NATIVE FISH IN THE CLASSROOM

Manual and Activities Guide to Fishes of New Mexico




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U.S. FISH AND WILDLIFE SERVICE
New Mexico Fish and Wildlife Conservation Office
2015 Fifth Edition

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Table of Contents

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Arizona, Virginia, New York, New Jersey, Pennsylvania, and Kentucky Trout Unlimited's on-line Trout in the Classroom (TIC) lesson plans inspired the "Native Fish in the Classroom" activities. We are grateful for the insight, research and experience that went into these activities before the Native Fish in the Classroom Project came to fruition. To exemplify the fish biology, geography, river ecosystems, and social history specific to New Mexico, we modified references and activities accordingly. We would like to thank the writers of The Bosque Education Guide for their valuable insight and activities involving local watershed issues. We also wish to thank the U.S. Forest Service's Santa Fe National Forest for most of the information regarding Rio Grande Cutthroat Trout. We are also grateful to the agencies and their personnel who annually participate in our *Releasing the Natives Field Day*. These agencies include the Bureau of Land Management - Taos Field Office, the New Mexico Department of Game and Fish, and the U.S. Forest Service. You help us make the day memorable for all the students involved.

A very special "Thank You" goes to all the teachers who have helped bring the project to life in the classroom.

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The initial *Native Fish in the Classroom: Manual and Activities Guide to Fishes of New Mexico* was compiled and written by Sara Blocker and Angela James, Fish Biologists, U.S. Fish and Wildlife Service (USFWS) - New Mexico Fish and Wildlife Conservation Office. The 2015 Fifth Edition revisions were completed by Angela James and edited by Thomas Sinclair, Project Leader, USFWS - New Mexico Fish and Wildlife Conservation Office. Additional resources were provided by Joaquin Baca, Hydrologist, USFWS - Water Resources.

Introduction to Guidelines and Activities

Raising native fish in your classroom is a hands-on activity that engages students and helps to connect them to real-life water quality, fish and wildlife issues and problems, and inspires them to seek solutions. This project aims to generate enthusiasm among students and to develop caring attitudes about fish species and their habitats. This is a step towards fostering a sense of stewardship for all animals and the planet within the students.

The Native Fish in the Classroom (NFIC) Project crosses all scholastic disciplines and can result in a stronger understanding of science, social studies, and mathematics. The enthusiasm of students and teachers involved in the program manifests itself in an amazing variety and number of activities and projects. This reference guide provides background information and activities that teachers can use in the classroom.

Activities may be completed in any order that follows the progression of lessons pertaining to raising the fish in the classroom. The activities presented in this document are designed for the 5th grade level. Teachers may plan their own lessons or adapt the ones provided to suit any grade level. Teachers are encouraged to select additional activities from the supplemental CD (provided) or other "Trout in the Classroom" (TIC) and natural resources programs. Supplemental activities are also available from Project Wild, Project Wet, Project Learning Tree, and The Bosque Education Guide.

In addition to the suggested activities, this program also involves rearing fish, checking water quality, and maintaining journals and logs. Classes will be responsible for maintaining the aquarium system to achieve clean water with beneficial bacteria and good water chemistry that provides the appropriate environment for the selected species of fish. This will help students to develop critical skills in observation, problem solving, and developing solutions with group consultation and communication. Students keep a scientific journal of their observations, problems, and resolutions, which provides evidence of their progress as they rear the fish and release them into the Rio Grande.

Classroom activities include:

- ✓ journaling
- ✓ scientific thinking
- ✓ life sciences
- ✓ mathematics
- ✓ reading comprehension and writing
- ✓ technology integration (through the use of internet and media)
- ✓ art
- ✓ geography

Aquarium Set-Up

Aquarium set-up is accomplished in stages to provide additional opportunities for learning.

Recommended Activity: Activity 1 – Getting to Know Your Aquarium

DISEASE CONTROL

To prevent introduction of disease and harmful bacteria or viruses, do not introduce any materials, plants, or fish not approved by the New Mexico Fish and Wildlife Conservation Office (NMFWCO). Equipment and materials for aquarium set-up will be cleaned and disinfected prior to delivery to the classroom.

To prevent spread of disease into a stream, the fish will NOT be released if they display any signs of illness, fungus, or parasites.

EQUIPMENT LIST

Most equipment necessary for the aquarium set-up will be provided by the NMFWCO. Classrooms are strongly urged to obtain the additional remaining equipment not provided by the NMFWCO. The provided "Equipment List" sheet can be used to verify the condition and quantity of equipment received by the classroom. At the end of the program, NMFWCO staff and participating teachers will examine all equipment to ensure its integrity upon return.

Provided by USFWS - New Mexico Fish and Wildlife Service	
1	Aquarium
1	Aquarium stand
1	Chiller
1	Pump head
1	Canister filter
1	Water quality testing kit
1	Aquarium scrubber
2	5-gallon buckets
1	Aquarium net
	Substrate
1	Siphon
1	Water reservoir
1	Scale (grams)
1	Portable (battery operated) aerator
To be provided by class	
	Foam Poster Board (for background)
	Baking Soda
	Thermometer

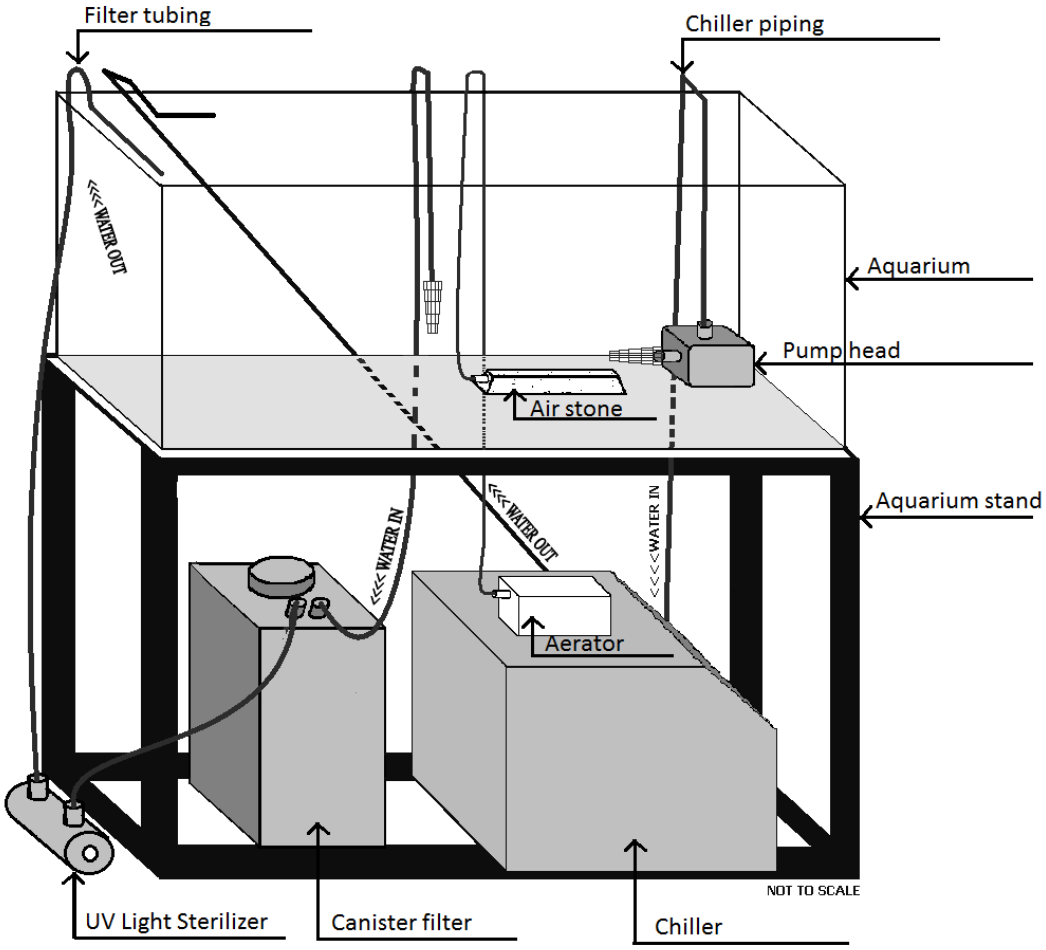
Stage I – Aquarium Set-up

Recommended Activity: Activity 1: Getting to Know Your Aquarium

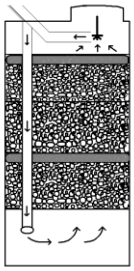
Aquarium set-up should be completed at least one month prior to the introduction of fish. This will allow sufficient time for the water quality to stabilize, beneficial bacteria to establish themselves in the filtration system, and ensure that the equipment is functioning properly. During this time, teachers and students should practice water quality testing and water exchanges to determine the best process for the class. NMFWCO staff will aid teachers and students with aquarium set-up.

- ✓ Determine a suitable location for the aquarium.
  Considerations:
  - Easy accessibility to electrical outlets to safely plug in the equipment.
  - Avoid direct sunlight to reduce algae growth and maintain stable temperatures.
  - Ensure adequate space to accommodate the aquarium, complete equipment maintenance, and perform daily aquarium care.

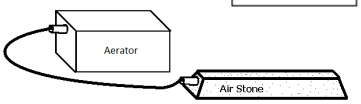
- ✓ Once a location has been determined, the aquarium can be placed on the aquarium stand. Equipment will vary depending on type of fish in the classroom. Review the diagram below:



Canister Filter: Two lines run from the canister filter. The first line, with the aid of a built-in pump, pulls water from the aquarium. This water then passes through filter media and pads. The filter media, when prepared properly, contains beneficial bacteria that breakdown ammonia and nitrites. The filter pads strain out large debris. Filtered water is then returned to the aquarium through the second line.

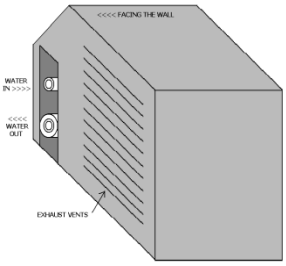


Aerator (optional): The aerator is an air pump with tubing that attaches to air stones. Air stones are porous structures that allow air from the air pump to pass through and dissolve in the water. The aerator increases the level of dissolved oxygen necessary for fish to breathe. This may or may not be used in your aquarium.



Ultraviolet (UV) Light Sterilizer (Optional): The sterilizer helps to reduce the incidence of disease by destroying many disease organisms before they have a chance to infect fish or spread. The UV sterilizer uses ultraviolet light to sterilize or remove bacteria, fungi, protists, viruses, etc. from the aquarium water.

Chiller (optional): A chiller is used when coldwater fish, like trout, are being raised. The chiller has two lines. Attached to the first line is the pump head, which will pull water from the aquarium. This water passes through a cooling unit, which is controlled by a thermostat. Water is then returned to the aquarium through the second line. The thermostat is normally set at 51º Fahrenheit.



Chiller Thermostat: Thermostat programming will be completed by NMFWCO staff upon set-up; however, the thermostat may need to be reset due to power failure, etc. The thermostat has a sensor that reads the water temperature within the aquarium. The default view is the aquarium temperature.

Programming Steps:

Step 1. Press the **SET** key. Press the **UP (^)** or **DOWN** (v) key to Select **F** for degrees Fahrenheit.

Step 2. Press the **SET** key again to access the setpoint temperature. S1 will be blinking in the upper left corner. Press the **UP** or **DOWN** key to display the required temperature.

Step 3. Press the **SET** key again to access the differential temperature. **DIF1** will be blinking in the upper left corner. Press the **UP** or **DOWN** key to display **2**. This setting will allow the chiller to shut off if the temperature is within 1° of the setpoint temperature.

Step 4. Press the **SET** key again to access cooling and heating mode. Press the **UP** or **DOWN** key until it displays **C1**. This ensures it is in cooling mode.

CRITICAL WATER QUALITY ELEMENTS

Recommended Activity - Activity 2: Testing Your Water & Activity 4: Doing the Math

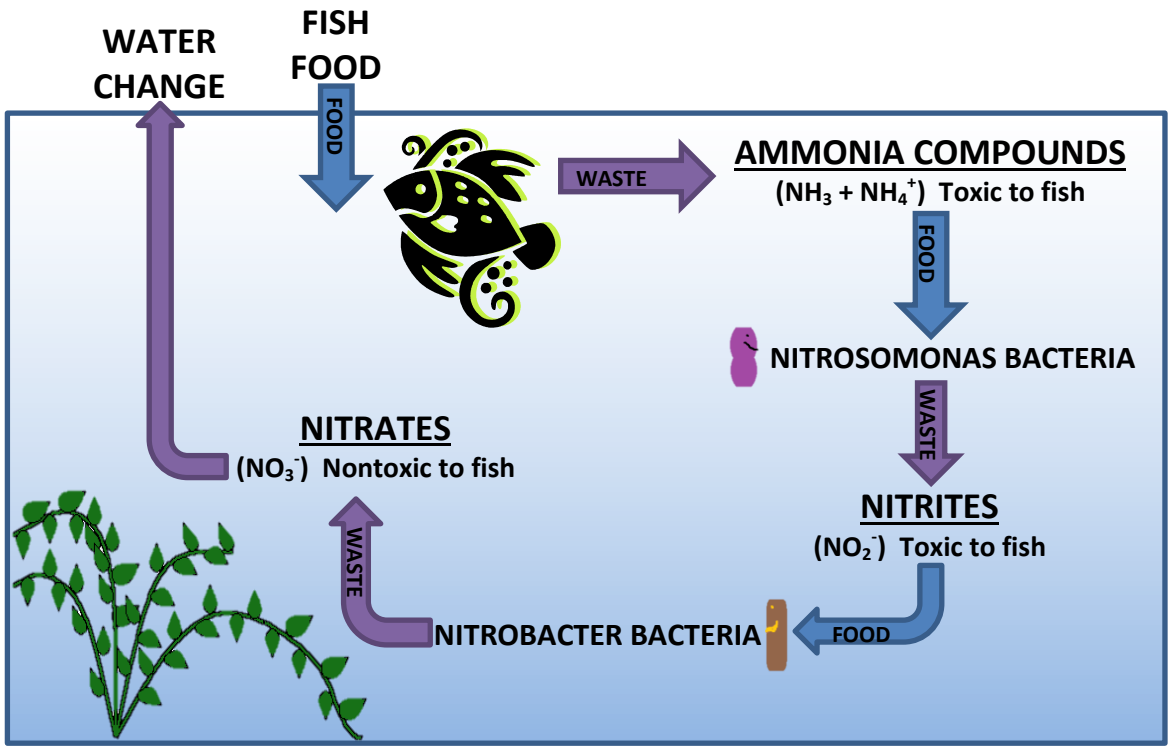
Ammonia and nitrites should not be an issue during Stage I; however, chlorine is a concern. Tap water processed by a water treatment facility will contain chlorine. Chlorine at high concentrations is lethal to fish and the beneficial bacteria we are trying to establish in the canister filter. Water for the aquarium must be aged or de-chlorinated prior to adding fish and bacteria.

Water Testing: (Use kit provided with set-up)
Because our aquarium is a closed environment, we need to test our water quality on a regular basis. In nature, several processes occur to reduce and naturally breakdown wastes like ammonia and nitrite, which are toxic to fish. The provided test kit contains chemicals specific for testing ammonia, nitrite, pH, high range pH, and nitrate in freshwater aquariums. The tests use reagents combined with water samples to produce various colored solutions. The resulting solution colors are compared to color charts specific to each test. Directions are provided for each test within the kit. You must follow the directions explicitly to obtain accurate results. All test results should be recorded on the *Weekly Inspection Sheet* on a daily basis. This will provide real data for the students to graph, serve as a chronology of water quality changes, and provide a basis for system troubleshooting.

- ✓ Students will have an opportunity to practice assessing water quality with the API Master Freshwater Kit during Activity 2: Testing Your Water. Use the high range pH test for the classroom. Waters in New Mexico generally have a higher pH than in some parts of the United States because of the alkaline soils present.

Temperature: Use a standard thermometer or the chiller's temperature controller (if installed) to measure the water temperature. Temperature affects ammonia, oxygen concentration, and fish metabolism in an aquarium. A sudden increase or decrease of 3 to 5 degrees within a 15-minute period (even within the acceptable temperature range) can stress fish, compromising their immune system. Make small changes in temperature by adding water slowly.

- ✓ Middle Rio Grande fish species prefer water temperatures in a range from 60 to 80° F. Store the reservoir of aged water near the aquarium. This will allow the water in your aquarium and your reservoir to be at the same temperature.
- ✓ Rio Grande Cutthroat Trout adults prefer water temperatures below 60° F. We will be holding our Cutthroat Trout at the same temperature as Seven Springs State Hatchery, 51°F. The temperature controller will allow the temperature to fluctuate by one degree.



Ammonia: Fish waste, decomposing fish, and decaying food produce ammonia. The values of pH determine the toxicity of ammonia. In water with pH levels greater than 7, toxic unionized ammonia forms. In water with pH levels less than 7, non-toxic ionized ammonia forms. Large water changes (>25%) are needed if the ammonia levels become consistently too high for the bacteria in the canister filter to handle. This usually occurs when the fish are over-fed. If the problem is frequent, the number of weekly water changes may be increased until bacteria are re-established. High ammonia levels can damage fish gills, essentially disrupting the ability of the fish to breathe.

Nitrite: Nitrite results from nitrifying bacteria breaking down ammonia. Presence of nitrite means nitrosomonas bacteria is present in the filter; however, it is also toxic to fish and must remain near zero.

Nitrate: Nitrate results from bacteria breaking down nitrites. It occurs with decomposition of organic material and animal waste. Although nitrates are not lethal to fish, levels greater than 40 ppm can indicate a build-up of organic material and animal waste in your aquarium and a water change is recommended.

pH: The degree of acidity or alkalinity of a solution is represented by pH. It is defined as the logarithm of the activity of dissolved hydrogen ions (H+). A value of pH 7 is neutral. Values less than 7 are acidic and values greater than 7 indicate alkalinity. Although most National Trout in the Classroom guides recommend striving for a neutral pH of 7.0, New Mexico waters have elevated pH levels due to the geology. As a result, the pH in classroom aquaria will generally range from 7.0 to 8.5. Because we have a high pH, it becomes even more important to monitor ammonia.

Pollutants: Pollutants should not be a problem if you are using tap or well water in your aquarium. It is important, however, to ensure that students who are taking care of the aquarium have clean hands. This means that they need to rinse their hands of soap, lotion, and anti-bacterial sanitizer residues before working in and around the aquarium.

Chlorine: Chlorine is a disinfectant used to remove bacteria in drinking water. Chlorine can be toxic to fish and to the beneficial bacteria in your canister filter. Because chlorine is an active element, it can be easily removed from tap water. De-chlorinate tap water by leaving it exposed to the air for a minimum of 24 hours. By aging your water, you minimize the use of de-chlorinating chemicals.

Dissolved Oxygen (DO): Students will not be measuring dissolved oxygen, but it is an important water quality parameter to understand. Oxygen is necessary for all forms of life. Oxygen infuses water through aeration, diffusion from the surrounding air, and from photosynthesis (byproduct of plant respiration). Once it is in the water it is measured as dissolved oxygen (DO). In the absence of submerged aquatic plants or phytoplankton, the amount of DO in water is a function of water temperature. Generally, as water temperature increases, DO decreases (and vice versa). Fish extract DO from the water with their gills.

- ✓ Do the students see a pattern yet? Levels of one water quality parameter influence another parameter and essentially the well-being of the fish. Teachers must emphasize the importance of maintaining good water quality.

TEACHER REFERENCE: WATER QUALITY PARAMETERS

Parameter	What it tells us	Acceptable Level*	Remedy
Temperature	Is the water too cold or too warm	MRG - 60° F - 80° F RGCT - 45° F - 55° F	Adjust room temperature. Ice down if too warm.
Ammonia	Decomposing and decaying animal waste and food is present	<4.0 ppm - Toxic to fish	Water change. Remove waste. Check feeding level.
Nitrite	Nitrosomonas bacteria is present and breaking down ammonia compounds	<3.0 ppm – Toxic to fish	Water change. Remove waste. Check feeding level – lower if necessary.
pH (power of Hydrogen)	Degree of acidity or alkalinity: 0-6.9 indicates acidity, 7 indicates neutral, and 7.1-14 indicates alkalinity.	7.0 - 8.5	Water change
Nitrate	There is a build-up of organic material and waste	< 40 ppm	Water change
Chlorine	Presence of a disinfecting agent used during water purification.	0 – Toxic to fish and bacteria in filters	Age water before adding to aquarium. Chlorine will evaporate. Use a de-chlorinator only in an emergency

*Levels are specific to the water quality test kit, fish, & aquarium supplied for the program. Values will vary by testing kit, fish, & set-up.

In addition to water quality parameters, fish behavior can also be an indicator of a problem.

Behavior	What it tells us	Remedy
Fish are lethargic	Poor water quality Parasites/Fungus	Check water quality. Do a water change. Look for external parasites or differences in skin and fins. Notify biologist.
Fish are piping (at the surface and look like they are gulping for air)	Low oxygen	Check for water flow from canister filter and/or chiller. Check to ensure aerators are functioning.
Fish are not feeding	Poor water quality Parasites/Fungus Feeding to much food Stress	Check water quality and complete a water change. Look for external parasites or differences in skin and fins. Notify biologist. Ensure feeding proper amount Provide additional cover

Initial ammonia spikes from the addition of fish and potential overfeeding are likely to occur during Stage III (the addition of fish). Water changes (physical removal of ammonia sources) are the only solution. If any water quality parameters are out of the acceptable range, complete a water change with de-chlorinated water. Use the siphon to clean the gravel and remove large debris, while changing out the water. Water from the siphon should empty directly into a bucket, in case a fish is caught in the siphon. Use the aquarium net to return the fish immediately to the aquarium. **Do not change more than 25% of the water during a water change.** Appropriate water temperatures must be maintained.

Stage II – Imitating a River

Recommended Activity: Activity 3: A Happy Home

Rio Grande fish habitats include clean, although sometimes turbid, water. The filter provides for clean water (pollutant free) in the aquarium. In addition to clean water, fish also need cover and food. Students will create cover, which will include clean sand and gravel (substrate), a background, and artificial plants. The substrate, background, and artificial plants will help the aquarium mimic a river, creating a naturalized rearing system for your fish.

Steps for Imitating a River:

- ✓ Place a layer of substrate on the bottom of the aquarium. Remember to place the sand or gravel on the bottom gently, so the aquarium is not damaged.

- ✓ Cut out foam board, for each side, to match the measurements of the aquarium. After completing *Activity 3: A Happy Home,* students can decorate the foam boards to create their aquarium backgrounds, reflecting the habitat of their fish. Remind students that the fish are coming from the Rio Grande. Have them picture the Rio Grande as they design their foam boards. Students can use items that will lay flat once attached to the aquarium such as construction paper, paint, and magazine cutouts. Once the foam boards surround the aquarium, they will provide a sense of cover for the fish, reducing their level of stress.

- ✓ Use Velcro squares to attach fitted foam boards to the sides and back of the aquarium. The foam board will serve as a layer of insulation. Have a foam board prepared for the front of the aquarium to use during loud activities to minimize stress to the fish.

- ✓ Students may bring in artificial plants or structures that can provide cover within the aquarium. Aquarium plants from the pet store are optimal but expensive. Artificial plants completely made of plastic, without glues or exposed metal, can also be used. Plants and structures should be provided to NMFWCO staff prior to adding them to the aquarium so they can be cleaned and disinfected.

Stage III – Introducing Fish Species

Recommended Activity: In class presentation at time of delivery

NMFWCO staff will inform each participating school as to the time and date to expect fish arrival. Prior to fish arrival, NMFWCO staff will visit the class to ensure the aquarium system is functioning properly. A week prior to fish arrival, staff will add a food source for nitrifying bacteria. This will help build-up beneficial bacteria within the canister filter. NMFWCO staff will transport the fish directly to the school.

Hatcheries use a specially formulated diet for the fish they raise. The formulated feed ensures that the fish obtain all of the nutrients required for good growth and development. Students will feed the fish formulated fish food.

- ✓ Middle Rio Grande fish species: You will raise up to seven difference fish species with varying nutritional requirements and diets. Students will be feeding three different types of feed. These include a flake feed, a sinking wafer, and a frozen feed (bloodworm and brine shrimp). Ask students if they think the feeds looks like food that the fish will encounter out in the wild.

- ✓ Rio Grande Cutthroat Trout: Students will feed the Cutthroat Trout a pelleted food specific to trout. Ask students if they think pellet feed looks like food that Cutthroat Trout will encounter out in the wild. Students will also introduce natural feeds (frozen), closer to what the Cutthroat Trout will encounter in the wild. This will help the Cutthroat Trout with prey recognition when they are released into the wild.

Do not give more than the scheduled amount of feed. The fish will seem hungry all the time; but remember that they are wild animals and their instinct is to eat when food is available. Overfeeding can cause an ammonia spike, leading to water quality problems.

- ✓ You do not need to feed fish over the weekend, but do need to arrange for feeding during vacations.

After receiving fish, the ammonia and nitrite levels will need to be checked daily for at least two weeks or until ammonia and nitrite levels are within the acceptable levels provided on Page 16. Expect to complete a water change the day after fish arrive.

VACATION NOTES

Fish are wild animals that can survive lean times in a natural stream system. However, our aquariums are maintained *closed* systems and vigilance will be essential in ensuring we maintain healthy fish. Although it is unlikely to you will experience a system failure, should one occur, there is a short response time to correct the problem without hurting our native fish.

Preparing for short vacations (3-day weekend)

- ✓ Complete your daily check as normal.
- ✓ Continue with the normal feeding cycle in the days leading up to the vacation.
- ✓ Complete a water change on the day you are leaving. If you can, complete a water change in the morning and one that afternoon. Do not fill your water reserve until you have completed all scheduled water changes for the day. Be careful to watch the temperature as you do this. Do not let the aquarium temperature fluctuate more than 2 degrees.

Preparing for extended vacations (4+ days)

Arrange for someone to check the fish multiple times throughout the vacation. This can be you, the teacher, or a designated person who has access to your classroom.

Notify NMFWCO staff prior to your vacation. Please provide a schedule and a contact list of persons who will be providing fish care and maintenance during the vacation.

- ✓ Continue with the normal feeding cycle in the days leading up to the vacation.
- ✓ Complete your daily check as normal.
- ✓ Address any problems that are identified during your daily check.
- ✓ Complete a water change on the day you are leaving. If you can, complete a water change in the morning and one that afternoon. Be careful to watch the temperature as you do this. Do not let the aquarium temperature fluctuate more than 2 degrees.
- ✓ Care for the native Rio Grande fish over vacation includes:
    - Feeding every other day: Feed only 1/2 the amount of normal daily allowed food. Remember, we feed our fish multiple times throughout the day, so only give them a single portion,—**do not** feed their entire daily amount.
    - Complete a water change midway through the vacation.
    - Contact NMFWCO staff should any problems arise, such as equipment failure or ammonia/nitrite spikes above normal range.

Aquarium Maintenance

Water Changes

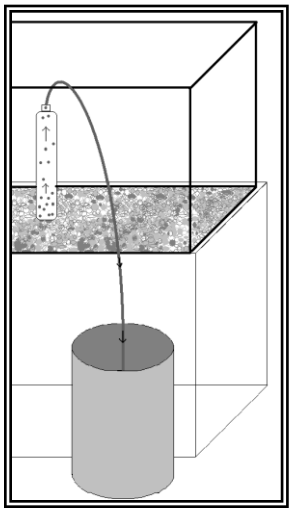
Conducting water changes efficiently and correctly will usually resolve or prevent any water quality issues. Each aquarium set-up includes a siphon and aquarium scrubber. The siphon serves two purposes: 1) it is a tool used to remove water from the aquarium so you can add fresh water; and 2) it functions as a vacuum to remove large debris settled on the bottom of the aquarium and between the gravel crevices. The aquarium is marked with a line to signify 25% aquarium volume. Do not go below the 25% line when completing a water change. This is to ensure the water temperature remains stable and fish stress is minimized. If another water change is required, wait for the temperature to return to its initial temperature. Remember to measure your water temperature prior to the water change to determine your baseline value.

Water Change Steps:

Step 1. Gather necessary equipment: bucket, siphon, aquarium scrubber, water quality kit, and *Weekly Inspection Chart*.

Step 2. Lightly scrub the interior glass of the aquarium to remove algae build-up.

Step 3. Prime the siphon. The hose end should be down in the bucket. Place the siphon end just below the surface of the water. Let the siphon fill with water. Raise the tip of the siphon above hose to move water down the hose. Once it starts flowing, re-submerge the siphon before the siphon starts pulling air into the hose. Gravity will now pull water and debris through the hose into the bucket.



Step 3. Push the siphon end down onto the surface of the gravel and wait for a few seconds. The siphon will pull waste and debris up and into the hose. Quickly move throughout the aquarium. Focus on areas were most of the feeding occurs to ensure most food waste is removed. Clean until the water level reaches the 25% line. SPILL ALERT! Watch water level in the bucket. Stop the siphon (raising it out of the water or place your finger over the tube end to block flow) before the bucket overflows. Also, watch the hose and make sure it is not pulled out from the bucket.

Step 4. Slowly add aged water from your water reservoir until the aquarium is back to its full mark. Add water slowly to minimize disturbance to any remaining debris and your fish.

Step 5. Wipe down the exterior glass to remove water stains and debris.

Step 6. Complete water testing and record data on the *Weekly Inspection Sheet*. If any parameters are out of range, plan to complete a water change the later in the day or the next day.

Cleaning Canister Filter

During previous years of NFIC, it has not been necessary to clean the canister filter. However, it is necessary to ensure water is flowing through all of the lines. If there is reduced flow in either line, it may be necessary to clean the canister filter. This is most likely due to debris clogging the filter. Use aged water to clean the filter to minimize harming the good bacteria. Do not clean the filter unless you are able to complete it quickly. The canister filter should be shut off for as short a period as possible. Contact NMFWCO staff before cleaning your canister filter.

Canister Filter Cleaning Steps:

Step 1. Unplug filter.

Step 2. Disconnect hosing.

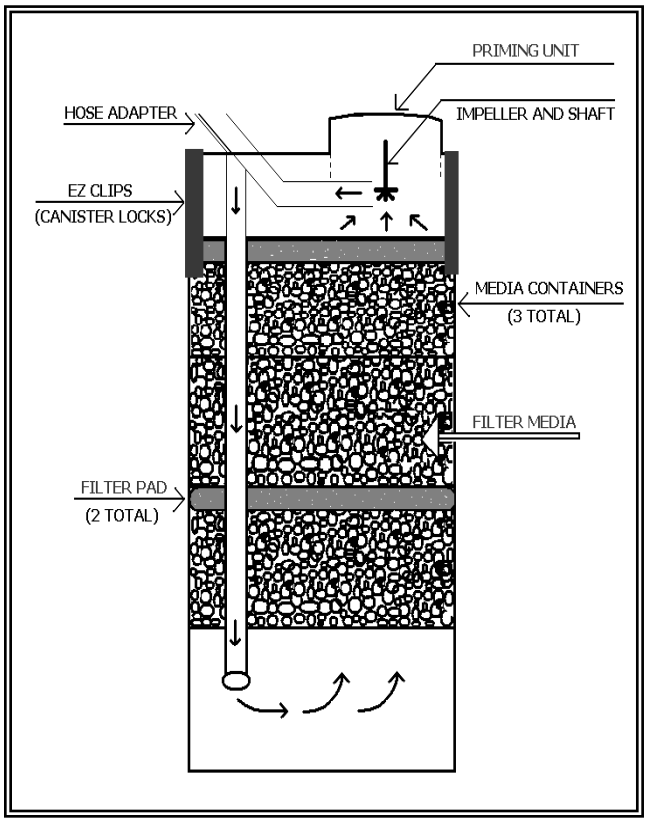
Step 3. Empty the water in the canister filter (water a tree, it will be good fertilizer).

Step 4. Rinse pads and flush filter media with aged water. It does not need to be completely clean, but most debris should be removed.

Step 5. Refill canister with aged water to the top and re-attach the lid. Fill the canister all the way; it helps with priming when you are ready to restart the filter.

Step 6. Re-connect the hosing and put it back under the aquarium. Return the hosing to the aquarium.

Step 7. Plug unit back in and check for water flow and leaks. If no flow, push down on priming unit to create a siphon action.



Core Classroom Activities

We suggest that students become dedicated to the list of activities necessary for the survival of the fish in the aquarium. Emphasize the importance of the student's responsibility to the caretaking of the fish as they study them and make critical observations of the fish and their environment.

Record Keeping – Weekly Inspection Chart

Standard Correlations - Grade 5:

New Mexico Science Content Standards, Benchmarks, and Performance Standards
Strand I, Standard I, Benchmark I, Performance Standard 2 & 3
Strand I, Standard I, Benchmark III, Performance Standard 1

Common Core State Standards
CCSS ELA-Literacy, Writing Standards 5.7

A team of three students will monitor the aquarium set-up and perform the following Daily and Weekly Check Lists. After they have checked each item on the list, they will record their observations and solutions to any issues on the *Weekly Inspection Chart*. In addition, encourage students to record their observations in their Field Journal. Each week a new student will be assigned to the team and the one that has served the longest will step down. This rotation system will allow each student to have experience monitoring everything about the fishes for up to three weeks at a time. In this way, experienced students conduct the monitoring while a new student is being trained.

Daily Check List:

1. Check, count, and remove any dead fish the aquarium.
2. Ensure that water is flowing through canister filter and chiller.
3. Check for leaks.
4. Check that water is clear and at the correct level.
5. Check and record water temperature.
6. Test the water quality parameters: ammonia, nitrite, pH, and nitrate. Record the values on the *Weekly Inspection Chart*. This may be done every other day once levels are stable.
7. Feed fish the appropriate amount of food.

Weekly Check List (recommended for Fridays):

1. Scrub interior glass of aquarium to remove any algae growth.
2. Complete a water change, while cleaning the gravel.
3. Refill water reservoir after completing water change(s).
4. Wipe down exterior glass of aquarium for any water stains and debris. **Do not** use any cleaners.

STUDENT WORKSHEET: WEEKLY INSPECTION CHART

As a caretaker, it is important to know the condition of your water and to make sure your aquarium system is working correctly. Daily observations and recorded information (data) provides an initial reference point. The initial set of data is often called baseline data. When your data begins to move away (deviate) from the baseline data, you can review your data, troubleshoot, and correct the problem (if there is a problem).

Inspectors: _____
The amount of daily feed: _____

Check Item	Item to Check	Example July 17	Monday	Tuesday	Wednesday	Thursday	Friday
Daily	Mortalities (#, Species)	***1 Red Shiner***					
	Canister filter flowing (green tube)	***Yes***					
	Chiller flowing (white pipes)	***N/A***					
	UV Light On	***Yes***					
	Check for leaks	***None***					
	Water clear/ correct level	***Yes***					
	Temperature	***74°F***					
	Total Ammonia	***0 ppm***					
	Nitrite	***0 ppm***					
	pH	***8***					
	Nitrate	***5 ppm***					
Weekly	Water change (amount)	***20%***					
	Water reservoir refilled	***Yes***					
	Interior/Exterior Glass Clean	***Yes***					
As Needed	Notes Observations Problems fixed	***Fish are active and feeding*** ***Water added to bring up to correct level***					

Maintaining a Field Journal

Standard Correlations - Grade 5:

New Mexico Science Content Standards, Benchmarks, and Performance Standards
Strand I, Standard I, Benchmark II, Performance Standard 1 & 2

Common Core State Standards
CCSS ELA-Literacy, Writing Standards 5.10

Objective: At the end of this activity, students will be able to demonstrate data collection, make complete observations, and analysis data to apply towards the monitoring of fish condition.

Each student will keep a Field Journal. The journal becomes their personal record of what they have discovered through observation, problems encountered, and how they solved their problems.

Raising native fish in your classroom will provide many opportunities for students to use their observation skills. It will generate opportunities for recording, measuring, formulating and answering questions, writing, illustrating, hypothesizing, and drawing conclusions. Journaling is a natural way for students to record their findings about fish. Suggest students purchase a composition notebook to use as their journal. Encourage the students to write in the journals, focusing on notable events—from setting up the aquarium to the release day. Descriptions of changes as the fish grow and eat, drawings of the fish, observations about fish behavior, and completed handouts should be included in journals. Below are some questions you might pose to students as they observe the native fish throughout the program. Questions open their minds to critical observation and aid them in forming their thoughts before they write them down.

Starting off…

- ✓ Observe how the fish move.
- ✓ How many fins are there? Draw the fish and label the fins.
- ✓ Describe the motion of each fish. What is the direction and range of movement?
- ✓ Do paired fins move together in the same way? Do the fish use some fins more?
- ✓ What happens to the fish's fins when it is still?

Color

- ✓ What colors can you identify on the fishes?
- ✓ Do males and females colored have the same colors? Is this true for each species?

Senses

- ✓ Do you think fish have good eyesight? Why?
- ✓ Can fish hear? How do you know?
- ✓ Can you see the lateral line? What purpose does it serve?

Behavior

- ✓ What do fish do when they are startled? Why?
- ✓ Do the fish move as a group? What is this called?
- ✓ How do the fish interact with each other?
- ✓ What do fish do at feeding time?

- ✓ Do they "hang out" in the same area of the aquarium (such as the bottom of the aquarium, in the larger rocks, or in the open water)?
- ✓ Do they all eat the same amount of food?

STUDENT CHALLENGE: EXPANDING A FIELD JOURNAL

As students develop their skills of observation, provide an opportunity for them to try their newfound skills outside of the classroom. Find a green space outside and have the students observe what they see. Challenge them to find living creatures, no matter how little. Depending on the type of green space you have available, students can observe a tree, the grass, the desert scrub, a garden, or the sky.

STUDENT REFERENCE: CREATING A FIELD JOURNAL

A field journal is a tool used by many people like painters, writers, and scientists. Journals help people slow down, observe, and focus on details of a specific animal, ecosystem, or object. Today, you will begin your own field journal. As you watch (observe) your fish, make sketches, record your observations and thoughts, and ask questions in your field journal. Your field journal will be unique to you, reflecting your personal style and thoughts. There is no "right way" to keep a field journal but there are a few basics to remember. These things help to remind you of the day of your observation; sometimes you cannot always remember every detail. Record the following at the start of your journal entry.

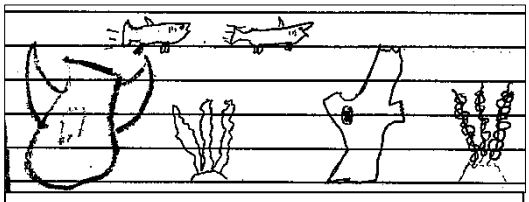
- ✓ Location
- ✓ Date and time
- ✓ Conditions in the classroom (ex. Very loud, lights turned off, cooler not working)
- ✓ For times you complete a journal entry for something outside you would record things like the weather conditions (ex. cloudy, sunny, windy, or raining) and location.

Some scientists will sketch simple pencil drawings, and others will paint colorful, detailed images. You can use whatever tools work best for you. Try working with pens, pencils, or watercolors to capture an image. Some people record their observations with charts, lists, and labels, while others will write long, detailed descriptions.

Here are some questions that may help you get started:

Starting off…

- ✓ What do I see?
- ✓ What is the condition of the water in the aquarium?
- ✓ Does the temperature affect how the fish act?
- ✓ Do I see anything that surprises me?
- ✓ Have the fish changed since last observed? How?
- ✓ Can I identify individual fish within the aquarium?

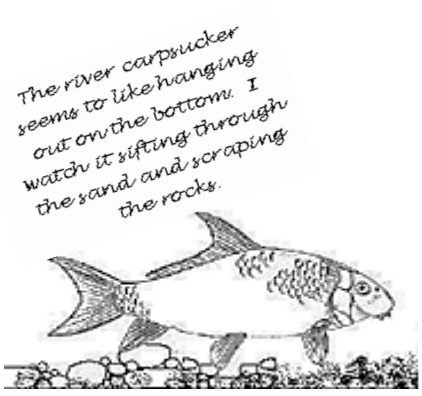


I've named one Joe. Joe is like the only one that goes in the pot. He is the medium one. He likes to chase Bob for some reason.
Isaac

Behavior

- ✓ Are there differences in behavior among the many species of fish?
- ✓ Do the fish move as a group? What is this called?
- ✓ What do fish do at feeding time?
- ✓ Do they "hang out" in the same area of the aquarium?

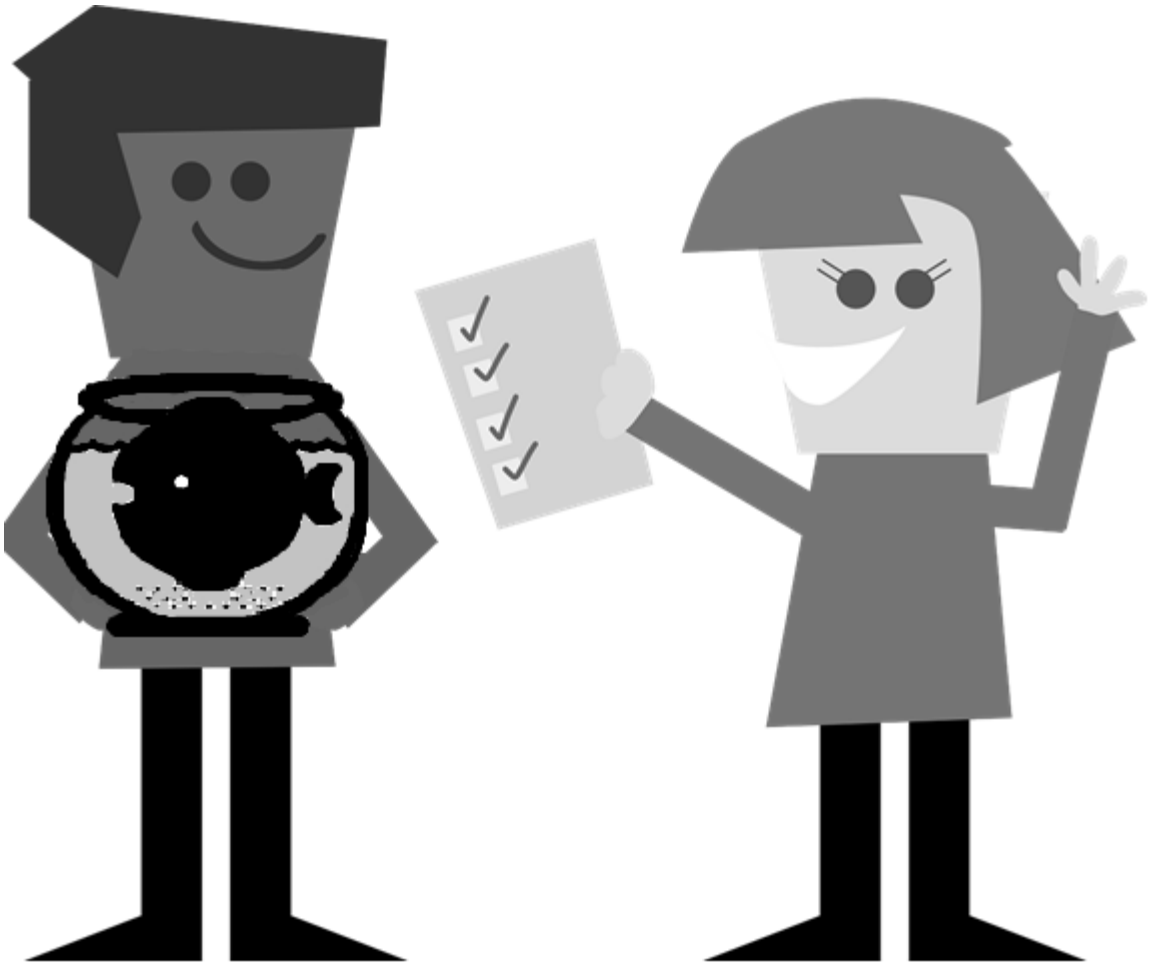
Use the questions to begin identifying *Cause and Eff*ect. Compare present observations to previous observations.



The answers to these questions, along with all your observations, explanations, and data will be a valuable source of information as you complete your native fish study. Did you know that scientists share their field journals? Their journals are a permanent record of their work and are kept in libraries for scientists to study in the future.

Section 1 - Preparing for Your Fish

Our intention with this section is for students to complete these activities prior to receiving the fish in the classroom.



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Activity 1: Getting to Know Your Aquarium

Standard Correlations - Grade 5:

New Mexico Science Content Standards, Benchmarks, and Performance Standards
Strand II, Standard II: Benchmark I, Performance Standard 1, 2, & 3

Common Core State Standards
CCSS ELA-Literacy, Reading Standards for Informational Text 5.3

Timeline: Approximately 60 minutes.

Objective: At the end of this activity, students will be able to identify the parts of the aquarium and describe the functions of the filter, chiller, UV light, and aerator (if present).

Preparation and Background: Review the Aquarium Set-up Section of the Reference Guide to familiarize yourself with all parts of the aquarium. The aquarium should be set up and running before doing this activity.

- ✓ **Fish**: A cold-blooded animal with gills and fins that lives solely in water.
- ✓ **Stress**: A condition where a fish or animal is under physical or mental duress.
- ✓ **Filter hosing**: A plastic tubing that moves water from the aquarium, to the filter, back to the aquarium.
- ✓ **Canister filter**: A container that houses beneficial bacteria, which break down ammonia and nitrites.
- ✓ **Aquarium**: This is a container where aquatic animals are housed.
- ✓ **Air stone (optional)**: A porous structure used to mix oxygen into the water.
- ✓ **Aerator (optional)**: A pump used to push air through the air stone.
- ✓ **Aquarium stand**: A platform specially made to hold the weight of an aquarium.
- ✓ **Substrate**: Material placed at the bottom of an aquarium, such as sand or rocks.
- ✓ **UV light sterilizer**: A device that uses ultra violet (UV) light to reduce harmful bacteria.
- ✓ **Chiller (optional)**: A device used to cool water for cold-water fish like trout.

Materials:

1. Student Worksheets: *Getting to Know Your Aquarium*, *Find and Define*
2. *Weekly Inspection Chart*

Procedure:

1. Inform students that for the next several months, they will be raising native fish in the classroom. Native species in their aquarium may include Flathead Chub, River Carpsucker, Red Shiner, Longnose Dace, Western Mosquitofish, Fathead Minnow, and White Sucker **OR** Rio Grande Cutthroat Trout. If all goes well, students will be able to release these fish back into their natural habitat in the Rio Grande near the end of the school year.

2. Gather around the aquarium. Describe the parts of the aquarium set-up, identifying the equipment and the purpose of each item. Inform students that their job will include monitoring the fish, the water, and the equipment. Display the *Weekly Inspection Chart* to students. Advise the students that the charts will provide the class with valuable data that can be used to evaluate and improve the project. Emphasize that by maintaining a properly functioning system, we minimize stress to our fish, thereby keeping them healthy. Quickly discuss the meaning of stress, if they do not already know the concept.

3. Discuss with students what their roles will be during the project. Explain that every student will keep a field journal where they will record their observations of the fish both in words and in sketches. In addition, they will each be responsible for monitoring the water quality and aquarium equipment. Explain how students will rotate through the responsibilities of caring for the fish. Emphasize to the students that this rotating process will allow experienced students to monitor the water quality and aquarium equipment while training new students. Inform students that at the end of the program, the fish will be released and students will have an opportunity to participate in the release.

4. While all the students are watching, complete an inspection. Have the students fill out the *Weekly Inspection Chart* for the day as they complete the inspection with you.

   NOTE: You will complete the water quality testing during Activity 2: Testing Your Water.

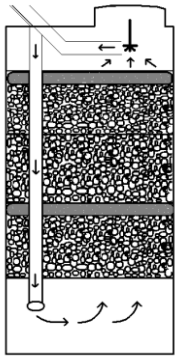
5. Provide time for students to complete the *Getting to Know Your Aquarium*.

STUDENT REFERENCE: GETTING TO KNOW YOUR AQUARIUM

Fish are wild animals that are adapted to survive in a natural stream, river, lake, or ocean system. However, our aquariums are maintained *closed* systems and vigilance will be essential in ensuring we maintain healthy fish. Although it is unlikely to have a system failure, should one occur, there is a short response time to correct the problem without hurting our native fish.

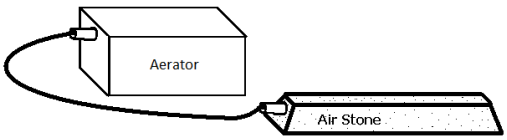
In your class, we will use an aquarium to hold our native fish species. An aquarium is a specialized container made to hold water and house aquatic species. This aquarium is generally set upon an aquarium stand; a platform specially made to hold the weight of an aquarium.

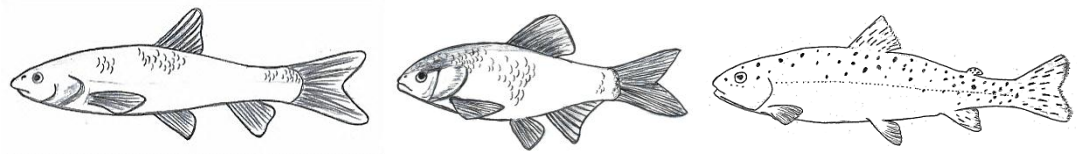
Fish are cold-blooded animals with gills and fins that live solely in water. Cold-blooded means they cannot internally regulate their temperature. Their temperature matches the temperature of their surroundings. To maintain ideal water conditions we will use a chiller (if necessary) and a canister filter. The chiller cools water to the ideal temperature for our fish. Some of our fish can survive at room temperature, so we may not need one. Either way we need to help keep the water temperature where the fish will least stressed.



In addition, to keep fish and food waste from poisoning the water, we use a canister filter. The canister filter pulls water from the aquarium and pushes it past media within the canister. The media contains millions of bacteria that help break down the fish and food waste into a safe form for our fish. After the water moves through the filter, it passes through an ultra-violet light sterilizer. This knocks out any bad bacteria that may harm our fish.

Fish can stress if their living conditions are not ideal. To make the fish feel at home we will add substrate, which is earthy material placed at the bottom of the aquarium. You will also have the chance to add cover, such as artificial plants and hiding spots for our fish. If they can hide and feel safe, they are less likely to be stressed. We will also have an aerator with an air-stone to make sure our fish plenty of oxygen to breathe. The aerator pushes air through a porous stone. The porous stone breaks up the air into tiny bubbles to help put oxygen into the water in the form of dissolved oxygen.



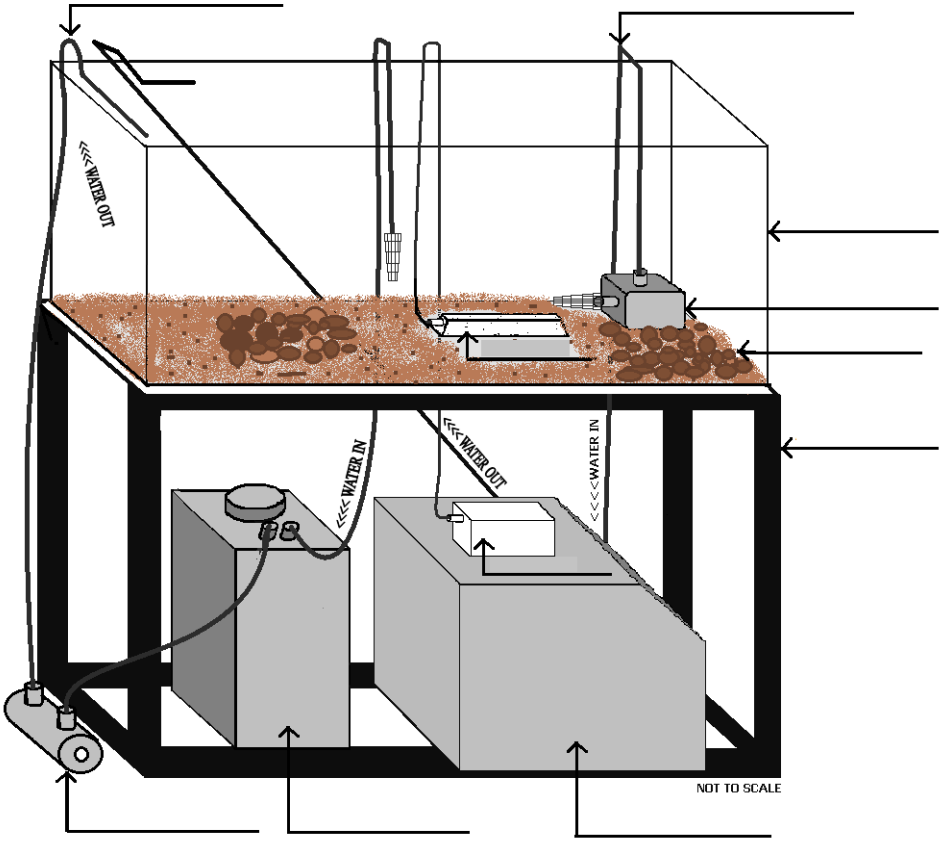


As you learn about your aquarium and the set-up keep in mind you want to make your fish as comfortable as possible to keep them healthy for their release in May!

STUDENT WORKSHEET: GETTING TO KNOW YOUR AQUARIUM

Name _____

It is important for you to know your aquarium and all its parts (you may not have all these parts). Understanding the aquarium set-up enables you to troubleshoot when and if something goes wrong. **Label the diagram below:**



Match the terms to the descriptions.

TERMS		DESCRIPTIONS
Filter Hosing	____	A. Pipes that carry water from the aquarium, to the chiller, back to the aquarium.
Canister Filter	____	B. A container that houses beneficial bacteria, which breaks down ammonia and nitrites.
Aquarium	____	C. When water is moved through this, it cools the water for cold-water fish like trout.
Chiller	____	D. This actively pushes water from the aquarium to the chiller.
Chiller Pumphead	____	E. This is the container where living aquatic animals are kept.
Aquarium Stand	____	F. This is a platform specially made to hold the weight of an aquarium.
Chiller Piping	____	G. Hoses that carry water from the aquarium, to the filter, back to the aquarium.
Substrate	____	H. The earthen material placed at the bottom of an aquarium.
UV Light Sterilizer	____	I. A device that uses ultra violet light to reduce harmful bacteria.

STUDENT WORKSHEET: FIND AND DEFINE

Name _____

Find the words listed below in the word puzzle and then write their definition.

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

Aquarium -

Chiller -

Substrate -

Ammonia -

UV Light -

Fish -

Nitrate -

Nitrite -

Aquarium Stand -

Canister Filter -

Stress -

Aerator -

Activity 2: Testing Your Water

Standard Correlations - Grade 5:

New Mexico Science Content Standards, Benchmarks, and Performance Standards
Strand I, Standard I, Benchmark I, Performance Standard 3
Strand I, Standard I, Benchmark III, Performance Standards 1, 2, 3
Strand II, Standard II, Benchmark I, Performance Standard 3

Common Core State Standards
CCSS ELA-Literacy, Speaking and Listening 5.1 & 5.4

Timeline: Approximately 60 minutes.

Objective: At the end of the activity, students will be able to follow proper procedures and techniques to test ammonia, nitrites, nitrates, and pH.

Preparation and Background: Emphasize the importance of following directions. In science, biologists must follow instructions when using various chemical tests and equipment. If we misuse the chemical tests and equipment, mistakes can happen. Mistakes, in some cases, can be lethal for the fish or animals with which we are working.

Students must follow the directions to ensure accurate test results. Accurate test results are necessary to ensure that we are maintaining good water quality or to help determine if something is wrong. When we use our water quality kit (a chemical test), our values are determined by the final color of the solution compared to a color chart specific to the test.

- ✓ **Accurate**: Free from mistake or errors, consistent with a standard
- ✓ **Test tube**: A cylindrical glass tube used in scientific experiments
- ✓ **Dropper bottle**: A bottle containing a known solution used in the water quality testing kit
- ✓ **Color chart**: A chart displaying colors used to compare the test solution's color
- ✓ **Chemical test**: Test made with standard chemical reagents that are known to react with other solutions in a given manner. Each chemical test provides results within a range of values.

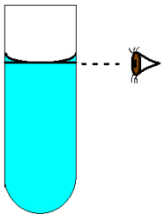
Review the nitrogen cycle in *Critical Water Quality Elements* section.

Materials:

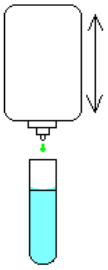
1. Student Reference: *Testing the Water – Information Cards* (in color) and *Testing the Water – Nitrogen Cycle*
2. Freshwater testing kit
3. Cat litter with baking soda
4. Ammonium chloride (small vial for known solution to be provided by NMFWCO)

Procedure:

1. Provide a demonstration of one water quality test to your students emphasizing proper technique.
    a. Read and follow the directions
        i. Fill test tube with aquarium water to the 5ml line
        ii. Add the correct number of drops
        iii. Add the solutions in proper order
        iv. Wait/shake liquids for the correct amount of time
        v. Read the results after the correct amount of time



    b. Things to remember
        i. Avoid contamination of liquids
            1. The top of the dropper bottle cannot touch anything, including test tube, water, or hands
        ii. Hold dropper bottles in an upright (vertical) position
            1. This allows for equal, proportional drops
        iii. When disposing of the chemicals, pour them into a container of cat litter with baking soda to help neutralize their effects. The cat litter can then be disposed of in the trash. Rinse tubes thoroughly with water and gently scrub with a test tube cleaner to remove any residue.



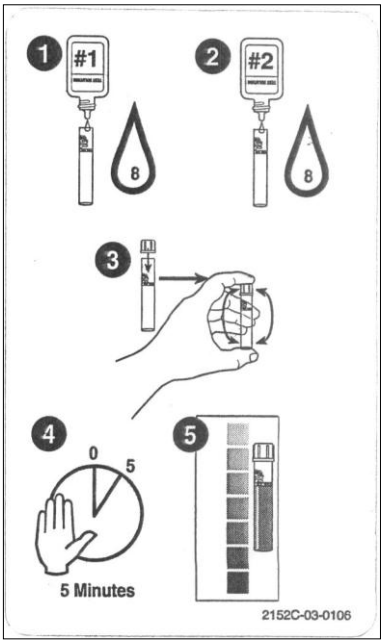
2. Break students into four groups (nitrite, nitrate, ammonia, and pH). Working together, each group should read the background information on their test. For practice, have each group complete their assigned test.

