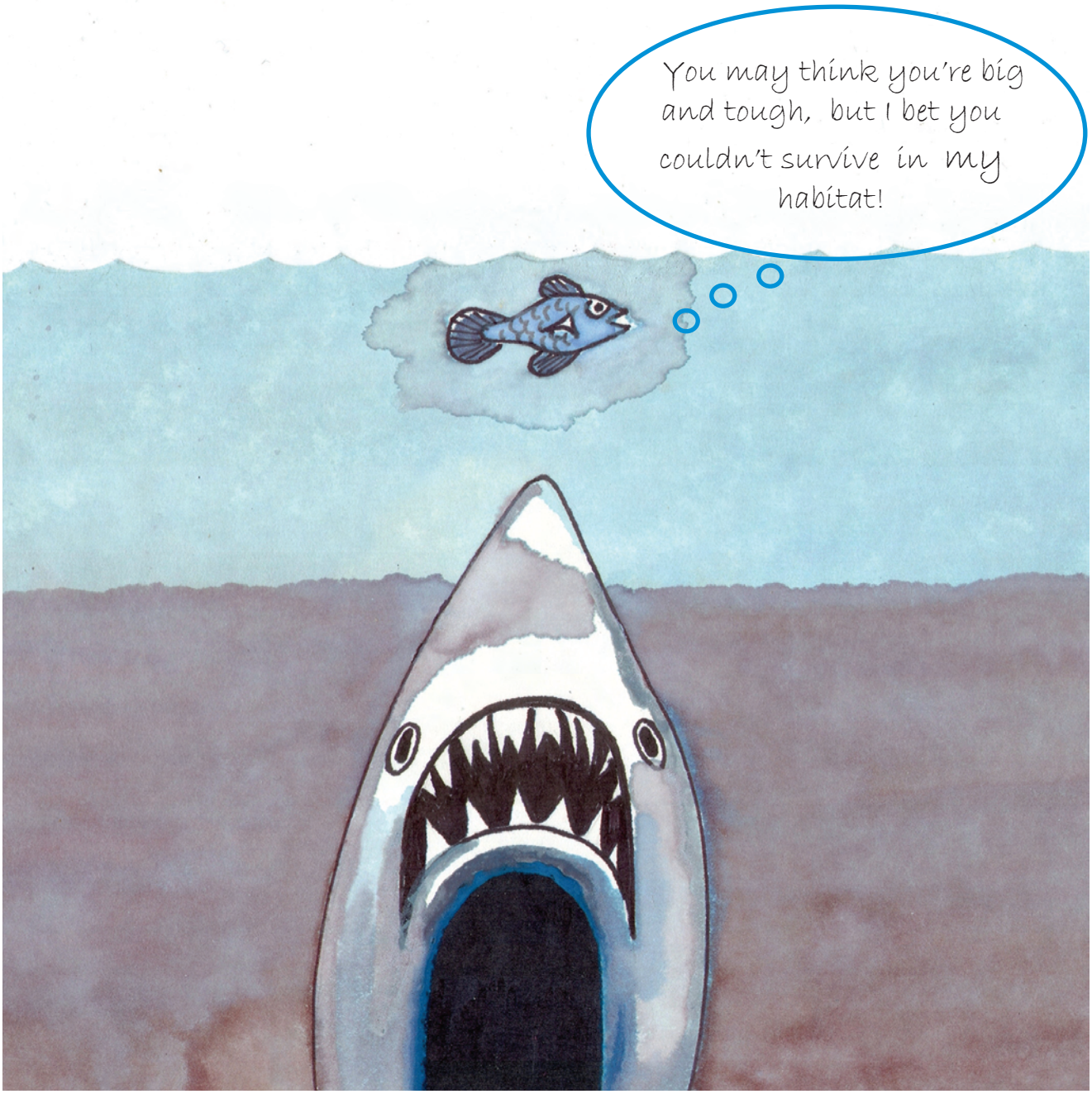
Death Valley
National Park

National Park Service
U.S. Department of the Interior

The World of the Small



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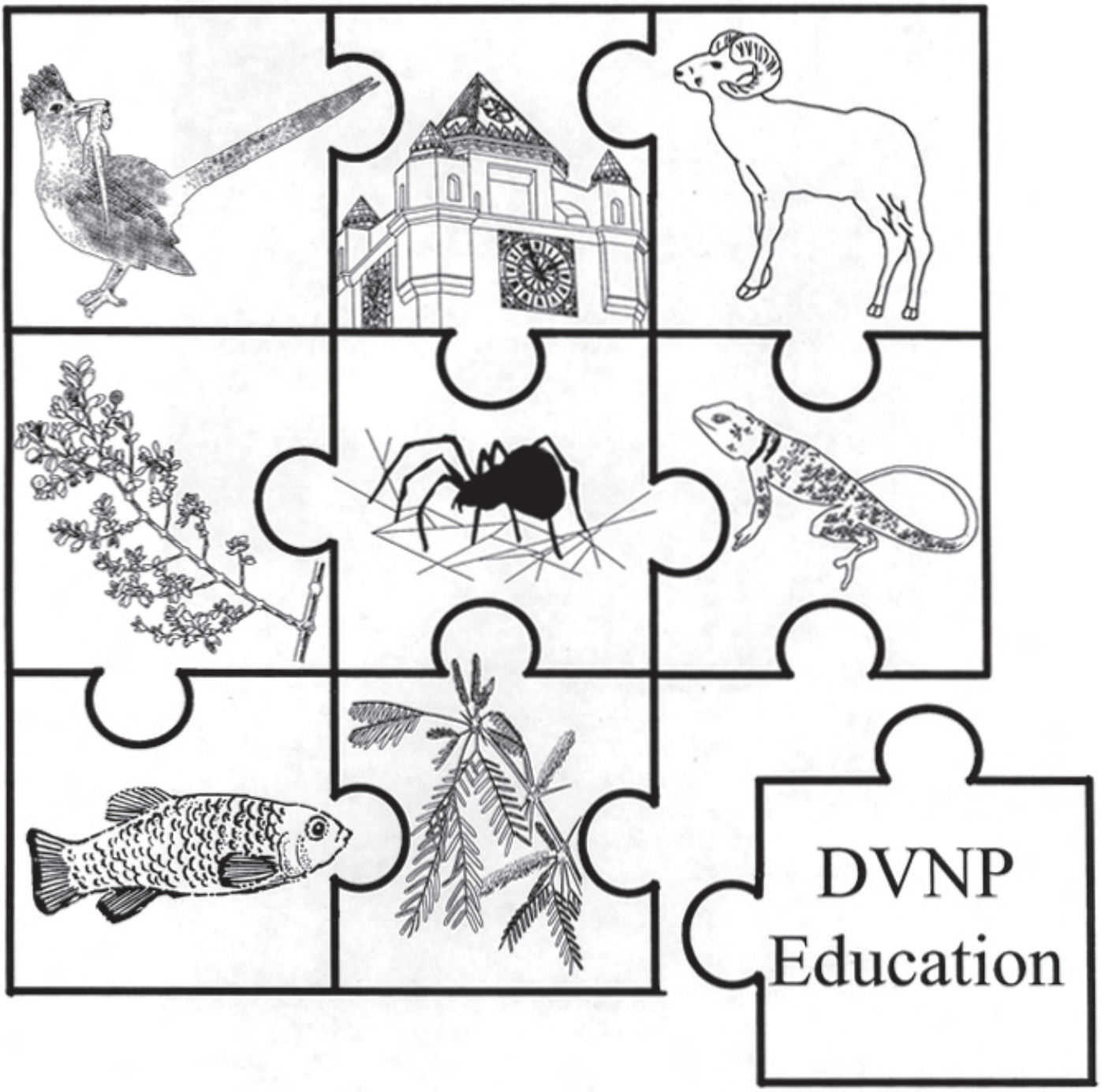
DVNP
Education

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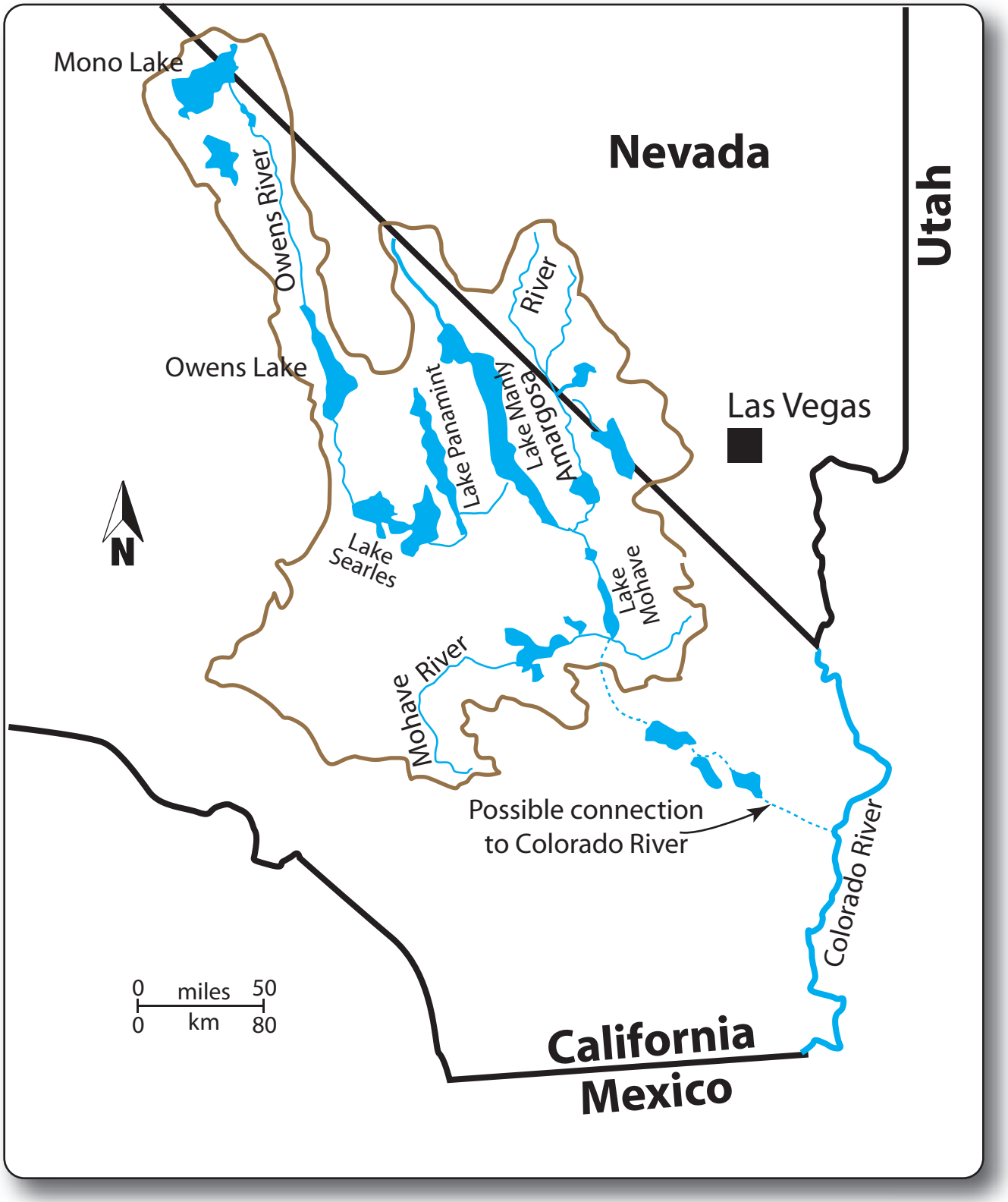
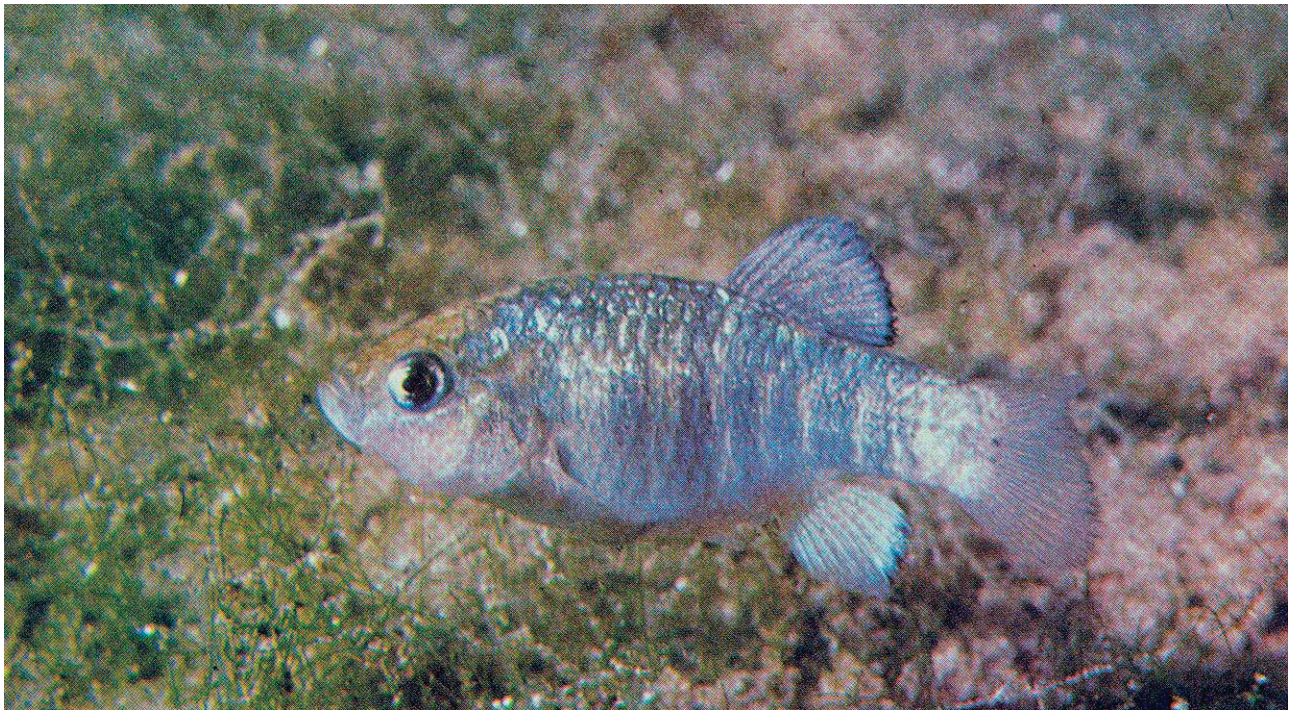


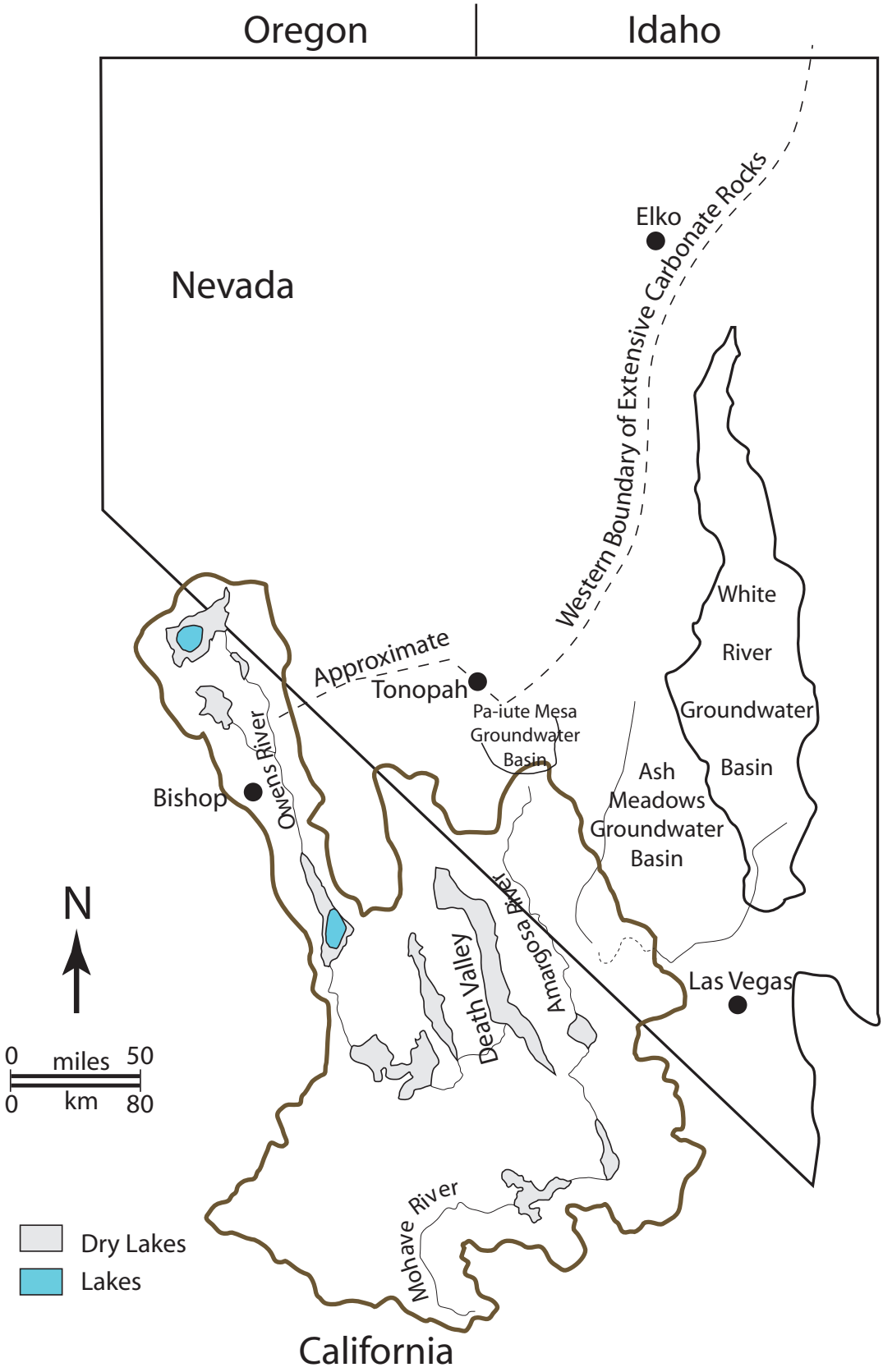
Background for Teachers

Pupfish

Pupfish (Cyprinodon sp.) are tiny fish (1.5-3" long) that live in springs, ponds, marshes, and slow-flowing streams in our California and Nevada deserts. Pupfish can also be found in Texas, New Mexico, Florida, Arizona and even as far south as Mexico. They are even found in coastal estuaries from Virginia along the coastline all the way south to northern South America. The word "pupfish" comes from their playful tail-wagging, and sometimes aggressive, behavior (like watching a puppy that doesn't know its own strength, play with a new toy). Their color varies from a silvery-brown to a silvery-blue. Many species are currently listed as Endangered or Threatened.

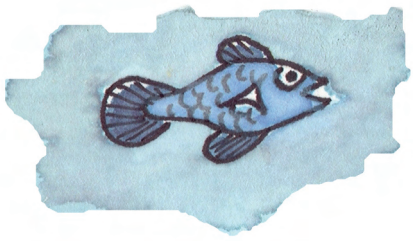


Map of Local Areas



Scientific Classification of Pupfishes

Category – Fish
Kingdom – Analmalia
Phylum – Chordata
Class – Actinopterygii
Super-Class - Osteichthyes
Order - Cyprinodotiformes
Family - Cyprinodontidae -
Killifish (Dutch for "fish of creeks or streams")
Genus – Cyprinodon
Species –
Cyprinodon radiosus (Owens pupfish) Endangered
Cyprinodon salinus salinus (Salt Creek pupfish)
Cyprinodon salinus milleri (Cottonball Marsh pupfish)
- Listed in the State of California as Threatened.
Cyprinodon nevadensis nevadensis (Saratoga Springs pupfish)
Cyprinodon nevadensis armargosae (Amargosa River pupfish)
Cyprinodon nevadensis calidae (Tecopa pupfish) extinct
Cyprinodon nevadensis shoshone (Shoshone pupfish) Thought to be extinct
Cyprinodon nevadensis mionectes (Ash Meadows pupfish) Endangered
Cyprinodon nevadensis pectoralis (Warm Springs pupfish) Endangered
Cyprinodon diabolis (Devil's Hole pupfish) Endangered



What Happened?

Over 15,000 years ago, Death Valley National Park and Ash Meadows National Wildlife Refuge were wet. Very wet! Many of the valleys that are dry today were filled with lakes. The lakes were the habitat of numerous types of small fishes. Each year the lakes collected rain and snow melt from the glacier filled valleys of the Sierra Nevada to the west and smaller mountain ranges to the east. The water was transported to the lakes by three large rivers the Owens, Amargosa, and Mojave. At the end of the "ice age," some 8,000 - 12,000 years ago, there was no more snow melt and rain was captured by distant mountain ranges, the climate had become warmer and drier. The lakes began to evaporate faster than they were filling. The lakes dried up with only small pools or marshes remaining. Long, dry distances gradually isolated the pools, marshes, springs and slow-flowing streams. Today the water that supplies these pools, marshes, and stream flows deep underground, only occasionally rising to the surface to supply these aquatic islands in the desert. Note maps on previous pages.

