Stream Table - Waterways on the Move

Adapted from: "Stream Table Investigations: Lab Manual for the Earth Science Stream Table" by Gregory Beckway, published by Hubbard Scientific. 1998.

Grade Level: Basic, intermediate

Duration: Depends on level of investigation and instruction. 45 minutes to 3 days.

Setting: laboratory setting, ideally with sinks and faucet

Summary: Students will observe stream movement using a stream table and make comparisons between a youth stream, mature stream, and old-age stream.

Objectives: Students will learn some of the common characteristics of stream movement as it carves its way through a landscape.

Vocabulary: valley, channel, floodplain, youthful stream, mature stream, meander, levee, cutbank, cutoff, oxbow lake, deposition, point bars, braided stream, old-age stream, alluvium, alluvial fan.

Related Module Resources:
- Stream Movement slide show (envelope in module)
- Textbook sections in the Resource binder.

Materials (Included in Module):
- Stream table tray
- Stream table trough (for input flow)
- Stream table inserts (for landscapes and for burying in sand)
- Sand
- Rulers or meter stick
- Landscape trees, fences, people, animals for placing on sand/land.

Additional Materials (NOT Included in Module):
Access to water

ACADEMIC STANDARDS: ENVIRONMENT & ECOLOGY

10th Grade
4.1 A Describe the changes that occur from a streams origin to its final outflow.

4.1 B Explain the relationships among landforms, vegetation, and the amount and speed of water.
- Analyze a stream's physical characteristics.
- Explain how the speed of water and vegetation cover relates to erosion.

4.1 C Describe the physical characteristics of a stream and determine the types of organisms found in aquatic environments.
- Describe and explain the physical factors that affect a stream and the organisms living there.
- Identify the types of organisms that would live in a stream based on the stream's physical characteristics.

BACKGROUND:

Rivers and streams can vary greatly. Some waterways follow a straight path while some curve through a valley. Some will flow quickly over rapids and waterfalls, while some will take a lazy, slow approach. A stream table is a great way to investigate differences in waterway behavior and the factors that influence how a waterway will carve its way through the landscape.

Streams create ravines and valleys as they cut down into the landscape, into the bedrock, or into surficial sediments. A **valley** comprises the entire area between the tops of the slopes on both sides of the waterway. Valleys can differ in shape in size depending on the size, intensity, and age of the waterway (more on this later). At the bottom of the valley is the stream **channel**, the trough through which the water flows. It is usually the deepest part of the streambed in which the main current flows. Under high flow conditions, water will fill and flow through most of the channel. If water spills out of the channel, it will flow into the **floodplain**. This is the flat area on both sides of the waterway that is about at the level of the top of the channel.

All streams go through similar developmental stages - youth, mature, and old age. How long each stage lasts depends on the geology and landforms of the area. A **youthful stream** usually erodes the land quickly. The stream keeps cutting backward up into the higher elevation usually creating a V-shaped valley with steep sides. Waterfalls and rapids are common features of a youthful stream as it usually moves pretty fast. Youthful streams are always smaller than older streams, carrying less water volume, and being contained within a smaller valley. They also tend to be pretty straight as they flow forward.

A **mature stream** is bigger than a youthful stream, carrys greater volume, and has more tributaries. The flow slows down as the stream gradient (steepness) lessens for a mature stream. Instead of cutting straight forward, the slower mature stream tends to bend or **meander** back and forth. A mature stream erodes along its side, causing the valley to widen. A mature stream can erode into very small sediments, unconsolidated sediments, or erodible bedrock. The erosion brings new rocks and sediments into the waterway.

Water can overflow the banks, forming levees in the floodplains. **Levees** are low ridges running parallel to the stream along its banks. Under high flow conditions, the creek might overflow its channel but be contained within the natural levees. Beyond the levees, water would spread out through the rest of the floodplain.

