18 U.S.C. 707

ENVIRONMENTAL SCIENCE FIELD KITS

TRAINER GUIDE

TOYOTA
Indiana

ENVIRONMENTAL SCIENCE FIELD KITS

Kit Supplies

- Each Kit Includes:
- 1 storage kit
- 2 iPads with otterbox cases
- 1 classroom foldscope kit which includes 20 foldscopes
- 1 Q-scope handheld WIFI microscope
- 1 SEEK thermal imager
- 1 Kestrel 3000 handheld weather meter
- 1 BioPaddles Microbe Analysis Kit
- 1 Soil Backpack Lab Kit including: testing materials for: Nitrogen, Phosphorous, and Potassium (materials for 50 tests)
- 1 Water Monitoring F.I.E.L.D. Kit including: student waters, pH paper, turbidity tube, and a kit to measure dissolved oxygen, phosphates, nitrates, and coliform bacteria.
- 1 Tree study kit including an increment borer, tangent height guide, and tree bicuits.
- 1 Enviroscape water/watershed model

Shared Resources:

- Groundwater simulation system

Applications Needed on Ipads:

- Q-Focus app to pair with the wifi microscope
- SEEK thermal imaging app
- Biopaddles Colony ID

Apps helpful to download:

- Kestrel LiNK

ENVIRONMENTAL SCIENCE FIELD KITS

Item Overview

I. iPad and Cases

a. Each of the 11 counties will receive 2 iPads with Otterbox cases for rugged use.

II. Foldscope Kit

a. Foldscope classroom kit includes several options for youth to create their own microscope in a low-cost and low-tech way.

b. Use these low-cost microscopes to analyze plants, insects and more. With the deluxe kit, prepared slides are included and can be used or youth can explore their environment.

III. Q-scope

a. The Q-Scope is a handheld digital microscope: utilize the Q-scope to examine leaves, soil, grass, and different materials; the Q-scope can be utilized with the soil, water, air, tree, etc. sampling kits as an additional activity.

IV. SEEK Thermal Imager

a. If you have not already, download the SEEK thermal imager application.

b. If you utilize the thermal imager with the provided iPads the case may have to be removed to allow access to the port for the device.

c. The thermal imager is going to analyze the approximate temperature of objects in the environment. The most popular use for these tools is to identify areas of "hot" or "cold" spots in homes to increase efficiency. However, for this project the thermal imager will be used to analyze heat dispersion in the environment.

V. BioPaddles Microbe Analysis Paddles

a. BioPaddles are testing mediums to analyze air quality and microbes in the atmosphere. They are small tubes containing prepared test "paddles". Using the appropriate side and analysis this item can be used to test for mold and indoor and outdoor air quality.

VI: Enviroscape

a. A large hands-on model that demonstrates watershed management, pollution, and runoff.

ENVIRONMENTAL SCIENCE FIELD KITS

Item Overview

VII. Kestrel Meter

a. The Kestrel weather meter measures accurate atmospheric conditions for: temperature, humidity, wind speed, pressure, air flow, and evaporation rate. This data can be used to complete a weather analysis or included in an educational section on weather conditions and discussions regarding temperature, humidity, heat stress, etc. Recording weather data is also beneficial information for other kit materials; for example, when collecting samples utilizing the BioPaddles it would be helpful to record the ambient temperature and atmospheric conditions.

VIII. Soil Backpack Lab

a. This kit is complete with testing supplies for soil health parameters including: phosphorous, nitrogen, conductivity, pH, and potassium. Step by step guides are included for completing each test with background information on how these nutrients and parameters impact soil health, quality, and overall productivity.

IX. Water Monitoring F.I.E.L.D. Kit

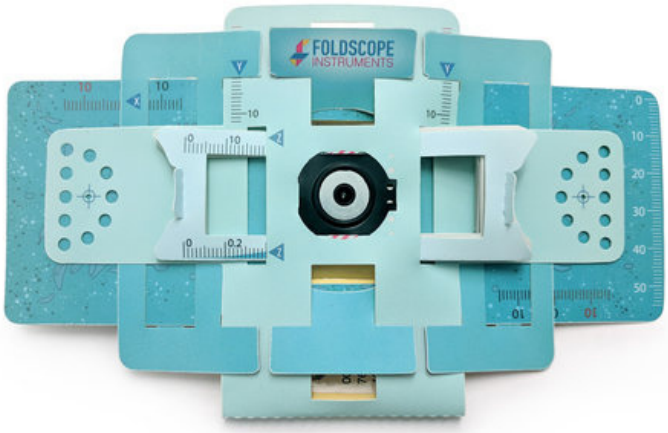
a. The water quality field kit and included testing supplies measure various parameters of an aquatic system or water sample; these parameters can gauge the quality of a water resource. Kit tests include Dissolved Oxygen., Phosphates, Nitrates, pH, turbidity, Coliform Bacteria, and Temperature

b. Included are materials for field sampling or water samples can be taken prior to the program.

X. Tree Study Kit

a. This kit contains materials to determine tree age, growth patterns, and field methods for tree analysis. In this kit there is an increment borer, an item used to extract core samples from trees; using this participants can learn about tree rings and their correlation to growing conditions and tree health. Also included are tree “biscuits” or small cross sections of different tree types; these can be utilized as a further tree ring resource or to exemplify the difference between tree types.

Foldscope Classroom Kit



OPERATION

Each foldscope set comes with a deluxe individual kit and 20 classroom kits. Foldscope kits can be utilized as low-cost microscopes in classrooms, as field instruments, and more! Each kit comes in a mesh bag and is ready to be assembled. Instructions for assembly are included or several helpful videos are included on the foldscope website.

CLASSROOM USE

Foldscope kits can be taken to classrooms for multiple use. Youth can assemble them once distributed or you can have them pre-assembled. Once completed, they can use them as a microscope to view various items.

Program Applications

Fold Scope Classroom Kit:

Foldscope classroom kit includes several great options for kids to explore in a low-cost and low-tech way. Each mesh storage bag contains the elements to make a microscope.

Kit Contents

Each classroom set includes:

- 20 Foldscopes (140x lens)
- 20 Cell phone couplers
- 20 Paper/tape slides
- 20 Instruction sheets
- 20 Nylon carrying pouches
- 20 unique ID stickers
- 1 Field guide
- 1 LED/Magnifier
- 1 Slide box with pre-made glass slides and blank glass slides

Delux models include additional supplies including pre-made slides that are great as initial viewing material.