The fish that occupied these diminishing lakes adapted to the changes. Today more than 20 isolated pupfish populations exist within the Death Valley system. There are eight different types of pupfish with distinctive shapes and markings. (see illustrations) Some desert pupfish can survive in water many times saltier than the ocean or so warm it would make a comfortable bath (the highest temperature tolerated by pupfish is 104 ºF). Pupfish adapted to survive in these desert extremes. Each species of fish is unique and represents a distinctive habitat.

How do they survive?

Many species have adapted to the extreme heat and temperature variations of these Death Valley waters. Early ancestors of today's pupfishes had to withstand daily and seasonal changes in dissolved gases, salinity, and temperature. This may account for the relative ease with which the fish we see today adapted to their various environments. In the winter when temperatures can drop to nearly 70º F, the pupfish burrow into the mud to keep warm and lie dormant. In the heat of the summer when air temperatures can be above 120ºF, the fish often go into deeper, cooler waters to avoid the direct sun and extreme temperatures.

Where do they live?

Pupfish habitat today consists of small pools, marshes, springs, and occasionally streams. They feed on such foods as algae, plankton, small insects, snails and crustaceans in the water. Cattails, pickleweed, mesquite, and native grasses sometimes make up the surrounding environment. These oases also support snails, insects, spiders, birds, and other animals that visit in search of water. Critical to the survival of the pupfish, however, are the variables of the water - salinity, temperature, dissolved oxygen, and pollutants.

The Devils Hole pupfish (Cyprinodon diabolis) has the reputation of being the "most restricted vertebrate (animals with backbones) species in the world." This means that the entire population of Devils Hole pupfish lives in a pool whose surface area is approximately 330 square feet (33' long and 10' wide). Although the pool's depth is unknown (more than 500 feet) the fish's prime habitat is within a few feet of the surface where light can reach them. The fish are generally found in the top 80 feet of the water column.

What is Pupfish life like?

Pupfish generally live for less than one year. Members of many species die during the heat of the summer when their small habitats shrink. Some species die during the winter cold, while others can live up to two years. For those who survive the severe conditions, mating and reproduction occurs when the weather warms up in the spring and again in the fall. Most male pupfish are extremely defensive of their "territory." Territory for a pupfish is the substrate (sand, mud, gravel or silt) where the female lays her eggs and includes the water directly above it. Territorial and mating behaviors are generally exhibited from February through September. When at the bottom of a pond, spring pool or stream, they wriggle their bodies in order to churn up the mud and sand. This could be to release more food into the water, or just to have fun.

Pupfish are omnivorous but eat primarily algae. They occasionally consume aquatic insects (mostly beetles), crustaceans, plankton, detritus, flatworm larvae, snails, and invertebrate eggs. The bacterial and fungal coating on dead and decaying matter is a very important food source for the pupfish.

What is the Problem?

Despite their adaptability, the pupfish cannot adapt to **rapid** habitat changes, introduced predators, and many introduced competitors. When Euro-Americans arrived in the Death Valley region, pupfish numbers began to decline.

These tiny fish can be viewed as the "poster child" for endangered species and Ash Meadows and Devils Hole are considered by many to be the birthplace of the movement to save native fish. Some even consider the area the beginnings of the environmental movement in the 1960's. The Devils Hole Pupfish was designated as an endangered species in 1967. This designation provided no legal protection until The Endangered Species Act was signed in 1973. However this designation was an important contribution to motivating the US Government to defend the species when its habitat was threatened by groundwater pumping for irrigated agriculture at Ash Meadows.

The debate raged from 1968 to 1976 when the Supreme Court ruled in favor of protecting pupfish habitat – the first such ruling in United States history. This decision was based on the fact that Devils Hole had been designated as part of Death Valley National Monument in 1952, a date giving the fish priority over water rights held by the ranchers and

land owners. Through the efforts of dedicated individuals and the assistance of the Nature Conservancy, Ash Meadows National Wildlife Refuge was designated in 1984 to protect the unique plants and animals there. Three species of pupfish (Cyprinodon diabolis, Cyprinodon nevadensis mionectes, Cyprinodon nevadensis pectoralis) lie within the refuge protection.

Pupfish populations throughout the Death Valley region and the west have declined and in many locations are still shrinking in numbers for a variety of reasons.

Habitat destruction – Pupfish habitat is water. The levels of water within the region continue to drop. Ground water pumping within and surrounding the Death Valley region persists and is suspected of contributing to the decreased water levels.

Polluted water (toxic chemicals) – Within portions of the Death Valley region businesses and industries use chemicals to make their operations profitable. On occasion, these chemicals find their way into the waters where the pupfish live. Many of these chemicals are toxic to the fish and/or reduce the oxygen content to a level that the fish can suffocate within their own habitat.

Introduction of nonnative competition – Over many years, bass and other game fish have been introduced to reservoirs, streams and creeks for sport fishing. Unfortunately these fish will dine on pupfish, their larvae, and eggs.

– Bullfrogs and crawfish were also introduced into ponds and reservoirs for food and sport fishing. They multiplied rapidly in these habitats where they had few predators. These animals eat pupfish, their larvae and eggs.

– Tropical fish, such as sun fish, have been introduced to creeks and pools when folks want to find a place for aquarium fish they no longer can care for. These fish compete for pupfish food and often dine on pupfish larvae and eggs.

– Gambusia (Mosquito Fish) were introduced to marshy areas on the belief that they would eat the mosquito larvae and thus people living nearby would be free from bothersome mosquitoes. Mosquito Fish do eat mosquito larvae, but they also eat pupfish larvae and compete for algae and other pupfish food sources. The sad part about this great idea was that pupfish already living in these habitats consumed a greater number of mosquito larvae than did the introduced Mosquito Fish.

Overview

Educators from Death Valley National Park, the Timbisha Shoshone Tribe, Ash Meadows National Wildlife Refuge, and Inyo and Nye County school districts developed this curriculum. It was designed to follow 3rd and 4th grade instructional standards for California and Nevada.

Goal(s):

1. To increase knowledge and respect for natural processes as they relate to Death Valley National Park and Ash Meadows National Wildlife Refuge. 2. To expose students to the concepts of adaptation, habitat preservation, ecosystem management, and the scientific process.

Objectives: After completing this curriculum, students will be able to:

1) List diverse forms of life in the desert (including pupfish).

2) Explain how environmental changes can affect animals, plants and humans then list adaptations that animals and humans have made to adjust to these environmental changes.

3) Conduct simple investigations and experiments based upon the scientific process.

4) Record and perform simple analysis of their experiments.

5) Describe physical structures of fish and how they function perform simple analysis of their experiments.

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Standards/Frameworks

California 3rd/4th and Nevada 3rd

California – 3rd Grade Science Content Standards

Physical Sciences

1. Energy and matter have multiple forms and can be changed from one form to another.

As a basis for understanding this concept, students know:

a. energy comes from the sun to the Earth in the form of light.

b. machines and living things convert stored energy to motion and heat.

c. matter has three forms; solid, liquid and gas

d. evaporation and melting are changes that occur when the objects are heated.

Life Sciences

2. Adaptations in physical structure or behavior may improve an organism's chances for survival.

As a basis for understanding this concept, students know:

a. plants and animals have structures that serve different functions in growth, survival, and reproduction.

b. examples of diverse life forms in different environments, such as oceans, deserts, tundra, forests, grasslands, and wetlands.

c. living things cause changes in the environment where they live; some of these changes are detrimental to the organism or other organisms, whereas others are beneficial.

d. when the environment changes, some plants and animals survive and reproduce, and others die or move to new locations,

e. some kinds of organisms that once lived on Earth have completely disappeared; some of these resembled others that are alive today.

Investigation and Experimentation

3. Scientific progress is made by asking meaningful questions and conducting careful investigations.

As a basis for understanding this concept, and to address other standards, students should develop their own questions and perform investigations. Students will:

a. repeat observations to improve accuracy, and know that the results of similar scientific investigations seldom turn out exactly the same because of differences in the things being investigated, methods being used, or uncertainty in the observation.

b. Differentiate evidence from opinion, and know that scientists do not rely on claims or conclusions unless they are backed by observations that can be confirmed.

c. Use numerical data in describing and comparing objects, events, and measurements

d. Predict the outcome of simple investigation, and compare the result to the prediction.

e. Collect data in an investigation, and analyze them to develop a logical conclusion.

California – 3rd Grade History-Social Studies Content Standards

Continuity and Change

3.1 Students describe the physical and human geography and use maps, tables, graphs, photographs, and charts to organize information about people, places, and environments in a spatial context.

1. Identify geographical features in their local region (e.g. deserts, mountains, oceans, lakes).
2. Trace the way in which people have used the resources of the local region and modified the physical environment.

California – 3rd Grade Visual Arts Content Standards

1.0 Artistic Perception – Processing, Analyzing, and Responding to Sensory Information through the Language and Skills Unique to Visual Arts.

Students perceive and respond to works of art, objects in nature, events, and environment. They also use the vocabulary of the visual arts to express their observations.

1.1 Perceive and describe rhythm and movement in works of art and in the environment.

2.0 Creative Expression – Creating, Performing, and Participating in Visual Arts.

Students apply artistic processes and skills, using a variety of media to communicate meaning and intent in original works of art.

2.1 Explore ideas for art in a personal sketchbook.

2.2 Paint or draw a landscape, seascape, or cityscape that shows the illusion of space.

California 4th Grade Science Standards:

Life Sciences

2. Adaptations in physical structure or behavior may improve an organism's chances for survival.

   As a basis for understanding this concept, students know:

a. Students know plants are the primary source of matter and energy entering most food chains.

b. Students know producers and consumer (herbivores, carnivores, omnivores, and decomposers) are related in food chains and food webs and may compete with each other for resources in an ecosystem.

3. Living organisms depend on one another and on their environment for survival. As a basis for understanding this concept:

a. Students know ecosystems can be characterized by their living and nonliving components.

b. Students know that in any particular environment, some kinds of plants and animals survive well, some survive less well, and some cannot survive at all.

Earth Sciences

5. Waves, wind, water, and ice shape and reshape Earth's land surface. As a basis for understanding the concept:

a. Students know some changes in the earth are due to slow processes, such as erosion, and some changes are due to rapid processes, such as landslides, volcanic eruptions, and earthquakes.

c. Students know moving water erodes landforms, reshaping the land by taking it away from some places and depositing it as pebbles, sand, silt, and mud in other places (weathering, transport, and deposition).

Investigation and Experimentation

6. Scientific progress is made by asking meaningful questions and conducting careful investigations. Students will:

a. Differentiate observation from inference (interpretation) and know scientists' explanations come partly from what they observe and partly from how they interpret their information.

c. Formulate and justify predictions based on cause-and-effect relationships.

e. Construct and interpret graphs from measurements.

f. Follow a set of written instructions for scientific investigation.

California 4th Grade Visual Arts Standards:

2.0 Creative expression

Students apply artistic processes and skills, using a variety of media to communicate meaning and intent in original works of art.

2.1 Use shading (value) to transform a two-dimensional shape into what appears to be a three-dimensional form.

2.6 Use the interaction between positive and negative space expressively in a work of art.

2.7 Use contrast (light and dark) expressively in an original work of art.

Nevada 3rd Grade Science Standards:

Physical Science

Matter - Students understand properties of objects and materials.

P.5.A.3 Students know materials can be classified by their observable physical and chemical properties (e.g., magnetism, conductivity, density, and solubility).

Life Science

Heredity - Some characteristics are inherited, and some result from interactions with the environment.

L.5.A.1 Students know some physical characteristics and behaviors are inherited in animals and plants.

L.5.A.3 Students know that, while offspring resemble their parents and each other, they also exhibit differences in characteristics.

L.5.A.4 Students know how to observe and describe variations among individuals within the human populations.

L.5.A.5 Students know some animal behaviors are learned.

Structures of Life. Students understand that living things have specialized structures that perform a variety of life functions.

L.5.B.1 Students know plants and animals have structures that enable them to grow, reproduce, and survive.

L.5.B.2 Students know living things have predictable life cycles.

Nature of Science

Scientific Inquiry-Students understand that science involves asking and answering questions and comparing the answers to what scientists know about the world.

N.5.A.1 Students know scientific process is made by conducting careful investigations, recording data, and communicating the results in an accurate method.

N.5.A.2 Students know how to compare the results of their experiments to what scientists already know about the world.

N.5.A.3 Students know how to draw conclusions from scientific evidence.

N.5.A.4 Students know graphic representations of recorded data can be used to make predictions.

N.5.A.5 Students know how to make a safe and simple investigation.

N.5.A.7 Students know observable patterns can be used to organize items and ideas.

Science, Technology and Society. Students understand that many people, from all cultures and levels of ability, contribute to the fields of science and technology.

N.5.B.1 Students know that, throughout history, people of diverse cultures have provided scientific knowledge and technologies.

N.5.B.3 Students know the benefits of working with a team and sharing findings.

Earth and Space Science

Earth Composition and Structure – Students understand that features on the Earth's surface are constantly changed by a combination of slow and rapid processes.

E.5.C.1 Students know fossils are evidence of past life.

E.5.C.3 Students know landforms may result from slow processes (e.g. erosion and deposition) and fast processes (e.g. volcanoes, earthquakes, landslides, flood, and human activity.)

Nevada 3rd Grade Visual Arts Standards

Visual Arts

Students will know and apply visual arts, media, techniques and processes.

1.3.3 Use different media, techniques, and processes to produce works of art.

Death Valley National Park Field Trip

Salt Creek Research
For Teachers and Parent Helpers

To schedule this field trip, please contact the park's Chief of Interpretation at 760/786-3279. Pupfish Habitat Kits (containing research materials needed for this program) are available at the Furnace Creek Visitor Center for visiting teachers who have completed the Teacher's Training.

Note: For details on Teacher's Trainings, please contact the park's Education Specialist at 760/786-3226.

*** Pupfish are not visible during cooler months of the year. To truly observe pupfish behavior, field trips need to be planned during the early spring months. Again for more specific information on the best viewing times, contact the park.*

A tour of the Death Valley National Park Library facility can be included in your trip upon request.

Death Valley National Park is the largest park in the lower 48 states and is dedicated to the protection and preservation of the Great Basin and Mojave Desert ecosystems. It has more than 3.3 million acres of spectacular desert scenery, interesting and rare desert wildlife, complex geology, undisturbed wilderness, and sites of historical and cultural interest. Death Valley National Park includes the lowest point in North America (-282 feet) and holds the record for the hottest temperature in the nation (134º F). Visiting Death Valley National Park can be rewarding and challenging!

Located within Death Valley National Park are several rare and special environments. One such area is Salt Creek. Salt Creek is the only home of the Salt Creek Pupfish (Cyprinodon salinus salinus). Salt Creek begins at McLean Springs and flows between 2 and 4 miles on the valley surface during the wet months, but shrinks greatly in the summer. This is one of the harshest environments for pupfish in the Death Valley region.

The creek's salinity varies from two to three times that of ocean water; air temperatures in the summer can reach over 120º F! Despite its high salinity, it's one of the few sources of water for several miles. Thus many types of animals can be found around the creek as evi-

denced by the many tracks in the mud and sand around the creek and boardwalk. Birds and insects are abundant. On warm days, reptiles can also be readily seen. Salt grass, pickle weed, sedges, and cattails can be found in and around Salt Creek.

The boardwalk is approximately one mile long. There are several areas along the boardwalk where the pupfish can be viewed. Please remain on the boardwalk at all times in order to protect this fragile ecosystem.

There is one restroom (vault toilet) at the parking lot. It contains one toilet, thus if you have a large group, it is recommended that they take advantage of other facilities before arriving at the Salt Creek site. The parking lot has ample room for a bus to turn around. There are two picnic tables and a garbage can at the parking lot. Please offer meals and/or snacks at this location and do not eat while on the boardwalk. Food and wrappers eventually find their way into the creek and pollute the water, so please throw all garbage in the garbage cans.

For your safety:

What to bring?

Death Valley National Park is in the desert. Remember that deserts are dry and hot in the summer, cold in the winter. Be sure to carry plenty of water during any visit. Dress appropriately (see below) for the weather and be prepared for extremes in all seasons. **Note**: The nearest facilities are 12.5 miles away at Stovepipe Wells or 15 miles away at Furnace Creek. Bring meals, snacks and beverages with you. Reminder, do not eat while on the boardwalk. Sunscreen and insect repellent are necessary during some seasons.

What to wear?

Dress in layers. Desert temperatures can be variable. Wear good, sturdy walking and/or hiking shoes. (Open-toed shoes are not recommended!) Wear a hat that keeps the sun off your face, head and neck. Wear sunscreen and sun glasses.

Who lives here?

Students need to be warned to be careful where they place their hands and feet. Venomous creatures such as scorpions, rattlesnakes, and black widow spiders live in Death Valley National Park. This is their home. Spiders, snakes, and scorpions can be found in dark locations (such as under rocks or inside shoes). For your students' and the animals' protection avoid any direct contact with the wildlife.

Logistics:

How to get there?

Salt Creek is located 1.2 miles off of Highway 190 on a gravel road. Follow the NPS directional signs to the parking lot. See map on page 19 for directions to Highway 190 from your location.

Where do we park?

Buses: Park in the Salt Creek Parking lot. Please do not block the road and allow plenty of space for visitor parking.

Cars: Park in the Salt Creek Parking Lot. Please allow plenty of space for visitor parking.

How do we receive an Educational Fee Waiver?

Death Valley National Park charges an entrance fee of $20.00 per vehicle. If your field trip is for educational purposes and through an accredited educational institution, an Educational Fee Waiver can be obtained by contacting the Fee Collection Office at (760) 786-3247. Be prepared to submit a detailed outline of your itinerary and a letter of request on your institution's stationary. Educational Fee Waivers are issued to accredited schools that are visiting the park for curriculum-related, educational field trips only. Please indicate how this trip directly relates to what is currently being taught in the classroom.

Behavior:

Students are expected to be on their best behavior when visiting national parks. To assist with this expectation, Death Valley National Park requires a ratio of one adult over eighteen for every seven students under 18 years of age. Group size on the boardwalk needs to be limited to no more than 35 students. Even with a group of this size, the group needs to be divided in half and each walk and work in opposite directions. This will help to protect the boardwalk and reduce the amount of habitat disturbance.

Students and adults need to be informed of park rules and regulations. Students need to be respectful of other visitors, keep their "indoor voices" and remain on the boardwalk and/or trail. In National Parks everything is protected for current and future visitors to enjoy. Please do not collect items such as rocks, plants or artifacts. Reminder: please do not disturb or feed the wildlife.

For further questions on specific park rules, please feel free to contact the park at 760/786-3200.

Facilities:

A restroom is located at Salt Creek. However to accommodate an entire class, it is recommended that you stop at a location with more than one toilet. They can be found at the Furnace Creek Visitor Center, Emigrant Rest Stop, and various picnic areas.

There are two picnic tables located at the parking lot. These are appropriate for eating snacks. Please place all trash in the cans provided at this location. It is extremely important to maintain a pristine habitat for the pupfish and other animals and plants in this fragile area.

Ash Meadows National Wildlife Refuge Field Trip

Crystal Springs Research

For Teachers and Parent Helpers

To schedule this field trip, please contact the refuge at 775/372-5435. Pupfish Habitat Kits (containing research materials needed for this program) are available at the contact station for visiting teachers who have completed the Teacher's Training.

Note: For details on Teacher's Trainings, please contact the Education Specialist at 775/372-5435 or 760/786-3226.

***In the future, a tour of the School Springs Refugio can be scheduled with this field trip. At the present time, the refugium is under planning and construction. Be sure to ask about its status when you call.*

Ash Meadows National Wildlife Refuge was established June 18, 1984 to protect threatened and endangered species, some found nowhere else in the world! The Refuge is over 23,000 acres in size and is considered the largest oasis within the Mojave Desert. The refuge contains over 30 springs bubbling up from underground to reveal clear turquoise-blue water that supports plants and animals of special interest.

Located within Ash Meadows are several special environments. One environment is Crystal Springs. Crystal Springs is the largest spring within the refuge and desert environs.

Salt grass, mesquite trees, salt brush, sedges, and cattails can be found in and around Crystal Springs pool. The salinity of the creek and pool can vary with the air temperature which can reach up 87° F! Despite its alkalinity, the source for this water moves through deep underground aquifers for nearly 100 miles. The water begins as a groundwater sub-basin extending about 100 miles to the north and 60 miles to the east. The larger basin which Ash Meadows is part of extends into western Utah! Since water is a precious commodity within a desert, a large variety of animals can be found around the springs as evidenced by the many tracks in the mud around the boardwalk. Birds, rabbits, and insects are abundant. On warm days, reptiles are readily seen.

The boardwalk is approximately 0.3 miles one way. There are several areas along the boardwalk where the pupfish can be viewed. Please remain on the boardwalk at all times in order to protect this fragile ecosystem.

There are two outdoor restrooms at the parking lot. The parking lot has ample room for a bus to loop around. There is a covered picnic area with several picnic tables and garbage cans at the parking lot. Please offer meals and/or snacks at this location and do not eat while on the boardwalk. Food and wrappers eventually find their way into the creek and pollute the water, so please put all your garbage in the garbage cans.

For your safety:

What to bring?

Ash Meadows National Wildlife Refuge is located in Mojave Desert. Remember that deserts are dry and hot in the summer, cold in the winter. Be sure to carry plenty of water during any visit. Dress appropriately (see below) for the weather and be prepared for extremes in all seasons. **Note**: The nearest facilities are 28 miles away in Pahrump, Nevada. Bring meals, snacks and beverages with you. **Reminder**: Do not eat while on the boardwalk. Sunscreen and insect repellent are necessary during some seasons.

