BiT Stream Study - Guided Observations:

Streams are the pathways that transport water through a watershed. They are also critical to the healthy functioning of the watershed and the myriad of habitats found downstream. Streams provide flood control, trap sediments, recycle nutrients, provide habitats for biological communities, and sustain high water quality. These and other qualities of streams benefit the people living within the watershed.

Begin by explaining to students that there are three important sets of characteristics that help biologists determine how healthy a stream habitat may be. We will be investigating the stream by examining some of its **physical, chemical and biological characteristics**. Once we gather this information, we will be able to decide how healthy the stream is. A data sheet is available to record the information and may be used by the instructor, a student assigned as a data keeper, or every student (who can then record their own information). Alternately, the experience can be discussion led without the use of the data sheets.

Assessing the Physical Characteristics:

- What is the weather like today? What has the weather been like recently?
- Describe what can be found nearby in the watershed (roads, houses, industry, forest, farmland, etc.).
- Is the stream shaded by vegetation?
- Does the area have a riparian forest buffer? What other vegetation exists along the stream?
- Do you see any invasive plant species?
- What might the presence of algae in the stream indicate?
- Were root wads or other vegetative materials found along the stream banks?
- Is the stream impacted by sediments and high flows? Do you see evidence of erosion?
- What is the substrate or bottom structure of the stream (size of rocks, embeddedness in silt/ sand, etc.)?
- What are the in-stream habitat types (riffles, runs, pools, leaf packs, etc.)?
- What are the average depth and width of the stream section?
- Is the stream flow high, normal, or low?
- Is the stream in a natural path, or has it been channelized?
- What man-made structures are affecting the stream?
- Can you identify areas fish could use for cover? Places they might use to spawn?
- What could you do to improve the physical characteristics of this stream?

Measuring the Chemical Characteristics:

- Measure stream pH and explain what it means and how it affects living things.
- Identify stream Dissolved Oxygen (DO) content and describe how it may affect living things living there.
- Are DO levels influenced by other factors? If so, describe how other factors affect DO (temperature, rainfall, runoff, aeration).
- How does turbidity affect the stream's water quality?
- Identify the temperature of the stream and describe its relationship to the stream.

Investigating the Biological Characteristics:

- What is a macroinvertebrate?
- Where in the stream might they live? What are their different niches?
- What can studying macroinvertebrate populations tell us about the health of the stream?
- Is the quantity of macroinvertebrates as important as the types of species found in the stream?
- How can weather affect the macroinvertebrate sample collected? What else can affect the samples?
- What do you expect to find in this stream when you sample the macroinvertebrates? Why?

After sampling:

- Does the rating seem accurate based on the physical and chemical characteristics we observed? If not, what happened?
- Do you think weather or pollution had an effect on the sample?
- Where did we find the most macroinvertebrates?
- How do you think the macroinvertebrates fit into the food web here? Are they important?
- Did we find any vertebrates in the water? What is their role in the food web?
- Did you know there were so many macroinvertebrates in the stream before you came here today?

Conclusion:

Briefly review the data gathered from the physical, chemical and biological assessments. Ask the group for their impression of the health of the stream based on this information. Solicit ideas on how the stream could be improved, and what students could do to help.

Stream Habitat Assessment
Student Data Sheet

Name: Date:

Physical Characteristics:

Name of stream:

Weather - current and last 3 days:

What is found in the watershed?

What is found in the riparian zone?

What is the condition of the stream banks?

Describe the bottom of the stream:

What is the estimated average depth and width of the stream?

Describe the stream flow: High Normal Low

Other observations:

Chemical Characteristics:

What is the pH of the water?

What is the dissolved oxygen level?

Describe the turbidity of the stream: Clear Cloudy Muddy

What is the average temperature of the water?