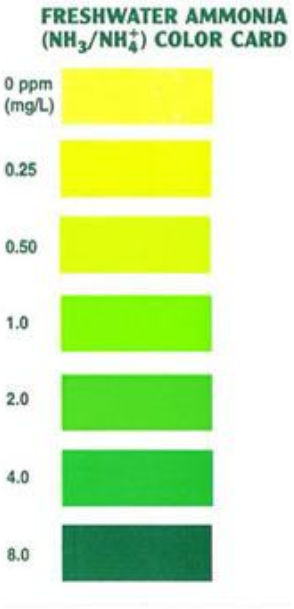
3. Each group should now present to the rest of the class; what they are testing, what their results mean, and explain the steps they took to complete their test.

4. After each group has presented their test, display the nitrogen cycle. Ask each group to point out where their test falls within the nitrogen cycle.

5. Discuss the four tests along with the nitrogen cycle.
    a. Do students notice relationships between each water quality element?
        i. Toxicity of ammonia depends on pH values.
        ii. Ammonia needs bacteria to break it down into nitrites.
        iii. Nitrates are not present, if nitrites are not present.
        iv. If nitrates are present, it means the nitrogen cycle has run its course.
        v. Temperature influences how fast or slow bacteria work.
        vi. Does the nitrogen cycle continue if one element is not present?

STUDENT REFERENCE: TESTING THE WATER – AMMONIA AND PH





AMMONIA

Ammonia is a colorless gas. It is the beginning of the nitrogen cycle. In the aquarium, ammonia comes from fish waste, rotting (decomposing) fish, and rotting (decaying) food. Ammonia can be poisonous or toxic. The toxicity of ammonia to fish increases as pH increases. Levels of total ammonia greater than 4 ppm can begin to damage fish gills and the fish may begin to have trouble breathing.

Water changes are needed when the ammonia levels (>4 ppm) become too much for the bacteria in your canister filter to breakdown. This usually happens when the fish are over-fed, so make sure not to over-feed your fish.

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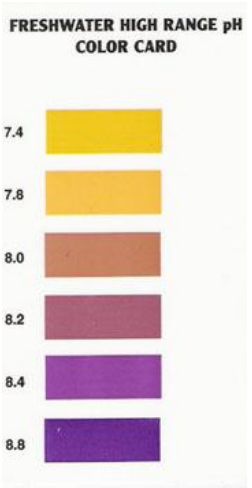
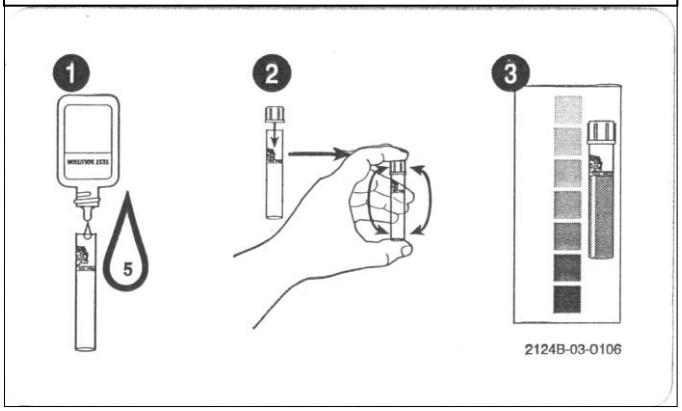


pH

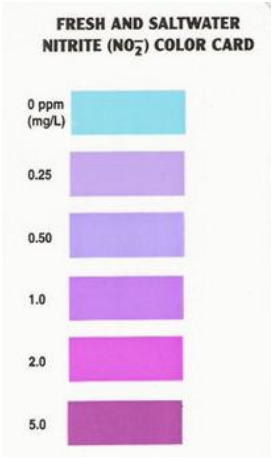


The value of pH tells us if a solution is acidic or alkaline. The pH scale range from 0 to 14, with the value of 7 representing neutral (pure water). Values less than 7 are acidic (stomach acid pH 1-5, orange juice pH 3). Values greater than 7 are alkaline (baking soda pH 9, soapy water pH 12).

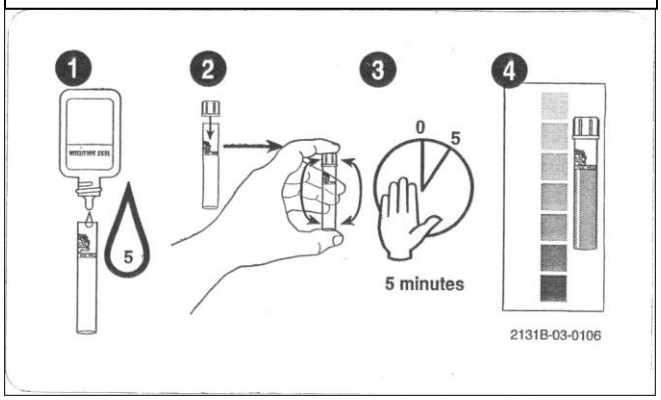
The rocks and soils (geology) of New Mexico are alkaline. Because New Mexico soils are alkaline, and our water runs over the rocks or through the soils, our water is also alkaline. Our water usually has a pH between 7 and 8.5. Since we have an alkaline pH, it becomes even more important to watch the ammonia levels. A pH greater than 7 produces a toxic form of ammonia (unionized). A low pH less than 7 produces a non-toxic form of ammonia (ionized).

STUDENT REFERENCE: TESTING THE WATER – NITRITE AND NITRATE

Nitrite results from bacteria breaking down ammonia. Presence of nitrite means that a very good bacteria, known as nitrosomonas, is in your filter. Temperature can influence how fast your nitrosomonas bacteria work. The colder the water, the slower your bacteria work to break down ammonia. Coldwater aquariums need more bacteria than warmwater aquariums to handle equal amounts of ammonia. Pay close attention to your nitrite levels because they are also toxic to fish and must remain near zero.



NITRITE



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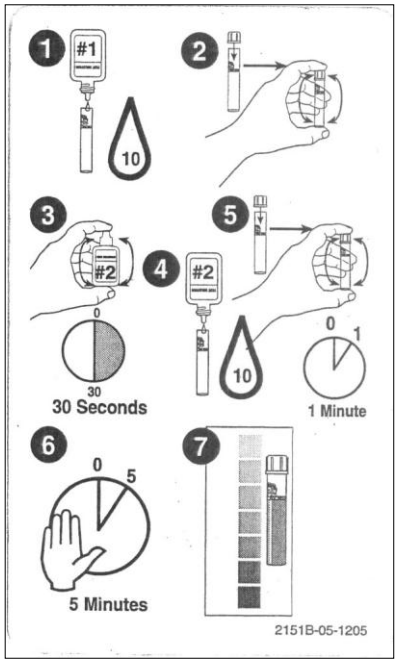


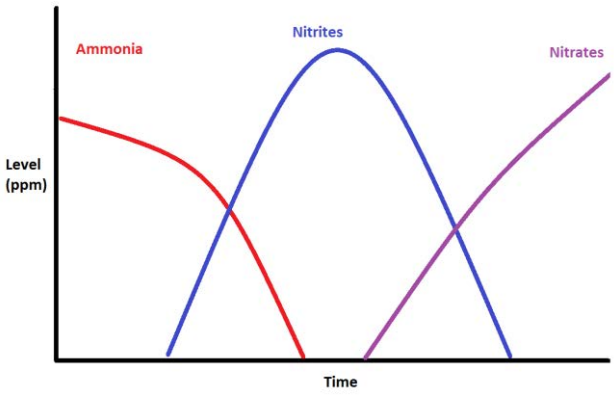
NITRATE

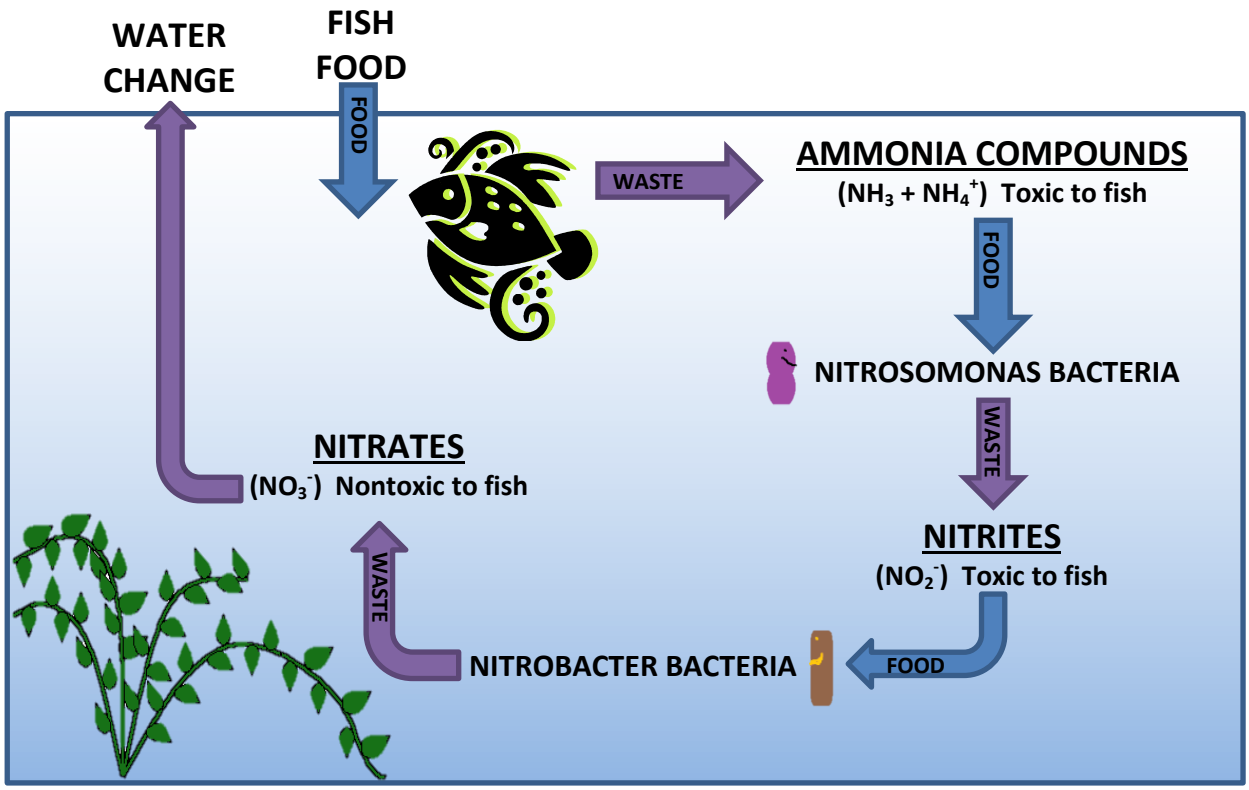
Nitrate result from bacteria breaking down nitrites. Presence of nitrate means that a very good bacteria, known as nitrobacter, is in your filter. Although nitrates are not toxic to fish, levels greater than 40-ppm indicate that there is a build-up of organic material like fish waste, rotting (decomposing) fish, and/or rotting (decaying) food. This means it is time for a water change.

Pay attention to Step 3 in the test. The chemical solution #2 for nitrate separates easily, so you must shake the solution. If you do not shake the bottle to remix the solution, you will not get accurate test results.

STUDENT REFERENCE: TESTING THE WATER – THE NITROGEN CYCLE

We initiated the nitrogen cycle with the addition of ammonium chloride, a food source for nitrosomonas bacteria. As the nitrosomonas bacteria break down ammonia, reducing it to nitrites, a food source for nitrobacter bacteria is provided. Nitrobacter bacteria reduce the nitrites to nitrates. This completes the nitrogen cycle in your system. As your system continues to cycle, bacteria grow and will stabilize the system by eating the ammonia and nitrites as quickly as they are made. Eventually, when you test your water, ammonia and nitrites will be near zero because there are enough bacteria to eat them as fast as they are made.





STUDENT WORKSHEET: THE FALLEN NITROGEN CYCLE

Name _____

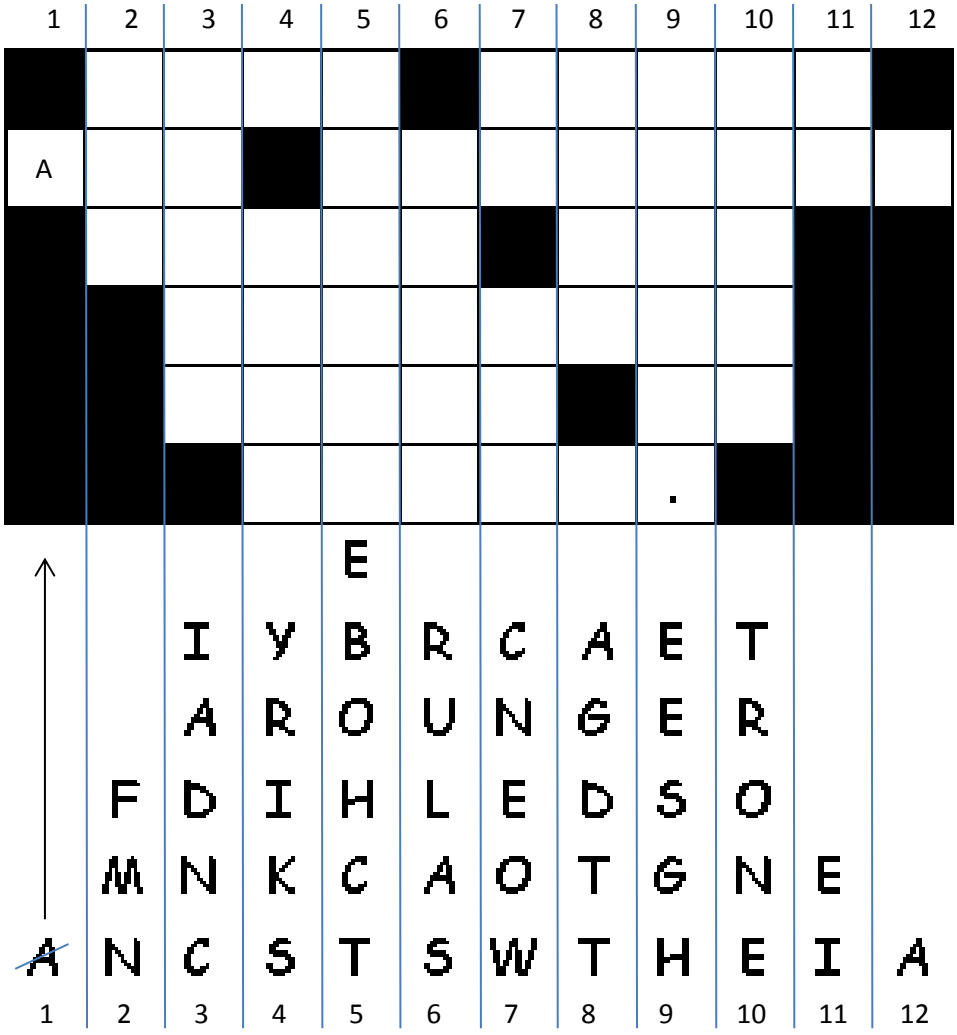
Answer the following question to help solve the fallen phrase puzzle.

QUESTION: What makes the nitrogen cycle go round?

Fallen phrase puzzle - a puzzle where all the letters have fallen to the bottom. The letters were jumbled on their way down, but remain in the same column. The phrase reads normally from left to right. However, you make the words in the phase using only the letters from the same column. Puzzle solving tips are below.

- Find a column with only one blank square. That column will have only one letter. Fill in the blank square with the letter underneath the column. For example, column #1 has only one letter. Fill in the blank square with the letter "A".
- Next, attempt to figure out any two word options.
- Then use trial and error to keep filling in the blanks until you get a finished puzzle.
- Cross off the letters as you use them.

ANSWER:



Activity 3: A Happy Home

Standard Correlations - Grade 5:

New Mexico Science Content Standards, Benchmarks, and Performance Standards
Strand II, Standard II: Benchmark I, Performance Standards 1, 2, & 3

Common Core State Standards
CCSS ELA-Literacy, Speaking and Listening Standards 5.1

Timeline: Approximately 60 minutes.

Objective: At the end of the activity, students will be able to identify three limiting factors; food, water, & shelter. Students will be able to identify how the three limiting factors are met in the wild and in captivity.

Preparation and Background: The aquariums we are establishing in the classroom are artificial habitats. They represent a simplified version of a complex system. In the wild, these fish encounter a wide variety of habitats, interact with other species, and adjust to seasonal changes in water dynamics (hydrology).

The students will provide the three limiting factors for their fish: food, water, and shelter. All three limiting factors must be available in order for any species to survive. For fish and other aquatic species, water provides all three limiting factors; water for purposes of hydration, a carrier for their food, and for shelter. With this in mind, it is very important to pay close attention to aquarium water quality.

In this activity, students will study how the aquarium provides all three limiting factors and how it mimics a natural stream system. Specific fish requirements vary among the species. Our job is to provide a suitable environment that can accommodate the basic needs for all the fish that will be living in the aquarium. Some fish like fast flowing water, while others like slow or still backwater. Some fish like sand substrate and others like gravel and cobble.

Students will provide various feeds meant to meet the nutritional requirements of the fish. Water will serve to hydrate, deliver food, and provide shelter. Furthermore, the filter will clean the water the fish need to survive. It does this in two ways; it physically removes debris from the water and provides home for bacteria needed to break down ammonia and nitrites. Students will provide additional shelter consisting of substrate, background, and artificial plants. This provides the fish with a sense of security and reduces stress.

Materials:

1. Student Worksheet: *Creating a Happy Home*
2. Internet access, if time permits, for students to research what makes up their fish's home.
3. Crayons, paint, construction paper, glue, scissors, magazine clippings – be creative!
4. Aquarium insulation (foam poster board or cardboard) cut to the size of you aquarium including the back, sides, and front.

Procedure:

1. Discuss with students how the aquarium will simulate fish habitats in nature. Display the *A Happy Home* worksheet on the board.

1. Working in small groups, have students decide what parts of your aquarium imitate features in nature. How does the aquarium set-up meet each of the three limiting factors?

2. Have students complete a quick research project to identify what kinds of habitats the fish require. Your fish may be Rio Grande Cutthroat Trout or fish of the Middle Rio Grande like Red Shiner, Fathead Minnow, Western Mosquitofish, Flathead Chub, River Carpsucker, Longnose Dace, and White Sucker.

3. Allow time for groups to share their findings. Record responses on the board. For each item, call on the students to identify how, and if, the aquarium will meet those same conditions.

4. After the discussion, have students write in their Fish Journals and describe *in their own words* how their aquarium mimics a natural stream.

5. Once this activity is completed, have the students create backgrounds on the aquarium insulation using any nontoxic materials that will lay flat against the aquarium. Be creative! While students are creating their backgrounds, they will need to begin finding habitat cover to go inside of the aquarium as well.

STUDENT WORKSHEET: A HAPPY HOME

Name _____

	In Nature	In Aquarium
Limiting Factor: Food		
Food	may include algae, zooplankton, aquatic bugs (invertebrates), terrestrial bugs (insects), and other fish.	
Limiting Factor: Water		
Water temperature is influenced by	source of water (springs, snowmelt, city run-off), elevation, amount of shade, amount of sunlight	
Source of oxygen	is aeration of water through turbulence created by fast flows over gravel and boulders or wind causing waves at the surface and photosynthesis of plants during the day.	
Water is cleaned (removal of ammonia, nitrites, and nitrates)	by bacteria and scavengers breaking down fish waste, rotting (decomposing) fish, and rotting (decaying) food in rivers and streams. Plants absorb nitrates and water flows or storm events flush a stream of debris.	
The pH of water is influenced by	the rock and soils (geology) that the water runs through and over as it moves. Human-caused pollutants can also cause pH to fluctuate.	
Limiting Factor: Shelter		
Source of Shelter	includes overhanging vegetation, trees, deep pools, substrate (bedrock, gravel, & cobble) and submerged vegetation	
Predators	includes mammals like bears, raccoons, snakes, frogs, birds, or other fish and humans.	

Activity 4: Doing the Math

Standard Correlations - Grade 5:

New Mexico Science Content Standards, Benchmarks, and Performance Standards
Strand I, Standard I, Benchmark III, Performance Standards 1 & 2

Common Core State Standards
CCSS Math Standards 5.OA.1
Math Standards 5.MD.1 & 5

Timeline: Approximately two 60-minute periods.

Objective: At the end of the activity, students will be able to explain the importance of using proper units in math and the importance of math in biology. Students will be able to calculate temperature conversions and liquid volumes. Student will be able to demonstrate how to read a thermometer.

Preparation and Background: Science and math often work hand in hand. Biologists use math in every aspect of their various fields. We use it when we are trying to figure out how much food to feed, or how much a fish has grown in a month, or in analyzing water quality when we record temperature. The temperature of water will determine if a fish can survive in the river or stream.

Temperature: To convert a temperature reading into something you recognize you need math. Temperatures are often given in different scales like Celsius, Fahrenheit, and Kelvin. The most common scales in our field are Celsius and Fahrenheit. Our daily air temperature is generally given in Fahrenheit. For example, it is going to be hot day today in Albuquerque when temperatures reach 99° Fahrenheit. However, people may not recognize the extreme heat if they were told it was going to be 37° Celsius.

- ✓ The Fahrenheit scale is the temperature scale people are probably most familiar with here in the United States. The Fahrenheit scale is commonly used to report things like weather or body temperature.
- ✓ The Celsius scale is commonly used for scientific work. The thermometers that we use in our laboratory and in the field are marked with the Celsius scale.
- ✓ During the students' research, they will likely come across temperatures given in one or both of these scales. It is good to know how to convert between the two scales to understand if the temperature is warm or cold, especially if someone is not used to working in Celsius.
    - °F = (°C x 1.8) + 32
    - °C= (°F - 32) / 1.8

Volume: Not only do biologists work with temperatures, but fish biologists also work with volumes. The volume of a body of water is an important piece of information when trying to figure out how to resolve a problem or how best to manage a pond, lake, or a reservoir.

For our purposes in the classroom, we need to know the capacity of our aquariums. How much water the aquarium holds will ultimately determine how many fish we can safely hold. It also helps determine the size of filter required to keep the water in the aquarium clean. Should the fish become sick, we would need to know the volume of water to provide the proper dosage of medicine for the fish.

Materials:

1. Student Worksheets: *Degrees of C or F* and *How Much Water*
2. Celsius and Fahrenheit thermometers
3. Measuring tape

Procedure:

Temperature

1. Hand out *The Thermometer* and *Degrees of Celsius and Fahrenheit* worksheets for students to complete.

2. Let students practice collecting temperatures from around the room and outside.

3. Have students practice converting temperatures from Celsius to Fahrenheit.
    a. Emphasize the importance of temperature and recording the proper scale. For example, the Red Shiner can handle warm water. However, even some water is too warm. What is too warm? In the Celsius scale, it would be greater than 36.3°C but in the Fahrenheit scale, it would be greater than 97.3°F. If the water temperature becomes too warm, the fish will die. It is important to know the temperature as well as the scale it represents.

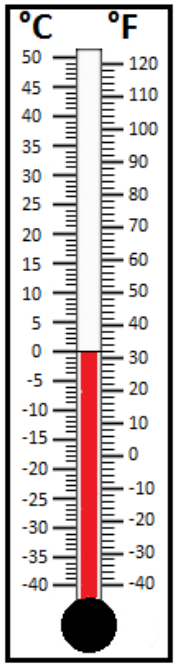
Volume

1. Let students measure the dimensions of the aquarium: length, width, and height. Measurements should be taken in inches or centimeters. Emphasize that they always need to record the units of measurement.

2. Have students work out the volume of the aquarium on the *Calculating Water Volume* worksheet. Students can practice additional problems on the *Calculating Water Volume II* worksheet.

STUDENT WORKSHEET: THE THERMOMETER

Name _____



Refresher: *Thermometers measure the temperature, which is a measurement of how hot or cold something might be. The liquid inside a thermometer will rise as the temperature rises and fall as it cools. Read the highest point of the liquid to determine the temperature. In our example, the temperature reads 0 ℃ and 32 ℉*

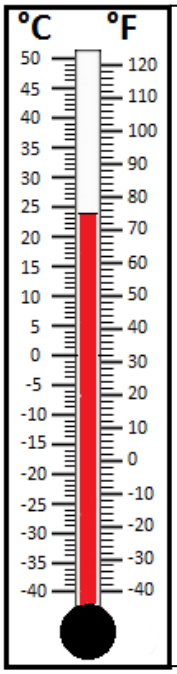
What are Celsius (℃) and Fahrenheit (℉)? They are two of the three temperature scales. The third scale is called Kelvin. The Fahrenheit scale is the temperature scale most people in the United States recognize especially when it comes to weather and checking for a fever. The Celsius scale is commonly used for scientific work. The thermometers that we use in our lab and in the field are marked with the Celsius scale.

Water temperatures are a significant piece of information for a Fish Biologist and the fish they manage. A fish is a coldblooded animal, which means its temperature is regulated by the water in which it lives. However, fish have a specific range of temperatures that they needs for survival and to complete their life cycle.

Help the biologists gather data for your class. Collect temperatures from around your classroom. Make sure to write if your temperature is in Celsius or Fahrenheit, it makes a difference!

Aquarium _____ **Classroom Air _____** **Tap Water _____**

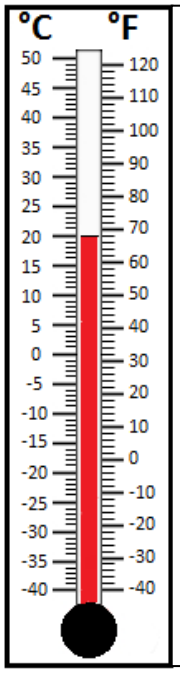
Practice reading the thermometer and record the temperatures. Make sure to record your scale (units) for each temperature reading, it makes a difference.



Rio Grande Cutthroat Trout do not survive when the water reaches this temperature for an extended period of time.

1) _____

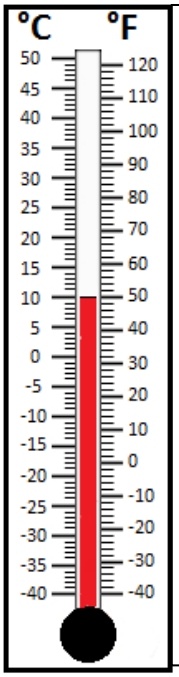
2) _____



Rio Grande Silvery Minnow eggs develop at different rates depending on the temperature. At this temperature, the egg is free-swimming about 7 days after it was released by the female.

5) _____

6) _____



Temperature also plays a role in the life cycle of parasites of fish. At this temperature it would take 2 to 3 weeks for the Ich parasite to complete its life cycle (at 21 °C it would take only 3 to 4 days).

3) _____

4) _____

STUDENT WORKSHEET: DEGREES OF CELSIUS AND FAHRENHEIT

Name _____

*The Fish Biologists collected water temperatures from different rivers and streams. Some of our biologists recorded the temperatures in Celsius (℃) and some in Fahrenheit (**°F**).*

Can you help convert each temperature? Use the formulas below to help you convert the temperature into Celsius or Fahrenheit. Show your work.

°C= (°F - 32) / 1.8	**°F = (°C x 1.8) + 32**
°C= (75 - 32) / 1.8	°F = (22 x 1.8) + 32
Answer = 23.9 °C	Answer = 71.6 °F

1) 88.7°F = ____ °C

2) 34.0°F = ____ °C

3) 60.0°F = ____ °C

4) 52.0°F = ____ °C

5) 90.0°F = ____ °C

6) 5.0°C = ____ °F

7) 34.0°C = ____ °F

8) 20.0°C = ____ °F

9) 29.0°C = ____ °F

10) 11.0°C = ____ °F

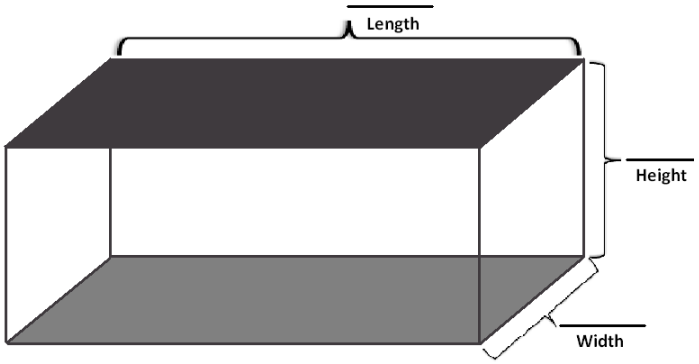
STUDENT WORKSHEET: CALCULATING WATER VOLUME

Name _____

As a junior biologist, you are entrusted with taking care of the fish. There is an important piece of information that we need you to figure out. We need to know the volume of water in our aquarium.

The volume (amount of water) the aquarium holds can help us figure out how many fish we can hold and what size filter we need so as to keep the water in the aquarium clean. If the fish become sick, we would also need to know the volume of water to provide the right amount of medicine.

Your job is to tell the biologist how many gallons of water are in your aquarium. Record your aquarium measurements on the diagram below. Remember to record your units of measurement; you will need them to complete your conversion correctly.



Formula: ***Volume = length X width X height = cubic inches (or cubic centimeters)***

Step 1:
Volume of aquarium = _____ (length) _____ (width) X _____ (height) = _____

Step 2:
Once you calculate the volume of your aquarium, you will need to convert your answer into gallons. Use only the conversion factor that matches your units of measurement; inches or centimeters.

Conversion factors: $\frac{0.00433 \text{ gal}}{1 \text{ cubic inch } (in^3)}$ $\frac{0.000264 \text{ gal}}{1 \text{ cubic centimeter } (cm^3)}$

Convert to gallons = _____ (answer from Step 1) X _____ (conversion factor) = _____ gallons

STUDENT WORKSHEET: CALCULATING WATER VOLUME II

Name _____

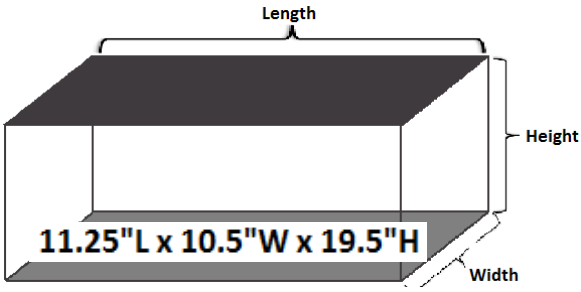
Fish Culturists use various sizes of aquariums. Some are for quarantine, young fish, or even for macroinvertebrates. Can you help figure out the volume of water for each aquarium?

Step 1: First, find the volume using the given dimensions of each aquarium.
Formula: ***Volume = length X width X height = cubic inches (or cubic centimeters)***

Step 2: Second, convert the calculated volume into gallons. Remember, use only the conversion factor that matches your units of measurement, inches or centimeters.

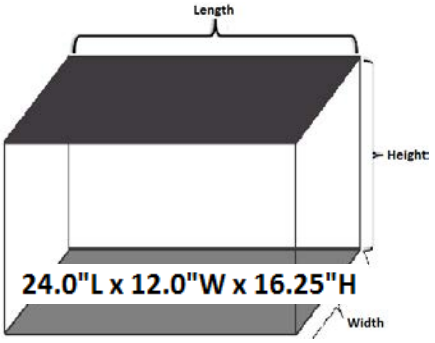
Conversion factors: *0.00433 gal / 1 cubic inch (in^3)* | *0.000264 gal / 1 cubic centimeter (cm^3)*

1)



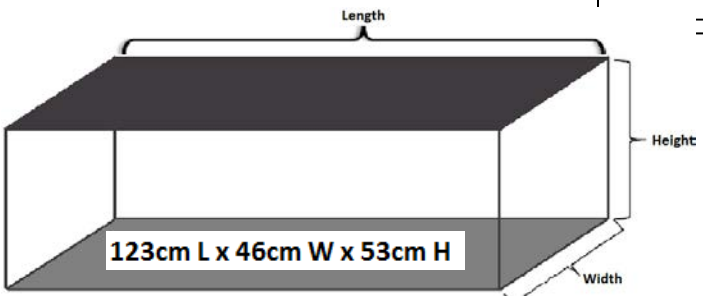
Volume: _____ Gallons: _____

2)



Volume: _____ Gallons: _____

3)



Volume: _____ Gallons: _____

Activity 5: Working Together for the Fish

Standard Correlations - Grade 5:

New Mexico Science Content Standards, Benchmarks, and Performance Standards
Strand II, Standard II, Benchmark III, Performance Standard 3

Art Content Standards
Art Strand Visual Arts, Standard 1, K-5 Benchmark 1A: 1 & 2
Art Strand Visual Arts, Standard 2, K-5 Benchmark 2A: 2

Common Core State Standards

Timeline: Approximately 90 minutes.

Objective: At the end of this activity, students will be able to identify at least three reasons for developing a partnership. Students will be able to explain the importance of partnerships and collaboration for the protection and recovery of native species.

Preparation and Background: Gather materials and print out the puzzle image in color. Number the back of each square in sequential order. This will help you piece the image together once students are finished drawing and coloring their larger square.

Humans are the only species who recognize political and land ownership boundaries. Most species have home ranges and daily and yearly migration patterns that do not recognize these boundaries. Because of this, various agencies, organizations, industries, and individuals are brought together to mitigate damages to habitat and restrictions to movement, as well as for the overall protection of a species. One lone person cannot achieve the protection and recovery of a species. Collaboration, creative thinking, compromise, and communication are necessary among all the parties to prevent extinction, recover, and maintain a healthy population of any given species.

Why would you need to develop a partnership?

- ✓ Varying levels of land ownership (Private vs Government)
- ✓ Varying levels of expertise
- ✓ Leveraging resources
- ✓ Political/jurisdictional boundaries (County, State, Tribal, Federal, International)
- ✓ Time constraints
- ✓ Full representation of interested or affected parties
- ✓ Potential to achieve goals on a grander scale
- ✓ Emergency response to catastrophic events such as flooding or wildfires

Additional Reference Sites (these represent only a minute number of the many partnerships):

Oregon Chub Proposed as First Fish to be Removed from Endangered Species List Due to Recovery at http://www.fws.gov/pacific/news/news.cfm?id=2144375311 & Endangered Species Act Scores

Another Success as Oregon Chub Becomes First Fish Delisted Due to Recovery at http://www.fws.gov/pacific/news/news.cfm?id=2144375359
Save the Monarch Butterfly at http://www.fws.gov/savethemonarch/ and Pollinator Partners and Affiliates at http://www.nwf.org/Pollinators/Partners-and-Affiliates.aspx. Note the line: "**We can save the Monarch, but it will take a concerted national effort".**

Fort Bragg Reaches Recovery Milestone for the Endangered Red-cockaded Woodpecker Five Years Earlier than Expected at http://www.fws.gov/southeast/news/2006/r06-035.html

10 World Wildlife Funds Success Stories of 2014 at http://www.worldwildlife.org/stories/10-wwf-success-stories-of-2014

Materials:

1. Teacher Reference: Working Together for the Fish (image 1, 2, or 3; squares = 1-inch)
2. 4" x 4" or larger (1" increments) white paper squares
3. Pencils
4. Crayons
5. Glue
6. One poster board at least 24" x 16"
7. Partnership stories

Procedure:

1. Use the reference sites above to begin a discussion on the importance of partnerships for achieving species protection and recovery. As students read through them, have them identify how many agencies, organizations and individuals participated or continue to participate in the recovery of a species.

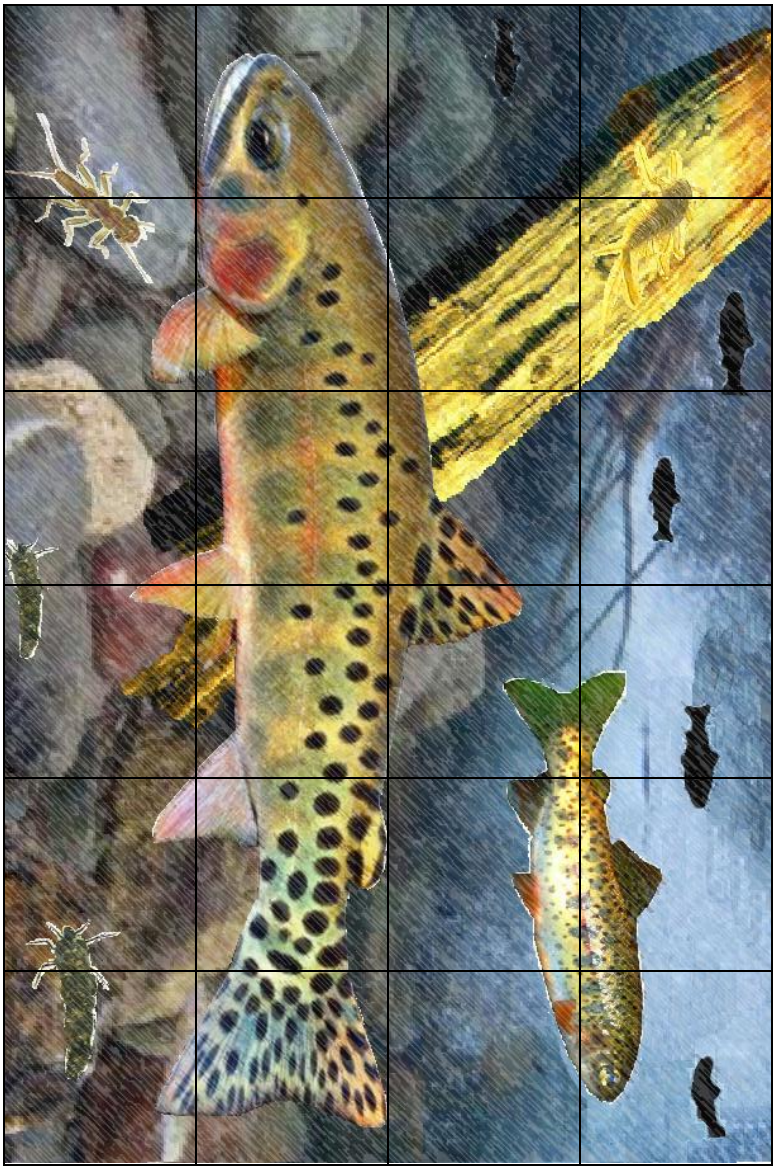
2. Explain to the students they will be working together to complete this project. To create this piece of art, each student's contribution is important to in order to view the whole picture.

3. Provide each student with a 1-inch square of the puzzle image and a blank, square sheet of paper. To the students, their square may look like a random arrangement of colors, lines, or shapes.

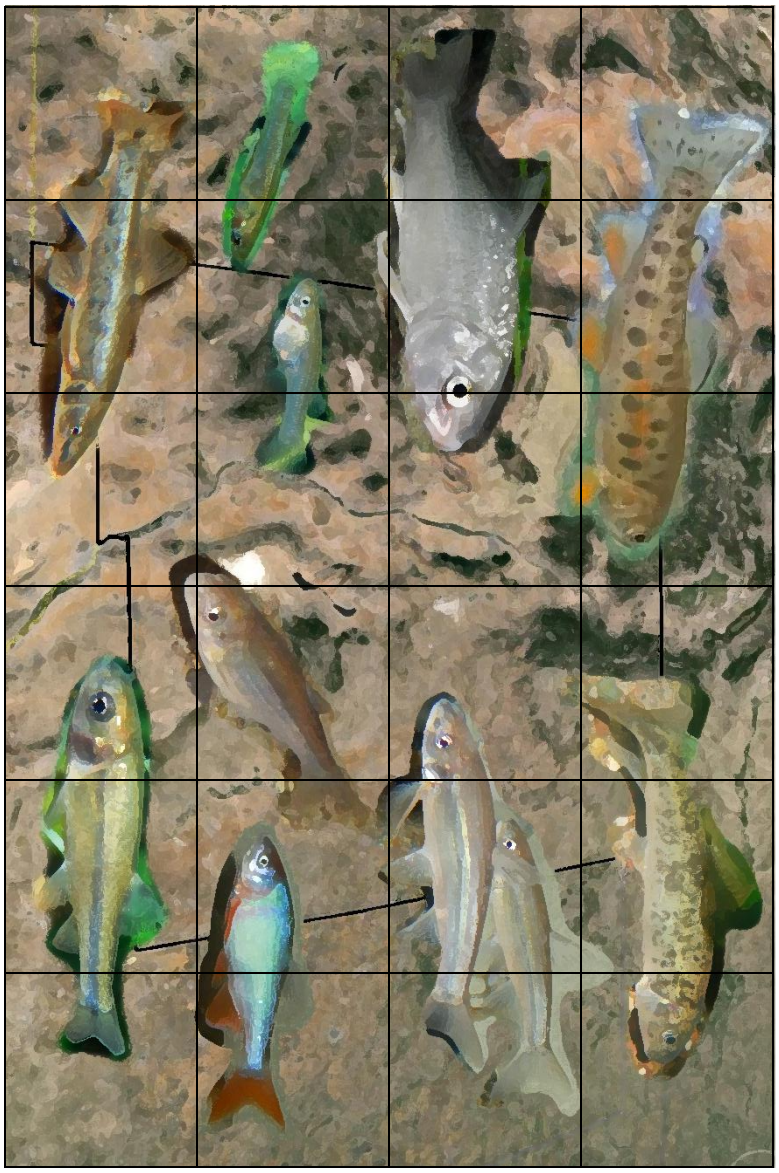
4. Have each student re-draw their image square to the larger blank square to the best of their ability. Emphasize they are trying to match colors and enlarge their image in uniform dimensions. Their square is part of a larger puzzle; students should not try to work the puzzle out just yet.

5. Once students have completed their puzzle pieces, students should work together to piece together the puzzle on a classroom wall or hallway. As students complete the puzzle, the teacher should discuss the concept that all of nature, including humans, is part of the larger conservation picture.

TEACHER REFERENCE: WORKING TOGETHER FOR THE FISH - IMAGE 1



TEACHER REFERENCE: WORKING TOGETHER FOR THE FISH - IMAGE 2



TEACHER REFERENCE: WORKING TOGETHER FOR THE FISH - IMAGE 3

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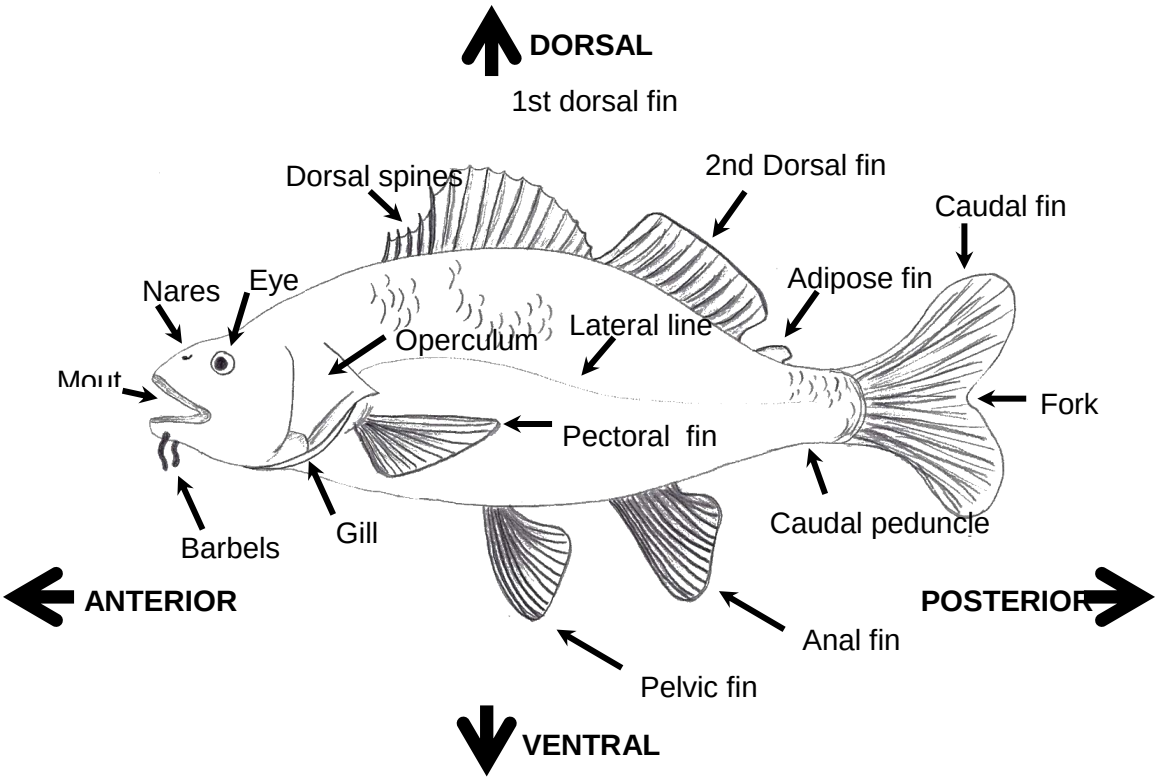
Section 2 – All About the Fish

This section focuses on the life history and biology of the native fish species in New Mexico, specific to species utilized within the NFIC Project.



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Activity 6: Option I – External Trout Anatomy

Standard Correlations - Grade 5:

New Mexico Science Content Standards, Benchmarks, and Performance Standards
Strand II, Standard II, Benchmark II, Performance Standards 2 & 3

Art Content Standards
Strand Visual Arts, Standard 1, Benchmark 1-A, 4-5.2

Common Core Standards
Reading Standards for Informational Text 5.4
Speaking and Listening Standards 5.3

Timeline: Approximately two 60-minute periods.

Objective: At the end of this activity, students will be able to identify at least four anatomical features. Students will be able to interpret a basic species description. Students will be able to explain how a trout uses coloration and markings for camouflage.

Preparation and Background: A Species Description is a formal explanation of the defining characteristics of an organism. It provides a narrative of a particular species, distinguishing it from other species. Anatomy of various species is important to know, in order to understand a species description.

- ✓ **Species description**: Formal explanation of the defining characteristics of an organism.
- ✓ **Anatomy**: The study of the structures of a body.

Species Description: Rio Grande Cutthroat Trout are light rose to red-orange on the sides and pink or yellow-orange on the belly. During the spawning season, the colors of mature adults can be brighter. The Cutthroat Trout has relatively large, irregular shaped dark spots that are concentrated posterior to the dorsal fin, but may also occur anterior to the dorsal fin above the lateral line. In common with all Cutthroat Trout species, Rio Grande Cutthroat Trout have a red to orange slash on the lower jaw. Adults remain relatively small, ranging from 6 to 10 inches in length.

The *Trout Anatomy Defined* worksheet includes a picture of the Rio Grande Cutthroat Trout and features of its external anatomy. A definition of each anatomical feature is provided.

The body shape of an animal helps us understand its place or niche in the environment. Overall, there are roughly six body shapes for fish, which include rover-predator, lie-in-wait predator, surface-oriented fish, bottom fish, deep-bodied fish, and eel-like fish. The Cutthroat Trout is considered to have a rover-predator body shape. Rover-predators are generally streamlined, have a pointed head ending with its mouth, fins that are evenly distributed and a narrow caudal peduncle tipped with a forked tail. The distribution of fins provides for stability and maneuverability.

- ✓ Does the rover-predator description fit the Cutthroat Trout?

The streamlined shape of the Cutthroat Trout and distribution of the fins allow the Cutthroat Trout to slice through water and move upstream with minimal water resistance, conserving energy.

Colorations and markings are just as important as the body structures identified on the *Trout Anatomy Defined* handout. Cryptic coloration, a means of camouflage by coloration, is a predator avoidance mechanism for the trout. Trout fry have dark spots, called "parr marks" and coloration that helps them hide from predators. The light and dark patterns (parr marks) breakup the outline of a trout and minimize a predator's or an observer's ability to see the trout. Countershading, lighter ventral surface and darker dorsal surface, is considered an important element of cryptic coloration. Native trout of a given stream, color match very well to their habitat.

- ✓ When salmon and steelhead go out to sea, the backs become very dark and their stomachs very light. This helps them to avoid predators from above and below the surface.
- ✓ Sea-run trout are mostly silver.
- ✓ Trout in the arid West usually feature golden hues.

Variations in colors of aquatic plants, substrate, stream depths, and lighting can all influence coloration of a habitat. Because habitats vary in color; then so do the colors of a trout.

Materials:

1. Student Worksheets: *Trout Anatomy Defined*, *Trout Anatomy Double Puzzle*, *Trout Anatomy Crossword Puzzle* and *Color a Trout*
2. Index cards (one per student)
3. Images of various trout species
4. Drawing or coloring material (cups, paint brushes, watercolor palettes, and/or crayons)

Procedure:

Anatomy

1. Prior to providing the *Trout Anatomy* worksheet, read the species description for the Rio Grande Cutthroat Trout (in Preparation and Background section). Ask students if they understand the species description and can picture the Cutthroat Trout in their head.

2. Define anatomy

3. Briefly discuss with students how our senses and our anatomy allow us to function in our environment. Point out that humans move through air; trout through water.

4. Ask students to think about how things might look, taste, smell, sound, and feel in a water environment.

5. Questions help us define what we observe. Observation is the first step in the scientific method.

- ✓ What physical features would an animal (like a trout) need to function in a water environment?
- ✓ What sort of body shape do trout need to move quickly through the water?
- ✓ What helps propel a trout through the water?
- ✓ What sensory organs help a trout find food?

6. Have students work in small groups. Let students know they are going to examine the trout's features and how they function in its environment. Distribute the *Trout Anatomy Defined* handout to students. Instruct them to read the information on the handout and to identify each body part and how it helps the trout to function.

7. Distribute one index card to each student. Have students write a question about a trout feature on the front of the card and the answer on the back. For example, "What is the biggest fin?" (answer: caudal fin). Collect the cards and use them to play a quick question-answer game.

   - ✓ The *Trout Anatomy Double Puzzle* and *Trout Anatomy Crossword Puzzle* can be completed in class or as homework to help reinforce the basic anatomy of the Cutthroat Trout.

Coloration

1. Have students look at the pictures of the various trout. Ask them to identify and notice the colorings of the trout body, the eight fins, the gill cover, any spots, the parr marks, and the lateral line.

2. Explain to students that trout often match their habitats in coloration and ask why this might be a good idea (protection from predators, more successful hunting).

3. Give each student water coloring supplies and a *Color a Trout* (or blank sheet) handout. Some students may like to have crayons to make small spots that resist the paint. Ask students to paint their trout, keeping in mind or referring to the images they just saw. Their trout can be unique, but it must still have trout-like features.

4. Inspire your students to be creative but factual with their drawings:
   - ✓ The lateral line is often marked by color.
   - ✓ Most trout have spots.
   - ✓ Many trout never lose their parr marks—the dark, oval-shaped splotches along their bodies that can be a form of camouflage.
   - ✓ Coloring of a trout often matches their environment to some degree.
   - ✓ Males and females within a species can have different colors.
   - ✓ Colors can change over the lifetime of a trout, usually becoming more distinct and vivid as they age.
   - ✓ Trout colors become even more vivid at spawning time.

5. Students who finish quickly can add habitat with paint or crayon.

6. Ask students to share their trout paintings, explaining to the class which distinct features they gave their trout. Students might also explain in which kind of habitat their trout lives.

In small groups or as a whole class, have students look at artistic images and photographs of different species and subspecies trout.

7. Once students have completed the tasks covering trout anatomy, reread the species description for the Rio Grande Cutthroat Trout. Ask students if they can now understand and picture the Rio Grande Cutthroat Trout in the head.

TEACHER REFERENCE: NATIVE TROUT

Images by W.H. Brandenburg

Gila Trout

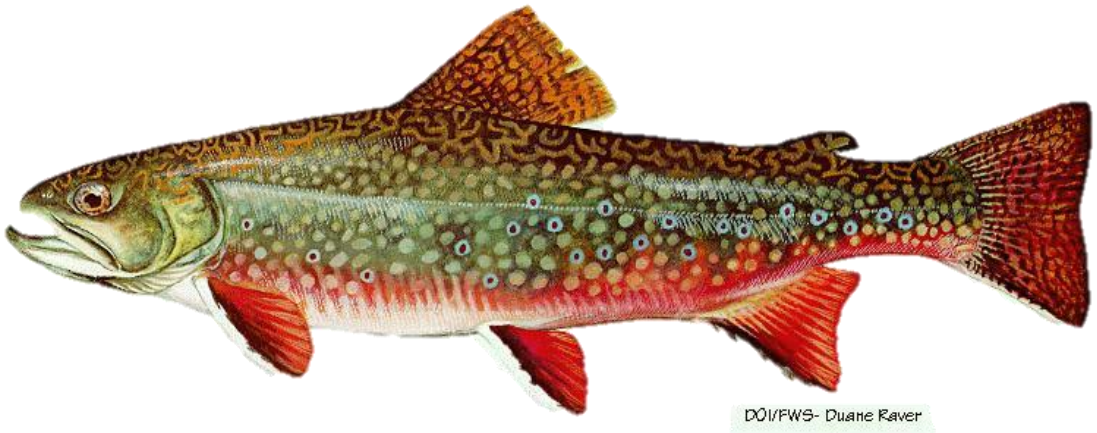
Rio Grande Cutthroat Trout

TEACHER REFERENCE: NONNATIVE TROUT

Images from: http://www.fws.gov/mountain-prairie/fish/fish.html

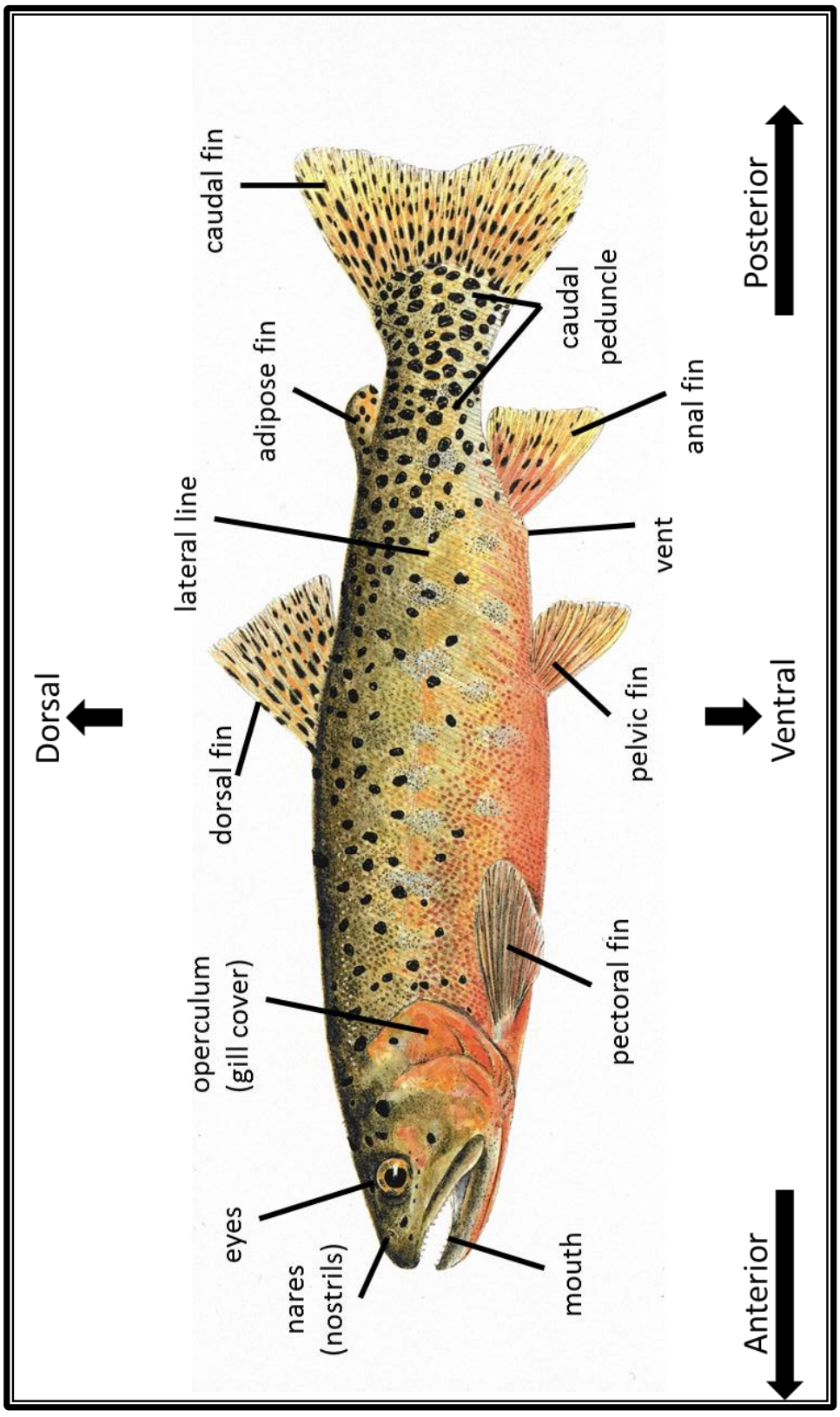
Rainbow Trout

Brown Trout



Brook Trout

STUDENT REFERENCE: AN EXTERNAL VIEW OF A TROUT



STUDENT REFERENCE: TROUT ANATOMY DEFINED

Eyes: A sensory organ used for sight. The pupils are slightly triangular instead of circular, allowing for a larger field of vision. Trout can see clearly in front and to the sides of them. Trout can see above them and slightly behind them, but the images are not as clear. In addition, the eyes have large pupils that allow all the available light to be admitted.

Nares: A sensory organ used to smell. The nares are closed sacs that functions as nostrils, helping the trout to detect odors. Trout return to their home stream yearly to spawn. They can identify their home stream by the smell of the water.

Mouth: A sensory organ used to taste and eat. The trout will take many things into its mouth to see if it is worth eating. It closes its mouth to crush it. If it feels like food and the juices taste good, it will reposition it in its mouth and swallow it whole. If it does not like what it tastes, it will spit it out. It is also used to feel things around them.

Gills: A respiratory organ used to breathe. This allows fish to breathe. Trout draw water in through their mouths. The water passes through the gills where a tiny blood vessels exchange carbon dioxide for oxygen.

Operculum: A hard plate that protects the gills.

Pectoral fins: The pectoral fins are paired fins that act as brakes and help with side-to-side and gliding movement in fast current.

Pelvic fins: The pelvic or ventral fins are paired fins that are set back from the pectoral fins. They help with up and down movement.

Vent: The vent is an opening through which extra water is excreted. The vent is the opening through which eggs or sperm (milt) pass during spawning.

Anal fin: The anal fin is behind the vent and is used for swimming and stabilization.

Caudal fin: The caudal fin is the tail fin. It provides the initial “push” for a fish to start moving and acts as a rudder for steering through the water. It is the Cutthroat Trout’s biggest fin with the most power.

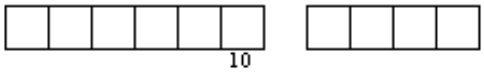
Dorsal fin: The dorsal fin is a single fin used for swimming and stabilization.