Foldscope Lesson Plan

Objectives: **Students will be able to utilize the foldscope as a low-cost microscope.**

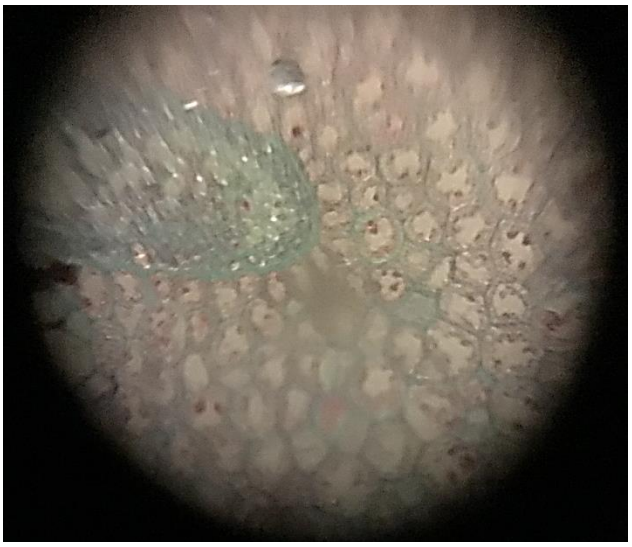
Time to complete activity: **~45 minutes**

Background/Setting the Stage: **I strongly suggest having the foldscopes prepared before using them. Older participants may be able to assemble the foldscope themselves however, younger members will find this difficult. There is an instructional YouTube video with step by step instructions for assembly on the foldscopes website. Follow these instructions to assemble your foldscopes.**

Materials: Foldscope kits and Deluxe Foldscope kit.

Activity: **Distribute foldscopes to participants and go over operation. Discuss the zoom features and how to center items for viewing. A great starting point is to use the pre-created slides in the deluxe kit to show students what they should be able to see using the foldscopes. Members will need to have a light source to see their samples. A light coupler is included in the deluxe kit that can be used in situations with low lighting. There is also the option of pairing the foldscopes with a tablet/phone. It can be paired with one of the provided iPad however you will have to remove the case; instructions for pairing with electronic devices can also be found on their website. Please note, I would avoid using personal devices as the magnets in the foldscope can interfere with electronics.**

Reflection Questions: (Discussion): **Results will depend upon the subjects analyzed however, have students explain or sketch what they are seeing. If you are in an outdoor setting and members are exploring have them document the items they analyzed. Return as a group and discuss the findings. Ask members if they were surprised by any of their findings or if they found what they were expecting. Below is an image captured with the iPad and provided slide of the fern leaf in the deluxe kit.**



Groundwater Simulation

OPERATION

Using the provided manual, set up the groundwater simulation system. There are step by step instructions on how to add each layer of material to create the appropriate zones. Also included in the manual is excellent background information on groundwater, its formation, and underground storage.

CLASSROOM USE

Once the Groundwater Simulation System has been assembled instructors can utilize the user guide to provide background information on groundwater and pollution. In the handbook there are 28 different demonstrations with the concept, action, and discussion provided for the educator. First, introduce the concept such as human activities polluting a well, complete the action with the model, and then discuss the consquences with students.

Program Applications

Groundwater Simulation System

Using the system, educators can explain how groundwater forms, aquifers are depleted or recharged, and groundwater pollution can occur. Also introduced are the concepts of: soil types, percolation, porosity, and the overall qualities soil has on water filtration.

This system can also be paired with the soil and water curriculum to provide further hands-on resources. Additional concepts that can be a point of discussion for this kit are: oil well drilling, fracking, aquifer depletion, and soil types across the U.S.!

Enviroscape

OPERATION

The enviroscape kit is composed of a plastic top with a tray underneath to collect water and an assortment of items to place on the enviroscape. For use, fill the included water bottle and place all the pieces on the board; these will include: houses, animals, equipment, factories etc. Place them around the enviroscape in their designated spots. Ensure that you have enough "pollutants" (kool aid mix, cocoa powder, etc.) and you are ready to go!

CLASSROOM USE

This product is excellent for teaching youth a variety of topics. Participants will spread the "pollutants" different colored powders on the enviroscape then use the water bottle to simulate rain. They will then see the pollutants gather in storm runoff and collect in local water sources.

Program Applications

The enviroscape is designed to exemplify the impacts of pollution on water systems. By showing how runoff collects in local waterways youth can learn how water quality is deteriorated and all the pollutants concentrate in local water systems. The enviroscape teaches the foundation for runoff and water pollution but can be used to also exemplify the impacts of:

- Agricultural runoff including pesticides and fertilizers
- Combined sewer overflow systems
- The collection of local pollution also impacts larger systems (rivers, gulf shores, ocean, wetlands, etc.)
- Water quality degradation
- Water treatment- a large portion of the population does not understand the water treatment process. This is a great time to include it in a lesson!

How Does Land Usage Affect Your Watershed?

Experience the impact of point and non-point source pollution using the EnviroScape watershed model

Objectives:

At the end of this activity, youth should be able to:

- Explain what a watershed is
- Identify point and non-point source pollution
- Apply how land usage impact a watershed
- Apply practices to reduce impact on watersheds

Prep time: 10 minutes
Time to complete activity: 30 minutes per demonstration (2)

Skill level: Grades 3-8 and higher

Background:

The facilitator guide contains two demonstrations: 1) How Water Pollution Occurs- understanding how a watershed works and sources of point and nonpoint source pollution. 2) How You Can Prevent Water Pollution- identifying and implementing best management practices. The facilitator guides directs you step-by-step through both demonstrations to be able to preparing the model, check audience awareness, discussion and demonstration of activities, and provide a summary review. In addition, a Location Key Diagram is included that identifies where all the figurines goes, what different structures are on the model, and where to identify pollution sources.

The begging of the guide gives safety, quick set-up, clean-up instruction, and a description of the facilitator's role. **Please read those sections carefully before facilitating the demonstration**. The guide also provides suggested related activities and guest speakers to enhance the learning experience. This demonstration gives you the freedom to present as much information as you deem appropriate, and to adapt the information you present to different audience levels. The demonstration can last a minimum of 15 minutes (reviewing demonstration 1 only) or up to an hour or more including both demonstrations and in-depth content. For beginner audiences, grades 3-8, a brief overview of demonstration 1 is appropriate. For more intermediate to advance audiences, grades 8-12, both demonstration and in-depth content is appropriate.