What to wear?

Dress in layers. Desert temperatures can be variable. Wear good, sturdy walking and/or hiking shoes. (Open-toed shoes are not recommended!) Wear a hat that keeps the sun off your face, head and neck. Wear sunscreen and sun glasses.

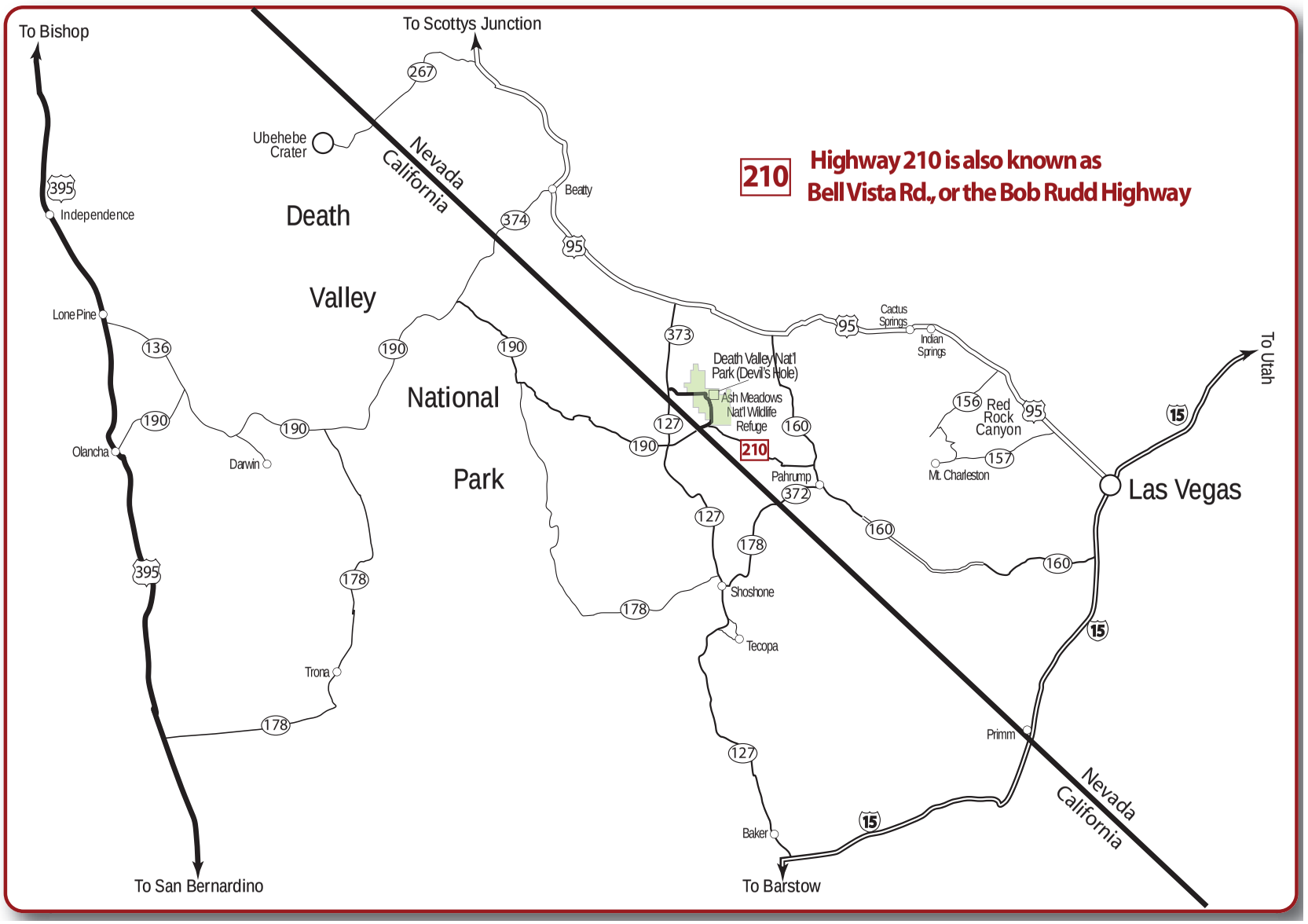
Who lives here?

Students need to be warned to be careful where they place their hands and feet. Venomous creatures such as scorpions, rattlesnakes, and black widow spiders live in the Mojave Desert. This is their home. Spiders, rattlesnakes, and scorpions can be found in dark locations (such as under rocks or inside shoes). For your students' and the animals' protection avoid any direct contact with the wildlife.

Logistics:

How to get there?

Ash Meadows is located off Highway 210, also known as the Bob Rudd Highway or Bell Vista Road when coming from Highway 160 in Nevada) and/or Highway 373 in Nevada off of Highway 95 From Las Vegas (373 is an extension of Highway 127 in California). See map on page 19 for directions to the Bob Rudd Highway/Bell Vista Road and Highway 373 from your location. The refuge is clearly marked along these highways by brown highway signs. From the highway, travel on the gravel road following the directional signs to the Refuge Office.


To Bishop
To Scottys Junction
267
Ubehebe Crater
Nevada
California
395
Independence
Death
Valley
National
Park
Beatty
374
95
210
Highway 210 is also known as
Bell Vista Rd., or the Bob Rudd Highway
Lone Pine
136
190
190
190
190
373
Death Valley Nat'l Park (Devil's Hole)
Ash Meadows Nat'l Wildlife Refuge
127
160
210
Cactus Springs
Indian Springs
95
156
Red Rock Canyon
157
Mt. Charleston
Pahrump
372
To Utah
15
Las Vegas
Olancha
Darwin
395
178
178
178
Shoshone
Tecopa
Trona
127
160
160
15
Primm
Nevada
California
127
15
Baker
To San Bernardino
To Barstow

Where do we park?

Buses: Park in the Refuge Office Visitor Parking lot. Please do not block the road and allow plenty of space for other visitor parking.

Cars: Park in the Refuge Office Visitor Parking lot. Please allow plenty of space for visitor parking.

How do we receive an Educational Fee Waiver?

There is currently no fee to enter Ash Meadows National Wildlife Refuge.

However, if following your trip, you plan to visit Death Valley National Park, there is an entrance fee of $20.00 per vehicle. If your field trip is for educational purposes and through an accredited educational institution, an Educational Fee Waiver can be obtained by contacting the Fee Collection Office at (760) 786-3247. Be prepared to submit a detailed outline of your itinerary and a letter of request on your institution's stationary.

Behavior:

Students are expected to be on their best behavior when visiting wildlife refuges. To assist with this expectation, Ash Meadows National Wildlife Refuge requires a ratio of one adult over eighteen for every seven students under 18 years of age. Group size on the boardwalk needs to be limited to no more than 35 students. Even with a group of this size, the group needs to be divided in half and each walk and work in opposite directions. This will help to protect the boardwalk and reduce the amount of habitat disturbance.

Students and adults need to be informed of refuge rules and regulations. Students need to be respectful of other visitors, keep their "indoor voices" and remain on the boardwalk as there are threatened plant species found next to the boardwalk. In a National Wildlife Refuge everything is protected for future visitors to enjoy. Please do not collect items such as rocks, plants or artifacts. **Reminder**: Please do not disturb or feed the wildlife.

For further questions on specific refuge rules, please feel free to contact the refuge office at 775/372-5435.

Facilities:

Restrooms are located at the Refuge Office. However, it is recommended that you have students use the restroom prior to leaving school grounds as well. Ash Meadows is a long distance from most Nevada locations.

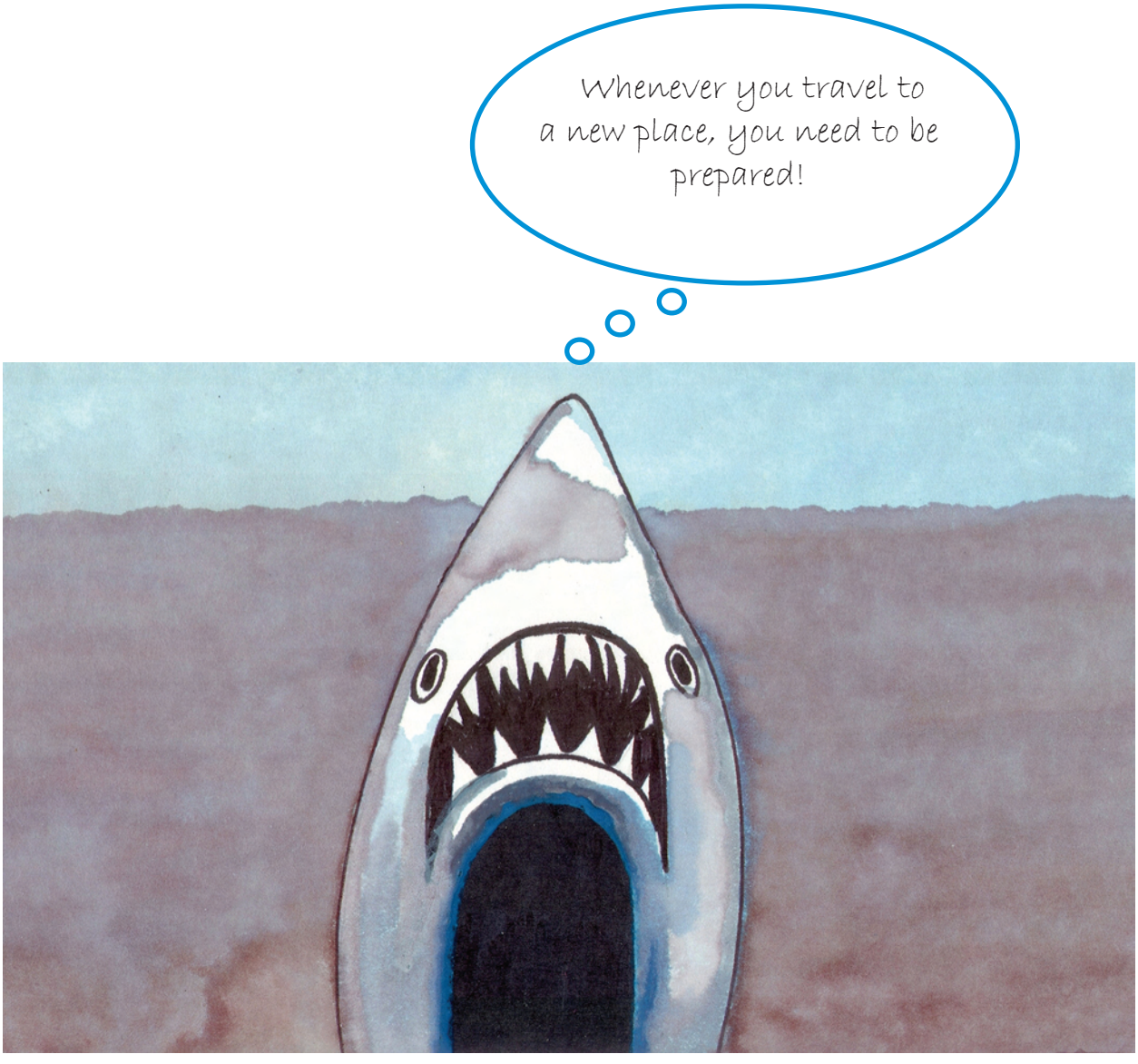
There is a small visitor contact station at the Refuge Office. Students are encouraged to look at the displays and ask the staff questions. Due to the small space indoors within the contact area, students need to be divided into groups of no more than eight and accompanied by an adult.

There is a covered picnic area with several tables located at the parking lot. These are appropriate for eating snacks or having a lunch. Please place all trash in the cans provided at this location. It is extremely important to maintain a pristine habitat for the pupfish and other animals and plants in this fragile area.


Respect Yourself
Respect Each Other
Respect the Environment
Respect Teachers and
Respect Parents

The World of the Small

Before Your Visit



Activity #1

Agree or Disagree

Time 2 hours

2 1-hour sessions

Introduction: All good field naturalists and scientists keep a journal of what they see (observe) learn, hypothesize, or theorize. Keeping a journal helps the student remember his/her experiences, questions, and results. Drawings, stories, poems, are also excellent means of keeping records.

Journal questions are suggested here to stimulate thoughts and to attempt to help students understand the difference between opinions and scientific facts. There are no right or wrong answers to these questions. It is only important to discover where students stand on certain issues.

Background: Information is the basis for making all decisions. Gaining information on a subject allows us to differentiate evidence from opinion. Scientists do not rely on claims or conclusions unless they are backed by observations, but all scientists begin with hypotheses, theories and opinions of their own.

Objectives: Students will be able to -

1. Begin to think for themselves.
2. Differentiate between opinions and facts.
3. Practice writing skills (art).

Part One: Fishy Field Journal Time: 1 hour (not including preparation)

Materials: Paper bags or recycled paper, felt pens, pictures/illustrations of fish, Death Valley National Park or Ash Meadows National Wildlife Refuge, deserts, desert animals and plants, pupfish etc., stamps, stickers, student drawings. Glue, hole-punch, scissors, string, metal ties, and card stock.

Data sheets for experiments, word search, maps and other materials can be copied from this curriculum.

Procedure:

1. Have students bring in paper bags or recycled paper. Cut into 8-1/2" x 11" journal-sized" pages. Use heavy card stock for the front and back cover. Have the students assemble enough pages for the entire curriculum (at least 20 blank pages), punch holes in paper and set aside. Have students insert data sheets (see originals on pages 31 - 34).

2. Design and prepare the cover sheets. Allow the students to be creative! Put the journals together with string, hoops, or metal ties. Have them create a collage in their own way using the stickers, pictures, and post cards you have collected related to deserts, fish, Ash Meadows National Wildlife Refuge or Death Valley National Park. They can add their own artwork and/or illustrations.

Part 2: (Time 1 hour)

1. Pass out copies of the following questions to the students and have them insert one at the beginning of the journal. Students need to respond only with "agree" or "disagree"! Have them record their answers, but also respond in class by putting their thumbs up if they agree and thumbs down if they don't agree.

Extension: Have students develop a hypothesis about fish that by the end of the curriculum they will have either proven to be true of false – or that they can either agree with or disagree with.

Questions:

1. Humans are part of the environment.

2. Fish are good for food and sport but not a major part of the food chain.

3. All fish are the same.

4. It is important to protect fish and their habitat.

5. Fish are only found in clean, fresh, cool water.

6. Studying science is boring.

7. Science lets us look at things more closely.

8. The life of big things (organisms) is more important than the life of little things (organisms).

9. The desert is an empty place.

10. Things remain the same on earth from one day to the next.

Activity #2
Fish Stories

Time: 2 hours

Introduction: The original people of the Death Valley region are known as the Timbisha Shoshone. They are recognized for their basket making skills. Baskets were used for boiling water, trapping birds, carrying food, etc. The Timbisha Shoshone would move from the valley floor into the mountains during the summer months, then return for the winter. Today Timbisha Shoshone still live within their ancestral homelands; Death Valley National Park surrounds 313 acres of these homelands in the valley. Living nearby, the Pahrump Paiute would share some area with the Timbisha. Ash Meadows and the spring pools located there were considered to be "shared' habitats for mutual use. In Ash Meadows area, the Paiute and Shoshone collected and ground mesquite beans, and used the spring pools as a source of water.

Background: We can learn by asking questions and listening to our elders such as our parents, aunts, uncles, grandparents, or even brothers and sisters. When we are young, we ask our elders to tell us stories about their lives. If we listen, we learn about our history and family.

Paulene Esteves, Timbisha tribal elder, shares what her mother told her:

"The old people would sometimes collect the pupfish on their way up north when traveling through Salt Creek. At the top of the springs is where they would get fresh water to drink. If plentiful they would catch and dry the fish to take with them on their trip. We were not fish eaters, so we did not have baskets made especially for catching fish. The pupfish were considered a delicacy. It was over 200 years ago that these fish were used as a food source by the Timbisha Shoshone."

Paulene is now an elder for us to learn from:

"When I was a child the only fishlike creature we ate was crawdads. A crawdad is an underwater fish that looks like a crab. The crawdads at Ash Meadows would be cooked or dried then eaten. We would pick up these creatures and make them walk on their little legs. We would get into trouble for this because you're never supposed to play with your food."

Note: Crawfish (or crawdads) were introduced to the area in the early part of the 20th Century and are not native to the Death Valley region.

Objectives: Students will be able to –

1. Practice writing skills.

2. Practice speaking and listening skills.
3. Trace the way their families have changed the environment.

Materials: Journals and pen or pencil.

Procedure: Have students take their journals home. Instruct them to "interview" an adult (parent, relative or friend) about an experience the adult had on a fishing trip. If the students do not know anyone who has caught fish, create the interview question to relate to eating fish or any "story" that relates to a fish "experience."

Activity: Conduct an interview with family or friends relating to a personal experience with fish and/or fishing. Ask for a story about fishing and/or fish. Have the students write the story down in the journal.

Extension: Students can later read the stories to the class.

Further research: Read the "fish stories" posted on websites.

Some suggestions:
www.underwaterworld.com/fishstories.html
www.gbtu.org/events/fishstories/storylist.html

Activity #3

What makes a fish a fish? – Fish Anatomy

Time: 30 minutes

Introduction: To us, the environment of water may seem dark, cold and mysterious; however it is the perfect home for fish. They spend their entire lives in water – water has given them their shapes, way of breathing, and means of movement or locomotion.

Background: Fish are unique in the animal kingdom. They are the oldest of the vertebrates (animals with backbones). Water is "incompressible" and thus fish have a streamlined shape (sharply pointed head, wide in the middle and tapers toward the back) so they can move easily through water. Water flows smoothly past the fish's sides as it swims.

Fish are generally "bilaterally symmetrical" (as are humans). This means that the left and right sides are mirror images of each other. Fish have fins. Fins provide stabilization, locomotion, and steering. They are moveable and worked by muscles. Dorsal (near the back) and pectoral (side or chest) fins work together to provide stabilization while each separately may produce a change in direction. The tail fin is used to steer or to increase speed.

Fish are "cold blooded"; their body temperatures change with that of the water temperature (unless it becomes too hot or too cold and then even fish will die).

Their circulatory system is very simple. Blood flows from the heart through the gills to other organs and back to the heart again. The respiratory system is also simple and adapted for living in water. Oxygen is dissolved in water. As the fish gulps water in through its mouth, the oxygen passes through the gills where it is then collected and scattered to the organs of the fish's body for use.

Fish have scales – flexible armor of rounded overlapping plates of bone. These scales are a protective covering fixed in the inner layer of skin. Fish also have layer of antiseptic slime called mucus that reduces friction while swimming and protects them from fungi and bacteria.

Fish have a "sixth sense" that allows them to respond to the movements and currents in the water. The specialized sense organs are found along the "lateral line" of the fish from head to tail.

Fish Anatomy

Fins – Fins are made of stiff rays covered by skin. Each fin is designed to perform a specific function: (see diagram)

Dorsal fin - lends stability in swimming

Ventral fin – Serves to provide stability in swimming

Caudal fin – Main fin for moving the fish or propelling the fish

Anal fin – Lends stability when swimming

Gills – These are the fish's breathing mechanism, similar to human lungs. Water is taken in and forced over the gills where oxygen is removed by flows into the blood.

Lateral line – the lateral line consists of a series of scales, which connects sensory cells and nerves. It can detect minute electrical currents in water. It can also function as an echo-location (use of sound waves to identify movement) process that helps the fish identify where it is.

Heart – Fish have a two-chambered heart (humans have a four chambered heart). The heart pumps the oxygenated blood to the body. Oxygen is necessary for all cells of the body to operate. As blood delivers oxygen to the cells, it picks up carbon dioxide and carries it back to the gills. The gills release it to the environment before picking up more oxygen and the process continues.

References:

Fishes, Brian Wildsmith
I Wonder How Fish Sleep (I Wonder Series), Mona Gansberry Hodgson and Chris Sharp – Illustrator
Fish, Colin S. Milkens
Exploring Freshwater Habitats, Dr. Edwin Gould and Silvia James
Fish (First Discovery Books), Saabine Krawcxyk
It Could Still be a Fish, Allan Fowler
What is a Fish? (Science of Living Things Series), Bobbie Kalman and Allison Larin
GASP!, Terry Denton (A very fun book!)

Objectives: Students will be able to:

1. Identify various fish parts and state their function.
2. State how fish are adapted to a water environment.

Materials: Overhead projector, overlay, skills sheets, coloring pencils, paints and/or crayons.

Procedure: Review the background information and fish language with the class. Use the overhead overlay to illustrate the part of the fish discussed. Have the students fill in the blanks on the "skills sheet."

Activity: Complete the "skills sheet". Fill in the blank labels and describe what the gills, fins, and lateral line are used for. Students need to color each internal structure a different color for further identification.

Extension: Make up a "new words" sheet based upon the glossary and have students define words relating to fish and aquatic habitats.

Fishy language (glossary):

Circulatory system – circulating blood through the fish body

Detritus – loose material, such as rocks and organic matter, resulting from breakdown of living material.

Dissolved Oxygen – the amount of oxygen within a given amount of water

Fin – a membrane-covered, bony structure used for locomotion on a fish.

Fry – any young fish (larvae is a term used for young pupfish).

Gill – the breathing organ in fish.