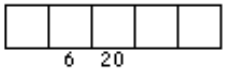
Lateral line: The lateral line is a sensory organ that runs from the operculum to the caudal fin. It detects pressure waves or vibrations. It helps the trout maintain position without bumping into other fish or objects in the water. The lateral line can detect when someone is stepping on the bank or a log on shore.

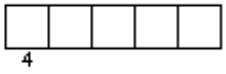
STUDENT WORKSHEET: TROUT ANATOMY DOUBLE PUZZLE

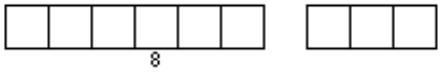
Name _____

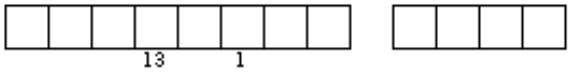
Unscramble each of the clue words. Copy the letters in the numbered cells to the cells in the bottom row with the same number.

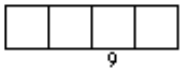
LEVPIC SIFN 

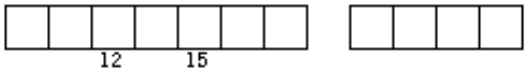
NASRE 

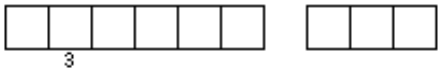
LIGSL 

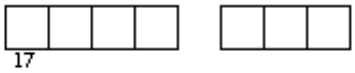
DUCALA NFI 

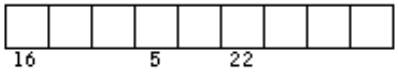
AEROLCTP NIFS 

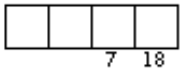
SYEE 

LELRATA NILE 

DAORSL INF 

NAAL NIF 

CUULORMPE 

NEVT 

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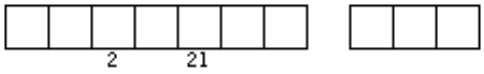
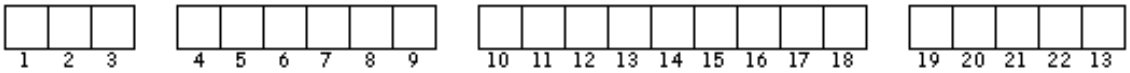
SOAPEDI NIF 

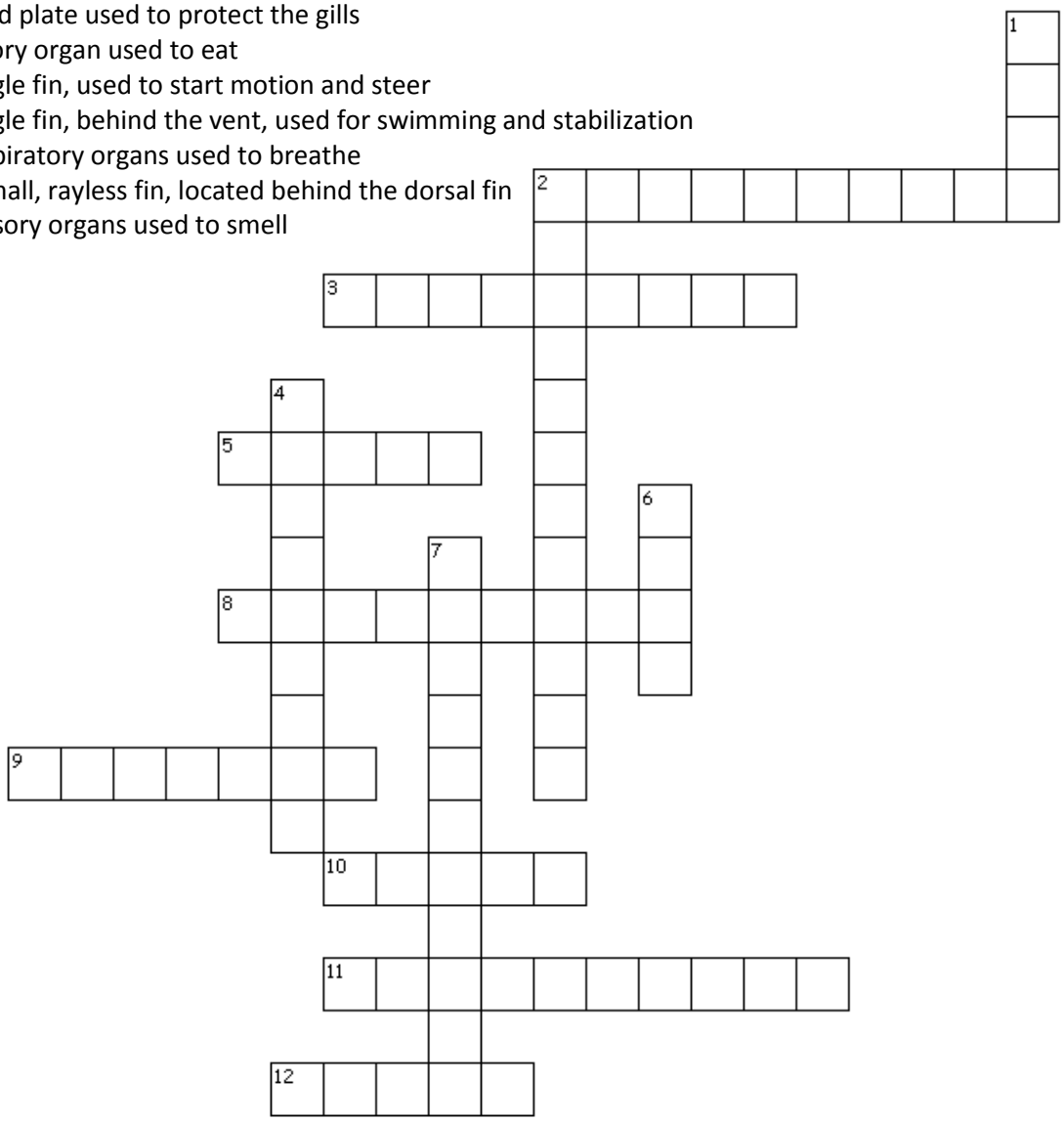


STUDENT WORKSHEET: TROUT ANATOMY CROSSWORD PUZZLE

Name _____

Complete the crossword puzzle using trout anatomy terms.

Across
2. Paired fins that help with up and down motion
3. A hard plate used to protect the gills
5. Sensory organ used to eat
8. A single fin, used to start motion and steer
9. A single fin, behind the vent, used for swimming and stabilization
10. Respiratory organs used to breathe
11. A small, rayless fin, located behind the dorsal fin
12. Sensory organs used to smell

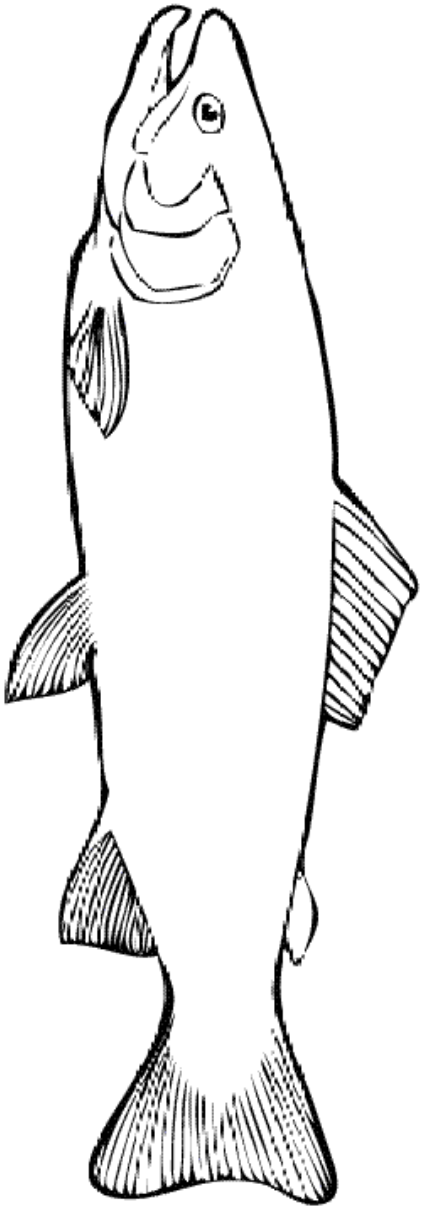


Down
1. Sensory organs used for sight
2. Paired fins that act as brakes and control side-to-side motion
4. A single fin, located on the back, used for swimming and stabilization
6. An opening used to excrete eggs or milt for spawning
7. A sensory organ that detects pressures waves and vibrations in the water

STUDENT WORKSHEET: COLOR A TROUT

Name _____

Paint or color your trout. Keep in mind the descriptions and images of all the trout you have learned. Your trout can be unique. If you finish quickly, add habitat in the background.



Activity 6: Option II - External Fish Anatomy

Standard Correlations - Grade 5:

New Mexico Science Content Standards, Benchmarks, and Performance Standards
Strand II, Standard II, Benchmark II, Performance Standard 2

Common Core State Standards
CCSS ELA-Literacy, Language Standards 5.4c
CCSS ELA-Literacy, Reading Standards for Informational Text 5.4

Timeline: Approximately two 60-minute periods.

Objective: At the end of this activity, students will be able to identify at least four anatomical features. Students will be able to interpret a basic species description. Students will be able to explain how a fish species is adapted to specific habitats or niches within the ecosystem.

Preparation and Background: Species Description is a formal explanation of the defining characteristics of an organism. It provides a clear account of the species and its differences from other organisms. Knowledge of anatomy for the species is vital to fully understanding it. The anatomical features of a species can provide clues to its life history.

Prior to providing the *Fish Anatomy* worksheet, read the species description below. Ask students if they understand the descriptions and can picture the fish in their heads. There may be unfamiliar terms describing anatomical features of the fish, so it will probably be difficult to picture the species. However, after the students review the Fish Anatomy worksheet, the species description will start to make more sense and students will begin interpreting the information much like a biologist does.

- ✓ Species Description: *Western Mosquitofish have terminal mouths. Pectoral fins much larger than pelvic fins. Pelvic fins small and oval. The female's anal fin is oval, but the male's anal fin is modified and looks like a tube. The caudal fin is square (truncate) to slightly round. Dorsal fin is rounded. Back is nearly straight. Female larger and heavier bodied than the male. Females can grow up to 2 1/2 inches and males are smaller, only reaching about 1 1/2 inches total length. They are short-lived fish seldom living longer than one year in the wild.*

The *Fish Anatomy Described* worksheet includes a picture of a fictional species and displays examples of anatomical structures found on many different fish. Each anatomical feature is defined.

The body shape of an animal helps us understand its place (niche) in the environment. Overall, there are roughly six body shapes for fish: rover-predator, lie-in-wait predator, surface-oriented fish, bottom fish, deep-bodied fish, and eel-like fish. What body shapes describe the fish in your aquarium? You may want to have the students research these different body types and then decide as a class.

Colorations and markings are just as important as the body structures identified on the *Fish Anatomy Defined* handout. Cryptic coloration, a means of camouflage by coloration, is a predator avoidance mechanism. Counter-shading, a lighter ventral surface and darker dorsal surface, is

considered an important element of cryptic coloration. Have students think of fish that are colorful. What do they know of their habitat? Do fish in clear waters have more color than fish in turbid (murky) water? Variations in colors of aquatic plants, bottom (substrate) material, stream depths, and lighting can all influence coloration of a habitat. If habitats vary in color, then so do the colors of a fish.

Materials:

1. Student References: *Fish Anatomy Described* and *Fish Anatomy Defined*
2. Student Worksheets*: Fish Anatomy Double Puzzle*, *Fish Anatomy Crossword Puzzle*

3. Online resource: Designs of the Deep - The Fishes (Earth guide) http://earthguide.ucsd.edu/fishes/kinds/kinds_parts.html

Procedure:

1. Briefly discuss with students how our senses and our physical features allow us to function in our environment. Point out that humans move through air; fish through water.

2. Ask students to think about how things might look, taste, smell, sound, and feel in a water environment. If necessary, use these questions to stimulate discussion. Observation is the first step in the scientific method. Questions help us define what we observe.

   - ✓ What physical features would an animal (like a minnow) need to function in an aquatic environment?
   - ✓ What sort of body shape do different fish need to move quickly through the water or to maintain a position at the bottom of a stream?
   - ✓ What helps propel a fish through the water?
   - ✓ How do fish turn?
   - ✓ What sensory organs help a fish find food?

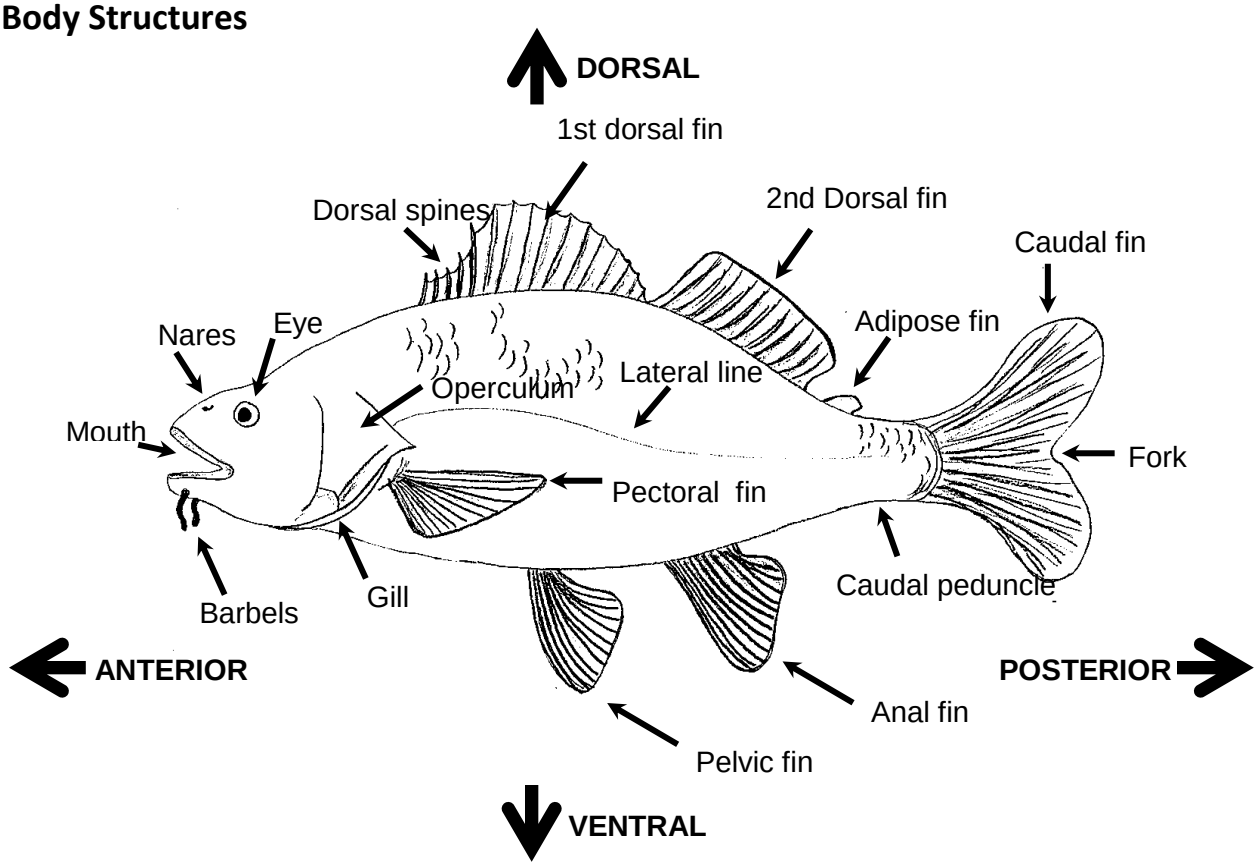
3. Have students work in small groups. Explain that they are going to examine the features of a fish and how they help it function in its environment. Distribute the *Fish Anatomy Described* and *Fish Anatomy Defined* handouts to students. Instruct them to read the information on the handout and to identify each body part and how it helps fish function.

4. Distribute one index card to each student. Have students write a question about a fish feature on the front of the card and the answer on the back. For example, “What is the biggest fin?” (answer - caudal fin). Collect the cards and use them to play a quick question-answer game.

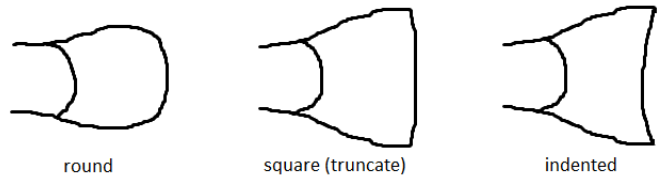
5. The *Fish Anatomy Double Puzzle* and *Fish Anatomy Crossword Puzzle* can be completed in class or as homework to help reinforce the basic anatomy of the species in your tank.

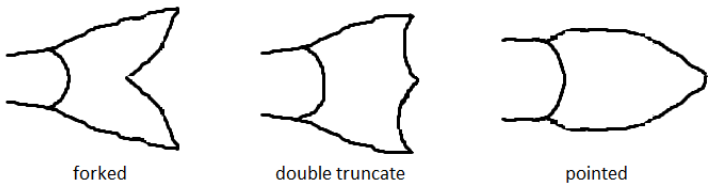
STUDENT REFERENCE: FISH ANATOMY DESCRIBED

Body Structures



Caudal Fin Shapes and Locomotion





Round and pointed: Usually slow swimming fish but quick in short bursts

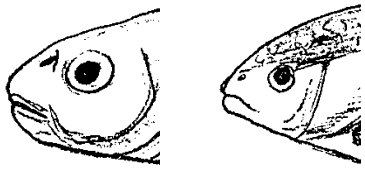
Square and double truncate: Strong swimmer with moderate acceleration and maneuverability

Indented: Slightly faster swimmers with a powerful thrust

Forked: Fast fish that is constantly swimming

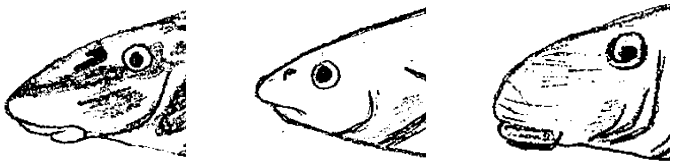
STUDENT REFERENCE: FISH ANATOMY DESCRIBED (CONTINUED)

Mouth Shapes and Feeding Behavior



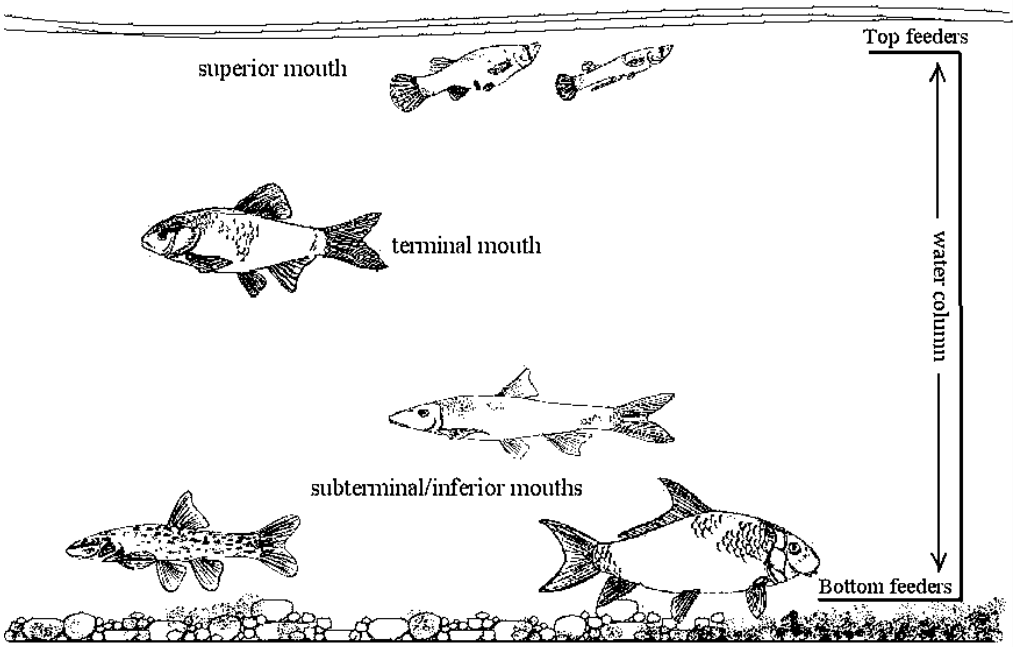
Terminal mouth: a mouth that faces forward so the fish can feed on items directly in front of it

Subterminal or inferior mouth: a mouth that faces downward; usually present in fish that are near-bottom feeders or suckers



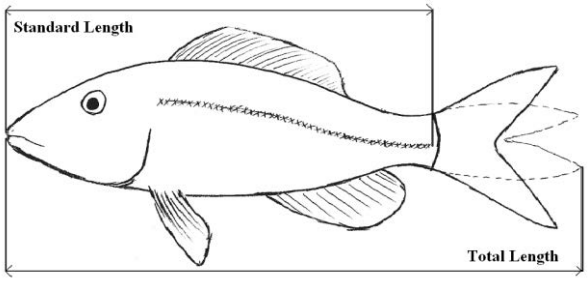
Superior mouth: a mouth that faces upwards, used for catching prey items on the surface of the water or above the fish

Feeding Position in Water Column



Measuring a fish

While completing your research, you may encounter standard length (SL) and total length (TL) as length measurement terms for any given fish. Both are common measurements used by biologists. The measurements are defined in *Fish Anatomy Defined* handout.



STUDENT REFERENCE: FISH ANATOMY DEFINED

Adipose fin: A small "fatty" fin without rays.

Anal fin: The anal fin is behind the vent and is used for swimming and stabilization.

Anterior: Pertaining to the front or head of an animal.

Barbels: This is a sensory organ (whiskers) growing on the mouth or head of a fish equipped with taste buds.

Caudal fin: The caudal fin is the tail fin. It provides the initial "push" for a fish to start moving and acts as a rudder for steering through the water.

Caudal peduncle: This is the narrow part of a fish's body where the caudal fin attaches.

Dorsal: This is the upper side or back of an animal.

Dorsal fin: The dorsal fin is a single fin used for swimming and stabilization.

Dorsal spines: The bony, needlelike projections found on the anterior end of the dorsal fin.

Eyes: This is a sensory organ used for sight.

Fork: This is the part of the caudal fin that forms a depression.

Gills: These are respiratory organs used to breathe; the water passes over the gills where tiny blood vessels exchange carbon dioxide for oxygen.

Lateral line: The lateral line is a sensory organ that runs from the operculum to the caudal fin. It detects pressure waves or vibrations. It helps fish maintain position without bumping into other fish or objects in the water. The lateral line can detect when someone is stepping on the bank or a log on shore.

Mouth: This is a structure used to taste and eat food. Fish will take many items into its mouth to see if they are worth eating. If they feel like food and the juices taste good, the fish will reposition the items in its mouth and swallow them whole. If it does not like what it tastes, it will spit them out.

Nares: These are sensory organs used to smell. The nares are closed sacs and function as nostrils, helping the fish to detect odors.

Operculum: This hard plate covers and protects the gills on a fish.

Pectoral fins: These paired fins act as brakes and help with side-to-side and gliding movement in fast currents.

Pelvic fins: The pelvic or ventral fins are paired fins that are set back from the pectoral fins. They help with up and down movement through the water column.

Posterior: Further back in position or pertaining to the rear end of an animal.

Standard length: This is the length of a fish measured from the tip of the snout to the end of the last vertebra (the end of the spine), excluding the caudal fin.

Total length: This is the length of a fish measured from the tip of the snout to the end of the caudal fin. Often the lobes of a forked caudal fin are slightly squeezed together to take this measurement.

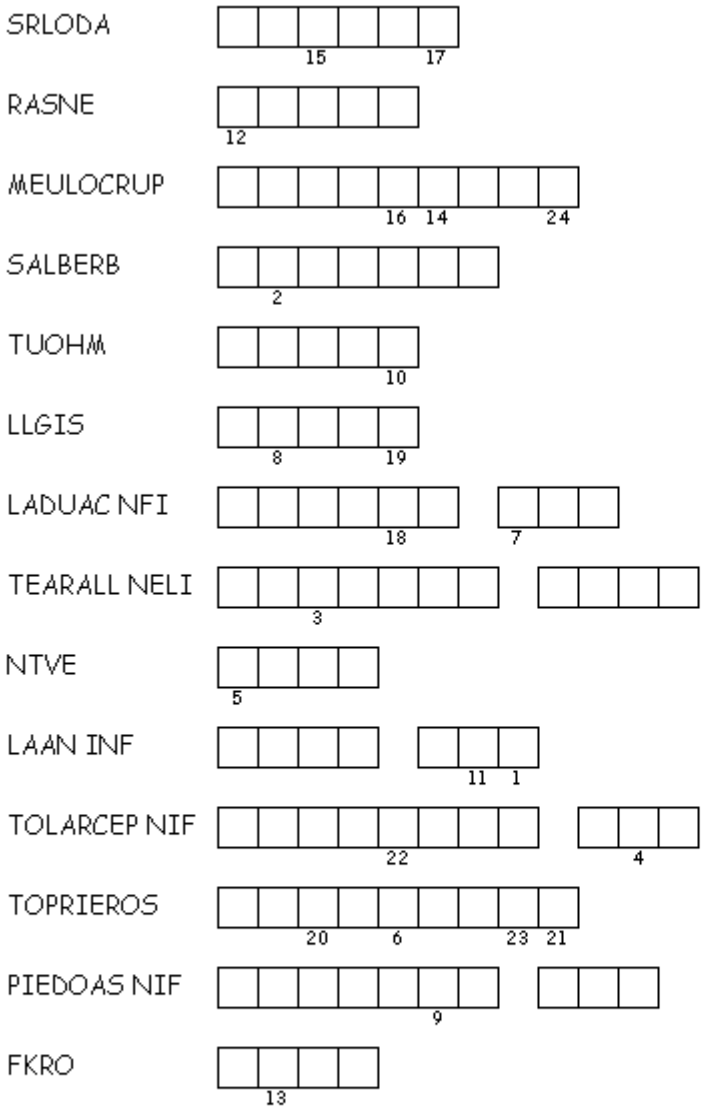
Vent: The vent is an opening through which waste is excreted. It is also the opening through which eggs or sperm (milt) pass during spawning.

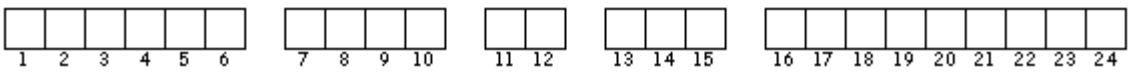
Ventral: This is the underside surface or belly of an animal.

STUDENT WORKSHEET: FISH ANATOMY DOUBLE PUZZLE

Name _____

Unscramble each of the clue words. Copy the letters in the numbered cells to the cells in the bottom row with the same number.



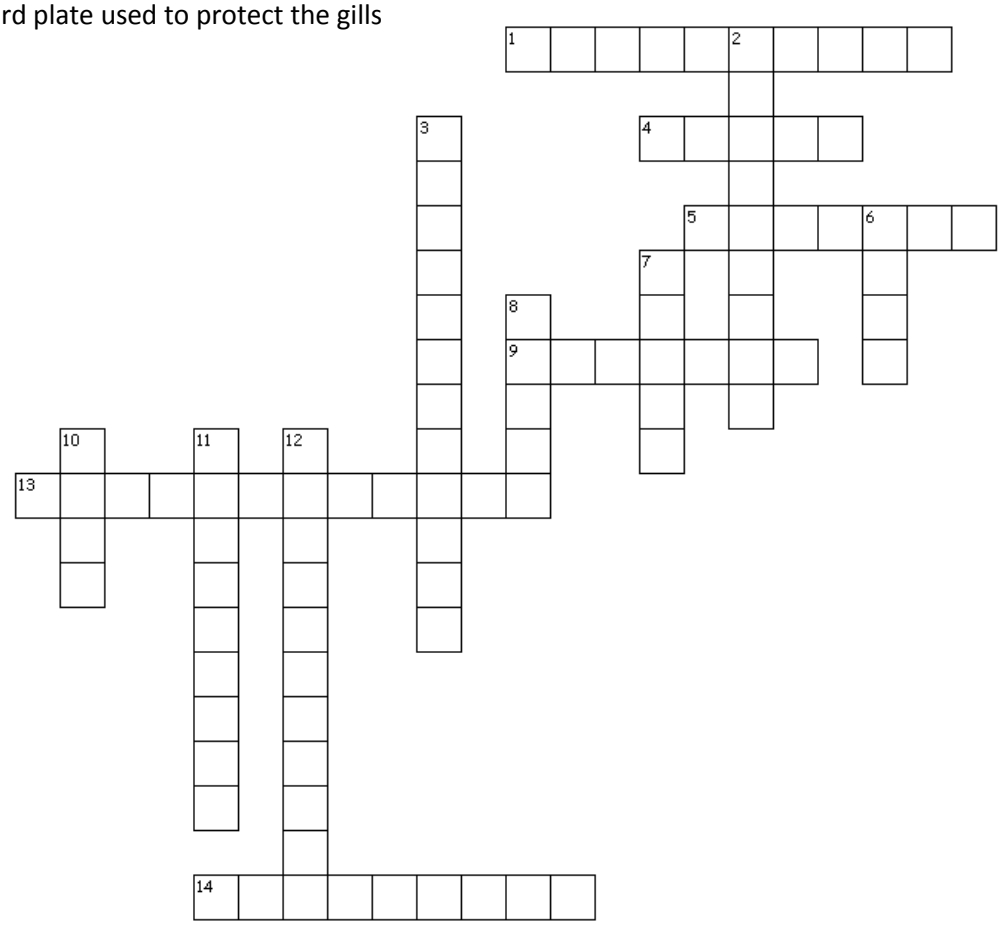


STUDENT WORKSHEET: FISH ANATOMY CROSSWORD PUZZLE

Name _____

Complete the crossword puzzle using trout anatomy terms.

Across
1. Paired fins that help with up and down motion
4. A sensory organ used to eat
5. A sensory organ (whiskers) growing on the mouth or head of a fish equipped with taste buds
9. A single fin, used for swimming and stabilization
13. Paired fins that act as brakes and control side-to-side motion
14. A hard plate used to protect the gills

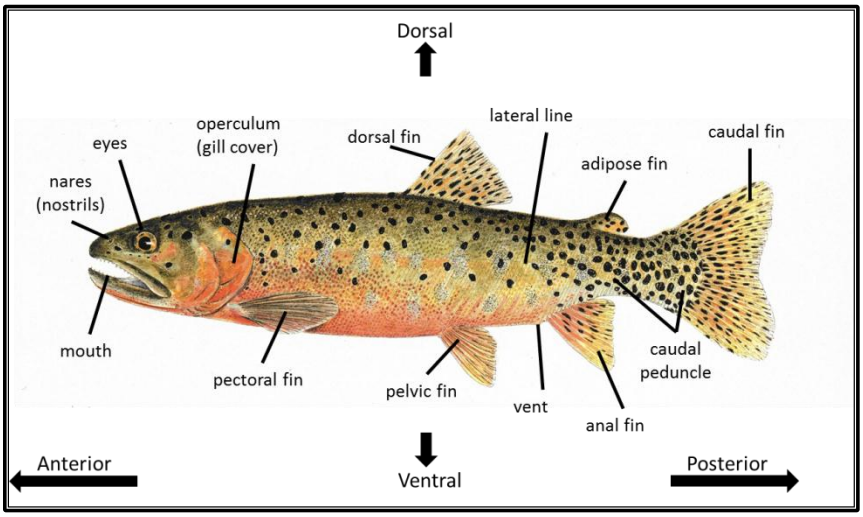


Down
2. A single fin, used to start motion and steer
3. Bony, needlelike projections found on the anterior end of the dorsal fin
6. A sensory organs used for sight
7. Respiratory organs used to breathe
8. A sensory organs used to smell
10. An opening used to excrete eggs or milt for spawning
11. A single fin, located on the back, used for swimming and stabilization
12. A sensory organ that runs from the operculum to the caudal fin

STUDENT WORKSHEET: EXTERNAL TROUT ANATOMY

Name _____

Examine the external anatomy of the Rio Grande Cutthroat Trout and answer the following:



1) Write down a description of the color, pattern, and body shape of the trout.

2) Feel and look (with magnifying glass) at the skin. Are the trout scales large or small?

3) Find the lateral line on the trout. What is its function?
   (a) to confuse prey (b) to feel vibrations (c) to help swim (d) to help balance

4) How many fins does the Cutthroat Trout have? ____

5) What does the shape of the caudal fin (tail fin) tell us about the fish?
   (a) It is a slow swimmer (b) It swims in short bursts (c) It is constantly swimming

6) Observe the mouth and teeth. Are these teeth made for:
   (a) Chewing (b) grinding (c) ripping (d) grasping prey

7) Find the nares (nostrils). What are their function?

8) Find the gills. Why are gills an important anatomical feature for fish?

9) True / False: Poor water quality (such as pollution) will hurt the gills of a fish.

Activity 7: Internal Trout Anatomy

Standard Correlations - Grade 5:

New Mexico Science Content Standards, Benchmarks, and Performance Standards
Strand II, Standard II, Benchmark II, Performance Standards 2 & 3

Common Core State Standards
CCSS ELA-Literacy, Reading Standards Information Text 5.4 & 5.7

Timeline: Approximately 1.5 hours with NMFWCO biologists.

Objective: At the end of this activity, students will be able to identify at least four anatomical features and describes its function.

Preparation and Background: Complete Activity 6 prior to this lesson. Biologists will provide additional reading materials and anatomy/physiology descriptions during the classroom visit.

Materials:

1. Student Reference: *External Anatomy Review*
2. Preserved trout specimens (provided by NMFWCO at time of lesson)
3. Anatomy key cards (provided by NMFWCO at time of lesson)
4. Dissecting tools (provided by NMFWCO at time of lesson)

Procedure:

1. Students in the classroom will be separated into four groups.

2. Students working on the internal anatomy will use a set of key cards to identify various structures inside the trout's body. They will label these structures on their trout diagram worksheets and write a short description of each organ's function.

3. Students in the external anatomy groups will work together to answer questions about the overall body shape and how external features have helped the trout adapt to its environment.

4. After students have completed both the internal and external anatomy sections, NMFWCO biologists will lead a classroom discussion covering the wrap up questions below.

   - ✓ Is the study of anatomy important? What can it tell us about a species?
   - ✓ How do the external and internal features of the trout allow it to survive in its habitat?
   - ✓ How is the anatomy of a trout similar and different to that of a human?

STUDENT REFERENCE: EXTERNAL ANATOMY REVIEW

Anatomy is the study of structures of a body.

All animals are adapted to their environment and the body shape of an animal helps us understand its place (niche) in the ecosystem. The scientific classification of bony fishes (Osteichthyes) make up about 50% of all vertebrates on Earth (that is more than mammals, birds, and reptiles combined). This large group supports a huge diversity of unique fish species found in many different aquatic habitats across the world.

Body Shape

Rover-predator: Fast swimming, ultra-streamlined, constantly moving.

Lie-in-wait predator: Suited for ambush of prey, long body, fins arranged for thrust.

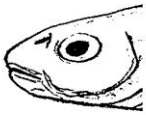
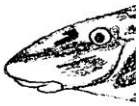
Surface-oriented fish: Upward-pointing mouth, flattened head, deep body.

Bottom fish: Variety of shapes suited for bottom living, flattened heads or bodies.

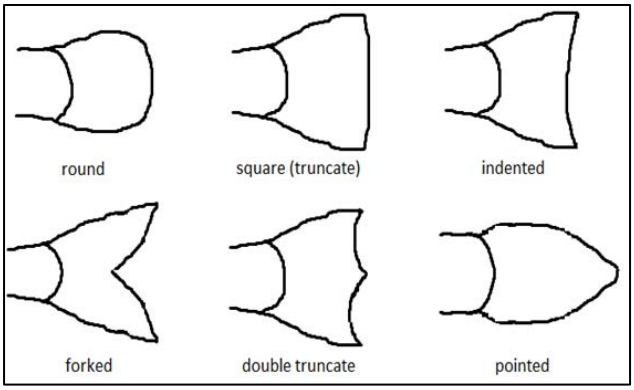
Deep bodied: Laterally flattened, dorsal, anal fins long, adapted for moving in tight quarters.

Eel-like: Long bodies, blunt or wedge shaped head.

Mouth Shapes and Feeding Behavior

Terminal mouth	Inferior mouth	Superior mouth
		
A mouth that faces forward so the fish can feed on items directly in front of it	A mouth that faces downward; usually present in fish that are near-bottom feeders or suckers	A mouth that faces upwards, used for catching prey items on the surface of the water or above the fish

Caudal Fin Shapes and Locomotion

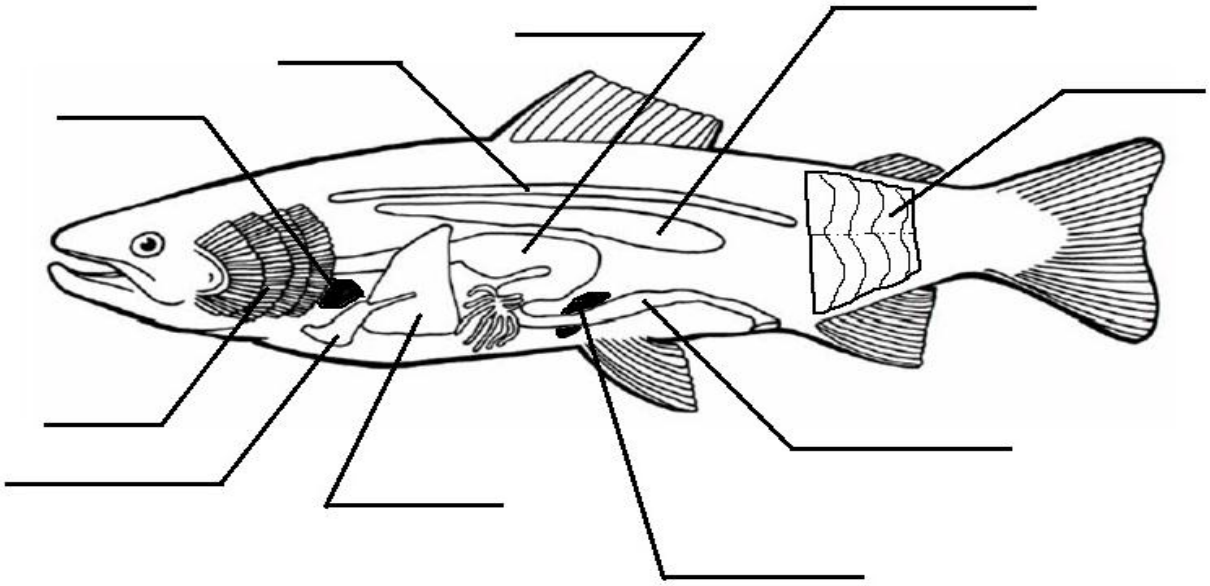


Round and pointed: Usually slow swimming fish, but quick in short bursts.
Square and double truncate: Strong swimmer with moderate acceleration and maneuverability.
Indented: Slightly faster swimmers with a powerful thrust.
Forked: Fast fish that is constantly swimming.

STUDENT WORKSHEET: INTERNAL TROUT ANATOMY

Name _____

Find the following organs on your fish specimen. Label the organs on the diagram below.



Use the Organ Key Cards to read about the functions of the different organs. Write a short description of the function of each organ in the spaces below.

1. Stomach:
2. Intestines:
3. Swim bladder:
4. Spleen:
5. Liver:
6. Gills:
7. Kidneys:
8. Heart:
9. Gall bladder:
10. Reproductive organs:
11. Muscle:
12. Spine:

Activity 8: Rio Grande Cutthroat Trout Basics

Standard Correlations - Grade 5:

New Mexico Science Content Standards, Benchmarks, and Performance Standards
Strand II, Standard II, Benchmark I, Performance Standards 1, 2, & 3

Common Core Standards
CCSS ELA-Literacy, Reading Standards for Informational Text 5.4

Objective: At the end of this activity, students will be able to specify at least one component of the Rio Grande Cutthroat Trout's life history, life span, habitat, and reproduction.

Timeline: Approximately 60 minutes.

Preparation and Background: Read the Student Reference: *The Rio Grande Cutthroat Trout*.

Materials:

1. Student Reference*: The Rio Grande Cutthroat Trout*
2. Student Worksheets: *The Rio Grande Cutthroat Trout* and *The Life of a Rio Grande Cutthroat Trout*

Procedure:

1. Begin a discussion by asking students if they know the name of our state fish. Ask if they can name any fish that are found in New Mexico.

2. Provide the *Student Handouts: The Rio Grande Cutthroat Trout* and *The Life of a Rio Grande Cutthroat Trout* as an introduction to the Rio Grande Cutthroat Trout. Let them know these will be the fish in their classroom and they will continue to learn more details about these fish throughout the semester.

TEACHER REFERENCE: THE RIO GRANDE CUTTHROAT TROUT

The Rio Grande Cutthroat Trout is New Mexico's state fish. The Rio Grande Cutthroat Trout is one of 14 distinct Cutthroat Trout (*Onchorhynchus clarkii*) in western North America. The Rio Grande Cutthroat Trout (*Onchorhynchus clarkii virginalis*) was first reported in the upper Pecos River by Coronado's expedition in 1541 and was formally described for science in 1857. It lives further south than any of the other Cutthroat Trout and is native to the Rio Grande, Pecos, and Canadian River drainages.

This Cutthroat Trout is part of a native fish group that lives in coldwater streams in Northern New Mexico. The Cutthroat Trout co-exists with Longnose Dace, Flathead Chub, Rio Grande Sucker, and Rio Grande Chub. Currently this fish lives in only 7-10% of its original occupied habitat. The Rio Grande Sucker and Rio Grande Chub populations are also declining, occupying only a small part of their former habitat.

The Rio Grande Cutthroat Trout has a distinctive red or orange slash mark beneath the lower jaw. It has light rose to red-orange hues on the sides and pink or yellow-orange colorations on the bottom. This Cutthroat Trout species has many dark circular spots on the tail and sparsely scattered along its back. The average size for these fish in their native habitat is 6 to 10 inches, but they can grow much larger if they live in lakes, larger streams, or hatcheries. The Rio Grande Cutthroat Trout diet consists mostly of aquatic bugs and bugs that fall into the water.

This Cutthroat Trout generally lives 5 to 8 years. Males normally mature at 2 to 3 years of age and females at 3 years of age. Cutthroat trout begin reproducing (spawning) at 4 years of age when the Cutthroat Trout are 4 to 10 inches long. Spawning can occur anytime between March and July, but usually happens from mid-May to mid-June in New Mexico. Time of spawning depends on factors such as water temperature (42 to 48 °F is best), runoff from snowmelt (when the stream flow is decreasing during spring runoff), elevation, and latitude. Females build a gravel nest, called a redd, in flowing water where the water is well aerated (has a lot of oxygen). The female will lay between 200 and 4,500 eggs in these nests, but only a small percent of these eggs will survive to become an adult Cutthroat Trout. Some eggs may never hatch, others become sick, and some will be eaten by predators.

The Rio Grande Cutthroat Trout requires four types of habitat for survival. Adults need clean gravel with little or fine sediment present, to spawn. Young Cutthroat Trout need slow moving water, with cover (places to hide), and slightly warmer water temperatures. The adults prefer clear, cold streams and lakes with water temperatures below 60 °F. The last habitat required is for overwintering and must include large deep pools that do not freeze in the winter.

Rio Grande Cutthroat Trout are threatened by several factors including; habitat destruction, nonnative species, pollution, disruption of water flow in streams, and increasing water temperatures. In New Mexico, competition with nonnative species like the European Brown Trout and the Rainbow Trout affects Rio Grande Cutthroat Trout populations. The Brown Trout is very aggressive and out-competes the Cutthroat Trout for food, habitat, and other resources. Brown Trout will also eat smaller Rio Grande Cutthroat Trout. Brown Trout can survive in warmer water temperatures, so when stream water temperatures rise, a Brown Trout is more adapted to these temperatures than the Cutthroat Trout is. The Rainbow Trout, originally from western U.S. coastal streams, is not as aggressive as the Brown Trout but still competes for food and space, and easily interbreeds with the Rio Grande Cutthroat Trout.

Numerous agencies and organizations are working together to recover the Rio Grande Cutthroat Trout. The New Mexico Department of Game and Fish (NMDGF) is determined to make the Rio Grande Cutthroat Trout a large component of New Mexico's trout fishery. NMDGF's Seven Springs Hatchery currently produces fish for restoration projects and wilderness stockings. Numerous restoration projects, including habitat restoration and nonnative trout removal, have been completed with still more planned for the future.

STUDENT WORKSHEET: THE RIO GRANDE CUTTHROAT TROUT

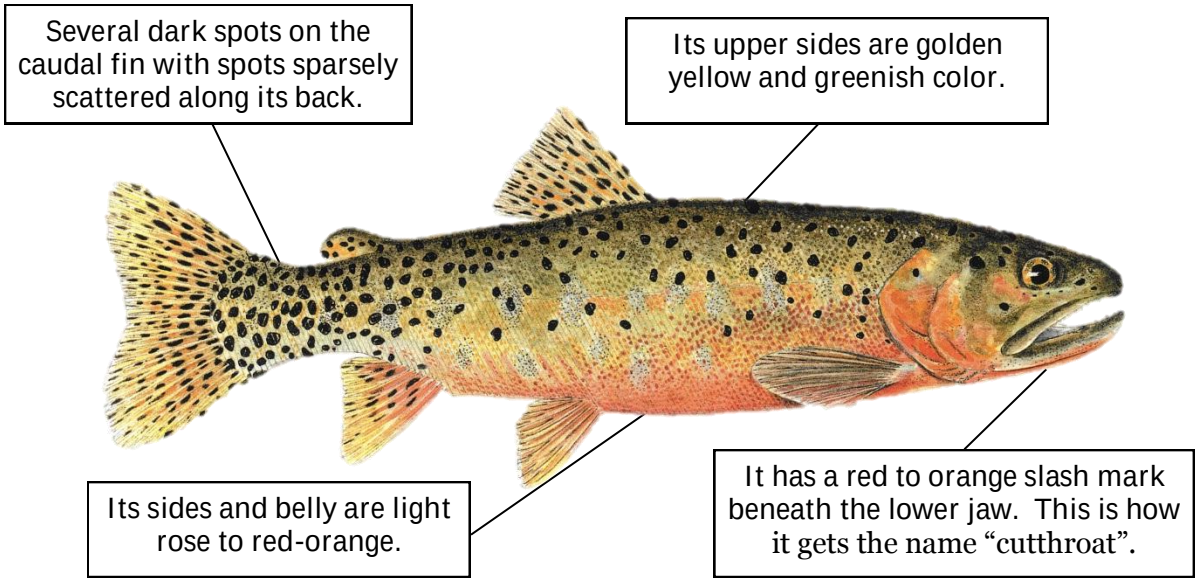
Name _____

Read the information and then answer the questions below**.**

Background

The Rio Grande Cutthroat Trout is New Mexico's state fish. The Rio Grande Cutthroat Trout is one of 14 distinct Cutthroat Trout in western North America. In 1541, Coronado's expedition found it in the upper Pecos River. The Rio Grande Cutthroat Trout lives further south than any of the other Cutthroat Trout. It is native to the Rio Grande, Pecos, and Canadian River drainages. Currently, it is now only found in 7-10% of its historic habitat.

What do you see?



1. In what year were Rio Grande Cutthroat Trout discovered?

   a. 1451 b. 1541 c. 1741

2. True / False: Rio Grande Cutthroat Trout is found in its entire native historic habitat.
3. True / False: Rio Grande Cutthroat Trout is New Mexico's state fish.
4. What physical characteristic gives Cutthroat Trout their name?

STUDENT WORKSHEET: THE LIFE OF A RIO GRANDE CUTTHROAT TROUT

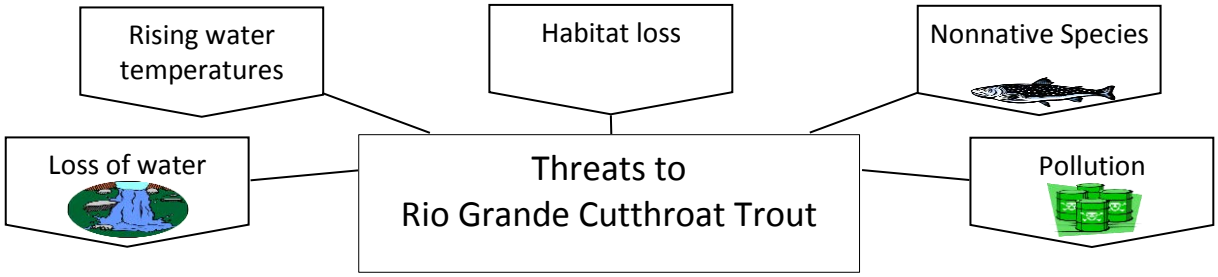
Name _____

Read the information and then answer the questions below**.**

Life History

Life span	5-8 years in the wild
Average size	6-10 inches in the wild
Reach adulthood	Males at 2-3 years, females at 3 years
Reproduction	When fish reach 4 years old, spawning occurs from mid-May to mid-June
Nest building	Females build a gravel nest (redd) where they can lay 200-4,500 eggs
Diet	Aquatic insects and crustaceans

Threats to survival



Rio Grande Cutthroat Trout face many threats. These include habitat loss, competition from nonnative species, pollution, and habitat changes like less water and rising water temperatures. In New Mexico, Rio Grande Cutthroat Trout compete for food and shelter with nonnative fish like the Brown Trout and Rainbow Trout. The Brown Trout is very aggressive and is a predator of Cutthroat Trout. The Rainbow Trout is not as aggressive, but breeds with Cutthroat Trout creating hybrid fish.

1. How many eggs can a female lay?
   a. 10-200 eggs b. 200-4500 eggs c. 4500-6000 eggs
2. How long can Rio Grande Cutthroat Trout live in the wild?
   a. 2-3 years b. 4 years c. 5-8 years
3. What are three major threats to Rio Grande Cutthroat Trout?

4. Name two nonnative fish that are harmful to Rio Grande Cutthroat Trout"

5. What do Rio Grande Cutthroat Trout eat?

Activity 9: Option I – Rio Grande Cutthroat Trout 101

Standard Correlations - Grade 5:

New Mexico Science Content Standards, Benchmarks, and Performance Standards
Strand II, Standard II, Benchmark I, Performance Standard 1
Strand II, Standard II, Benchmark II, Performance Standard 1

Common Core Standards
CCSS ELA-Literacy, Reading Standards for Informational Text 5.4
CCSS ELA-Literacy, Language Standard 5.c

Timeline: Four 30-minute periods.

Objective: At the end of this activity, students will be able to recount a fact for the Rio Grande Cutthroats Trout's life history, habitat, behavior, and predators.

Preparation and Background: This section covers information on the Rio Grande Cutthroat Trout and general background information on Salmonids. Teachers are encouraged to use this information in conjunction with lesson plans involving biological classification (taxonomic ranks), ecology, conservation, and species niches. Subjects on the student worksheets (such as habitat and life stages) are addressed in detail in other activities provided in this guide.

The Rio Grande Cutthroat Trout Zip Game is an interactive tool used to encourage questions and an understanding of the role of this Cutthroat Trout species in New Mexico. This game can be found on the supplemental disc provided with this booklet.

Materials:

1. Student worksheets: *Family of Fishes, The Life Cycle, The Home of a Trout,* and *The Odds & Ends*
2. Teacher reference: *Word Wall Vocabulary List*
3. *Rio Grande Cutthroat Trout Zip Game* from the Santa Fe National Forest Rio Grande Cutthroat Trout Curriculum located on the Supplementary Activities CD (RGCT folder).

Procedure:

1. Start a "Word Wall" to display pertinent vocabulary words and keep track of what the students are learning.

2. Allow students to read the *student worksheets* as a homework assignment or in class. Hold a short review of the information and help the students relate this to any current lessons in your classroom (ecosystems, taxonomy, ecology, etc.). Have them answer questions in class about what they read.

3. Play the *Rio Grande Cutthroat Trout Zip Game* with your students (found on the supplemental disc). Discuss with them the importance of this species in New Mexico.

TEACHER REFERENCE: WORD WALL VOCABULARY LIST

Salmonidae : Trout and salmon all belong to one large family group. Salmonids (the name for fish in this group) prefer cool water temperatures and some migrate to the ocean.

Trout: Fish in Salmonidae family that are usually found in freshwater and spawn more than once; trout normally have a pattern of dark spots on a light colored body.

Char: Any of several freshwater fish species that are found in the Salmonidae family, but distinguished from their trout relatives the light-colored spots on a dark body (rather than black spots on a light-colored body) and a special boat-shaped bone in their mouth. Examples of Char include Brook Trout, Lake Trout, and Arctic Char.

Anadromous: This describes the life history of any fish born in fresh water but that migrates to the ocean at some point in its life, and later returns to freshwater to spawn.

Food-chain: The dependence for food of an organism upon another organism in a series beginning with plants and ending with top predators.

Ecosystem: All the abiotic (nonliving elements such as sunlight, minerals, soil, water, temperature) and biotic (living things) features and all their relationships contained within a set amount of space.

Anatomy: A description of the body structures, inside and outside, of living organisms.

Lateral line: A line of sensory organs along a fish's side that allows it to detect vibrations in the water.

Habitat: A place where an organism lives (which includes all the other animals, plants, and nonliving factors such as soil, water, and sunlight).

Niche: An "occupation" of an organism; the role of an organism in its ecosystem.

Fingerlings: Trout that are larger than fry that can move into different habitats within the stream; usually 4-6 inches long.

Spawn: A term used to describe reproduction behavior in fish; it includes the fertilization of eggs with sperm.

Migration: Moving from one ecosystem to another. For example, some species of salmon migrate from the ocean to freshwater rivers.

Redd: The nest a trout makes in the gravel bottom of a stream or river where the female lays her eggs.

Aquatic ecosystem: A variety of habitats pertaining to salt or freshwater. Examples include streams, lakes, rivers, ponds, wetlands, estuaries, seas, and oceans.

Riffle: A shallow portion of a stream where water breaks over rocks producing surface agitation.

Taxonomy: The goal of ranking an organism into a group of similar organisms based on its structure and function; organisms are placed into groups based on their similarities or differences to each other.

Conservation: The goal of preventing the loss (extinction) of animals, plants, and other organisms from the environment, while at the same time allowing for their wise use.

Biodiversity: The variety of life found in a particular space (either the whole planet or a specific habitat). The greater the number of unique organisms in a space the greater the biodiversity.

STUDENT WORKSHEET: A FAMILY OF FISHES

Name _____

Read the information below and then answer the questions.

The Salmonidae Family

Rio Grande Cutthroat Trout belong to the Family Salmonidae (*humans* are in the family Hominidae or "great apes"). The Salmonidae Family can be divided into three groups of fish: true trout, salmon, and char. True trout include Gila, Apache, Rainbow, and Brown Trout. True trout typically reproduce (spawn) more than once. Chinook, Atlantic, Coho, Chum, Kokanee, and Sockeye are all examples of salmon, which usually spawn only once. Char include fish like Brook Trout, Bull Trout, Arctic Char, and Lake Trout.

Salmonids are all predators and they may even eat other smaller fish. Another feature fish in this family share is an adipose fin. This is a small fatty fin on the fish's back that we do not think is used for swimming, but to be honest, we do not exactly know its function.

The Rio Grande Cutthroat Trout

The Cutthroat Trout are the most widely distributed trout of the West. Cutthroats are found from California to Colorado. They occur as far north as Alaska and as far south as New Mexico. The reddish-orange slash mark on the folds of its lower jaw is a distinguishing characteristic of this group of trout. The cutthroat in New Mexico is called the Rio Grande Cutthroat Trout. Scientists call the Rio Grande Cutthroat Trout, *Oncorhynchus clarkii virginalis,* its Latin name.

1) What is the Latin name for the Rio Grande Cutthroat Trout?

2) What are the three groups of fish in the Salmonidae Family?

3) What is a common feature (mark) of the Cutthroat Trout?

4) How often can true trout spawn?
   a. Not at all b. More than once c. Only once

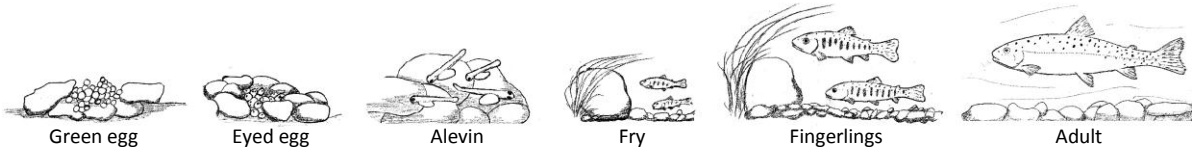
STUDENT WORKSHEET: THE LIFE CYCLE

Name _____

Read the information below and then answer the questions.

The Look of a Rio Grande Cutthroat Trout

The Rio Grande Cutthroat Trout has a long, skinny body with eight fins. It has a golden yellow to greenish body with black spots along its back and tail fin. Its lower sides and belly are a light rose to red-orange color. A male's belly will turn a bright red color between March and July. Just like other cutthroat in its family, it has a reddish-orange slash mark on both sides of its lower jaw. Adult Rio Grande Cutthroat Trout usually reach only 6 to 10 inches total length in the wild. In hatcheries, lakes, or larger streams these fish can sometimes grow larger than 16 inches.



Green egg | Eyed egg | Alevin | Fry | Fingerlings | Adult

Life Stages

Green egg:	Freshly laid and fertilized eggs that are very delicate and must remain in darkness
Eyed egg:	An egg that has a set of eyes developing that are visible to people
Alevin:	A cutthroat that comes out of the egg and has a yolk sac attached to its body. The yolk sac is its only source of food.
Fry:	A Cutthroat Trout that has used up all of its yolk sac and must now look for food.
Fingerling:	Cutthroat trout that are about 3-4 inches long. The fingerlings may develop parr marks – a series of dark markings on their sides.
Adult:	A 2 to 3 year old Cutthroat Trout. Although it usually does not reproduce (spawn) until it is 3 to 4 years old.

1) In the wild, a Rio Grande Cutthroat Trout can grow up to:
   a. 10 inches b. 12 inches c. 4 inches

2) What is the difference between a green egg and an eyed egg?

3) At what stage does a Cutthroat Trout start looking for food?