A slow stream in a lowlands that meanders back and forth, perhaps from one edge of the floodplain to the other, can demonstrate some unique characteristics. The channel will shift positions through time. Because the flow of water and energy of water around a curve is greater on the outside bank, called the **cutbank**, erosion tends to be greater here. There tends to be a shift in the stream toward the outside of the bend. If the curve is great enough, the cutbank might give way and a straighter, new channel may form, abandoning the old, curved, longer route section. The **cutoff** is the new shortcut channel. Cutting off the loopy curve creates an **oxbow lake**. This abandoned, stagnant water-filled loop that is left behind can be great habitat for many animals and a repository for flood waters. These oxbow lakes can dry up and fill with sediment, but scars of these abandoned curves are often evident from an aerial view of the waterway.

On the inside of a curve, water moves slower, with less force. **Deposition** (settling out of material) usually occurs here. Fine sediments, sands will settle out and be deposited in sand bars or **point bars.** These ridges of sediments deposited can be found on the inside of the curve, but also along straight stretches of the stream bank, or along islands in the channel. Point bars can move around in the stream as the overall channel changes shape and as flow conditions vary. High flow streams have less chance for deposition. Streams with wide, shallow, slow stretches that have heavy loads of sediments may be deposited into many sand bars. Multiple small channels to form around the sand bars, created a **braided** stream. Braided stream are in lowland, flat stretches with plenty of sediment being deposited.

Often when sediments drop out of a creek, they are usually well-sorted in size and uniform in size. Because it takes different amount of water flow and energy to pick up various sized particles, stream transport provides a mechanism in which particles of various sizes become separated out and sorted. This process is called sorting and explains why particles of similar size are deposited together. Within a stream, the well-sorted material deposited is collectively called **alluvium**. So the point bars and islands of braided streams contain alluvium. Sometimes alluvium can be deposited in a fan-like or triangular pattern, called an **alluvial fan**, especially if a smaller stream enters into larger waterway. These deposition patterns may be created when any waterway that has been moving is greatly slowed down as it reaches the lowest base level and enters a new, bigger waterway, or even an ocean. The alluvial fan is the dropping out of the majority of the sediments in the waterway and the deposition occurs in a fixed order. Large materials fall out first with finer sediments settling out further out. An alluvial fan can be referred to as a **delta** when it is at the end of a waterway as it enters a large lake or the ocean. Some deltas like the Mississippi River Delta can be huge. Some deltas get almost completely wiped out by ocean currents.

An **old age stream** can exhibit all or some of characteristics of a mature stream, but it is usually slower in flow, less powerful in erosion capacity, and is contained within a broad valley. There might be many meander scars and oxbow lakes. Because the volume of water is greater with increased number of tributaries to an old stream, flooding is more common. An old age stream also has more deposition than upstream stretches. The channel can often be clogged with fine sediments washed from uplands. Dredging may need to be done to keep the channel open, especially if the waterway is an important transportation route. An old age stream may also deposit sediments in alluvial fans or deltas.

Moving water is a major factor in sculpting our landscape. Waterways produce valleys, floodplains, and alluvial fans through the process of erosion and deposition of sediments. This constant carving and settling changes our landscape continuously.

OVERVIEW:

Students will observe demonstrations of stream maturation and movement using a stream table. Students will make illustrations, make observations, and answer questions. A variety of geological concepts relating to stream movement can be observed using a stream table.

PROCEDURE:

Working with a stream table is somewhat of an art. Results, procedures, conditions will always vary and will likely never be repeated from period to period. Practicing with the stream table helps. There are some suggestions for conditions and some guidelines to obtain better results provided below, but you may need to make adjustments to create better results/scenarios on the stream table. There are many geological concepts that can be demonstrated and discussed with the stream table. Below are just uses to show stream movement, erosion, and deposition. Check the stream table section of the binder for more stream table ideas.

Preparing the Stream Table for Use

Place the large, black, empty tray near a water source, on a flat, sturdy table. The stream table is easier to use if you have the black trough running directly from a faucet to the upper end of the stream table. If no faucet is available, a pop bottle or milk jug can be filled with water. Make a large nail hole in the bottle and use it a source of water. Keep bottle filled for consistent water force. The lower end (drain end) has a plastic hose that should reach to another sink or into a bucket.

