed get its name? Does it look different if you observe it with a magnifying glass? What scientific instruments are needed to cut and view the internal structures of duckweed?

Look at this plant. Draw it in the boxes below.

\[\text{leaf} \quad \text{root}\]

Look at this plant using a magnifying glass. Draw what you see in the boxes below.

\[\text{leaf} \quad \text{root}\]

Name: ___________________________
Date: ___________________________
Water hyacinth is a free-floating flowering plant that spreads rapidly. It can clog rivers, canals and ditches in short order. The plants can be used in water treatment facilities to remove toxins and screen heavy metals from the water. They are then harvested and mulched for reuse as a soil amendment.

Today's questions: What is inside the water hyacinth leaf? Is the surface of the leaf smooth or rough? When you cut across the bulb of the water hyacinth, what do you see inside? What manufactured item have you seen that looks like the inside of the bulb? How does this help the water hyacinth to float?

Look at this plant. Draw it in the boxes below.

- Leaf
- Root/bulb

Look at this plant using the magnifying glass. Draw what you see in the boxes below. Carefully cut across the bulb with your plastic knife or scissors.

- Leaf
- Bulb
- Cross section

Name: ________________________________
AQUATIC PLANT EXAMINATION WORKSHEET
Water lily

Water lilies remain closed during the morning, open towards noon, close again towards evening and sink slightly in the water. Some of the largest leaves of any plant belong to the Amazonian water lily with a single leaf more than five feet across.

Today's questions: How does a water lily leaf stay on the surface? Is the surface of the leaf smooth or rough? Does the leaf look the same on the top and the bottom? What is inside the stem that may help the plant float in the water?

Look at this plant. Draw it in the boxes below.

Look at this plant using the magnifying glass. Draw what you see in the boxes below. Carefully cut across the stem of the water lily with a plastic knife or scissors.

Name: _________________________
Date: _________________________
AQUATIC PLANT EXAMINATION WORKSHEET
Water lettuce

Water lettuce is a free-floating plant. It covers a large area quickly. The growth of water lettuce is so dense and compact that it looks like solid ground. It prefers still or slow moving water in which to grow. Sometimes leaves grow ten inches across.

Today's questions: Does the shape of water lettuce leaves help the plant to float? How would you describe the feel of the leaf? What is inside the leaf that helps it float? What else about the leaf helps it float?

Look at this plant. Draw it in the boxes below.

![Leaf and Root Diagram]

Look at this plant using the magnifying glass. Draw what you see in the boxes below. Carefully cut across the base of the water lettuce leaf with your plastic knife or scissors.

![Leaf, Root, and Cross-section Diagram]

Name: ____________________________
Lesson Five

WETLAND BIOSPHERE

Purpose: Students will make paper creatures and a plastic-sheeting biosphere. They will next install the paper creatures inside the biosphere and utilize the space for listening to stories, reading, and individual wetland study.

Objectives: Students will appreciate the creatures living in an underwater environment by exploring a make-believe wetland.

Materials:
For Creatures:
Scissors
Markers
Glitter
2 paper plates
Plastic
Turtles
Glue sticks/glue
*creature and plan pages on colored paper

For Biosphere:
2 packages clear plastic sheeting: 3 or 4 mil thick, 12' x 25' or 10' x 25'
1 or 2 rolls of clear mailing tape 2" wide, more rolls shorten the time
Large box fan
Scissors

Standards Addressed:
Science:
3.0 Adaptation in physical structure or behavior may improve an organism's chance for survival.
2.0 Plants and animals have structures for respiration, digestion, waste disposal, and transport of materials.

Background: This "air room" was first shown to this author at the California Science Teachers Association conference in San Jose, 1998, during a class presented by Maureen Allen, Irvine Unified School District.
Make the creatures first and then build up to the idea that they need a place to reside. This activity may be continued for several weeks if space is available for the biosphere. Use the biosphere as a reward for students where they can go and learn about wetlands.

Procedure:
1. Begin by constructing biosphere.
2. Unfold plastic sheeting completely to 12' x 25' single layer.
3. Unfold and lay the second piece of plastic sheeting over the first, matching edges and corners.
4. Tape the corners in place to prevent sliding.
5. Have students tape the two long sides and one short side, in the following manner:
   a) Cut or tear a piece of mailing tape 1' long.
   b) Place the tape under the two layers of plastic sheeting, sticky side up.
   c) Fold the tape up and over the top layer.
   d) Overlay each piece of tape 1" to prevent leaks.
6. On the remaining short side, tape from each corner towards the center. Leave a 2' section in the center without tape to insert the box fan.
7. Tape the fan in place and turn it on medium or high to allow environment to fill. Check for leaks and re-tape as needed.
8. While inflated make the door. Place a 5' piece of tape down the middle of one long side. Lay another 5' piece next to the first piece. Cut an opening between the two pieces of tape. Reinforce the top and bottom with tape to prevent tearing.
9. When the biosphere is complete, place the creatures on top and on the sides using mailing tape to keep all parts fastened securely. The fish can be mounted, forming schools, by adding a string to the top of each one and then taping the strings to the top of the biosphere. *Patterns for all the underwater animals are provided.

Assessment: Biosphere and student constructed creatures.
Extension: Discuss the food chain and food web with regard to the importance of wetlands in the world. Students will write a journal entry about an animal's perspective of life in the biosphere.
Curl tips of the lily with a pencil, then glue smaller flower on top of larger. Glue completed flower onto lily pad.
Water Lily Pad

Sketch several water lily pads on the roof of the birdhouse to create areas of shade within the underwater environment. Twist matching green crepe paper into long strands, attach to the center.
Water Boatman
a pond insect

Water boatman gets its name from the way the legs move through the water... as if rowing a boat.

Cut out both parts and glue wrong sides together.
Frog Tongue
Color red or pink and curl around a pencil.
Glue in frog's mouth.
Frog Back

Fit frog back onto frog legs by gluing only around the edge of the back. This gives a 3-D look.

Color eyes yellow or glue on plastic eyes
Turtle Back

This circle is glued on the underside of a paper plate to form the turtle's back.

The two paper plates are glued right sides together forming the complete shell
The Plastron
or underside

The plastron or underside of a turtle shell is glued on the underside of a second paper plate.
Glue legs, head and tail to inside of plastron before joining paper plates together.

The top and bottom of the head are glued wrong sides together around the edges for a 3-D look.
1. Cut out two fish halves and two fins A and B.
2. Glue on the little fins.
3. Cut out the gut of the pupfish. Then cut out parts 1, 2 and 3.
4. Glue parts 1, 2 and 3 to the gut.
5. Turn fish half "B" over and glue gut to wrong side of fish. BE SURE THE FISH IS RIGHT SIDE UP.
6. Glue fish together on the top fin. DO NOT GLUE ANY OTHER PART OF FISH IF YOU WANT TO SEE INSIDE.
CORNUCOPIA SNAIL
Cut out all pieces

Snail's body

Place this edge against the fold on the shell and glue.

Glue B on top of A matching stars.
The snail's internal organs should be inside the shell. The snail's head and foot should come outside of the shell through the opening that has been cut.
Rosy Boa Snake

Place back sides together and glue.
Internal organs

Did you notice what the snake had for lunch?
Lesson Six
MAPPING THE PACIFIC FLYWAY

Purpose: Students will begin to understand the importance of California wetlands in the annual migration. Migratory birds fly north and south each year. Students will understand that certain birds including Canadian Geese are banded, and why.

Objectives: Students will work in small groups (minimum of 2) to trace the migration of Canadian Geese on the Pacific Flyway using a map and the bird band provided in this guide.

Materials:
Class set of worksheets: Why Band Birds
Class set of maps of the Pacific Flyway
Colored markers: 4 colors per student pair/groups
Two pages of banded report tags cut into 38 strips and placed in zip-lock plastic sandwich bags: one for every small group

Standard Addressed:
Social Studies:
3.1 Describe physical and human geography.
3.1.1 Identify geographical features found in local regions.
Language Arts:
2.1 Reading Comprehension: understand how text features make information accessible and usable.
2.5 Distinguish facts, supported inferences and opinions in text.

Background: Wetlands serve as places to rest and feed. There must be a series of wetland habitats a day's flight apart so that birds can migrate all the way from the Arctic Circle to Mexico. Crowded or disappearing wetlands would mean food shortage, disease, intense competition and death for many birds.
Procedure:

**Note:** These are replicas of bands used by scientists in the fields. The actual bird bands included date and place of banding and this information is not included on the majority of bird bands in this exercise.

**Note:** Briefly discuss why we would want to know information about banding.

Take a few minutes to familiarize the students with the map about the Pacific Flyway.