4) How many years will it take before a Cutthroat Trout is ready to reproduce?

5) At what stage does a Cutthroat Trout have parr marks?

STUDENT WORKSHEET: THE HOME OF A TROUT

Name _____

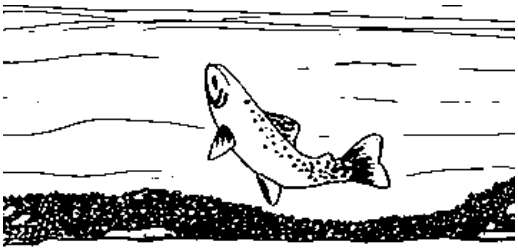
Read the information below and then answer the questions.

Habitat

Rio Grande Cutthroat Trout are usually found in clear, cold mountain streams and lakes in Colorado and New Mexico. A Cutthroat Trout needs different kinds of habitats throughout its life cycle. Cutthroat trout need gravel areas with flowing, oxygenated water to have a successful spawn and good egg survival. Alevin (cutthroat with a yolk sac) use the crevices of gravel and cobble as cover. Fry move to pools with aquatic and overhanging plants. These plants provide cover where there are plenty of aquatic insects to eat. An adult cutthroat will move back into areas of the stream with faster moving water. Even older Cutthroat Trout like deep pools that form behind large woody plants, boulders, and tree roots.

Rio Grande Cutthroat Trout remain in freshwater their whole lives, but some of the fish in this Family, like Steelhead Trout, travel or migrate to the ocean at some point. Fish that are born in freshwater but then migrate to the ocean are called anadromous.

Rio Grande Cutthroat Trout become adults around 2 to 3 years old. They will spawn when they are 3 to 4 years old. Before a female lays her eggs, she will build a nest called a redd. She builds a redd by flapping her tail hard against the gravel, making a shallow hole. Then she will lay 200 to 4,500 eggs in the redd. This usually happens during the spring and summer months.



1) What are fish called that migrate to the ocean?

2) What is a redd?

3) What kind of habitat do Cutthroat Trout need to be able to spawn and have good egg survival?

4) How many eggs can a female Cutthroat Trout release?
   a. 1 to 10 b. 100,000 to 200, 000 c. 200 to 4,500

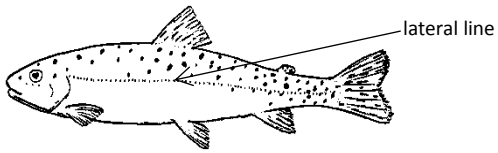
STUDENT WORKSHEET: THE ODDS AND ENDS

Name _____

Read the information below and then answer the questions.

The Senses

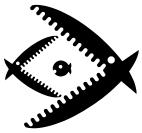
Trout have many senses, just as people do. Trout have ears that detect sound and movement. They have a lateral line on their sides that runs from their head to their tail. The lateral line senses vibrations in the water. They have an amazing sense of smell and use their fins and mouth to taste or feel their surroundings. Sight is probably the most important sense for a trout. They use sight to capture food and can see up to 30 feet away.



Feeding

Rio Grande Cutthroat Trout are predators! Their favorite foods are caddisflies, midge larvae, and mayflies. They will also eat other aquatic insects, zooplankton, crustaceans (like crayfish), and even other fish.

Predators



Although Cutthroat Trout are predators, there are other animals that may eat Rio Grande Cutthroat Trout. These include black bears, raccoons, and garter snakes. Some birds, like ospreys, great blue herons, and belted kingfishers will also eat Cutthroat Trout. Even the nonnative Brown and Brook Trout will eat small Cutthroat Trout.

1) True or False: Rio Grande Cutthroat Trout are NOT predators.

2) Name three predators of the Rio Grande Cutthroat Trout.

3) Name three foods of the Rio Grande Cutthroat Trout.

4) How far away can a trout see?
   a. 10 feet b. 20 feet c. 30 feet

5) The lateral line senses vibration in the water, what else do trout use to detect motion?

Activity 9, Option II - Middle Rio Grande Fish 101!

Standard Correlations - Grade 5:

New Mexico Science Content Standards, Benchmarks, and Performance Standards
Strand II, Standard II, Benchmark I, Performance Standards 1, 2, 3, & 4.

Common Core State Standards
CCSS ELA-Literacy, Language Standards 5.4c
CCSS ELA-Literacy, Reading Standards for Informational Text 5.4

Timeline: Multiple 30-minute periods.

Objective: At the end of this activity, students will be able to recount one fact (life history, habitat, behavior, or predator) for each species of the Middle Rio Grande.

Preparation and Background: This section covers introductory information on native fish. Teachers are encouraged to use this information in conjunction with lesson plans involving biological classification (taxonomic ranks), ecology, conservation, and species niches.

- ✓ **Niche:** The "occupation" of an organism; the role of an organism in its ecosystem.
- ✓ **Taxonomy:** The goal of ranking an organism into a group of similar organisms based on its structure and function; organisms are placed into groups based on their similarities or differences to each other.

Materials:

1. Teacher References: Word Wall Vocabulary List, Rio Grande Silvery Minnow & Fathead Minnow, Western Mosquitofish & River Carpsucker, White Sucker & Longnose Dace, Flathead Chub & Red Shiner
2. Student Worksheets: Rio Grande Silvery Minnow & Fathead Minnow, Western Mosquitofish & River Carpsucker, White Sucker & Longnose Dace, Flathead Chub & Red Shiner

Procedure:

1. Prepare an activity for your class to use the vocabulary list provided (and more words you find applicable). Start a "Word Wall" to display pertinent vocabulary words and keep track of what the students are learning.

2. Teachers (or student) read aloud a fish description. With eight species to cover, it is best to spread this over multiple days, possibly one to two fish a week. Students can do more research on each of the species at home. In the following class period, hold a short review using the *Student Worksheets* (specific to each species) to help reinforce the more detailed fish descriptions. Relate the various life histories to any current lessons in your classroom (i.e., ecosystems, taxonomy, and ecology).

3. Have them answer questions in class about what was read. How are the fish similar? How are they different? Ask students to think about why the Rio Grande is a suitable habitat for all these species. Have them consider why it may no longer be suitable in cases where species are declining. Are some of the species competing for the same niche?

4. Have students complete the *What Am I* handout when the students have learned about each species.

TEACHER REFERENCE: WORD WALL VOCABULARY LIST

Anatomy: A description of the body structures, inside and outside, of living organisms.

Aquatic ecosystem: A variety of habitats pertaining to salt or freshwater; examples include streams, lakes, rivers, ponds, wetlands, estuaries, seas, and oceans **.**

Barbel: A whisker-like organ found near the mouth in some fish (like catfish and carp).

Biodiversity: The variety of life found in a particular space (either the whole planet or a specific habitat). The greater the number of unique organisms in a space the greater the biodiversity.

Carnivore: An animal that feeds on other animals.

Clutch: A group of eggs laid and fertilized at the same time.

Conservation: The goal of preventing the loss (extinction) of animals, plants, and other organisms from the environment, while at the same time allowing for their wise use.

Detritivore: An organism that feeds on detritus.

Detritus: Non-living particulate organic matter (such as decomposing fragments of organisms or fecal waste).

Ecosystem: All the abiotic (nonliving elements such as sunlight, minerals, soil, water, temperature) and biotic (living things) features and all their relationships within a set amount of space.

Fish: A vertebrate organism that has gills and lacks any limbs with digits.

Food-chain: The order in which energy (in the form of food) is transferred from one organism to the next.

Gonopodium: In male Western Mosquitofish, the elongated anal fin used in reproductive behavior.

Habitat: A place where an organism lives (which includes all the other animals, plants, and nonliving factors such as soil, water, and sunlight).

Lateral line: A line of sensory organs along a fish's side that allows it to detect vibrations in the water.

Native: A species that occurs naturally with respect to a particular ecosystem; the species has evolved or developed within the surrounding habitat.

Niche: The "occupation" of an organism; the role of an organism in its ecosystem.

Nonnative (introduced): A species that occurs as a result of an accidental or deliberate introduction into a particular ecosystem; the species did not occur in that ecosystem prior to human introduction.

Omnivore: An animal that feeds on both animals and plants.

Riffle: Fast moving water that is flowing over a gravel or rocky bottom in a stream.

Spawn: A term used to describe reproduction behavior in fish; it includes the fertilization of eggs with sperm.

Substrate: Aquarium - the material placed at the bottom of an aquarium. Natural environment - the earthy material that exists in the bottom of a habitat, like dirt, sand, gravel or cobble.

Subterminal mouth (inferior): A downward pointing mouth of fishes that tend to be bottom feeders.

Superior mouth: An upward pointing mouth of fishes that tend to feed on the water surface.

Taxonomy: The goal of ranking an organism into a group of similar organisms based on its structure and function; organisms are placed into groups based on their similarities or differences to each other.

Terminal mouth: A mouth that faces forward and is found on fishes that eat food directly in front of them.

Turbidity: Murky water that is created by sediments becoming suspended in the water column; typically, turbid water will have a very muddy appearance.

TEACHER REFERENCE: RIO GRANDE SILVERY MINNOW & FATHEAD MINNOW

Rio Grande Silvery Minnow (*Hybognathus amarus*)

In 1994, this species was listed as Federally Endangered. Its body has an overall silvery appearance. It has a subterminal mouth with a snout that projects slightly past the upper lip. In New Mexico, this fish reaches a total length of 3.9 inches (100.0 mm), although they seldom reach this size in the wild. The dorsal fin originates in front (anterior) of the pectoral fin. There is no obvious difference between males and females. Silvery minnows prefer large streams with a low to moderate water velocity. They are most often found in habitats with a mud, sand, or silt bottom. It feeds on diatoms, algae, sediment, and plant material it finds on the bottom of the river. In the wild, this species usually lives 1-2 years. It spawns in the spring and summer and releases up to 3,000 semi-buoyant eggs. Threats to its survival include loss of habitat, competition and predation by introduced nonnative species, water quality degradation, and changes of water flow patterns (due to dams).

Kingdom: Animalia
Phylum: Chordata
Class: Actinopterygii
Order: Cypriniformes
Family: Cyprinidae

Fathead Minnow (*Pimephales promelas*)

This fish has olive colored sides and back with a creamy belly. A dark lateral stripe is usually visible. It has a very tiny mouth pointing slightly downward (nearly terminal) that does not extend past the eye. In New Mexico, this fish reaches a total length of 3.0 inches (76.2 mm), but can grow larger in other parts of its range. Females are smaller than males. During breeding season, the males develop small lumps on their head, called nuptial tubercles. The males will also develop a black head. They spawn during the spring and summer and males are aggressive nest protectors (guarding up to 12,000 eggs at a time). In the wild, this fish can live to be 3 years old. They prefer slow moving turbid (murky) waters and pools along the shoreline that have submerged plants.

Kingdom: Animalia
Phylum: Chordata
Class: Actinopterygii,
Order: Cypriniformes
Family: Cyprinidae

TEACHER REFERENCE: WESTERN MOSQUITOFISH & RIVER CARPSUCKER

Western Mosquitofish (*Gambusia affinis*)

This fish is dusky on its back and has a whitish color on its belly. It has dark blue spots below its eye and on its side. It has a large upturned (superior) mouth, which allows it to feed on the water surface. Females can grow up to 2.5 inches (63.5 mm) and males are smaller, only reaching 1.5 inches (38.1 mm). The male has a modified anal fin that is elongated and specialized for breeding (the structure is called a gonopodium). The Western Mosquitofish is a predator and an omnivore. It will eat insects, crustaceans, algae, and even small fish. This fish is found in many different habitats and is widespread throughout New Mexico, but it prefers sluggish backwaters, pools, and side streams. It is also found in unique spring and sinkhole habitats in Roswell, New Mexico. Mosquitofish have a very short life span, rarely exceeding one year in the wild. A unique feature of this species is that it has internal fertilization of eggs, and females give birth to live young (most fish just lay eggs).

Kingdom: Animalia
Phylum: Chordata
Class: Actinopterygii
Order: Cyprinodontiformes
Family: Poeciliidae

River Carpsucker (*Carpiodes carpio*)

This species is common throughout New Mexico. In New Mexico, they grow up to 13.5 inches (342.9 mm) in total length, but can grow up to 25.0 inches (635.0 mm) in other parts of its range. It is found in pools and backwaters of large rivers, streams, and even lakes. The back is greenish brown, with silvery sides, and a yellowish white belly. This fish looks very similar to the introduced common carp, but lacks barbels on its mouth (which the carp has). It has a long (elongated) dorsal fin and deeply forked tail (caudal) fin. Its mouth is small and faces down (subterminal). Its mouth is specially adapted to let it feed on algae, detritus, protozoa, and other small bottom-dwelling microorganisms. In the wild, this fish can live up to 11 years. In the early spring and summer, females produce sticky eggs that sink to the bottom. Within a year, a female can release over 100,000 eggs.

Kingdom: Animalia
Phylum: Chordata
Class: Actinopterygii
Order: Cypriniformes
Family: Catostomidae

TEACHER REFERENCE: WHITE SUCKER & LONGNOSE DACE

White Sucker (*Catostomus commersoni*)

This fish has a typical "sucker-like" downward pointing (subterminal) mouth. The lobes of its lips are fleshy and thick. Adults of this species can reach 12.0 inches (304.8 mm) in New Mexico but can grow up to 25.0 inches (635.0 mm) in other areas. The backs are greenish or brownish, with silvery sides and whitish belly. Small fish have dark spotting marks, which will become more solid as they grow older. Breeding males and females develop a darker coloration, and males may have a faint rosy band. White Suckers are common throughout New Mexico but prefer pool habitats with cover and a sandy or rocky substrate. Spawning occurs in early spring and summer with females releasing eggs that sink to the bottom. Each female can lay up to 50,000 eggs per year. In the wild, this fish can live up to 17 years. It feeds on insects and crustaceans that live on the bottom, as well as detritus, plant material, and zooplankton.

Kingdom: Animalia
Phylum: Chordata
Class: Actinopterygii
Order: Cypriniformes
Family: Catostomidae

Longnose Dace (*Rhinichthys cataractae*)

This species of fish has an overall mottled (spotty) dark coloration with the presence of a dark spot on its caudal fin. It also has a very small, not easily seen, barbel in the corners of its mouth. In New Mexico, this species does not generally grow larger than 4.0 inches (101.6 mm) in total length. In other parts of its range, this species can grow up to 7 inches (177.8 mm). It occurs mostly in riffle (faster moving, shallow, wavy water) habitats with a gravel or rock substrate. It mainly feeds on the bottom of streams and eats aquatic insects, algae, and detritus. In the wild, Longnose Dace can live up to 5 years. In the spring and summer, females release sticky eggs that adhere to surfaces in the river. Within a year, a female can produce up to 10,000 eggs.

Kingdom: Animalia
Phylum: Chordata
Class: Actinopterygii
Order: Cypriniformes
Family: Cyprinidae

TEACHER REFERENCE: FLATHEAD CHUB & RED SHINER

Flathead Chub (*Platygobio gracilis*)

The Flathead Chub has an overall silvery coloration and a broad, flattened head. Its pectoral fin is sickle-shaped. This species has a very large mouth with a small barbel at each corner. In New Mexico, it reaches up to 6 inches (152.4 mm) in total length. Outside of New Mexico, this fish can grow up to 12.5 inches (317.5 mm). It prefers faster moving waters with a shifting sand substrate and turbid (murky) water. In the wild, it can live up to 5-6 years. Breeding occurs in the summer and a female can release an average of 500 eggs per clutch. Flathead Chub eat aquatic and terrestrial insects and plant material.

Kingdom: Animalia
Phylum: Chordata
Class: Actinopterygii
Order: Cypriniformes
Family: Cyprinidae

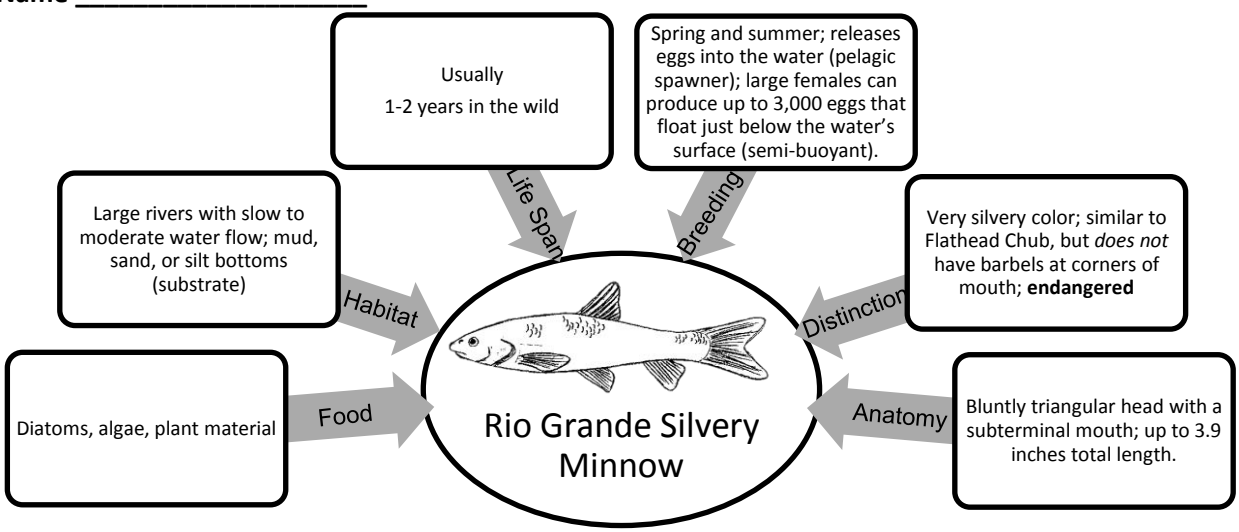
Red Shiner (*Cyprinella lutrensis*)

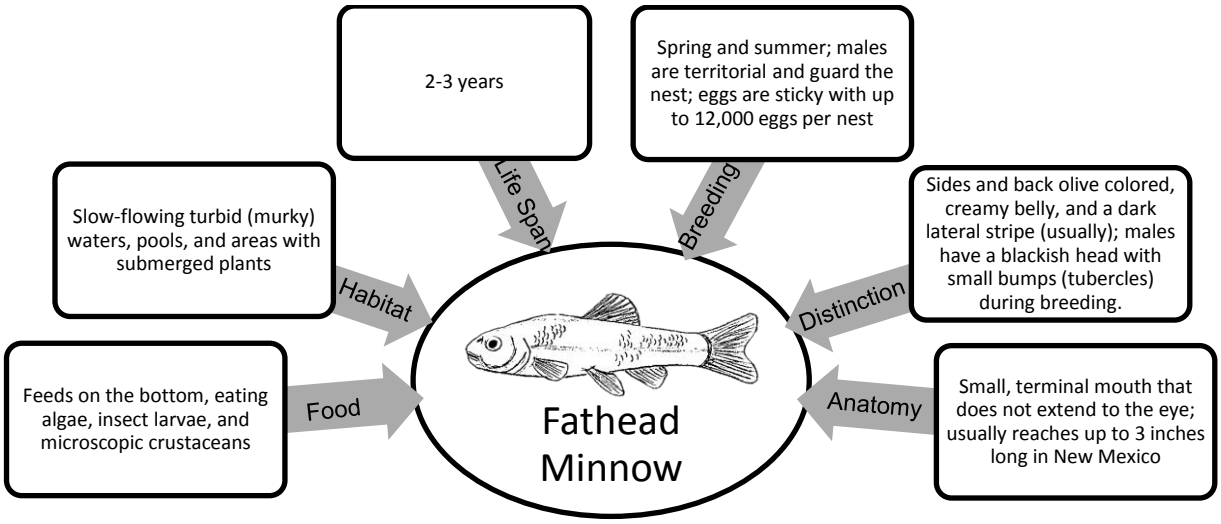
This species has a darker back with silvery sides. The scales of this fish are outlined in a thin black color. It has a blunt snout and a terminal mouth. Red Shiner are found throughout New Mexico and can grow up to 3.5 inches (88.9 mm) in total length. These fish are native to the Rio Grande, Pecos, and Canadian River drainages but have been introduced to water bodies throughout the state. It prefers backwaters, pools, and shorelines with turbid (murky) water and a sandy bottom. It feeds on insects, algae, small crustaceans, detritus, and other microorganisms. In the wild, this fish can live up to 3 years. Breeding season extends from April to September. A female can produce multiple clutches per year, and each clutch can have over 500 eggs. During the breeding season males display bright red fins and bumps (tubercles) on their heads. Males are territorial and defend their spawning areas aggressively.

Kingdom: Animalia
Phylum: Chordata
Class: Actinopterygii
Order: Cypriniformes
Family: Cyprinidae

STUDENT WORKSHEET: RIO GRANDE SILVERY MINNOW & FATHEAD MINNOW

Name _____



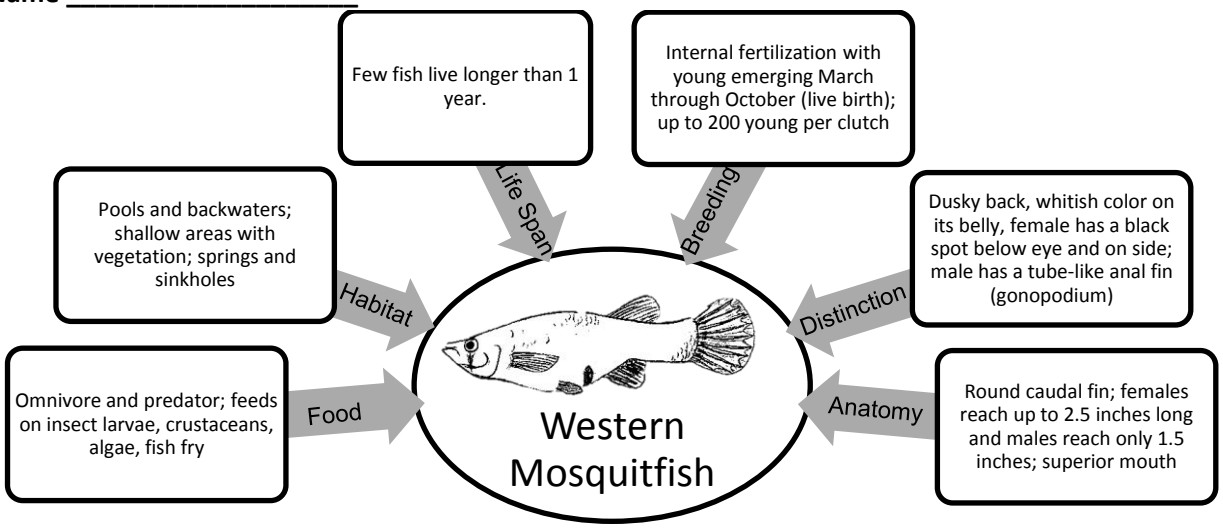


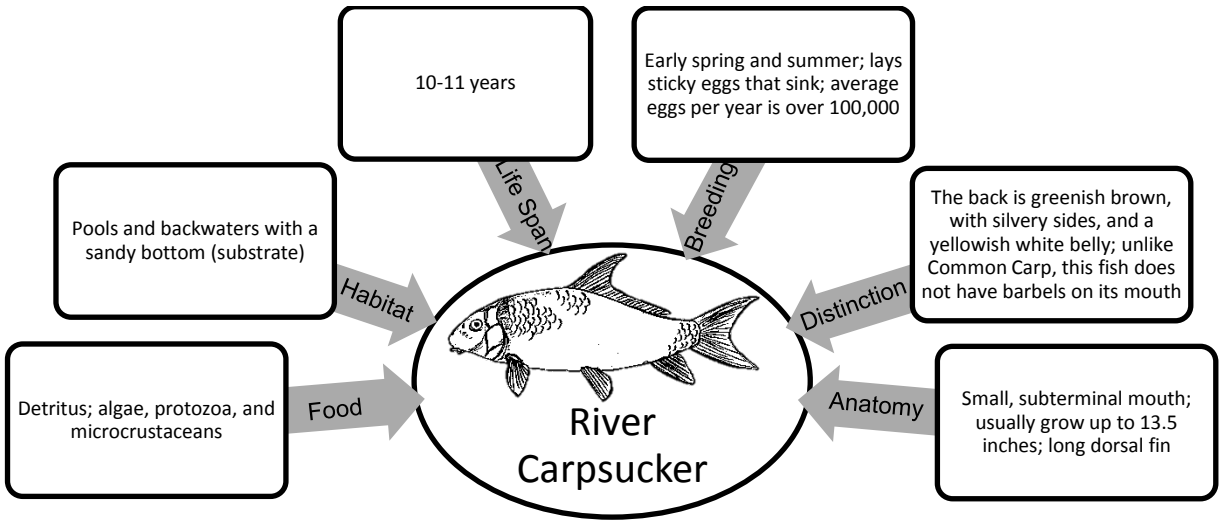
Answer the following questions:

1. TRUE FALSE The Rio Grande Silvery Minnow is an endangered species.
2. How long do Rio Grande Silvery Minnow live in the wild? _____
3. Does the Rio Grande Silvery Minnow reproduce in the winter or the summer? _____
4. What type of mouth does a Fathead Minnow have? _____
5. What key feature distinguishes a Fathead Minnow male from female? _____
6. How long do Fathead Minnows live in the wild? _____
7. Does the Fathead Minnow generally live longer than the Rio Grande Silvery Minnow? _____

STUDENT WORKSHEET: WESTERN MOSQUITOFISH & RIVER CARPSUCKER

Name _____



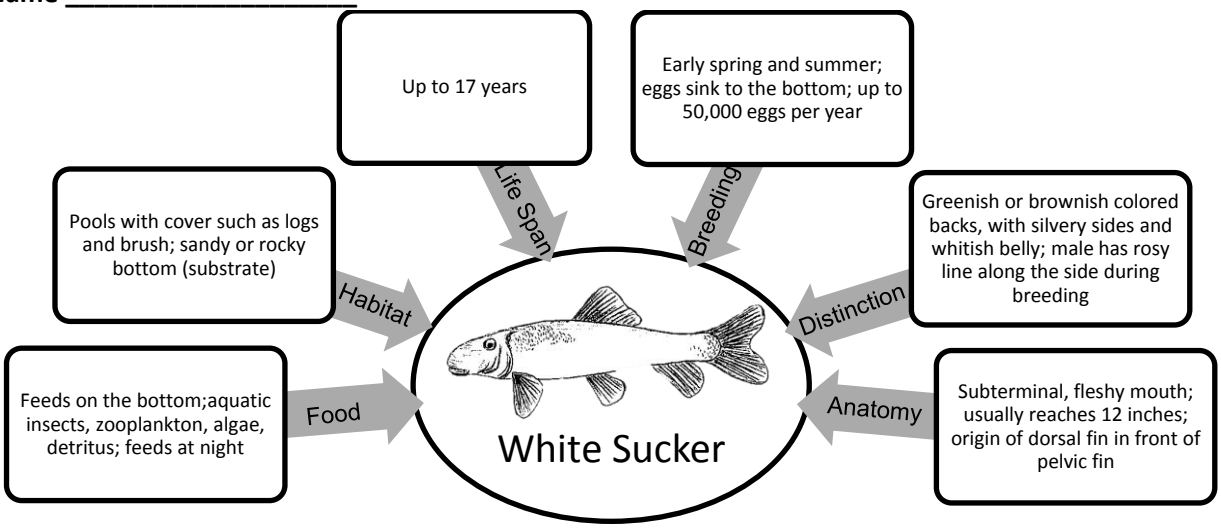


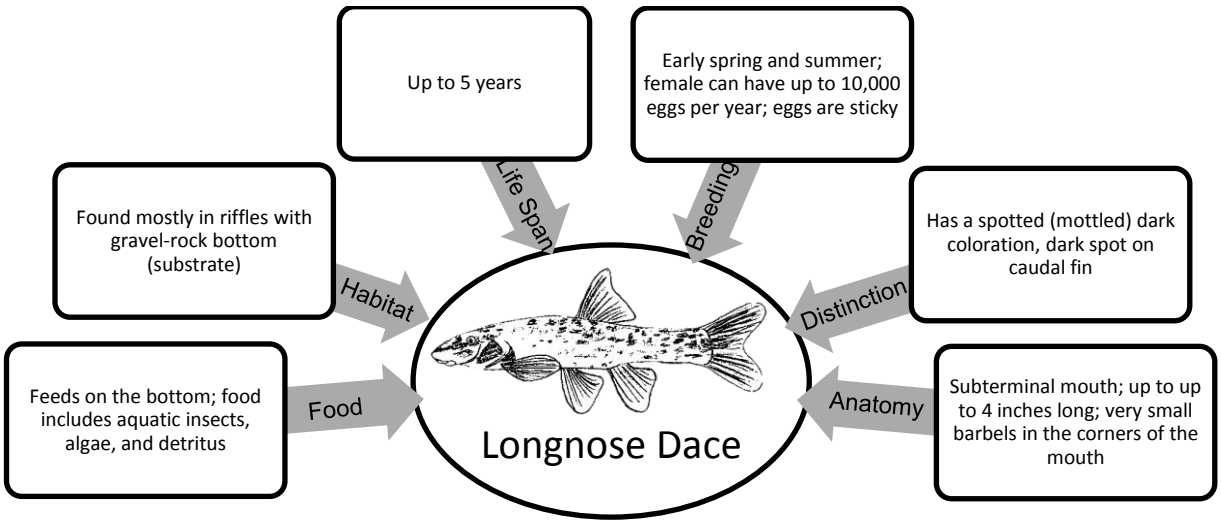
Answer the questions below.

1. TRUE FALSE Western Mosquitofish give birth to live young.
2. Name two habitats where you can find Western Mosquitofish. _____
3. What is a gonopodium? _____
4. TRUE FALSE River Carpsucker can live 10 years in the wild.
5. River Carpsucker feed on the bottom of the water column, with what type of mouth? _____
6. How many sticky eggs can a River Carpsucker lay? _____
7. How are the mouths of the River Carpsucker and the Mosquitofish different? _____
   _____

STUDENT WORKSHEET: WHITE SUCKER & LONGNOSE DACE

Name _____



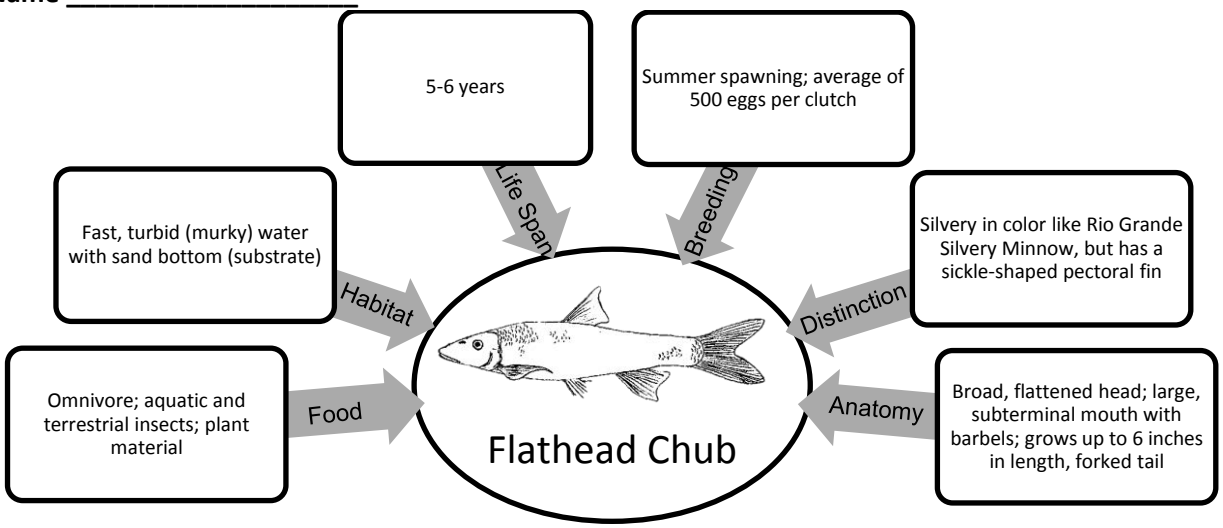


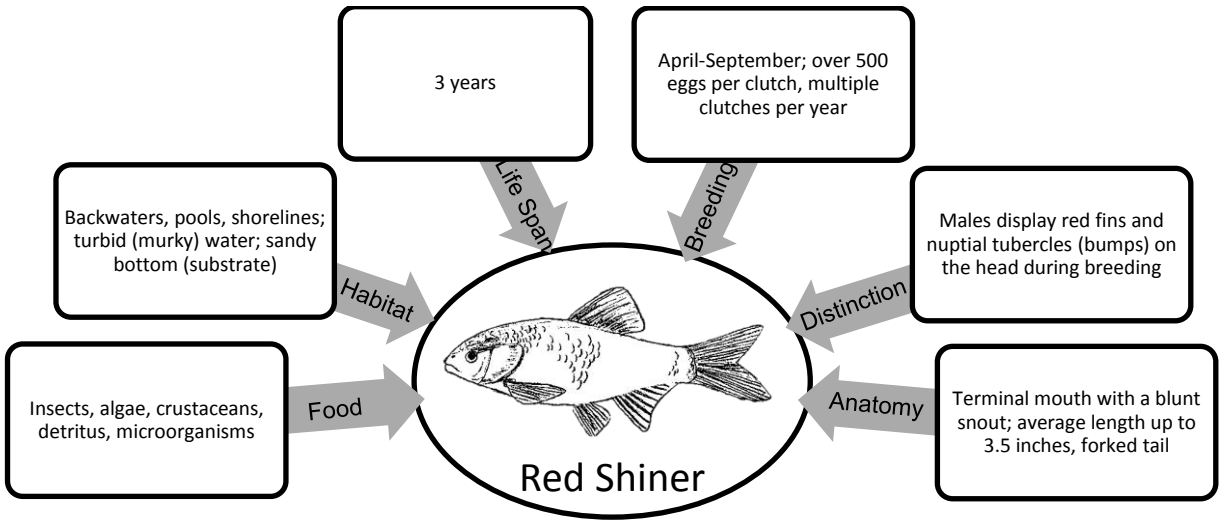
Answer the questions below

1. TRUE FALSE White Suckers can lay 50,000 eggs that sink to the bottom of the river.
2. Describe the habitat where White Suckers live. _____
3. How long do White Suckers live in the wild? _____
4. TRUE FALSE Longnose Dace have barbels.
5. Does the Longnose Dace prefer pools or riffles with a gravel bottom? _____
6. How long do Longnose Dace live? _____
7. What does the Longnose Dace and the White Sucker both feed on? _____

STUDENT WORKSHEET: FLATHEAD CHUB & RED SHINER

Name _____





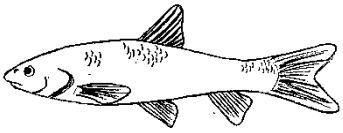
Answer the questions below.

1. How does the Flathead Chub get its name? _____
2. What does a Flathead Chub eat? _____
3. TRUE FALSE Flathead Chub lives in turbid waters.
4. TRUE FALSE Red Shiners only reproduce once per year.
5. How does a Red Shiner get its name? _____
6. A Red Shiner has what type of mouth? _____
7. What type of tail do both the Flathead Chub and the Red Shiner have? _____

STUDENT WORKSHEET: WHAT AM I?

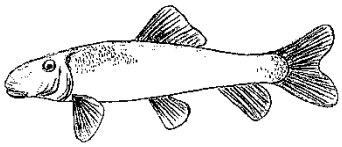
Name _____

Draw a line from the fish to the correct name and description.

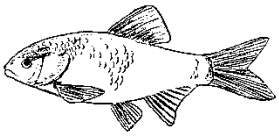


I am a western mosquito: I am known to give birth to live young. I have been introduced around the U.S. to control a pest.

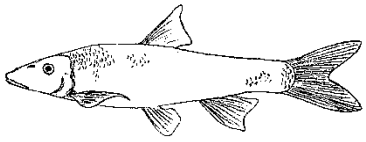
I am a Longnose Dace: I prefer faster riffles with gravel substrate. I have a mottled (spotty) dark coloration and barbels.



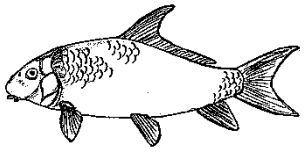
I am a Flathead Chub: I prefer faster water and have sickle-shaped pelvic fins and barbels.



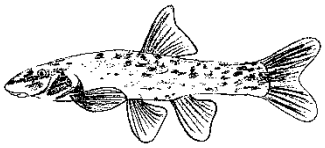
I am a Rio Grande Silvery Minnow: My eggs a semi-buoyant. I am an endangered species.



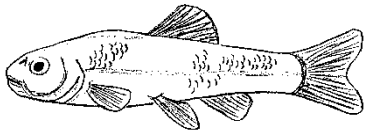
I am a White Sucker: I can live up to 17 years and have a subterminal (downward pointing) mouth.



I am a Fathead Minnow: The males of my species protect the nest. I usually have a dark lateral line.



I am a Red Shiner: I am common in the Rio Grande. The males of my species display bright red fins during breeding season.



I am a River Carpsucker: I have a long dorsal fin and produce sticky eggs that sink to the bottom.

Activity 9: Option II, Part II - Fishy Fun 101 Matching Game

Standard Correlations - Grade 5:

New Mexico Science Content Standards, Benchmarks, and Performance Standards
Strand II, Standard II, Benchmark I, Performance Standards 1, 2, 3, & 4.

Common Core State Standards
CCSS ELA-Literacy, Speaking and Listening 5.1

Timeline: Approximately 60 minutes (complete after students have finished Activity 9, Option II).

Objective: At the end of this activity, students will be able to identify similarities and differences among the Middle Rio Grande fish species.

Preparation and Background: This lesson is used after students are familiar with the information presented in Activity 9, Part II of this booklet.

Materials:

1. Fishy Fun 101 activity cards
2. Large poster paper and a thick marker to draw the Fishy Fun 101 grid

Procedure:

1. Draw the Fishy Fun 101 grid on a large piece of construction paper. Tape the grid to the black/white board at the front of the room or lay it in the center of the room so all students can see and access it. The blank grid will look like this:

	silvery minnow	River Carpsucker	White Sucker	Western Mosquitofish	Flathead Chub	Fathead Minnow	Longnose Dace	Red Shiner
Mouth								
Key feature								
Food								
Lifespan								
Breeding								
Habitat								
Max length								

2. Print out Fishy Fun 101 activity cards and randomly distribute two cards (or more) to each student.

3. Have the students read their cards and decide where the card belongs on the grid. Most importantly, they must decide what species of fish the card is describing. The answer key is located in Appendix A.

4. Have the students come up one at a time, read their card aloud to the class, and place their card on the grid in the correct box. If they need extra help deciding where the card belongs, encourage the class to have an open discussion about what species the card is describing and why.

5. After all the cards have been placed on the grid, discuss any similarities or differences among the species.

   - ✓ Do some fish have similar characteristics, such as food or mouth structure?
   - ✓ What fish lives the longest?
   - ✓ What are the differences in reproduction?
   - ✓ What type of fish has a unique breeding method different from the rest?

STUDENT WORKSHEET: FISHY FUN 101 ACTIVITY CARDS

2.5 in, 1.5 in (63. mm, 38.1 mm)	**subterminal**	**subterminal, large with barbels**
3.5 in (88.9 mm)	**endangered**	**flattened head**
about 1 year	**diatoms, algae**	**aquatic and terrestrial insects**
3 years	**1-2 years**	**5-6 years**

multiple clutches per year with 500 eggs	**pelagic spawner with 3,000 semi-buoyant eggs**	**500 eggs per clutch**
superior	**slow water with muddy/sandy bottom**	**fast, turbid waters**
200 live young	**3.9 in (100 mm)**	**6.0 in (152.4 mm)**
pools, backwaters, springs, sinkholes	**subterminal, fleshy**	**terminal, very small**

backwater, pools, shorelines	**long dorsal fin**	**males have tubercles**
algae, detritus, protozoa	**algae, microscopic crustaceans, insect larvae**	**superior**
10-11 years	**2-3 years**	**terminal**
100,000 sticky eggs that sink	**12,000 sticky eggs per nest that the male guards**	**male has tube-like anal fin (gonopodium)**

pools and backwaters with a sandy bottom	**slow, turbid waters, submerged plants**	**males have red fins during breeding**
13.5 in (342.9 mm)	**3.0 in (76.2 mm)**	**insect larvae, algae, fish fry**
subterminal, small	**subterminal, very small barbels**	**insects, algae, crustaceans, microorganisms**
male has rosy line during breeding	**mottled dark coloration**	**10,000 sticky eggs per year**

algae, insects detritus, usually feeds at night	**algae, detritus, aquatic insects**	**riffles with gravel and rock bottom**
17 years	**5 years**	**4 in (101.6 mm)**
50,000 eggs that sink	**pools with cover and sandy or rocky bottom**	**12 in (304.8 mm)**

Activity 10: In the Life of a Fish…

Standard Correlations - Grade 5:

New Mexico Science Content Standards, Benchmarks, and Performance Standards
Strand II, Standard II, Benchmark II, Performance Standard 1

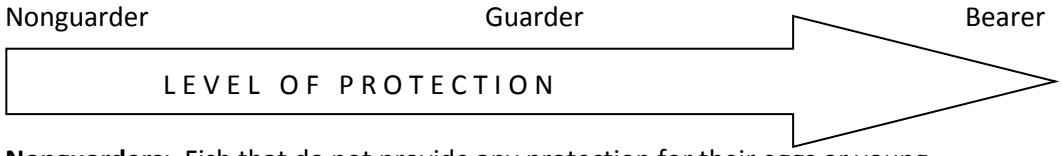
Common Core State Standards
CCSS ELA-Literacy, Reading Standards for informational Text 5.4
CCSS ELA-Literacy, Speaking and Listening 5.1 and 5.2

Timeline: Approximately 60 minutes.

Objective: At the end of this activity, students will be able to identify similarities and differences among the life cycles of the Rio Grande Silvery Minnow, the Rio Grande Cutthroat Trout, and the Western Mosquitofish.

Preparation and Background: A stream or river is a complex living system. Native fish develop life cycles to use the various features of a system to their advantage. Reproduction (spawning) is a major part of the life cycle in all fishes. Fish strategies can be simply classified as nonguarders, guarders, and bearers.

- ✓ **Life cycle**: The complete series of changes undergone by an organism during its life.
- ✓ **Spawning**: The act of laying and fertilizing eggs to produce offspring.



- ✓ **Nonguarders**: Fish that do not provide any protection for their eggs or young.
- ✓ **Guarders**: Fish that protect their eggs and sometimes will even guard their young.
- ✓ **Bearers**: Fish that carry their eggs with them until they find a safe location or until the eggs develop and are actively swimming young.

Among these classifications, fish can be pelagic spawners, brood hiders, or live-bearing. The *Life Cycle Explored* handout demonstrates life cycles of three Rio Grande fish that use these methods.

- ✓ **Pelagic spawner**: A fish that spawns in open-water, producing floating or semi-floating eggs.
- ✓ **Brood hiders**: A fish that hides its eggs in some manner.
- ✓ **Live-bearing**: Fish that retain their eggs internally until they have developed into actively swimming young.

Materials:

1. Student Reference: *Rio Grande Silvery Minnow*, *Rio Grande Cutthroat Trout*, and *Western Mosquitofish Life Cycle*
2. Student Worksheet: *Life Cycle Explored*

Procedure:

1. Call on students to describe the term "life cycle". Tell students they are going to work in groups to learn about the life cycle of three fish.
   - ✓ The Rio Grande Cutthroat Trout has a life cycle with stages common to fish throughout the world (eggs, larvae, juvenile, and adult).
   - ✓ The Western Mosquitofish represents a unique group of fish that gives birth to live young instead of releasing eggs.
   - ✓ The Rio Grande Silvery Minnow spawn during the Rio Grande's spring run-off flows. These high flows carry its eggs downstream and eventually the hatched larvae settle into slower waters (like pools and backwaters) created by the overbanking river.

2. Distribute or display the *Rio Grande Silvery Minnow*, *Rio Grande Cutthroat Trout*, and *Western Mosquitofish Life Cycle* and distribute the *Life Cycle Explored* worksheet to the students.

3. Brainstorm with students to discover some creative ways of presenting the life cycles. Encourage ideas such as: presenting the life cycle in a play, a short story, or poetry; present the life cycle in a series of artistic drawings or a poster; make up a song with lyrics that describe the life cycle and present it to the class; or a "This just in" newscast could be a possibility. After brainstorming, have students work in small groups.

4. The groups should decide how they would present their life cycle. Each member should be responsible for some aspect of the presentation.

5. When groups are ready, have the groups make their presentations to the rest of the class.

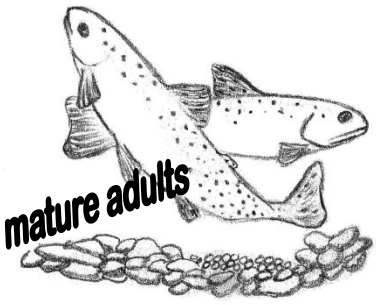
Extension: Students may be assigned a research project to create a life cycle diagram for a fish (or other living creature) native to New Mexico. Various levels of information exist for species and students may need to use the scientific name to locate some information. Below are only a few of the roughly 66 species native to New Mexico.

Pecos Gambusia (*Gambusia nobilis*)
Greenthroat Darter (*Percina macrolepida)*
Pecos Pupfish (*Notropis simus pecosensis*)
Gila Trout (*Oncorhynchus gilae*)
Mottled Sculpin (*Cottus bairdi)*
Bonytail Chub (*Gila elegans)*
Razorback Sucker (*Xyrauchen texanus)*
Loach Minnow (*Tiaroga cobitis*)
Longnose Gar (*Lepisosteus osseus*)
Rio Grande Chub (*Gila Pandora*)
Flathead Catfish (*Pylodictis olivaris*)

TEACHER REFERENCE: CUTTHROAT TROUT LIFE CYCLE

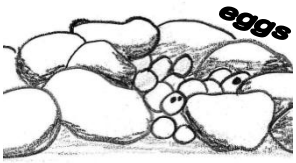
To protect native trout, we need to understand the details of their life cycle. Certain life stages, especially when they are young, are at risk to disturbances.

In New Mexico, Rio Grande Cutthroat Trout spawn (reproduce) in the spring months, usually March through July. Only mature adults will spawn and it usually takes three to four years for them to mature. During the spawning months, males develop bright red colors on their fins and belly that show they are ready for a mate.

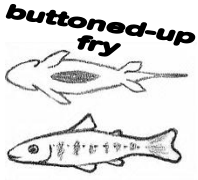


As spawning begins females will search for a place to make a redd, which is a trout nest. They look for an area with a gravel bottom, shade, and good water flow. This continuous flow of water helps bring plenty of oxygen to the eggs while they are in the redd. Once she finds a good spot, the female will flap her body and her fins to dig out a hole in the gravel. This hole now becomes her redd. Once she has a redd and finds a mate, it is time to spawn. With a male close by, the female will lay her eggs and the male will release his milt. The eggs are now fertilized. A female Rio Grande Cutthroat Trout can release from 200 to 4,500 eggs in one season!

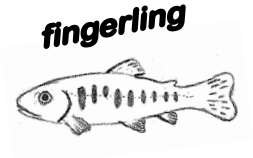
Trout eggs will go through a process called water hardening within the first hour of being laid. During this process, the sticky new eggs absorb water and become firm. For the next few days, these "green eggs" must remain in complete darkness. As the eggs develop (about 20 days after being laid), a set of eyes begin to develop in the embryo. Once the eyes are clearly visible they are called "eyed eggs".



When the eggs hatch, the tiny trout are called alevin. The alevin get their nutrients from attached sacs called yolk sacs. Eggs and alevins are particularly vulnerable to environmental disturbances, because they cannot leave their redd to escape danger. As the alevin develops, it remains in the redd. It absorbs nourishment from the yolk sac and the yolk sac shrinks. The seam where the yolk sac is attached will start to shrink as well.



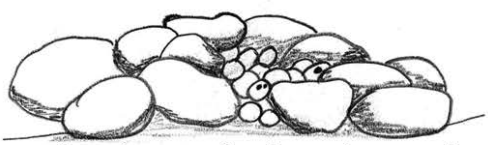
When the yolk is no longer visible from either the bottom or the sides of the fish, and the seam is less than one millimeter wide, the fish are called "buttoned-up fry". The fry swim up to the surface of the stream and begin actively looking for food. The fry will grow and eventually be called fingerlings.



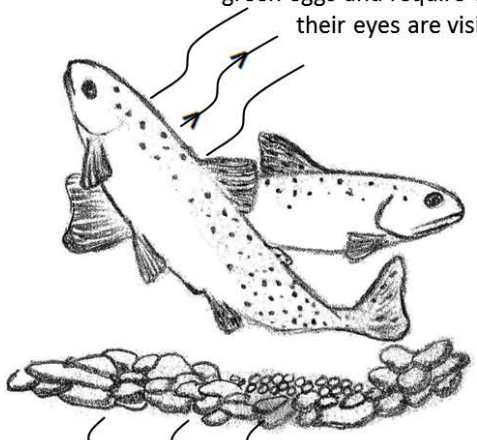
Fingerlings will develop dark spots along their sides called parr marks. These parr marks act as camouflage. The young fingerlings will feed on insects. As they grow, their diet becomes very similar to that of a mature trout. Prey items at this stage include invertebrates, small animals, and fish. They are agile swimmers and can move easily in the strong current of a stream. Fingerlings will grow into mature adult trout and begin the cycle again.

STUDENT REFERENCE: RIO GRANDE CUTTHROAT TROUT LIFE CYCLE (WILD)

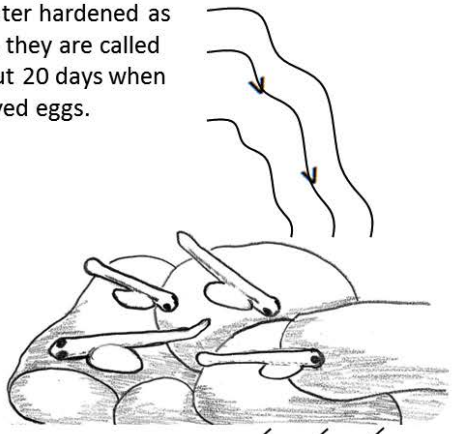
Compare the life cycle of wild trout to the life cycle of a hatchery trout.



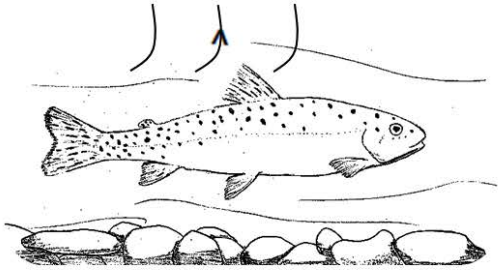
Eggs - Eggs transform in stages, first becoming water hardened as they absorb water. Over the next couple of days, they are called green eggs and require total darkness. After about 20 days when their eyes are visible they are known as eyed eggs.



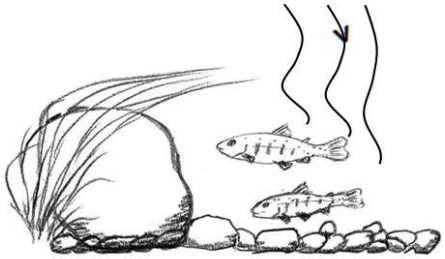
Spawning - A female trout will make a nest called a redd. With a male near, the female releases her eggs and the male releases milt. The eggs are now fertilized.



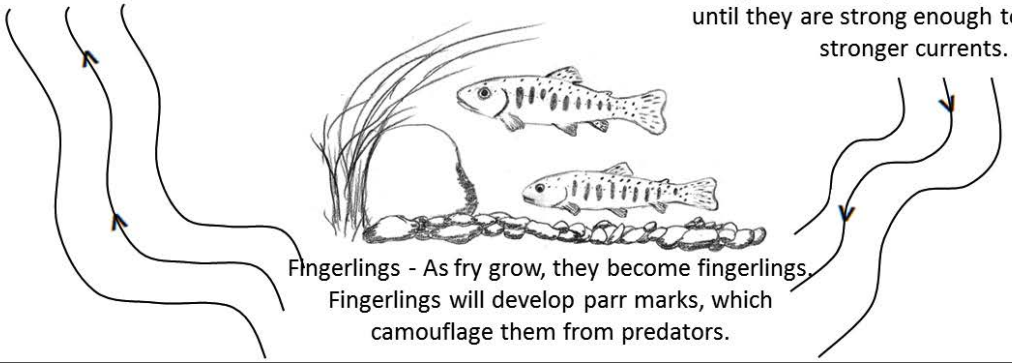
Alevin - When the tiny trout hatch from their eggs they are called alevin. Alevin stay hidden in the gravel redd. They do not need to come out to eat since they get all their nutrients from the yolk sacs attached to their abdomen.



Mature Adults - Rio Grande Cutthroat Trout mature around the age of three to four years old. The adults are responsible for producing the next generation of cutthroat trout.



Fry - The alevins are called fry or buttoned-up fry once they have used up their yolk sac. The fry swim up and out of their redd to begin looking food. The fry will stay in calmer water until they are strong enough to move into stronger currents.

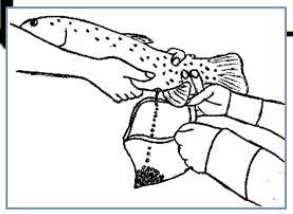


Fingerlings - As fry grow, they become fingerlings. Fingerlings will develop parr marks, which camouflage them from predators.

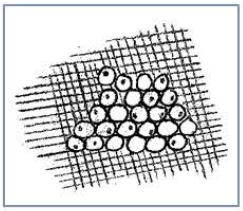
STUDENT REFERENCE: RIO GRANDE CUTTHROAT TROUT LIFE CYCLE (HATCHERY)

Compare the life cycle of hatchery trout to the life cycle of a wild trout.

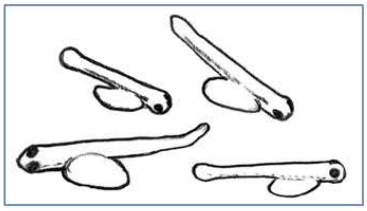
>> Flow >>



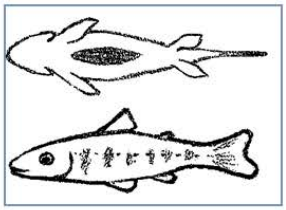
Eggs - Immediately after the eggs are fertilized, the eggs absorb water and become water hardened. Then they are called green eggs for the next couple of days and require total darkness. After about 20 days their eyes are visible and they are called eyed eggs.



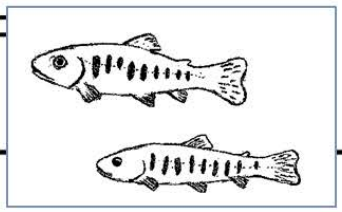
Alevin - After the eggs hatch, the new trout are called alevin. Alevin obtain their nutrients from the yolk sacs attached to their abdomen.



Fry - Alevins become buttoned fry once they have used up their yolk sacs. Fish Culturists begin feeding the fry at this stage.

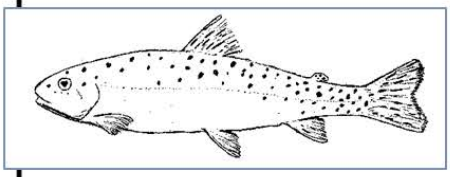


Fingerlings - As fry grow, they become fingerlings. Fingerlings will develop parr marks, which in the wild help camouflage them from predators.



>> Flow >>

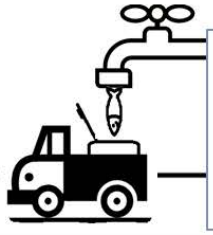
Spawning - A Fish Culturist will collect eggs and milt from mature trout and fertilize the eggs by hand. The eggs are cared for in an incubator.



Mature Adults - Fish Culturists will hold mature adults to develop a broodstock. The broodstock are used to produce the next generation of hatchery spawned trout.

Recovery - Hatcheries play a vital role in the recovery of many threatened and endangered species. Fish may be spawned in captivity for recovery, housed for research, or held as a refuge population. Trout are usually stocked as fingerlings and occasionally as adults to help maintain or re-establish a wild trout population.

Recreation - Stocking for recreational fishing is a traditional role of the hatchery and it continues to be an important role.