Gill membrane – the covering of the gill on a fish

Lateral line – A longitudinal line running along each side of the body of most fishes marking the position of sensory cells. (These cells can detect currents and vibrations in the water.)

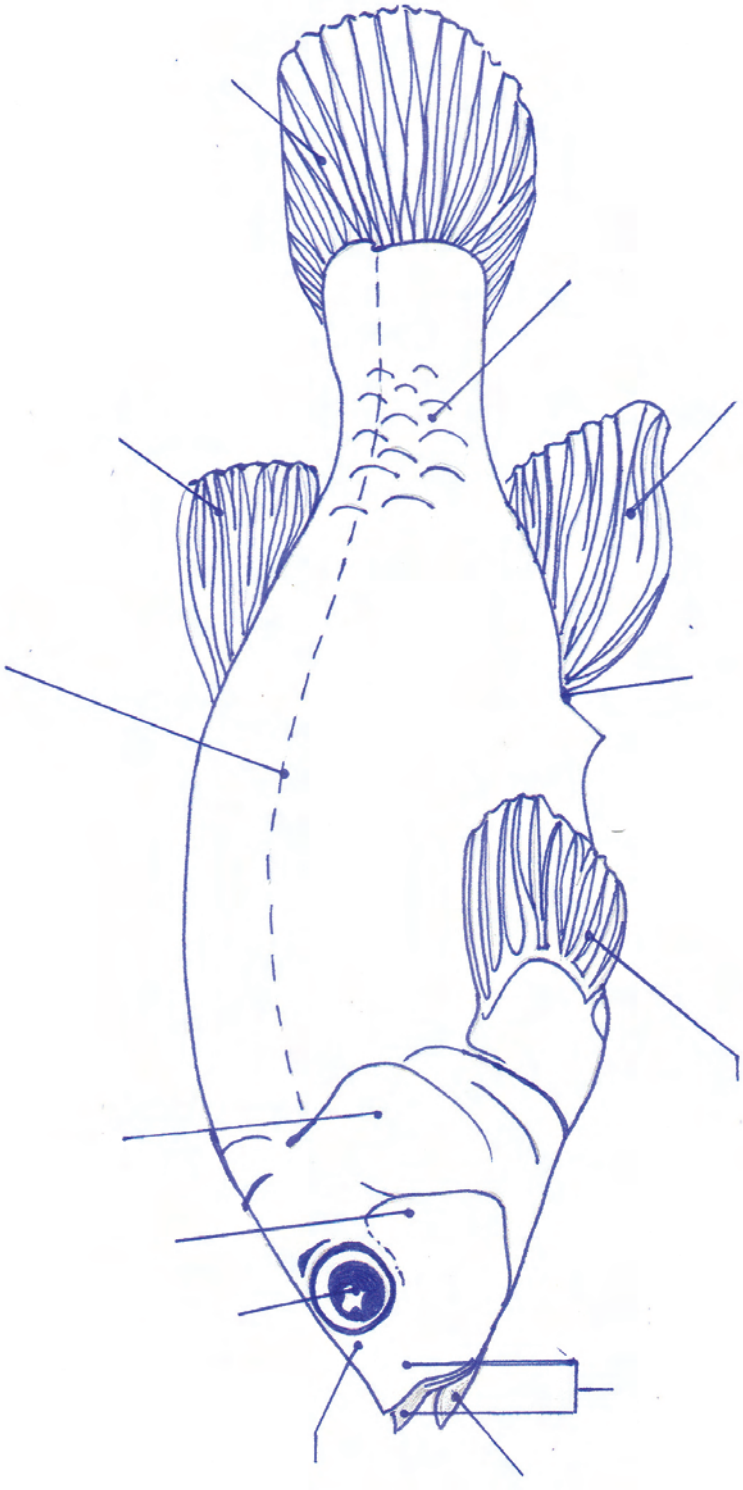
Minnow – common name for members of the family Cyprinidae or a small fish.

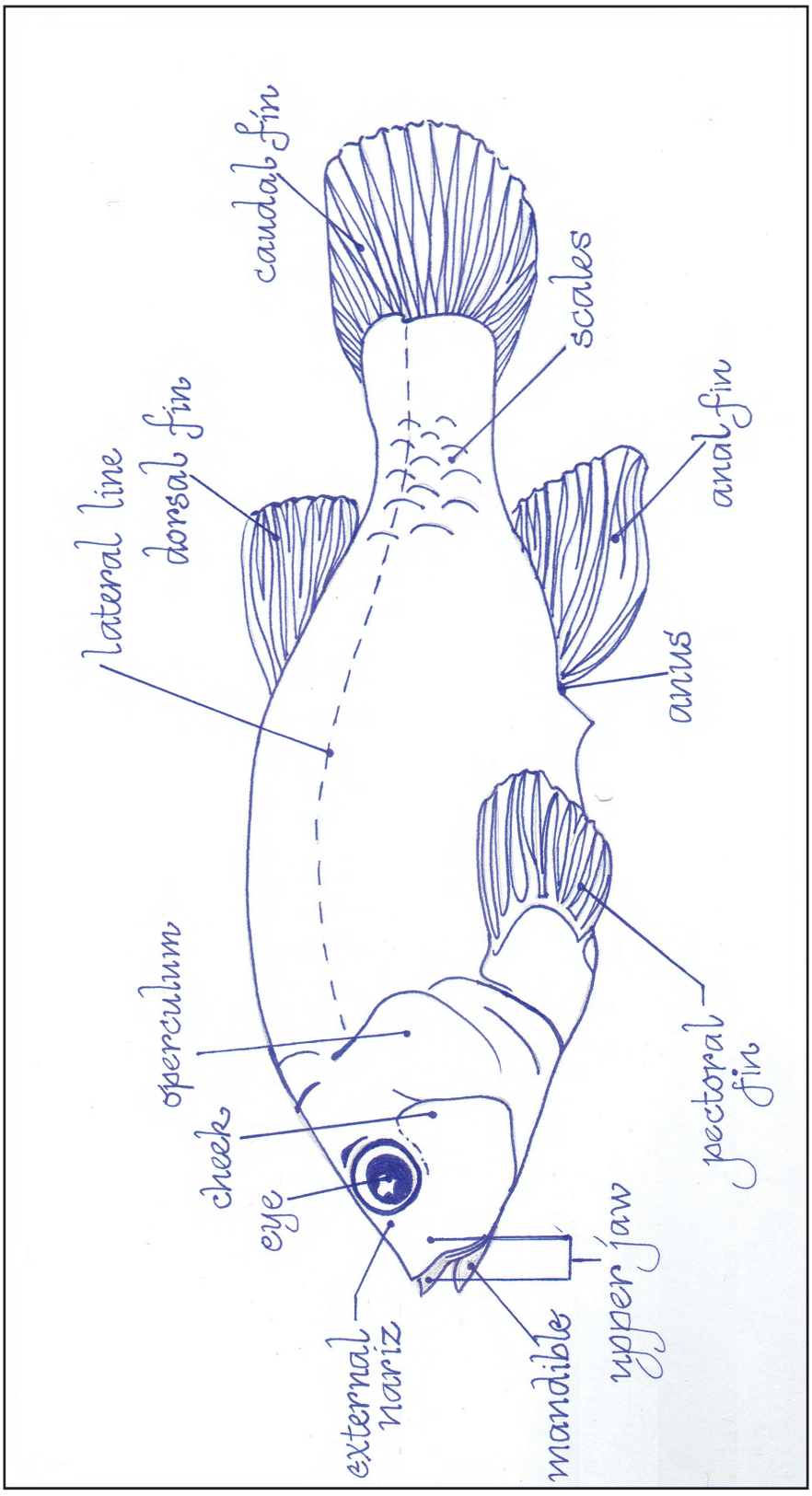
Respiratory System – circulating oxygen through the fish to reach all parts of the fishy body.

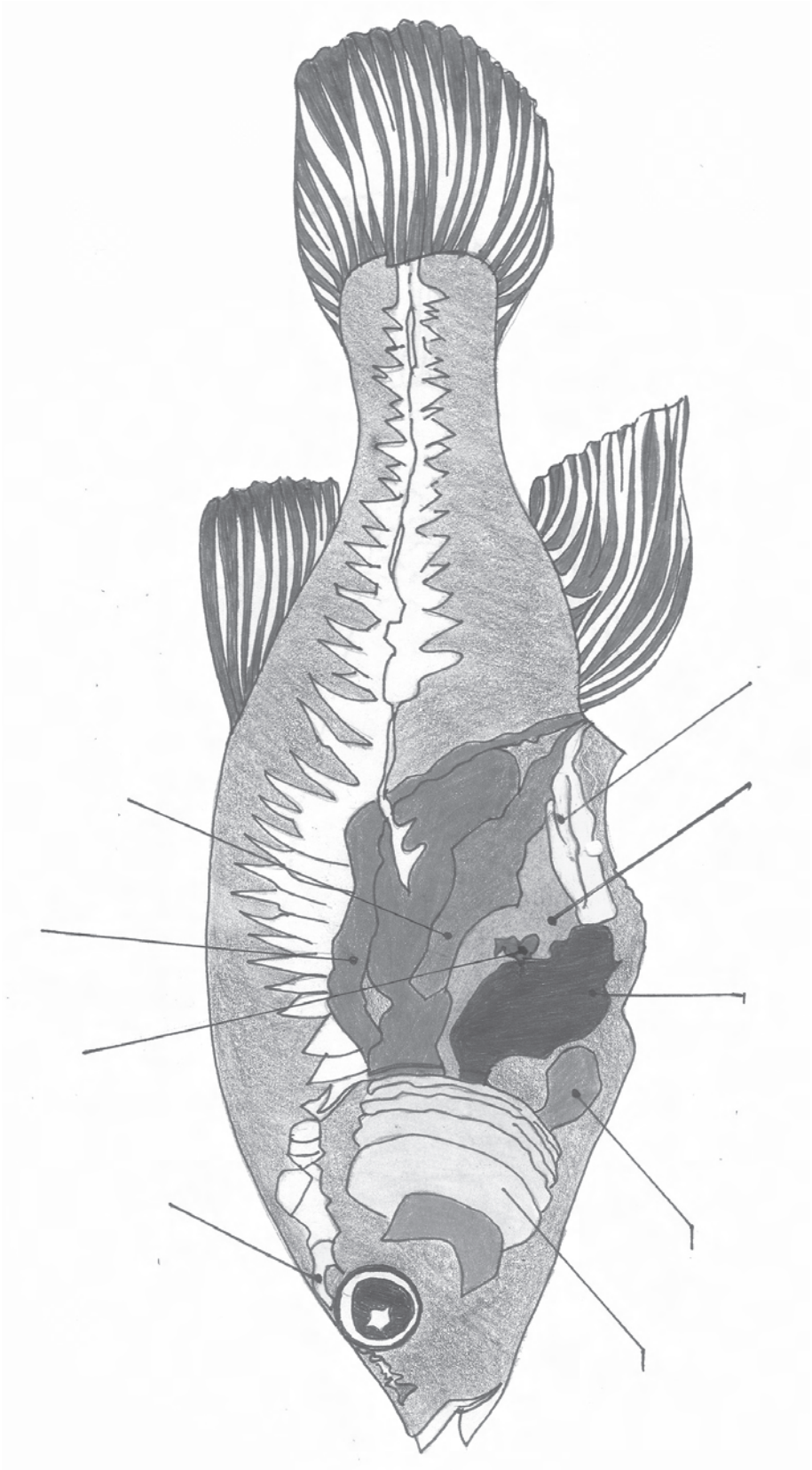
Scales – small, flat, rigid, plates covering the outside of fish.

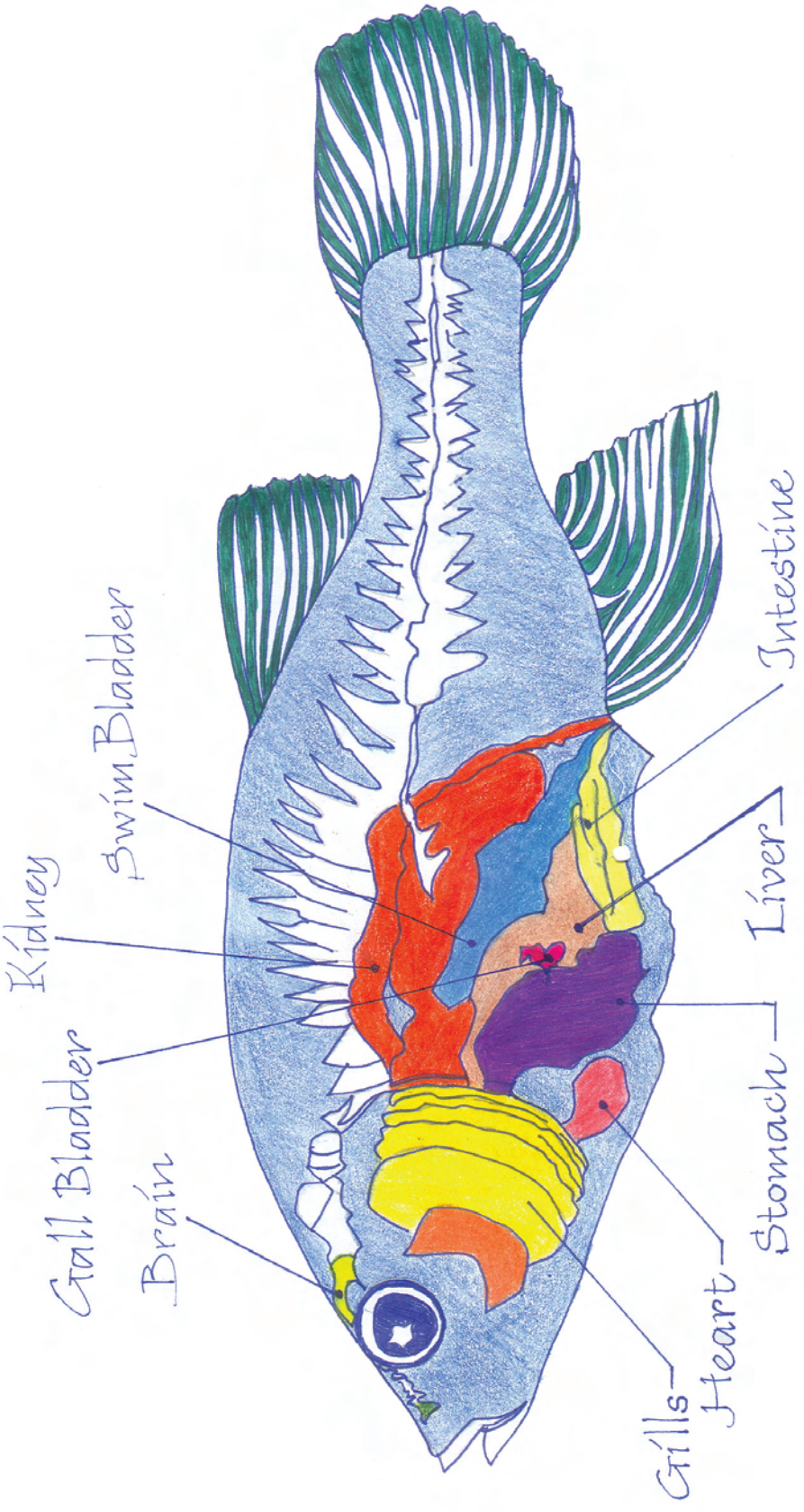
Spawning – the process of egg laying and external fertilization in fish.

Anatomy Illustrations




caudal fin
scales
lateral line
dorsal fin
anal fin
anus
operculum
cheek
eye
external naris
mandible
upper jaw
pectoral fin

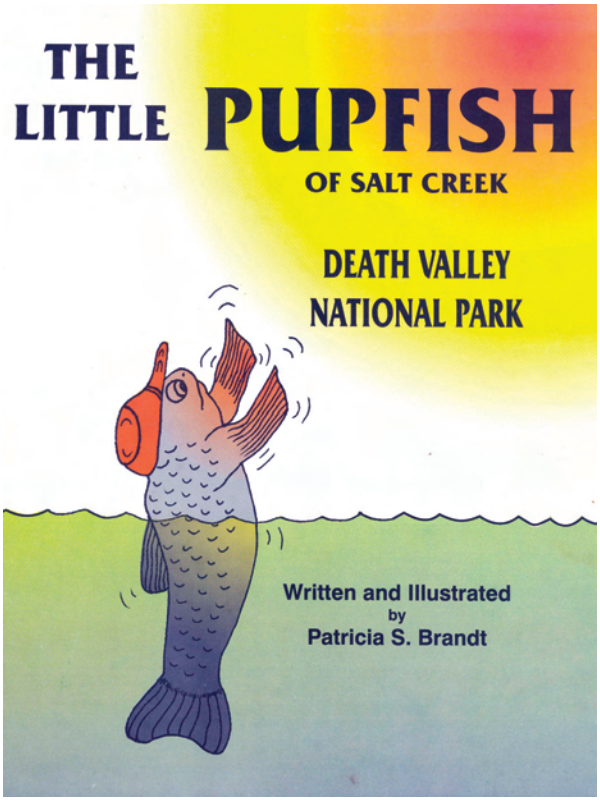



Kidney
Swim Bladder
Gall Bladder
Brain
Intestine
Liver
Stomach
Heart
Gills

Activity #4

The Little Pupfish of Salt Creek

Time: 1 hour,
Two-30 minute segments



Introduction: The Pupfish of the Death Valley area have been in existence for thousands of years. They are unique and highly adaptable fish. Learning more about this fish will assist the students in understanding its importance.

Background: Read: The Little Pupfish

Objectives:

1. State what a pupfish is and describe some of its history at Salt Creek.

2. Describe some physical and biological aspects of pupfish.

3. Explain that pupfish have survived for so many years.

Materials: *The Little Pupfish*, by Patricia S. Brandt, published by Death Valley Natural History Association (if not in your school library, contact the park's Education Specialist for a copy).

Activity: After reading the book to the class, conduct a brief discussion.

Procedure: Read the book during class time. Take at least two days and discuss the special features of the fish after each reading. Have students use their journals to write down notes on what they learn about pupfish based upon the book.

Extension: Have the students write a story in their journals about a pupfish named Gil who lives in one of the other pupfish locations (such as Saratoga Springs, Ash Meadows Wildlife Refuge or Devils Hole). Instruct the students to use their imaginations, but also try to use some of the facts they learned from the book and the discussion. Each story can be read to the class before or following the field trip.

*** Note: Inconsistency in the book implies that the Timbisha ate large quantities of these fish. Although it is true that while relocating from the heat of the valley to the cooler climates, the Timbisha gathered fish in baskets (when abundant), they did not do this on a regular basis. The fish were dried and used for snacks for traveling.*

The World of the Small

Welcome to the Pupfish World!

During Your Visit

Pupfish Habitat at Salt Creek, Death Valley National Park. Pupfish Habitat at Crystal Springs, Ash Meadows National Wildlife Refuge

***See hints for Field trip*

Activity 5 – During Your Fishy Visit-Science

Introduction: Salt Creek pupfish (Cyprinodon salinus salinus) lives only in Salt Creek that flows south of the Devil's Cornfield toward Cottonball Marsh. Salt Creek originates at McLean Springs and flows for three to five miles in the spring, but dries to a series of small marshes in the summer months. It is one of the harshest and most variable pupfish habitats. It is also one of Death Valley National Park's most accessible and reliable locations for viewing pupfish in the spring.

The salt creek pupfish is a slender pupfish with very small scales. Females are brownish with a silvery sheen; males are bluish to turquoise with dark gray lateral bars and have a silvery sheen on the sides.

The Ash Meadows pupfish (Cyprinodon nevadenses mionectes) lives within the confines of the springs located at Ash Meadows Wildlife Refuge. Located in several of the spring pools throughout the area, it can be easily viewed from Crystal Springs outflow and pool. The Ash Meadows pupfish are short and deep with long heads. Breading males become strikingly iridescent silver blue during the breeding time. Females are a silvery brown. This little fish has survived within this habitat for tens of thousands of years.

A variety of pupfish behaviors can be observed at these locations. The fish form colonies or schools in numbers up to the hundreds. They can often be observed "eating" or sucking in bottom materials and spitting it out again, especially where algae is present. As the water and algae are taken in, the fish filters out what it needs to survive and gets rid of the rest. Males establish territory and defend it, sometimes aggressively, by chasing other fish away. Territory is approximately 2" square of creek bottom and the water habitat directly above it. A female may enter the territory and nip at the creek bottom to indicate her interest in the male. Males will not chase away a female who behaves in this manner.

Background: Pupfish habitat at Salt Creek and Crystal Springs (and pool) includes the creek and surrounding area. Since this is the only water for many miles, it is also a popular location for other animals to visit and live. Observing the fish as well as identifying the plants and animals that make up this habitat is critical to understanding the pupfish.

A Reminder: Please stay on the boardwalk!

Objectives: Students will be able to –

1. Relate what they learned in the classroom to what they see in the field.
2. Conduct scientific experiments and record information on pupfish habitat.
4. Observe pupfish habitat and use language and art to describe what the have learned.
5. Calculate an average population of pupfish within a given area.
6. Observe fish behavior. Observe plants closely. Record the observations in their journals.
7. Relate fish parts learned earlier to the chemistry of the water they live in.
8. Use their art to communicate what the area looks and feels like and how it functions.