Biological Characteristics:

Checklist of sampling sites:

- ☐ in leaf packs
- ☐ under rocks
- ☐ on aquatic vegetation
- ☐ in woody debris
- ☐ in mud/silt
- ☐ along the bank
- ☐ in the substrate of riffle areas

Macroinvertebrate Inventory:

Pollution Sensitive	Somewhat Pollution Sensitive	Pollution Tolerant
☐ caddisfly larvae	☐ beetle larvae	☐ aquatic worms
☐ hellgrammite	☐ clams	☐ blackfly larvae
☐ mayfly larvae	☐ cranefly larvae	☐ leeches
☐ gilled snails	☐ crawfish	☐ midge larvae
☐ riffle beetle	☐ damselfly larvae	☐ lunged snails
☐ stonefly larvae	☐ dragonfly larvae	Index value: # of boxes checked multiplied by 1 =____
☐ water penny	☐ scuds	
Index value: # of boxes checked multiplied by 3 =____	☐ sowbugs	
	☐ fishfly larvae	
	☐ alderfly larvae	
	Index value: # of boxes checked multiplied by 2 =____	

Water Quality Rating:

Total index value = _______

Excellent (> 22) Good (17 - 22) Fair (11 - 16) Poor (0 - 11)

BiT Stream Study – Measuring pH:

The pH is a measure of how acidic the water is. It is represented by a scale that goes from 0 to 14. A pH level of 7 is considered neutral. Pure water has a pH of 7. Substances with pH less than 7 are increasingly acidic, while substances with pH greater than 7 are increasingly basic. The pH of natural water should be between 6.5 and 8.5. Fresh water sources with a pH below 5 or above 9 may not be able to sustain many plant or animal species (see chart on reverse).

What effect does pH have? The pH of water determines the solubility (amount that can be dissolved in the water) and biological availability (amount that can be utilized by aquatic life) of nutrients (phosphorus, nitrogen, and carbon) and heavy metals (lead, cadmium, copper). For example, in addition to determining how much and what form of phosphorus is most abundant in the water, pH also determines whether aquatic life can use it. Similarly, heavy metals tend to be more available, and therefore more toxic, at lower pH.

What determines the pH? Geology of the watershed and the original source of the water determine the initial pH of the water. The greatest natural cause for change in pH in a stream is the seasonal and daily variation in photosynthesis. Photosynthesis uses up hydrogen molecules, which causes the pH to increase. Respiration and decomposition processes lower pH. For this reason, pH is higher during daylight hours and during the growing season, when photosynthesis is at its peak.

Although pH may be constantly changing, the amount of change remains fairly small. Natural waters are complex, containing many chemical "shock absorbers" that prevent major changes in pH. Small or localized changes in pH are quickly modified by various chemical reactions so little or no change may be measured. This ability to resist change in pH is called buffering capacity. Not only does the buffering capacity control would-be localized changes in pH, it controls the overall range of pH change under natural conditions. The pH scale may go from 0 to 14, but the pH of natural waters hovers between 6.5 and 8.5.

What causes pH to be out of balance? Industries and motor vehicles emit nitrogen oxides and sulfur oxides into the environment. When these emissions combine with water vapor in the atmosphere, they form acids. These acids accumulate in the clouds and fall to earth as acid rain or acid snow. Acid rain damages trees, crops, and buildings. It can make lakes and rivers so acidic that fish and other aquatic organisms cannot survive. Pollution from industrial discharges can also change the pH. Often times polluted conditions cause huge algal and plant blooms which can cause pH to increase.