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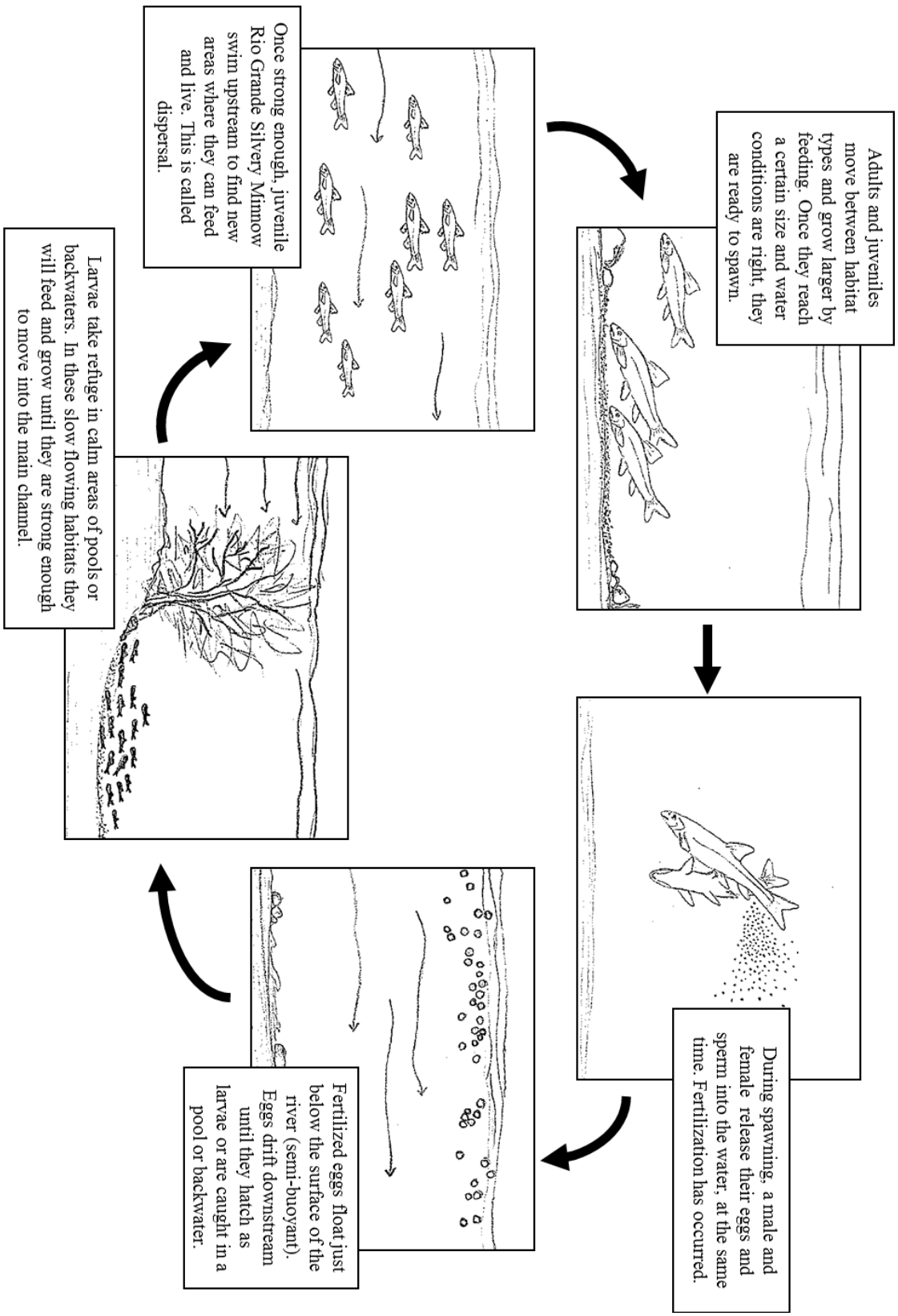
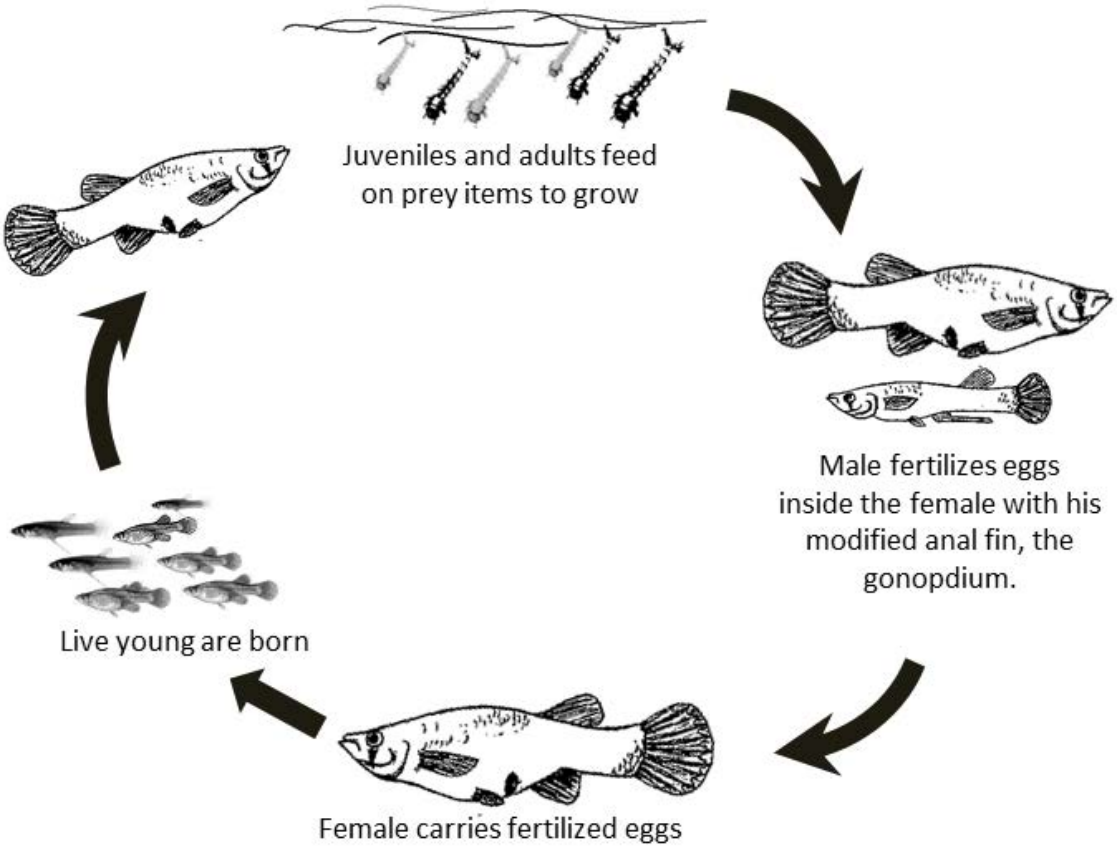
STUDENT REFERENCE: RIO GRANDE SILVERY MINNOW LIFE CYCLE



STUDENT REFERENCE: WESTERN MOSQUITOFISH LIFE CYCLE



STUDENT WORKSHEET: LIFE CYCLE EXPLORED

Name _____

Research a native fish of New Mexico and create a life cycle diagram. You may need to use the fish's scientific name to learn more about the species.

Here are some questions to get you thinking about your fish.

Does your fish have any of these stages in their life cycle: eggs, larval fish, fry, or juveniles? When do your fish first spawn? Can they spawn at any time? How many eggs do they have? What is their average life span? Do the young fish look different from the adult fish?

Sketch your fish

Fish Species _____ Life Span _____

Section 3 – The Bigger Picture

Our intention with this section is expand the view beyond our city and to demonstrate the interconnectedness of our ecosystems and components of our watersheds.

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Activity 11: In the Course of a River

Standard Correlations - Grade 5:

New Mexico Science Content Standards, Benchmarks, and Performance Standards
Strand II, Standard II, Benchmark 1, Performance Standard 1 & 3
Strand III, Standard I, Benchmark 1, Performance Standard 1
Social Studies
Strand Geography, Content Standard II, 5-8, Benchmark 2-A, Performance Standard 1
Strand Geography, Content Standard II, 5-8, Benchmark 2-D, Performance Standard 1

Common Core State Standards

Timeline: Four 30-minute periods.

Objective: At the end of this activity, students will be able to comprehend the size of the Rio Grande by identifying the states and countries the river crosses. Students will be able to list three of the four habitats discussed; pools, runs, riffles, and backwaters.

Preparation and Background: The Rio Grande is a large dynamic system spanning Colorado, New Mexico, Texas, and five states in Mexico before it reaches the Gulf of Mexico. It is an ever-evolving ecosystem as it grows and makes its way to the Gulf of Mexico and eventually the Atlantic Ocean.

The Rio Grande begins with its headwaters in the San Juan Mountains, 12,000 feet above sea level. The headwaters are the source of any given major river. The river will travel roughly 1,900 miles before it reaches the Gulf of Mexico. Smaller streams and rivers (known as tributaries) that feed in to the Rio Grande, do so throughout its long journey.

Rio Chama, Jemez River, Rio Puerco, Devils River, and Pecos River are major tributaries to the Rio Grande within the United States. Within Mexico, Rio Conchos, Rio Salado, and the Rio San Juan are the major tributaries. Each stream contains its own watershed, which contributes to a larger watershed, ultimately, in this case, the Rio Grande Watershed.

Snowmelt and summer rains are natural influences on flow of the Rio Grande. Generally, the Rio Grande has a low winter flow, increasing during the spring, usually around April and May when the snow begins to melt in the mountains. Historically, these spikes in flows allowed for flooding and overbanking of flood plains to create backwater habitat for many of our native fish species. Flows gradually declined until the summer monsoons created small rises in flow.

Humans have altered the Rio Grande's historical flow regime by constructing water diversions, levees, and dams. This includes the water transfer project called The San Juan-Chama Project . The project diverts water from the San Juan River drainage basin to increase water supplies in the Rio Grande watershed. The project supplies water for irrigation and to cities along the Rio Grande, including Albuquerque and Santa Fe. In addition to supplying water for human use, the Rio Grande also supports a vast number of species including insects, amphibians, reptiles, mammals and birds. Cooperation among varying agencies and governments is necessary for management of limited water resources for both humans and wildlife.

- ✓ **Watershed:** An area of land that drains into a body of water like a river, a stream, an estuary, a bay, or an ocean. Watersheds vary in size and you can have a watershed within a watershed. The Rio Puerco has its own watershed, land area where surface water drains into the Rio Puerco. The Rio Puerco is a tributary to the Rio Grande and becomes a part of a larger watershed, the Rio Grande Watershed.
- ✓ **Headwaters:** One or more tributary streams that form the source of a major river.
- ✓ **Tributary:** A creek, stream, or river that feeds a larger stream, river, or lake.
- ✓ **Meander:** A winding curve or bend in a stream or river.
- ✓ **Upstream:** In or towards the higher part of a stream or river; against the current.
- ✓ **Downstream:** In or towards the lower part of a stream or river; with the current.
- ✓ **Confluence:** The area where two streams or rivers join.

Aquatic Habitats of streams and rivers

As tributaries feed into the Rio Grande, the river grows in size; the channel widens and deepens. Headwater streams generally have cooler temperatures than the downstream sections. Cold water springs, cool mountain temperatures, and shoreline shade help keep the temperatures low. The temperatures begin to increase as shade from shoreline vegetation no longer spans the widening river and sources of water come from other streams and rivers instead of underground springs.

The substrate found in headwaters is usually cobble and gravel. As you move downstream, the substrate begins to decrease in size and will eventually become sand.

Elevation usually drops rapidly at first, creating a steep slope, which creates fast flows. As the river moves from the mountains, where they began, the degree of slope decreases and the waters slow down.

At any point in the river, you can locate pools, riffles, backwaters, and runs. These are aquatic habitats used by various fish of the Rio Grande. Each fish species uses a specific habitat within the river, although habitat needs can change throughout its life. **A healthy river system will have diverse habitat. If rivers are not healthy and habitat diversity declines, so does fish diversity.**

- ✓ **Pool:** An area with slow, calm water and silt or sand substrate. This usually occurs because the water is moving so slow it allows the silt (fine sediment) to settle out of the water.
- ✓ **Backwater:** An area that is out of the main channel with still water. This area will likely have silt or sand substrate like a pool.
- ✓ **Riffle**: Shallow rapid; water flows quickly over rocky substrate creating waves and splashes.
- ✓ **Vegetation (overhanging)**: Plants like grass, shrubs, and trees that hang over the edge of the shoreline providing shade.
- ✓ **Run**: A section of stream or river where water moves quickly, but calmly. A run lacks rapids like a riffle and moves too quick to allow silt to settle.
- ✓ **Debris (in-stream)**: Structure that is located in the stream providing cover and refuge from faster waters. Debris can be natural such as logs and tumbleweed or fabricated structures such as jetty-jacks.
- ✓ **Shoreline**: The line where a body of water meets the land.

- ✓ **Substrate**: The earthy material that is on the bottom of the stream or river such as silt, sand, gravel, or cobble. The substrate will change as you move from the headwaters to the mouth of a river.
- ✓ **Floodplain:** Low-lying ground along the shoreline, generally bordering both sides of the river, likely to flood during rain or snowmelt events. This area also usually consists of soils rich in nutrients deposited by floodwaters.

Materials:

1. Handout: Student Reference Sheets - *Geography of the Rio Grande, The Rio Grande Continuum, and Pieces of the Aquatic Habitat.*

2. Handouts: Student Worksheets - *Geography of the Rio Grande, The Rio Grande Continuum, and Pieces of the Aquatic Habitat.*

Procedure:

1. Read background material.

2. Review *Student Reference: Geography of the Rio Grande* with students.

3. Have each student complete the Student Worksheet: *Geography of the Rio Grande*.

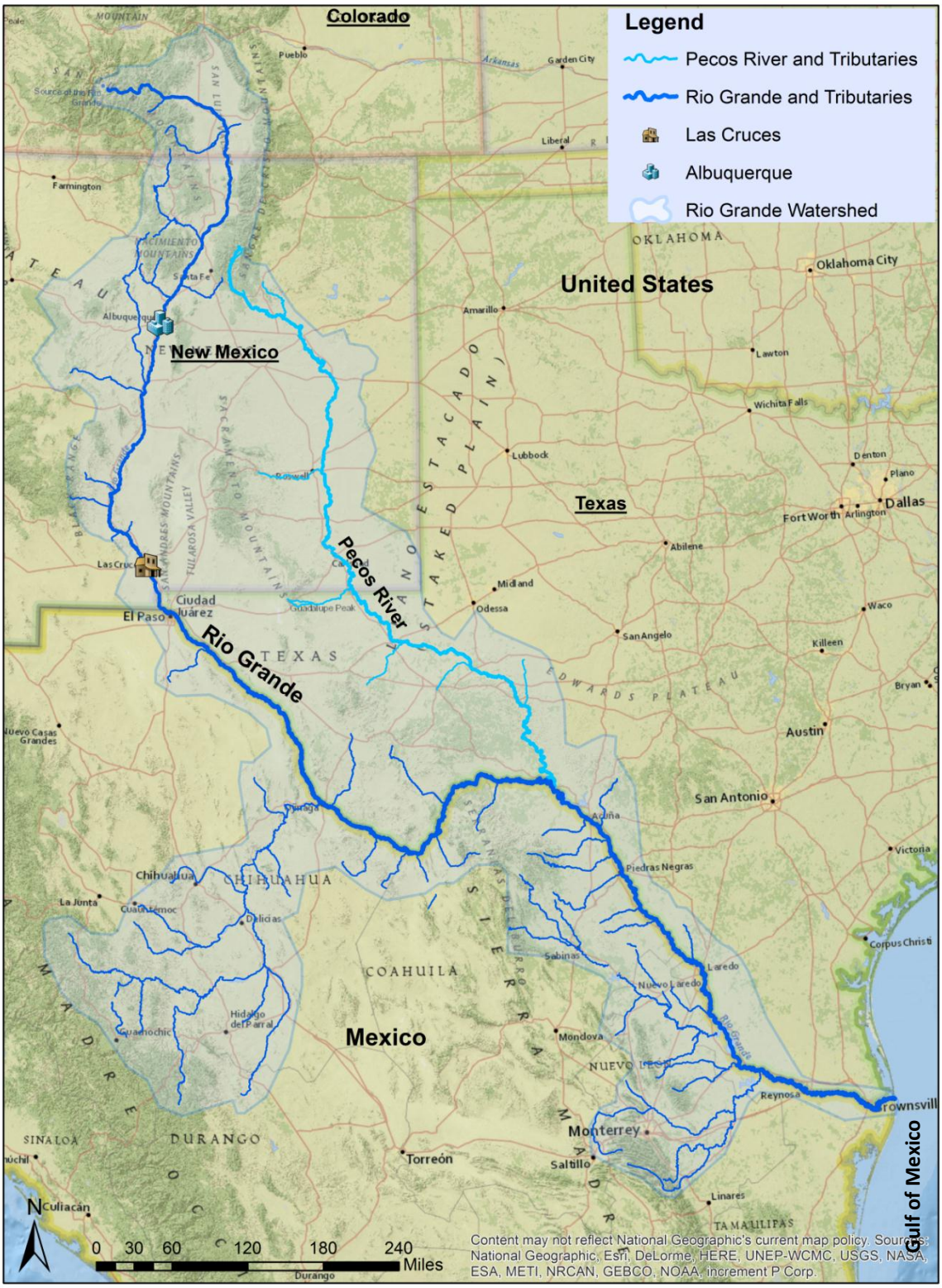
4. Review *Student Reference: The Rio Grande Continuum* with students.

5. Have each student complete the Student Worksheet: *The Rio Grande Continuum Grande*.

6. Review *Student Reference: Pieces of the Aquatic Habitat* with students.

7. Have each student complete the Student Worksheet: *Pieces of the Aquatic Habitat*.

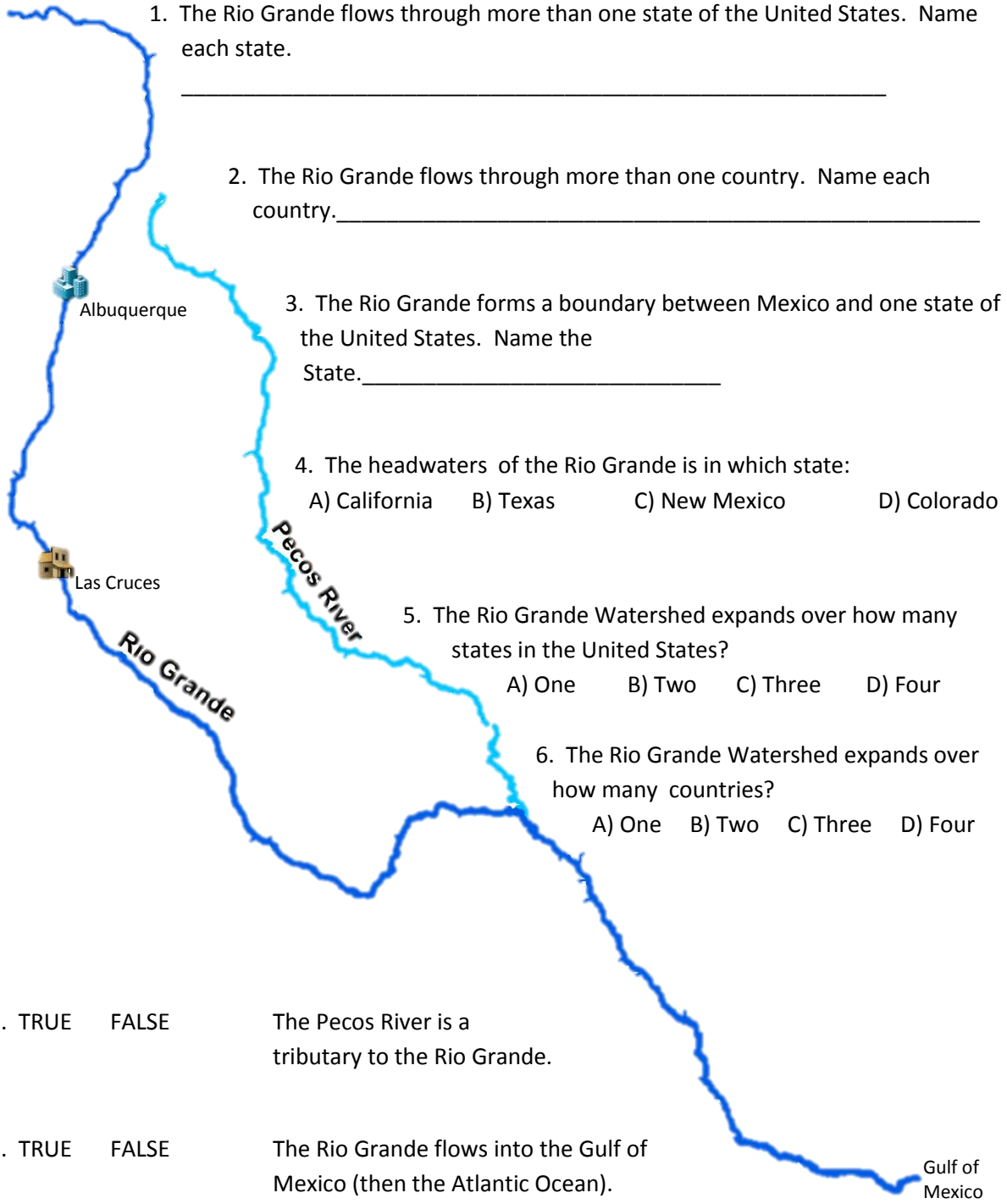
STUDENT REFERENCE: GEOGRAPHY OF THE RIO GRANDE



STUDENT WORKSHEET: GEOGRAPHY OF THE RIO GRANDE

Name _____

Use your reference sheet to answer the following questions.



1. The Rio Grande flows through more than one state of the United States. Name each state.

   _____

2. The Rio Grande flows through more than one country. Name each country._____

3. The Rio Grande forms a boundary between Mexico and one state of the United States. Name the State._____

4. The headwaters of the Rio Grande is in which state:

   A) California B) Texas C) New Mexico D) Colorado

5. The Rio Grande Watershed expands over how many states in the United States?

   A) One B) Two C) Three D) Four

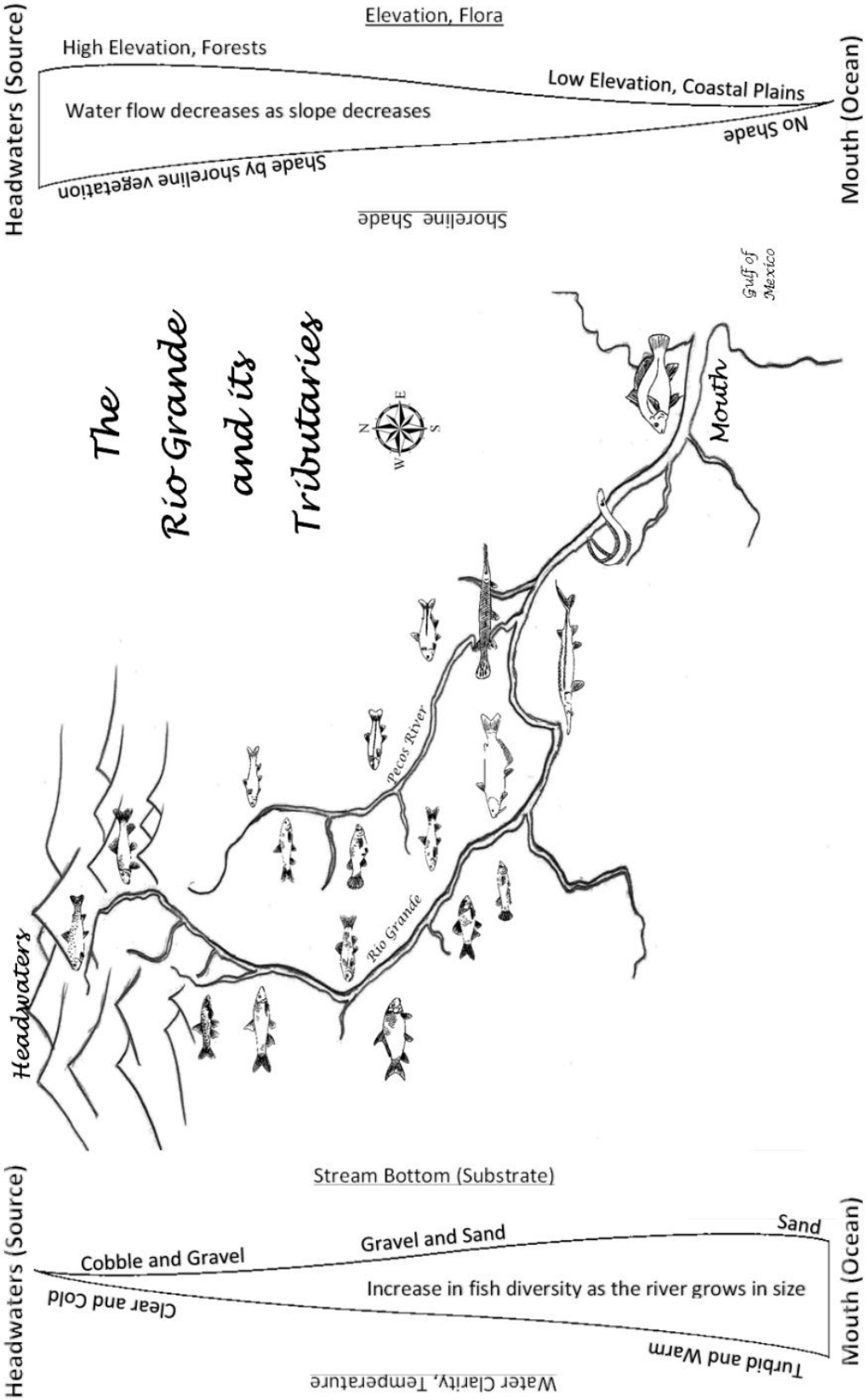
6. The Rio Grande Watershed expands over how many countries?

   A) One B) Two C) Three D) Four

7. TRUE FALSE The Pecos River is a tributary to the Rio Grande.

8. TRUE FALSE The Rio Grande flows into the Gulf of Mexico (then the Atlantic Ocean).

STUDENT REFERENCE: THE RIO GRANDE CONTINUUM



STUDENT WORKSHEET: THE RIO GRANDE CONTINUUM

Name _____

Unscramble the words

1. andS _____
2. duiTrb _____
3. Haetdraews _____
4. Mhtuo _____
5. aedSh _____
6. laaoPsiCnstla _____
7. tonievhgEHail _____
8. cettiVaoelyWr _____
9. itiyDisFrshev _____
10. tryibrTau _____

Use the words above to fill in the blanks.

1. _____ is the expected substrate near the mouth of the Rio Grande.

2. As the Rio Grande grows in size, from the headwaters to the mouth, _____ also increases.

3. In a section of river that is warm, water clarity is expected to be _____.

4. The streams at the sources of a river are called_____.

5. The _____ is the end of the Rio Grande where it empties into the Gulf of Mexico?

6. Shoreline vegetation provides a lot of _____ for the headwaters of the Rio Grande.

7. The flora (plant life) is called _____ at the mouth of the Rio Grande?

8. The headwaters are in _____ areas.

9. As the slope decreases in a river, the _____ also decreases.

10. The Pecos River is a _____ to the Rio Grande.

STUDENT REFERENCE: PIECES OF THE AQUATIC HABITAT PUZZLE

1) Pool: An area with slow, calm water and silt or sand substrate. This usually occurs because the water is moving so slow it allows the silt (fine sediment) to settle out of the water.

2) Backwater: An area that is out of the main channel with still water. This area will likely have silt or sand substrate like a pool.

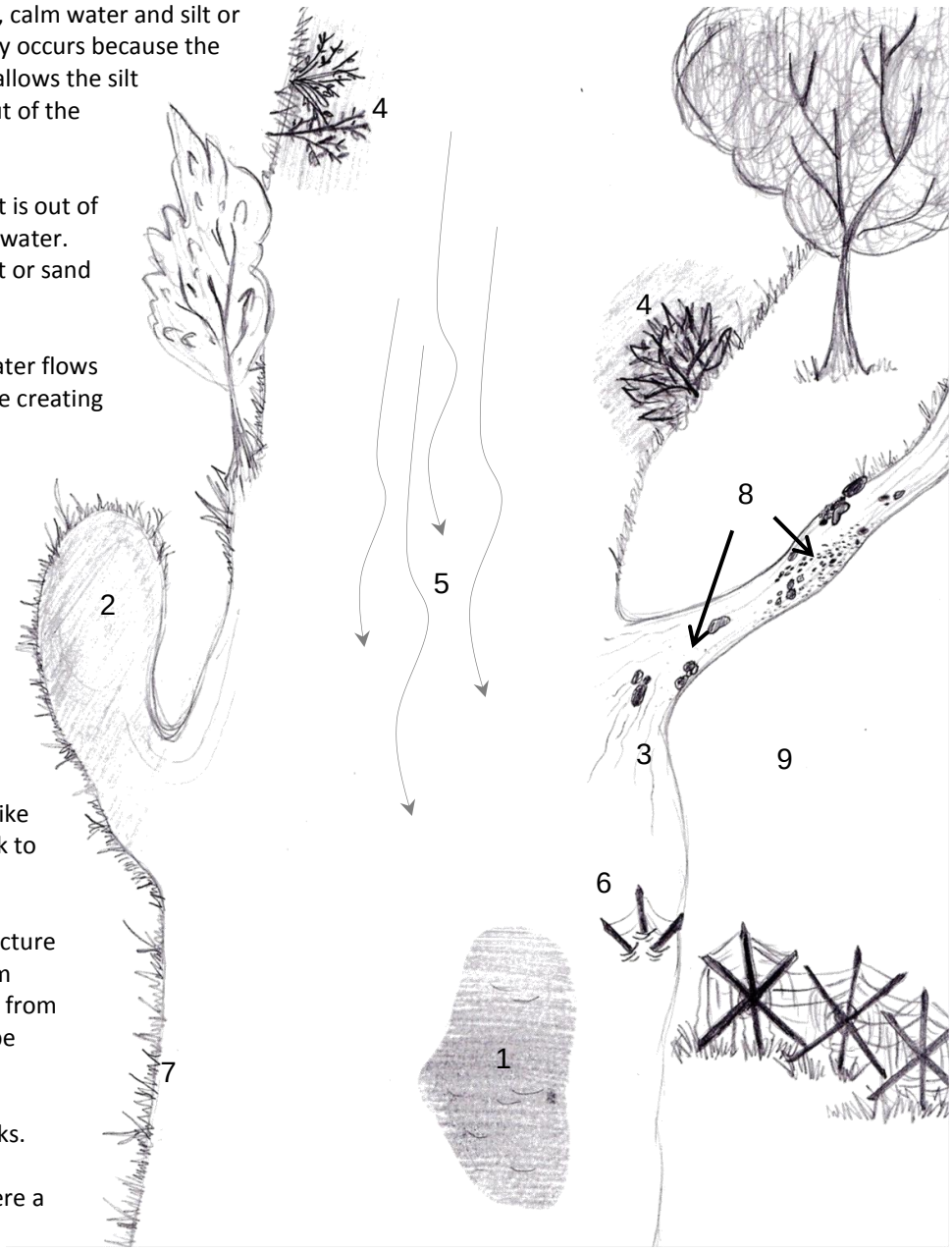
3) Riffle: Shallow rapid; water flows quickly over rocky substrate creating waves and splashes.

4) Vegetation (overhanging): Plants like grass, shrubs, and trees that hang over the edge of the shoreline providing shade.

5) Run: A section of stream or river where water moves quickly, but calmly. A run lacks rapids like a riffle and moves too quick to allow silt to settle.

6) Debris (in-stream): Structure that is located in the stream providing cover and refuge from faster waters. Debris can be natural such as logs and tumbleweed or fabricated structures such as jetty-jacks.

7) Shoreline: The line where a body of water meets the land.



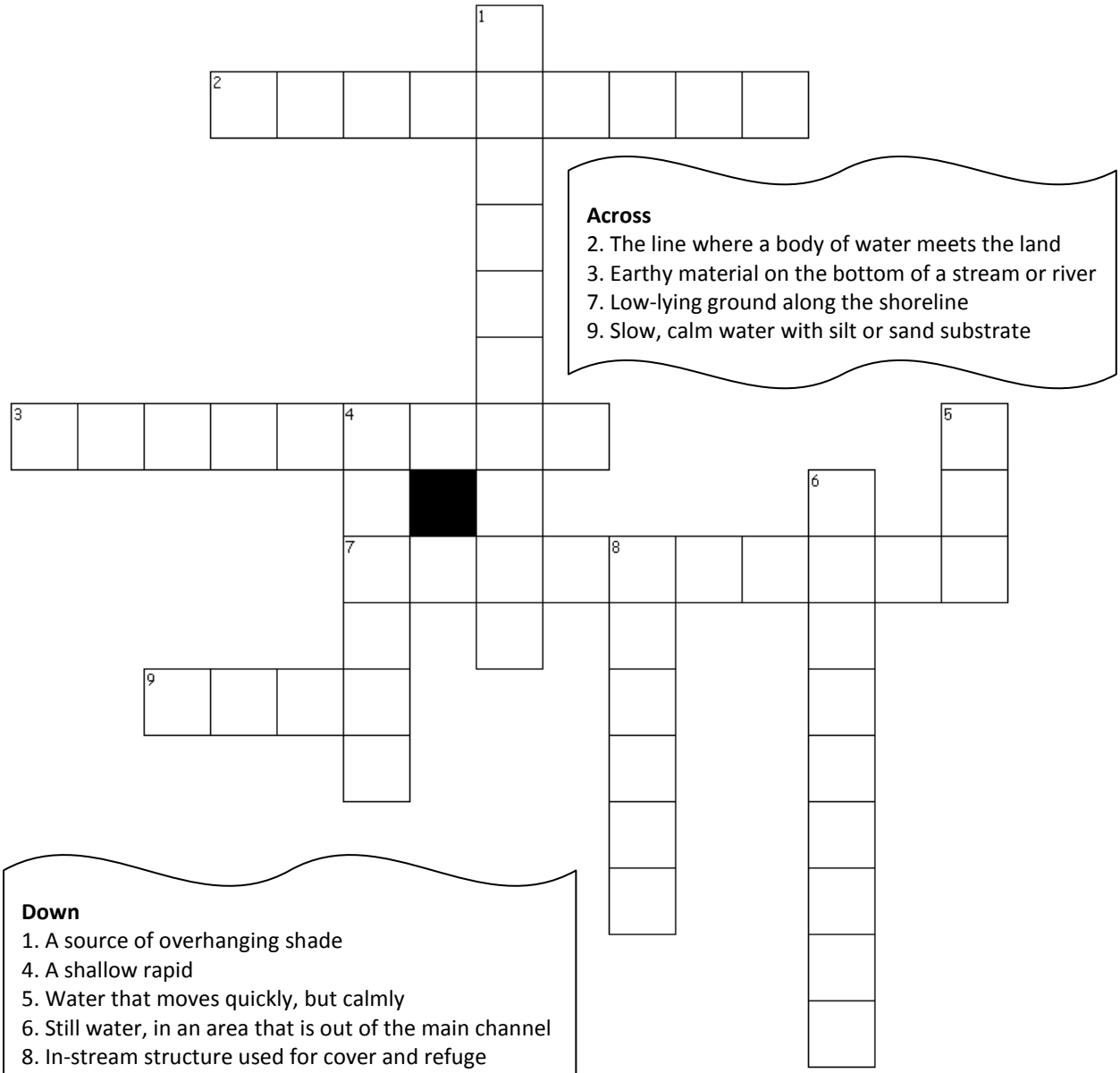
8) Substrate: The earthy material that is on the bottom of the stream or river such as silt, sand, gravel, or cobble. The substrate will change as you move from the headwaters to the mouth of a river.

9) Floodplain: Low-lying ground along the shoreline, generally bordering both sides of the river, likely to flood during rain or snowmelt events. This area also usually consists of soils rich in nutrients deposited by floodwaters.

STUDENT WORKSHEET: PIECES OF THE AQUATIC HABITAT PUZZLE

Name _____

Complete the crossword puzzle.



Across
2. The line where a body of water meets the land
3. Earthy material on the bottom of a stream or river
7. Low-lying ground along the shoreline
9. Slow, calm water with silt or sand substrate

Down
1. A source of overhanging shade
4. A shallow rapid
5. Water that moves quickly, but calmly
6. Still water, in an area that is out of the main channel
8. In-stream structure used for cover and refuge

Riffle, runs, pools and backwaters are all in the course of a river!

Activity 12: Environmental Protection Agency – After the Storm

Standard Correlations - Grade 5:

New Mexico Science Content Standards, Benchmarks, and Performance Standards
Strand II, Standard III, Benchmark II, Performance Standard 1
Strand III, Standard I, Benchmark I, Performance Standard 1

Social Studies
Strand Geography, 5-8 Benchmark 2-C, 5.1 & 5.2

Common Core State Standards
Speaking and Listening 5.2

Timeline: One 60-minute period.

Objective: At the end of this activity, students should be able to comprehend the relationship between upstream and downstream communities of families, farmers, businesses and industrial plants that exist within a watershed. Students will be able to define *watershed, polluted run-off, litter,* and *wetlands.*

Preparation and Background:

- ✓ **Continental Divide**: A separation of drainage basins; Water west of the separation flows to the Pacific Ocean and water east flows to Atlantic Ocean.
- ✓ **Closed basin**: A drainage area that is surrounded by high land (like mountain ranges) and where surface water soaks into the ground, becoming groundwater or pools to become a lake instead of connecting to a larger river and ultimately an ocean.
- ✓ **Fecal coliform**: A general group of bacteria like *E. Coli*, salmonella, or enterococcus that indicates feces (poop) from animals, including humans, are present.
- ✓ **Hypoxic zone**: An area of water lacking in vital oxygen.
- ✓ **Litter**: Trash, such as paper, cans, cigarette butts, and bottles, which are not disposed of properly and dirty an open or public place.
- ✓ **Polluted run-off**: Surface water flow that has picked up bacteria, toxic chemicals, fertilizers, pesticides, and trash.
- ✓ **Watershed**: An area of land that drains into a body of water like a river, a stream, an estuary, a bay, or an ocean. Watersheds vary in size and you can have a watershed within a watershed. The Rio Puerco has its own watershed, land area where surface water drains directly into its main channel. The Rio Puerco in turn is a tributary to the Rio Grande and becomes a part of a larger watershed, the Rio Grande Watershed.

Additional Resources: Read *Watersheds in New Mexico* from the Bosque Education Guide for additional information and activities. The activity is located on the Supplemental Materials CD in the BEMP folder.

Materials:

1. Request a free copy (http://water.epa.gov/action/weatherchannel/) of "After the Storm" or provide access to the internet to view it online. To view online, simply click on the text ***Complete Copy of "After the Storm" Video posted on Internet*** at the top of the webpage listed above. You can also view the video on YouTube at https://www.youtube.com/watch?v=0fIXhs6DzIE. The video is approximately 22 minutes.
2. Student Reference: *New Mexico Watersheds*
3. Student Worksheet: *After the Storm*
4. Items of litter or items that will represent litter or pollution in a river and its watershed. Provide enough for each student to have an item of litter.

Procedure:

Video

1. Provide an introductory discussion on the concept of watersheds. Use the *New Mexico Watersheds* handout to display watersheds of New Mexico.

2. Provide the *After the Storm: Review* handout to review questions prior to watching the video *After the Storm*.

3. Review questions to help students key in on what they have discovered. The main point to leave with the students is that we are neighbors to other families, farmers, businesses and industrial plants in our watershed whether upstream or downstream.

Activity

The Human River (Concept from Canadian Geographic Education Website at http://www.cgeducation.ca/resources/learning_centre/classroom_activities/human_river.asp)

1. Your students will become the river to demonstrate the upstream/downstream connection within a rivers watershed and visualize the flow of polluted run-off.

2. Have students line up in a curvy line, with a couple of students off to the sides to represent a tributary.

3. Designate a student (at each end of the line) as the headwaters and the opposite end as the mouth, where the river drains into the ocean. One student will represent the ocean.

4. Beginning from the headwaters, one by one, have each student pass their litter or pollutant to the next student downstream from them while stating aloud what their litter represents.
   - ✓ Have students consider where they are at in the course of the river, headwaters may have different sources of pollution from the lower elevation big rivers with large cities nearby.
   - ✓ Ex. Headwaters - My litter is from a campsite.
   - ✓ Ex. Middle Rio Grande : Oil from leaking vehicle engines
   - ✓ Ex. Lower Rio Grande : Agriculture run-off from fertilized fields.

5. Other sources of litter and pollution such as gas spills at gas stations, tires, plastic bags, styrofoam, animal waste (ex. horse, cattle, cats, & dogs), food wrappers, cigarette butts, mining waste, soap from washing cars, electronics, pesticides, fertilizers, and treated water from water treatment facilities to name a few.

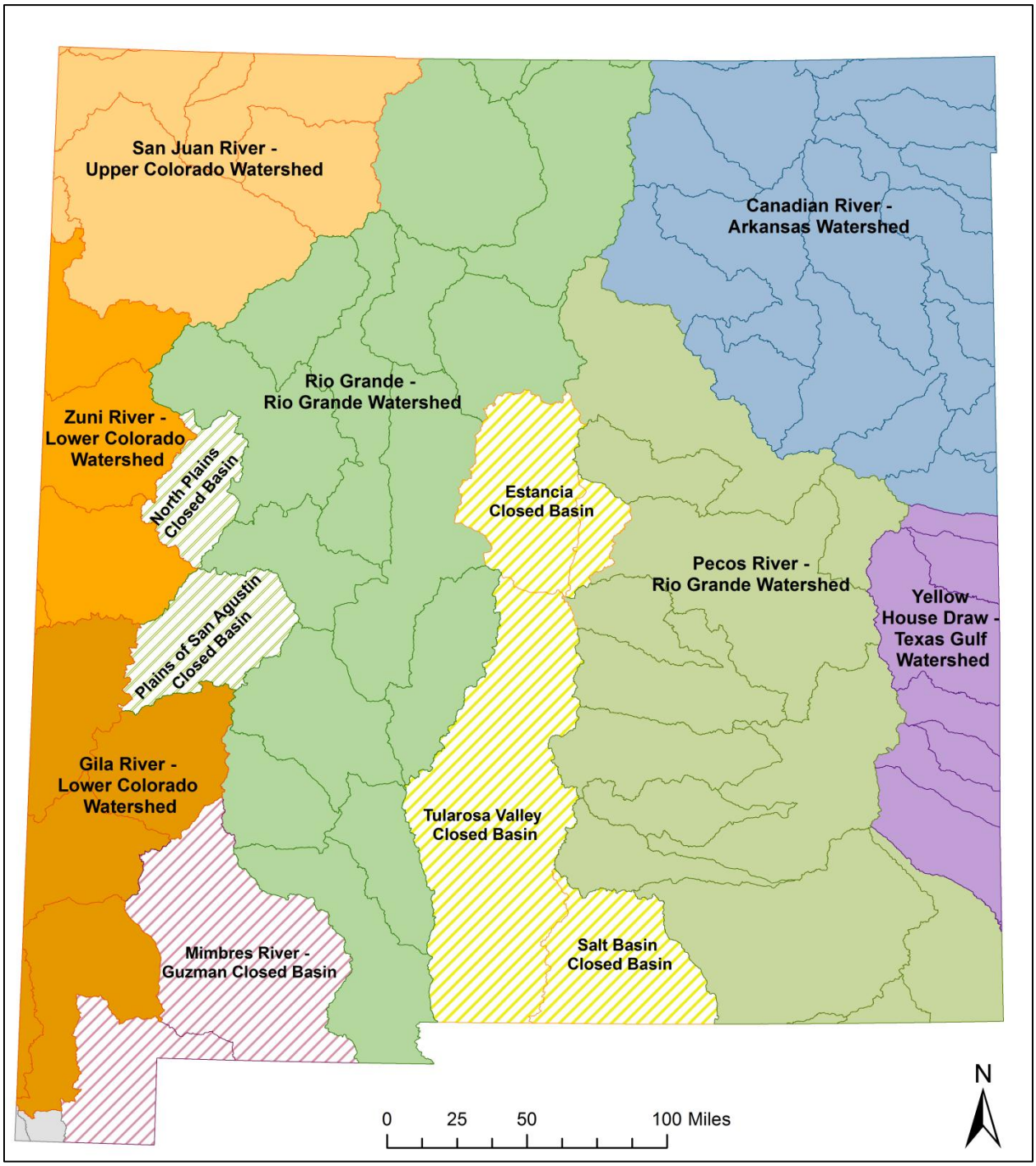
6. By the end, the student that is representing the ocean will be holding all the litter and pollution from its upstream neighbors.

7. Have students discuss ways they can help prevent litter and pollution from entering the Rio Grande.

Supplemental Activity: Define Watershed Boundaries activity

TEACHER REFERENCE: NEW MEXICO WATERSHEDS AND CLOSED BASINS

A watershed is an area of land where surface water drains to a body of water like a river, a stream, an estuary, a bay, or an ocean. A closed basin is surrounded by high land and the surface water does not make it to the ocean. Water from closed basins becomes a lake or seeps into the groundwater.



STUDENT WORKSHEET: AFTER THE STORM

Video co-produced by the U.S. EPA and The Weather Channel

Name _____

Match the terms to the descriptions.

TERMS		DESCRIPTIONS
Watershed	__	A. An area of water lacking in vital oxygen.
Fecal coliform	__	B. Surface water flow that has picked up bacteria, toxic chemicals, fertilizers, pesticides, and trash.
Hypoxic zone	__	C. A general group of bacteria like *E. Coli*, salmonella, or enterococcus that indicates feces (poop) from animals, including humans, are present.
Polluted runoff	__	D. Area of land that drains to a body of water like a river, a stream, an estuary, a bay, an ocean.
Wetlands	__	E. A natural resource that removes pollutants and provides important habitat such as swamps, marshes, and bogs

Circle True or False for each question.

True False: What we do in our watershed, affects people downstream of our watershed.

True False: Approximately 97% of the water on earth is freshwater.

True False: The hypoxic zone in the Gulf of Mexico is roughly 9,000 square miles, the size of New Jersey.

True False: Impervious surfaces allow water to soak into the ground.

True False: One person can make a difference.

Name as many pollutants identified in the video as you can. _____

_____

_____

What can you do to make a difference? _____

_____

_____

Activity 13: Population Estimation

Standard Correlations - Grade 5:

New Mexico Science Content Standards, Benchmarks, and Performance Standards
Strand II, Standard II, Benchmark I, Performance Standards 1, 3, & 4
Strand III, Standard I, Benchmark I, Performance Standard 1

Common Core State Standards
CCSS, Math 5.G.1 & 5.G.2

Timeline: Approximately 1.5 hours with NMFWCO biologists.

Objective: At the end of this activity, students will have calculated a population estimate for a year class while developing a population trend line for the Pinto Fish. Students will be able to name three limiting factors for any species survival: food, water and shelter. Students will be able to identify two circumstances that can influence the trend of a population.

Preparation and Background: Fish and Wildlife biologists are often concerned with a population of species. Biologists will frequently attempt to estimate a population number in order to determine if a species is stable, increasing, or decreasing in numbers. Formulas are the main tool biologists use to aid in estimating population numbers.

Three limiting factors make up a species habitat: **food, water, and shelter**. If there is a modification to the habitat, a species population size will likely respond. If it is a negative impact such as limited water due to a drought, a population will probably decline. If it is a positive impact, such as above normal rainfall and food is abundant, a population may increase. Now if you were a fish, what would be your limiting factors? Water becomes vital, not only to stay hydrated, like other animals, but as part of their shelter and a source for their food. If a river, such as the Rio Grande were drying, what would happen to a population of fish in the Rio Grande or any other drying river or stream?

Biologists can monitor a species to establish trends in its population over several years. When a species is declining and there is no predicted improvement in the future, it may become a species of concern leading to threatened or endangered status. Management efforts are then increased and attempts are made to recover the specie's population. When population numbers become so low that even recovery efforts fail, the population will likely go extinct. Unfortunately, there are many examples of extinct species. Here in the Rio Grande, the Phantom Shiner and the Rio Grande Bluntnose Shiner (a subspecies of the Bluntnose Shiner) are now extinct. Some species may no longer exist in portions of their historical habitat. In unoccupied historical ranges the species are considered extirpated. Big river fish like the Shovelnose Sturgeon and the Longnose Gar are extirpated from the stretch of the Rio Grande in New Mexico.

- ✓ **Population**: A group of organisms of the same species that live in the same area at the same time.
- ✓ **Extinct**: A species of animal or plant that is no longer in existence.
- ✓ **Extirpated**: A species of animal or plant that no longer exists in a given area.

- ✓ **Threatened species**: A species of animal or plant that is rare and may become an endangered species in the future.
- ✓ **Endangered species**: A species of animal or plant in danger of becoming extinct.
- ✓ **Trendline**: A line drawn on a plot of points to show a relation, or general trend, among the points.

Materials:

1. Bags of beans, one light and one dark variety (pinto and kidney beans work well)
2. Two bowls or bags to hold the beans
3. Paper lunch bags (one for each group)
4. Copies of *Mark-Recapture* handout

Procedures:

The method below is a technique used in fisheries management to estimate fish populations.

1. Have students work in pairs. One student will be the sampler and the other will be the data recorder.

2. Provide one *Mark-Recapture* handout to each group.

3. Assign each group with a year (in consecutive order) to represent the species population for one year.

4. Have each group follow the step-by-step instructions to complete the exercise.

5. Once each group is finished with the exercise, graph each groups estimated population in consecutive order to create a trendline.

6. Discuss with the class possible reasons for the trends seen in the graph. Answers and graphs will vary with every class.
   - ✓ Biologists are required to interpret trends and there can be several interpretations. Encourage students to be creative in thinking what may explain the trend displayed by the student's estimates: the increases, decreases, or relatively stable numbers for a population. There is no right or wrong answer.
   - ✓ Potential causes of declines - disease outbreak, new development, natural disasters (i.e. drought, floods, volcano), human caused disasters (i.e., chemical spill, fire, pollution), poor management (i.e., over-harvesting, over-grazing), and loss of habitat.
   - ✓ Potential causes of increases – good rain, active management (i.e., stocking, limited harvest), protected habitat, habitat restoration, predator numbers declined, increase in food base.

Mark-Recapture - Population guess and count, and calculated population estimate based on numbers of captured, marked, and recaptured individuals using a simple mark-recapture technique.

1. Put five handfuls (one hand) of light-colored beans into a bag. Do not count them.

2. Guess how many light-colored beans you just placed in the bag and record this guess:
3. Box 1: _____.

4. One student, the sampler, will remove one handful of light-colored beans out of their bag. This represents your first capture (*M*). Count your handful of beans and record the number as the value for *M*: Box 2: _____. Do not return these beans to your bag.

5. You will now "mark" the organisms (beans) just captured. To mark them, simply replace them with the exact same amount of dark-colored beans.

6. You will now release the marked individuals (dark-colored beans) back into the population (your bag). Return the light-colored beans that you replaced with dark-colored beans to the original container (not your bag).

7. Shake your bag and then, without looking, have the sampler grab one handful of beans from your bag (this is your second capture = *n*). Count the total number of beans grabbed in this handful (regardless of color) and record the value for *n*: Box 3: _____.

8. Examine the same handful and count the number of beans that were marked. Record this number as *m*: Box 4: _____. When you are finished counting, return the entire sample to your bag.

9. After completing your calculations count the actual total number of beans in your bag. Record your final count **Box 5: _____.**

10. Separate the beans and return them to their original containers.

STUDENT WORKSHEET: MARK-RECAPTURE

Names_____

Use the following equation to calculate your population estimate (***N***). After completing your calculations, count the actual total number of beans in your bag. Record your final count **Box 5: _____.**

Equation: $\boldsymbol{N = (M \times n) \div m}$

Where: ***N*** = Population estimate
M = Number of individuals captured in first sample (and marked)
n = Total number of individuals captured in second sample
m =Number of individuals captured in second sample and marked.

Box Value	Group Year	
-	Guessed Population Size	
Box 1	Number of individuals captured in first sample and marked (*M*)	
Box 2	Total number of individuals captured in second sample (*n*)	
Box 3	Number of individuals captured in second sample and marked. (*m*)	
Box 4	Estimated Population Size (*N*)	
Box 5	Actual Population Size (Counted value)	

Show your work:

1. For the simple mark-recapture, how did your initial guess of the population size compare to the actual population number and the calculated population estimate (***N***)?

2. Do you think it would be easier or harder to estimate a population of fish or wildlife without being able to see the entire population as you were able to see the beans? Why?

Activity 14: Native and Nonnative Species

Standard Correlations - Grade 5:

New Mexico Science Content Standards, Benchmarks, and Performance Standards
Strand II, Standard I, Benchmark I, Performance Standards 3 & 4
Strand II, Standard I, Benchmark II, Performance Standards 1 & 3
Strand III, Standard I, Benchmark I, Performance Standard 1

Common Core State Standards
CCSS ELA-Literacy, Speaking and Listening 5.1 & 5.4
CCSS ELA-Literacy, Reading Standards for Informational Text 5.7

Timeline: One to two 60-minute periods.

Objective: At the end of this activity, students will be able to comprehend and explain the difference between a native species and nonnative species.

Preparation and Background:

- ✓ **Native**: A species that occurs naturally with respect to a particular ecosystem. The species has evolved or developed within the surrounding habitat.
  - All of the fish in your classroom aquarium are native to New Mexico. However, certain species may be native only to a particular river in New Mexico. Several species of fish have been extirpated from the Rio Grande (like the Shovelnose Sturgeon and the Rio Grande Shiner).
  - The Rio Grande Cutthroat Trout and the Gila Trout are the native trout that occur in New Mexico.
- ✓ **Nonnative**: A species that occurs because of an accidental or deliberate introduction into a particular ecosystem. The species did not occur in the habitat prior to human introduction.
  - Some of the most common and most popular sport fish found in New Mexico are *not* native. Fish introduced to New Mexico for sport fishing include Rainbow Trout, Brown Trout and Striped Bass.
    - Rainbow Trout are native to western coastal streams of the Pacific Ocean, west of the Rocky Mountains.
    - Brown Trout are nonnative to New Mexico; in fact, they are nonnative to North America. It is a European species.
  - A number of small fish species, like Inland Silverside and Bullhead Minnow, have also been introduced while being used as baitfish for fishing.
  - Other species are accidentally or unintentionally introduced and are often called nuisance species such as the group of Asian Carp (primarily Grass Carp, Bighead Carp and Silver Carp). These fish were brought in to help aquaculture and wastewater treatment facilities keep retention ponds clean and subsequently escaped. These fish now threaten the Mississippi River drainage and Great Lakes ecosystems.

View the following websites for additional information.

Common Fishes of the Middle and Lower Rio Grande:
http://aces.nmsu.edu/pubs/_circulars/CR-653.pdf

The Western Native Trout Initiative:
http://www.westernnativetrout.org

New Mexico Department of Game and Fish BISON-M database:
http://www.wildlife.state.nm.us/conservation/index.htm

Trout Unlimited—Stream Explorers:
http://www.streamexplorers.org/fish-facts/trout-and-salmon-species

Materials:

1. Access to the Internet
2. Computer lab, library, miscellaneous research materials
3. Poster board
4. Markers
5. Miscellaneous art supplies depending on the creativity of the students

Procedure:

1. Instruct students to research the difference between native and nonnative fish. You can keep it simple by having the students focus on one group of fish—trout for example—or for a more thorough lesson extend it to common fish of New Mexico. The list of introduced species in the state is extensive, and you can usually find out how and why it occurs here.

   ✓ Rio Grande Cutthroat Trout and Gila Trout are the native trout of New Mexico. Brown Trout, Rainbow Trout, and Brook Trout are all introduced.
   ✓ Common fish in the Rio Grande include (N= native, I= introduced):

   Rio Grande Silvery Minnow (N)
   Red Shiner (N)
   Flathead Catfish (N)
   Longnose Dace (N)
   Rio Grande Chub (N)
   River Carpsucker (N)
   Flathead Chub (N)
   Fathead Minnow (N)
   Gizzard Shad (N)
   Bluegill (N)
   Western Mosquitofish (N, I)
   Blue Catfish (N)
   Largemouth Bass (I)
   White Bass (I)
   Striped Bass (I)
   Common Carp (I)
   White Sucker (N, I)
   Channel Catfish (I)
   Yellow Bullhead Catfish (I)
   Crappie (I)
   Yellow Perch (I)
   Walleye (I)
   Bullhead Minnow (I)

2. Have students research the pros and cons of native and nonnative fishes in New Mexico waters.

3. Divide the class into multiple teams of 2-4 students. Ask half the teams to choose a native fish and the other half to select a nonnative fish.

4. Ask each team to design an ad campaign for their fish: "_____ for New Mexico Streams!" Students should focus on why their fish should be in New Mexico's waterways.

5. Provide leading questions that point students in the direction for the various reasons that nonnative fish were introduced. For example, ask your students if they have ever been fishing with their family. If so, what did they fish for and why? Most nonnative species were introduced because people like to fish for them, they are desirable "sport fish".

   Other ways nonnative species were introduced into New Mexico include:
   - ✓ People have released baitfish into a stream or river after fishing.
   - ✓ People have introduced fish for pest control.
   - ✓ People have introduced fish for vegetation control, like the grass carp.
   - ✓ People have released their aquarium pets for various reasons.
   - ✓ Some fish have hitched a ride in boats and other watercraft.

   Some nonnative fish continue to be stocked in New Mexico waters. However, the purchase of fishing licenses is a huge benefit to the state's economy and fund restoration projects for native species.

6. Encourage your students to research the benefits of Rio Grande Cutthroat Trout and other fishes for purposes of recreation, economic benefits, conservation efforts, etc.

7. The ad campaign can include a poster, fliers, bumper stickers, and/or a 60-second verbal advertisement.

8. Each team presents their ad campaign to the rest of the class. The class then evaluates each team's advertisement.

Activity 15: The Food-Chain

Standard Correlations - Grade 5:

New Mexico Science Content Standards, Benchmarks, and Performance Standards
Strand II, Standard II, Benchmark I, Performance Standards 1 & 2

Common Core State Standards
CCSS ELA-Literacy, Speaking and Listening 5.1

Timeline: One to two 60-minute periods.

Objective: At the end of this activity, students will be able to explain the concept of an ecosystem and where a native species, like the Rio Grande Cutthroat Trout, fits within its ecosystem.

Preparation and Background: Review the concept of ecosystems.

- ✓ **Ecosystem**: Includes all the living and nonliving things in an area. There is an interaction among living and nonliving things in an ecosystem.
- ✓ **Food chain**: The sun's energy moves through a community from producers to consumers. Producers and consumers must exist for the food chain to be complete.
- ✓ **Keystone species**: A species that greatly affects the structure of a community, such that removing the species will cause substantial changes to the composition of that community.

The Rio Grande Cutthroat Trout is the official state fish of New Mexico. It lives in cold, clear streams with diverse habitats and cover (like logs or in-stream plants). These cutthroats are found primarily in clear, cold mountain streams and lakes in Colorado and New Mexico. They like to spend most of their time moving between riffles (fast, shallow water with gravel bottoms) and pools of deeper, slow water. Areas of gravel and well-oxygenated water are necessary for successful spawning and egg development. The Rio Grande Cutthroat Trout diet consists mostly of aquatic bugs, bugs that fall into the water, and small fish. This cutthroat is part of a native fish group that lives in coldwater streams in Northern New Mexico. The cutthroat co-exists with Longnose Dace, Flathead Chub, Rio Grande Sucker, and Rio Grande Chub.

Materials:

1. Student Worksheets: *Rio Grande Cutthroat Trout in the Ecosystem: Energy Pyramid* and Rio Grande Cutthroat Trout *in the Ecosystem: Food Chain*
2. Pictures of organisms within the Rio Grande Cutthroat Trout habitat (students will need multiple copies to complete the activities; as an alternative, display these organisms and have the students create their own drawings to use in the activities).
3. Scissors
4. Glue or tape
5. Additional sheets of paper

Procedure:

1. Call on students to define ecosystem.

2. Ask students to consider the ecosystem that Rio Grande Cutthroat Trout inhabit and to name some of the living and nonliving things in this ecosystem. Write their responses on the board.
   - ✓ Items may include, but are not limited to, sun [energy], algae [phytoplankton], water, plants, insect larvae, insects, small fish, frogs, birds, mammals, and trout.

3. Ask students to define "food chain". Have students identify which of their responses are producers and which are consumers.
   - ✓ Algae and aquatic plants are producers
   - ✓ Insect larvae, fish, frogs, birds, and trout are consumers

4. Ask students what the role of Rio Grande Cutthroat Trout is in their food chain? Is this fish a "keystone" species? What happens when other nonnative trout are introduced into the same streams as the cutthroat?