Materials: Journals, pencils, Pupfish Habitat Kits

Activity: Make field observations and chemical tests while expressing their feelings and relating to the area. With the use of stations, each student gets an opportunity to learn in small groups.

Procedure: Set up field trip to Salt Creek or Crystal Spring. When possible, arrange for assistance from National Park Service and/or Fish and Wildlife Service staff while on site. Schedule a time for check-in and check-out of the Pupfish Habitat Kits with park and/or refuge staffs.

Students should be prepared for the severe Mojave Desert conditions.

At the site:

Set up 5 stations. Divide students into 5 groups. Each station will last approximately 20 minutes with 5 minutes between to move from station to station. Each group will have an opportunity to participate in each station. Each station should have a parent helper capable of maintaining discipline, understanding the procedures, and assisting the students while allowing them to do the work.

Discussion: After completing all stations, the students can be brought together for a brief discussion about what they learned. Using their journals, they can discuss what makes up the Salt Creek or Crystal Springs habitat. To stimulate questions, ask the students if these fish could live in the habitat that makes up their own homes. Why not? Allow the students to think on their own. Do not supply answers.

Note: In order to protect Salt Creek and Crystal Springs watersheds, please do not dump the water samples containing chemicals into the soil or back into the creek. A waste water bottle is provided in the Pupfish Habitat Kits. Dump all wastes into the bottle and then dispose of the waste down a sink or drain or flush toilet. Place the used dissolved oxygen ampoules in the zip lock bag labeled trash and place in a proper trash receptacle. Please do not leave the boardwalk except to conduct the chemical analysis. Choose a site that has already been impacted by visitors for the chemical analysis and fish counts.

Station #1 – Count and Observation

Introduction: Several species of pupfish are endangered. This means that their population is very small. In the case of the Devils Hole pupfish, the population exists in a very small habitat and the numbers range from a few thousand to less than a hundred. It is important for scientists to determine how many fish are living in a given area in order to decide what to do to help them.

Background: Biologists have developed a way to count pupfish within the contained environment of Devils Hole. This method can be applied to Salt Creek and Crystal Springs.

Materials: Plastic pipe rectangles (plots) (Pupfish Habitat Kit), watch, journals with data sheets, pencils.

Procedure: Have students sit along the boardwalk in a location where they can easily observe pupfish behavior. Set the "plot" in the water (this plot is a rectangle 35 X 25 cm of plastic pipe – the area within the rectangle is the area of substrate and water to be studied). Students will count the number of pupfish within the "plot" for 30-60-90 and 120 seconds and record their findings. An average will be determined from these counts. Students will complete the observation data sheet in between counts.

Station #2 – Stream Chemistry.

Introduction: Fish amaze us with their ability to live underwater. We have already learned that oxygen is dissolved in water, but how much does a fish need to survive? We now know that fish are cold-blooded animals and can adapt to temperature changes if not too extreme. But how do we know the water's temperature? We know that fish can survive in both fresh and salt water, but how does the pupfish survive in water saltier than the oceans?

Background: Fish must maintain a balance between the salts in their blood and body and those in the water around them.

Temperature: Pupfish in the Death Valley area live in one of three types of habitat: constant-temperature spring heads (pools); streams and marshes (where conditions can change daily and seasonally); or thermal streams where temperatures can regularly change depending upon surrounding conditions. In the springs, the temperature, pH, oxygen and salinity remain relatively constant. Streams and marshes can change rapidly. Most fishes never experience more than a few degrees range in temperature in a day. Temperatures in streams and marches can change as much as 50ºF in a day. Few fishes other than pupfish are able to withstand such wide daily changes.

Pupfish are one of the most heat-tolerant of all fishes. These fish gradually adjust to the changes in temperature as the season changes. A fish in the cool winter waters at Salt Creek could not survive being removed and immediately placed in water heated to the temperature of the creek in August. The adjustment must be gradual. Also, as the fish matures its ability to adjust changes. Juvenile fish appear to adjust the best to all extremes. Eggs appear to have the least tolerance and adult fish somewhere in between.

Salinity

Death Valley waters have extreme salinity due to high evaporation rates, natural salts that leach out from the rock, and a lack of rain to dilute the salts. Fishes in these desert environments have to drink more water due to the slowed rate of osmosis or the ability to equalize the salts in the body to those concentrated in the water surrounding them. Pupfish have

adapted the ability to drink water with high concentrations of salt and excrete the salts while utilizing the water. If they were not adapted in this way, they would die of dehydration.

Body salinity – Cottonball Marsh Pupfish can withstand salinities 2.5 times that of sea water and most pupfish can withstand salinities at least 2 times that of sea water.

Dissolved Gasses

The concentration of oxygen, carbon dioxide, and hydrogen sulfide in water are the important environmental factors relating to pupfish. Oxygen and carbon dioxide are generally the most critical for fish survival.

Pupfish have adapted tolerances to the lowest oxygen levels for all fishes, 0.13 – 0.22 mg oxygen/liter. Normally, water contains 50 to 70 times that concentration. Some pupfish bury their entire bodies in the mud to survive when the water has nearly evaporated away while others will bury all but their heads which continue to breathe in oxygen through their open mouths.

Activity: Determine the temperature, salinity, and dissolved oxygen of the spring or creek by conducting tests on water samples (and air temperature). With the assistance of a parent helper, have the students complete the Salt Creek/Crystal Springs Chemistry data sheets. Each group will test for salinity, dissolved oxygen, and water/air temperature.

Materials: Thermometer(s), LaMotte Salintiy kit, Chesmets Dissolved Oxygen Kit (Pupfish Habitat Kit) pencils and journals.

Procedure: Dissolved oxygen. Set out kit. Follow instructions. Adult helper required.

Salinity. Set out the kit. Teacher/adult helper performs demonstration and students record results. Students conduct the remainder of the tests.

Water/air temperatures. Distribute insulated thermometers and immersion thermometers.

**Each student/pair/group needs to take three readings of each water sample to average and find three different locations. Three readings need to be taken for air and water temperatures. These readings can be in shaded, sunny and covered areas in order to get different air and water temperatures.

When all the stations are finished the students need to complete the final data sheets in their journals.

**All temperature readings will be taken in both Celsius and Fahrenheit.*

Station #3 – Pupfish Habitat, Plants

Background: Prior to your trip review reference pages for further information on the plants most likely found at Salt Creek and Crystal Springs. Plant cards with illustrations and photographs are supplied in the Pupfish Habitat Kits.

Introduction: The environment surrounding the creek and pools is very important to the survival of the fish and the water where the fish live is extremely important to many of the plants that live in the desert. Knowing what plants live in the desert helps us learn more about how things survive here.

Activity: With the assistance of an adult helper, students use the Plant Cards to identify the plants along the boardwalk. On the data sheets the students will record the adaptations that allow the plants to survive in such a harsh environment.

Material: Journals, Plants Cards (Pupfish Habitat Kit), pencils (include crayons, colored pens or colored pencils).

Procedure: Stroll slowly along the boardwalk until you see a plant you wish to identify. Using the Plant Card, have the students decide what it is. Have the students sit and draw the plant or write a brief description of it in their journals. Then have them develop a theory as to how this plant survives in the heat, high salt soils, and dryness.

Repeat this process to complete several plants within the 20 minutes.

Station #4 – Pupfish Habitat, Animals

Background: Prior to your trip, review reference pages for further information on the animals most likely found at Salt Creek and Crystal Springs. Animal cards with illustrations and photographs are supplied in the Pupfish Habitat Kits.

Introductions: These creeks are the ribbon of life for the animals living in the desert. They twist and meander through this dry, desolate country providing relief from the heat by cooling the animal off, supplying water to plants that then provide shade and if not too salty, curing thirst. As a result, animals visit these creeks and springs. Evidence can be found of their presence through the use of several of our senses. Tracks, scat, and dens can be seen along the bank. Chew marks or galls can be found on plants. If you are quiet, you can hear the buzzing of bees and wasps. Odors left by stinkbugs or skunks can be detected (some plants can fool you by smelling like a stinky skunk).

Materials: Journals, Animal Cards (Pupfish Habitat Kit) and pencils.

Activity: With the assistance of a parent helper, students will use the Animal Track sheet to identify the animal prints in the mud surrounding the creek and complete the data sheet. Students will also record any other evidence they see, smell or hear that proves animals have been around.

Procedure: Adult helper explains the use of other senses. Groups sit quietly for 30-60 seconds and listen. Then they record the sounds they have heard (ignoring their fellow students talking). Adult helper walks around a portion of the boardwalk with the group challenging them to find other animal signs and using the Animal Cards, identifies tracks or other animal sign. These are recorded in their journals.

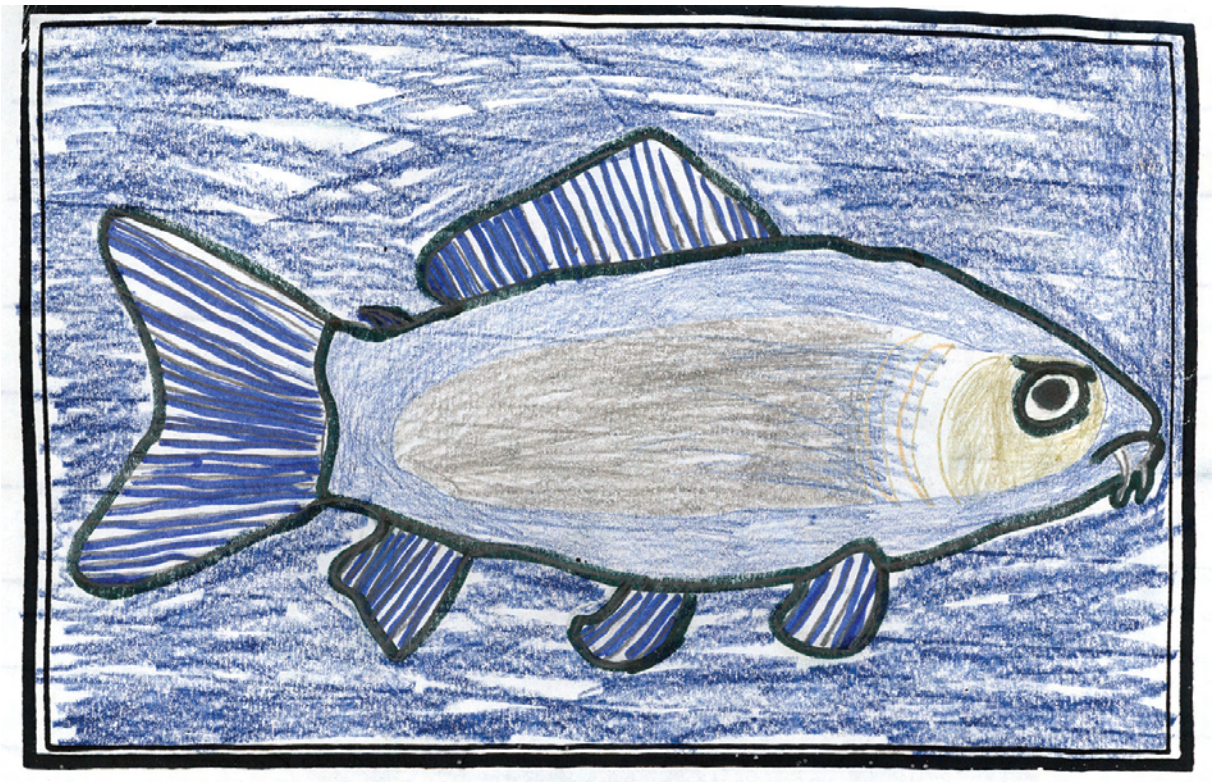
Station #5 – Pupfish Habitat Appreciation Art

Introduction: Biologists do not just record information and facts. In many journals, they record their feelings about the location and/or plants and animals they are there to study. Many write poetry, some create illustrations, and draw or paint and others create stories or prose. They become attached or emotionally involved with their work, their studies, and the habitat.

Materials: Journals, pens and art materials (crayons, colored pencils, charcoal, colored pens etc. – (please no water colors or paints that can spill).

Activity: With the assistance of a parent helper, students will find a "special' place, track, plant or scene. The student will then to write a poem and/or create an illustration of Salt Creek or Crystal Springs, pupfish habitat, or one specific item in their journal. Allow the students to be creative! If possible, bring an art kit they can use to paint, draw write or create other images.

Some stations may take more time than others for some students. The "word search" can be used as a means of keeping students busy while waiting for the entire group to complete a station. Pass out a copy and instruct the students it needs to be completed following the field trip. It can also be done at home that evening if there is no time on-site.



Chemistry Data Sheets
Dissolved Oxygen, Salinity and Temperature

Dissolved Oxygen: Record as

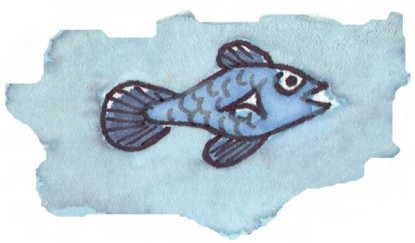
Date and Time	Location #1	Location #2	Location #3	Average

Note: Each group makes one test and gains one reading. In order to get an average, you must contact two other groups and get their readings

Salinity: Record in ppt) parts per thousand)

Date and Time	Result #1	Result #2	Result #3	Average

Note: Each group makes one test and gains one reading. In order to get an average, you must contact two other groups and get their readings



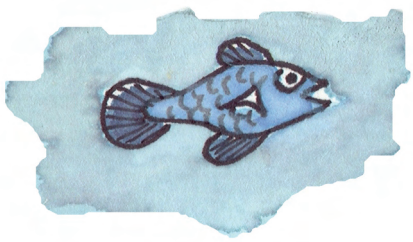
Chemistry Data Sheets
Dissolved Oxygen, Salinity and Temperature

Air Temperature: Record in degrees Celsius and Fahrenheit

Date and Time	Temperature Reading #1 (in the sun)	Temperature Reading #2 (in shady area)	Temperature Reading #3 (your choice)	Average

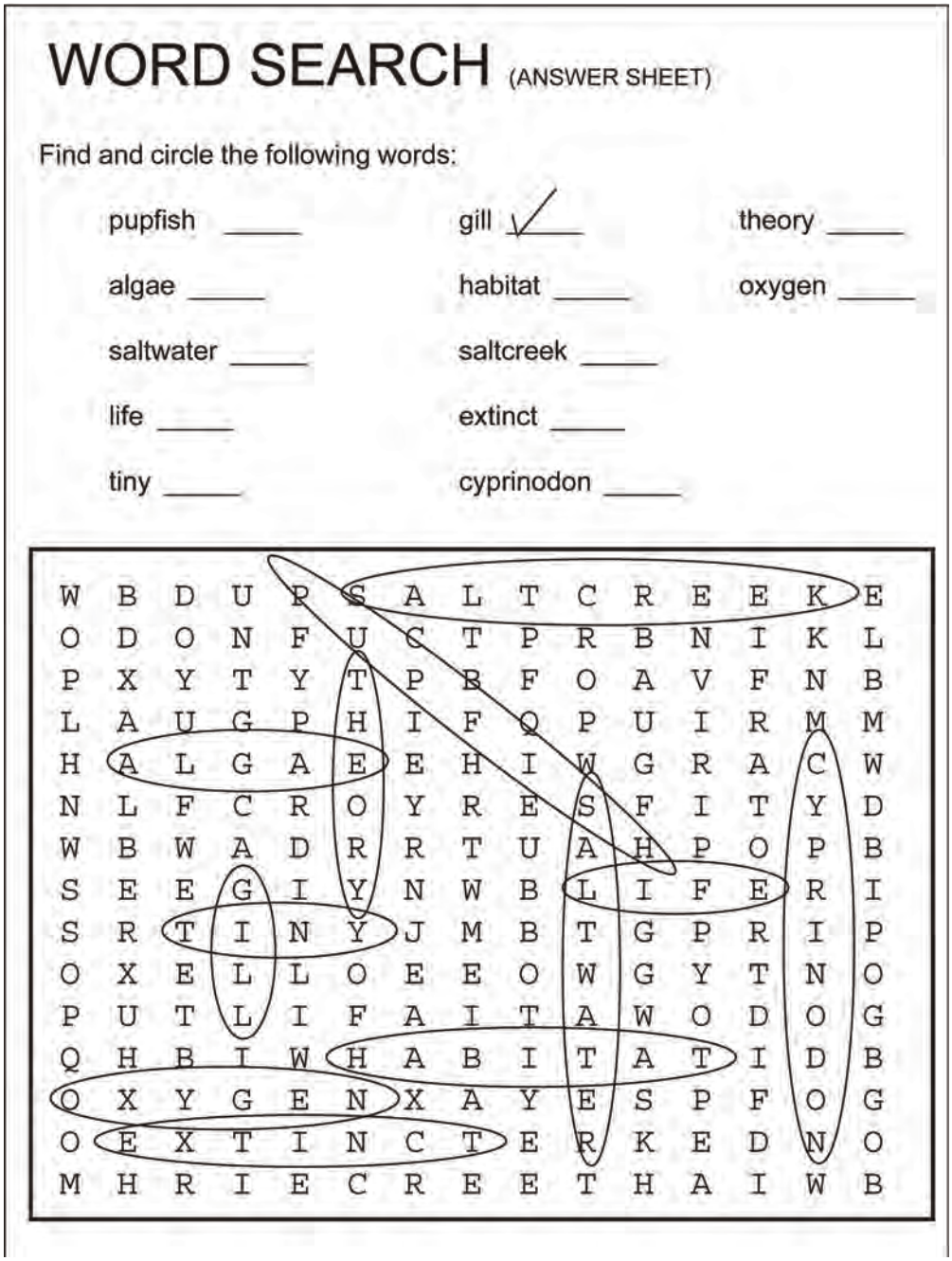
Water Temperature: Record in degrees Celsius and Fahrenheit

Date and Time	Temperature Reading #1 (in the sun)	Temperature Reading #2 (in shady area)	Temperature Reading #3 (your choice)	Average



Suggested time filler

Some stations may take more time than others for some students. The "word search" can be used as a means of keeping students busy while waiting for the entire group to complete a station. Pass out a copy and instruct the students it needs to be completed following the field trip. It can also be done at home that evening if there is no time on-site.



WORD SEARCH (ANSWER SHEET)

Find and circle the following words:

pupfish _____	gill ✓	theory _____
algae _____	habitat _____	oxygen _____
saltwater _____	saltcreek _____	
life _____	extinct _____	
tiny _____	cyprinodon _____	

W	B	D	U	P	S	A	L	T	C	R	E	E	K	E
O	D	O	N	F	U	C	T	P	R	B	N	I	K	L
P	X	Y	T	Y	T	P	B	F	O	A	V	F	N	B
L	A	U	G	P	H	I	F	Q	P	U	I	R	M	M
H	A	L	G	A	E	E	H	I	W	G	R	A	C	W
N	L	F	C	R	O	Y	R	E	S	F	I	T	Y	D
W	B	W	A	D	R	R	T	U	A	H	P	O	P	B
S	E	E	G	I	Y	N	W	B	L	I	F	E	R	I
S	R	T	I	N	Y	J	M	B	T	G	P	R	I	P
O	X	E	L	L	O	E	E	O	W	G	Y	T	N	O
P	U	T	L	I	F	A	I	T	A	W	O	D	O	G
Q	H	B	I	W	H	A	B	I	T	A	T	I	D	B
O	X	Y	G	E	N	X	A	Y	E	S	P	F	O	G
O	E	X	T	I	N	C	T	E	R	K	E	D	N	O
M	H	R	I	E	C	R	E	E	T	H	A	I	W	B

Word Search

WORD SEARCH

Find and circle the following words: (Check off the word when found:)

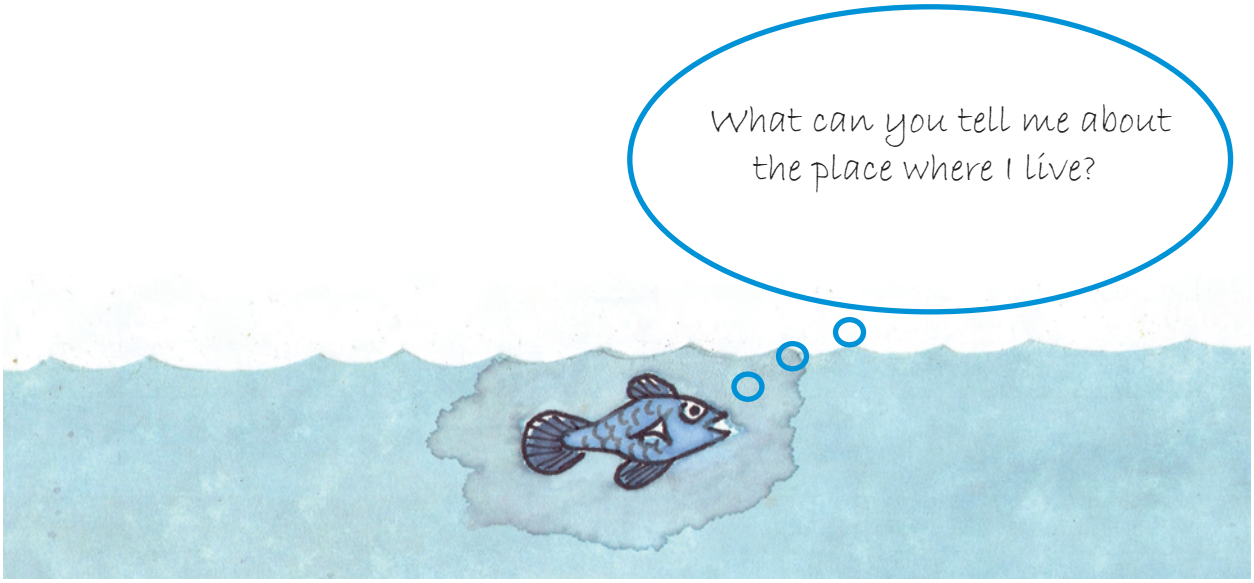
pupfish _____	gill ✓	theory _____
algae _____	habitat _____	oxygen _____
saltwater _____	saltcreek _____	
life _____	extinct _____	
tiny _____	cyprinodon _____	

W	B	D	U	P	S	A	L	T	C	R	E	E	K	E
O	D	O	N	F	U	C	T	P	R	B	N	I	K	L
P	X	Y	T	Y	T	P	B	F	O	A	V	F	N	B
L	A	U	G	P	H	I	F	Q	P	U	I	R	M	M
H	A	L	G	A	E	E	H	I	W	G	R	A	C	W
N	L	F	C	R	O	Y	R	E	S	F	I	T	Y	D
W	B	W	A	D	R	R	T	U	A	H	P	O	P	B
S	E	E	G	I	Y	N	W	B	L	I	F	E	R	I
S	R	T	I	N	Y	J	M	B	T	G	P	R	I	P
O	X	E	L	L	O	E	E	O	W	G	Y	T	N	O
P	U	T	L	I	F	A	I	T	A	W	O	D	O	G
Q	H	B	I	W	H	A	B	I	T	A	T	I	D	B
O	X	Y	G	E	N	X	A	Y	E	S	P	F	O	G
O	E	X	T	I	N	C	T	E	R	K	E	D	N	O
M	H	R	I	E	C	R	E	E	T	H	A	I	W	B

The World of the Small

What did YOU experience in the Pupfish World!