1. Read Why Band Birds.
2. Have students break into small groups.
3. Teacher directions given to group on how to fill in map key boxes with colors provided.
4. Students will pick one band tag from zip-lock bag and read aloud to rest of group.
5. Students will look at map key boxes and determine which box fits information read aloud on band tag.
6. Students will use appropriate color to place a dot on map where band tag was located/found.
7. If band includes information on where banding occurred, then place a "B" (for banding) on the proper place on the map using the appropriate color to match date also on band.
8. Continue until all the band tags have been taken from the zip-lock bag and mapped using the appropriate colors.

Assessment: The process just completed is the actual process used by scientists to figure out the routes of migratory birds. Students will first orally answer these questions: Why would geese want to migrate south for the winter? What are some of their destinations? Where do Canadian Geese rest during their long migration? What might be the effect on migratory birds when wetlands are lost to development or drained for agriculture? What will happen when the Salton Sea becomes too salty for fish? Is the Salton Sea part of the Pacific Flyway? Next the students will mark their maps showing banded bird tags. Finally, students will write a journal entry telling about their geese's journey.

Extension: Students will study the migratory flight pattern of geese on the East Coast.
Why band birds?

History of bird banding

Birds were banded during the Roman Empire to identify the king’s falcons. Modern bird banding began when Hans Christian Mortensen, a schoolteacher in Denmark, put metal bands on a number of different kinds of birds’ legs. These bands told his name and address. As these banded birds began to appear in many places in Europe, other persons contacted him and became interested in the idea of marking and studying bird behavior.

The idea caught on in American. In 1909 some people in the United States formed a group they called the "American Banding Association". During World War I banding lagged. Biologists working for the national wildlife services in Canada and the United States felt that the work of the banding association was so important that they offered to take over the work. Since 1920 the banding of migratory birds has been under the joint direction of the federal governments of the two countries.

According to the U.S. Fish and Wildlife Service more than a million birds are banded every year.

Banding birds has shown behaviors of individual birds as well as the species or group to which the birds belongs.

Life span: It was found that Canada geese live to be 20 years or more.

Migration routes: When banded birds are captured, released alive and recaptured or observed, the routes they followed can be reconstructed. Canada geese have been followed from nesting in the North to their southern wintering ground.

Life cycle: Not only can we learn how old a particular bird is, but we can also watch to see how long family groups live together. We can learn at what age the young choose mates and begin families of their own.

Waterfowl are banded each year during specific time periods at their breeding grounds and wintering areas. Bands that hunters encounter and return are a primary source of data obtained from banding. Other information comes from organizations such as the Audubon Society that hold regular bird counts. Birds as large as Canada geese can have large bands on their necks that can be read through binoculars. The Bird Banding Laboratory receives more than 65,000 reports each year. Information is used to calculate survival, monitor migration and determine harvest rates and distribution of many waterfowl populations.
<table>
<thead>
<tr>
<th>Event</th>
<th>Location</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goose caught by hand in southern Alberta, Canada.</td>
<td></td>
<td>August 16, 1997</td>
</tr>
<tr>
<td>Neck-collared goose observed by a family hiking in southwestern Montana.</td>
<td></td>
<td>November 28, 1997</td>
</tr>
<tr>
<td>Goose shot by hunter in Alberta, Canada.</td>
<td></td>
<td>August 16, 1998</td>
</tr>
<tr>
<td>Band number of goose read from a distance by observer on Vancouver Island, British Columbia.</td>
<td></td>
<td>July 9, 1998</td>
</tr>
<tr>
<td>Hunter reports band from central Oregon.</td>
<td></td>
<td>December 30, 1998</td>
</tr>
<tr>
<td>Goose in southern Oregon caught by junior high school students after it was weakened by a severe storm.</td>
<td></td>
<td>November 15, 1997</td>
</tr>
<tr>
<td>Goose found dead by campers in central Utah.</td>
<td></td>
<td>November 11, 1997</td>
</tr>
<tr>
<td>Goose band sent in from Alberta, Canada with no information about recovery or cause of death.</td>
<td></td>
<td>August 4, 1998</td>
</tr>
<tr>
<td>Hunter reports goose that was shot by his hunting party in eastern Idaho.</td>
<td></td>
<td>October 13, 1997</td>
</tr>
<tr>
<td>Goose banded in northern California was identified by neck collar and reported from northern Montana by resident.</td>
<td></td>
<td>May 19, 1998</td>
</tr>
<tr>
<td>Skeleton of banded goose found and reported from central Nevada.</td>
<td></td>
<td>September 30, 1998</td>
</tr>
<tr>
<td>Goose recaptured almost a year later in the same place as banded in northern Oregon.</td>
<td></td>
<td>October 8, 1998</td>
</tr>
<tr>
<td>Goose banded in Utah killed by a hunter in Idaho.</td>
<td></td>
<td>October 31, 1997</td>
</tr>
<tr>
<td>Dead goose found near borders of Nevada, California and Arizona.</td>
<td></td>
<td>January 13, 1998</td>
</tr>
<tr>
<td>Goose carcass found on outskirts of San Diego, California.</td>
<td></td>
<td>February 2, 1998</td>
</tr>
<tr>
<td>Goose found injured in northwestern Nevada.</td>
<td></td>
<td>May 13, 1998</td>
</tr>
<tr>
<td>Banded goose captured live near Lake Tahoe, California.</td>
<td></td>
<td>August 29, 1998</td>
</tr>
<tr>
<td>Live goose captured by naturalist on northern coast of British Columbia.</td>
<td></td>
<td>August 18, 1998</td>
</tr>
<tr>
<td>Banded goose observed in Arctic Circle by volunteer on a scientific research trip.</td>
<td></td>
<td>July 17, 1998</td>
</tr>
</tbody>
</table>

Goose found after being hit by a vehicle on the central coast of British Columbia. September 26, 1997.


Goose recaptured by another bander in southern Northwest Territories on July 4, 1998.

Banded goose captured live by campers, coastal Northwest Territories, April 9, 1998.

Two geese banded on the same day in 1984 found dead near the central Oregon/Idaho border. March 30, 1999.


Goose found dead by back packers near a small lake in the Sierra Mountains of California. October 9, 1998.

Goose shot over the border of Baja Mexico and band turned in January 1998.

Goose living at the Salton Sea dies of old age. Banded carcass found February 1999.


Band number of goose read from a distance by naturalist in northern Yukon, Canada. August 1, 1998.

Banded goose accidentally injured and killed while being recaptured in banding operation, southwestern Utah, February 14, 1998.


Dead goose found by a family in central Alberta, Canada. May 1, 1998.

Band number of goose observed by bird watching group at south end of the Salton Sea. October 31, 1998.


Banded goose captured and released at Sonny Bono Wildlife Refuge at south end of Salton Sea. May 19, 1999.
Lesson Seven
A POND ENVIRONMENT

Purpose: Students will cut and place various animals and plants on their own worksheet representing a pond environment in both a pre-test and post-test format.

Objective: Students will demonstrate a gained knowledge of a wetland environment.

Materials:
Animal, plant and pond worksheet: one per student
Glue
Scissors

Standards Addressed:
Science:
2A All organisms need energy and matter to live and grow.
3A Living organisms depend on one another and their environment for survival.
3C Adaptations in physical structure or behavior may improve an organisms chance for survival.

Language Arts:
1.0 Listening and Speaking strategies.
1.1 Writing Applications and Word Analysis.

Background: Starting at the bottom of a muddy pond, aquatic plants may be found living and decomposing. Open water can contain fish, frogs, turtles, migrating ducks and any number of creatures. The top of the pond is capped with surface film. Some insects walk on the water supported by surface tension. Floating plants are partially supported by surface tension as well as by specific adaptations. It is helpful during the beginning of the wetland unit to discuss where the various plants and creatures live. A pond environment will be useful as a pre and post test of student knowledge.
Procedure:
1. Cut apart plant and animal square worksheet.
2. Discuss and demonstrate to students where plant and animal squares might be placed on the pond worksheet (encourage students to use logic and past experiences to make their decisions about where to place the animals and plants).
3. Paste remaining animal and plant squares on pond worksheet.
4. Save the pre-test for a comparison and present this activity again towards the end of this unit.

Scoring Rubric:
Placement of this pond activity is:
Shore: cattails, pickle-weed, marsh hawk, raccoon, harvester mouse, snake.
Surface Film: mosquito, larvae, dragonfly, nymph, duckweed, water lettuce, mosquito, dragonfly.
Open Water: great blue heron, frog, muskrat, mosquito fish, tadpole, algae.
Bottom: snail, clapper rail, (or open water).

Assessment: Teacher observation, informal oral discussion, and student created worksheet.