Materials:

- EnviroScape watershed model (available at the state office) Includes:
    - EnviroScape facilitator guide
    - 1 packet of red Kool-Aid
    - 1 packet of greed Kool-Aid
    - 1 packet of hot coco
    - Squirt bottle
    - Paper towels
    - Figurines

- Clay
- Sponge
- Travel case
- Water
- Table (greater than 25” x 30”)

Methods

See facilitator guide pages 9-31 for demonstration 1 and page 33-50 for demonstration 2

Reflection Questions (Journal or Discussion):

- What is a watershed?
- How does land usage affect a watershed?
- What can be done to reduce the impacts of land usage on a watershed?
- Why is it important to protect a watershed?

Supplemental Information:

Indiana 4-H Soil and Water Science manuals:
https://www.edustore.purdue.edu/item.asp?Item_Number=4-H-1027-W

How to become a citizen scientist and monitor your local watershed:
http://www.hoosierriverwatch.com/

The Nature Conservancy, Nature Works Everywhere:
https://www.natureworkseverywhere.org/resources/

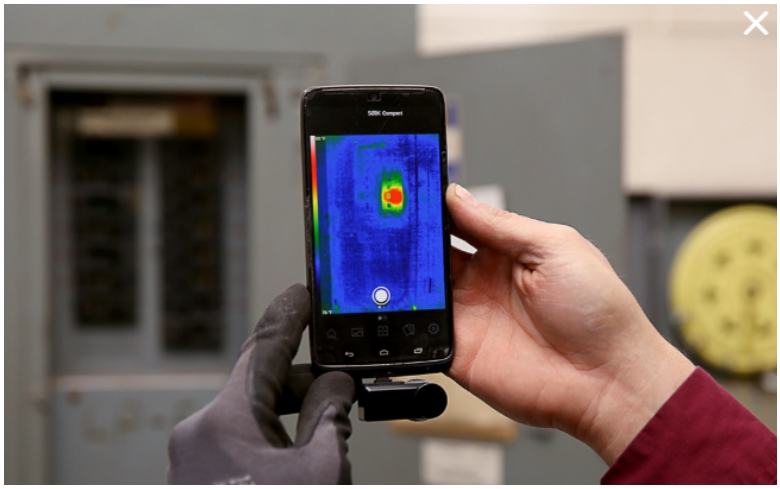
United States EPA, Surf Four Watershed: https://www.epa.gov/waterdata/surf-your-watershed

United States EPA, Watershed Academy: https://www.epa.gov/watershedacademy

Vocabulary:

See facilitator guide’s glossary pages 53-56

Seek Thermal Imaging



OPERATION

SEEK Thermal imagers work by coupling with an iPhone/iPad or similar device. The purchased model is specifically designed for Apple products. Each environmental kit contains two iPads and Otter Box protective case. To utilize the thermal imager, you will need to remove the case for the device to fit on the charge port. Once attached you can open the SEEK app and begin exploring!

DIGITAL APP

To utilize the SEEK Thermal Imager device you will need to download the "SEEK Thermal" App from the App store. Once downloaded, you can connect your device and open the App. The App will recognize the connected device and let you start viewing your surroundings. You can capture still shots from viewed materials.

Program Applications

Energy in your Environement

SEEK Thermal devices can be utilized to discuss energy dispersion in the environment. For example, identifying and discussing the temperature changes associated with energy absorption and sunlight by analyzing the difference in dark and light objects.

Applications

SEEK Thermal imagers can be used alone or paired with other kit materials to enhance the experience. For example, when completing water analysis it might be important to explain the heat retaining properties of a body of water. Additionally, it can be utilized to demonstrate the difference in temperatures associated with canopy/tree cover using the tree kit.

SEEK Thermal Imager

Objectives: **Students will be able to understand heat dispersion in the environment the impacts created on organisms. After completion of this activity, participants should have a better understanding of habitat and available energy in the ecosystem.**

Time to complete activity: **~30 minutes**

Background/Setting the Stage: **Students should be in an outdoor environment. The best place to take students would be a wooded/forested area. Have students work in groups of 2-3 to answer the following questions:**

1. **How does the amount of sunlight received in an area impact the habitat?**
    a. **How might this influence the animals/organisms/plant life found at this location?**
2. **What type of heat profile would you expect in a desert? Forest? Etc.**

Materials: List of materials for class to use:

Ipad and thermal imager attached.

Notebooks/pencils for students to record observations

Activity: **After completing the discussion questions have each group explain their thoughts and how available energy impacts habitat. Use the thermal imager and iPad to then explore the surrounding areas making note of areas with high and low thermal output. Each group should get the chance to record observations and explore the area.**

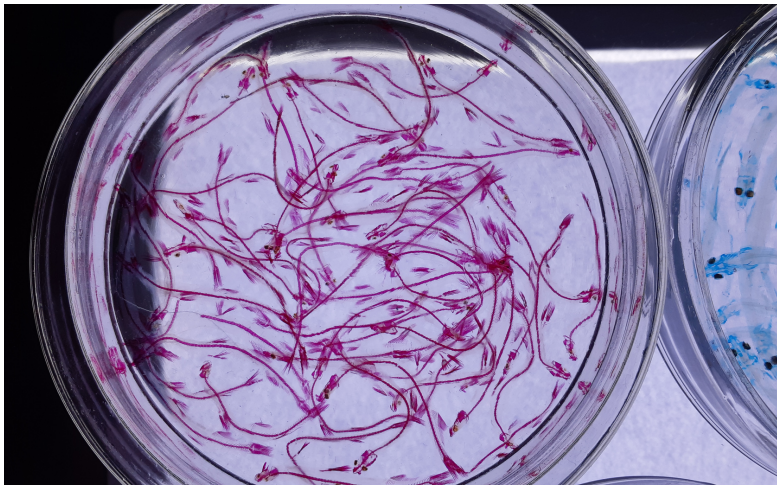
Reflection Questions: (Discussion): **Results will depend upon the area however, students will discover that dark surfaces retain heat much more readily than lighter colors or reflective surfaces. Participants should also note a noticeable temperature decrease when in the forest or under a tree canopy.**

Taking these results, the group should discuss how the tree canopy blocks sunlight (and solar energy) from reaching the forest floor. How does this impact plant life? How else might this impact organisms trying to thrive in this environment? What would happen if the tree canopy was removed?

Darker surfaces absorb more solar radiation while lighter surfaces absorb less. How might this impact solar energy dispersion across the planet? What will happen when sea ice continues to melt and is replaced with darker sea water? In a warming climate, what impacts might this cause?