Following Your Visit



Activity #6

What Does it All Mean?

Time: 1 hour

Introduction: A scientist spends many hours conducting research. They read everything that is in print on their subject. They conduct tests in the lab and in the field. They observe the object they want to study. Then they develop a hypothesis to explain what they have seen and researched. They spend hours and hours trying to prove their theory incorrect. Thus far, we have done the research and the tests. Is there a hypothesis we could test?

Background: Pupfish live in small, isolated habitats. They survive under extreme conditions and have for thousands of years. What would happen if these habitats were lost?

Objectives: Students will be able to –

1. Relate what they have researched to what may happen in the future

2. Discuss the relationships between what they tested for and what the fish need to survive.

3. Communicate what makes these fish different or special based upon what they were able to observe and learn.

Activity: Presentation of journals and discussion of the future of these tiny fish.

Materials: Completed journals.

Procedure: Have each student present their artwork or poem to the class. The student can also state why they chose to write or draw that specific thing. They can also state what is unique or special to them about these fish and surrounding environment. This is followed by a brief discussion of the comparison between their home and Salt Creek/Crystal Springs. What does this mean about the fish habitat? What would happen if the water were to dry up or other conditions were to change?

Activity #7

Agree or Disagree

Introduction: Refer to Activity #1 - Agree or Disagree. Time: 1 hour

Background: Information is the basis for making all decisions. Gaining information on a subject allows us to differentiate evidence from opinion. Scientists do not rely on claims or conclusions unless they are backed by observations, but all scientists begin with a hypothesis and opinions of their own. Each of these students began this research with their own opinions.

Objectives: students will be able to –

1. Review their own answers and see if they have changed.
2. Discuss the difference between opinions and facts.
3. Practice writing skills (art).

Materials: Journals, pencil or pen

Activity: Written and verbal response to questions asked before the experiment.

Procedure: Have students turn to their last page of questions. They should not review the previous answers! Ask the student to respond again with "agree" or "disagree"!! Have them record their answers, but also respond in class by putting their thumbs up if they agree and thumbs down if they disagree.

Questions:

1. Humans are part of the environment.

2. Fish are good for food and sport and not part of the food chain.

3. All fish are the same.

4. It is important to protect fish and their habitat.

5. Fish are only found in clean, fresh, cool water.

6. Studying science is boring.

7. Science lets us look at things more closely.

8. The life of big things (organisms) is more important than the life of little things (organisms).

9. The desert is an empty place.

10. Things remain the same on earth from one day to the next.

Discussion: Ask students to share if what they learned changed the way they answered the questions and why or why not.

Ask students to turn in journals for review.

The World of the Small

Common Plants of Crystal Springs

There are a variety of plants found in and around Ash Meadows. Many of them are present along the boardwalk at Crystal Springs. Typically one would think the main stresses that desert plants face are heat and lack of water. However, Ash Meadows is an oasis within the Mojave Desert and there is water around the springs, spring pools and unseen underground. The plants living here are still subject to extremes in heat and many are unique because they have been isolated from other plant relatives for many years.

Ash Meadows is an island within the Mojave Desert. Although islands are technically defined as areas of land surrounded by water, this area is a wetland surrounded by dry desert. It has taken thousands of years for the water to run off, evaporate and disappear from the desert. The plants (and animals) that survived were ones that either adapted to the severe desert conditions or found water in isolated locations. Ash Meadows is one of those isolated locations where plants survived over thousands of years.

These plants are an important food source for pupfish. As the plant dies, parts fall or are blown into the creek. Decomposing fungi and bacteria grow on the surface of the leaves and stems. When the dead and decomposing material becomes small enough, the pupfish eat the particles digesting the bacteria and fungi off the surface, often passing the plant material through its digestive system and starting the cycle over again. Even though these plants are growing on land, they play an important role in the lives of the pupfish.

Inland Saltgrass *(Distichlis spicata)*

This is the most obvious grass growing along the boardwalk. This grass has special salt glands to remove the excess salt from its tissues. The salt accumulates on the leaves. Look closely at the leaves and see if you can see salt crystals. This plant tolerates high concentrations of sodium (salt). The Southern Paiute, and probably others, used the grass to make matting, cordage, basketry and other items.

Velvet Ash *(Fraxinus velutina velutina)*

This tree is what gives Ash Meadows its name. This subspecies of ash tree has adapted to the dry conditions of the Mojave Desert, assisted by the presence of springs. At one time, this area had many large groves of ash trees. Due to early settlers removing them for homes, agricultural fields and roads, there are far fewer today than when this area was shared by the Paharmp Paiutes and Timbisha Shoshone. These trees provide a location for birds to nest and the seeds are eaten by birds and small mammals. As they grow, the trees provide a great quantity of shade – appreciated within the desert.

Screw Bean Mesquite *(Prosopsis pubescens)*

This prickly deciduous tree and its cousin the Honey Mesquite (Prosopsis glanulosa) were the staple for the Native peoples who lived in this area. The pods were ground to make sweet, nutritious flour. These same pods provide food for birds, small mammals, and insects. It can represent as much as 75% of the coyote's diet during the middle of the summer.

Mesquites grow extremely deep roots to collect water and have tiny, compound leaves that do not transpire as much as plants with a large leaf surface. The spines protect it from predation by many types of animals such as horses and cattle.

Alkali Sacatone Grass *(Sporabulus arioides)*

A beautiful and delicate plant when seen blowing in the winds around the boardwalk, this grass is important to the survival of many of the animals within Ash Meadows. The tiny seeds are food for insects and small mammals. True bugs lay eggs on the stem of the plant to over winter in the protection of the space between the leaf and stem. In the spring they hatch and take advantage of their location by sucking out the succulent juice of the grass. Early desert travelers considered this grass a reliable indicator of water sufficiently fresh to drink within a few feet of the surface.

Quail Bush *(Atriplex lintiformus)*

Also known as a "salt bush", it is a halophyte. The word halophyte means salt (halo) plant (phyte). It has developed adaptations to overcome excess salt in the tissues. It secretes the salt from its leaves, thus also making it less tasty to the plant eaters (herbivores) living in the area. It can compete with other plants by growing in locations with more salt and less water. It has a deep tap root to gather water from the depths of the soil. It gets its common name "quail bush" because it is a popular food for quail. If you pay attention you might see or hear a Gambel's quail in these bushes along the boardwalk.

Coyote Brush *(Baccaris emoryi)*

This moisture-loving plant is one of the tallest brushes found in the refuge. It can be found near most of the spring pools and along the stream channels. It provides a home to a variety of insect species seeking protection, shade and cover from birds, lizards and other insects. Insects use this plant to lay their eggs which in turn form galls. Galls are colorful and unusual deformations of the growing plant tissues. This plant is dioecious, which means the male and female flowers are found on different individual plants. The females produce the fuzzy fruits which give the plant its common name. In the fall, this bush will produce an abundance of white, furry seeds that resemble a coyote's tail.

Cattail *(Typha domingensis)*

These tall, green plants are adapted to having their roots in water and thus are found only along the streams and pools throughout Ash Meadows. Cattails have minute, brown colored male flowers (staminate) thickly clustered on a club-like spadix and lower portion of the spadix bares the female flowers (pistillate). Cattails were a valuable plant to Native Americans. The roots can be eaten cooked like a potato or raw like a radish. The pollen was added to flour to increase nutrition and as a seasoning. The seed case that we think of as the "cat's tail" is made up of thousands of downy, umbrella-like attachments allowing the seeds to carry long distances in the wind. This soft, "cat's tail" is very absorbent and was used for diapers for both Native Americans and early settlers. Although the cattail is native to this area, it has gotten "out-of-hand" by growing into the spring channels where it clogs up the springs

and forces water to flow over the surface of instead of following the stream channels. Today, Ash Meadows staff removes cattails by cutting them off at the base.

Ash Meadows also has eight endemic (only grows here) plant species:

Amargosa niterwort *(Nitrophila mohavensis)*

Spring-loving centaury *(Centaurium namophilum)*

Ash Meadows milk-vetch *(Astragalus phoenix)*

Ash Meadows sunray *(Enceliopsis nudicaulis var. corrugate)*

Ash Meadows ivesia *(Ivesia eremica)*

Ash Meadows gumplant *(Grindelia fraxino-pratensis)*

Ash Meadows blazing-star *(Mentzelia leucophylla)*

Ash Meadows lady's tresses *(Spiranthes infernalis)*

Common Plants of Salt Creek

Plants are an important food source for pupfish. As the plant dies, parts of it fall or are blown into the creek. Decomposing fungi and bacteria grow on the surface of the leaves and stems. When the detritus (dead matter) becomes small enough, the pupfish eat the particles digesting the bacteria and fungi off the surface. Then the plant material passes through the fish's digestive system and the cycle starts again. Even though these plants are on land they play an important role in the lives of the pupfish.

There are four common plants found in the lower Salt Creek drainage. As one might think, the main stresses that desert plants face are heat and lack of water. In low elevations, where water and minerals pool, salt can also stress plants. Nearly all plants found in Death Valley have adaptations to overcome these stresses. The four plants described below are "halophytes." The word halophyte means salt (halo) plant (phyte). They each have adaptations to overcome excess salt in their tissues. Three of the plants discussed are flowering plants. Each produces very small flowers and relies on the wind for pollination. Making beautiful flowers to attract insects and hummingbirds is an energy expensive process that desert plants often cannot afford.

Inland Saltgrass *(Distichlis spicata)*

This is the only grass growing along the boardwalk. This grass has special salt glands to remove the excess salt from its tissues. The salt accumulates on the leaves. Look closely at the leaves and see if you can see salt crystals. This plant not only tolerates high concentrations of sodium (salt) but also high concentrations of boron. Boron is a mineral that Death Valley miners considered very valuable. Would you look for this plant if you were prospecting for boron? The Southern Paiute, and probably others, used the grass to make matting, cordage, basketry and other items.

Desert Holly *(Atriplex hymenelytra)*

This shrub is also called Salt Bush and is one of the best known of Death Valley's plants. It is called Desert Holly because of the shape of its silver or gray leaves. During the hot and dry summers the leaves develop a reddish or pinkish tint. During the growing season the leaves take on a greenish hue. This plant is dioecious, which means the male and female flowers are found on different individual plants. Look carefully at different plants. Can you find a male plant and a female plant?

Pickleweed *(Allenrolfea occidentalis)*

The stems of this shrub, also called Iodine Bush, are unique and look like little pickles strung together. It is probably the most common plant along the Salt Creek boardwalk. It favors alkaline (salty and a pH of over 7.0) soils. If you want to see the leaves and flowers of this plant you will need a hand lens as they are very tiny. This shrub has two adaptations for dealing with salt. First, it is believed that having its juicy stems allows it to store more water

and thus dilute the salts contained within stems and leaves. Second, Iodine Bush has a salt pump that removes sodium and replaces it with less toxic potassium. The energy to run the pump comes from photosynthesis.

Mojave Seablite *(Suaeda moquini)*

This plant is the least salt tolerant of the four. This means it is less able to live in salty soils. It can be found along the outside edges of the wet zones where the salts have been diluted by increased water flow. Look for a dark green shrub with a bluish tinge and a scraggly appearance. It has a number of assumed names including Desert Blite, Bush Seepweed. and Inkweed. A light black ink and dye can be made from it. This was a very useful plant for the Indians. Its seeds were sometimes eaten. The herbage (green parts) was eaten raw and cooked as greens (similar to spinach). The leaves and stems were mashed and the poultice used for cuts and to relieve itching from chicken pox. A tea was made to ease bladder and related problems. Seablite is a defender of its territory. It stores excess salt in its leaves dropping them at the end of the growing season. The salt from the leaves increases local surface soil salt creating soils too salty for many other plants to grow in.

Common Animals of Crystal Springs

The animals found in Ash Meadows NWR and along Crystal Springs have adapted to living in the hot and arid conditions of the desert, taking advantage of the closeness to life-giving water. The water of Crystal Springs, and the other springs found within Ash Meadows, is a vital source of drinking water for many of these desert animals. The presence of animals along the boardwalk indicates that other resources important to them, such as food or shelter, can also be found at Crystal Springs. Mammals, reptiles, birds and insects are all seen here. Some of the animals that may be seen during the field trip are described below.

Common Zebra-Tailed Lizard *(Callisaurus draconoides)*

Zebra-tailed lizards are often referred to as the clowns of the desert. They can run very fast carrying their striped tails proudly above their heads. They are the fastest lizards within the Mojave Desert. They need to be fast because they can often be prey to many other animals and birds, including other lizards such as the leopard lizard. Zebra tails will burrow into the sand at night for protection. During the day, they are around the boardwalk in search of insects, which are abundant both on the ground and in the air.

Desert Side-blotched Lizard *(Uta stansburiana)*

The side-blotched lizard is small and can heat its body quickly in the sun; because of this it is one of the few species of lizards in Ash Meadows that is active during the cold winter months. If you find a lizard that looks like it has sweat stains under its "armpits" it is a side-blotched lizard. It eats mainly insects and spiders and gets most of its water from its prey. It will occasionally eat plant material, perhaps to increase its water intake. Despite its ability to gain water elsewhere, it is a frequent visitor to the Crystal Springs Boardwalk.

Coyote *(Canis latrans)*

The coyote is an incredibly adaptive animal. It can adjust its behavior and diet to suit almost any environment found in North America. It is a predator of small animals, hunting rodents, rabbits, birds and reptiles, and when these are not readily abundant it will eat plant materials like mesquite beans. The coyote can be described as an "opportunivore" feeding on small animals, insects, carrion, garbage and seeds. Due to its intelligence and adaptability, its range and population is increasing despite human attempts to control and even reduce its population. One can find coyotes in big cities such as Las Vegas, Nevada. The coyote demonstrate cunning intelligence and so is portrayed as the trickster in many Native American stories. Although not often seen during the day, evidence of coyote's presence can often be found around the boardwalk.

Roadrunner *(Geococcyx californianus)*

The familiar cartoon character of the roadrunner as a clever and extremely fast racer has been planted firmly in our minds. It is true that it can run up to 18 miles per hour after its prey, but more typically it is found sitting quietly and scanning for small mammals or insects to come its way. It is one of the only animals known to attack rattlesnakes. Pairs sometimes

hunt them cooperatively – one bird distracts the snake while the other sneaks up and pins its head. They then kill the snake by bashing its head against a rock. It adapts to the heat by staying in cool, shady areas during the heat of the day to emerge in search of a meal when the sun sets.

Phainopepla *(Phainopepla nitens)*

These omnivorous (eating both plants and animals) bird can be seen in the winter, spring and fall in their favorite trees – the Mesquite. Their diet includes bugs, caterpillars, beetles and berries. They are closely tied to the availability of mistletoes (Phoradendrons) – parasitic plants that grow on the trunk and branches of plants (including mesquite). These birds are a primary source for spreading the mistletoe throughout the birds' range. Phainopepla adapts to its environment by migrating to cooler climates during the summers' high temperature then returning to the waters of Ash Meadows in the fall.

Dragonflies and Damselflies *(orders –Odonata; Anisoptera and Zygotera)*

Dragonflies and damselflies are amongst the most conspicuous of all insects, most especially near the pools and springs at Ash Meadows. Dragonfly and damselfly eggs are laid in or near the water and the naiads (immature young) live within the water until they have grown and metamorphosed into adults (taking anywhere from a few months to 4 years). Just before they emerge from their youthful casings, they crawl upon a leaf or stem then break out and emerge as the beautiful fliers we know. At certain times of the year, the left over skeletons can be found attached to the sides of cattails and reeds.

Dragonflies are large with bright colors and enormous compound eyes. These eyes allow them to prey on other flying insects, catching them in their large, protruding mandibles while on the wing. When dragonflies land on a stem, they leave their stained-glass like wings spread wide, resembling small planes. The dragonfly naiads are stocky and slow-crawlers over rocks and debris. When they need to move fast, however, they can squirt a jet of water from their abdomens that will propel them long distances in search of prey.

Damselflies are smaller, equally as colorful as their dragonfly cousins, and more delicate-looking. Their wings close primly when they perch. Like the dragonfly, their feet are adapted for grasping, not walking. You will rarely find a damselfly on the ground unless they are grasping a blade of grass or stock of reed. Naiads are also found in the water, but do not resemble those of the dragonfly. They are longer, more slender without the clumsy appearance.

Black-tailed Jackrabbit *(Lepus californicus)*

Although it is called a "rabbit" it is actually a hare. Hares are different from rabbits because hare babies (leverets) are born with all their fur and their eyes are open. This helps the young to escape predators soon after birth. Jackrabbits have huge ears and can absorb heat or cool off through them. They prefer to live in open areas where they can see their predators coming from a long distance. This makes sense since their major means of escape is by using their long, rangy legs to outrun the predators (running up to 36 mph).

Desert Cottontail *(Sylvilagus audubonii)*

These true rabbits (young is born hairless and blind) have large erect ears with dark tips, similar to their Jackrabbit cousins. They are smaller than Jackrabbits and can be easily distinguished by characteristically upturned white, fluffy tail (that looks like a cotton ball). These rabbits are commonly found in groups (the Jackrabbit is a solitary hare). Young cottontails can be seen foraging during the day, but the adults are rarely away from the protection of the shade until the sun sets.

Both cottontails and jackrabbits are "herbivores" eating grasses, leaves and twigs. They conserve water by eating their food twice. This is kind of gross, but they will eat their own poop to gain all the moisture, minerals and nutrients. They are preyed upon by larger mammals such as coyotes and bobcats as well as large birds such as hawks and owls.

Bull Frog *(Rana catesbeiana)*

Bullfrogs are the largest frogs in the United States ranging in size from 3.5 to 6 inches in length. They have a distinctive call that is sometimes described as a deep "jug-a-rum" sound. These large frogs originally lived in the Eastern and Midwestern US, but were brought west for sport hunting and as a food source. At Ash Meadows they were introduced to ponds for food when the area was privately owned. Bullfrogs eat anything that they can swallow! This includes insects, other frogs, crayfish, earthworms, lizards, . . .and fish eggs, fish larvae and adult pupfish. Since these amphibians are not "native" to these waters and thus not natural to this habitat, the Fish and Wildlife Service is trying to remove them and other non-native species such as the crayfish. By removing these predatory animals that also compete for food, it is hoped that the pupfish and other native fishes will continue to survive and possibly even increase in number.

Common Animals of Salt Creek

The animals found in Death Valley and along Salt Creek have adaptations allowing them to live in the hot and arid conditions of the desert. The Salt Creek water is not a source of drinking water for the desert animals. If animals or humans were to drink the water from most of Salt Creek, it would dehydrate them and worsen their condition. The presence of animals along the boardwalk indicates that other resources important to them, such as food or shelter, can be found at Salt Creek. Mammals, reptiles, birds and insects are all seen at Salt Creek. Some of the animals that may be seen during the field trip are described below.

Common Zebra-Tailed Lizard *(Callisaurus draconoides)*

Zebra-tailed lizards are often referred to as the clowns of the desert. They can run very fast carrying their striped tails proudly above their heads. They are the fastest lizards within the Mojave Desert. They need to be fast because they can often be prey to many other animals and birds, including other lizards such as the leopard lizard. Zebra tails will burrow into the sand at night for protection. During the day, they are around the boardwalk in search of insects, which are abundant both on the ground and in the air.

Desert Side-blotched Lizard *(Uta stansburiana)*

The side-blotched lizard is small and can heat its body quickly in the sun; because of this it is one of the few species of lizards in Death Valley that is active during the cold winter months. If you find a lizard that looks like it has sweat stains under its "armpits" it is a side-blotched lizard. It eats mainly insects and spiders and gets most of its water from its prey. It will occasionally eat plant material, perhaps to increase its water intake.