5. Write algae, caddisfly larva, human, trout, and sun on the board. Call on a volunteer to use these examples to draw a diagram showing how the energy moves through this food chain. Ask students to help explain the flow of energy.
   - ✓ The sun provides energy for the algae to grow; caddisfly larva consumes algae; Rio Grande Cutthroat Trout consume larva; and people consume trout.
   - ✓ There are multiple energy chains in an ecosystem. What other food chains can the students think of using the organisms provided in the handout?

6. Point out to students that there are other ways of showing energy flow through an ecosystem. In an energy pyramid, the producers are at the base and the top consumer is at the tip of the pyramid. As you move from the base to the tip there is less and less food and energy available.

7. Ask students to define a food web and discuss how it is different from food chains and energy pyramids.
   - ✓ Answers should include that a food web shows the relationship between all of the species in an environment. It shows the competition for food and is a map of overlapping food chains.

8. Point out that every food chain and food web ends with decomposers—worms, insects, bacteria, and fungi—organisms that break down dead organisms and waste into matter that is absorbed by the decomposers or returned to the environment and used by producers.

9. Have students work with a partner or in a group of three. Distribute the *Rio Grande Cutthroat Trout in the Ecosystem: Energy Pyramid*, Rio Grande Cutthroat Trout *in the Ecosystem: Food Chain*, and *Producers and Consumers* handouts to each student. Explain that groups will use the handouts to create the following: a food chain of the Rio Grande Cutthroat Trout, an energy pyramid, and a food web. Instruct students to cut out the

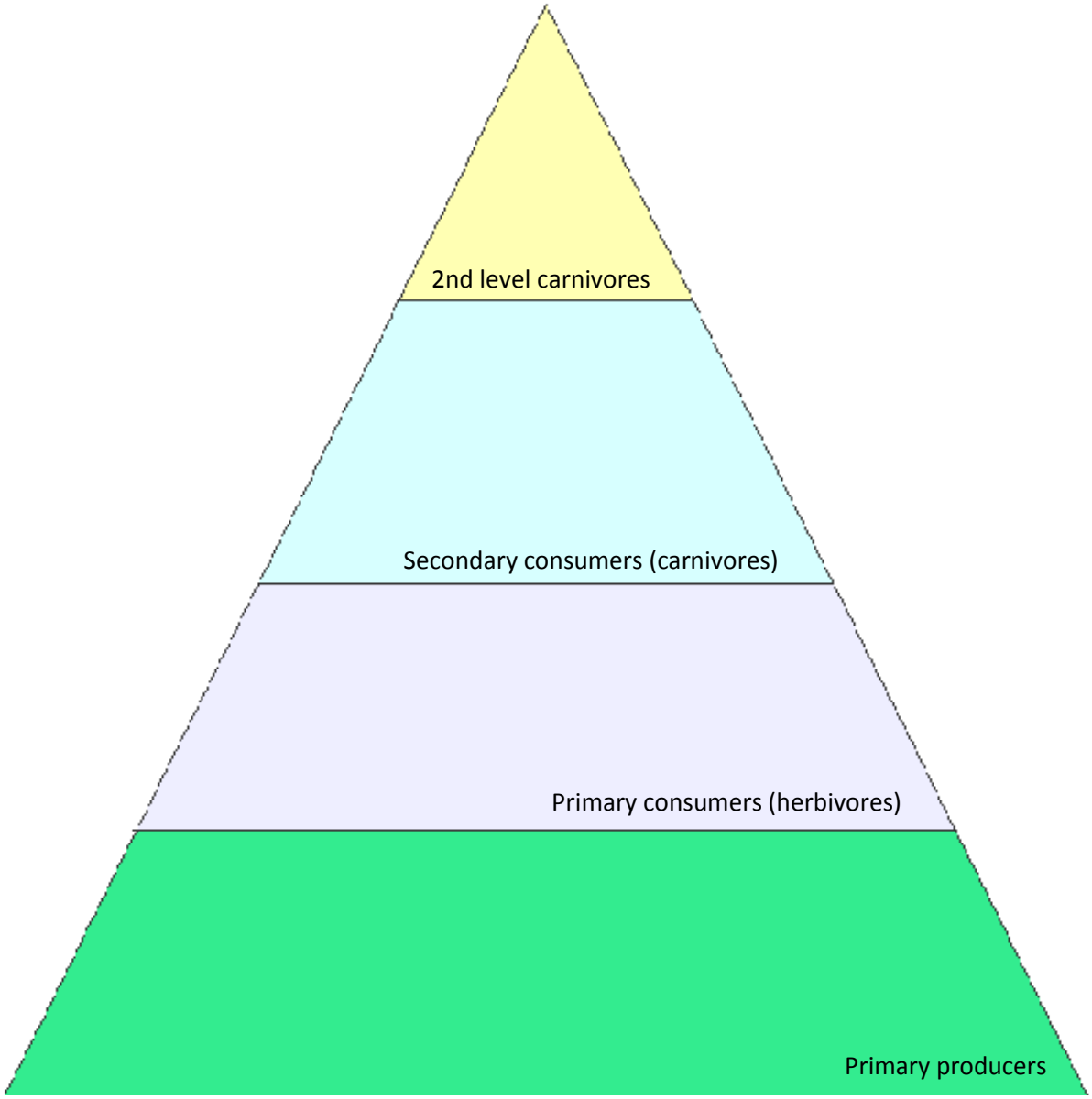
pictures and to arrange them on the food chain and energy pyramid. With the other pictures, they will construct a food web and draw arrows to show the relationship among the members of the Cutthroat Trout community. When students have finished, have them share and compare their energy pyramids and food webs.

10. Discuss with them what would happen if some of the members of the ecosystem died. How would this change affect the trout?

STUDENT WORKSHEET: THE ENERGY PYRAMID

Name _____

Place the producers and consumers in the appropriate levels of the energy pyramid:



STUDENT WORKSHEET: THE FOOD-CHAIN

Name _____

Place the producers and consumers in the appropriate levels of the Rio Grande Cutthroat Trout food chain:

Primary producer

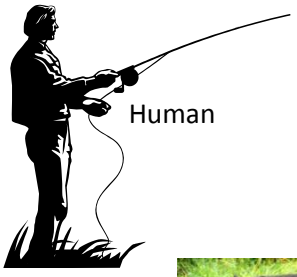
Primary consumer

Secondary consumer

Tertiary consumer

STUDENT REFERENCE: PRODUCERS AND CONSUMERS


Raccoon


Human

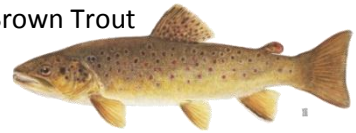
Rio Grande Cutthroat Trout



Belted Kingfisher


Mayfly larvae


Black Bear

Brown Trout



Riffle Beetle larvae


Grasshopper


Gilled Snail


Caddisfly larvae in its case made of sand


Water Boatmen


Aquatic Worms


Tadpoles


Dragonfly larvae


Midge larvae


Crayfish


Caddisfly larvae

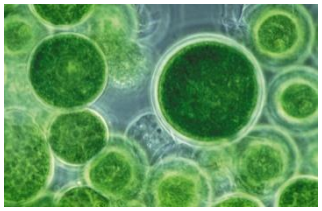

Stonefly larvae


Rio Grande Chub


Rio Grande Sucker


Bacteria (decomposers)


Aquatic Plants


Phytoplankton


Aquatic Plants


Rainbow Trout

Activity 15: Option I - Rio Grande Silvery Minnow in the Ecosystem

Standard Correlations - Grade 5:

New Mexico Science Content Standards, Benchmarks, and Performance Standards
Strand II, Standard II, Benchmark I, Performance Standards 1 & 2

Common Core State Standards
CCSS ELA-Literacy, Speaking and Listening 5.1 & 5.4

Timeline: One to two 60-minute periods.

Objective: At the end of this activity, students will be able to describe the Rio Grande Silvery Minnow's natural habitat and list two threats to their survival in the wild.

Preparation and Background: Review handouts for background information. View the following websites for more information.

U. S. Fish and Wildlife Service—Species Profile:
http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode=E07I

Return of the Rio Grande Silvery Minnow:
http://cdri.org/publications/nature-notes/animals/fish/minnow/

The Middle Rio Grande Endangered Species Collaborative Program—RGSM coloring page:
http://www.mrgesa.com/Default.aspx?tabid=332

Materials:

1. Student Reference: *Rio Grande Silvery Minnow Habitat and Threats*
2. Student Worksheet: *Rio Grande Silvery Minnow Habitat and Threats*
3. Poster material
4. Colored markers

Procedure:

1. Discuss with students the factors in their own environment that make it livable. Their responses may include clean water, air, food, housing, etc.

2. Discuss with them how their environment would be impacted if, for example, there were significantly less oxygen in their air or the air was polluted.

3. Discuss with students the types of disease pathogens in humans – bacteria, viruses, parasites.

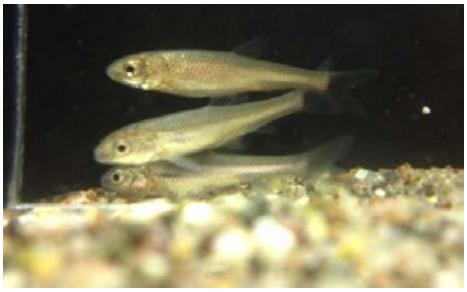
4. Call on students to describe factors in a fish's environment that make it habitable. Write students' responses on the chalkboard. If students have trouble coming up with ideas, suggest categories such as habitat (lake or stream), water quality, availability of food, oxygen, etc.

5. Tell students they are going to examine Rio Grande Silvery Minnow habitat and factors that threaten it. Have students work in small groups. Distribute the *Rio Grande Silvery Minnow Habitat and Threats* handout to each student. Have groups read and discuss the information in the handouts.

6. Have each group choose one threat to further research. Suggest the groups use the information in the handout along with internet resources. Have each group make a poster that highlights the threat and its effect on Rio Grande Silvery Minnow and on their habitat.

7. When groups are ready, have them present their posters to the rest of the class. Display the posters in the classroom or in the school corridor.

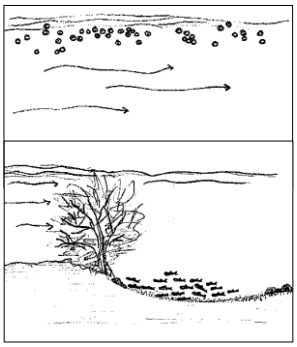
STUDENT REFERENCE: RIO GRANDE SILVERY MINNOW HABITAT AND THREATS



ITS HOME: The Rio Grande Silvery Minnow was listed as Endangered in 1994. The historical range of this fish included the Rio Grande and Pecos River. The species now lives in the middle Rio Grande, between Cochiti Dam and Elephant Butte Reservoir.

Rio Grande Silvery Minnow of all sizes like slow flowing habitats like backwaters, pools, and shorelines. They eat diatoms, algae, and plant material.

ITS LIFE: In the wild, the Rio Grande Silvery Minnow usually lives only one to two years. It spawns in the spring and summer and releases up to 3,000 eggs that float just below the water surface (semi-buoyant).



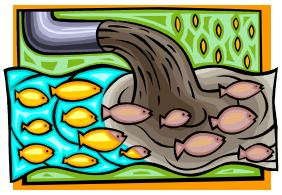
The semi-buoyant eggs float downstream until they hatch into larvae. When the larvae are strong enough to swim, they move into shallow areas with little or no water flow, like backwaters, pools, and shoreline. As the Rio Grande Silvery Minnow grow, they begin to use areas of the river with faster moving current.

THREATS: The Rio Grande Silvery Minnow lives in only about 7% of its historic range. Threats to its survival include loss of habitat, water pollution, disease, and predation.

LOSS OF HABITAT -The Rio Grande used to be a wide, braided, sandy bottom river. The floodplain had numerous secondary channels, marshes, and woody debris.

The Rio Grande has changed in the last 150 years. Several large dams and irrigation diversions were built on the river to help reduce flood threats and supply water people and farming. These changes have reduced the amount of water in the river, reducing the habitat for the fish. Dams limit upstream movement of fish and change how fish species act together.

WATER POLLUTION - During dry weather, gasoline, oil, dust, pesticides, and other pollutants collect in the ground, on roadways, sidewalks, and parking lots. When it rains, these pollutants wash into streams, rivers, and lakes. Now the pollutants are in the streams, rivers, and lakes like the Rio Grande.



DISEASE AND PREDATION - All species are at risk of catching a disease or being caught by a predator. However, a changed habitat ups the chances that this may happen to our native fish. Less water means fewer places to hide and more chances of being preyed upon or catching a disease.

STUDENT WORKSHEET: RIO GRANDE SILVERY MINNOW HABITAT & THREATS

Name _____

1. Name three threats to the Rio Grande Silvery Minnow:

2. The Silvery Minnow is found in what percent of its historic range:
   a. 1%
   b. 7%
   c. 40%
   d. 100%

3. Name one example of water pollution that may affect Rio Grande Silvery Minnows:

4. True / False: The Rio Grande is the same as it was 150 years ago.

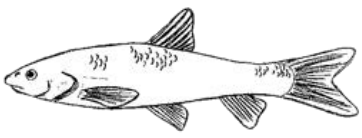
5. What do Rio Grande Silvery Minnow eat?

6. How long do Silvery Minnow live in the wild?
   a. 3-5 years
   b. 1-2 years
   c. 4-6 months
   d. 1-2 months

7. True / False: The Rio Grande Silvery Minnow is Endangered.

8. The Rio Grande Silvery Minnow lives in what type of habitat?
   a. Pools
   b. Shorelines
   c. Backwaters
   d. All of the above

9. In your own words, describe how loss of river habitat affects fish in the river.



Activity 15: Option II - Rio Grande Cutthroat Trout in the Ecosystem

Standard Correlations - Grade 5:

New Mexico Science Content Standards, Benchmarks, and Performance Standards
Strand II, Standard II, Benchmark I, Performance Standards 1 & 2

Common Core State Standards
CCSS ELA-Literacy, Speaking and Listening 5.1 & 5.4

Timeline: One to two 60-minute periods.

Objective: At the end of this activity, students will be able to describe the Rio Grande Cutthroat Trout's natural habitat and list two threats to their survival in the wild.

Preparation and Background: Review handouts for background information. View the following websites for more information.

- ✓ 2008 news article on Rio Grande Cutthroat Trout
  - http://www.ens-newswire.com/ens/may2008/2008-05-14-091.html
- ✓ Native Montane Fishes of the Middle Rio Grande Ecosystem
  - http://www.fs.fed.us/rm/pubs/rmrs_p007/rmrs_p007_231_237.pdf
- ✓ Albuquerque BioPark Aquarium information on their Rio Grande Cutthroat Trout stream display
  - http://www.cabq.gov/biopark/aquarium/exhibits/rio-grande-cutthroat-trout-stream
- ✓ NMDGF article on whirling disease
  - http://www.wildlife.state.nm.us/conservation/disease/whirling/index.htm
- ✓ Trout Unlimited article on "The Science of Whirling Disease"
  - http://www.tu.org/understanding-the-challenge-of-whirling-disease

Materials:

1. Student Reference: *Rio Grande Cutthroat Trout Habitat* and *Threats to Rio Grande Cutthroat Trout*
2. Poster material
3. Colored markers

Procedure:

1. Discuss with students the factors in their own environment that make it habitable. Their responses may include clean water, air, food, housing, etc.

2. Discuss with them how their environment would be impacted if, for example, there was significantly less oxygen in the air or the air was polluted.

3. Discuss with students the types of disease pathogens in humans – bacteria, viruses, parasites.

4. Call on students to describe factors in a trout's environment that make it habitable. Write students' responses on the chalkboard. If students have trouble coming up with ideas, suggest categories such as habitat (lake or stream), water quality, availability of food, oxygen, etc.

5. Have students work in small groups. Review the *Habitat Refresher* handout with students.

6. Distribute one threat to each group from the *Threats to Rio Grande Cutthroat Trout* handout. Have groups read and discuss the information in the handouts.

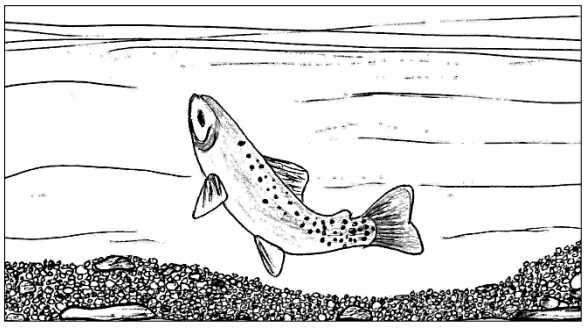
7. Have each group research their assigned threat. Suggest the groups use the information in the handout along with Internet resources. Have each group make a poster that highlights the threat and its effect on Rio Grande Cutthroat Trout and on their habitat.

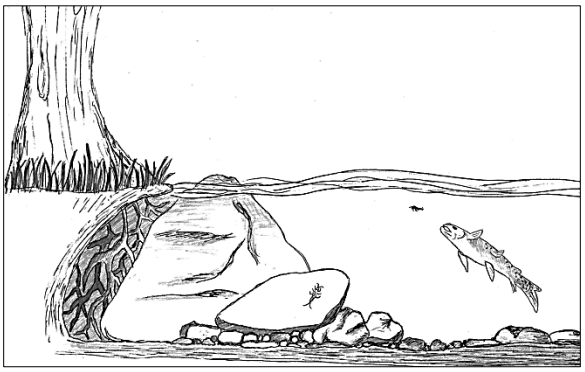
8. When groups are ready, have them present their posters to the rest of the class. Display the posters in the classroom or in the school corridor.

STUDENT REFERENCE: HABITAT REFRESHER

Rio Grande Cutthroat Trout are native to the Rio Grande, Pecos River, and Canadian River drainages. Like most members of the trout family, Rio Grande Cutthroat Trout require clear, cold, flowing water. They also need pools, stream banks, and a lot of stream cover. Snowmelt, underground springs, and rainfall feed streams where trout live. Trees and vegetation that line the stream make the banks stable and provide shade. The shade helps to keep the water cool and offers a hiding place for fish. Leaves that drop into the stream decay and become food for insects, which in turn are eaten by fish.

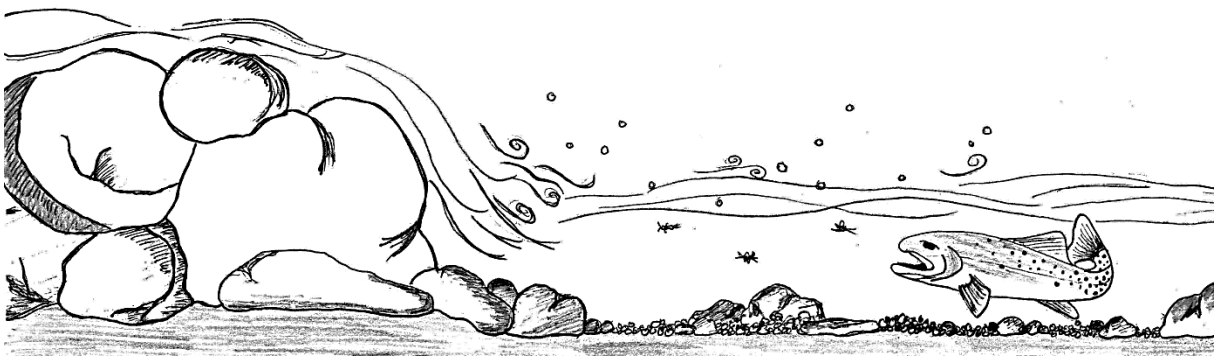
There are several microhabitats (habitat within a habitat) in a stream. Each microhabitat has different features and contains a different species (insects and fish). During the spawning season (usually spring months), adult trout need gravel bottom sections of stream where they can lay their eggs in redds. After a fish hatches from the egg, the fry need slow moving water near side channels and lots of protective cover, like logs or overhanging tree branches.





The fingerlings begin to venture out into other areas of the stream. They may be found in shallow rocky areas with faster water, or deeper pools. Once the Cutthroat Trout is large enough to avoid being eaten by larger fish, it will move between different habitats, including deep water, fast water, cover, and riffles where food drifts down. During the winter, trout will survive the cold by staying in deep water near large boulders or pools that have protective cover.

Riffles are the area of streams where the water is shallow and runs swiftly over rocks. The riffle is a favorite place for Cutthroat Trout. In the riffle predators do not easily spot them, there is plenty of oxygen, and the current brings them a fresh and constant supply of food. At some time during its life, the Cutthroat Trout makes its home in one of these microhabitats and each one is important to its survival of the Cutthroat Trout.



STUDENT REFERENCE: THREATS TO RIO GRANDE CUTTHROAT TROUT

Nonnative Species

The biggest threat to Rio Grande Cutthroat Trout is the presence of nonnative trout in the streams where our native Cutthroat Trout live. Nonnative trout found in New Mexico include Rainbow Trout, Brown Trout, and Brook Trout. Rainbow Trout compete with Cutthroat Trout for food and shelter. Brook Trout and Brown Trout add to the problem by eating small Cutthroat Trout, causing their numbers to decline. In New Mexico, Rainbow Trout and Rio Grande Cutthroat Trout sometimes reproduce together, creating a hybrid fish that has characteristics of both species. Many of the nonnative species were introduced for fishing. Biologists often work to manage the demand for fishing and the survival of native species.

Pollution

Pollutants are defined as harmful chemicals or waste material. Some examples of pollution include ash run-off from forest fires, excessive manure from cows, urban runoff, sewage, sediment, and old mining runoff. Rio Grande Cutthroat Trout can tolerate pollutants at various levels. Pollutants may cause illness, parasite breakouts, or death. Not only do pollutants affect the fish but also other organisms like aquatic insects that trout eat. If the trout have nothing to eat, they will starve.

Habitat Disturbance - Human Caused or Natural

Stream channels are always changing. High elevation streams are known to be very dynamic systems. Drought, ice build-up, high water flows, and forest fires are a few disturbances that happen in a stream naturally. Other disturbances are caused by human related activities including road construction, grazing, mining, logging, and water diversions. All these disturbances can cause short-term and/or long-term damage when they change stream habitat. These disturbances can cause gravel bottoms to fill in with sand and silt, remove cover and structure for fish, kill stream bank vegetation and eliminate shading, or even block the movement of fish up or downstream. The severity of the impact will depend on management actions employed and the ability of a stream to recover and once again support a population of Rio Grande Cutthroat Trout.

Disease and parasites

Whirling disease is the main example of a nonnative parasite. Young Rio Grande Cutthroat Trout are very vulnerable to the disease. It does not hurt populations of the nonnative Brown Trout because it evolved with Whirling disease. Various diseases and parasites spread to streams and rivers where the Rio Grande Cutthroat Trout live, many times unknowingly moved by animals, birds, and humans. Always remember to clean and disinfect your gear before visiting new streams; you never know what may be hitching a ride on your boots or gear.

Activity 16: An Eco Mystery

Developed by Emerson Elementary 5th Grade Teacher's
Mrs. C. Gonzales - Espinoza, Ms. Ortiz, and Mrs. Chacon

Standard Correlations - Grade 5:

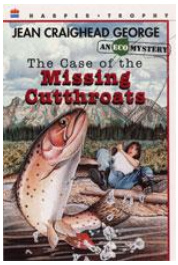
New Mexico Science Content Standards, Benchmarks, and Performance Standards
Strand I, Standard I, Benchmark II, Performance Standard 1
Strand II, Standard II, Benchmark I, Performance Standards 1, 2, 3, & 4

Common Core State Standards
Reading Standards for Literature 5.2, 5.3, & 5.4
Reading Standards for Informational Text 5.4 & 5.7
Reading Standards: Foundational 5.4b
Speaking and Listening Standards 5.1, 5.1c, 5.1d

Timeline: Multiple class periods depending on method of reading the book.

Objective: At the end of this activity will have utilized the book, *The Case of the Missing Cutthroats: An Eco Mystery,* as a means to integrate reading and the study of fish biology. Students will be able to read complex text, determine the theme of a story from details in the text, and identify concepts of fisheries management.

Preparation and Background: The novel weaves facts with fiction throughout the story. Many conservation and fisheries concepts presented in the novel are as true today, as when it was first published in 1975.



"This mystery begins when Spinner, a New York City native who would rather pirouette than fly cast, catches the family prize—much to her boy cousins' dismay. The prize fish, a huge Cutthroat Trout, had been thought to be extinct in the river, and Spinner and her cousin set out to solve the mystery of how this one spectacular cutthroat survived until Spinner reeled him in. HarperCollins is pleased to republish Jean Craighead George's fourth ecological mystery, which was first published in 1975 as Hook a Fish, Catch a Mountain." Harper Collins Publishing (http://www.harpercollinschildrens.com/books/Case-Missing-Cutthroats/)

Materials:

1. Classroom set of *The Case of the Missing Cutthroats: An Eco Mystery*
2. Copies of the poem *The Fish* by Elizabeth Bishop
3. Filing folders, construction paper
4. Notebook Paper
5. Poster paper

Learning Activities and Assessments:

1. Class Discussion – Review information learned in Activity 7: Trout Anatomy. Before beginning this discussion, find out what students remember about the Rio Grande Cutthroat Trout. Create an Inquiry Chart.

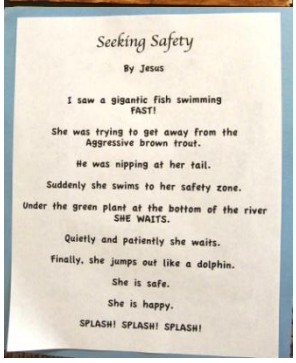
2. Class Discussion – Introduction to *The Case of the Missing Cutthroats: An Eco Mystery.* What is meant by the term eco-mystery? Make a chart to record the name of each animal mentioned in the book, record key details, such as where the animal lives (i.e., habitat), what the animal eats (i.e., whether it is an herbivore, carnivore, or omnivore), and an interesting fact. Compare and contrast the description of the cutthroat mentioned in the book with the background information presented in the informational text on the Rio Grande Cutthroat Trout.

3. Graphic Organizer - As a class, keep a chart with the following categories. As the chart is filled in, and at the end of the unit, use the information to make comparisons and generalizations about characters (and people) who undergo changes in their development:

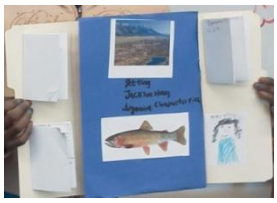
   - ✓ Setting
   - ✓ Main character who undergoes a change, and adjectives that describe her
   - ✓ Mystery
   - ✓ Obstacles faced by the main character
   - ✓ Climax (where the main character resolves the conflict)
   - ✓ Resolution (how the story ends; what the character learns)

4. Poetry Response - Read and discuss the connection between the novel and the poem *The Fish*. Relate the experience of the character in the poem to the character in the novel. Students will use simple crayon resist art techniques to create the fish they visualize and write their own poems.

   - ✓ Writing focuses on a topic
   - ✓ Uses a familiar text structure (free verse)
   - ✓ Descriptive words that create an image or feeling
   - ✓ Voice is evident
   - ✓ Creates tone that reflects feelings/emotions consistent with the topic
   - ✓ Tone is easy to describe (funny, sarcastic, angry, joyful…)



5. Literature Response – Lapbook - As students continue to read *The Case of the Missing Cutthroats: An Eco Mystery* they will create a lapbook to demonstrate their understanding of the story. This 3-D presentation of what they learned will include:



   - ✓ Summaries of Chapters
   - ✓ Figurative language “poof” book
   - ✓ Resolution of mystery
   - ✓ Characters/setting

STUDENT REFERENCE: THE FISH

By Elizabeth Bishop (http://www.poemhunter.com/poem/the-fish/)

I caught a tremendous fish
and held him beside the boat
half out of water, with my hook
fast in a corner of his mouth.
He didn't fight.
He hadn't fought at all.
He hung a grunting weight,
battered and venerable
and homely. Here and there
his brown skin hung in strips
like ancient wallpaper,
and its pattern of darker brown
was like wallpaper:
shapes like full-blown roses
stained and lost through age.
He was speckled with barnacles,
fine rosettes of lime,
and infested
with tiny white sea-lice,
and underneath two or three
rags of green weed hung down.
While his gills were breathing in
the terrible oxygen
- the frightening gills,
fresh and crisp with blood,
that can cut so badly-
I thought of the coarse white flesh
packed in like feathers,
the big bones and the little bones,
the dramatic reds and blacks
of his shiny entrails,
and the pink swim-bladder
like a big peony.
I looked into his eyes
which were far larger than mine
but shallower, and yellowed,
the irises backed and packed
with tarnished tinfoil
seen through the lenses
of old scratched isinglass.
They shifted a little, but not
to return my stare.
- It was more like the tipping
of an object toward the light.
I admired his sullen face,
the mechanism of his jaw,
and then I saw
that from his lower lip
- if you could call it a lip
grim, wet, and weapon like,
hung five old pieces of fish-line,
or four and a wire leader
with the swivel still attached,
with all their five big hooks
grown firmly in his mouth.
A green line, frayed at the end
where he broke it, two heavier lines,
and a fine black thread
still crimped from the strain and snap
when it broke and he got away.
Like medals with their ribbons
frayed and wavering,
a five-haired beard of wisdom
trailing from his aching jaw.
I stared and stared
and victory filled up
the little rented boat,
from the pool of bilge
where oil had spread a rainbow
around the rusted engine
to the bailer rusted orange,
the sun-cracked thwarts,
the oarlocks on their strings,
the gunnels- until everything
was rainbow, rainbow, rainbow!
And I let the fish go.

Elizabeth Bishop

Activity 17: How Much Water Do We Use?

Standard Correlations - Grade 5:

New Mexico Science Content Standards, Benchmarks, and Performance Standards
Strand I, Standard I, Benchmark I, Performance Standards 1 & 2
Strand I, Standard I, Benchmark III, Performance Standard 1 & 2

Common Core State Standards
Math 5.NBT.5

Timeline: Two 60-minute periods.

Objective: Students will calculate and learn about the amount of water their household uses.

Preparation and Background: Review the *Water Budget Activity* from Bosque Education Guide for background information and an additional activity. The activity is located on the Supplemental Materials CD in the BEMP folder.

Additional Reference sites:

EPA Water Sense
(http://www.epa.gov/watersense/our_water/learn_more.html#tabs-6)
EPA Water Trivia Facts
(http://water.epa.gov/learn/kids/drinkingwater/water_trivia_facts.cfm)

Materials:

1. Copies of *How Much Water Do We Use* and *Student and Family Pledge to Filter out Bad Water Habits* (online) handouts.

Procedure:

1. Discuss water usage with students. Ask them to think about all the ways they and their families use water at home. Remind them to include things like watering the lawn, washing a car, doing laundry, washing dishes, etc. Write their responses on the board.

2. For each listed water usage, ask students to estimate how many gallons of water are used. If their responses range widely, see if you can get students to come to a consensus of how much water is used.

3. Based on the list, ask students to each estimate how much water their family uses each day. Give students 5 to 10 minutes to calculate their family's usage. Have students divide the number of gallons they came up with by the number of family members to get an average of each person's daily usage.

4. Call on a few volunteers to share their water usage averages with the class. Point out to students that these are estimates. Tell them that over the next 24 hours they are going to monitor their families' water usage.

5. Distribute the *How Much Water Do We Use* handout to each student. Read over the handout with them. Have them compare actual water usage for each activity with their estimates. Explain that they should interview each family member to find their daily water activity and the number of times they did the activity, such as, brushing their teeth. Have students complete the handout as a homework assignment. The number of times per day an activity is carried out should be multiplied by the gallons used for that activity to calculate the activity's total daily water use.

6. Call on volunteers to share their findings. Have students compare their estimates to their family's calculated amount of water used.

7. Point out that the average American uses 100 to 400 gallons of water a day. The average person in a developing country uses just 13 gallons a day. Discuss with students what might account for such a large difference.

8. Brainstorm with students on ways that they might cut down on water usage. Write their suggestions on the board. Suggest students encourage their families to adopt some of these water-saving practices to see if they can bring the total water usage for the class down.

9. Have students complete the *Student and Family Pledge to Filter Out Bad Water Habits* pledge form found on the EPA website *(http://www.epa.gov/watersense/docs/drop_pledge508.pdf)*

   Extension: You may wish to conduct the water usage survey again a few weeks later to see if the water-saving practices were effective. Have them calculate the savings per home, per year. If people in your area pay for water, have students calculate the monthly water bill before and after conservation measures are adopted.

STUDENT WORKSHEET: HOW MUCH WATER DO WE USE?

Name: _____

Water is scarce in deserts, including here in New Mexico. Do you know how much water you and your family use in one day? Record the number of times you and your family members do each activity in a day. Can you think of ways to lower your water use?

Family Member Name:											
Activity	Times per day	Times per day	Times per day	Times per day	Times per day	Total		Gallons used*		Daily use
wash hands							x	0.25	=	
brush teeth							x	1	=	
wash face							x	3	=	
flush toilet							x	2-7	=	
laundry							x	30/load	=	
shower							x	25-40	=	
bath							x	35-50	=	
wash car							x	80-100	=	
hand wash dishes							x	9-20	=	
dishwasher							x	12-20/load	=	
Watering lawn							x	180	=	
cooking/drinking water							x	1	=	
Family Total Water Use for One Day										

***** Use the low end of the range if you have water saving appliances or consciously conserve water

Activity 18: Zentangle Animals of the Middle Rio Grande

Developed by Emerson Elementary 5th Grade Teacher's
Mrs. C. Gonzales - Espinoza, Ms. Ortiz, and Mrs. Chacon

Standard Correlations - Grade 5:

New Mexico Science Content Standards, Benchmarks, and Performance Standards
Strand II, Standard II, Benchmark I, Performance Standard 1
Strand II, Standard II, Benchmark II, Performance Standard 1
Art Strand Visual Arts, Standard 1, K-5 Benchmark 1A: 1 & 2
Art Strand Visual Arts, Standard 2, K-5 Benchmark 2A: 2

Common Core State Standards
Reading Standards for Information Text 5.9

Timeline: Multiple class periods.

Objective: At the end of this activity, students will have utilized information from previous activities to create a zentangle of an animal with images accurately portraying elements of the animals life history, habitat, food, and predators.

Preparation and Background:

Zentangles are an abstract art created in a very structured method from an ensemble of repetitive patterns. We will be modifying the Zentangles to the shape of the animal that the student will choose to research.

Materials:

1. Art paper
2. Color pencils, markers, or crayons
3. Research materials

Procedure:

1. Have students select their own fish or animal native to the Middle Rio Grande Valley. Have students research the animal of their choice.
2. Students will draw the elements of the animal's life and habitat within the basic outline of the animal.
3. After the illustrations are completed, have students fill in the background of the animal with basic pattern art known as "tangles".
4. Have students complete a research paper about their animal.

Section 4 – The Field

This section is specific to field related activities should you have the opportunity to get the students outside and hands in the water.

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Field Activity 1: Habitat Assessment

Standard Correlations - Grade 5:

New Mexico Science Content Standards, Benchmarks, and Performance Standards
Strand I, Standard I, Benchmark I, Performance Standards 1 & 4

Common Core State Standards

Timeline: Two-hour field trip.

Objective: At the end of this activity, students will gain an understanding of the relationship between a healthy habitat and the organisms that live in that habitat. Students will be able to list elements within the environment that make up the aquatic habitat such as presence of vegetation, water, water depth, substrate, and components of water quality.

Preparation and background: We recommend completing a site visit prior to the class visit to plan the activity and take care of any logistical problems. NMFWCO biologists can assist in the selection of an appropriate location and can provide most of the equipment. Make copies of the "Stream Description" handout for each student.

A visit to a local stream—or even a local pond or lake, would help students make connections between the cutthroat in the classroom aquarium and the cutthroat in their natural habitat. Two site visits are preferable, but if you have just one day then you should prepare your students to complete the Habitat Assessment and Macroinvertebrate Survey Activities on the same day. If you cannot physically do a field trip, download various images of different streams and lakes. Use the images to complete the discussion and observations.

When a biologist visits a stream or lake for the first time, we start with habitat assessments before we start looking for fish. General water quality testing, identification, and recording of vegetation types, identifying substrates, are part of a habitat assessment. In addition, we take note of any other impacts to the water body including human disturbances such as road crossings, livestock grazing, agriculture, and barriers (dams). As we assess the habitat, we can predict the type of fish community we may see in the water body.

Materials:

1. Water testing kit
2. Thermometer
3. Secchi disc
4. Measuring tape
5. Pencils, pens, colored pencils
6. Stream Habitat Assessment handout

Procedure:

1. Call on students to name some factors that might affect stream habitat. List student responses on the board. Stream habitat characteristics to identify and consider when completing a habitat assessment should include some of the following items:
   - ✓ Presence of overhanging vegetation to help keep the stream cool.
   - ✓ Presence of vegetation or gravel/cobble substrate on the banks of the stream to minimize sediment erosion and promote bank stability.
   - ✓ The gradient (change in elevation) of the land influence how fast water will move downhill. Cold water streams are high gradient and move faster than low elevation, low gradient big rivers.
   - ✓ The type of substrate (sand, silt, gravel, and cobble) changes with habitats and can sometimes indicate a problem. Silt is not good for streams that have trout, but is normal in big rivers.
   - ✓ Are habitat requirements for a species of interest (e.g., calm shallow waters near the bank, deep pools, and shallow riffles) present within the overall habitat?
   - ✓ Are point and non-point sources of pollution present? Pollutants restrict light needed by plant plankton and reduce food production. Fertilizers, pesticides, animals waste, and sewage runoff can deplete oxygen and kill stream organisms.

2. Let students know they will be completing a site visit to a stream or viewing photos of streams to complete a habitat assessment and determine if the stream would be able to support fish. They will complete a visual assessment, stream measurements, and water quality testing. Ask students to recall some of the stream habitat characteristics and water quality factors that are necessary for fish survival. Write responses on the board.

   Water quality factors should include:
   - ✓ pH (pH levels between 7.0 and 8.5)
   - ✓ Temperature will determine what species can survive in the water
   - ✓ Dissolved Oxygen
   - ✓ Turbidity or sediment
   - ✓ Pollutants (water free of pollutants)

3. Let students know that they will examine these characteristics and factors when they visit the stream. Have students work in small groups. Remind students to bring their fish journals and writing implements (pencils, pens, colored pencils) with them on the field trip.

4. At the stream, have students spend 20 to 25 minutes drawing a map of the stream and its banks and noting vegetation, surrounding area (farmland, highway, industrial area, etc.), pollution (cans, paper, trash) both in the stream and on the banks.

5. Give them additional time to write a description of the stream—including what they see, smell, hear, etc.

6. Distribute stream description handout and have students use it to guide their writing.

7. Have each group test one to two water quality factors. Students can use a secchi disk or make a visual assessment for the turbidity factor.

8. Back in the classroom, discuss student's observations. Identify those characteristics and factors that are beneficial to fish survival and those that would be harmful to fish survival. If the stream is polluted, brainstorm to find solutions for making the stream healthier. Find out about land use regulations in your area. Develop a plan that is both appropriate and realistic for improving the stream's health. For example, plan a stream pick-up day. Have students along with family and friends meet at the stream to pick up trash and other debris. Have students hand out flyers in the community so that other residents can help.

STUDENT WORKSHEET: STREAM HABITAT ASSESSMENT

Name _____

Record assigned water quality factors. After drawing a picture of what you see, write a physical description of the stream. Use these questions and previous discussions to guide your writing.

Water temperature: _____ Stream width: _____ pH: _____

Secchi (turbidity – clear, cloudy, muddy): _____ Dissolved oxygen: ____

- ✓ How fast is the water moving? Is it clear, cloudy, or muddy?
- ✓ Can you see any traces of chemicals, such as an iridescent film on the water?
- ✓ Do you see large rocks (boulders) in the water? Are they smooth or rough?
- ✓ How many riffles do you see?
- ✓ Estimate the width and depth of the stream.
- ✓ Does the stream run in a more-or-less straight line or does it twist and turn?
- ✓ What is the streambed like? Is it sandy or does it have small rocks (gravel and cobble)?
- ✓ Are there algae, weeds or other plants growing in the water?
- ✓ What is the stream bank like? Is it sandy or rocky? Does it look like it is eroding?
- ✓ Are there plants growing on the bank? Are there trees on the bank that provide shade?
- ✓ What evidence of human activity do you see? Is there trash or fishing tackle?
- ✓ Are sources of pollution evident—highway, parking lot, farm, industrial area?
- ✓ Does the stream smell clean or stagnant?

Field Activity 2: Part I - Fishy Food!

Part I—Identification of Macroinvertebrates

Standard Correlations - Grade 5:

New Mexico Science Content Standards, Benchmarks, and Performance Standards
Strand I, Standard I, Benchmark I, Performance Standards 1, 2, & 3

Common Core Standards
CCSS ELA-Literacy, Speaking and Listening 5.1
CCSS ELA-Literacy, Reading Standard for Informational Text 5.4

Timeline: This activity requires two classroom periods in addition to the field visit (Part II): one before (Part I) and one after the streamside survey (Part III).

Objective: At the end of this activity, the students will learn to identify and understand the importance of food sources of the Rio Grande fish.

Preparation and background: Macroinvertebrates are important species within stream ecosystems. They provide food for other aquatic organisms (like trout) and help biologists assess the health of a particular stream. Some macroinvertebrates can tolerate polluted waters, whereas others will not survive. If there are not enough macroinvertebrates present in a stream, there probably will not be enough food to support fish.

Please review the following resources listed below to help you introduce students to aquatic macroinvertebrates:

- ✓ The Macroinvertebrate Background handout.
- ✓ The PowerPoint presentation on aquatic macroinvertebrates. The Power Point presentation is located on the Supplemental Materials CD in the Power Point folder. You can use the slideshow provided or create your own to show your class.
- ✓ Review the *Kick Net Kritters* activity from The Bosque Education Guide located on the Supplemental Materials CD in the BEMP folder.
- ✓ Visit the website: http://chamisa.freeshell.org/inhab.htm for more information to present to your students on macroinvertebrates and animals that live in streams.
- ✓ Visit the website: http://www.troutintheclassroom.org/teachers/library/catch-critter-game to download the Catch the Critter game.

Materials:

1. Teacher Reference: *Macroinvertebrate Background*
2. Download macroinvertebrate identification guides. Guides may be downloaded from, but not limited to, the following sites.
    a. The Missouri Stream Team at http://www.mostreamteam.org/Documents/VWQM/BugCard1.10.pdf

   b. Water Resources Education - University of Wisconsin Extension at http://clean-water.uwex.edu/pubs/pdf/riverkey.pdf
   c. Stroud Water Research Center at http://www.stroudcenter.org/education/MacroKey_Complete.pdf
3. Slideshow on aquatic macroinvertebrates
4. Catch the Kritter game

Procedure:

1. Present the slideshow on aquatic invertebrates to the class.

2. Call on volunteers to name some of the foods that trout eat in the wild. Point out to students that Rio Grande fish feed on some of these macroinvertebrates. Write the following on the chalkboard:
   - ✓ Arthropods (aquatic)
   - ✓ Arthropods (terrestrial)
   - ✓ Crustaceans
   - ✓ Mollusks
   - ✓ Nematodes
   - ✓ Flatworms
   - ✓ Annelids

3. Divide the class into small teams. Assign each team the task of researching and reporting on one invertebrate group. Each report should include a short description of the group, an overview of the life cycle of some of the members of the group, and conditions the members of the group must have to survive (clean water, cool water, oxygen, etc.).

4. Have students use the Internet with Wikipedia and library resources to investigate their groups. Then have students present their findings to the rest of the class. Information should include the following:
   - ✓ **Arthropods (aquatic)**: Organisms from the Phylum Arthopoda, characterized by segmented bodies and hard exoskeletons. The most common arthropods are insects. Some are aquatic or have aquatic stages, like the damselfly.
   - ✓ **Arthropods (terrestrial)**: Organisms from the Phylum Arthopoda, characterized by segmented bodies and hard exoskeletons. The most common arthropods are insects. Terrestrial insects can fall from trees or vegetation on the bank into the stream where they become food for fish.
   - ✓ **Crustaceans**: A Class of arthropods with hard exoskeletons. Crayfish are an example of a crustacean that fish eat.
   - ✓ **Mollusks**: An invertebrate that has a soft, unsegmented body and lives in aquatic or damp habitats, and most kinds have an external shell. Snails, clams, mussels, and slugs are common mollusks.
   - ✓ **Nematodes**: An unsegmented worm of the Phylum Nematoda . Roundworms are nematodes that fish eat.
   - ✓ **Flatworms**: Any worm of the Phylum Platyhelminthes, having bilateral symmetry and a soft, solid, usually flattened body. Planarians, tapeworms, and trematodes are common flatworms. Planaria are aquatic flatworms that fish eat.

- ✓ **Annelids**: A segmented worm of the Phylum Annelida. Earthworms and leeches are common annelids that fish eat.

5. Ask students the following questions:
   - ✓ Question: Do different parts of the stream need to be surveyed or sampled? Why?
     - Answer: Yes, because different macroinvertebrates inhabit different parts of the stream.
   - ✓ Question: How are macroinvertebrates adapted to their environment?
     - Answer: There are varieties of answers the students might come up with ranging from their small size, colors that help them hide from predators, special lungs or gills, compressed bodies, feet that can grip different surfaces, different morphological stages, etc. Help your students brainstorm.

6. Distribute the *Macroinvertebrate Identification* handout and have students read and identify the organisms. If necessary, review the meaning of larva, pupa, and nymph. Tell students these are the organisms they will be collecting in order to determine the health of the stream.

7. If a field trip is schedule, let students know they will be visiting a stream in Part 2 to complete a survey of the aquatic invertebrates.

8. If time permits, ask the students to form groups of three or four and distribute the "Catch the Critter Game". Distribute the macroinvertebrate cards among the groups. Explain the rules of the game and let them play the game for about 15 minutes. Stop the game and have them calculate their scores using the card they've drawn and the weighted values in the formula for those invertebrates most sensitive to pollution. If time does not permit, you may use another classroom lesson to introduce the "Catch the Critter" game at another time. The game may target a lower grade level than the one presented in this lesson. The "Catch the Critter" game can be found at: http://www.troutintheclassroom.org/teachers/library/catch-critter-game

TEACHER REFERENCE: MACROINVERTEBRATE BACKGROUND

Many fish are opportunistic feeders, meaning they will eat whatever gets within range of their mouths. Sometimes they will even eat smaller fish. Fish may feed on aquatic larvae or insects that are drifting in the water or on the surface of the stream. These larvae and insects are called *macroinvertebrates*. It is important to know if these macroinvertebrates are in streams and rivers to provide food for the fish to eat. If there are not very many macroinvertebrates in the stream, then there may be some very hungry fish!

Environmentalists, biologists, and water quality researchers all conduct aquatic invertebrate surveys to measure the health of a stream. They watch (monitor) for changes in the stream over time to make sure food sources are readily available for fish and to monitor for pollution.

Pollution can really affect the health of a stream, and cause numbers of certain aquatic insects to drop. Some aquatic macroinvertebrates, such as mayfly larvae, gilled snails, and riffle beetles are extremely sensitive to pollution. Some will leave polluted areas for friendlier habitats; others will die or will be unable to reproduce. Crayfish, sowbug, and damselfly larvae are not as sensitive to pollution.

They prefer good stream quality, but can survive in polluted conditions. Mosquitoes, worms, black fly larvae, and leeches will thrive in polluted waters. By surveying the diversity of aquatic invertebrates present in a stream, the health of the stream can be determined.

Field Activity 2: Part II - Macroinvertebrates Survey

Part II—Field Trip

Standard Correlations - Grade 5:

New Mexico Science Content Standards, Benchmarks, and Performance Standards
Strand I, Standard I, Benchmark I, Performance Standards 1, 2, & 3

Common Core Standards
Speaking and Listening 5.1
Reading Standard for Informational Text 5.4

Timeline: One class field trip.

Objective: At the end of this activity, students will have learned how to collect aquatic invertebrates from a natural environment.

Preparation and background: Before conducting the field trip, it is best to visit the site to determine if there are any potential hazards, such as poisonous plants, dangerous wildlife, etc. Check the stream for depth, velocity, and temperature. Identify several different areas of the stream as collection sites (for example, shallow areas near the bank, areas in the middle of the stream, riffle areas, etc.). You should be able to wade in the stream.

Materials:

1. Download macroinvertebrate identification guides. Guides may be downloaded from, but not limited to, the following sites.
    a. The Missouri Stream Team at http://www.mostreamteam.org/Documents/VWQM/BugCard1.10.pdf
    b. Water Resources Education - University of Wisconsin Extension at http://clean-water.uwex.edu/pubs/pdf/riverkey.pdf
    c. Stroud Water Research Center at http://www.stroudcenter.org/education/MacroKey_Complete.pdf
2. Student Worksheet: *Macroinvertebrate Survey*
3. Waders or high waterproof boots
4. Thermometer
5. Several light colored plastic wash basins
6. Plastic containers for collecting invertebrates
7. Dip nets or strainers
8. Large spoons or small gardening spades
9. Water testing kit (temperature, dissolved oxygen, pH, etc.)

Procedure:

1. Review ground rules and safety rules with students prior to the field trip. Divide the class into small groups. Ask the following questions:

   - ✓ Question: How could a macroinvertebrate survey be useful?
     - Answer: It could be useful in assessing the health of a stream; macroinvertebrates are pollution indicators. In addition, if the food a fish eats is not available, then it is not a good habitat for fish.

   - ✓ Question: Are the numbers and kinds of invertebrates found important? Why?
     - Answer: Some invertebrates might be less tolerant of pollution than others might. If they were not present in the stream, this might mean that the stream is polluted.

2. Distribute several *Macroinvertebrate Survey* sheets to each group. Explain that groups will use one survey sheet for each area in the stream that they sample. They will begin downstream and work their way upstream to avoid muddying locations they might want to sample later. They will first describe the part of the stream they are sampling. Students should be encouraged to make a simple map of the stream and use a star or arrow to indicate where they obtained their sample.

   - ✓ Is it a location near the bank, mid-stream, near a riffle?
   - ✓ Is the sample from the streambed, from under a rock, or from the plants on the bank?
   - ✓ How deep or shallow is the area they are sampling?
   - ✓ What is the water temperature?

3. Describe the procedure for collecting invertebrates.

   - ✓ Muckraking: Use a large spoon or gardening spade to scoop up some muck from the bottom of the stream. Place it in the dishpan. Look for things that are moving. Add some water and swish it around as you look for organisms.
   - ✓ Collecting from under rocks: Simply turn over rocks and look for scuds, nymphs and other arthropods.
   - ✓ Collecting from the water: Use a strainer or dip net to catch organisms you see moving in the water.

4. After collecting, carefully move any invertebrates into the collection containers. Be sure to label the containers with the name of the site where the organisms were collected. Repeat the procedure.

5. When students have sampled several areas and collected invertebrates from each area, have them return to the classroom to assess their data and draw conclusions.

STUDENT WORKSHEET: MACROINVERTEBRATE SURVEY

Group members: _____
_____

Date: _____ Stream location: _____ Stream temperature: _____

Approximate stream width: _____ Approximate stream depth: _____

Site location: (draw a simple map and identify location of site using a ☆)

Observations at site:

_____

_____

_____

_____

_____

_____

_____

_____

Field Activity 2: Part III - Macroinvertebrates Assessment

Part III—Assessing Data and Drawing Conclusions

Standard Correlations - Grade 5:

New Mexico Science Content Standards, Benchmarks, and Performance Standards
Strand I, Standard I, Benchmark I, Performance Standards 1, 2, & 3

Common Core Standards
Speaking and Listening 5.1
Reading Standard for Informational Text 5.4

Timeline: One to two class periods.

Objective: At the end of this activity, students will have learned how to use macroinvertebrates to determine the health of a stream or other aquatic system. Students will be able to list macroinvertebrate that falls into each category: sensitive to pollution, somewhat sensitive to pollution, and tolerant to pollution.

Preparation and Background: Review *Macroinvertebrate Background* and previous identification materials from Field Activity 2, Part I and II.

Environmentalists, biologists, and water quality researchers all conduct aquatic macroinvertebrates surveys to measure the biological health of a stream. They monitor changes in the stream over time and assess the effects of environmental problems on stream life. Some aquatic invertebrates, such as mayfly larvae, gilled snails, and riffle beetles, are extremely sensitive to pollution. Some will leave polluted areas for friendlier habitats; others will die. Crayfish, sowbugs, and damselfly larvae are somewhat sensitive to pollution. They prefer good stream quality, but can survive in polluted conditions. Mosquitoes, worms, black fly larvae, and leeches have a high tolerance for pollution. They will thrive in polluted conditions. By surveying the numbers and types of aquatic invertebrates present, the health of the stream can be determined. If a stream is unhealthy, there is not enough food to feed a population of fish.

Materials:

1. Teacher Reference: Macroinvertebrate Background
2. Download macroinvertebrate identification guides. Guides may be downloaded from, but not limited to, the following sites.
    a. The Missouri Stream Team at http://www.mostreamteam.org/Documents/VWQM/BugCard1.10.pdf
    b. Water Resources Education - University of Wisconsin Extension at http://clean-water.uwex.edu/pubs/pdf/riverkey.pdf
    c. Stroud Water Research Center at http://www.stroudcenter.org/education/MacroKey_Complete.pdf
3. Student Worksheets: Habitat Assessment and Macroinvertebrate & Chemical Water Testing
4. Completed Student Worksheets: Macroinvertebrate Survey

5. Kick-net Kritters field activity worksheet from The Bosque Education Guide located on the Supplemental Materials CD in the BEMP folder.
6. Hand lenses
7. Insect field guides
8. Old newspapers
9. Tweezers (optional)

Procedure:

1. Discuss the field trip with students encouraging them to share their observations. Tell students they will now identify and record the macroinvertebrates they collected and use the data to determine whether the stream is healthy or not.

2. Have students work in their original groups. Distribute *Macroinvertebrate Background* and *Assessment Worksheet* to students. Review the background information with them. Have them identify those organisms that are tolerant to pollution, somewhat tolerant, and sensitive. Review the formulas for determining index value. Cover work areas with newspaper. Have groups work with the organisms they collected at their sites.

3. They should use the *Macroinvertebrate Identification Sheet* (and insect field guides, if needed) to identify each organism. The type of organism found should be recorded just once. For example, if three mayfly larvae are found at three different sites, only one check is marked on the assessment sheet. After identifying each organism students should calculate the water index value for each group and the water quality rating for the stream.

4. When groups finish, allow them time to discuss their findings within the group. Call on one person from each group to present the group's findings to the rest of the class. Have them write the water quality ratings on the board and ask students to compare the findings. Discuss the diversity of organisms found. Were there a large number of pollution tolerant organisms? How did they compare to the number of pollution sensitive organisms found.