Place the hard, black plastic (3" x 8") insert at the upper end of the stream table, right where the water input will drop/run into the stream table. This insert helps lessen the impact of the faucet input. There are other inserts that can be used to mimic hard bedrock that does not erode and an insert that will help create a waterfall. Flat pieces of shale buried under the sand are a great way to mimic large sheets of hard bedrock.

You will then need to fill the stream table tray with play sand or coarse sand. The sand should not be fine sand. Dampen the sand. When placing in the table, there should be more sand in the upper end, gradually lessening as you go down the table. Do not place any sand minimally 6 inches (15.2 cm) from the drain valve opening. You can use the stream table accessories to enhance the experience (small people, animals, trees, animals, fences).

Youth Stream

<u>Expected results</u>: A stream that flows swiftly, cutting a deep, straight, narrow channel in the landscape. Erosion dominates with no deposition.

1. Raise the stream table to approximately 6-8 inches (15.2-20.3 centimeters). Smooth the sand and cut a groove, in the center, the length of the stream table. Allow the flow input to be moderate to heavy. Allow water to run for at least five minutes.
2. Observations that students can make: What is happening to the stream channel? Is it staying straight? Is it cutting deeper? How would you describe the ravine/valley that is being formed? Is erosion occurring? Is deposition occurring? Is the velocity consistent the entire length of the channel? Students could make an illustration of this youth stream.
3. If desired, you can measure out a certain length along the stream channel or lay a meter stick beside straight channel, and have students measure how long it takes for an object (cork, Styrofoam peanut, small scrap of paper) to flow down the channel. Divide distance traveled by the time it took. This would be the stream's velocity or flow rate (cm/sec).
4. Where would you find a youthful stream? *In higher areas, cutting down through a hillside or mountain, creating a ravine. You would not find a youthful stream in lowlands.*

Maturity of a Stream

<u>Expected results:</u> A stream begins to lose its velocity and erosive capacity. It begins to meander, erode in some areas, but deposit in other areas. A flood plain may develop.

1. Lower the height of the stream table to 4 inches (10.2 centimeters). For this stage you will use a moderate input flow rate.
2. You have two options for your channel: A) Use the youth stream channel that was cut, but it will take quite a bit of time for the water to create a mature stream. Results might not be as effective this way. B) Smooth out the sand again, keeping more in the upper end and leaving the lower area near drain hole free of sand. Cut a groove in the sand that has 2 or 3 gentle curves. Water should flow down the channel and begin to erode some of the cutbanks, creating new channels with cutoffs or making a curve go wider. If a cutoff is created, an oxbow lake may be formed. New meanders will likely be formed as well.
3. Observations that students can make: Illustrate the way the stream began and then again after time has elapsed. Why did the channel change? Identify places that the stream water had the most force and velocity. Where there places that you could identify as cutbanks? As deposition points? Did a new channel develop? Why? Were any oxbow lakes made?
4. If desired, increase the input flow for a few minutes and have students make observations on what happened. Did new channels develop? Did erosion occur even more? Did the stream become braided at any point? Did the water leave the channel and enter the floodplain?
5. Have students ever seen a stream that has had some of the characteristics just observed? Which waterways? Any in your local area? *Many streams, unless in extreme lowlands, will demonstrate some of these characteristics. Mid-order, medium sized streams in Western PA will often meander and exhibit cutbanks and deposition in spots.*

Old Age Stream

Expected results: Meandering may occur, but channel changes will be slow to occur since the stream velocity and erosive force will be reduced. Old age streams will deposit more than erode. Erosion will occur, new cutoffs will be made, but it may take more time to do so. Alluvial fans may occur at the mouth of the stream.

1. Lower the height of the stream to 2 inches (5.1 centimeters). You will use moderate input flow for this stream table.
2. Smooth the sand out. Leave area for a lake /ocean of water to accumulate around the drain hole. You may want to clamp down the drain hole hose to reduce the speed at which the table drains, allowing a lake/ocean to be created at the lower end. Before turning on the faucet, prefill the lake.. Cut a groove with sharp meanders. Water should flow slowly down the channel, eroding in some spots, but mainly running slow enough to deposit in places. Deposition should occur at the end of the stream as it enters the lake/ocean, creating a delta.
3. Observations that students could make: Have students draw an illustration of the stream before you turn on the input water. Then draw the stream again after time has elapsed. Were there meanders to this stream? Did the meanders and the channel change? Why? Was the force of the water greater or less than other streams

studied? Where did deposition occur? What happen at the end of this stream as the water entered the lake? Where might a waterway like this one be located?