Extension: After completing various lessons from the unit, students will repeat the test and compare their progress by studying their pre and post activities.
Pond Regions

Shore

Surface film

Open water

Muddy bottom
<table>
<thead>
<tr>
<th>Harvester Mouse</th>
<th>Mosquito Larvae</th>
<th>Dragonfly Nymph</th>
<th>Algae</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pickleweed</td>
<td>Tadpole</td>
<td>Mosquito</td>
<td>Great Blue Heron</td>
</tr>
<tr>
<td>Muskrat</td>
<td>Mosquito Fish</td>
<td>Duckweed</td>
<td>Water Lettuce</td>
</tr>
<tr>
<td>Clapper Rail</td>
<td>Raccoon</td>
<td>Snail</td>
<td>Cattail</td>
</tr>
<tr>
<td>Frog</td>
<td>Marsh Hawk</td>
<td>Snake</td>
<td>Dragonfly</td>
</tr>
</tbody>
</table>
MURAL BACKGROUND
Lesson Eight:  
CANADIAN GEESE ON THE PACIFIC FLYWAY

Purpose: To reinforce flight patterns and behavior of Canadian Geese.

Objective: Students will study how Canadian Geese fly in formation as they migrate.

Materials:
Brown paper grocery bags: one per student
Five sets of card stock patterns of geese
Glue sticks
Black and brown markers
Bird banding page
Scissors
Photocopied markings page: one per student

Standards Addressed:
Language Arts:
3.0 Reading Comprehension.
2.0 Structural features in informational text.
Science:
5A Organisms in ecosystems exchange energy and nutrients among themselves and their environment.
Social Studies:
4.1 Students demonstrate an understanding of physical and human geographic features that define places and regions in California.

Background: Along with the Pacific Flyway board game and mapping the Pacific Flyway lesson, this activity helps complete this section on Canadian Geese and their migration.

Procedure:

1. Read bird banding page together.
2. Pass out grocery bags and patterns to each student.
3. Trace the body and the wings on the bag and cut out.
4. Flip on wing patter over to the back of the grocery bag so that both wings can be place on the body with elbows facing forward.
5. Cut out photocopied marking page, placing and gluing neckband around the goose's neck.
6. Color the markings on photocopied page according to the directions and paste them on the paper bag goose body.
7. Fold the paper bag wings along the dotted lines as shown on the pattern.
8. Place glue only on the small section of the fold.
9. Glue one wing behind the body and one wing in front, keeping them aligned with elbows of the wings facing forward.
Assessment: Student created goose and informal discussion.

Extension: Place your lead goose up on the wall so that students can complete and place their goose in a V formation behind the leader. Discuss migration and the countless volunteers who donate their time and effort to band geese for the benefit of their species.
Canada goose

Cut out all parts after coloring and glue onto paper bag goose following the markings on the pattern.

Color black or trace on black paper.

Color solid brown or trace on brown paper.

Write your name in the box.
Brown paper bag goose pattern

Trace this pattern onto card stock as many times as necessary for a classroom pattern set and cut out. Old folders work well.

To make the goose, trace the wings and body onto brown paper grocery bags or brown butcher paper. Turn the wing over to trace the second wing. Cut out and glue details onto the brown paper goose after coloring correctly. Mount finished geese on the wall or by their wings from the ceiling in a "V".
Fold under on dotted line.
Lesson Nine:
WETLANDS FOOD CHAIN CARD GAME

Purpose: Student will appreciate the inter-dependency of living organisms in a food web by playing a game.

Objective: Students will identify wetland creatures in a food chain.

Materials:
Colored cardstock playing card worksheets
Reference pages
Scissors

Standards Addressed:
Science:
2A All plants are primary sources of matter and energy entering most food chains.
2B Producers and consumers are related in food chains and food webs and compete with each other for resources in an ecosystem.

Language Arts:
2.0 Reading Comprehension, non-fictional text.
1.2 Vocabulary development.
2.2 Making informational presentations.

Social Studies:
4.1 Students demonstrate an understanding of physical and human geographical features that define places and regions in California.
3.1 Students describe physical and human geography using maps, tables, photographs and charts to organize information about people, places and environments in spatial context.

Background: The creatures in this food chain game are introduced on large reference pages with facts about each one on the opposite pages. Students will play the game in groups of two or more. These games are played the same manner as "Go Fish" or "Concentration." There should be 64 cards in each deck. Teacher will reproduce and laminate reference pages to keep together with the game.
Teacher Preparation:
1. Using two master pages of animal cards, teacher will duplicate 4 copies of each card page on to card stock. *Student groups will have a total of 64 cards.
2. Teacher will cut apart cards using the black lines as a guide.
3. Teacher will duplicate directions for each game.

Procedure:
1. Teacher will introduce the wetland food chain and reference page of each creature to the students.
2. Create an oral discussion of a wetland food chain.
3. Student will be grouped to play the game.
4. Teacher will distribute cards and directions to each group.

Directions For:

BUILD YOUR FOOD CHAIN GAME

Shuffle cards and deal them one at a time. If two are playing, each player gets seven cards; if more are playing each player gets five cards. The rest of the deck is placed face down in the middle of the table and becomes the "stock". The point is for players to collect books, that is, four cards of one plant or animal.

The player to the left of the dealer begins by asking another player (his choice) for cards that are needed. For instance if two raccoon cards are in the hand, he/she might say, "Mike, give me all your raccoons." If Mike has any raccoon cards, he must hand them over. If he has none, he says, "build your own food chain!" The player must then draw the top card from the "stock." If the player should happen to draw a raccoon, or if it was obtained from Mike, he/she continues until he/she is no longer successful in getting a desired card.

When a player gets four cards of one rank, they are shown to the other players and kept in a book on the table in front of him/her. The winner is the one with the most books at the end of the game when the entire stock is gone.
Teacher Preparation:
1. Duplicate two copies of the playing card pages on to colored card stock.
2. Duplicate directions for wetland concentration to keep with the game.

Procedure:
1. Pass out cards to each group.
2. Distribute reference pages for class discussion on wetland organisms
3. Introduce game directions to the students.

WETLAND CONCENTRATION

Choose eight picture cards from the deck and arrange them face up on a table in two rows. Say the name of each animal or plant as it is placed.

Below the first two rows, arrange the same set of eight cards from the deck into two rows using a different order. Say the name of each plant or animal as it is placed.

Allow students to look carefully at the arrangement of the sixteen cards. Turn all cards face down. Place a small post-it on the backs of the cards with the numbers from 1 to 16.

The game begins when a pair of students or two teams take turns trying to match up the animal and plant cards. As a number is called, the card is turned face up. If the two numbers called are matching pictures, they remain face up; if not, both are placed face down. A point is given for correct matching; another given if the correct name for plant or animal is known. The person or team continues if correct matches are made. Winners are the persons or team with most points.

Assessment: Teacher observation, informal oral discussion.

Extension: Continue to review the names of the wetland food chain creatures and their relationships with one another. Create a mural or big book of wetland habitats.

Adapted from California’s Wonderful Wetlands by Ann Copeland, Coachella Valley Water District.
Build your food chain game

DIRECTIONS CARD

Shuffle cards and deal them one at a time. If two are playing, each player gets seven cards; if more are playing each player gets five cards. The rest of the deck is placed face down in the middle of the table and becomes the "stock". The point is for players to collect books, that is, four cards of one plant or animal.

The player to the left of the dealer begins by asking another player (anyone he/she chooses) for cards that are needed. For instance if two raccoon cards are in the hand, he/she might say, "Mike, give me all your raccoons". If Mike has any raccoon cards he must hand them over. If he has none, he says, "Build your food chain!" The player must then draw the top card from the "stock". If the player should happen to draw a raccoon, or if it was obtained from Mike, he/she continues until no longer successful in getting a desired card.

When a player gets four cards of one rank, they are shown to the other players and kept in a book on the table in front of him/her. The winner is the one with the most books at the end of the game when the entire "stock" is gone.

Wetlands concentration

DIRECTIONS CARD

Choose eight picture cards from the deck and arrange them face up on a table in two rows. Say the name of each animal or plant as it is placed.

Below the first two rows, arrange the same set of eight cards from the deck into two rows using a different order. Say the name of each plant or animal as it is placed.

Allow students to look carefully at the arrangement of the sixteen cards. Turn all cards face down. Place a small post-it on the backs of the cards with the numbers from 1 to 16.

The game begins when a pair of students or two teams take turns trying to match up the animal and plant cards. As a number is called, the card is turned face up. If the two numbers called are matching pictures, they remain face up; if not, both are placed face down. A point is given for correct matching; another given if the correct name for plant or animal are known. The person or team continues if correct matches are made. Winners are the persons or team with most points.
Wetlands food chain

Algae
need sunlight, nutrients and water.
Pickleweed
needs sunlight, nutrients and water.
Mosquitoes
suck blood from mammals and birds.
Mosquito larvae
eat algae
Dragonflies
eat mosquitoes.
Dragonfly nymphs
eat tadpoles and small fish.
Snails
eat algae.
Frogs
eat insects and fish.
Tadpoles
eat larvae.
Mosquito fish
eat mosquito larvae, other small insects and small fish.
Snakes
eat frogs and fish.
Clapper rails
eat insects and snails.
Marsh hawks
eat fish, mice and insects.
Great blue herons
eat frogs and fish.
Harvester mice
eat pickleweed.
Raccoons
eat pickleweed, fish, insects, snails, mice and reptiles.
Algae under a microscope
All algae are plants and need sunlight, nutrients, and water to live. Algae are usually very small but some algae like the sea weeds are much larger. Many animals eat alga. Like other plants it is at the base of the food chain.