5. Based on the aquatic assessment how healthy is the stream the students sampled?

STUDENT WORKSHEET: HABITAT ASSESSMENT

Group members: _____
_____

Stream name: _____ Site location: _____

Put a checkmark next to the name of each macro-invert that you found:

Sensitive to pollution	Somewhat sensitive to pollution	Tolerant to pollution
____ mayfly larvae ____ stonefly larvae ____ caddisfly larvae ____ dobsonfly larvae ____ gilled snails ____ planarians ____ water penny larvae ____ adult riffle beetle	____ clams ____ cranefly larvae ____ crayfish ____ alderfly larvae ____ scuds ____ sowbugs ____ damselfly larvae ____ dragonfly larvae ____ whirligig beetles ____ true bugs (including water boatmen, backswimmers, water scorpions, water striders)	____ lunged snails ____ black fly larvae ____ midge larvae ____ leeches ____ worms ____ mosquito larvae
Types found _____ x 3 = _____ index value	Types found _____ x 2 = _____ index value	Types found _____ x 1 = _____ index value

To determine the water quality rating, add the index values of all three sections together. Then compare them to the chart below:

Water quality rating	Stream health assessment
11 and below	very poor
11-27	fair
22-27	good
27-32	excellent

STUDENT WORKSHEET: MACROINVERTEBRATE & CHEMICAL WATER TESTING

Group Members _____

_____

Location: _____ Date/Time: _____

Water Quality

Air temperature		
Water temperature		
Dissolved oxygen (DO)		Measures the amount of oxygen gas dissolved in the water. Best if between 8 and 12 parts per million (ppm).
pH		Acidic = below 7 Basic = above 7 Best if between 6.5 and 8.5

Macroinvertebrate Tally

Group 1 Taxa	Tally	Group 2 Taxa	Tally	Group 3 Taxa	Tally
water penny larvae		damselfly nymphs		blackfly larvae	
mayfly nymphs		dragonfly nymphs		aquatic worms	
stonefly nymphs		cranefly larvae		midge larvae	
dobsonfly nymphs		beetle larvae		left-hand snails	
caddisfly larvae		crayfish		leeches	
riffle beetle adults		scuds (sideswimmers)		bloodworms	
right-hand snails		clams			
planaria (flatworms)		sowbugs (isopods)			

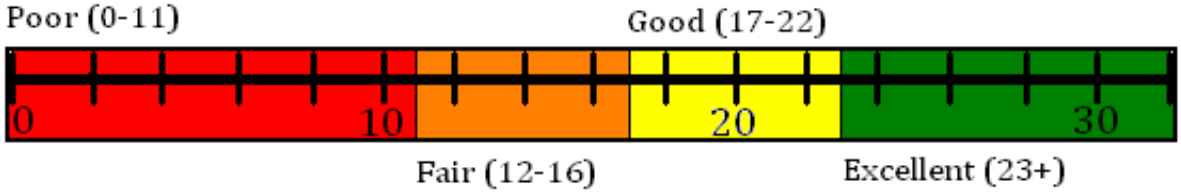
Number taxa present:		Number taxa present:		Number taxa present:	
Times index value of 3:		Times index value of 2:		Times index value of 1:	

Total Index Value: _____

Other organisms seen: _____

_____

Biological Quality Assessment Scale



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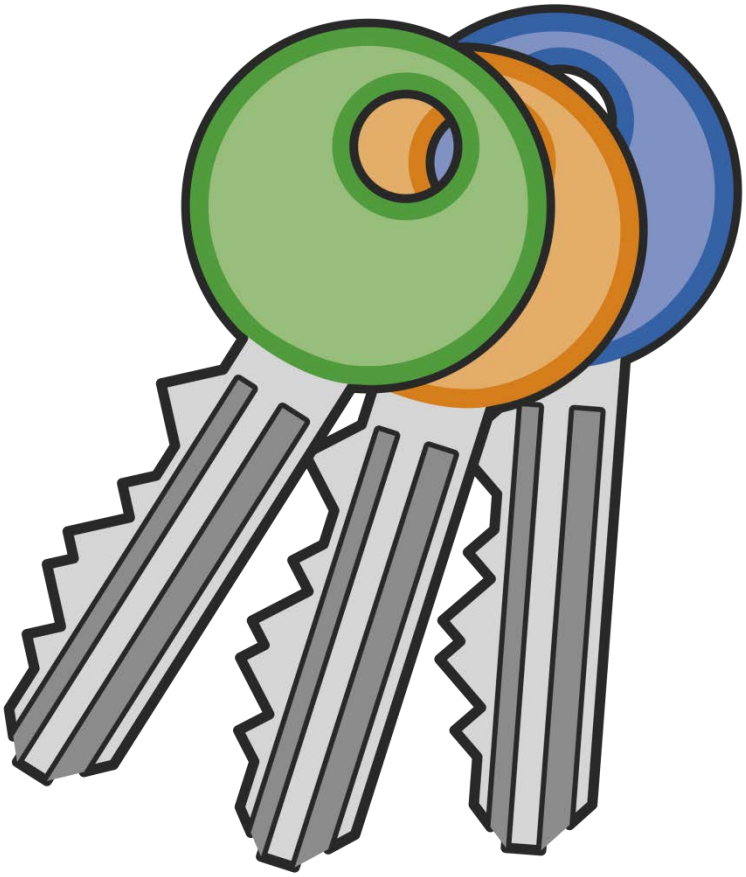
Appendix A – Answer Keys



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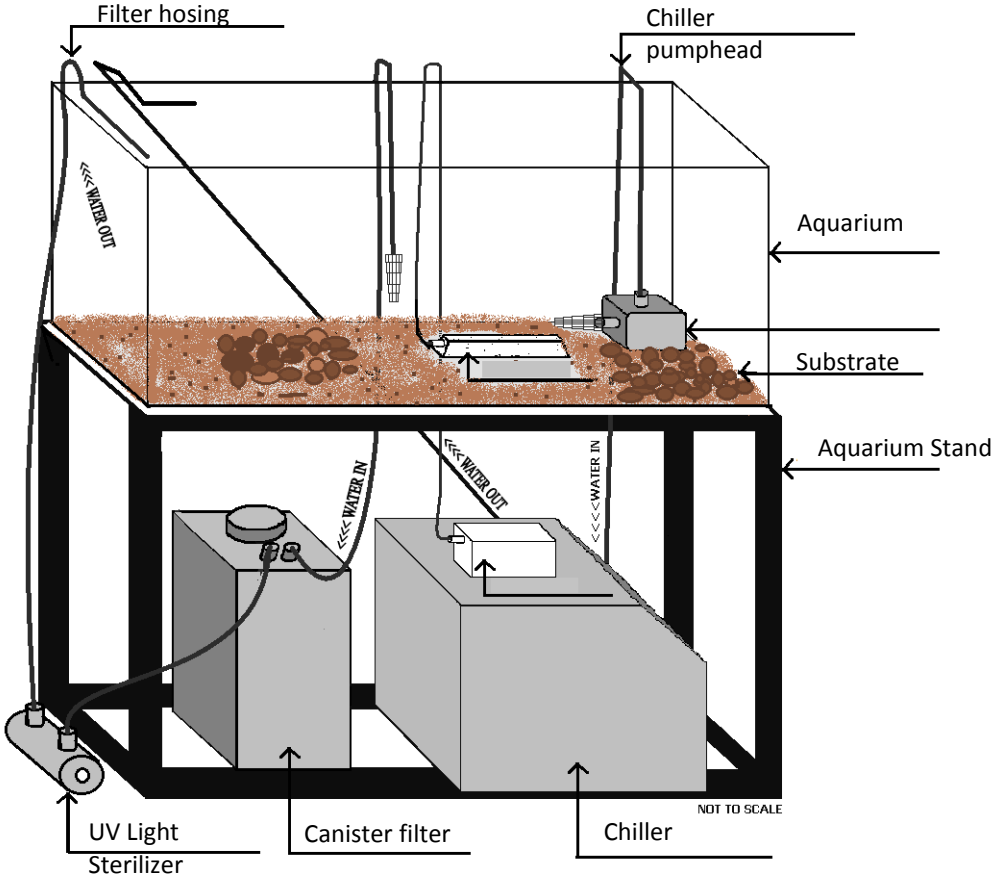
ANSWER KEY: GETTING TO KNOW YOUR AQUARIUM

Name _____

It is important for you to know your aquarium and all its parts (you may not have all these parts). Understanding the aquarium set-up enables you to troubleshoot when and if something goes wrong. **Label the diagram below:**



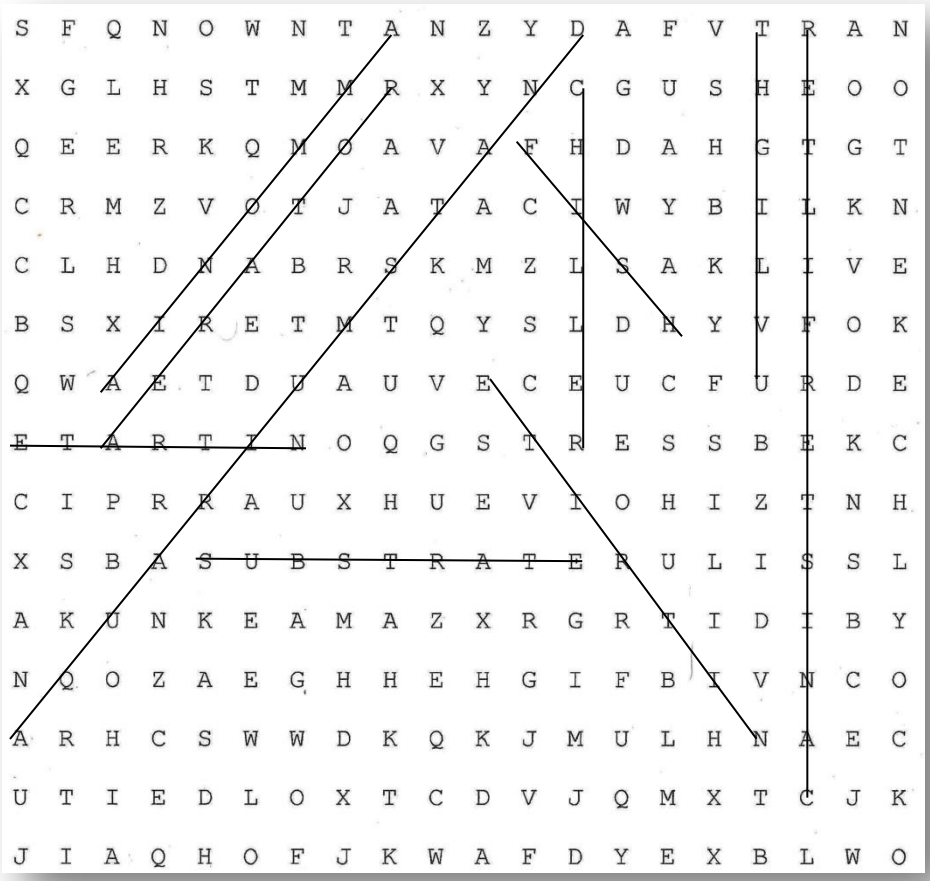
Match the terms to the descriptions.

TERMS		DESCRIPTIONS
Filter Hosing	_G__	A. Pipes that carry water from the aquarium, to the chiller, back to the aquarium.
Canister Filter	_B__	B. A container that houses beneficial bacteria, which breaks down ammonia and nitrites.
Aquarium	_E__	C. When water is moved through this, it cools the water for cold-water fish like trout.
Chiller	_C__	D. This actively pushes water from the aquarium to the chiller.
Chiller Pumphead	_D__	E. This is the container where living aquatic animals are kept.
Aquarium Stand	_F__	F. This is a platform specially made to hold the weight of an aquarium.
Chiller Piping	_A__	G. Hoses that carries water from the aquarium, to the filter, back to the aquarium.
Substrate	_H__	H. The earthen material placed at the bottom of an aquarium.
UV Light Sterilizer	_I___	I. A device that uses ultra violet light to reduce harmful bacteria.

ANSWER KEY: FIND AND DEFINE

Name _____

Find the words listed below in the word puzzle and then write their definition.



Aquarium - A container where living aquatic animals are kept
Chiller - When water is moved through this, it cools the water for coldwater fish like trout
Substrate - earthen material at the bottom of a stream, like sand or gravel
Ammonia - NH3, a waste produced by eggs and fingerlings
UV Light - A device that uses ultra violet light to reduce harmful bacteria.
Fish - a member of a large group of finned, aquatic, cold-blooded vertebrates

Nitrate - a product formed from the breakdown of ammonia and nitrite during the nitrogen cycle. Safe for fish
Nitrite - a product formed from the breakdown of ammonia
Aquarium Stand - A platform specially made to hold the weight of an aquarium
Canister Filter - A container that houses beneficial bacteria, which breaks down ammonia and nitrites
Stress - A condition where a fish or animal is under physical and mental duress
Aerator - a pump used to push air through the air stone

ANSWER KEY: THE FALLEN NITROGEN CYCLE

Name _____

A fallen phrase puzzle is a puzzle where all the letters have fallen to the bottom. The letters were jumbled on their way down, but remain in the same column. Fill in the puzzle with the letters from the same column.

Hint: What makes the nitrogen cycle go round?

Tips: Fill in any blank spaces with just one letter underneath.
Next, figure out the two word options.
Now, use trial and error to keep filling in the blanks until you get a finished puzzle.
Cross off the letters as you use them.

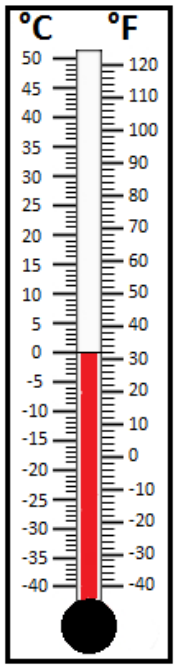
ANSWER KEY: A HAPPY HOME

Name _____

	In Nature	In Aquarium
Limiting Factor: Food		
Food	may include algae, zooplankton, aquatic bugs (invertebrates), terrestrial bugs (insects), and other small fish.	fish are fed a nutrient rich pellet or flake food and frozen food (e.g., mysis shrimp, bloodworms) that is similar to aquatic insects in the wild.
Limiting Factor: Water		
Water Temperature is influenced by	source of water (springs, snowmelt, city run-off), amount of shade, amount of sunlight	Water temperature is controlled by chiller or room temperature and placement of aquarium to avoid direct sun.
Source of Oxygen	includes turbulence over gravel and boulders increasing aeration of water and photosynthesis of plants during the day	Flowing water from the inflow of the canister filter and/or chiller creates surface agitation, adding oxygen. Aerator is optional if oxygen is low.
Water is Cleaned (removal of ammonia, nitrites, and nitrates)	by bacteria and scavengers breaking down fish waste, rotting (decomposing) fish, and rotting (decaying) food in rivers and streams. Plants absorb nitrates and storm events flush a stream of debris.	A canister filter, which houses beneficial bacteria, maintains water quality in addition to water changes.
The pH of water is influenced by	the rock and soils (geology) that the water runs through and over as it moves. Human-caused pollutants can also cause pH to fluctuate.	pH is influenced by tap water, removal of organic material (cleaning), and pollutants (keep hands clean).
Limiting Factor: Shelter		
Source of Shelter	includes overhanging vegetation, trees, deep pools, and submerged vegetation	Shelter will consist of side and back covers, substrate and habitat structures placed within the aquarium.
Predators	includes bears, raccoons, snakes, frogs, birds, other fish, and humans.	No Predators

ANSWER KEY: THE THERMOMETER

Name _____



Refresher: *Thermometers measure the temperature, which is a measurement of how hot or cold something might be. The liquid inside a thermometer will rise as the temperature rises and fall as it cools. Read the highest point of the liquid to determine the temperature. In our example, the temperature reads 0 ℃ and 32 ℉*

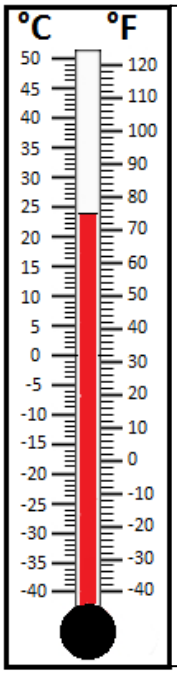
What are Celsius (℃) and Fahrenheit (℉)? They are two of the three temperature scales. The third scale is called Kelvin. The Fahrenheit scale is the temperature scale most people in the United States recognize especially when it comes to weather and checking for a fever. The Celsius scale is commonly used for scientific work. The thermometers that we use in our lab and in the field are marked with the Celsius scale.

Water temperatures are a significant piece of information for a Fish Biologist and the fish they manage. A fish is a coldblooded animal, which means its temperature is regulated by the water in which it lives. However, fish have a specific range of temperatures that they needs for survival and to complete their life cycle.

Help the biologists gather data for your class. Collect temperatures from around your classroom. Make sure to write if your temperature is in Celsius or Fahrenheit, it makes a difference!

Aquarium _____ **Classroom Air _____** **Tap Water _____**

Practice reading the thermometer and record the temperatures. Make sure to record your scale (units) for each temperature reading, it makes a difference.

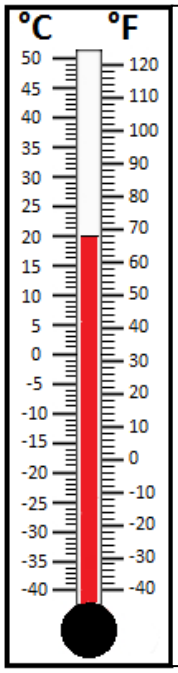


Rio Grande Cutthroat Trout do not survive when the water reaches this temperature for an extended period of time.

7) **24°C**

8)

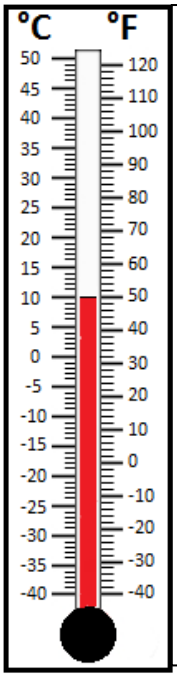
9) **75°F**



Rio Grande Silvery Minnow eggs develop at different rates depending on the temperature. At this temperature, the egg is free-swimming about 7 days after it was released by the female.

12) **20°C**

13) **68°F**



Temperature also plays a role in the life cycle of parasites of fish. At this temperature it would take 2 to 3 weeks for the Ich parasite to complete its life cycle (at 21 °C it would take only 3 to 4 days).

10) **10°C**

11) **50°F**

ANSWER KEY: DEGREES OF CELSIUS AND FAHRENHEIT

Name _____

*The Fish Biologists collected water temperatures from different rivers and streams. Some of our biologists recorded the temperatures in Celsius (℃) and some in Fahrenheit (**°F**).*

Can you help convert each temperature? Use the formulas below to help you convert the temperature into Celsius or Fahrenheit. Show your work.

°C= (°F - 32) / 1.8	**°F = (°C x 1.8) + 32**
°C= (75 - 32) / 1.8	°F = (22 x 1.8) + 32
Answer = 23.9 °C	Answer = 71.6 °F

1) 88.7°F = **31.5** °C

2) 34.0°F = **1.1** °C

3) 60.0°F = **15.6** °C

4) 52.0°F = **11.1** °C

5) 90.0°F = **32.2** °C

6) 5.0°C = **41.0** °F

7) 34.0°C = **93.2** °F

8) 20.0°C = **68.0** °F

9) 29.0°C = **84.2** °F

10) 11.0°C = **51.8** °F

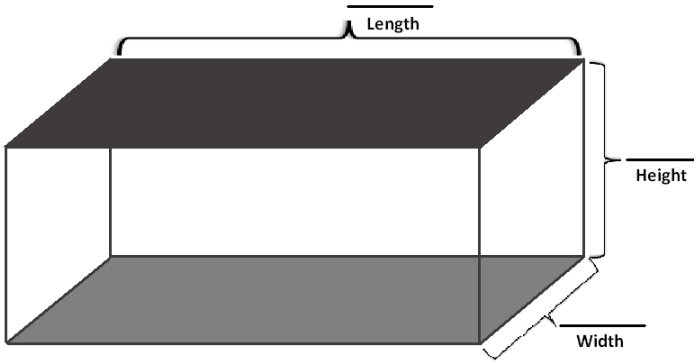
ANSWER KEY: CALCULATING WATER VOLUME

Name _____

As a junior biologist, you are entrusted with taking care of the fish. There is an important piece of information that we need you to figure out. We need to know the volume of water in our aquarium.

The volume (amount of) water the aquarium holds can help us figure out how many fish we can hold and what size filter we need so as to keep the water in the aquarium clean. If the fish become sick, we would also need to know the volume of water to provide the right amount of medicine.

Your job is to tell the biologist how many gallons of water are in your aquarium. Record your aquarium measurements on the diagram below. Remember to record your units of measurement; you will need them to complete your conversion correctly.



Formula: ***Volume = length X width X height = cubic inches (or cubic centimeters)***

Step 1:
Volume of aquarium = __**48.5 in**__ (length) __**12.7 in**___ (width) X _**18.8 in**__ (height) = **11579.9 in^3**

Approximate – these are the dimensions provided on the aquarium label. One aquarium does stand taller than the others.

Step 2:
Once you calculate the volume of your aquarium, you will need to convert your answer into gallons. Use only the conversion factor that matches your units of measurement; inches or centimeters.

Conversion factors:

0.00433 gal / *1 cubic inch (in^3)*	*0.000264 gal* / *1 cubic centimeter (cm^3)*

Convert to gallons = **11579.9 in^3** (answer from Step 1) X **0.00433** (conversion factor) = **50.14** gallons

Most of the aquariums are rated as 50 gallons with one aquarium rated as 55 gallons.

ANSWER KEY: CALCULATING WATER VOLUME II

Name _____

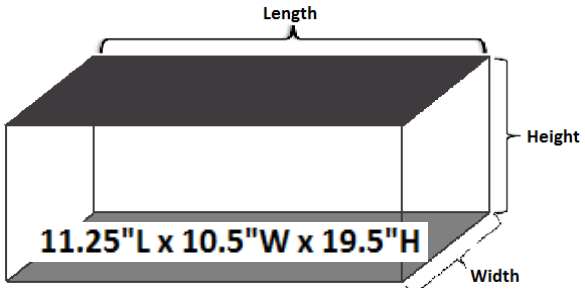
Fish Culturists use various sizes of aquariums. Some are for quarantine, young fish, or even for macroinvertebrates. Can you help figure out the volume of water for each aquarium?

Step 1: First, find the volume using the given dimensions of each aquarium.
Formula: Volume = length X width X height = cubic inches (or cubic centimeters)

Step 2: Second, convert the calculated volume into gallons. Remember, use only the conversion factor that matches your units of measurement; inches or centimeters.

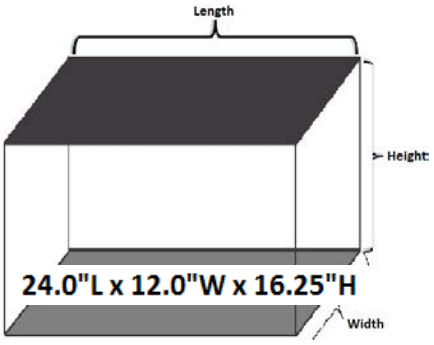
Conversion factors: *0.00433 gal / 1 cubic inch (in^3)* | *0.000264 gal / 1 cubic centimeter (cm^3)*

1)



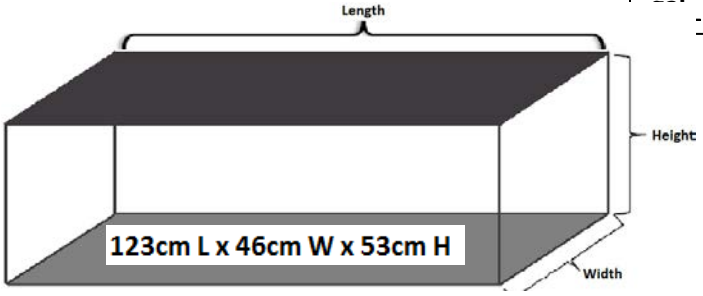
Volume: **2303.4 in^3** Gallons: **9.97 gal**

2)



Volume: **4680 in^3** Gallons: **20.26 gal**

3)



Volume: **299874 cm^3** Gallons: **79.16**

ANSWER KEY: TROUT ANATOMY DOUBLE PUZZLE

Name _____

Unscramble each of the clue words. Copy the letters in the numbered cells to the cells in the bottom row with the same number.

LEVPIC SIFN — P E L V I C (10) F I N S

NASRE — N A R E S (6 20)

LIGSL — G I L L S (4)

DUCALA NFI — C A U D A L (8) F I N

AEROLCTP NIFS — P E C T O R A L (13 1) F I N S

SYEE — E Y E S (9)

LELRATA NILE — L A T E R A L (12 15) L I N E

DAORSL INF — D O R S A L (3) F I N

NAAL NIF — A N A L (17) F I N

CUULORMPE — O P E R C U L U M (16 5 22)

NEVT — V E N T (7 18)

HOMTU — M O U T H (11 19 14)

SOAPEDI NIF — A D I P O S E (2 21) F I N

R	I	O	G	R	A	N	D	E	C	U	T	T	H	R	O	A	T	T	R	O	U	T
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	13

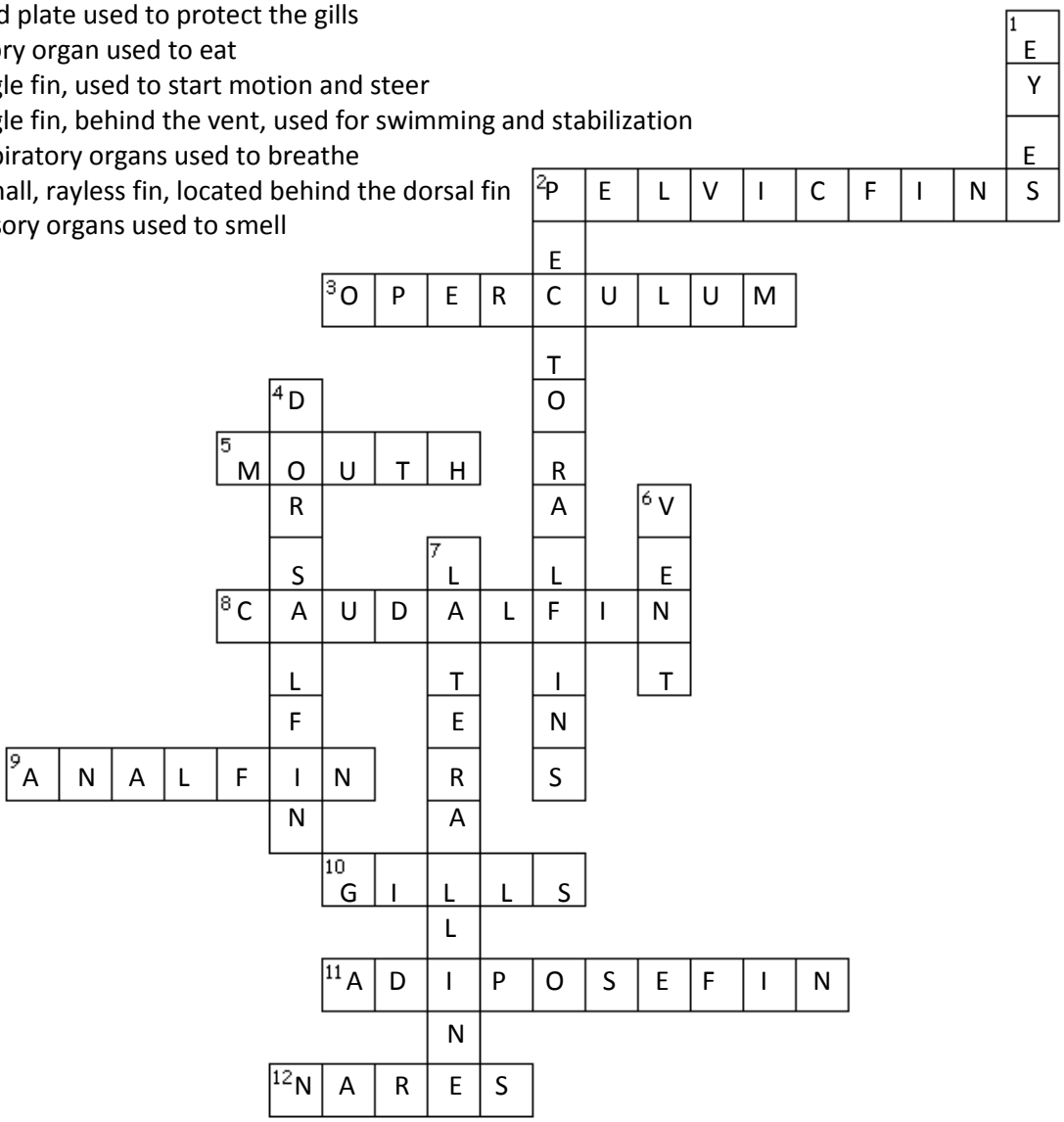
ANSWER KEY: TROUT ANATOMY CROSSWORD PUZZLE

Name _____

Complete the crossword puzzle using trout anatomy terms.

Across

2. Paired fins that help with up and down motion
3. A hard plate used to protect the gills
5. Sensory organ used to eat
8. A single fin, used to start motion and steer
9. A single fin, behind the vent, used for swimming and stabilization
10. Respiratory organs used to breathe
11. A small, rayless fin, located behind the dorsal fin
12. Sensory organs used to smell



Down

1. Sensory organs used for sight
2. Paired fins that act as brakes and control side-to-side motion
4. A single fin, located on the back, used for swimming and stabilization
6. An opening used to excrete eggs or milt for spawning
7. A sensory organ that detects pressures waves and vibrations in the water

ANSWER KEY: FISH ANATOMY DOUBLE PUZZLE

Name _____

Unscramble each of the clue words. Copy the letters in the numbered cells to the cells in the bottom row with the same number.

SRLODA — D O R(15) S A L(17)

RASNE — N(12) A R E S

MEULOCRUP — O P E R C(16) U(14) L U M(24)

SALBERB — B A(2) R B E L S

TUOHM — M O U T H(10)

LLGIS — G I(8) L L S(19)

LADUAC NFI — C A U D A(18) L F(7) I N

TEARALL NELI — L A(3) T E R A L L I N E

NTVE — V(5) E N T

LAAN INF — A N A L F(11) I N(1)

TOLARCEP NIF — P E C T O(22) R A L F I N(4)

TOPRIEROS — P O(20) S T E(6) R I O(23) R(21)

PIEDOAS NIF — A D I P O S(9) E F I N

FKRO — F O(13) R K

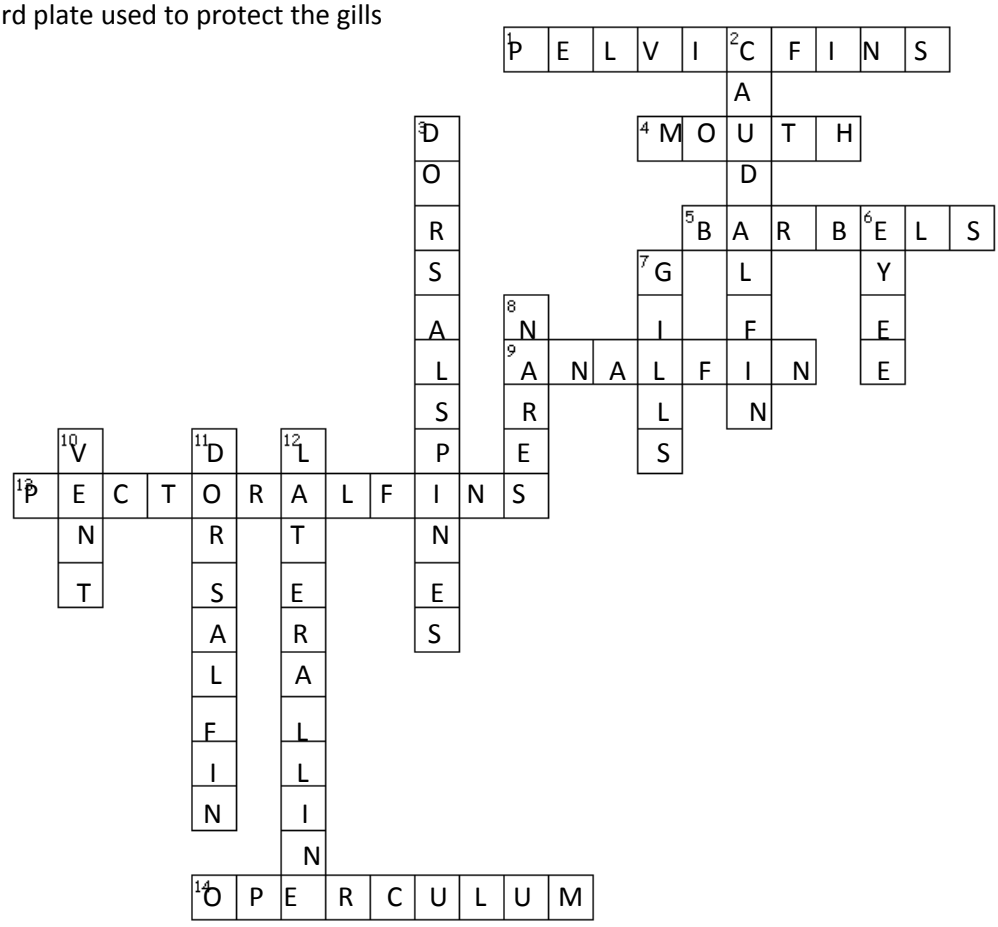
N	A	T	I	V	E		F	I	S	H		I	N		O	U	R		C	L	A	S	S	R	O	O	M
1	2	3	4	5	6		7	8	9	10		11	12		13	14	15		16	17	18	19	20	21	22	23	24

ANSWER KEY: FISH ANATOMY CROSSWORD PUZZLE

Name _____

Complete the crossword puzzle using trout anatomy terms.

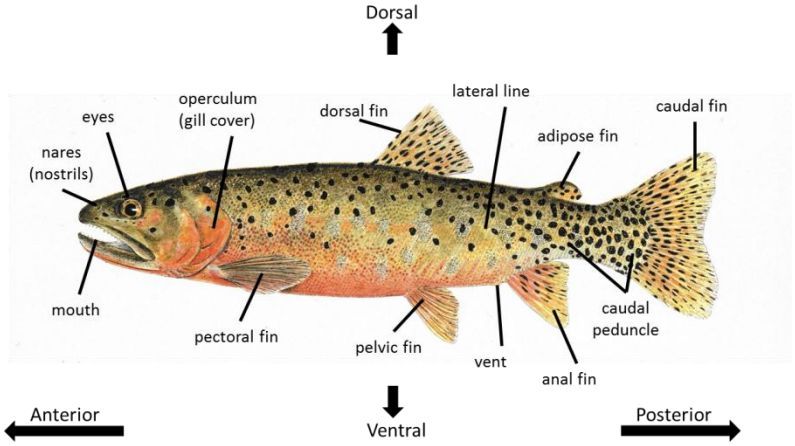
Across
1. Paired fins that help with up and down motion
4. A sensory organ used to eat
5. A sensory organ (whiskers) growing on the mouth or head of a fish equipped with taste buds
9. A single fin, used for swimming and stabilization
13. Paired fins that act as brakes and control side-to-side motion
14. A hard plate used to protect the gills



Down
2. A single fin, used to start motion and steer
3. Bony, needlelike projections found on the anterior end of the dorsal fin
6. A sensory organs used for sight
7. Respiratory organs used to breathe
8. A sensory organs used to smell
10. An opening used to excrete eggs or milt for spawning
11. A single fin, located on the back, used for swimming and stabilization
12. A sensory organ that runs from the operculum to the caudal fin

ANSWER KEY: EXTERNAL TROUT ANATOMY

Name _____



Examine the external anatomy of the Rio Grande Cutthroat Trout and answer the following:

1) Write down a description of the color, pattern, and body shape of the trout.
They have large spots on the sides that are more to the posterior (back end) of fish. Light rose to red-orange on the sides. They are elongated, longer than they are wide. The mouth face forward (terminal). Any type of answers that show they were looking at the fish and attempting to describe it.

2) Feel and look (with magnifying glass) at the skin. Are the trout scales large or (small)?

3) Find the lateral line on the trout. What is its function?
(b) to confuse prey (b) to feel vibrations (c) to help swim (d) to help balance

4) How many fins does the Cutthroat Trout have? *8*

5) What does the shape of the caudal fin (tail fin) tell us about the fish?
(b) It is a slow swimmer (b) It swims in short bursts (c) It is constantly swimming

6) Observe the mouth and teeth. Are these teeth made for:
(b) Chewing (b) grinding (c) ripping (d) grasping prey

7) Find the nares (nostrils). What are their function? *To smell*

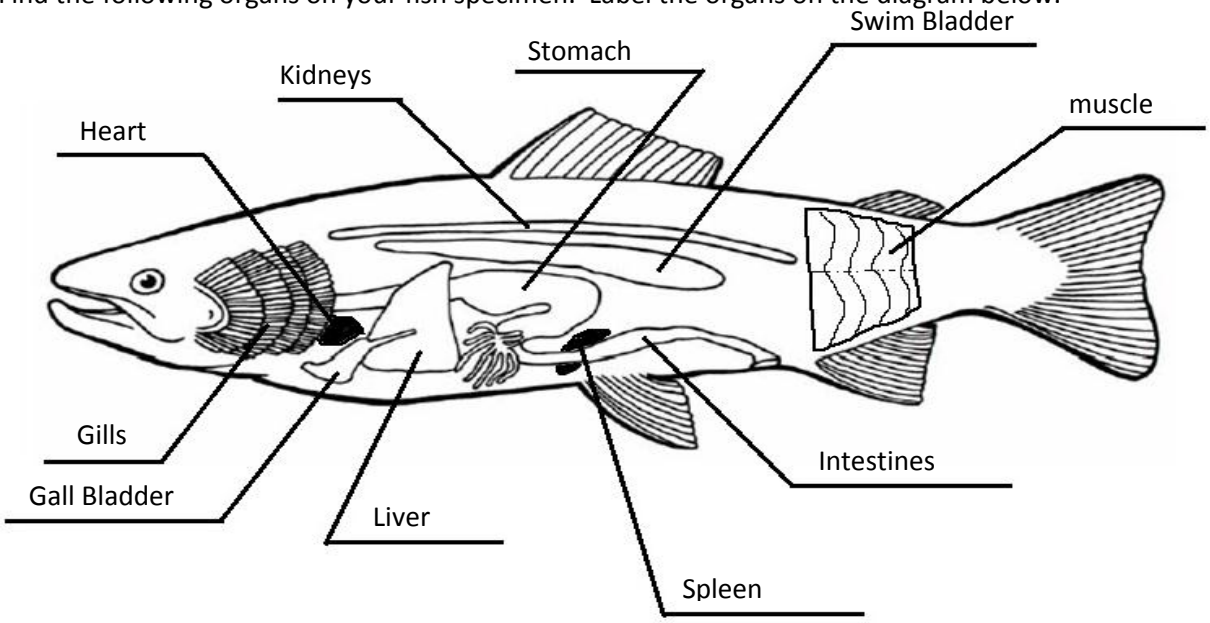
8) Find the gills. Why are gills an important anatomical feature for fish?
The gills absorb oxygen from the water, which allows the fish to breath. If you cannot breathe, you cannot survive.

9) True / False: Poor water quality (such as pollution) will hurt the gills of a fish.

ANSWER KEY: INTERNAL TROUT ANATOMY

Name _____

Find the following organs on your fish specimen. Label the organs on the diagram below.



Use the Organ key cards to read about the functions of the different organs. Write a short description of the function of each organ in the spaces below.

1. Stomach: *Where food mixes with acids to begin digestion.*
2. Intestines: *Last part of the digestive tract that continues to break down food and absorb nutrients.*
3. Swim bladder: *An air-filled sac, that helps a fish stay buoyant.*
4. Spleen: *Makes and stores red blood cells.*
5. Liver: *Secretes bile and helps process waste in the blood.*
6. Gills: *Absorbs oxygen from the water.*
7. Kidneys: *Filters waste and toxins from the blood.*
8. Heart: *Pumps red blood and oxygen from the gills to body tissue and organs.*
9. Gall bladder: *Stores bile which helps breakdown fat.*
10. Reproductive organs: *Makes cells (eggs/sperm) that allow fish to reproduce.*
11. Muscle: *An organ made of fibers that contract and expand to move.*
12. Spine: *a bony structure that protects the central nervous system.*

ANSWER KEY: THE RIO GRANDE CUTTHROAT TROUT

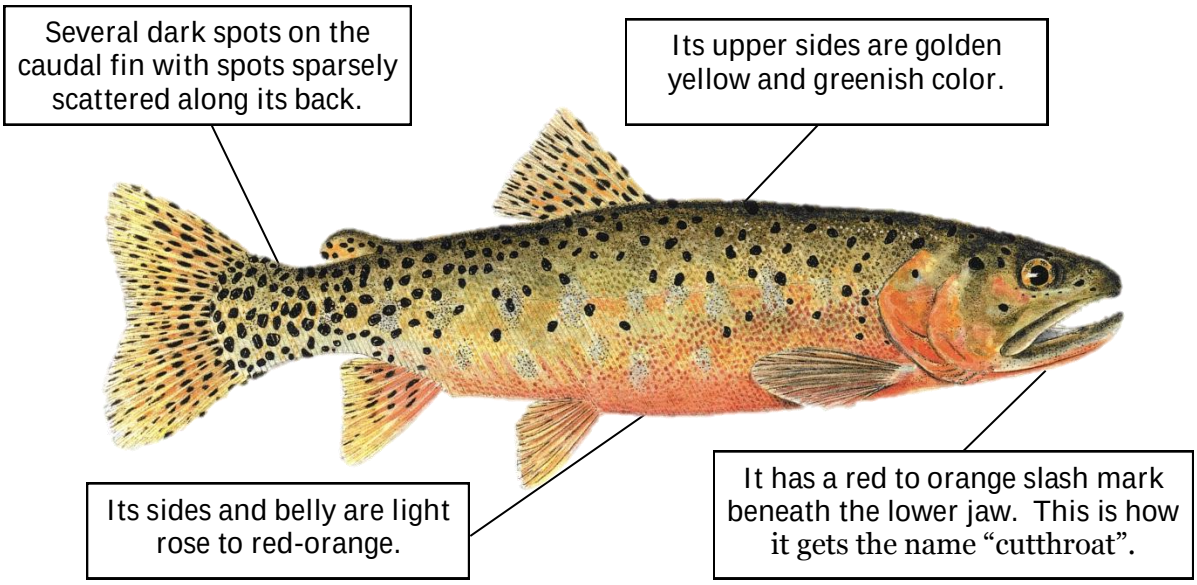
Name _____

Read the information and then answer the questions below**.**

Background

The Rio Grande Cutthroat Trout is New Mexico's state fish. The Rio Grande Cutthroat Trout is one of 14 distinct Cutthroat Trout in western North America. In 1541, Coronado's expedition found it in the upper Pecos River. The Rio Grande Cutthroat Trout lives further south than any of the other Cutthroat Trout. It is native to the Rio Grande, Pecos, and Canadian River drainages. Currently, it is only found in 7-10% of its historic habitat.

What do you see?



1. In what year were Rio Grande Cutthroat Trout discovered?

   a. 1451 b. 1541 c. 1741

2. True / False: Rio Grande Cutthroat Trout is found in its entire native historic habitat.
3. True / False: Rio Grande Cutthroat Trout is New Mexico's state fish.
4. What physical characteristic gives Cutthroat Trout their name? The red/orange slash mark beneath the lower jaw.

ANSWER KEY: THE LIFE OF A RIO GRANDE CUTTHROAT TROUT

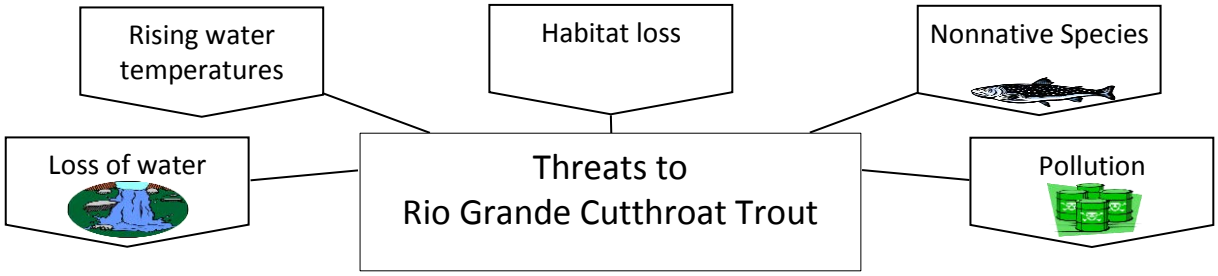
Name _____

Read the information and then answer the questions below**.**

Life History

Life span	5-8 years in the wild
Average size	6-10 inches in the wild
Reach adulthood	Males at 2-3 years, females at 3 years
Reproduction	When fish reach 4 years old, spawning occurs from mid-May to mid-June
Nest building	Females build a gravel nest (redd) where she can lay 200-4,500 eggs
Diet	Aquatic insects and crustaceans

Threats to survival



Rio Grande Cutthroat Trout face many threats. These include habitat loss, competition from nonnative species, pollution, and habitat changes like less water and rising water temperatures. In New Mexico, Rio Grande Cutthroat Trout compete for food and shelter with nonnative fish like the Brown Trout and Rainbow Trout. The Brown Trout is very aggressive and is a predator of Cutthroat Trout. The Rainbow Trout is not as aggressive, but breeds with Cutthroat Trout creating hybrid fish.

1. How many eggs can a female lay?
   a. 10-200 eggs b. 200-4500 eggs c. 4500-6000 eggs
2. How long can Rio Grande Cutthroat Trout live in the wild?
   a. 2-3 years b. 4 years c. 5-8 years
3. What are three major threats to Rio Grande Cutthroat Trout? *Habitat loss, competition by nonnative species, pollution*
4. Name two nonnative fish that are harmful to Rio Grande Cutthroat Trout. B*rown Trout, Rainbow Trout*
5. What do Rio Grande Cutthroat Trout eat? *Aquatic insects and crustaceans*

ANSWER KEY: A FAMILY OF FISHES

Name _____

Read the information below and then answer the questions.

The Salmonidae Family

Rio Grande Cutthroat Trout belong to the Family Salmonidae (*humans* are in the family Hominidae or "great apes"). The Salmonidae Family can be divided into three groups of fish: true trout, salmon, and char. True trout include Gila, Apache, Rainbow, and Brown Trout. True trout typically reproduce (spawn) more than once. Chinook, Atlantic, Coho, Chum, Kokanee, and Sockeye are all examples of salmon, which usually spawn only once. Char include fish like Brook Trout, Bull Trout, Arctic Char, and Lake Trout.

Salmonids are all predators and they may even eat other smaller fish. Another feature fish in this family share is an adipose fin. This is a small fatty fin on the fish's back that we do not think is used for swimming, but to be honest, we do not exactly know its function.

The Rio Grande Cutthroat Trout

The Cutthroat Trout are the most widely distributed trout of the West. Cutthroats are found from California to Colorado. They occur as far north as Alaska and as far south as New Mexico. The reddish-orange slash mark on the folds of its lower jaw is a distinguishing characteristic of this group of trout. The cutthroat in New Mexico is called the Rio Grande Cutthroat Trout. Scientists call the Rio Grande Cutthroat Trout, *Oncorhynchus clarkii virginalis,* its Latin name.

1) What is the Latin name for the Rio Grande Cutthroat Trout? *Oncorhynchus clarkii virginalis*

2) What are the three groups of fish in the Salmonidae Family? *Char, True Trout, Salmon*

3) What is a common feature (mark) of the Cutthroat Trout? *Slash mark on the folds of its lower jaw.*

4) How often can true trout spawn?
   a. Not at all b. More than once c. Only once

ANSWER KEY: THE LIFE CYCLE

Name _____

Read the information below and then answer the questions.

The Look of a Rio Grande Cutthroat Trout

The Rio Grande Cutthroat Trout has a long, skinny body with eight fins. It has a golden yellow to greenish body with black spots along its back and tail fin. Its lower sides and belly are a light rose to red-orange color. A male's belly will turn a bright red color between March and July. Just like other cutthroat in its family, it has a reddish-orange slash mark on both sides of its lower jaw. Adult Rio Grande Cutthroat Trout usually reach only 6 to 10 inches total length in the wild. In hatcheries, lakes, or larger streams these fish can sometimes grow larger than 16 inches.

Green egg | Eyed egg | Alevin | Fry | Fingerlings | Adult

Life Stages

Green egg:	Freshly laid and fertilized eggs that are very delicate and must remain in darkness
Eyed egg:	An egg that has a set of eyes developing that are visible to people
Alevin:	A cutthroat that comes out of the egg and has a yolk sac attached to its body. The yolk sac is its only source of food.
Fry:	A Cutthroat Trout that has used up all of its yolk sac and must now look for food.
Fingerling:	Cutthroat trout that are about 3-4 inches long. The fingerlings may develop parr marks – a series of dark markings on their sides.
Adult:	A 2 to 3 year old Cutthroat Trout. Although it usually does not reproduce (spawn)

1) In the wild, a Rio Grande Cutthroat Trout can grow up to:
   a. 10 inches b. 12 inches c. 4 inches

What is the difference between a green egg and an eyed egg? *An eyed egg has a set of eyes that are visible to people*

2) At what stage does a Cutthroat Trout start looking for food? *fry*

3) How many years will it take before a Cutthroat Trout is ready to reproduce? *3 to 4 years*

4) At what stage does a Cutthroat Trout have parr marks? *fingerling*

ANSWER KEY: THE HOME OF A TROUT

Name _____

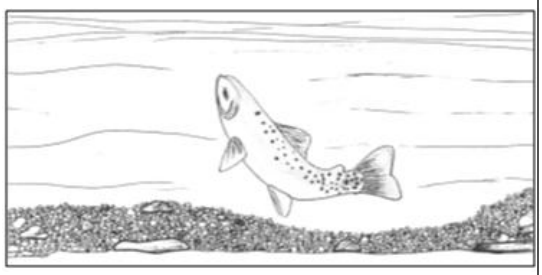
Read the information below and then answer the questions.

Habitat

Rio Grande Cutthroat Trout are usually found in clear, cold mountain streams and lakes in Colorado and New Mexico. A Cutthroat Trout needs different kinds of habitats throughout its life cycle. Cutthroat trout need gravel areas with flowing, oxygenated water to have a successful spawn and good egg survival. Alevin (cutthroat with a yolk sac) use the crevices of gravel and cobble as cover. Fry move to pools with aquatic and overhanging plants. These plants provide cover where there are plenty of aquatic insects to eat. An adult cutthroat will move back into areas of the stream with faster moving water. Even older Cutthroat Trout like deep pools that form behind large woody plants, boulders, and tree roots.

Rio Grande Cutthroat Trout remain in freshwater their whole lives, but some of the fish in this Family, like Steelhead Trout, travel or migrate to the ocean at some point. Fish that are born in freshwater but then migrate to the ocean are called anadromous.

Rio Grande Cutthroat Trout become adults around 2 to 3 years old. They will spawn when they are 3 to 4 years old. Before a female lays her eggs, she will build a nest called a redd. She builds a redd by flapping her tail hard against the gravel, making a shallow hole. Then she will lay 200 to 4,500 eggs in the redd. This usually happens during the spring and summer months.



1) What are fish called that migrate to the ocean? *anadromous*

2) What is a redd? *A nest that is a shallow hole in gravel*

3) What kind of habitat do Cutthroat Trout need to be able to spawn and have good egg survival?
Gravel areas with a lot of oxygen

4) How many eggs can a female Cutthroat Trout release?
   a. 1 to 10 b. 100,000 to 200, 000 c. 200 to 4,500

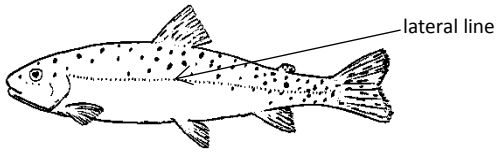
ANSWER KEY: THE ODDS AND ENDS

Name _____

Read the information below and then answer the questions.

The Senses

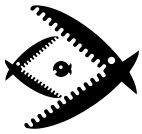
Trout have many senses, just as people do. Trout have ears that detect sound and movement. They have a lateral line on their sides that runs from their head to their tail. The lateral line senses vibrations in the water. They have an amazing sense of smell and use their fins and mouth to taste or feel their surroundings. Sight is probably the most important sense for a trout. They use sight to capture food and can see up to 30 feet away.



Feeding

Rio Grande Cutthroat Trout are predators! Their favorite foods are caddisflies, midge larvae, and mayflies. They will also eat other aquatic insects, zooplankton, crustaceans (like crayfish), and even other fish.

Predators



Although Cutthroat Trout are predators, there are other animals that may eat Rio Grande Cutthroat Trout. These include black bears, raccoons, and garter snakes. Some birds, like ospreys, great blue herons, and belted kingfishers will also eat Cutthroat Trout. Even the nonnative Brown and Brook Trout will eat small Cutthroat Trout.

1) True or False: Rio Grande Cutthroat Trout are NOT predators.

2) Name three predators of the Rio Grande Cutthroat Trout. *Bear, raccoons, osprey, garter snakes, great blue herons, belted kingfishers, humans, Brown and Brook Trout.*

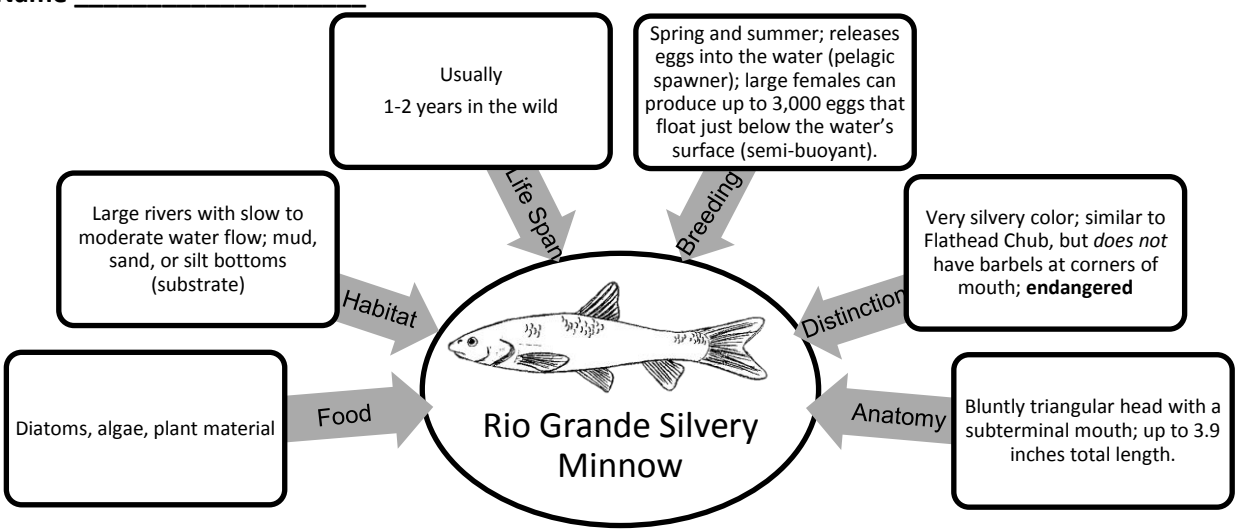
3) Name three foods of the Rio Grande Cutthroat Trout. *caddisflies, midge larvae, and mayflies, other aquatic insects, zooplankton, crustaceans (like crayfish), fish*

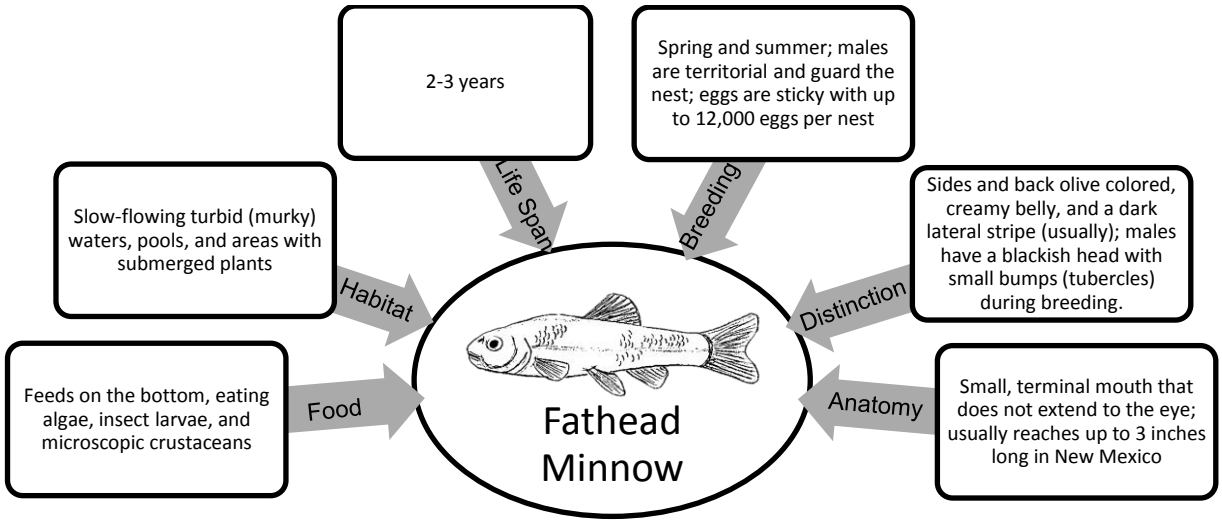
4) How far away can a trout see?
   a. 10 feet b. 20 feet c. 30 feet

5) The lateral line senses vibration in the water, what else do trout use to detect motion? *Ears*

ANSWER KEY: RIO GRANDE SILVERY MINNOW & FATHEAD MINNOW

Name _____



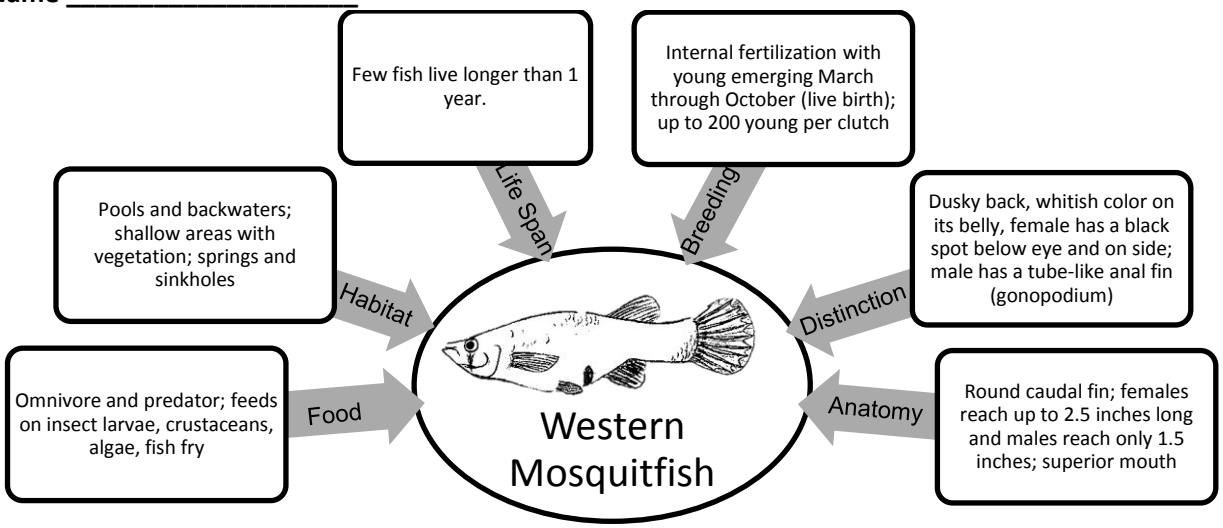


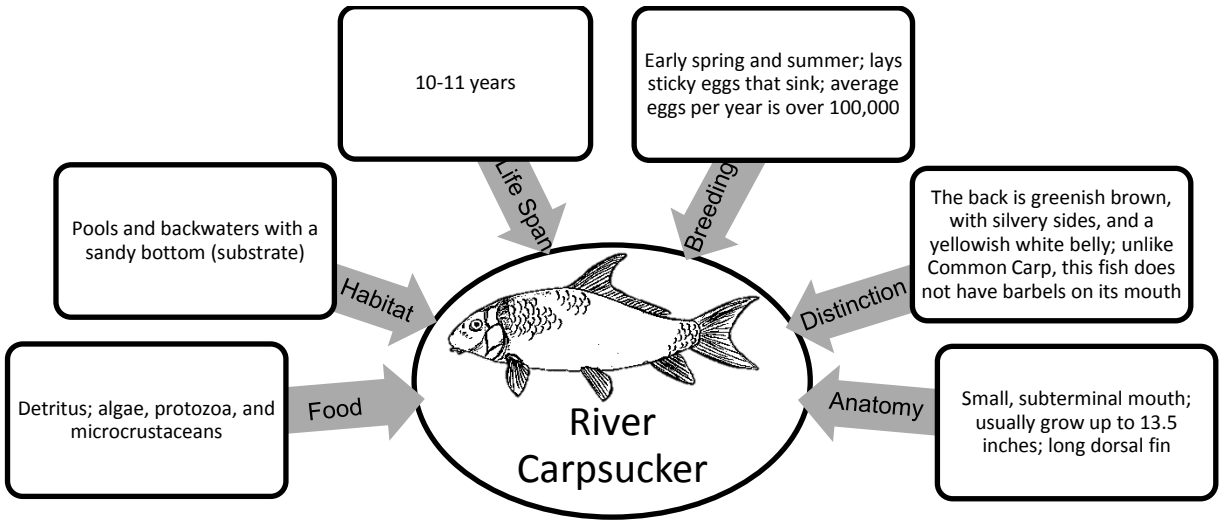
Answer the following questions:

1. (TRUE) FALSE The Rio Grande Silvery Minnow is an endangered species.
2. How long do Rio Grande Silvery Minnow live in the wild? __*1-2 years*_____
3. Does the Rio Grande Silvery Minnow reproduce in the winter or the summer? __*summer*_____
4. What type of mouth does a Fathead Minnow have? __*terminal*_____
5. What key feature distinguishes a Fathead Minnow male from female? _*males develop tubercles and a blackish head*__
6. How long do Fathead Minnows live in the wild? _*2-3 years*
7. Does the Fathead Minnow generally live longer than the Rio Grande Silvery Minnow? __*yes*

ANSWER KEY: WESTERN MOSQUITOFISH & RIVER CARPSUCKER

Name _____



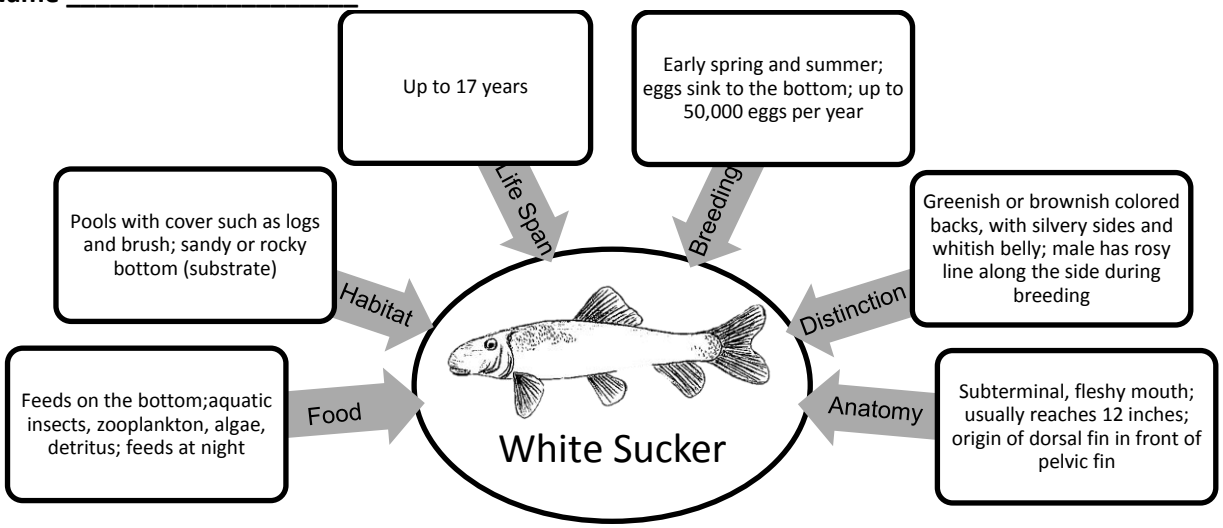


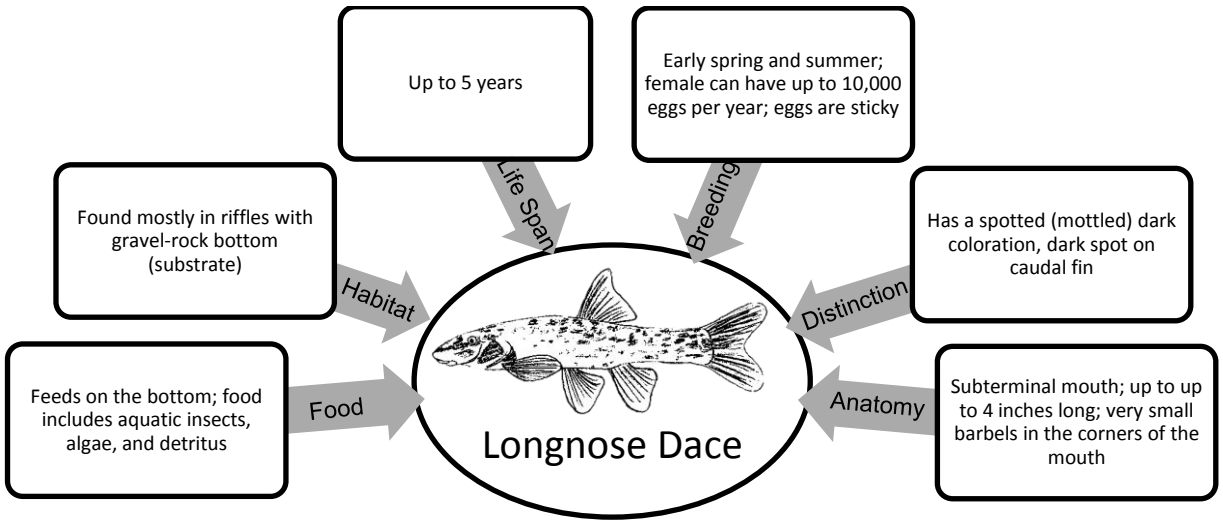
Answer the questions below.