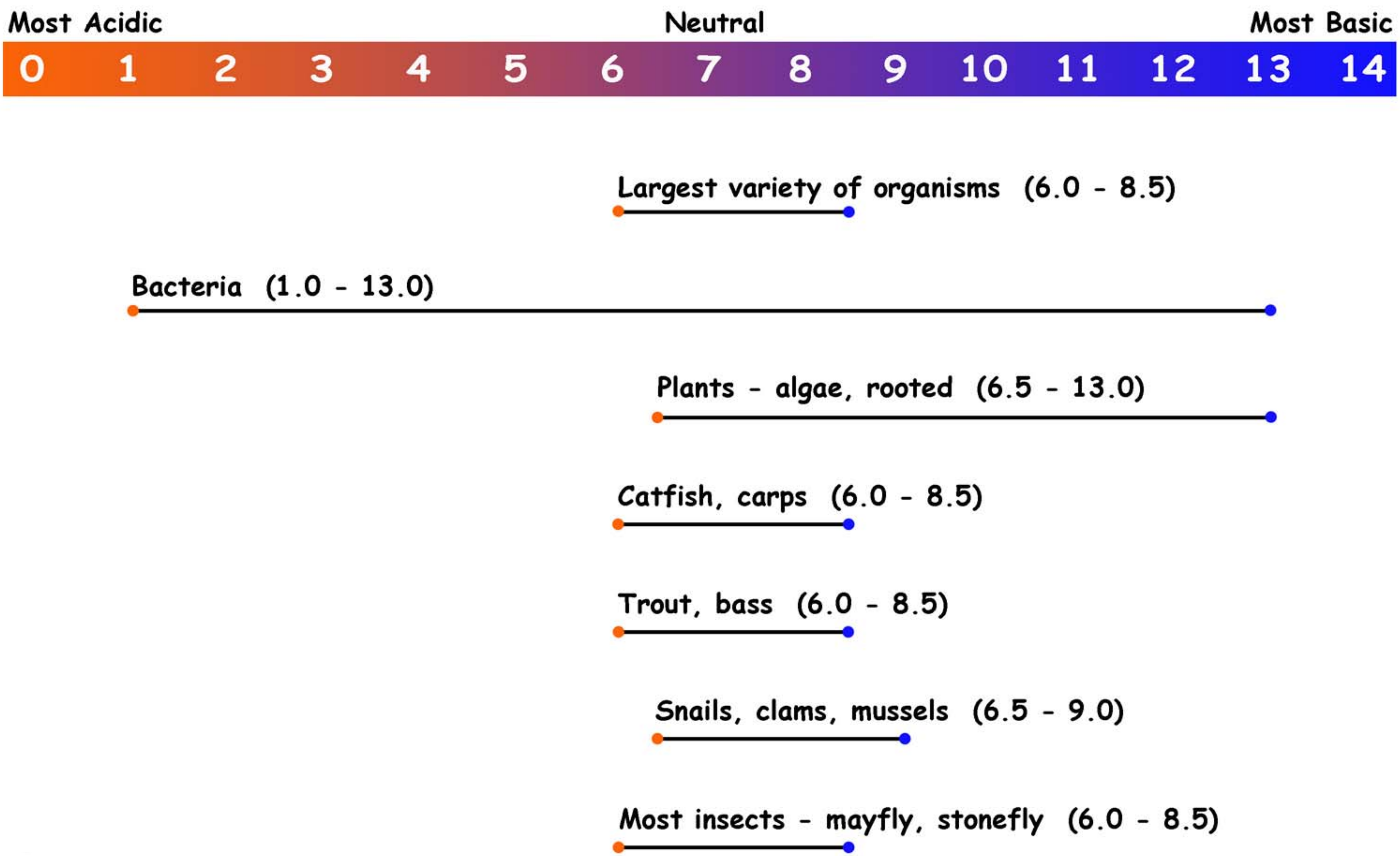
How do we measure pH?: Use the LaMotte pH test kit, or an electronic meter. Closely follow the instructions provided. pH will be shown with a number value only; there are no units associated with it.

When collecting your water sample, here are some important guidelines:

- Take the water sample at a location away from the bank.
- Sample facing upstream to minimize sediments in the sample.
- Make sure you take a sample that is below the water surface.
- Test the pH immediately. Changes in temperature affect pH value.
- Pour any leftover sample into the waste bottle. Dilute before sending down the drain.

What should I expect? The pH should measure between 6.5 and 8.5. Nearly neutral is ideal. Streams flowing through regions rich in limestone will have naturally higher alkalinity.

pH Ranges that Support Aquatic Life



pH of Common Household Items

- 1 - battery acid
- 2 - limes, lemon juice, vinegar, stomach acid
- 3 - strawberries, apple juice, cola
- 4 - orange juice, tomatoes
- 5 - banana, white bread, coffee
- 5.6 - unpolluted rain
- 6 - milk, maple syrup
- 6.5-7.5 - human saliva
- 7 - distilled water
- 7 - 7.5 - human blood
- 8 - egg whites, sea water, baking soda
- 9 - hand soap
- 10 - milk of magnesia
- 11 - household ammonia
- 12 - bleach
- 13 - lye
- 14 - drain cleaner

BiT Stream Study – Measuring DO:

When we wake up in the morning, we never stop and think to ourselves "I hope there's enough oxygen for me to breathe today." But in the aquatic environment oxygen is often a limiting factor. Dissolved oxygen (DO) is the oxygen that is dissolved in water and is essential to healthy streams and lakes. The dissolved oxygen level can be an indication of how polluted the water is and how well the water can support aquatic life. Generally, a higher DO level indicates better water quality. If DO levels are too low, some fish and other organisms may not be able to survive.