Further resources can be found at:
For canopy impacts on incoming solar radiation:
https://www.nature.com/scitable/knowledge/library/the-physical-environment-within-forests-24202119/

Handheld Digital Microscope



OPERATION

The wifi Q-scope digital microscope offers a complete range of magnifications suitable for a variety of subjects. Standard focus zoom magnification range is 10x to 25x plus an additional high magnification of 100x for mobile devices. Using the adjustable zoom bar on the side of the device students can easily focus in on the correct magnification. The built in light and photo capture feature make use of the Q-scope simple.

DIGITAL APP

To utilize the Q-scope you will need to download the Q-Focus app and pair your microscope and iPad using the wifi signal emitted by the microscope. Once the microscope is paired, you can begin analyzing objects. Still images can be captured and will be recorded on the iPad.

Program Applications

Analyzing your Environement

Q-Scope digital microscopes are digital and handheld microscopes that can be utilized to examine a variety of samples. The Q-scope has an adjustable zoom, built in light and is rechargeable. Once charged, it can be paired via wifi connection with one of the provided iPads and can be taken anywhere. The wireless connection makes it a perfect tool to include in field kits for additional analysis of sample materials.

Applications

Q-scopes can be added to almost all other kit materials. Microscopic analysis can be included when completing tree assessment to determine leaf structure, soils to see any microbes, and much more. The Q-scope can be integrated into almost any environmental analysis.

Q-Scope Lesson Plan

Uses: Students will be able to complete microscopic analysis of several items and use the Q-scope with other kit items.

Uses: The Q-scope can be utilized by itself or paired with other kit materials. Below are some images captured with the Q-scope to show it utilized with different kits:

The first image is the head and mouth of a mosquito; you can analyze any bugs found when completing soil/water/tree kits. The second image is of a very sandy soil. In this image you can actually see the individual sandy grains. The third image is of a tree leaf; clearly visible is a "vein" and then the leaf structure.

If you wish to complete a program utilizing the Q-scope by itself you can create a lesson that focuses on identifying the structure of a sample (leaf/bug/soil type, etc.!) anything you can magnify would be a great subject for use, below is a general outline for creating an individual lesson

Introduction: Background on item being identified

Use: Have students utilize the q-scope and identify the type or structure of their samples. Students can sketch their findings in their notebook. The app also allows for image capturing and marking on the images. Let members share their findings and discuss.

Reflection Questions: (Discussion):

Did you find the structure you were expecting? If not what was surprising?
What pieces helped the most in identifying your sample?

Handheld Digital Microscope

Q-SCOPE STEP BY STEP GUIDE

1. If you have not downloaded the Q-focus application you will need to do this before you can proceed.
2. Take the fully charged Q-scope and turn the switch to the WIFI position. Once the device has been turned on for a few seconds the light on the side will change from green to blue. The blue light signifies the device is now emitting its own WIFI. In your WIFI settings on your iPad, choose the q-scope signal. The default password for the login is: 12345678. You may change this password if you choose by following the instructions in the user manual.
3. The Q-scope is now ready for use! Switch back to the Q-focus app app and select the “microscope” option in the top left corner. This should connect and automatically stream to the device you connected via WIFI. You can now see in real time what you are examining with the microscope. Use the inset blue section on the device you can adjust the zoom and lighting is adjusted with the small scrolling wheel at the top of the device. Images can be captured on the iPad with the camera button that appears on the screen when streaming. The clear cap on the end of the microscope can be adjusted to remove reflectivity.
4. Calibration can be completed with the Q-focus app and is outlined in the device instructions. Calibration should be done regularly to ensure consistent and accurate results.

Kestrel Weather Meter

OPERATION

The Kestrel weather meter measures outdoor weather conditions. The meter can accurately determine dew point, heat stress index, relative humidity, temperature, wind chill, and wind speed. Weather measurements can be recorded and used as additional information when completing environmental analysis. Temperature, humidity, and other atmospheric variables can be important factors for a complete assessment.

TYPES OF DATA

On the right is a list of Kestrel's environmental measures that can be recorded. These measures are vital for accurate environmental analysis. For example, temperature can be recorded when using the SEEK Thermal device, or temperature when collecting water, or soil samples.

Program Applications

Kestrel Weather Applications

Weather measurements can be used in conjunction with other kit items. For example, current atmospheric conditions would be important to note when completing soil sampling or when utilizing the biopaddles for atmospheric aerosols.

Students can use the included National Audubon Society field guide to weather to identify clouds and atmospheric phenomenon that may be present. This book can also be used to provide your participants information on atmospheric circulation, seasonal changes and variation, and explain storm dynamics.

Weather Analysis Lesson Plan

Objectives: **Students will be able to understand the meaning of common weather terminology, take weather observations, and understand the use of data collected.**

Time to complete activity: **~30 minutes**

Background/Setting the Stage: **Students can be indoors but should have access to an outside testing location. Have students work in groups of 2-3 to answer the following questions:**

1. **What are some common weather measurements and what do they mean?**
2. **How do weather conditions impact ecosystems?**

Materials: List of materials for class to use:

Kestrel Meter

Notebooks/pencils for students to record observations

Activity: **Briefly introduce the topic of weather and atmospheric conditions. Ask students: How does the weather impact your day? How might it impact an ecosystem? What would be the implications of a flood/drought for human health? After the discussion, either read over or give the students a copy of the terminology below. Now start collecting your measurements using your kestrel meter! Step by step instructions are included in your binder for each measurement.**

Temperature: The measure of warmth/hotness or cold in the ambient atmosphere. Temperature can vary and be impacted by tree cover (shade), surface composition (dark vs light surfaces), and humidity. Extreme temperatures on both ends of the spectrum, very hot to very cold, can significantly impact human life, ecosystems, wildlife, and crops/plant life.

Humidity: The amount of water vapor present in the air. Increased humidity creates additional health impacts for humans. To cool down, we sweat and the absorption of our sweat into the atmosphere creates a cooling effect. When the humidity is high, and the air is very saturated, our sweat is not as readily absorbed into the atmosphere making it difficult to cool our body down. The next measure, the heat index, was created to give a value to the potential impacts of temperature and humidity on the body.

Heat Index: An addition to temperature data during hot and humid weather to indicate health risks more accurately than temperature alone. This is a measure of what the temperature "feels" like with humidity factored into the measurement.