Where there is enough sunlight the algae produce oxygen. The animals in the pond use this oxygen to breathe. Sometimes you can see the bubbles of oxygen come to the surface of the water. Photosynthesis works only when there is light. At night or on a very cloudy day the plants do not produce oxygen. They actually use oxygen just as animals do when it is dark.

Water stores the oxygen. Cool water can store more oxygen than warmer water. Some oxygen leaves the water and goes into the atmosphere.

When you see a pond that is very green you know that there are many algae plants in the water. You can not actually see each individual, small alga plant unless you use a microscope. If you were to look at algae with a microscope you would see that different types of algae have different shapes. Some seem to be made of only one cell and shaped as a coin, flat and round. Others resemble a long green string of beads with each bead being an alga cell. Other algae are round and hollow like a soccer ball. These are made of many cells.
Adult mosquito, mosquito larvae and dragonfly nymph
Once a **mosquito** becomes an adult it lives by biting birds and mammals. The insect makes its meal from the blood that it sucks through its tiny, sharp straw-like mouth.

Baby mosquitoes are called larvae. The eggs float on top of the water until they hatch. The **mosquito larvae** then swim away from the egg mass and begin to eat algae.

They rest at the surface with their breathing tubes exposed to the air. If disturbed they move away from the surface and go down to deeper water. The little ones grow larger until they are big enough to change (metamorphose) into adult mosquitoes. Then they climb out of the water and fly away.

Baby **dragonflies** are called nymphs. These small insects eat tadpoles and small fish. They get oxygen from water as they breath with gills. The nymphs have very small legs and do not have wings until they are adults. In order to move around the bottom of the pond they use a form of jet propulsion. Water is taken into their digestive system and then forced out. This sends the baby dragonflies darting away from enemies.

When the **dragonfly nymphs** have grown large enough to change (metamorphose) into adult dragonflies they crawl out of the water, up onto a plant stem. The new exoskeleton dries and hardens. Now the dragonflies are ready to start life out of the water.
Dragonfly
Another name for a **dragonfly** is "mosquito hawk". It is called this because this insect eats many mosquitoes. The dragonfly starts its life as an egg floating on the water. After the egg hatches, the larva swims away and begins to grow. It eats small fish and tadpoles.

When dragonflies become adults they can fly very well. Dragonflies are often seen resting on plants, but they are very fast. They can fly at speeds greater than 25 miles per hour.

Dragonflies have been on earth for many years. The fossil of one primitive dragonfly ancestor shows a wingspan of 30 inches.

Dragonflies have compound eyes made up of six-sided facets. There are 28,000 such facets making up some dragonflies' eyes.

Insects cannot close their eyes; they sleep with them open. Their vision is believed to be sharp only to a distance of two or three feet. However, compound eyes should be particularly expert at detecting movement, since an object in motion registers impressions on different facets one after the other. This special sight could help dragonflies catch the mosquitoes that they eat.
Adult frog, tadpole and snails
Frogs are amphibians. They begin their lives as eggs that are laid in the water. After the eggs hatch, they are called tadpoles. These little tadpoles eat a lot of algae before they grow up to be frogs. A newly hatched tadpole does not have legs. The hind legs grow first and then the front legs emerge. Slowly the tail is absorbed. By the time that it metamorphoses (changes) into a frog it will no longer be using gills and will be coming to the surface to breath air. After the frog becomes an adult it still spends a lot of time swimming in the water, sitting on the bank, or hiding among plants. Frogs eat insects and fish.

If you are ever near a wetland you may be serenaded with a frog chorus. Male frogs use this music to attract a mate. The frog's mouth and nostrils are kept tightly closed when it calls. Air is driven back and forth between mouth and lungs with inflated throat sacs acting as resonating chambers. This works the same as the Scottish bag pipes.

Snails spend their lives in the water. In the summer you can find gelatinous egg masses on almost every leaf, twig, and stone in shallow water. They have shells when they hatch from their eggs. These hard shells go with them everywhere that the snails go. Different types of snails have different shaped shells.

A snails sticks its "foot" out when it wants to move. In order to eat, a snail uses its mouth to scrape algae off of rocks and plants. Although aquatic snails look like land snails, they are unique in their ability to live and breathe under water.
Pickleweed and harvester mouse
**Pickleweed** needs sunlight, nutrients, and water to live. This plant got its name because it tastes salty, a little like deli pickles. Some people like its taste so much that in some countries pickleweed is served as a vegetable.

Pickleweed lives in wetlands all over the world. It can live in very salty places as well as in places that do not have much salt. Pickleweed is sometimes called glasswort. This is because it was used during olden times in making glass. "Wort" is an old word for plant.

**Harvester mice** are sometimes called harvest mice. If you have ever had a hamster you know that mice and their relatives are often more active in the night than they are during the day. Harvester mice are especially active on moonlit nights.

They build their nests of stiff grass that they find growing around the wetlands. The nest is lined with softer grass, soft feathers, or downy hair. Sometimes the nest is located in a clump of vegetation above the ground. The mice sometimes simply borrow an old birds nest.

These mice feed mainly on seeds and plants. Pickleweed is one of their favorites. These mice are very unusual as they can drink sea water. Owls, snakes and many mammals prey upon harvester mice.
Marsh hawk
The **marsh hawk** is a graceful bird of prey. It is found throughout the world but only in wetland areas. Some people call this bird the Northern Harrier. American marsh hawks migrate far south into Mexico and as far north as Alaska. Although some marsh hawks are year around inhabitants of Southern California wetlands, many more of these birds are seen in the winter. Males migrate later in the fall and earlier in the spring than females and immature birds.

These birds generally perch low rather than on tall poles as some hawks prefer to do. Sometimes marsh hawks fly close to the ground with their wings upraised as they search for mice, frogs, fish, snakes, and other prey. Other times they soar high above the wetlands. Soaring is usually done during migration or for courtship displays.

Male and female marsh hawks are easy to tell apart. Male marsh hawks have grayish backs and mostly white bellies, with strong black wing tips. Female marsh hawks have brown backs and whitish bellies. These are large birds but not as large as great blue herons. A marsh hawk might be twenty-three inches long and have a wing spread of four feet.
Raccoon, mosquito fish
**Raccoons** are cute, furry animals. They can live in many habitats from the wetlands to the city. In town they eat what they find in garbage cans but in the wetland they have to search for their food. Raccoons like to eat a varied diet. They eat snakes, fish, insects, snails, mice, and pickleweed.

Raccoons are native only to the Americas. They are the most active at night. That is when they leave their homes or dens and go out to hunt.

A litter of four or five baby raccoons are usually born in the spring. The babies weigh only about 2 oz. They do not open their eyes until they are three weeks old. At first the mother raccoon carries them about by the nape of the neck, as a cat carries kittens. The babies are not allowed to leave the den for a couple of months.

**Mosquito fish** are small, live-bearing fish. This means that mosquito fish do not lay eggs. They got their name because their favorite food is mosquito larvae. Actually they eat any small insect larvae, and baby fish.

These fish are often introduced into ponds, ditches, and other waterways so that they will help control the mosquito population.
Snake
Snakes are reptiles. Reptiles have scales, breathe air, usually lay shelled eggs and depend on outside sources such as the air temperature for their body heat. Reptiles are influenced by the weather. They are most active when the weather is warm.

Snakes eat frogs and fish. They do not chew or tear their food but swallow it whole. Snakes do not need to eat every day. The total intake of food by snakes is small in amount compared with the food necessary for birds and mammals.

The eggs of snakes are usually flexible. That means that the shell is not hard like the shell of a chicken. Most snakes lay between eight and fifteen eggs. When a baby snake hatches it must make a slit in the egg so that it can crawl out. This slit is made with an egg tooth. An egg tooth is a tiny hard sharp triangle on the edge of the baby's mouth. This tooth drops off soon after birth.

Snakes do not have legs so they move by sliding their bodies from side to side. The scales on the underside keep it from slithering backward. Snakes do not have ears and can hear only through their skull bones. These bones transmit vibrations from the ground. Snakes can't blink or close their eyes. Their eyes are covered and protected by glassy transparent scales.
Great blue heron and chick
Great blue herons are very large birds. These herons live in marshy areas all over the United States and in much of Canada.

Great blue herons stand almost four feet tall and have wing spreads of six feet. These birds wade in wetlands looking for frogs, fish, small reptiles, shellfish, or large insects. Their stilt-like legs carry the heron high above the water. Their long necks permit them to reach down to scoop up a morsel from below the surface. The feet of the heron have very long toes. There are small webs between these long toes. These specialized feet keep it from sinking into the mud.