Where does DO come from? Much of the DO in water comes from oxygen in the air that has dissolved in the water. Some of the DO is a result of photosynthesis of aquatic plants and algae. Stream turbulence also increases DO levels. Temperature has an important effect on DO. Colder water can hold more oxygen in it than warmer water. Cooler air temperatures and inflow of cold groundwater (even though groundwater is generally low in DO) usually increase the DO capacity of the water. Shade can also hold down temperatures and help elevate DO levels. During rainy seasons DO levels tend to be higher because the rain interacts with oxygen in the air as it falls.

What can cause DO to decrease? Pollution is often a culprit. Lots of decaying organic matter will decrease DO as huge populations of microorganisms consume it. Large amounts of suspended solids or sediments entering the stream lower the water's capacity to hold DO and can also increase the water's temperature. During hot, dry seasons when flow rates are slower, the water mixes less with the air causing DO levels decrease. Also, warmer water increases the metabolic rates (rates of respiration) of organisms in the water, reducing the amount of DO available.

What happens when levels drop? When DO levels drop, major changes in the types and amounts of aquatic organisms found living in the water can occur. Species that need high concentrations of dissolved oxygen, such as mayfly nymphs, stonefly nymphs, caddisfly larvae, trout, and bass will move out or die. They will be replaced by organisms such as sludge worms, blackfly larvae, and leeches which can tolerate lower dissolved oxygen concentrations. Waters that have low dissolved oxygen sometimes smell bad because of waste products (hydrogen sulfide) produced by organisms that live in low oxygen environments (anaerobic).

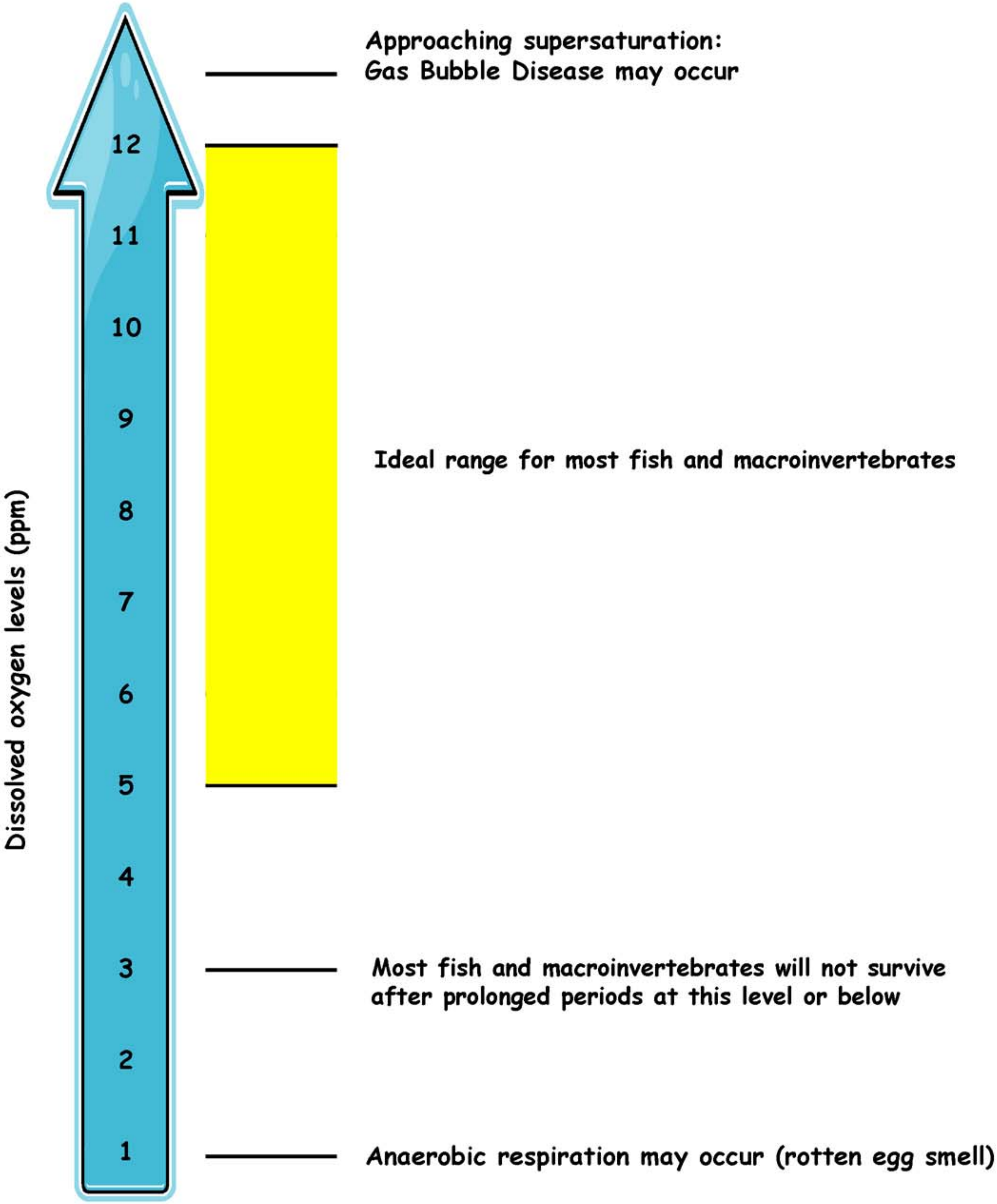
How do we measure DO?: Use the LaMotte DO test kit, or an electronic meter. Closely follow the instructions provided. Your results will be in parts per million (ppm). Think of a million marbles that represent water molecules. All are red, but just a tiny few (DO) marbles are blue.