1. (TRUE) FALSE Western Mosquitofish give birth to live young.
2. Name two habitats where you can find Western Mosquitofish. *pools and backwaters*
3. What is a gonopodium? *a tube-like anal fin on a mosquitofish*
4. (TRUE) FALSE River Carpsucker can live 10 years in the wild.
5. River Carpsucker feed on the bottom of the water column, with what type of mouth? *subterminal*
6. How many sticky eggs can a River Carpsucker lay? *100,000*
7. How are the mouths of the River Carpsucker and the Western Mosquitofish different? *River Carpsucker is subterminal, pointing downward and the mosquitofish is superior, pointing upward.*

ANSWER KEY: WHITE SUCKER & LONGNOSE DACE

Name _____



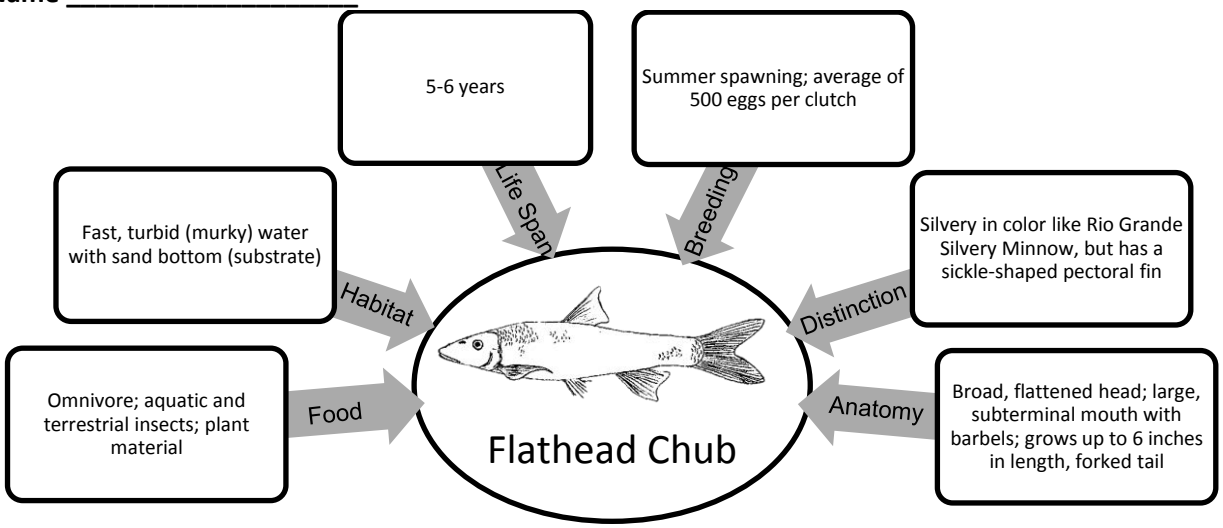


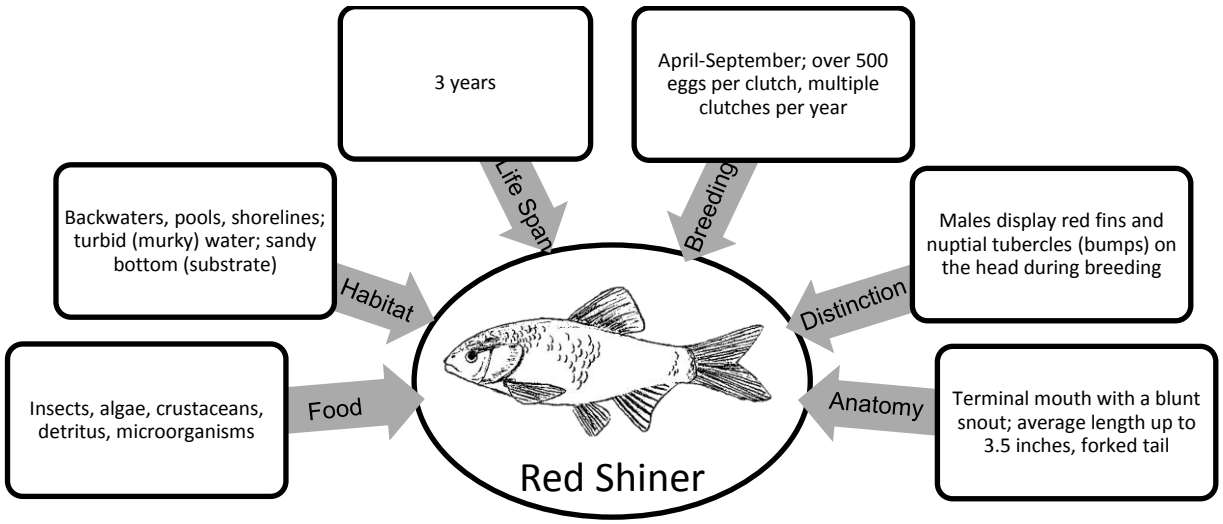
Answer the questions below

1. TRUE (FALSE) White Suckers can lay 100,000 eggs that sink to the bottom of the river.
2. Describe the habitat where White Suckers live. *pools with cover and sandy or rocky substrate*
3. How long do White Suckers live in the wild? *up to 17 years*
4. (TRUE) FALSE Longnose Dace have barbels.
5. Does the Longnose Dace prefer pools or riffles with a gravel bottom? *riffles*
6. How long do Longnose Dace live? *up to five years*
7. What does the Longnose Dace and the White Sucker both feed on? *aquatic insects, algae, and detritus*

ANSWER KEY: FLATHEAD CHUB & RED SHINER

Name _____





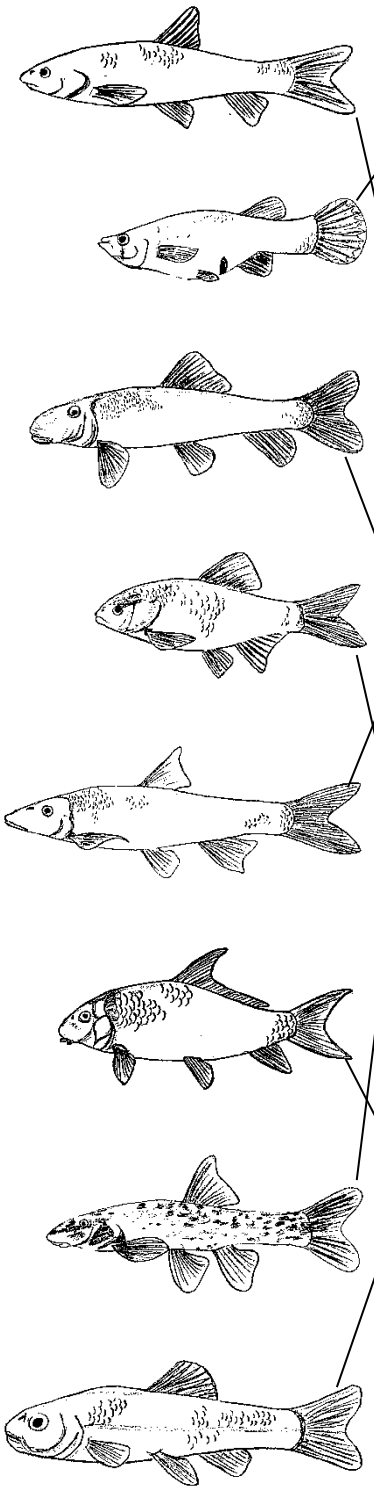
Answer the questions below.

1. How does the Flathead Chub get its name? __*it has a flattened head*_____
2. What does a Flathead Chub eat? __*aquatic and terrestrial insect, plant material*_____
3. (TRUE) FALSE Flathead Chub lives in turbid waters.
4. TRUE (FALSE) Red Shiners only reproduce once per year.
5. How does a Red Shiner get its name? __*males display red fins during spawning*_____
6. A Red Shiner has what type of mouth? _*terminal*_____
7. What type of tail do both the Flathead Chub and the Red Shiner have? __*forked tail*_____

ANSWER KEY: WHAT AM I?

Name _____

Draw a line from the fish to the correct name and description.



I am a western mosquito: I am known to give birth to live young. I have been introduced around the U.S. to control a pest.

I am a Longnose Dace: I prefer faster riffles with gravel substrate. I have a mottled (spotty) dark coloration and barbels.

I am a Flathead Chub: I prefer faster water and have sickle-shaped pelvic fins and barbels.

I am a Rio Grande Silvery Minnow: My eggs a semi-buoyant. I am an endangered species.

I am a White Sucker: I can live up to 17 years and have a subterminal (downward pointing) mouth.

I am a Fathead Minnow: The males of my species protect the nest. I usually have a dark lateral line.

I am a Red Shiner: I am common in the Rio Grande. The males of my species display bright red fins during breeding season.

I am a River Carpsucker: I have a long dorsal fin and produce sticky eggs that sink to the bottom.

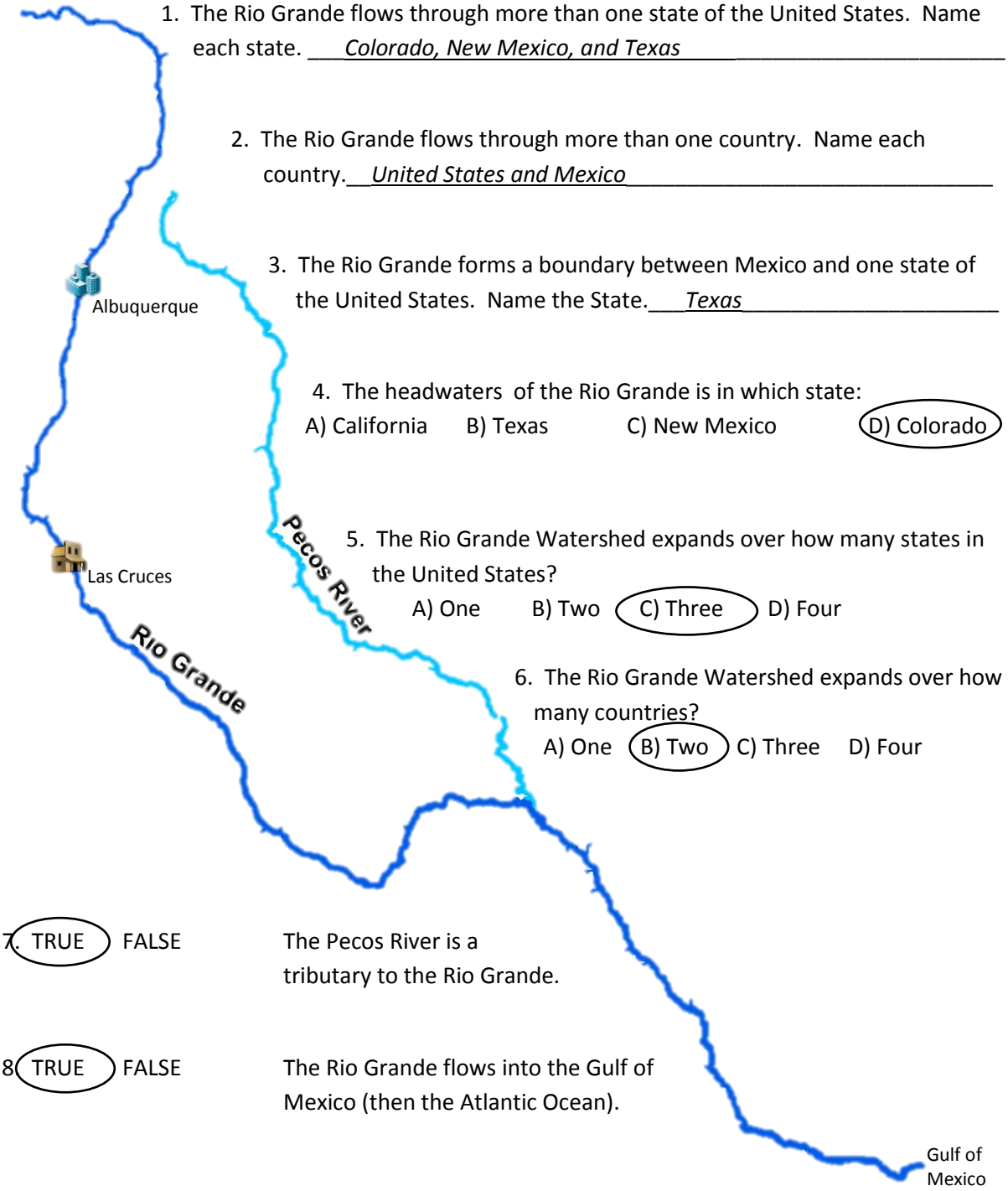
ANSWER KEY - FISHY FUN 101 MATCHING GAME

	Rio Grande silvery minnow	river carpsucker	white sucker	western mosquitofish	flathead chub	fathead minnow	longnose dace	red shiner
Mouth	subterminal	subterminal, small	subterminal, fleshy	superior	subterminal, large with barbels	terminal, very small	subterminal, very small barbels	terminal
Key feature	endangered	long dorsal fin	male has rosy line during breeding	male has tube-like anal fin (gonopodium)	flattened head	males have tubercles	mottled dark coloration	males have red fins during breeding
Food	diatoms, algae	algae, detritus, protozoa	algae, insects, detritus, usually feeds at night	insect larvae, algae, fish fry	aquatic and terrestrial insects	algae, microscopic crustaceans, insect larvae	algae, detritus, aquatic insects	insects, algae, crustaceans, microorganisms
Lifespan	1-2 years	10-11 years	17 years	about 1 year	5-6 years	2-3 years	5 years	3 years
Breeding	pelagic spawner with 3,000 semi-buoyant eggs	100,000 sticky eggs that sink	50,000 eggs that sink	200 live young	500 eggs per clutch	12,000 sticky eggs per nest that the male guards	10,000 sticky eggs per year	multiple clutches per year with 500 eggs
Habitat	slow water with muddy/sandy bottom	pools and backwaters with a sandy bottom	pools with cover and sandy or rocky bottom	pools, backwaters, springs, sinkholes	fast, turbid waters	slow, turbid water, submerged plants	riffles with gravel and rock bottom	backwaters, pools, shorelines
Max length	3.9 in (100 mm)	13.5 in (342.9)	12 in (304.8)	2.5 in, 1.5 in (63.5, 38.1 mm)	6 in (152.4 mm)	3.0 in (76.2 mm)	4 in (101.6 mm)	3.5 (88.9mm)

ANSWER KEY: GEOGRAPHY OF THE RIO GRANDE

Name _____

Use your reference sheet to answer the following questions.



1. The Rio Grande flows through more than one state of the United States. Name each state. ___*Colorado, New Mexico, and Texas*_____

2. The Rio Grande flows through more than one country. Name each country.__*United States and Mexico*_____

3. The Rio Grande forms a boundary between Mexico and one state of the United States. Name the State.___*Texas*_____

4. The headwaters of the Rio Grande is in which state:
A) California B) Texas C) New Mexico (D) Colorado

5. The Rio Grande Watershed expands over how many states in the United States?
A) One B) Two (C) Three D) Four

6. The Rio Grande Watershed expands over how many countries?
A) One (B) Two C) Three D) Four

7. (TRUE) FALSE The Pecos River is a tributary to the Rio Grande.

8. (TRUE) FALSE The Rio Grande flows into the Gulf of Mexico (then the Atlantic Ocean).

ANSWER KEY: THE RIO GRANDE CONTINUUM

Name _____

Unscramble the words

1. andS __Sand_____
2. duiTrb __Turbid_____
3. Haetdraews __Headwaters____
4. Mhtuo __Mouth_____
5. aedSh __Shade_____
6. laaoPsiCnstla __Coastal Plains___
7. tonievhgEHail __High Elevation__
8. cettiVaoelyWr __Water Velocity__
9. itiyDisFrshev __Fish Diversity___
10. tryibrTau __Tributary_____

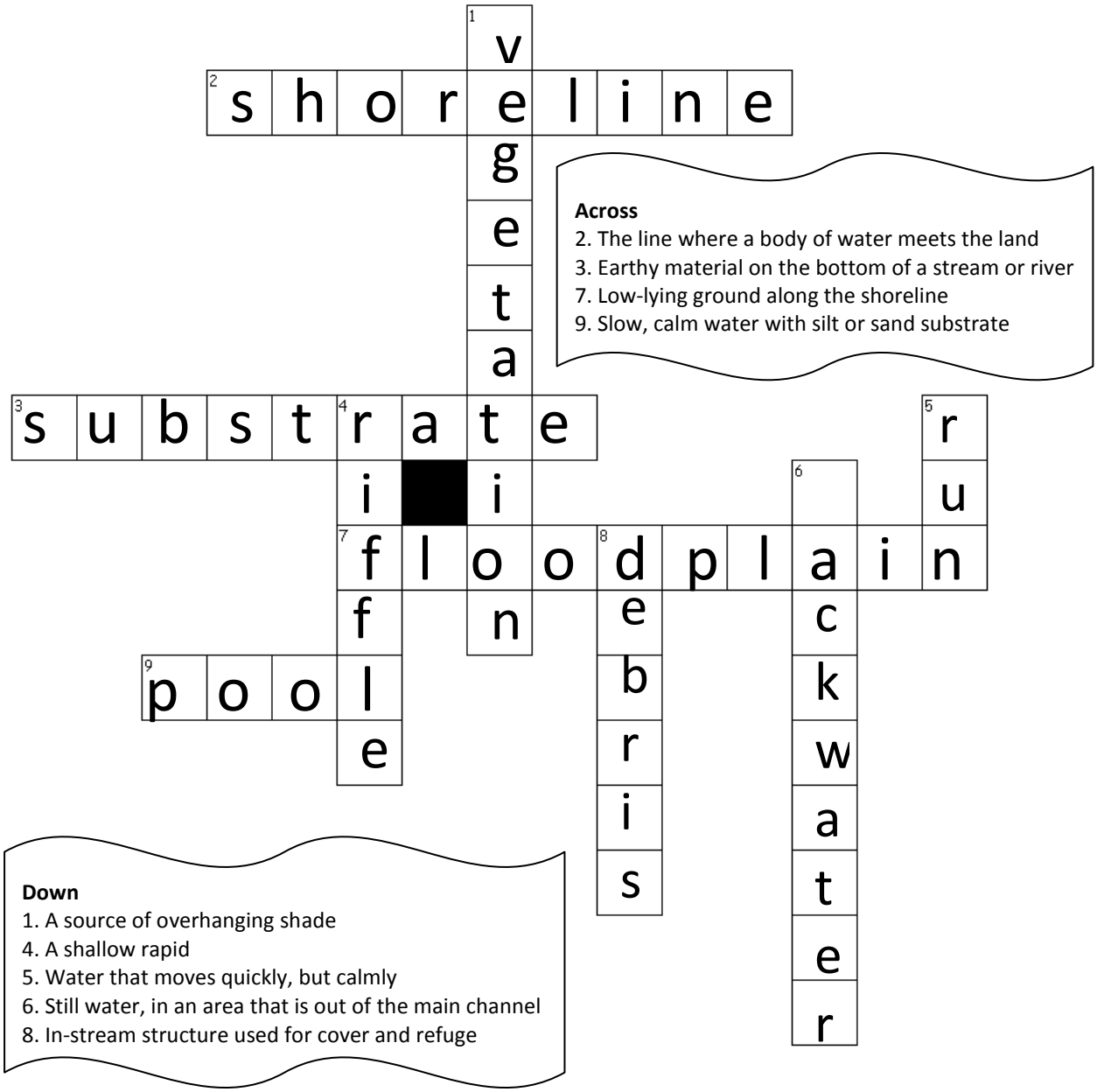
Use the words above to fill in the blanks.

1. __*Sand*_____ is the expected substrate near the mouth of the Rio Grande.
2. As the Rio Grande grows in size, from the headwaters to the mouth, __*fish diversity*_____ also increases.
3. In a section of river that is warm, water clarity is expected to be __*turbid*_____.
4. The streams at the sources of a river are called_*headwaters*_____.
5. The _*mouth*_____ is the end of the Rio Grande where it empties into the Gulf of Mexico?
6. Shoreline vegetation provides a lot of _*shade*_____ for the headwaters of the Rio Grande.
7. The flora (plant life) is called __*Coastal Plains*_____ at the mouth of the Rio Grande?
8. The headwaters are in _*high elevation*_____ areas.
9. As the slope decreases in a river, the _*water flow*_____ also decreases.
10. The Pecos River is a __*tributary*_____ to the Rio Grande.

ANSWER KEY: PIECES OF THE AQUATIC HABITAT PUZZLE

Name _____

Complete the crossword puzzle.



Across
2. The line where a body of water meets the land
3. Earthy material on the bottom of a stream or river
7. Low-lying ground along the shoreline
9. Slow, calm water with silt or sand substrate

Down
1. A source of overhanging shade
4. A shallow rapid
5. Water that moves quickly, but calmly
6. Still water, in an area that is out of the main channel
8. In-stream structure used for cover and refuge

Riffle, runs, pools and backwaters are all in the course of a river!

ANSWER KEY: RIO GRANDE SILVERY MINNOW HABITAT & THREATS

Name _____

1. Name three threats to the Rio Grande Silvery Minnow:
   Any - loss of habitat (water), water pollution, disease, predation

2. The Silvery Minnow is found in what percent of its historic range:
   a. 1%
   b. 7%
   c. 40%
   d. 100%

3. Name one example of water pollution that may affect Rio Grande Silvery Minnows:
   Any - urban, mining, ash, or agricultural run-off, manure, sediment, gasoline, oil

4. True / False: The Rio Grande is the same as it was 150 years ago.

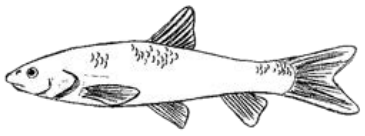
5. What do Rio Grande Silvery Minnow eat? *Diatoms, algae, plant material*

6. How long do Silvery Minnow live in the wild?
   a. 3-5 years
   b. 1-2 years
   c. 4-6 months
   d. 1-2 months

7. True / False: The Rio Grande Silvery Minnow is Endangered.

8. The Rio Grande Silvery Minnow lives in what type of habitats?
   a. Pools
   b. Shorelines
   c. Backwaters
   d. All of the above

9. In your own words, describe how loss of river habitat affects fish in the river.



ANSWER KEY: AFTER THE STORM

Video co-produced by the U.S. EPA and The Weather Channel

Name _____

Match the terms to the descriptions.

TERMS		DESCRIPTIONS
Watershed	**D**	A. An area of water lacking in vital oxygen.
Fecal coliform	**C**	B. Surface water flow that has picked up bacteria, toxic chemicals, fertilizers, pesticides, and trash.
Hypoxic zone	**A**	C. A general group of bacteria like *E. Coli*, salmonella, or enterococcus that indicates feces (poop) from animals, including humans, are present.
Polluted runoff	**B**	D. Area of land that drains to a body of water like a river, a stream, an estuary, a bay, an ocean.
Wetlands	**E**	E. A natural resource that removes pollutants and provides important habitat such as swamps, marshes, and bogs

Circle True or False for each question.

(True) False: What we do in our watershed, affects people downstream of our watershed.

True (False:) Approximately 97% of the water on earth is freshwater.

(True) False: The hypoxic zone in the Gulf of Mexico is roughly 9,000 square miles, the size of New Jersey.

True (False:) Impervious surfaces allow water to soak into the ground.

(True) False: One person can make a difference.

Name as many pollutants identified in the video as you can. *tires, bacteria, toxic chemicals, agricultural run-off (nitrogen rich fertilizers), trash, storm run-off, residue of urban living, salmonella, fecal coliform, dog poop, manure, pesticides*

What can you do to make a difference? *responsible herbicide/pesticide application, prevent oil and chemical spills (good vehicle maintenance), do not litter, pick up trash, green space, rain gardens, water conservation, hazardous waste to recycling facilities and any other way a student thinks will be helpful.*

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Appendix B – Supplemental Maintenance

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END-OF-YEAR CLEANUP

At the end of the program, please clean all equipment. However, it is not necessary to disinfect the equipment. This will be completed by NMFWCO staff to ensure appropriate disinfecting methods are used. For clarification, the act of cleaning is the removing of large debris, dirt, and grime from the equipment. Disinfecting is killing bacteria and viruses found on the equipment.

1. Turn off and unplug the filter.

2. Empty the aquarium with the siphon, cleaning as much debris as possible from the gravel as it empties.

3. Finish emptying the aquarium and disconnect the tubing.

4. Wipe down the interior and exterior of the aquarium with regular tap water. The aquarium scrubber can be used to scrub hard-to-remove scale and algae growth.

5. Remove and rinse out all tubing. Keep a bucket under all of them to prevent spills, or complete this process outdoors.

6. Gravel should be removed, rinsed, and dried by laying it out on a cloth or towel in the sun or a ventilated area.

7. Rinse off the air stones and let the stones dry in a well-ventilated area.

8. Drain the canister filter. Scrub the plastic parts and rinse the filter media. Dry them in the sun or a well-ventilated area.

TROUBLESHOOTING

It is best to prevent any problems and carefully maintain the aquarium environment. The priority in an emergency is to get the aquarium environment back to normal; no emergency procedure can replace the stability of a fully functioning aquarium set-up.

Are leaks a problem? How can I prevent leaks?
Physical contact with the system could damage connections, particularly movement of the hosing. For this reason, students should not touch the filter equipment without supervision. A serious leak will pump the entire contents of the aquarium onto the ground within a very short time.

What happens if there is a power failure? How much time do I have?
Short downtimes, of an hour or two, will not likely harm the fish or change aquarium temperatures by any great amount. However, lost power during the night or over a weekend (or worse still, a long vacation) will likely be fatal to the fish. The fish are able to survive a wide range of temperatures from 60 to 80° F as long as it is a gradual change. Our main concern will be providing aeration to maintain dissolved oxygen (necessary for respiration) for an extended period (>12 hours). It is recommended that you obtain a battery-operated aerator to provide aeration during power outages.

What do I do with my fish in an emergency?
A five-gallon bucket and battery-operated aerator are suitable for holding fish in an emergency, if there is a problem with the aquarium. The priority in an emergency is getting the aquarium environment back to normal; no emergency procedure can replace the stability of a working aquarium. If an emergency does occur, call the NMFWCO biologist (Angela James) immediately.

What should I do if there is a serious leak while I am away, and the aquarium is almost empty when I return?
If there is a serious leak, during the night or weekend, almost all of the aquarium water may be pumped out. It is unlikely that the aquarium set-up will fail on its own, but it is important to be ready in the event of such an accident. First, complete an immediate assessment to see if you can determine the location of the leak. Next, unplug all the equipment to prevent further damage to the equipment. Now focus on your fish. Move your surviving fish to your reserve water tub. Monitor the water temperature and make sure there are no large fluctuations. Agitate your water tub or add an aerator to increase dissolved oxygen levels. You will probably need to notify your janitorial staff to aid in clean up.

Next, figure out what went wrong with the aquarium set-up. Generally, you will need to find and fix a leak or return a hose to its proper location. Damage to the aquarium or loose hosing in the canister filter will be your likely causes. Once you have pinpointed your leak and repaired it, you can begin adding water back to your aquarium. You can move the reserve water (save some for canister filter) and your fish back into the aquarium at the same time. There should not be a need for tempering since the aquarium and reserve water are already at room temperature. As you fill the aquarium, make sure it is not leaking. Next, open the canister filter and pour out all the water and rinse the filter media. Because there was no water circulation, the filter will be full of dead bacteria that can harm your fish. Use some water from the reserve water tub to refill the filter. Reconnect the filter and check for leaks.

What is a normal death rate?
The life spans of your fish range from 1 to 5 years, with the fish at various stages of their life cycle.

Death is a natural part of that life cycle. However, losing several fish is a sign that the aquarium environment is not healthy. As they grow, fish produce more waste, so cleanings and water changes may be needed more often. Poor water quality because of insufficient cleaning or water changes is among the most serious threats to fish health. High ammonia concentrations can result in sudden fish death. Other causes of fish death might be temperature fluctuations, lack of aeration, and chemical exposure.

What do I do with dead fish?
It is very important that dead fish and decaying waste matter (discarded food for example) be removed as soon as possible. This should be done at least once a day, and even more often during critical periods or as needed. This process alone is very important in keeping the remaining fish alive.

How sensitive are the fish to temperature changes?
Fish are cold-blooded animals and must be allowed time to adjust to changes in temperature. Fish can handle small fluctuations of one or two degrees, but sudden changes of three degrees or more are a serious threat to fish survival, particularly if these changes occur suddenly within a few minutes of time.

How can I help keep a stable aquarium temperature?
Because water changes may introduce warmer water into the aquarium, please limit these changes to 20% of your aquarium volume at any one time. The use of insulation will help the aquarium maintain a stable temperature. Larger aquariums will also help protect fish because they have more water to buffer changes.

Should students wash hands before touching aquarium water?
Students should clean their hands (without using soap) before working in or around the aquarium. Simply use warm tap water for this, and for cleaning of other objects like nets and the bucket. This will help keep chemicals and dirt from getting into the aquarium. Moisturizers and other skincare products might also harm fish. It is very important that no soap enter the aquarium environment, because soap may harm or kill fish even in small concentrations.

Should students wash up after contact with aquarium water?
Yes. While aquarium water is not particularly hazardous to students, they should clean their hands with soap and warm water. Please do not use soap until all aquarium work is finished.

What is an ammonia spike? What can I do about it?
An ammonia spike is a sudden increase in ammonia levels, often nearing or going above our acceptable range. This is a serious threat to fish health. The aquarium filter and its bacterial population help reduce problems like this, but they cannot work alone. The best way to prevent any chemical imbalances in the aquarium is to regularly clean the aquarium, and change the water. All debris such as food, waste, and dead fish should be removed as soon as possible. Water changes of 20% per week are required and should not be skipped. There is no replacement for regular cleaning and water changes.

Can I use ammonia removal grains to prevent ammonia spikes?
Ammonia removal grains may be used only in a dire emergency if a large water change did not reduce the ammonia level. These chemicals tie up the ammonia in the water rendering it harmless to the fish. However, by tying up the ammonia, your nitrifying bacteria are deprived of the food they need to live and grow. So in the end, while you have reduced your ammonia, you are killing off your long-term ammonia reducer.

My aquarium is coated with a green slime. What is this? What should I do?
Green films or slime may indicate algal growth. This will not necessarily hurt your fish but should be cleaned in conjunction with your normal water changes. It can be mechanically cleaned by using an aquarium scrubber. In addition, to prevent further algal growth, it is best to limit the amount of light entering the aquarium. The use of foam board to cover the back and sides of the aquarium will help reduce algal growth. The aquarium should never be in direct sunlight at any time.

The water in my aquarium is cloudy. What should I do?
Cloudy water probably indicates an excess in decaying matter. This may be from dead fish, leftover food, or a problem with the filtration. A regular water change, as well as cleaning the aquarium of all solid material, is the best way to fight this problem. Make sure the filter is functioning properly, and that water is flowing out of it. Clean filter components if needed with aged or well water, but do not use soap or any chemical cleaners. If fish are not eating all provided food, you may reduce the amount given until they are able to eat it all. Excess food after 10 minutes of feeding should be removed and discarded.

Should I use the lid for my aquarium?
Fish jump! Keep the aquarium tops closed when you are not actively cleaning the aquarium. This prevents objects from falling in and prevents fish from jumping out. The aquarium lids include lights, but it is important that the light feature not be used.

Does my aquarium need insulation?
Many aquarium systems have worked without insulation. However, insulation will provide a darker, more stable environment for the fish. The reduced view will minimize stress for the fish. In addition, insulation will reduce the amount of work needed to maintain the water temperature.

How can I inform custodians, or other teachers, about what to do if there is an emergency while I am away?
It is a good idea to give custodians some basic information about the requirements of your aquarium. For example, it is important that custodians know that your aquarium always needs electricity. It would be most helpful to place a sheet of paper (in a visible location) describing emergency procedures. This might include contact numbers, and basic advice on what to do to stabilize the aquarium if there is a filter failure, leak, or power outage. An example is provided below:

AQUARIUM EMERGENCY PROCEDURE:

In the event of a power outage, aquarium leak, or any other aquarium related problem contact:

Primary Point of Contact: _____ at: _____
Secondary Point of Contact: _____ at: _____

Then,
If there is a problem with the aquarium, a 5-gallon bucket and a portable aerator are good choices for holding fish in an emergency.

In the event of a power outage or filter failure: The fish in this aquarium need aeration. If possible, the electricity to this aquarium should be turned on again. If the electricity must be off because of maintenance or construction, please contact me as soon as possible.

If I cannot be contacted in time: Place the battery operated aerator, located _____, in the aquarium to help keep it aerated.

In the event of a serious leak: A serious leak can be stopped by unplugging the filter and placing the hosing back into the aquarium.

- ✓ First, complete an immediate assessment to see if you can determine the location of the leak. Next, to prevent damage unplug the filter.
- ✓ Now focus on the fish.
- ✓ If the aquarium itself is leaking, you will need to move the fish to the reserve water tub.
- ✓ Add an aerator to the reserve water tub.
- ✓ If the filter is leaking, leave the fish in the aquarium.
- ✓ Ensure the aerator is still running, if not add the battery operated aerator.

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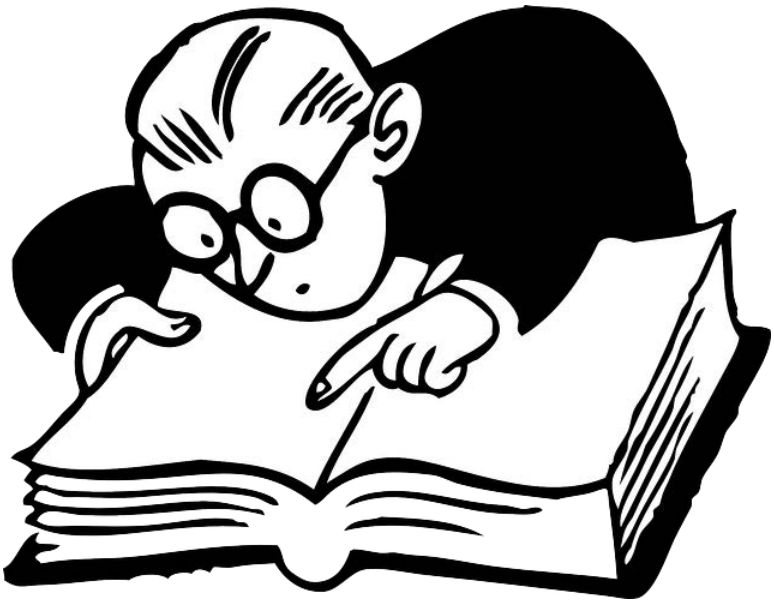
Glossary of Terms



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Glossary of Terms

Accurate: Free from mistake or errors, consistent with a standard.

Acid rain: Rainwater with an abnormally low pH level, generally caused by industrial pollution.

Acidity: State or degree of being acid; pH is less than 7.0.

Acre-foot: A volume of water that covers one acre to a depth of one foot; equal to 43,560 ft^3, 325,851 gallons or 1,233.48m^3.

Adaptation: The ability of an organism to adjust to a change.

Adipose fin: A small "fatty" fin without rays.

Aerator: A pump used to push air through the air stone.

Aggradation: The process of building up the riverbed relative to the surrounding floodplain, due to deposition of sediments from the river.

Air stone: A porous structure used to mix oxygen into the water.

Alevin: Larval fish that receive nutrients from a yolk sac.

Alkaline: Material that is basic rather than acidic; having a pH greater than 7.0.

Ammonia: NH_3, a waste produced by eggs and fish.

Anadromous: This describes the life history of any fish born in fresh water but that migrates to the ocean at some point in its life, and later returns to freshwater to spawn.

Anal fin: The anal fin is behind the vent and is used for swimming and stabilization.

Anatomy: The study of the structures of a body.

Annelids: A segmented worm of the phylum Annelida. Earthworms and leeches are common annelids.

Anterior: Pertaining to the front or head of an animal.

Aquarium stand: A platform specially made to hold the weight of an aquarium.

Aquarium: A container where living aquatic animals are kept.

Aquatic ecosystem: A variety of habitats pertaining to salt or freshwater. Examples include streams, lakes, rivers, ponds, wetlands, estuaries, seas, and oceans.

Aquatic: Inhabiting a fresh water environment.

Aquifer: An underground layer of sand, porous rock, or gravel containing water.

Arid: Describing a climate characterized by dryness, often designated as receiving annual precipitation less than 10 inches (25 cm).

Arthropod (aquatic): Organisms from the Phylum Arthopoda, characterized by segmented bodies and hard exoskeletons. The most common arthropods are insects. Some are aquatic or have aquatic stages, like the damselfly.

Arthropod (terrestrial): Organisms from the Phylum Arthopoda, characterized by segmented bodies and hard exoskeletons. The most common arthropods are insects. Terrestrial insects can fall from trees or vegetation on the bank into the stream where they become food for fish.

Backwater: An area that is out of the main channel with still water. This area will likely have silt or sand substrate like a pool.

Barbels: This is a sensory organ (whiskers) growing on the mouth or head of a fish equipped with taste buds.

Bearers: Fish that carry their eggs with them until they find a safe location or until the eggs develop and are actively swimming young.

Benthic: Living in or at the bottom of a sea or lake.

Biological diversity (Biodiversity): The variety of life found in a particular space (either the whole planet or a specific habitat). The greater the number of unique organisms in a space the greater the biodiversity.

Biotic community: All organisms living on and contributing to a specific region or area.

Bosque: Spanish for “woods” or “forest”; in the Southwest it has been used to describe the cottonwood area adjacent to a river.

Breed: To produce offspring; to reproduce.

Brood hiders: A fish that hides its eggs in some manner.

Brood year: The year eggs are produced.

Broodstock: Sexually mature fish from which eggs and milt are taken.

Button-up fry: The stage in fry development when the belly seam closes as the yolk sac is consumed.

Camouflage: Coloration or pattern to conceal from danger or for predatory advantage.

Canister filter: A container filled with media that houses beneficial bacteria.

Carnivore: An animal that feeds on other animals.

Catch and Release: The practice of releasing, live, all the fish caught.

Caudal fin: The caudal fin is the tail fin. It provides the initial "push" for a fish to start moving and acts as a rudder for steering through the water.

CFS: Cubic feet per second; the typical unit to record river flows, measuring the amount of water passing a given point; calculated by measuring the width and depth of the channel (area) multiplied by the velocity of the flow (feet per second).

Char: Any of several freshwater fish species that are found in the Salmonidae family, but distinguished from their trout relatives by light-colored spots on a dark body (rather than black spots on a light-colored body) and a special boat-shaped bone in their mouth. Examples of Char include Brook Trout, Lake Trout, and Arctic Char.

Chemical test: Test made with standard chemical reagents that are known to react with other solutions in a given manner. Each chemical test provides results within a range of values.

Chiller: A device used to cool water for cold-water fish like trout.

Chlorine: A disinfecting agent used to purify water. A gaseous chemical element.

Closed basin: A drainage area that is surrounded by high land (like mountain ranges) and where surface water soaks into the ground, becoming groundwater or pools to become a lake instead of connecting to a larger river and ultimately an ocean.

Clutch: A group of eggs laid and fertilized at the same time.

Cohort: A group of individuals of the same age.

Coldwater fish: A fish that prefers clear, cold waters that do not handle extreme temperature changes and cannot survive for long periods with temperatures above 68° Fahrenheit. Species such as trout, salmon, and grayling are recognized as cold water fish.

Color chart: A chart displaying colors used to compare the test solution's color.

Community: An association of organisms (plants, animals, microorganisms) that live in and contribute to a particular place or habitat.

Competition: The interaction between organisms over resources such as food, living space and mates; can either be between organisms of the same species (intraspecific competition) or between organisms of different species (interspecific competition).

Condensation: The process by which a gas is changed into a liquid.

Confluence: The area where two streams or rivers join.

Conservation: The goal of preventing the loss (extinction) of animals, plants, and other organisms from the environment, while at the same time allowing for their wise use.

Consumer: An organism that eats (consumes) other living things.

Continental Divide: A separation of drainage basins; Water west of the separation flows to the Pacific Ocean and water east flows to Atlantic Ocean.

Crustaceans: A class of arthropods with hard exoskeletons. Crayfish are an example of a food fish eat.

Data: Information collected by scientists.

Debris (in-stream): Structure that is located in the stream providing cover and refuge from faster waters. Debris can be natural such as logs and tumbleweed or fabricated structures such as jetty-jacks.

Degradation: Having a reduced quality or condition degradation of habitat refers to the reduction of the quality or condition of natural areas that provide habitat (food, water, shelter, space) for living organisms.

Detritivore: An animal that eats small pieces of dead plant, animal, or organic matter (detritus).

Discharge: In a stream or river, the rate of flow at a given instant, measured as volume per unit of time; see CFS.

Dissolved oxygen (DO): Oxygen in its gaseous form dissolved in aqueous water.

Dorsal spines: Bony, needlelike projections found on the anterior end of the dorsal fin.

Dorsal: This is the upper side or back of an animal.

Downstream: In or towards the lower part of a stream or river; with the current.

Dropper bottle: A bottle containing a known solution used in the water quality testing kit.

Ecological disturbance: A temporary change in the environmental conditions of an area that cause a notable change in the ecosystem.

Ecological niche: The role of an organism in its habitat and its interactions with other organisms.

Ecology: The science that studies the interactions among living organisms with each other and their environment.

Ecosystem: All the abiotic (nonliving elements such as sunlight, minerals, soil, water, temperature) and biotic (living things) features and all their relationships contained within a set amount of space.

Ectothermy: The condition whereby an organism's body temperature is determined by the surrounding ambient (air) temperature (such an organism is called "ectothermic" or an "ectothermic").

Egg: A mature female sex cell, also called the ovum.

Endangered species: A species of animal or plant in danger of becoming extinct.

Endothermy: The ability of an organism to produce sufficient metabolic heat to maintain its core body temperature above (or in situations below) the surrounding ambient (air) temperature (such an organism is called "endothermic" or an "endotherm").

Energy pyramid: A summary of energy relationships along a food chain.

Equilibrium: A state of balance due to equal actions of opposing forces, processes, etc.

Eutrophication: The process by which plant nutrients cause algal blooms resulting in oxygen depletion.

Exotic species: Plant or animal either brought into an area by humans accidentally or on purpose; introduced species, nonnative species, and alien species.

Extinct: A species of animal or plant that is no longer in existence.

Extirpated: A species of animal or plant that no longer exists in a given area.

Eyed egg: A stage in the development of the egg in which the embryo's eyes can be seen.

Eyes: A sensory organ used for sight. The pupils are slightly triangular instead of circular, allowing for a larger field of vision. Trout can see clearly in front and to the sides of them. Trout can see above them and slightly behind them, but the images are not as clear. In addition, the eyes have large pupils that allow all the available light to be admitted.

Fecal coliform: A general group of bacteria like *E. Coli*, salmonella, or enterococcus that indicates feces (poop) from animals, including humans, are present.

Filter Hosing: A plastic tubing that moves water from the aquarium, to the filter, back to the aquarium.

Fingerlings: Trout that are larger than fry that can move into different habitats within the stream; usually 4-6 inches long.

Fish: A member of a large group of finned, aquatic, cold-blooded (ectothermic) vertebrates.

Flatworms: Any worm of the phylum Platyhelminthes, having two-sided symmetry and a soft, solid, usually flattened body. Planarians, tapeworms, and trematodes are common flatworms.

Floodplain: Low-lying ground along the shoreline, generally bordering both sides of the river, likely to flood during rain or snowmelt events. This area also usually consists of soils rich in nutrients deposited by floodwaters.

Food chain: The dependence for food of an organism upon another organism in a series beginning with plants and ending with top predators.

Food web: A complex connection of multiple organisms depending on another for food and nutrients.

Fork: This is the part of the caudal fin that forms a depression.

Freshwater: An aquatic environment such as streams, rivers, and lakes with little dissolved mineral matter and which results directly from precipitation (rain) rather than salt water (seas and oceans).

Fry: Larval fish that no longer depend on their yolk sac for nutrients and actively seek food.

Generalist: An organism that feeds on a variety of other organisms.

Gills: These are respiratory organs used to breathe; the water passes over the gills where tiny blood vessels exchange carbon dioxide for oxygen.

Gonopodium: In male Western Mosquitofish, the elongated anal fin used in reproductive behavior.

Green Egg: A newly spawned egg that is very vulnerable at this stage of development.

Guarders: Fish that protect their eggs and sometimes will even guard their young.

Habitat: The area where an organism normally lives that provides the organism with food, water, and shelter.

Hatchery: A location where fish eggs are collected, incubated, hatched and reared for release.

Headwaters: One or more tributary streams that form the source of a major river.

Herbivore: An animal that eats plants.

Hydrograph: A graph showing the volume of water in a river or stream over time.

Hydrology: The study of the Earth's waters, their distribution, and the cycle involving evaporation, condensation, and precipitation.

Hypoxic zone: An area of water lacking in vital oxygen.

Inferior mouth (subterminal): A mouth that is on the bottom (subterminal) of a fishes head that allows it to scoop or scrape food from the substrate.

Insectivore: An animal that eats insects and other small invertebrates.

Invertebrate: An organism without a backbone.

Keystone species: A species that greatly affects the structure of a community, such that removing the species will cause substantial changes to the composition of that community.

Kype: The hooked lower jaw of a spawning male trout.

Larva: Stage of development of a newly hatched animal that is devoted to growth; in most insects, the immature, flightless stage that transforms into a resting stage called a pupa or another stage before becoming an adult (plural = larvae).

Lateral line: A line of sensory organs along a fish's side that allows it to detect vibrations in the water.

Levee: A natural or constructed embankment that confines a river to its channel or prevents it from overflowing.

Life cycle: The complete series of changes undergone by an organism during its life.

Litter: Trash, such as paper, cans, cigarette butts, and bottles, which are not disposed of properly and dirty an open or public place.

Live-bearing: Fish that retain their eggs internally until they have developed into actively swimming young.

Meander: A winding curve or bend in a stream or river.

Metamorphosis: The physical change that some organisms undergo as they mature from egg to adult.

Migration: Moving from one ecosystem to another. For example, some species of salmon migrate from the ocean to freshwater rivers.

Milt: A milky fluid produced by male fish that contains sperm.

Mollusks: An invertebrate that has a soft, unsegmented body and lives in aquatic or damp habitats, and most kinds have an external shell. Snails, clams, mussels, and slugs are common mollusks.

Mouth: This is a structure used to taste and eat food. Fish will take many items into its mouth to see if they are worth eating. If they feel like food and the juices taste good, the fish will reposition the items in its mouth and swallow them whole. If it does not like what it tastes, it will spit them out.

Nares: These are sensory organs used to smell. The nares are closed sacs that functions as nostrils, helping the fish to detect odors.

Native: A species that occurs naturally with respect to a particular ecosystem. The species has evolved or developed within the surrounding habitat.

Nematode: An unsegmented worm of the Phylum Nematoda. Roundworms are nematodes that fish eat.

Niche: The "occupation" of an organism; the role of an organism in its ecosystem.

Nitrate: A product (chemical compound) formed from the breakdown of ammonia and nitrite during the nitrogen cycle. NO_3- Nontoxic to fish.

Nitrite: A product (chemical compound) formed from the breakdown of ammonia during the nitrogen cycle. NO_2- Toxic to fish.

Nonguarders: Fish that do not provide any protection for their eggs or young.

Nonnative (introduced): a species that occurs as a result of an accidental or deliberate introduction into a particular ecosystem; the species did not occur in that ecosystem prior to human introduction.

Nonpoint source pollution: Pollution caused by land use practices, rather than from a single, identifiable source.

Nutrient: A substance that provides nourishment and encourages growth.

Nymph: An immature larval stage of various insects.

Omnivore: An animal that feeds on both animals and plants.

Operculum: This hard plate covers and protects the gills on a fish.

Parasitism: Two organisms living together, one benefiting at the expense of the other.

Pectoral Fins: These paired fins act as brakes and help with side-to-side and gliding movement in fast currents.

Pelagic spawner: A fish that spawns in open-water, producing floating or semi-floating eggs.

Pelvic Fins: The pelvic or ventral fins are paired fins that are set back from the pectoral fins. They help with up and down movement through the water column.

pH (the power of Hydrogen): A measure of the acidity or alkalinity of a substance. The pH scale indicates the concentration of hydrogen (H+) ions in the substance.

Point source pollution: Pollution that is caused by a single, identifiable source.

Pollution tolerance: An organism's ability to withstand the effects of pollution.

Pollution: Contamination of air, water, or soil.

Pool: An area with slow, calm water and silt or sand substrate. This usually occurs because the water is moving so slow it allows the silt (fine sediment) to settle out of the water.

Population: A group of organisms of the same species that live in the same area at the same time.

Posterior: Further back in position or pertaining to the rear end of an animal.

Predator: An organism that kills and eats other organisms.

Prey: An organism that is eaten by other organisms.

Primary consumer: An animal that eats plant material; an herbivore.

Producer: Organisms able to make organic material (food) using energy from the sun, thus forming the basis of the food chain or web. Plants, for example, convert the sun's energy into food that consumers can access by eating the producers.

Reclamation: The act or process of bringing a wild or wasteland into a condition for productive use, or repairing an area after activities such as mining.

Redd: The nest a trout makes in the gravel bottom of a stream or river where the female lays her eggs.

Regulated river: A river whose flow is artificially controlled, particularly by dams and diversions but also by modifications to the structure of the channel.

Reservoir: A lake in which water is stored for use; generally an artificial lake (Cochiti and Elephant Butte Lakes are reservoirs).

Respiration: The process by which oxygen is exchanged for carbon dioxide.

Restoration: The process of restoring an area to its natural condition (or a condition that mimics that natural condition as closely as possible).

Riffle: A shallow portion of a stream where water breaks over rocks producing surface agitation.

Riparian: Relating to living or being located on the bank of a fresh watercourse such as a river, stream, pond, or lake.

Riverine: An or near the banks of a river; of or pertaining to a river.

Run: A section of stream or river where water moves quickly, but calmly. A run lacks rapids like a riffle and moves too quick to allow silt to settle.

Run-off: The discharge of water through surface streams; the amount of water (originating as rain or snow) that drains from an area.

Sac-fry: A newly hatched alevin with the yolk sac still attached.

Salmonid: A fish in the trout or salmon family.

Salmonidae: A family which contains true trout, salmon and char. Salmonids (the name for fish in this group) prefer cool water temperatures and some migrate to the ocean.

Secondary consumer: An animal that eats other animals; a carnivore.

Sediment: Solid matter that settles to the bottom of a stream, lake, or pond (sand, silt, clay, rocks).

Shoreline: The line where a body of water meets the land.

Siphon: A tool used to remove water and vacuum debris from the aquarium.

Soils: The surface layer of earth.

Spawn: A term used to describe reproduction behavior in fish; it includes the fertilization of eggs with sperm.

Spawning: The act of laying and fertilizing eggs to produce offspring.

Specialist: An organism that eats only one type of food or prey.

Species description: Formal explanation of the defining characteristics of an organism.

Standard length: The length of a fish measured from the tip of the snout to the end of the last vertebra (the end of the spine), excluding the caudal fin.

Stress: A condition where a fish or animal is under physical or mental duress. Light, sounds, handling, and poor water quality can all cause stress for a fish.

Substrate: (Aquarium) the material placed at the bottom of an aquaria, (natural environment) the earthy material that exists in the bottom of a habitat, like dirt, sand, gravel or cobble.

Subterminal mouth (inferior): A mouth that faces downward; usually present in fish that are near-bottom feeders or suckers.

Superior mouth: A mouth that faces upwards, used for catching prey items on the water surface.

Taxonomy: The goal of ranking an organism into a group of similar organisms based on its structure and function; organisms are placed into groups based on their similarities or differences to each other.

Temperature: The degree of hotness or coldness of something. A key habitat component of the classroom aquarium, where temperatures must be kept between 60° - 80° Fahrenheit.

Terminal mouth: A mouth that faces forward and is found on fishes that eat food directly in front of them.

Test tube: A cylindrical glass tube used in scientific experiments.

Thermometer: A tool used to measure temperature.

Threatened species: A species of animal or plant that is rare and may become an endangered species in the future.

Total length: The length of a fish measured from the tip of the snout to the end of the caudal fin, often obtained by slightly squeezing the lobes of a forked caudal fin together.

Trendline: A line drawn on a plot of points to show a relation, or general trend, among the points.

Tributary: A creek, stream, or river that feeds a larger stream or river or a lake.

Trophic level: An organism's place in the energy pyramid. Producers are found at the first trophic level, primary consumers are found at the second level, secondary consumers at the third level, etc.

Trout: Fish in Salmonidae family that are usually found in freshwater and spawn more than once; trout normally have a pattern of dark spots on a light colored body.

Turbidity: Murky water that is created by sediments becoming suspended in the water column; typically, turbid water will have a very muddy appearance.

Upstream: In or towards the higher part of a stream or river; against the current.

UV light sterilizer: A device that uses ultra violet (UV) light to reduce harmful bacteria.

Vegetation (overhanging): Plants like grass, shrubs, and trees that hang over the edge of the shoreline providing shade.

Vent: The vent is an opening through which extra water is excreted. The vent is the opening through which eggs or sperm (milt) pass during spawning.

Ventral: This is the underside surface or belly of an animal.

Vertebrate: An organism with a backbone.

Warmwater fish: A fish that prefers warm water, generally above 60° Fahrenheit and as high as 80° Fahrenheit. Species such as crappies, small and largemouth bass, sunfish, yellow perch, and catfish are recognized as warmwater fish.

Water budget: A summary that shows the balance in a hydrological system between water supplies (inflow) to the system and water losses (outflow) from the system; a water budget is a common reporting tool for water-resource systems.

Water table: The upper surface of saturated ground water.

Watershed: A drainage area or basin in which all water areas drain or flow toward a central collector (such as a stream, river, or lake) at a lower elevation.

Wetland: A transitional zone between dry land and aquatic (water) areas which stays wet at least part of the year because the water table is at the surface; includes wet meadows, marshes, sloughs, ponds, and small lakes.

Yolk Sac: Sac attached to newly hatched fish that contains nutrients for growth.

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