4. Because erosion is less in this stream, you may want to sprinkle loose sand at the start of the stream and allow the water to carry it, simulating upstream erosion. This will provide more sediment to be deposited in the landscape.
5. You may elect to increase the flow for a little while, this will cause additional erosion to occur and create cutoffs and oxbow lakes.

Other Activities

Check the stream table section of the Module Resource Binder for additional activity ideas relating to the stream table.

DISCUSSION:

There are question posed in the procedure as well, but here are some additional review type questions:

What are the characteristics of a youth stream, mature stream, old age stream? *See background section.*

Why does a youth stream create a V-shaped valley? *This is due to the great downward cutting of the stream channel produced by the steep gradient. Mass wasting along the valley sides causes a widening toward the top, creating the resultant V-shape.*

Why does a cutoff occur? How does this shorten the stream channel? *Meanders grow in size as they actively cut on the outside of the bank and deposit on the inside slightly downstream. As these bends become more winding, occasionally the stream will cut through a bank enough from erosive forces (more force on the outside of a curve) to join another portion of the stream. This would separate the meander from the main stream channel. Instead of the water flowing around the large looping bend, the flow goes through the short cut cutoff, which is a straighter, shorter path.*

Which stream type (youth, mature, old-age) covers the shortest distance? Why? *Youth streams do not last long in distance in the development of a stream. Since the land is high about base level, the stream flows swiftly down the steep gradient. Due to the high erosive power at the quick speed, a deep, narrow channel, reminiscent of a youth stream, is cut. Soon though, the velocity becomes less because the land becomes less steep. The stream then begins to have room in the ravine or valley to move back and forth (meander) and take on characteristics of a mature stream.*

Why are old-age streams rare in nature? *Because many youthful and mature streams feed together to create larger stream, which may be old-age, there will generally be less of them. There must also be lowland to have an old-age stream. Plus, conditions must be constant for a long time for an old-age stream to create such sharp meanders that stretch from valley wall to valley wall. An disturbance, flooding, high flow will usually alter that landscape of an old-age stream.*

If you were going to buy creek-side property and two identical lots were offered, one on the inside of a meander and one on the outside of the meander, which would you invest your money on? Why? *The lot on the inside of the meander would be a wiser investment because the stream will be cutting away at the outside bend of the meander, possibly washing away that lot. The inside bend lot will actually have deposition occur.*

Rivers are often used as political boundaries, such as state lines. Why might a state with a 200+ mile river boundary lose (or gain) some of its total land area through the course of many years? *As observed from the stream table, mature streams and rivers have channels that are always shifting. A river may erode a bank, create a cutoff, create a wider meander, or abandon portions of a channel to create new channels. Depending on the side of a meander, this may cause land area to be lost or gained.*

Did the water always stay in the channel during the different stream table scenarios? What is the area around the stream called? *Floodplain.* Do you think it is a good idea to build a house in a floodplain? Do people build in a floodplain? *Yes. Not only houses are build, but entire cities. Some of the largest cities in the United State are at risk of flooding, which is one of the main reasons why the US Army Corp of Engineers build dams, levees, and regulates water flow.*

EVALUATION:

- Observations sheets/journal.
- Discussion questions above.
- Use of illustration visual aids in module - eliminate the vocabulary words /main concept words and have students fill in the blanks.

EXTENSIONS AND MODIFICATIONS:

- There are many other extensions and additional demonstrations that you can do using the stream table - see the Stream Table section in the Module Resource Binder.
- You can make smaller versions of stream tables using plastic sweater boxes or similar, low, waterproof containers. Students can use these after viewing demonstrations on the main stream table.

NOTES (PLEASE WRITE ANY SUGGESTIONS YOU HAVE FOR TEACHERS USING THIS ACTIVITY IN THE FUTURE):

Activity version: July 2003

Observation Sheets: Stream Table

Name____Date______________