Relative Humidity: The ratio of the amount of water vapor in the air compared to the amount of water vapor if the air is saturated, given as a percentage. For example, if the relative humidity is 50%, the air is only holding half as much water vapor as possible.

Windchill: Addition to temperature data during cold and windy weather to indicate health risks more accurately than temperature alone.

Wind Speed: The rate at which air is moving from areas of high to low pressure.

Pressure: The pressure of a mass of air at a given point. Pressure is usually measured in millibars

Evaporation Rate: Rate at which water will turn into water vapor.

WBGT (Wet Bulb Globe Temperature): The lowest temperature that can be obtained by evaporating water into the air.

Reflection Questions: (Discussion): After collecting data, students will have an accurate assessment of the current atmospheric weather conditions. Explain how they are interacting as a whole.
How is humidity currently impacting our temperature (heat index)? What would happen if we were to increase the wind speed? The evaporation rate would likely increase and the temperature would feel less "hot".

Weather can have large-scale and small-scale implications. Have the students think of an ecosystem, examples can include: desert, tundra, rainforest, deciduous forest, grassland, etc. Now have them work in pairs to discuss the impacts of large-scale weather changes. For example, a significant drought and lack of suitable crops led to the creation of the dustbowl in the United States. How might a long-term drought impact your ecosystem? Storms are often generated from slight disturbances and changes in pressure. These small changes can generate severe thunderstorms and even hurricanes. How might a change in pressure, that created a hurricane impact your ecosystem? Or if you are inland, increased flooding?

It is also helpful to include weather data when completing additional assessments with other kit materials. For example, the temperature and humidity would be relevant to soil sample collection depending on the analysis type.

Kestrel Weather Meter

KESTREL STEP BY STEP GUIDE

Temperature Functions:

For best accuracy when taking temperature measurements you must keep the air moving around the temperature sensor and keep the Kestrel out of prolonged, direct sunlight. If there is a strong breeze, just point the Kestrel into the wind. If there is no wind, swing the Kestrel around in a circle on its lanyard or rapidly wave it back and forth in hand. This ensures that the sensor measures the temperature of the air rather than the temperature of the case.

Alternatively, if you have time, allow the Kestrel to rest where you want to measure the air temperature (NOT in your hand or in direct sunlight if there is no wind) until the case temperature equalizes with the air temperature. When equalized, the display will read a constant value. Be aware that this could take a few minutes, particularly if there is no wind.

Humidity Functions:

One reason your Kestrel may not be reading accurate ambient humidity is because of proximity to humidity sources such as your hand, your body or the ground. Avoid covering the large humidity chamber opening on the case rear with your fingers. Keep all fingers below the finger groove and away from the chamber opening. Do not take reading that rely upon humidity with the Kestrel meter lying flat – raise it into the air vertically or stand it on its base and orient it into the wind or air flow.

Kestrel Weather Meter

KESTREL STEP BY STEP GUIDE

Pressure Functions:
All pressure and altitude measurements are made using the pressure sensor. Some units have a dedicated “Pressure” screen which shows Station Pressure, the raw pressure reading straight from the sensor. The Barometric Pressure measurement (Baro) displays the local Barometric Pressure using the Station Pressure measurement adjusted to the local altitude using the Reference Altitude value input by the user. The Altitude measurement displays the local altitude using the Station Pressure measurement combined with the Reference Baro value input by the user. To obtain an accurate barometric pressure or altitude readings, you must first know EITHER your location’s current barometric pressure OR your current altitude. If the Reference Altitude value is incorrect, the Barometric Pressure reading will also be incorrect. If the Reference Barometric pressure value is incorrect, the Altitude reading will also be incorrect. Because Barometric Pressure and Altitude are each dependent on the alternate reference value remaining constant, Barometric Pressure and Altitude cannot be accurately measured simultaneously. If your unit has a pressure recalibration function, a new Barometric Pressure calibration value may be input. If this value was not taken from a verified source (a local airport or weather station) with the Kestrel being calibrated at the same location as the reference device, pressure related measurements may be incorrect.

Kestrel Weather Meter

KESTREL STEP BY STEP GUIDE

Evaporation Rate:

(Kestrel 5200 Professional Environmental Meter) Kestrel Professional Meters can calculate a concrete evaporation rate (ACI 308) by combining a user input concrete temperature with measured air temperature, wind speed and relative humidity. Concrete mix temperature is generally measured with a probe or infrared thermometer and should be read at the time of making the evaporation rate measurement After inputting the mix temperature, hold the unit vertically, approximately 20 inches above the surface of the concrete while facing the rear of the unit directly into the wind. To avoid inaccurate Evaporation Rate readings due to thermal loading it is best to shade the Kestrel. (Be sure the source of shade is not obstructing the wind speed measurement.) The ACI recommends taking a 6-10 second average of the evaporation rate to account for fluctuating wind speeds. To measure an average Evaporation Rate, scroll right from the Evaporation Current Measurement Screen to the Min/Ave/Max Screen and press select to manually start and stop a capture.

Wind Meter Functions

Wind speed is highly dependent on surrounding obstructions such as buildings, yourself and the ground, with wind speeding up as it flows around and over obstacles and slowing down as it passes behind them.

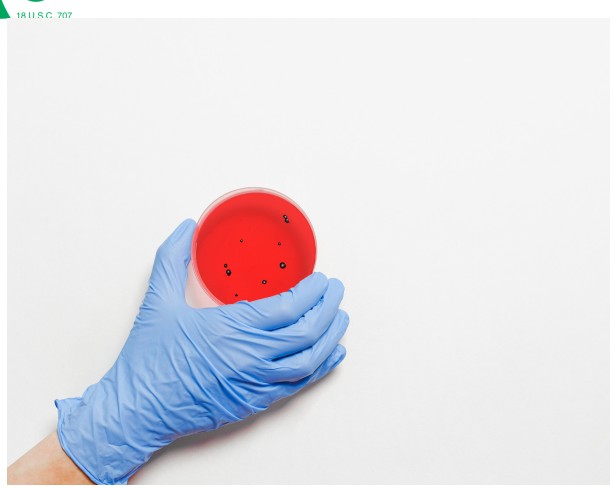
Kestrel Weather Meter

KESTREL STEP BY STEP GUIDE

WBGT:
When changing environments (such as moving form an air conditioned room to outdoors or removing the unit from your pocket) the unit requires between 8-15 minutes to equilibrate to its surroundings before taking readings. Take measurements at least 3 feet off the ground and in the same wind or air flow conditions as the people you are monitoring. Ensure the Kestrel is oriented into the wind and able to measure the full wind value. Be sure to take measurements in the same solar/radiant heat environment as the people you are monitoring. Unlike best practices for other measurements, WBGT is intended to be taken in direct sunlight. As long as there is occasional wind the Kestrel has software that allows it to maintain an accurate WBGT reading despite being placed in direct sunlight.