When collecting your water sample, here are some important guidelines:

- Sample the water away from the bank and below the water surface level.
- Be careful not to get any air bubbles in the sample during collection; it may result in a false high reading.
- Submerge the entire sample bottle, and allow the water to gently fill from bottom to top.
- Put a lid on the bottle while it is under water.
- Test the DO level immediately. Biological activity in the sample and exposure to air can quickly change the DO level.
- Pour any leftover sample into the waste bottle to be diluted and poured down the drain.

What should I expect? Colder, fast-moving waters should exhibit high levels of DO (8-12 ppm is very good), while warmer, slow-moving waters will have less DO (6-10 is very good). A diversity of aquatic life are adapted to survive at these and even lower oxygen levels (see chart on reverse).

Dissolved Oxygen Effects on Aquatic Life



www.fws.gov/southeast/fisheries/BiT

BiT Stream Study – Measuring Temperature:

Water temperature is important because it has a direct effect on the survival of some aquatic species. It also influences and is influenced by other water quality factors.

How does water temperature affect aquatic species? Water temperature may affect the reproductive rates of some aquatic species; some species may not be able to reproduce in warmer waters. Since bacteria and other disease causing organisms grow faster in warm water, the susceptibility of aquatic organisms to disease in warm water increases as well. Dissolved oxygen levels drop as water warms. The metabolic rates of aquatic organisms increase in warm water. Some species may not survive if there is not enough oxygen in the water to meet their needs. Sudden changes in water temperature may cause thermal shock in some aquatic species and result in the death of that species. Thermal pollution, even if gradual, may disrupt the ecosystem balance in such a way to eliminate heat intolerant species from that area.