Herons make their nests out of grasses that are found in the wetlands. Both parents take turns sitting on the eggs. Heron eggs are a favorite food of raccoon and some snakes. Young birds in the nest may require a daily food intake equal to or more than their weight. Baby birds must have many meals each day.

Over the years people have coined a number of different terms to describe birds in groups. Among these are a siege of herons, a gaggle of geese, and a cast of hawks. Herons are seen in large groups (or in a large siege) only during breeding season. The rest of the year herons prefer to hunt alone.
Clapper rail
Clapper rails are common but are rarely seen. They are very shy birds and live in tall grasses. The birds can slip into these plants very quietly and hide. They seem to melt into the marsh grasses without so much as a ripple. Some people think these birds can do this because they are thin. Have you ever heard the expression "you're as thin as a rail?"

The rails' disappearing act also works in water. They can dive under the water and swim away quickly. They can swim this fast because they can use their wings underwater. Clapper rails eat insects and snails.

Another name for clapper rail is marsh hen. They are closely related to a bird that is easily seen in the marsh. This relative is called a coot. Coots are sometimes called mud hens.

Both the male and female clapper rails build the nest. They make their nests by scraping out a saucer shaped indentation on bare ground or flattened vegetation. They usually chose a spot above damp ground so that their nest doesn't get flooded. The nest is lined with fine grass. After eight or nine cream colored eggs are laid, the nest is covered with a mat of grass a few inches deep. The entry to the nest is through a small hole in this canopy of grass. The mother bird sits on the eggs for about seventeen days before the eggs hatch. The baby birds will learn to fly when they are about a month old.
Another name for a dragonfly is “mosquito hawk”. It is called this because this insect eats many mosquitoes. The dragonfly starts its life as an egg floating on the water. After the egg hatches, the larva swims away and begins to grow. It eats small fish and tadpoles.

When dragonflies become adults they can fly very well. Dragonflies are often seen resting on plants, but they are very fast. They can fly at speeds greater than 25 miles per hour.

Dragonflies have been on earth for many years. The fossil of one primitive dragonfly ancestor shows a wingspan of 30 inches.

Dragonflies have compound eyes made up of six-sided facets. There are 28,000 such facets making up some dragonflies’ eyes.

Insects cannot close their eyes; they sleep with them open. Their vision is believed to be sharp only to a distance of two or three feet. However, compound eyes should be particularly expert at detecting movement, since an object in motion registers impressions on different facets one after the other. This special sight could help dragonflies catch the mosquitoes that they eat.
Lesson Ten:
A MINI FIELD GUIDE

Purpose: Students will learn names and gain knowledge of commonly characteristically animals associated with the biosphere in this resource guide.

Objective: Students will identify plants and animals in a wetland environment.

Materials:
Field guide worksheet
Scissors
8x11 sheets of white paper: one per student

Standards Addressed:
Social Studies:
4.1 Students demonstrate an understanding of physical and human geographic features that define place and regions in California.
2.2 Students demonstrate map skills by describing absolute and relative locations of people, places and environments.

Language Arts:
1.0 Word Analysis and Vocabulary Development.
2.0 Reading Comprehension of informational material.
3.0 Research and Technology skills.

Science
6A Scientific progress made by asking meaningful questions and conducting careful investigations.

Background: This short project works well before making paper creatures for biosphere. The animals in this lesson are generic and may be adapted to various locations in California. Younger students benefit if step one is done before receiving the mini guide paper. The author has done this activity with students as young as second grade.

Procedure:
1. Fold the worksheet of animals in half cross wise so the text appears on the outside.
2. Fold up ends separately to form a W shape.
3. Fold in half again to form a small rectangle shape. Then unfold this last fold and fold it again back the opposite way making hard creases on each fold.
4. Fold back to step one, so the page is folded only in half.
5. Place folded page flat on the table with folded edge closest to you and cut along the middle of the fold through both sides to the center as seen in the drawing.
6. Unfold the page entirely, refold the page in half lengthwise. Stand the page up on the table so the pictures appear right side up.
7. The part cut with scissors should be open and form a diamond. Grab the two outside panels and push inward until a four paneled door is formed.
8. Fold all pages together to form a small book. Make sure the cover page is on the front. Make hard creases on all its sides and then your project is completed.

Assessment: Student mini guide-books, informal oral discussion.

Extension: Create blank guide-books for students to use on local field studies.
Mini Field Guide of Wetland Creatures

marsh hawk
frog
harvester mouse
raccoon
Musk Rat

Great Blue Heron

Snake

Clapper Rail
Lesson Eleven:
WONDERFUL, WATERFUL WETLANDS

Objectives: The students will describe the functions of a wetland and observe a demonstration using a wetland model.

Materials:
Glass lasagna pan (or clear plastic sweater box)
Modeling clay
Strip of indoor-outdoor carpet (3" (7.5 cm) wide by width of pan)
Measuring cups
Clear water
Muddy water
Pictures of different kinds of wetlands
Construction paper (1 sheet per student)
Student sheet (included)
Teacher sheet

Standards Addressed:
History/Social Studies:
4.1 Use of maps and other geographic representations.
4.5 Use of maps, charts, and pictures to describe California communities.
Language Art:
3.0 Reading Comprehension.
3.1 Writing Strategies.
Science:
3 Living organisms depend on one another and on their environment for survival; ecosystems can be characterized by non living living components.
3a Adaptation in physical structure or behavior may improve an organisms chance for survival.
2 Plants and animals meet their needs in different ways.
2a Different types of animals and plants inhabit the earth.

Background: Wetlands are areas of land that are wet at least part of the year. They are often transition zones between dry land and open water. Some wetlands are consistently covered with water, while others are flooded only at certain times. All wetlands have water-soaked soil at some
time which affects the kinds of plants and animals that live there. Wetlands can be found in all parts of the world and are classified into many types. There are freshwater and saltwater wetlands. Some examples of freshwater wetlands are swamps, marshes, bogs, pasture ponds, and prairie potholes. Saltwater wetlands include mangrove swamps and saltwater marshes. Estuaries are bodies of water found where rivers empty into the sea; they include saltwater wetlands. The water in estuaries is a mixture of fresh and salt (sea) water; and its salinity usually varies with its distance from the open ocean.

Terms:

bog: a plant community that develops and grows in permanently water-logged areas having a thick layer of peat (partly decayed organic material).

estuary: (EHS· choo· ehr· ee) the bay area of a river, where it widens to meet the ocean, that receives and mixes with tidal salt water.

mangrove swamps: saltwater wetlands located in tropical and sub-tropical areas and dominated by woody shrubs called mangroves.

marshes: wet areas sometimes found at the edges of ponds, lakes, and rivers, usually treeless and having plants with soft stems, grasses, rushes, and sedges.

pocosin: (peh· Koh· sehn) an inland swamp of the southeastern United States coastal plain.

prairie potholes: wetlands occurring in the North Central United States and South Central Canada that provide nesting grounds for waterfowl.

salinity: saltiness, or the amount of salt; in water or other liquids.

saltwater marshes: wetlands found in coastal areas; the transition zones between land and sea (the tide rises and falls in these marshes twice each day).
swamps: land (with saturated soils for some of the year) supporting a natural vegetation of mostly trees and shrubs.

Advance Preparation:

1. Spread a sloping layer of plasticene modeling clay in half of the lasagna pan or sweater box to represent land. Leave the other half of the pan empty to represent a lake or other body of water. Shape the clay so that it gradually slopes down to the body of water (see the diagram below). Smooth the clay along the sides of the pan to seal the edges.

2. Cut a piece of indoor-outdoor carpeting that will completely fill the width of the pan along the side of the clay (see diagram). This will represent the wetland. Do not place the carpet into the model yet.

3. Use the enlargement capability of your school’s photocopier to make copies of the small drawings on the teacher sheet “Wetland Pictures”. Also, check you school or public library for books from which to get pictures. Travel or outdoor sports magazines are also good sources.
Procedure:
1. Without giving the students a definition of wetlands, ask them to tell you what they think wetlands are. List their answers on the chalkboard and derive a definition from their answers.

2. Explain what a wetland is, comparing your definition with the students' answers. Stress that all wetlands have water-soaked soil, are covered with water at least part of the year, and support specialized plants that are adapted to life in wet conditions.

3. Show students pictures of different kinds of wetlands and explain what they are. (NOTE: Use enlargements of those provided on the teacher sheet. If possible, get additional pictures from books or magazines.) Allow the students to compare the pictures (and definitions) to find the characteristics listed above.

4. Tell the students that until recently, most people did not consider wetlands to be important to our environment. Over the years, scientists have discovered that wetlands perform several vital functions for our environment.