Coyote *(Canis latrans)*

The coyote is an incredibly adaptive animal. It can adjust its behavior and diet to suit almost any environment found in North America. It is a predator of small animals, hunting rodents, rabbits, birds, and reptiles, and when these are not readily abundant it will eat plant materials like mesquite beans. The coyote can be described as an "opportunivore" feeding on small animals, carrion, garbage and seeds. Because of its intelligence and adaptability, its range and population is increasing despite human' attempts to control and even reduce its population. One can even find coyotes in big cities such as Los Angeles, California. Several coyotes in Death Valley National Park have learned to beg for food from visitors. It is unhealthy for the coyote to eat human food and dangerous to feed them. Do not feed any wild animals in any National Park. The coyote demonstrate cunning intelligence and so is portrayed as the trickster in many Native American stories.

Merriam Kangaroo Rat *(Dipodomys merriam)*

Kangaroo rats are amazing animals; they can live their whole lives without drinking one drop of water. They have a multitude of adaptations to the lack of water in the desert. The best way to beat the heat of the desert is to not be in the sun. The kangaroo rat is nocturnal, sleeping in a plugged burrow during the day and emerging at night. By plugging the entrance

to its burrow, its sleeping quarters are more humid and cooler than the above ground environment. The seeds and plant materials that the rat has stored there absorb some moisture lost by the kangaroo rat during breathing. Perhaps the most incredible adaptation is the kangaroo rat's ability to make its own water during the digestion of its food. When the animal eats plant material it regains some of that lost water. The kangaroo rat's kidneys are very efficient and its urine is five times more concentrated than humans'.

Say's Phoebe *(Sayornis saya)*

This brown and rust-colored flycatcher makes its living catching insects. It is particularly fond of bees, wasps, and ants, but will eat many other bugs and occasionally berries, and even pupfish. It can be seen flitting from perch to perch in search of its food. Birds have the advantage of flight and use it to find safe drinking water in the desert and to fly to higher elevations or latitudes to escape the heat of summer.

Raven *(Corvus corax)*

The raven is another very intelligent and adaptable animal and, like the coyote, can be found almost anywhere in North America. In stories told by the Native Americans of the Pacific Northwest, it replaces the coyote in playing the role of the trickster. The raven is one of the smartest birds on the planet and has been known to use tools to get to both water and food. The raven is another "opportunivore" and feeds on small animals, carrion, garbage and seeds. It mates for life and often hunts cooperatively with its mate. It is believed that increased human presence in the deserts of California has lead to greater raven numbers in this area. It has been suggested as one of the reasons for the decline in the threatened desert tortoise population, another good reason not to purposely or accidentally feed wildlife.

White-throated Swift *(Aeronautes saxatalis)*

Swifts are capable of doing almost anything while flying. In fact, some swift species do not land at all during the first two years of their life, landing at the end of their second year to nest. In the evening, some swifts will climb very high in the sky and sleep on the wing. The swift is another insect eater and can catch bugs while flying at speeds of 80 miles per hour. In fact, the white-throated swift may be the fastest North American bird. It has been seen escaping a hunting peregrine falcon at speeds of more than 200 miles per hour! They nest mainly in and on cliffs. In order to see them at Salt Creek, you may need to crane your neck skyward.

Loggerhead Shrike *(Lanius ludovicianus)*

The shrike is also known as the butcherbird because of its habit of impaling its prey on mesquite thorns or any other sharp object it can find (such as barbed wire). The butcherbird has a very good memory, returning to skewered food up to eight months later. It looks like a stocky little mockingbird with a black mask. It can be seen hunting from exposed perches from five to fifteen feet off the ground. Shrikes are the only predatory songbirds and prefer to eat insects. When insects are not abundant they will kill small birds, mice, horned and side-blotched lizards, and other reptiles and amphibians.

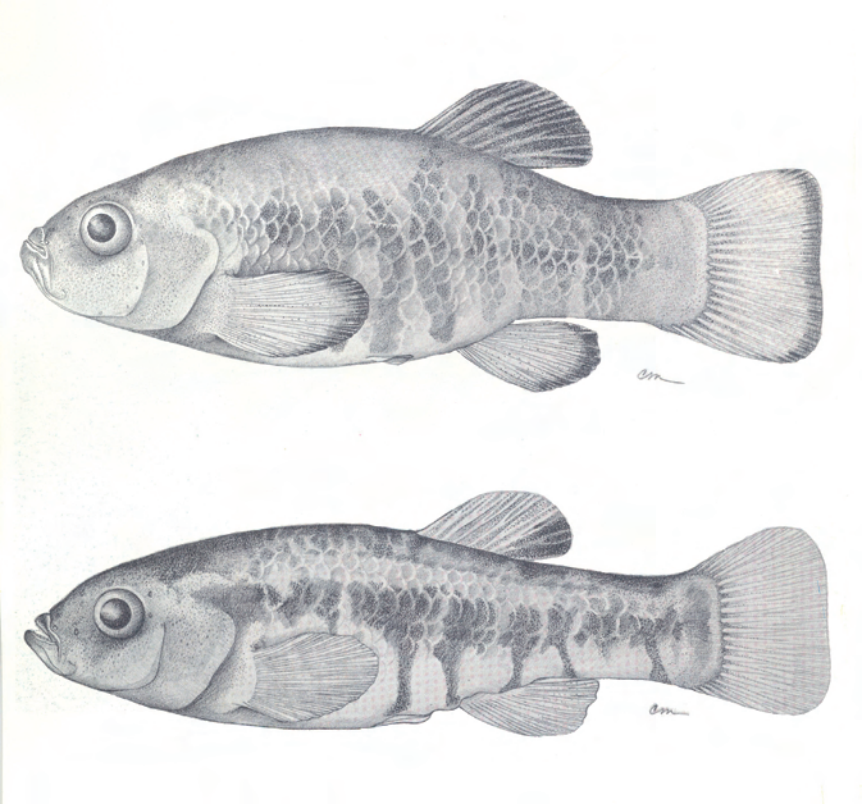
Great Blue Heron *(Ardea herodias)*

The great blue is the largest North American heron, standing four feet tall. It eats mainly fish and probably won't be found at Salt Creek unless the pupfish are also present. The great blue's bill is massive and allows it to eat fish much larger (12 to 14 inches long) than the pupfish. When fish are difficult to catch, it will switch to frogs, mice, rats, gophers, and ground squirrels, and other small animals. Some say that "patience is a virtue". If true, it can be learned from this bird. The heron stands motionless at the edge of a lake, river or stream for long periods of time and waits for its prey to come within striking distance of its long neck and power bill and then strikes with incredible speed.

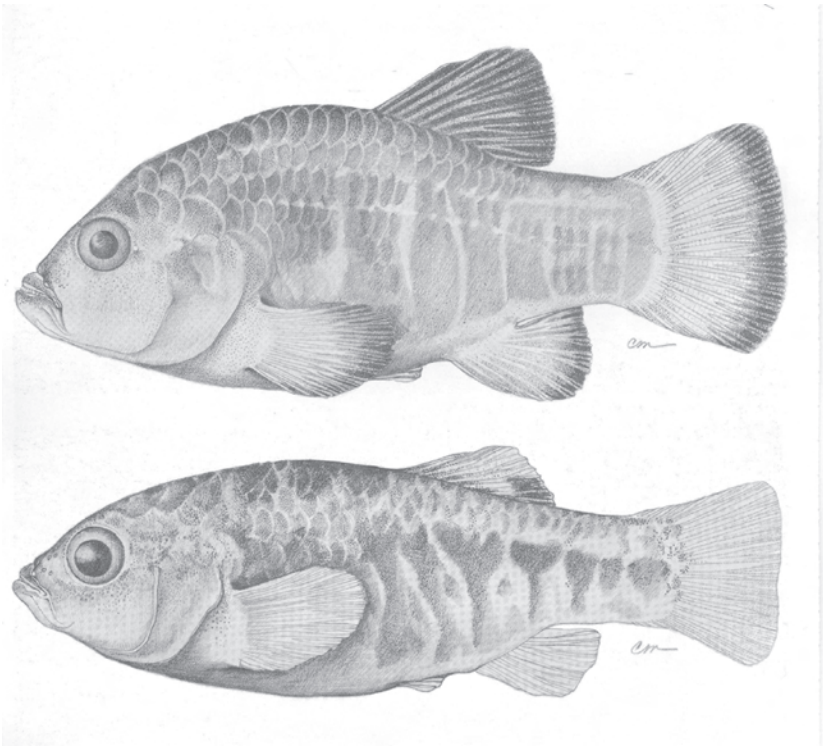
Caddisfly *(Order – Trichoptera; Family – Limnephilidae)*

These moth-like insects spend most of their lives as "youngsters" or aquatic larvae in the waters of lakes, ponds, and streams. Caddisfly larvae generally form a casing made from their "silk" which is sticky. Pebbles, debris, and other material stick to the silk to form a "cocoon-like" structure around the larvae for camouflage as protection against predators and as a means to collect food. Salt Creek's caddisfly larvae look like fine, tan tubes about 3/4" long moving over rocks and along the creek floor. As larvae they provide food for wading birds and as adults they provide food for birds such as the swifts flying above the creek.

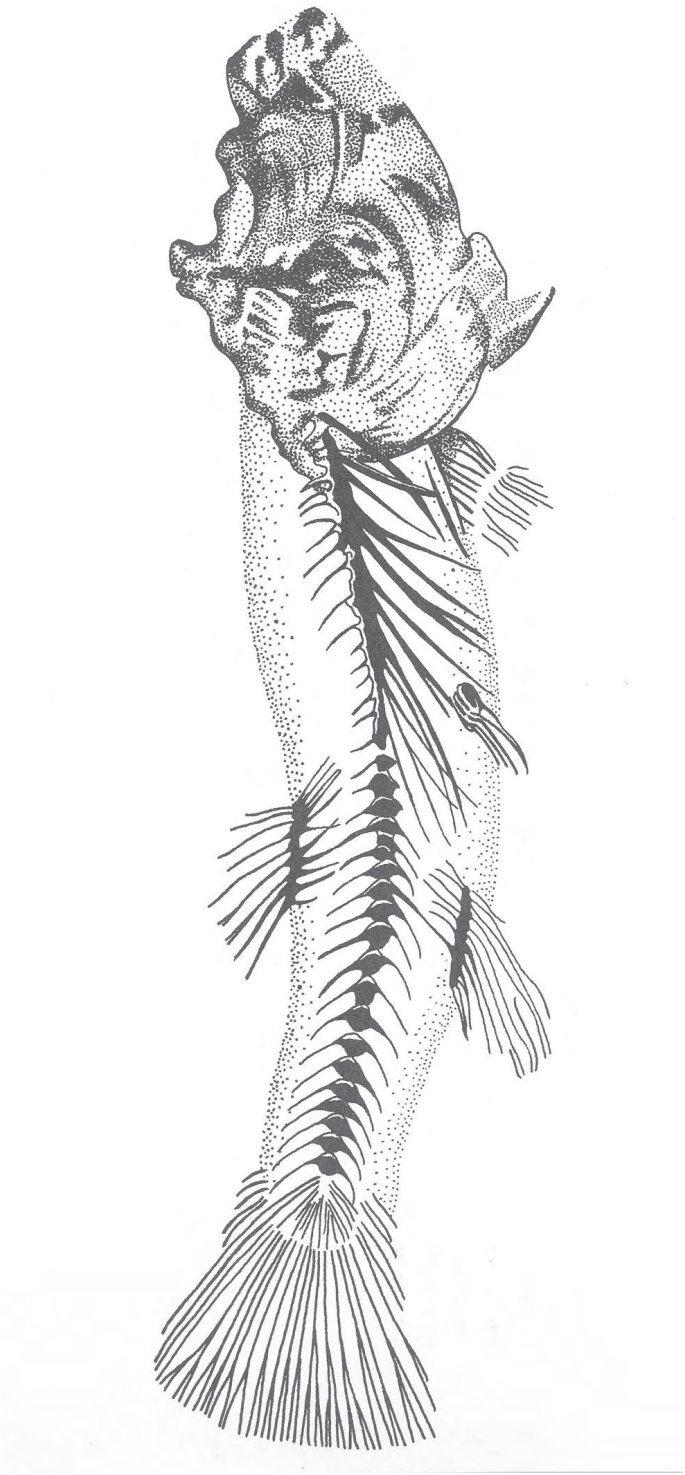
Cyprindon salinas salinas – **Salt Creek Pupfish**



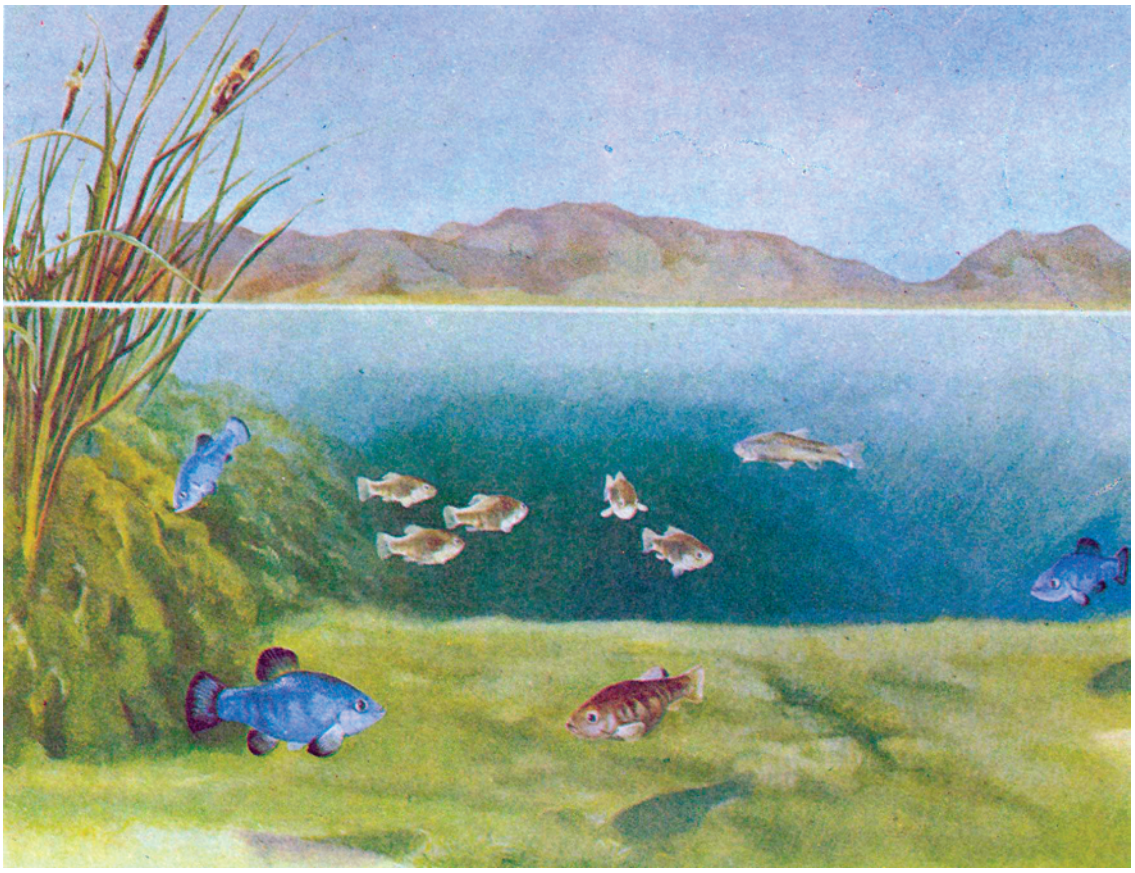
Cypridnon nevedensis – **Amargosa Pupfish**