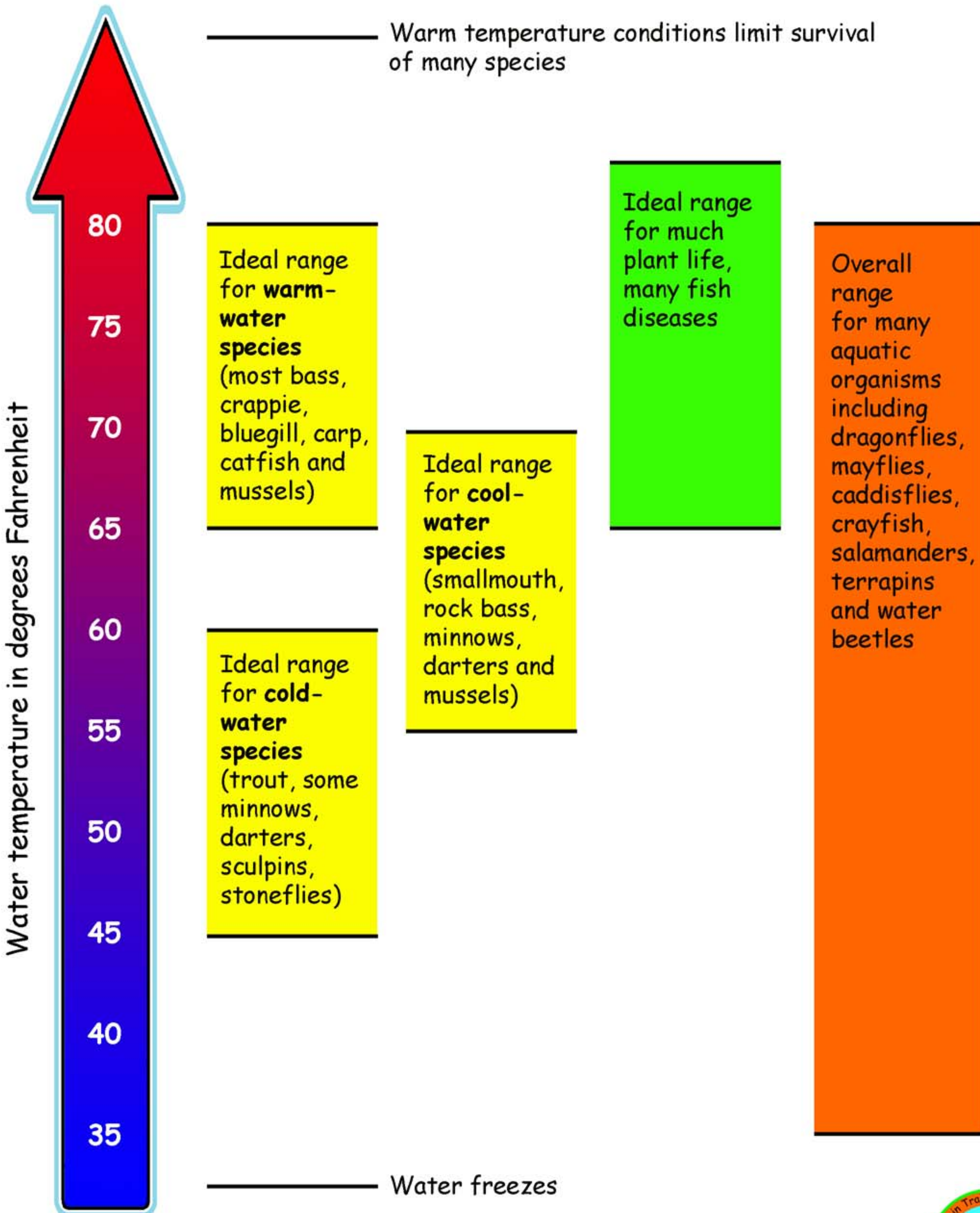
Certain species are adapted to life in different thermal environments. Warmwater fish species, such as catfish, sunfish and largemouth bass, survive best in water temperatures between 65 and 80 degrees Fahrenheit. Coldwater fish species, such as trout, survive best in water temperatures below 60 degrees Fahrenheit.

How is temperature affected by other factors? Shade and a healthy riparian buffer are important in maintaining proper stream temperatures. Runoff from hot roofs, parking lots and roads increases stream temperature. Large amounts of suspended solids, usually sediments caused by erosion, absorb heat energy and raise the overall stream temperature. Artificial ponds built off of streams can also raise the downstream temperature. Sudden increases in temperature may be a result of thermal pollution which is usually the discharge of large amounts of warm water from industrial plants.

How do we measure temperature? Measure the water temperature at the same level as the sample for the dissolved oxygen. That way, a correlation may be made between DO level and temperature. The tip of the thermometer should be at least a few inches below the surface of the water. Take a reading when the temperature has stabilized (usually after a couple of minutes).

What should I expect? In general, when the water temperature is colder, the amount of dissolved oxygen (DO) should be higher. This means the water will be able to support a large variety of aquatic life. The opposite can be expected in warmer waters. (see chart on reverse).