5. Show the students the wetland model and explain what it and what the clay represent. Explain to them that wetlands are complex systems and that no one yet knows exactly how they work. We do know, however, that there are three important functions wetlands perform: you will use your simplified model of a wetland to demonstrate these functions. (NOTE: For older students, you may adapt this procedure for cooperative groups. You may have them conduct it as an experiment.)

6. Begin the demonstration by pouring clear water slowly on the clay (this can represent rainfall, melting snow, drainage, etc.). Ask the students to describe what happens.

7. Drain the water back into the original container. Show the students the carpeting and, as you place it in the model, explain that it represents a wetland. Ask the students to predict what will happen when you pour the water onto the clay again.

8. Pour the same amount of water on the model again. Be sure to perform this exactly as you did before. Let the students describe what happens. (The water will drain more slowly into the body of water because it is now hindered by the wetland.) Explain that most
wetlands are shallow basins that collect water and slow its rate of flow. Using the model, explain how this helps reduce flooding and prevent the deposition or eroded soil (sediment) in bodies of water.

List these functions on the board.

9. Pour out the clear water. Leaving the carpet in place, pour some muddy water onto the clay. Ask the students to compare the water that flows through the wetland and into the body of water with the water left in the jar. Ask what happened. (Students should conclude that part of the soil in the muddy water was trapped by the wetland and that wetlands can act as a filter for sediment and some pollutants.) Add this function to the list on the board.

10. Remove the carpeting and repeat step 9. Ask the students why all the soil particles end up in the body of water. The students should infer that without the wetland to act as a filter, most of the soil (and perhaps pollutants) flow directly into the body of water.

Assessment: Refer to students back to the list of wetlands characteristics written on the board. Review the definition of a wetland and the functions demonstrated. Ask questions such as "Why are wetlands important?" and "How can they help us?" Tell the students that wetlands are also important because they improve water quality, reduce erosion, provide habitats for a wide variety of wildlife and plants, help to store floodwaters, help us replenish groundwater during dry times, and provide recreation for many people to fish and hunt. They are also an important source of products such as seafood, rice, and timber.

Give each student a piece of construction paper. Have the students fold the paper in half, lengthwise. On one side of the fold, have them draw a picture of one of the demonstrations, and on the other side have them write a complete sentence telling what wetland function they have illustrated. For older students, you might want to reinforce paragraph writing by having them write a topic sentence about the important functions of wetlands and supporting sentences telling the functions that were demonstrated in procedure # 4.

Extension: If possible, take a field trip to a wetland near you. Include activities such as listing several types of plants or animals the students
encountered, sounds they heard, and other observations. Back at school, extend these activities by having the students classify the types of animals, write a story or report about one of the animals, or illustrate one of the animals.

Divide the students into teams and provide each team with materials to create its own wetlands model. Have each team use measuring cups (NOTE: Canning jars with measurement marks work well for this) to measure an amount of water and add it to the model with carpet; then measure the amount of water that collects in the body of water. Have them repeat the experiment without the carpet, again measuring the water that runs off. They should repeat each step five times. Have them chart the measurements and compare them.

Acquire map(s) of wetlands in your area from the U.S. Geological Survey Earth/Science Information Center at 1-800-USA-MAPS (or the Canadian equivalent). Have the students research the type or types of wetlands most common in your area and report on the types of plants and animals found there.

To reinforce wetlands vocabulary, give each student a copy of the student sheet "Wonderful, Waterful Wetlands". Have the students find and circle the listed terms in the word search puzzle. A key is provided on the accompanying teacher sheet.

Adapted from "Wading into Wetlands," Nature Scope.
Lesson Twelve:
HOME, WET HOME

Objective: The student will identify components of a community, research an animal of a wetland community, and illustrate an animal of a wetland community.

Materials:
Between Cattails by Terry Tempest Williams (or other similar book)
Butcher paper
White paper (1 sheet per student)
Crayons
Scissors
Glue or paste
Teacher sheet (included)

Standards Addressed:
Social Studies:
4.1 Students demonstrate an understanding of physical and human geographic features that define place and regions in California.

Language Arts:
1.0 Listening and speaking strategies.
2.0 Reading Comprehension of informational material.
3.0 Research and Technology skills.

Science:
4.0 Scientific progress is made by asking meaningful questions and conducting careful investigations.
2.0 Animals and plants have predictable life cycles.
5.0 Organisms in an ecosystem exchange energy and nutrients among themselves and the environment.

Background: All wetlands provide unique habitats for many plants and animals. Wetlands are busy communities with many specialized populations, all of which are uniquely adapted to living in an aquatic or semi-aquatic environment. Populations of wetlands creatures are displaced by the destruction of wetlands. Without their wet homes, these water-loving organisms cannot survive. Perhaps the first step to help make sure that
we do not displace too many wetlands creatures is to be aware of their
great numbers and variety and to appreciate the roles they each play in
their wetland communities.

Terms

community: a related group of plants or animals living in a specific region
under relatively similar conditions.

habitat: the area where an organism lives; the habitat supplies food,
water, shelter, and space to live.

organism: a living being; plants and animals.

population: organisms of the same kind that live in the same place.

Advance Preparation:

1. This lesson takes a "whole language" approach; it begins with the
   reading of a book. Obtain "Between Cattails" or one of the other
   books from the wetland habitat list in the Resource section. Read
   the book and make a chart listing the animal populations mentioned
   in the book.

2. Using white butcher paper, prepare a mural background appropriate
   for the habitat in the book you choose. A suggested background for
   a marsh community to be used with "Between Cattails" can be found
   on the teacher sheet, "Mural Background" (included). (NOTE: you
   may want to involve students in this part.)

Procedure:

1. Explain to the students what an organism and an organism's habitat
   are. Ask the students if they are organisms. (yes) Have them
   identify their habitats.

2. Define the terms population and community for the students. Ask
   them to identify their communities and the populations of plants
   and animals (and other organisms such as fungi and microbes) which
   are part of their communities.
3. Tell the students you are going to read them a story about wetland community. Ask them to listen for the populations which make up the community as you read.

4. Read "Between Cattails" or one of the other books from the list in the resources section. Share the pictures as you read.

5. After reading display the populations chart you made and discuss the various organisms and populations which make up the wetland community (NOTE: population charts will vary depending upon the resource used.)

6. Tell the students they are going to briefly research an animal from the community and then create a mural of the community.

7. Assign each student an animal. (NOTE: Depending on the size of the class, you may want to assign the same animal to more than one student.) Using books in the classroom library, allow the students to look up their animals and briefly familiarize themselves with them. Ask them to look for one interesting fact about their animals. (You might require more of older students.)

8. Give each student a sheet of white paper. Allow fifteen minutes for each student to draw, color, and cut out a picture of his/her animal. Be sure to stress to the students that their pictures need to be outlined with a dark crayon to facilitate cutting and to help it show up on the mural. While the students work, lay out the mural background on a large table or the floor.

9. As the students finish, have them paste their animals to the mural background.

Assessment:
After the mural is completed, review the components of a community. Then allow time for each student to point out his/her animal, tell what it is, and share the interesting fact with the class.

As the students share with the class, jot down the names of the animals and the interesting facts. (NOTE: You might tape record the students as they share.) Later, on a chart tablet, record the names of the animals along with the interesting facts.
Extension:
Explain to the students that plant and animal populations in the wetlands are threatened when wetlands are destroyed (for example, when people fill in wetlands to build things on them). Have each student design a bumper sticker or t-shirt showing his/her wetland animal and a slogan for protection of the animal and its habitat.

Divide the students into cooperative learning groups. Have them classify the populations of the mural community into mammals, reptiles, amphibians, insects, and birds. Make a bar graph showing the number of populations in each group.

Have the students extend their research about their animals, then write a story telling about a day in the life of the animals.

Borrow the book "Small Habitats" (by Lilo Hess), from the library. It includes instructions for constructing a semi-aquatic or marshland terrarium. Gather the specified materials and allow the students to help you plan and construct the terrarium. Create a "Terrarium Maintenance Crew" of students on your helper list and give them the responsibility of caring for the terrarium.

Obtain a copy of the play "Willa in the Wetlands," from the Wetlands Division of the U. S. Environmental Protection Agency and let your class present it. This play tells about a wetlands community; a Teacher's Guide is available upon request.
Lesson Thirteen:
Understanding the concepts of parts per million and parts per billion

Purpose: The purpose of this exercise is for teachers to demonstrate what is meant by these ppm and ppb concepts and how chemicals may be present in concentrations, which are dangerously high and may not be detectable by sight, taste, or smell. A wetlands chemicals in the water are conculation level of ppm, ppb must be within reason limit in order for life to be maintained.

Objective: Students will understand the concepts of parts per million and parts per billion.

Materials:
Solid coffee stirrers or toothpicks
Medicine dropper
White paper
Clean water for rinsing the medicine dropper
Clean water for diluting
Set of 9 small clear plastic or glass containers (watch glasses or plastic spoons)
Red food coloring to represent contamination

Standards Addresses:
Math:
1.0 Students Choose and use appropriate units of measurement tools to quantify the properties of objects.
1.2 Students understand and compute the volumes of area of simple objects.
Science:
6 Scientific progress is made by asking meaningful questions.