Air Flow:
Kestrel Professional Meters can calculate air flow through a duct by combining user input information about the size and shape of the duct with the measured air velocity. In addition to reading the instantaneous Air Flow off the main measurement screen, a more accurate result may be obtained by capturing an average air flow on the Min/Ave/Max screen while traversing the duct. Traversing consists of dividing the area of the duct into evenly sized sections and averaging the air flows at the center of all sections. By spending an equal amount of time at each measurement location and quickly moving between measurement locations, the average air flow measurement can provide a more accurate measure of the air flow in the duct. Capturing an average can be particularly helpful when measuring ducts with registers or dimensionally uneven air flow.

BioPaddles Air Analysis



OPERATION

BioPaddles are dual-agar paddles each containing microbe-specific media enclosed in a sterile vial. These paddles can be used to identify and quantify microbes in air, soil, and water. These paddles are used by opening the sealed vial and collecting a sample. Depending upon sample type they are collected via touching the surface, collecting water, or exposing the test to air. The paddle then gets placed back in the vial and incubated for a set period of time. Once the incubation period is complete, participants can then identify the colonized microbes.

DIGITAL APP

To utilize the Biopaddles it is most beneficial to download the app to analyze samples. The app "BioPaddles Colony ID" and can be downloaded from the app store onto one of your provided iPads.

Program Applications

Microbe Analysis

BioPaddles can be used to identify any microbes present on a variety of surfaces. Using the app, participants can take pictures of their sample unknown microbe growth and compare them to images of known microbe colonies. Once identified participants can research the microbes and their impact on the environment and health consequences. Knowing the microbes present in samples such as: indoor air, outdoor air, or water samples can greatly enhance their understanding of environmental quality and can pair with other provided kit materials.

Bio-Paddles Air Analysis

BIO-PADDLES STEP BY STEP GUIDE

1. Curriculum is available on the supplied compact CD and should be printed in your binder. The powerpoint and teachers guide are great resources to review and provide background information on sample parameters, aerosol information, and environmental impacts. Using the sample tubes, you can collect indoor air samples to analyze; based on the ambient air type. For passive sampling, or sampling that is done where there is naturally moving air, open the sample tube exposing the sample paddle; do not touch the colored sample surfaces.
2. The pink side of the sample tube collects microbes associated with mold production while the white media collects bacteria.
3. For testing in areas where there is non moving air- choose a testing side (bacteria or mold) appropriate for the desired results. Open the testing tube and place the paddle horizontally with the appropriate sample size facing up. This will collect any microbes that settle from the ambient air. Try and avoid any drafts.
4. Contact sampling can also be performed on dust or mold layers. Be careful to not contact the mold directly with skin. If you suspect dangerous levels of mold ensure proper ventilation or air quality for individuals during sampling. Open the sample paddle and gently make contact with the mold surface for a minimum of 15 seconds; replace the sample lid and incubate the sample at room temperature for 5-7 days.
5. When taking samples use the Kestrel meter to record temperature, relative humidity, and wind speed.

Bio-Paddles Air Analysis

BIO-PADDLES STEP BY STEP GUIDE

6. Samples are suggested to be incubated at a specific temperature to promote the most rapid organism growth (this is not a requirement) however, simply allowing proper time for development at room temperature will allow for organism development. At room temperature samples should incubate for 5-7 days.

7. Once the sample has been incubated, compare sample results to LaMotte "Total Viable Count" section on the included instructions.

8. If you have downloaded the application (recommended) you can compare colony results to images on the app to determine bacteria type. Results are given in CFU or colony forming units and are given as:

i. CFU/mL- per milliliter
ii. CFU/g – gram
iii. CFU/cm2- square cm
iv. CFU/m3- square meter
i. TCC or total colony count is given for all colonies

5: To estimate colony size use the provided cross (+)
symbols on each paddle sample surface. The cross symbols are 4mm in length from point to point.

Soil Analysis Kit

KIT MATERIALS

Kit includes: Agriculture Combination Test Kit for testing nitrogen, phosphorus, and potassium (N, P, K) with materials for 50 tests of each parameter; Hanna pH/Conductivity/TDS Low-Range Tester; a Digital Thermometer; laminated laboratory instruction cards with step-by-step field test procedures; reproducible lab activity worksheets and testing procedure results/observations; and a backpack carrying case that holds all kit components.

SAMPLING

Soil samples can be taken prior to a program. Since the kit is included in a travel backpack it is also conducive to outdoor sampling. If collecting samples prior, it would be beneficial to gather several samples in various areas and at various depths to have a variety of nutrient compositions.

Program Applications

Testing Parameters

Parameters that are analyzed in this kit include nitrogen, phosphorous, and potassium. Testing can also be completed for pH, conductivity, and total dissolved solids; all parameters that can determine soil quality. Soil analysis can also be paired with other kit materials. For example, when testing water sources, analyzing the surrounding soil will provide a more accurate assessment of the environmental system as a whole. Furthermore, since Nitrogen, Potassium, and Phosphorous are often limiting nutrients, they are often added to increase productivity on agricultural land. Runoff from agricultural fields can impact water quality and ecosystem health.

Soil Backpack Lesson Plan Addendum

Use: **Have students understand the parameters that impact soil health and how to determine if soil is productive.**

Helpful Information: **The educational materials included in this kit are excellent. Background information on soil formation, composition, and classification are included in the Soil Quality Teachers Resource Guide. I recommend copying this and giving a copy to each student or reading the background to the participants before beginning any sampling. Also included in this guide are explanations for each test and why it is important. This information is also included on the PowerPoint Slides from the included CD.**

Additionally, when using this kit, it is also extremely helpful to introduce the parameters that will be measured and why they are important to soil health. To begin, show the PowerPoint from the CD; if you are completing this analysis in the field provide each student with a copy of this information. This information covers each nutrient, why it is important, and how it is measured and will give the students the necessary background to complete each test.

Also included are step by step instructions for each test that is to be completed; they are available on the CD and also as laminated cards to use in the field.