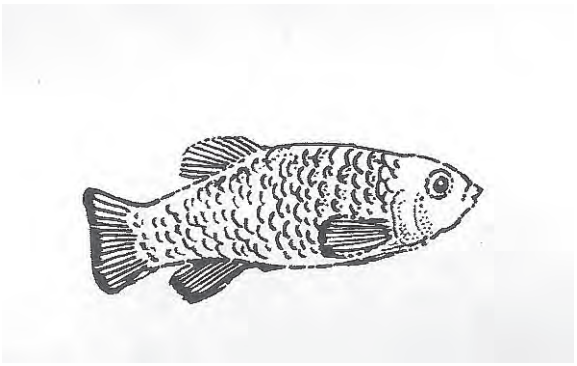


How We Know What Was Here – Death Valley Region Fossil Fish

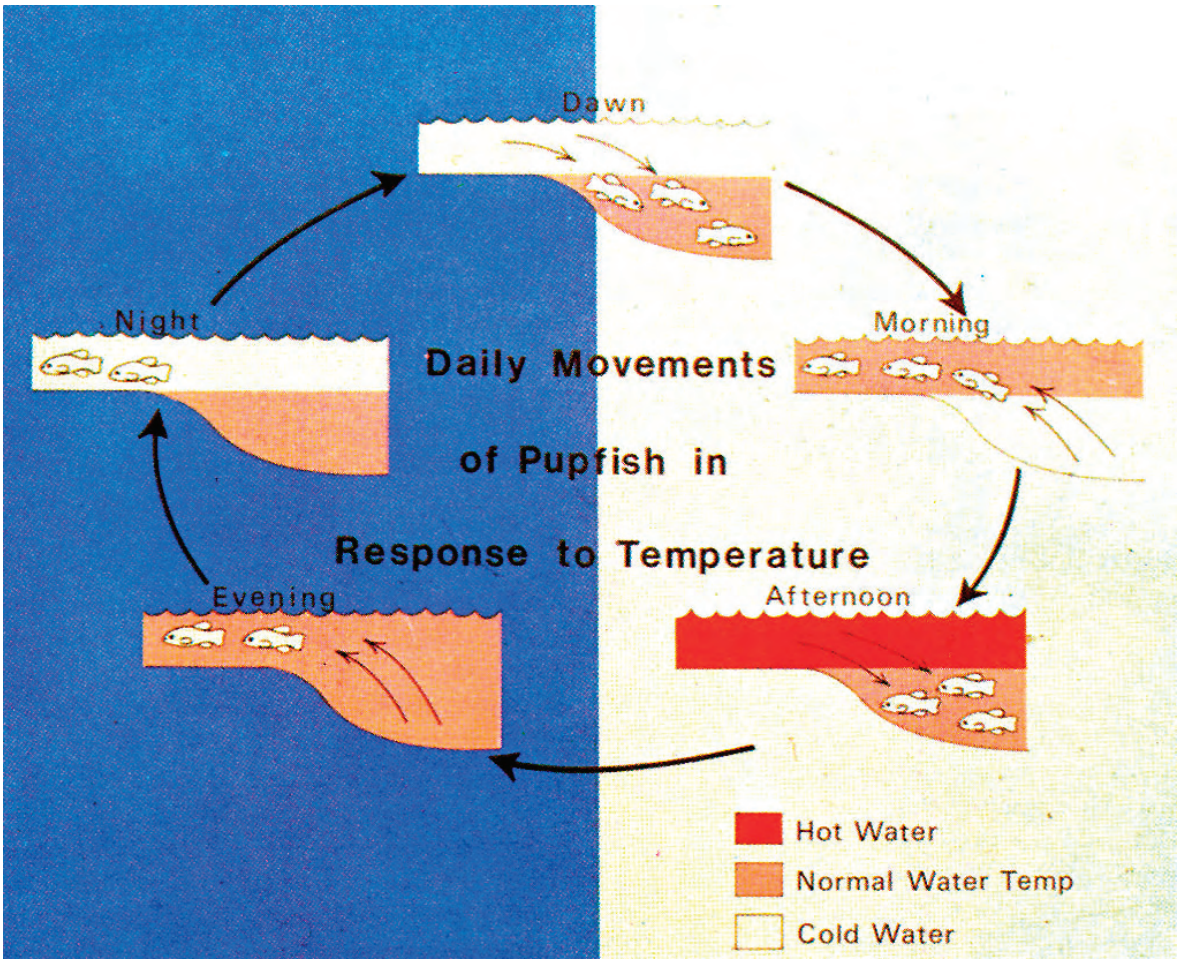


Pupfish

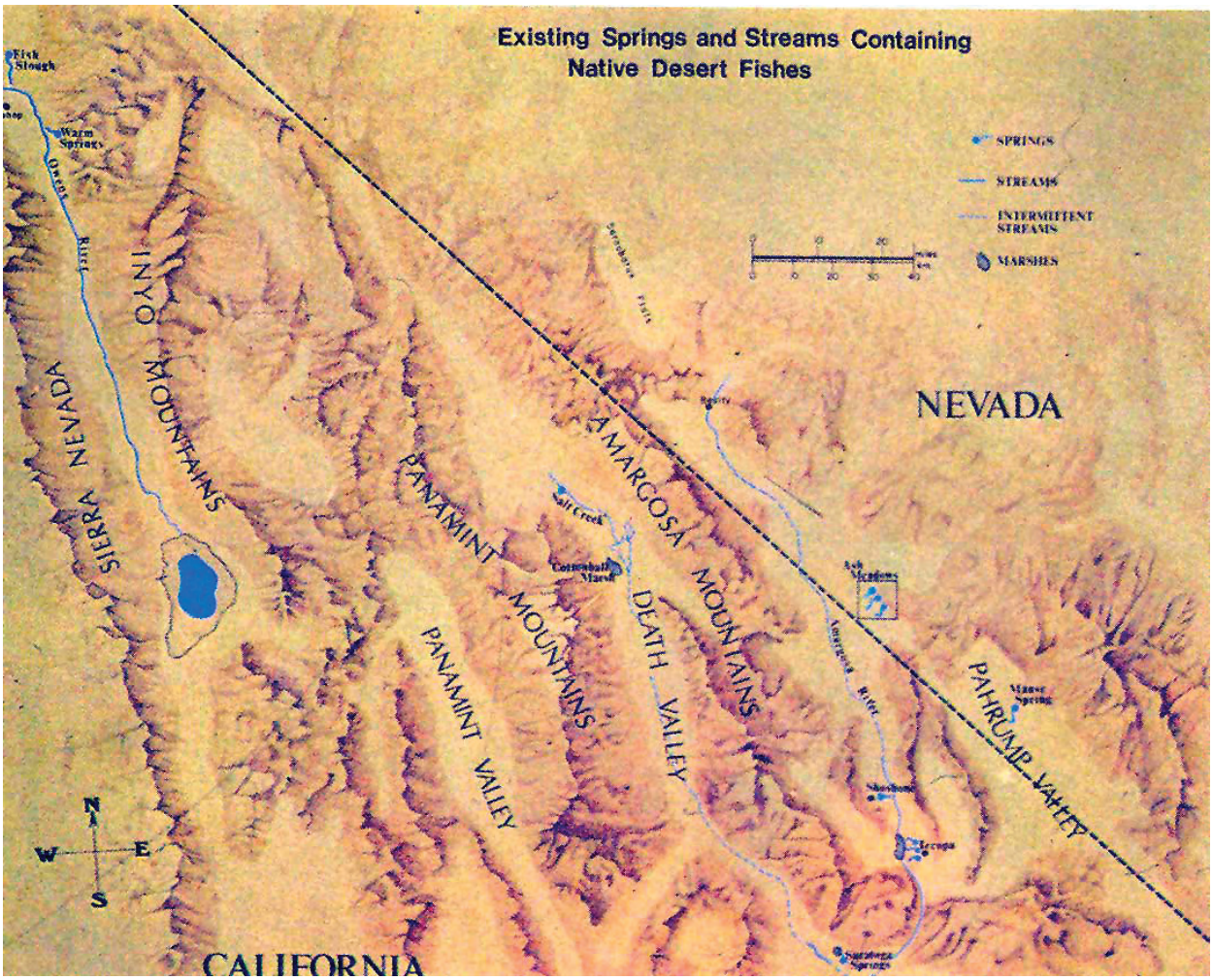




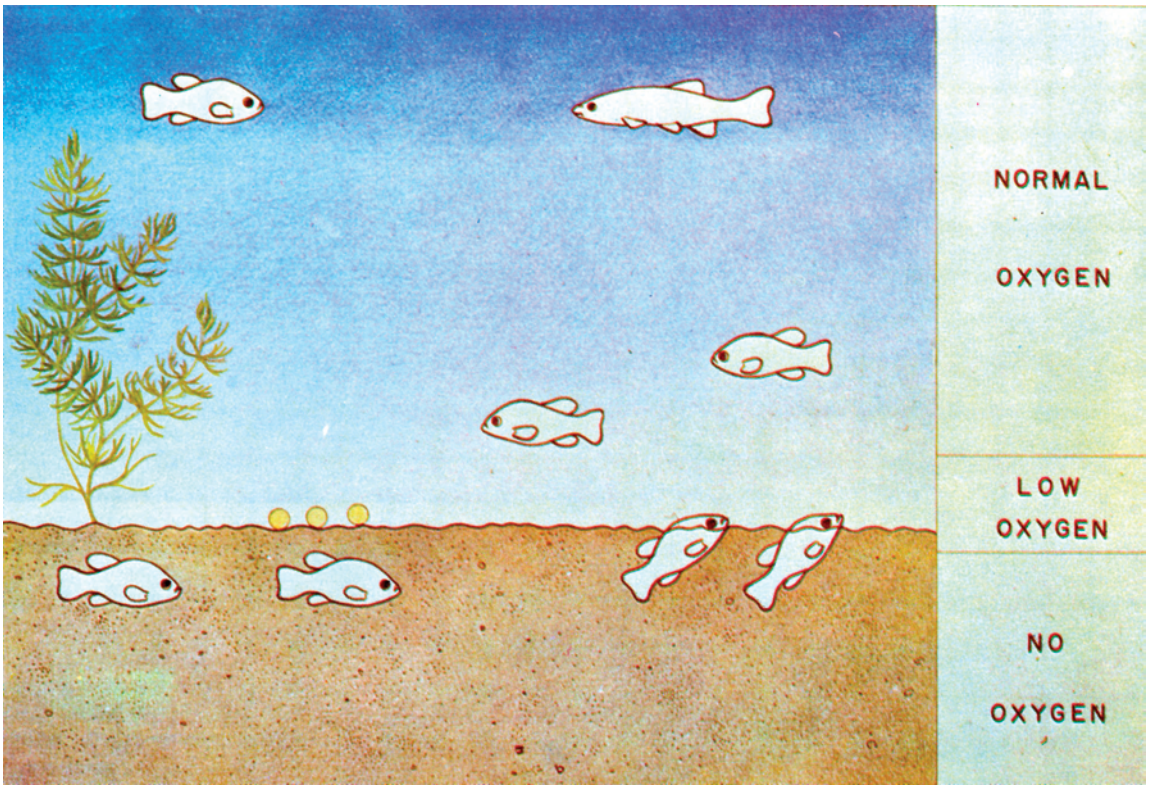
Pupfish Spawning

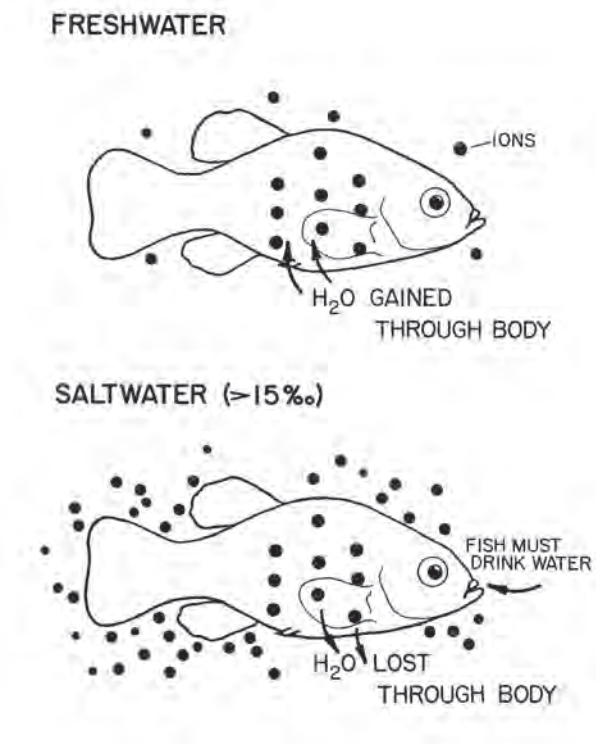

Dawn
Morning
Afternoon
Evening
Night
Daily Movements
of Pupfish in
Response to Temperature
Hot Water
Normal Water Temp
Cold Water

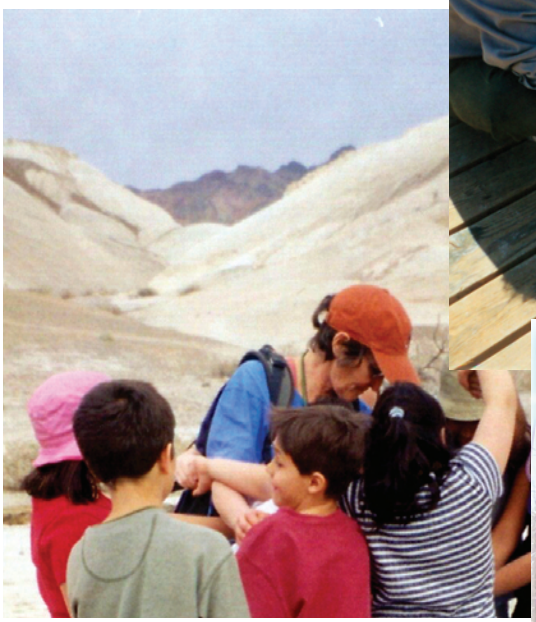
Death Valley Region Springs



Oxygen Exchange





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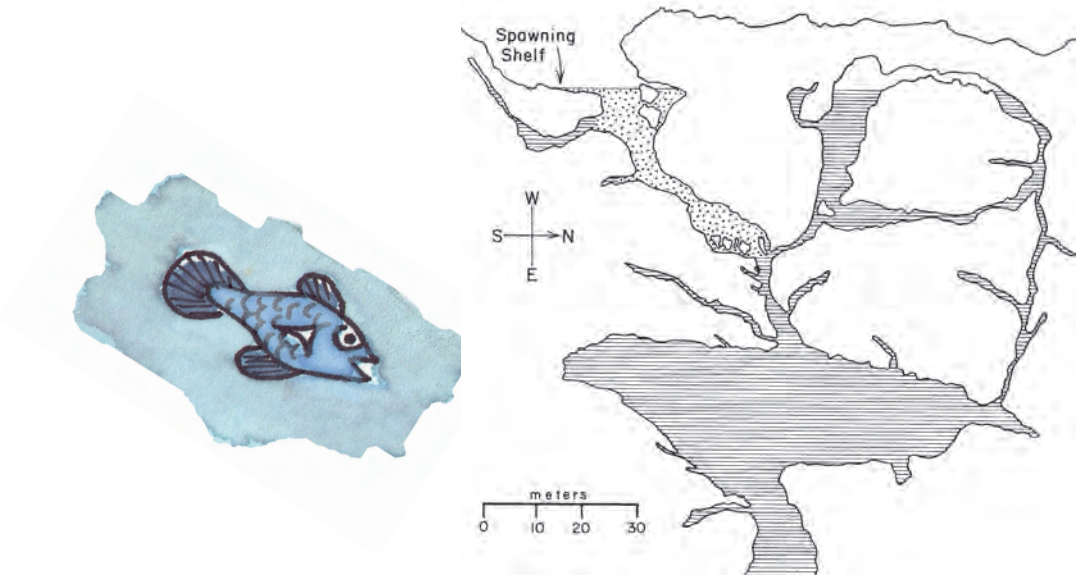
The World of the Small

More About The Pupfish World!

Teaching Aids



Teaching Aids

So you want to learn more:

Books and Articles:

Brandt, Patricia. The Little Pupfish of Salt Creek. Death Valley Natural History Association, P.O. Box 152, Death Valley, CA 92328: 1995

Dodgen Natt A. Flowers of the Southwest Deserts. Southwest Parks and Monuments Association, Tucson, AZ: 1985

Ferris, Roxanna S. Death Valley Wildflowers, Revised Edition. Death Valley Natural History Association, P.O. Box 152, Death Valley, CA 92328: 1983

Jaeger, Edmund C. Desert Wildflowers, Revised Edition. Stanford University Press, Stanford, CA: 1969

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Mozingo, Hugh N. Shrubs of the Great Basin, A Natural History. University of Nevada Press, Reno, NV: 1987.

Riggs, Alan C. and Deacon, James E. Connectivity in Desert Ecosystems: The Devil's Hole Story. Abstract – Conference Desert Fishes Council

Soltz, David L. and Naiman, Robert J. The Natural History of Native Fishes in the Death Valley System. Death Valley National Park Association, P.O. Box 152, Death Valley, CA 92328 1995

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Web Sites:

www.dfg.ca/gov/coned/outdr4.html
Fish in the Desert?

www.fguardians.org/news/n001020

www.orecity.k12.or.us/ochs/departments/science/species/pupfish.html
Report by students

www.coyoteptmuseum.org/whats_new/new.htm
Coyote Point Museum Aquarium

http://home.pacbell.net/gtfund/page12.html

Owens Pupfish

http://fwie.fw.vt.edu/WWW/esis/lists/e251017.htm
Species information in detail

www.ca.blm.gov/caso/wf-fsdanger.html
www.ca.blm.gov/caso/wf-fishslough.html
Fish Slough

www.tkphots.com/dsac/links_r.htm
Desert Springs Action Committee

www.tpwd.state.tx.us/nature/endang/animals/leonspf.htm
Leon Springs Pupfish (Texas)

www.tkphotos.com/ashmed/dvh_ra.htm
Ash Meadows and Devil's Hole photos and information

www.findarticles.com
Pupfish in Peril

www.brrc.unr.edu/data/fish/cyprenevm.html
Ash Meadows - Nevada information

desertcomplex.fws.gov/ashmeadows/
Official Ash Meadows NWR site

www.unlv.edu/News_bureau/News_Release/1994/Oct94/pup.html
UNLV Research to be Part of Discovery Channel Report

www.desertusa.com/mar97/du_pupfish.html
General information

Videos/Movies:

Ash Meadows Pupfish *(Cyprinodon nevadensis mionectes)* - Nye County, Nevada. USGS-BRD, Reno Field Station. Chris Mace videographer.

Pupfish of the Desert – Stanton Films, Los Angeles, CA. Jim Stanton.

The World of the Small

Glossary

Glossary

Adaptation - a change in the structure or habit of an organism that enables it to better adjust or survive in a particular environment

Biological Diversity - The variety and variation of living organisms on earth

Celsius - The international name for the centigrade scale named after Anders Celsius a Swedish Astronomer who posed it in 1742

Centigrade - A temperature scale for which 0 is taken as the freezing point of pure water and 100 is taken as the boiling point at standard atmospheric pressure, thus establishing the centigrade degree as one hundredth of the temperature difference between these two points

Community - groups of different animals and plants living interdependently in a specific habitat

Consumer - an organism that eats other organisms. Usually they are classified as primary consumers (herbivores), secondary consumers (carnivores), and micro-consumers (decomposers)

Decomposer - a plant or organism that feeds on dead material and causes its mechanical or chemical breakdown

Dehydration – a lowering of body fluids

Detritus – loose material, such as rocks and organic matter, resulting from disintegration

Dissolved Oxygen – the amount of oxygen within a given amount of water

Ecology - The study of inter-relationships among all organisms and between organisms and their environment

Ecosystem - An interacting system, consisting of a community of plants and animals in a given habitat, together with their non-living environment

Endangered species – Animals and plants that are in danger of extinction usually because of environmental changes and human activity

Endemic – found here and nowhere else

The Endangered Species Act – (1973) was created to protect vital habitat of an endangered species

Environment - Everything, both living and non-living, that surrounds and affects an organism

Exotic species – Species not native to the environment it currently inhabits

Extirpation – to root out, get rid of, utterly destroy (an animal or plant from a particular geographic region but not off of the entire planet)

Extinct – (of species) died out, no longer found (on Earth)

Fry – any young fish

Fahrenheit – Daniel Gabriel Fahrenheit (1686-1736). German physicist who established in 1715 the Fahrenheit scale

Fahrenheit Scale – A temperature scale for which 32 is taken as the freezing point of pure water and 212 is taken as the boiling point at standard atmospheric pressure

Geographic Isolation - physical separation of members of a population

Gill – the vascular respiratory organ in fish

Gill membrane – the covering of the gill on a fish

Habitat - a place or environment where an organism or group of organisms naturally lives and grows. The needs for food, water, living space and shelter are met here

Herbivore - an animal that eats plants

Hypothesis – A possible answer to or explanation of a question that accounts for all observable facts and is testable

Ichthyology- the study of fish

Interdependence - term referring to when living things are dependent on each other and upon the environment

Lateral line – A longitudinal line running along each side of the body of most fishes marking the position of sensory cells. (These cells can detect currents and vibrations in the water.)

Minnow – common name for members of the family Cyprinidae or a small fish

Native – occurring naturally in a given area

Natural selection – A process occurring in nature by which better adapted organisms are favored to reproduce to a greater degree and pass on their genes to the next generation

Niche - the ecological role or job performed by an organism

Non-native – placed into a habitat directly or indirectly by humans

Omnivore - an animal that eats both plants and animals

Organism - a general term for any living plant or animal, including fungus, bacteria, and many one-celled life forms

Osmosis – movement of a solvent through a semipermeable membrane into a solution of higher solute concentration that tends to equalize the concentration of solute on the two sides of the membrane

Plot – measured piece of land used for scientific study

Predator - an animal that kills and feeds on other animals

Prey - an animal that is killed and eaten by another animal

Pollution - The contamination of an area by unnatural substances or an excess of natural substances.

Refugium - an area of relatively unaltered climate that is inhabited by plants and animals during a period of continental climatic change and remains as a center of relic forms from which a new dispersion and speciation may take place after climatic readjustment

Salinity – the amount of salt (saline solution) in water in parts per thousand (ppt)

Scientific Method - principles and procedures for the systematic pursuit of knowledge involving the recognition and formulation of a problem, the collection of data through observation and experiment, and the formulation and testing of hypotheses

Spawning – the process of egg laying and external fertilization in fish

Species - a group of organisms that look similar and have the ability to interbreed and produce fertile offspring in their natural environment

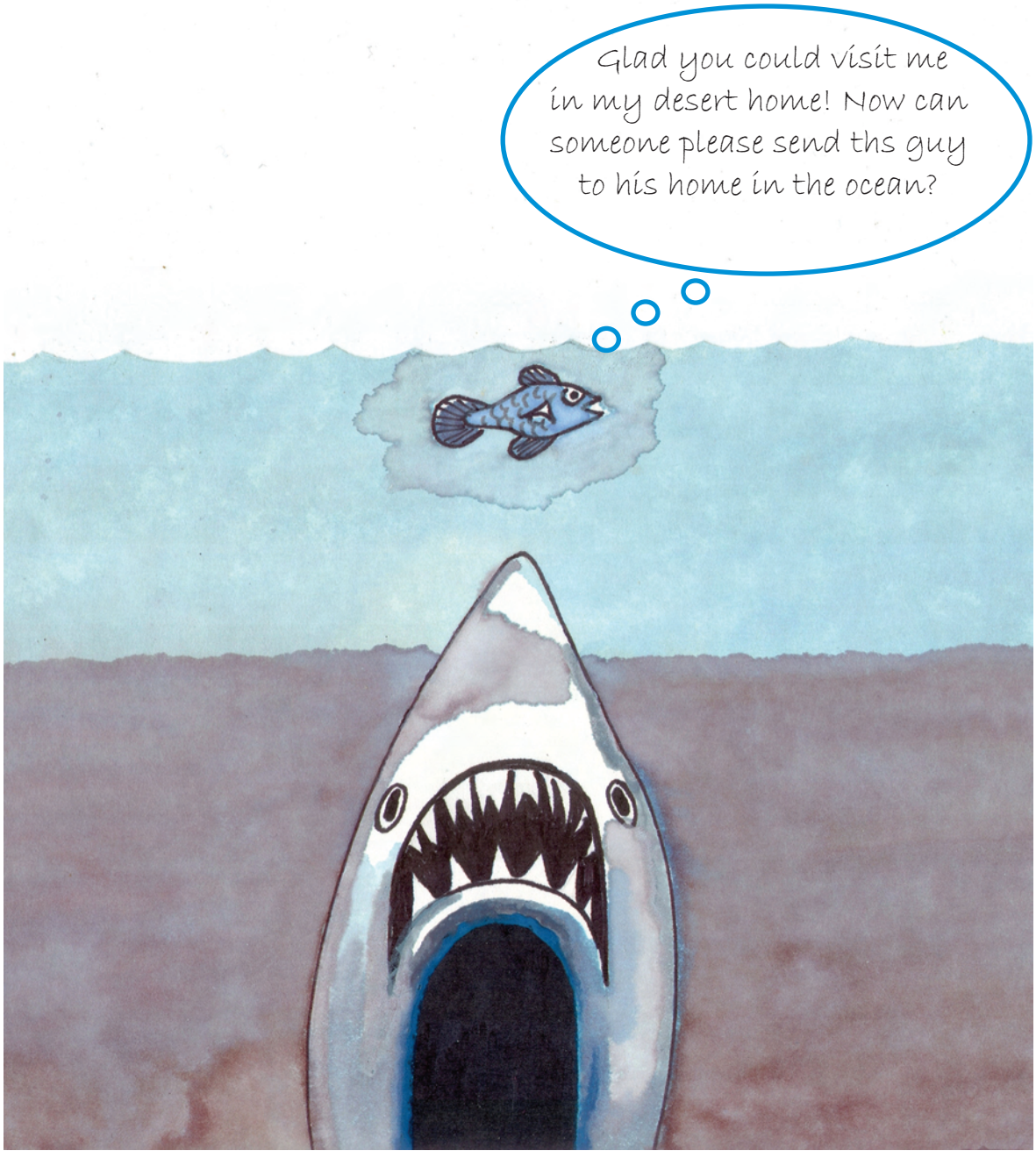
Temperature – degrees of hotness and coldness measured on a definite scale

Threatened species – A species (of plant or animal) that might soon become endangered (of extinction) within a short period of time

Territorial behavior or Territoriality – A behavioral process in which an animal protects space for its exclusive use of food, mating, or other purposes

Theory – a plausible scientifically acceptable generalization supported

The End


Glad you could visit me in my desert home! Now can someone please send ths guy to his home in the ocean?