Background: Concentrations of such materials as chemical pollutants and minerals are frequently expressed in units of “parts per million” (ppm) or “parts per billion” (ppb). For example, chemical fertilizers contain nitrates, a chemical which can be dangerous to pregnant women even in
quantities as small as ten parts per million. Trichloroethylene (TCE), a common solvent, is an even more dangerous chemical than nitrate. In the 1970’s and early 1980’s, Trichloroethylene in the well water of Woburn allegedly caused a higher than normal incidence of cancer among Woburn’s children.

To better understand how small a ppm or ppb is, assign your students the task of expressing either unit in terms of familiar experiences. For example:
A. The average distance to the moon is 239,000 miles or about 1.2 billion feet. So if you jump only 1.2 feet in the air, you have jumped one part per billion of the distance to the moon. So how long would it take you to jump a billion times?
B. The average distance to the sun is 93,000,000 miles. When you drive 9 miles you have driven one part per million of the distance to the sun.
C. If a record sells one million copies, then a single record is one part per million.

The following list contains the maximum contamination levels of some toxic or carcinogenic chemicals as listed by the Environmental Protection Agency (EPA).

<table>
<thead>
<tr>
<th>Substance</th>
<th>Concentration (ppb)</th>
<th>Substance</th>
<th>Concentration (ppb)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arsenic</td>
<td>50</td>
<td>Nitrate</td>
<td>10,000</td>
</tr>
<tr>
<td>Barium</td>
<td>1,000</td>
<td>Selenium</td>
<td>10</td>
</tr>
<tr>
<td>Cadmium</td>
<td>10</td>
<td>Endrin</td>
<td>0.2</td>
</tr>
<tr>
<td>Lead</td>
<td>50</td>
<td>Lindane</td>
<td>4</td>
</tr>
<tr>
<td>Mercury</td>
<td>2</td>
<td>2,4-D herbicide</td>
<td>100</td>
</tr>
</tbody>
</table>

Procedure:
1. Line up the clear containers side by side and place a piece of white paper under each one. From left to right, number the paper from 1 to 9 in front of containers.
2. Place ten drops of food coloring into container #1. (Food dye as it comes from the bottle is already a dilution of about one part in ten (1:10).)
3. Place one drop of food coloring into container #2.
4. Add 9 drops of clean water to container #2 and stir the solution. Rinse the medicine dropper.
5. Use the medicine dropper to transfer one drop of the solution from container #2 into container #3. Add nine drops of clean water and stir the solution. Again, rinse the dropper with clean water.
6. Transfer 1 drop of the solution in container #3 to container #4. Add 9 drops of water and stir. Rinse the dropper with clean water.
7. Continue the above process until all nine containers contain successively more diluted solutions.

Assessment: Student discussion/ questions

Student Discussion Questions:
1. The expression parts per billion is usually abbreviated ____ (ppb) ____.
2. List some possible reasons why our senses alone may not be sufficient for detecting pollutants. (Pollutants may be colorless, odorless, or tasteless even in high concentrations. In low concentrations chemicals which do have taste, odor, or color may be so dilute that our senses cannot detect them.)

NOTE: Food dye as it comes from the bottle is a 1:10 dilution. This information is important because it allows students to number the containers in such a way as to see the derivation of scientific notation. The first container is 10^1, the second 10^2, and on through 10^9.
Extra
SIMPLE CAPTURE DEVICES FOR WETLAND STUDY INVESTIGATIONS

A Pond Scope (for underwater observations)

Materials:
3 same size juice cans
1 rubber band
Wide waterproof tape
Heavy duty plastic wrap

Directions:
Take the bottoms off 3 empty juice cans. Fasten them into one long tube using strong waterproof tape to connect cans. Cover one end of the tube with heavy plastic wrap. Secure tightly with rubber band. Submerge the end with the plastic wrap into water. Make and record any observations.

The Hand Dip Net (for critters on top of the water)

Materials:
Wire coat hanger
Nylon stocking or cheese cloth
Needle and thread

Directions:
Bend coat hanger into a ring about 3 to 3 1/2 inches in diameter. Stitch a nylon stocking or piece of cheesecloth on to the ring. Trim to fit. Fasten the ring to a stick or pole.

A Flat Bottom Net (for underwater collection)

Materials:
Wire coat hanger
String or wire
Cheese cloth
Old broom handle
Needle and thread
Directions:
Bend another coat hanger into a D shaped frame 1 foot wide. Stitch a net bag made from cheese cloth onto the ring. Fasten the hanger to a broom handle.

Kitchen Materials To Take To The Wetland (for observing and collecting)

Materials:
Large Zip Lock plastic bags
Soup ladle
Kitchen sieve
Solo plastic cups
Plastic buckets
Magnifying glasses
Pen
Paper
EXTRA
WORDSEARCHES

Wetland Plants

ALGAE  PICKLEWEED
BULRUSHES  POLLEN
CATTAILS  SALTON SEA
CRITICAL HABITAT  SHOOTS
DUCKWEED  SHORE
EMERGENT  SUBMERGED
FLOATING  SUN
FOOD WEB  WATER HYACINTH
MANGROVE  WATER LETTUCE
NUTRIENTS  WATER LILY
### Wetland Words

<table>
<thead>
<tr>
<th>G</th>
<th>N</th>
<th>I</th>
<th>D</th>
<th>N</th>
<th>I</th>
<th>W</th>
<th>P</th>
<th>L</th>
<th>A</th>
<th>N</th>
<th>T</th>
<th>S</th>
<th>H</th>
<th>T</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>E</td>
<td>G</td>
<td>Y</td>
<td>X</td>
<td>O</td>
<td>D</td>
<td>E</td>
<td>B</td>
<td>R</td>
<td>O</td>
<td>S</td>
<td>B</td>
<td>A</td>
<td>N</td>
</tr>
<tr>
<td>I</td>
<td>G</td>
<td>N</td>
<td>C</td>
<td>D</td>
<td>N</td>
<td>V</td>
<td>R</td>
<td>O</td>
<td>W</td>
<td>D</td>
<td>D</td>
<td>T</td>
<td>E</td>
<td>E</td>
</tr>
<tr>
<td>W</td>
<td>N</td>
<td>O</td>
<td>L</td>
<td>S</td>
<td>L</td>
<td>O</td>
<td>W</td>
<td>M</td>
<td>O</td>
<td>V</td>
<td>I</td>
<td>N</td>
<td>G</td>
<td>G</td>
</tr>
<tr>
<td>O</td>
<td>O</td>
<td>E</td>
<td>H</td>
<td>S</td>
<td>I</td>
<td>K</td>
<td>C</td>
<td>A</td>
<td>R</td>
<td>B</td>
<td>D</td>
<td>O</td>
<td>A</td>
<td>R</td>
</tr>
<tr>
<td>L</td>
<td>P</td>
<td>Z</td>
<td>Z</td>
<td>S</td>
<td>Y</td>
<td>C</td>
<td>C</td>
<td>H</td>
<td>A</td>
<td>A</td>
<td>B</td>
<td>Q</td>
<td>A</td>
<td>E</td>
</tr>
<tr>
<td>F</td>
<td>S</td>
<td>L</td>
<td>K</td>
<td>I</td>
<td>T</td>
<td>A</td>
<td>I</td>
<td>H</td>
<td>N</td>
<td>H</td>
<td>U</td>
<td>E</td>
<td>D</td>
<td>M</td>
</tr>
<tr>
<td>O</td>
<td>T</td>
<td>I</td>
<td>H</td>
<td>E</td>
<td>L</td>
<td>N</td>
<td>L</td>
<td>G</td>
<td>S</td>
<td>A</td>
<td>S</td>
<td>A</td>
<td>R</td>
<td>E</td>
</tr>
<tr>
<td>O</td>
<td>R</td>
<td>B</td>
<td>A</td>
<td>M</td>
<td>E</td>
<td>A</td>
<td>E</td>
<td>E</td>
<td>T</td>
<td>N</td>
<td>H</td>
<td>E</td>
<td>L</td>
<td>Y</td>
</tr>
<tr>
<td>D</td>
<td>A</td>
<td>A</td>
<td>B</td>
<td>A</td>
<td>C</td>
<td>R</td>
<td>R</td>
<td>R</td>
<td>I</td>
<td>O</td>
<td>S</td>
<td>F</td>
<td>L</td>
<td>R</td>
</tr>
<tr>
<td>W</td>
<td>I</td>
<td>T</td>
<td>I</td>
<td>I</td>
<td>E</td>
<td>F</td>
<td>C</td>
<td>T</td>
<td>R</td>
<td>F</td>
<td>I</td>
<td>R</td>
<td>E</td>
<td>E</td>
</tr>
<tr>
<td>E</td>
<td>N</td>
<td>S</td>
<td>T</td>
<td>D</td>
<td>P</td>
<td>O</td>
<td>L</td>
<td>L</td>
<td>U</td>
<td>T</td>
<td>A</td>
<td>N</td>
<td>T</td>
<td>S</td>
</tr>
<tr>
<td>B</td>
<td>V</td>
<td>I</td>
<td>A</td>
<td>E</td>
<td>D</td>
<td>A</td>
<td>W</td>
<td>B</td>
<td>S</td>
<td>E</td>
<td>U</td>
<td>R</td>
<td>L</td>
<td>R</td>
</tr>
<tr>
<td>T</td>
<td>R</td>
<td>Z</td>
<td>T</td>
<td>E</td>
<td>S</td>
<td>N</td>
<td>A</td>
<td>E</td>
<td>L</td>
<td>C</td>
<td>N</td>
<td>N</td>
<td>I</td>
<td>U</td>
</tr>
<tr>
<td>C</td>
<td>B</td>
<td>T</td>
<td>S</td>
<td>M</td>
<td>U</td>
<td>D</td>
<td>D</td>
<td>Y</td>
<td>A</td>
<td>W</td>
<td>Y</td>
<td>L</td>
<td>F</td>
<td>N</td>
</tr>
</tbody>
</table>