Additional Activities: **Included in the environmental science kits are two shareable Groundwater Simulation Models that would be a great addition to this curriculum. Also, there is a hands-on activity called Earth's Filter included where students learn about the filtration qualities of soil. Both lesson plans are included.**

Forestry Suppliers Lesson Plan

Soil Moisture

Forestry Suppliers' Soil Analysis F.I.E.L.D. Kit™
Fundamental Investigation of the Environment Leading to Discovery™
Study Kit Correlated to National Science Education Content Standards

If you're interested in soil studies for classroom activities, consider the Forestry Suppliers' Soil Analysis F.I.E.L.D. Kit. Use the kit for the exercises outlined in this Lesson Plan, as well as other related activities (see "Further Studies" section for a few ideas).

This F.I.E.L.D. Kit is available exclusively from Forestry Suppliers and includes some of the items used in this lesson plan. All kit items may also be purchased individually. Call our Sales Department at 1-800-647-5368 or visit us on the web at www.forestry-suppliers.com.

Fields of Study:
- Earth Science
- Mathematics

National Science Education Content Standards Correlation

Grades	A	B	C	D	E	F	G
K-4	✓			✓	✓		✓
5-8	✓				✓	✓	✓
9-12	✓				✓		✓

Soil Analysis Kit Contents Stock Number 36845

Qty.	Description	Required For This Lesson Plan K-4	5-8	9-12	Stock Number
1	Soil Color Book, GLOBE Earth Colors				77369
1	Soil Texture Kit				77330
1	Soil N-P-K Kit				77960
1	Soil Thermometer				89028
1	Soil Sample Bags, 18 oz.				79227
1	Soil Sample Tube	✓	✓	✓	76971
1	Hydrion pH Papers, 0-13	✓	✓	✓	78105

Grades K-4

Background

All plant life requires three basic things: light, soil, and water. Some plants thrive in a very hot, arid environment with sandy soil. The desert regions provide a backdrop for plants with these needs. Other plants need continuous moisture, a warm humid environment with just the right amount of sunshine. Rain forest plants could never survive in a desert setting. Even some houseplants cannot tolerate full exposure to the sun. Different plant types have very different needs. You can control the amount and type of light your houseplants receive. For example, African violets prefer artificial light while other plants grow well in a windowsill. The amount of water or moisture a plant receives can also be controlled. You can also make sure your plants are healthiest by supplying them with fertilizer or other needed nutrients specific for that particular plant.

Soil type is very important to someone simply growing plants in their home as well as to the farmer who grows thousands of acres of crop plants, such as corn, rice, soybeans, wheat or cotton. A soil type which is good for one plant, may not serve the needs of another plant very well. Some soils tend to hold moisture quite well while others remain dry most of the time. Most of us have used a sponge; sponges take up water and hold it because they are composed of very "absorbent" material. A small sponge can hold more water than a large ordinary cloth. Some soil types are like an ordinary cloth while others are like a sponge that can absorb or hold much water.

In choosing an area to farm, a farmer must consider the soil type and its ability to hold moisture. Some land cannot support particular crops. How can someone know about the soil's ability to hold water or the moisture content of soil? In simple words, how wet or dry is dirt? Try this experiment and you will begin to learn about how much moisture is in soil, even when it looks dry!

Procedure

1. Select three different areas in which to collect soil (schoolyard, someone's backyard and maybe a flower garden or vegetable garden site.)
2. Dig about six inches into the site and collect enough soil to fill a coffee can. Seal the can with the plastic lid.
3. Remove enough of the soil (1/4 cup or less) to form a thin layer in an oven-safe baking dish and set aside for later use.
4. Weigh the empty dish to be used and record the weight. Repeat until you achieve the same weight results twice in a row. The balance being used should be sensitive enough to measure 0.1g differences.
5. Break up the collected soil as much as possible and pour a thin layer of soil into the bottom of the baking dish. Then, place the dish on the balance and record the weight.
6. Weigh three times and average the three weights to determine a final weight. (With younger students, you may want to weigh the sample until you get the same results twice in a row.)
7. Subtract the weight found in Step #4 from the weight found in Step #6 (e.g.: Step #6 - Step #4 = Weight of soil + water).
8. Heat the soil and container by one of the following methods: (Teacher must complete this step.)
   a. Place in a conventional oven at 100° Fahrenheit for 24 hours.
   b. Place in a conventional oven at 375° Fahrenheit until it is apparent that the sample is dry throughout.
   c. Place in a microwave with a rotating tray, heat on high until the sample is completely dry; make sure that the container is microwave safe.
9. Allow the container and sample to cool completely to room temperature. (A dish not completely cooled will weigh more.)
10. Weigh the container and sample again as you did in step 6.
11. Find the weight difference between the sample/container before heating and after heating and cooling. The weight difference is the weight of the moisture contained in the soil sample. The heating causes an evaporation of the water "held" in the soil.
12. Use the following formula to calculate this difference. With younger children you can simply perform the calculation difference yourself and share the value of the first weight and the final weight. They can grasp the difference if presented in this manner. With older children, they can easily calculate this difference. Example:
    A. Final weight of container and soil before heating: ___g or ___oz.
    B. Final weight of container and soil after heating: ___g or ___oz.
    C. A - B = weight of water
13. With older students, you can further the study by finding the percent of water in the soil by using the data from Steps 7 and 12:

$$\frac{\text{Weight of Water (\#12)}}{\text{Weight of Soil + Water (\#7)} \times 100} = \text{\_\_\_\_ \% water in soil sample}$$

14. Repeat procedure for all three soil samples. You can easily heat all three samples at the same time if oven space permits.
15. If the soil samples specifically differ in the moisture content, you should see a definite weight difference.