Temperature Ranges for Aquatic Organisms



BiT Stream Study – Sampling Macroinvertebrates:

We will be using the presence of macroinvertebrates to measure water quality. Macroinvertebrates are large enough to see with the naked eye (macro) and have no backbone (invertebrate). Stream macroinvertebrates generally include insect larvae, adult insects, worms, mollusks and crustaceans.

We can identify three groups of macroinvertebrates based on their sensitivity to pollution: pollution sensitive, somewhat pollution sensitive and pollution tolerant. This method involves collecting a sample of macroinvertebrates from the stream, identifying the organisms and rating the water quality. Water quality ratings are based on the tolerance levels of the organisms found and the diversity of organisms in the sample. A stream with excellent water quality should support organisms from all three pollution tolerance groups.

How do we begin? We must be safe and courteous, so there are a few rules: Wear shoes at all times and remember it is slippery. Be aware of broken glass and fish hooks. If a snake is spotted, just give it space and use the opportunity to observe it from a safe distance. Carry a litter bag to collect trash at the site but don't allow students to pick up broken glass or other hazardous items. Students should not lift large rocks without your help. We hope not to harm any of the creatures we are collecting, so treat their lives and their habitats with respect.

How do we sample? We will be using informal sampling methods as the idea is for every student to have the opportunity to explore using different methods. The discovery itself is the greater end rather than the data gathered. The conclusion may be slightly less accurate, but the experience is richer.

Demonstrate use of the kick seine (instructions come with the net). Identify riffle areas that are ideal for use of the seine. Make sure everyone who wants to has a chance to use it.

Point out other areas to sample. In leaf packs, bottoms of rocks, on aquatic vegetation, in woody debris, in mud, and in root holes along the bank are important places to explore in order to find the greatest diversity of macroinvertebrates. Encourage each participant to search each of these niches on their own by sharing the implements provided.

What do we do with what we find? Fill the ice cube tray and other containers with water and display the macroinvertebrates collected. Have the students identify what they have found. Record this information on the data sheets if you are using them, and then carefully return the critters to the approximate areas where they were found.

Add up the numbers on the data sheet (or summarize the overall diversity if not using the data sheets) to determine the water quality rating.

What should we expect? A stream that appears healthy based on the physical and chemical assessment should support a large diversity of macroinvertebrates (some from each of the tolerance groups). If it doesn't, then you are probably seeing the effects of a pollution event that could not be detected by the physical and chemical assessments. If you identified problems with the physical and chemical characteristics of the stream, this should be reflected in the types and variety of macroinvertebrates you find. Recent heavy rains may cause fewer macroinvertebrates to be present, and during extremely dry conditions many may burrow into the banks and substrate affecting your results.

Why Study Macroinvertebrates?

- **Stream-bottom macroinvertebrates are an important part of the community of life found in and around a stream.** Stream-bottom macroinvertebrates are a link in the aquatic food chain. In most streams, the energy stored by plants is available to animal life either in the form of leaves that fall in the water or in the form of algae that grows on the stream bottom. The algae and leaves are eaten by macroinvertebrates. The macroinvertebrates are a source of energy for larger animals such as fish, which in turn, are a source of energy for birds, raccoons, water snakes, and even anglers.

- **Stream-bottom macroinvertebrates differ in their sensitivity to water pollution. Some stream-bottom macroinvertebrates cannot survive in polluted water.** Others can survive or even thrive in polluted water. In a healthy stream, the stream-bottom community will include a variety of pollution-sensitive macroinvertebrates. In an unhealthy stream, there may be only a few types of nonsensitive macroinvertebrates present.

- **Stream-bottom macroinvertebrates provide information about the quality of a stream over long periods of time.** It may be difficult to identify stream pollution with water analysis, which can only provide information for the time of sampling. Even the presence of fish may not provide information about a pollution problem because fish can move away to avoid polluted water and then return when conditions improve. However, most stream-bottom macroinvertebrates cannot move to avoid pollution. A macroinvertebrate sample may thus provide information about pollution that is not present at the time of sample collection.

- **Stream-bottom macroinvertebrates are relatively easy to collect.** Useful stream-bottom macroinvertebrate data are easy to collect without expensive equipment. The data obtained by macroinvertebrate sampling can serve to indicate the need for additional data collection.