- **ABSORB**
- **AQUATIC**
- **BOG**
- **BRACKISH**
- **BUFFER**
- **CALM**
- **CLEANSE**
- **COOL**
- **CREEK**
- **CRITICAL HABITAT**
- **EMERGENT**
- **ENDANGERED**
- **FILTER**
- **FLOWING**

- **FLYWAY**
- **FOODWEB**
- **FRESH**
- **HABITATS**
- **MUDDY**
- **NEUTRALIZE**
- **NURSERY**
- **NUTRIENTS**
- **OXYGEN**
- **PLANTS**
- **POLLUTANTS**
- **SALT**
- **SALTON SEA**
- **SHADE**

- **SLOW MOVING**
- **SPONGE**
- **STABILIZE**
- **STILL**
- **STRAIN**
- **WADE**
- **WINDING**
APPENDIX C

RESOURCE GUIDE
TEACHER REFERENCE BOOKS


LITERATURE FOR PRIMARY LEVEL (GRADES K THROUGH 3)


**LITERATURE FOR ELEMENTARY LEVEL (GRADES 3 THROUGH 5)**


**LITERATURE FOR INTERMEDIATE LEVEL (GRADES 6 THROUGH 8)**


RESOURCES FOR EDUCATORS

Acorn Naturalists
155 El Camino Real
Tustin, CA 92780
(800) 422-8886
www.acornnaturalists.com

AIMS Education Foundation
Water Precious Water (3-6)
Floaters and Sinkers (6-9)
1595 S. Chestnut Ave.
Fresno, CA 93702
Toll-free 1-800-SEE-AIMS
www.aimsedu.org

Aquatic Project WILD & Project WILD
National Office
5555 Morningside
Suite 212
Houston, TX
(713) 570-1936
www.projectwild.org

California Department of Water Resources
P. O. Box 942836
Sacramento, CA 94236
www.watereducation.org

California Foundation For Agriculture In The Classroom
(Ask for teacher resource guide and classroom materials)
1601 Exposition Blvd FB16
Sacramento, CA 95815
www.cfaitc.org
California Science Teachers Association
3800 Watt Ave. #100
Sacramento, CA 95821
www.ca.science.org

Discover Wetlands
Publications Office
Washington State Department of Ecology
P.O. Box 47600
Olympia, WA 98504-7600
www.ccy.wa.gov

Estuarine Habitats, Elementary Teaching Series
Apalachicola National Estuarine Research Reserve
Florida Department of Environmental Protection
350 Carrol Street
East Point, FL 32328

National Geographic Society
Education Services
P. O. Box 98019
Washington, DC 20090-8019
www.nationalgeographic.com

National Audubon Society
950 3rd Avenue
New York, NY 10022
www.audubon.org
National Wildlife Federation
1400 16th Street NW
Washington, DC 20036-2266
Ask for NatureScope Environmental Education Series
The following issues are especially applicable:
75004 - Birds, Birds, Birds
75023 - Amazing Mammals I
75024 - Amazing Mammals II
75025 - Wading Into Wetlands
75045 - Pollution
www.nwf.org

ORCA: Ocean Related Curriculum Activities
Marshes, Estuaries and Wetlands
Discover More Store
Pacific Science Center
200 Second Ave. North
Seattle, WA 98109

Project WET
Culbertson Hall, Montana State University
Bozeman, MT 59717-0057
www.watereducation.org

Sierra Club
Public Affairs Division
730 Polk Street
San Francisco, CA 94109
www.sierraclub.org

The Story of Drinking Water
American Water Works Association
6666 West Quincy Avenue
Denver, CO 80235
Water Education Foundation
717 K Street, Suite 517
Sacramento, CA 95814
www.watereducation.org

Water Education Materials (k-12)
Publications
California State Department of Water Resources
P. O. Box 432
Sacramento, CA 94236-0001
(916) 653-1097

Water Inspectors: Examining H2O, Learning Activities for Youth Groups, Ages 10-15
California Aquatic Science Education Consortium
Human and Community Development
University of California
Davis, CA 951616
(916) 752-8824
www.rain.org

Windows on the Wild
World Wildlife Fund
1250 24th Street, NW
Washington, DC 20037-1175
www.worldwildlife.com

WOW! : Wonder of the Wetlands
Environmental Concern Inc.
Education Department
201 Boundary Lane.
St. Michaels, MD 21633
(410) 745-9620
FIELD TRIP RESOURCE GUIDE SITES

Big Morongo Canyon Preserve
P.O. Box 780
11055 East Drive
Morongo Valley, CA 92256
(760) 363-7190
FAX: (760) 363-1180
www.bigmorongo.org

Bureau of Land Management
California Desert District
P. O. Box 1260
690 W. Garnet Ave.
North Palm Springs, CA 92258
(760) 251-4800
FAX: (760) 251-4899
www.ca.blm.gov

Coachella Valley Preserve
P. O. Box 188
29-200 Thousand Palms Canyon Road
Thousand Palms, CA 92276
(760) 343-1234
www.cablm.gov

Coachella Valley Water District
P. O. Box 1058
Coachella, CA 92236
(760) 398-2651
FAX:(760) 398-3711
www.cvwd.org
Coachella Valley Wild Bird Center
P. O. Box 10160
46-500 Van Buren St.
Indio CA. 92202
(760) 347-2647
FAX: (760) 775-2299
www.pointhappy.com/wildbird

Imperial Irrigation District
Operation Headquarters
333 E. Bariono Blvd.
Mailing: P. O. Box 937
Imperial, CA. 9251
(760) 482-9605 or 1-800-750-2605 ext. 6605
FAX: (760) 482-9611
www.iid.com

Joshua Tree National Park
9800Black Rock Canyon Road
Yucca Valley, CA. 92284
Education office (760) 365-2371
General Info: (760) 367-5500
FAX: (760) 365-3155
www.joshuatree.org

Salton Sea Authority
78-401 Highway 111 Suite T
La Quina, CA. 92253
(760) 564-4888
FAX: (760) 564-5288
www.saltonsea.Ca.gov
Salton Sea State Department Parks and Recreation
100-225 State Park Road
North Shore, CA. 92254
(760) 393-3059
FAX: (760) 393-1338
www.saltonsea.statepark.org

(Salton Sea) Sony Bono National Wildlife Refuge
906 W. Sinclair Road
Calipatria, CA. 92233
(760) 348-5278
www.sfbws.gov/salton

The Living Desert
47-900 Portola Avenue
Palm Desert, CA. 92260
(760) 346-5694
Fax: (760) 568-9685
www.livingdesert.org

(Wister Wildlife Area)
California Fish & Game Imperial Wildlife Area
8700 Davis Road
Niland, CA. 92257
(760) 359-0577
www.saltonsea.ca.gov/birding
ORGANIZATIONS

California Aquatic Science Education Consortium (CASEC)
Graduate School of Education
University of California
Santa Barbara, CA

National Marine Educator's Association P.O. Box 51215
Pacific Grove, CA 92950
Publishes newsletter and Current, The Journal of Marine Education, A
network of teachers, aquarium, museum, and Sea Grant educators.

National Science Teachers Association
1742 Connecticut Ave. NW
Washington, DC 20009
www.nsta.org

NEST (Network For Environmental Science Teachers)
Dr. Darleen Stoner
College of Education
California State University
5500 University Parkway
San Bernardino, CA 92407
www.nest.csusb.edu

The GREEN Project
Global Rivers Environmental Education Network University of Michigan
School of Natural Resources
430 E. University Ave.
Dana Building
Ann Arbor, MI 48109-1115
REFERENCES