Further Studies

- Have students conduct a soil texture study by using the Forestry Suppliers, Inc. Soil Analysis F.I.E.L.D. Kit or the Soil Texture Kit. Students will be able to note differences in soil texture, which relates to the ability a soil type has in holding moisture. Younger students can easily see differences in soil texture types by using a hand held magnifier or by using a stereo microscope. (K-4)
- Students can measure the pH of the soil and make possible correlations. The Determining the pH of Soil Lesson Plan can be implemented to complete this activity. (K-4)
- Students can measure the immediate absorption and holding of moisture by obtaining equal amounts of sand and garden soil and placing the samples in a plastic cup with ten small holes punched in the bottom. Equal amounts of water can be poured through the cups and "caught" or retrieved by placing a measuring cup under the soil cup. The students can then measure the amount of water which was not absorbed and make comparisons between the different soil types. (K-4)
- Have students find information on soil types and textures and the importance to farmers and agriculture by using the school or public library. (3-4)

Rubric

- Students should be able to understand the importance of soil type as it relates to moisture retention. (K-4)
- Students should be able to identify different soil textures. (K-4)
- Students should be able to apply the procedure for mathematically finding the amount of moisture in soil by heating a soil sample. (3-4)

Assessment

- Have students list the common soil types, including those they observed during the activity. (K-4) (For younger students: clay, sand, etc.) You may want to collect basic types and have those on hand to allow the children to observe and categorize.
- Have students explain how you measure the moisture content of the soil by the weighing and heating process. (K-4)

These lesson plans are provided for the benefit of science educators and can be freely downloaded from our web site at www.forestry-suppliers.com. If you have an idea or other suggestions for future lesson plans, we'd like to hear from you! Send an e-mail to fsi@forestry-suppliers.com.

Content Standards Covered

A Science as inquiry
- Abilities necessary to do scientific inquiry
- Understanding about scientific inquiry

D Earth and Space Science
- Properties of earth materials

E Science and Technology
- Understandings about science and technology
- Abilities to distinguish between natural objects and objects made by humans

G History and Nature of Science
- Science as a human endeavor

Required Materials

The following items are required to complete all the activities in this lesson plan. Available from Forestry Suppliers, Inc.

- Electronic Balance **94003**
- Folding Pocket Magnifier **61122**

Supplied by Teacher/Student(s)

- Soil from 3 different areas
- Oven-safe baking dish
- Oven
- 3 regular size coffee cans with plastic lids

Grades 5-8

Background

Light, soil and moisture are crucial necessities to the health and development of plant life. Specific species of plants thrive in the desert regions and are very acclimated to an arid environment with extreme changes in temperatures. Plants found near the floor of tropical rain forests would not fare well in full sunlight.

The composition of the soil plays an important part in the moisture content of a soil type. Some soil types absorb and are better able to hold water than others; some soils have low water retention. It is crucial that agriculturists and farmers understand the moisture needs of specific crops and the soil type which is best able to meet these needs. Whether producing thousands of acres of wheat, soybeans, corn or cotton or just simply caring for a backyard vegetable garden, moisture availability is an important consideration. The composition of the soil can be enhanced toward a more healthy composition by the addition of fertilizers and nutrients. Water retention cannot be so easily changed; therefore, much consideration must be given to the soil site when deciding where to plant crops.

By completing this activity, you should be able to better understand the apparent differences among some soil types concerning moisture content. Watch out for the mud!

Procedure

1. Select five different testing sites from which to collect soil to be analyzed: Your backyard, a field or garden spot, schoolyard, etc. Record observable differences seen among the soil site environments.
2. Dig approximately six inches into the site and collect enough soil to fill the coffee can or plastic bag and seal.
3. Remove enough of the soil (1/4 cup or less; or 57 grams), to form a thin layer in the bottom of the oven-safe dish.
4. Weigh the empty dish to be used and record the weight to the nearest 0.1g. For accuracy, you may want to weigh the dish three times and take the average. The balance being used should be sensitive enough to measure 0.1g differences.
5. Break the soil up as much as possible when placing in the bottom of the dish.
6. Weigh the dish with the soil sample. Record the weight to the nearest 0.1 gram.
7. Repeat step #6 three times to get an average. Record the final weight to the nearest 0.1 gram.
8. Heat the soil sample in the container by using one of the following methods: (Teacher must conduct the heating process.)
   a. Place in a conventional oven at 100° Fahrenheit for 24 hours.
   b. Place in a conventional oven at 350° Fahrenheit until it is apparent that the sample is dry throughout.
   c. Place in a microwave with a rotating tray, heat on high until the sample is completely dry; make sure that the container is microwave safe.
9. Allow the sample and container to cool completely to room temperature. (A dish not completely cooled will weigh more than one that is cooled to room temperature.)
10. Following the steps in #6 and #7, weigh the sample and container.
11. Find the weight difference between the sample/container before heating and after heating and cooling. The weight difference is the weight of the moisture contained in the soil sample. The heating causes an evaporation of the water held in the soil.
12. Use the following formula to calculate this difference:
    a. final weight of container and soil before heating: ____ grams (#7)
    b. final weight of container and soil after heating: ____ grams (#10)
    c. a - b. = ____ (weight of water)
13. Calculate the percent of water in the sample by:

$$\frac{\text{Weight of Water (\#12)}}{\text{Weight of Soil + Water (\#7)}} \times 100 = \text{\_\_\_\_ \% water in soil sample}$$

14. Repeat procedure for all soil samples. You can easily heat all samples at the same time if oven space permits.
15. If the soil samples specifically differ in the moisture content, you should note a definite weight difference.

Further Studies

- Students can conduct soil texture studies utilizing the Forestry Suppliers' Soil Analysis F.I.E.L.D. Kit or a Soil Texture Kit. Textural differences should be noted especially if moisture content varies greatly among the samples.
- Students can measure and compare the pH differences among the soil samples. Correlated activity, in the Determining the pH of Soil Lesson Plan.
- Students can quickly measure the immediate water holding ability of the different soil types by obtaining equal amounts of sand and garden soil and placing the samples in a plastic cup with ten small holes punched in the bottom. Equal amounts of water can be poured through the cups and retrieved by placing a measuring cup or graduated beaker under the soil cup. The students can then measure the amount of water which was not absorbed and make comparisons between the different soil types.
- Students can conduct research on soil types and texture and the importance of these to farmers. Use school or public library.

Rubric

- Students should be able to discuss the importance of moisture content.
- Students should be able to distinguish between the textural differences among select soil types.
- Students should be able to apply the mathematical method used in determining the percent of water in each sample to other related calculations.

Assessment

- Present students with several different soil types and have them make observations concerning the apparent textural differences.
- Have students explain the method by which they determined the water percentage in each sample.
- Have students list and explain different soil types.

These lesson plans are provided for the benefit of science educators and can be freely downloaded from our web site at www.forestry-suppliers.com. If you have an idea or other suggestions for future lesson plans, we'd like to hear from you! Send an e-mail to fsi@forestry-suppliers.com.

Content Standards Covered

A Science as inquiry
- Abilities necessary to do scientific inquiry
- Understanding about scientific inquiry

E Science and Technology
- Understandings about science and technology

F Science in Personal and Social Perspectives
- Science and technology in society

G History and Nature of Science
- Science as a human endeavor

Required Materials

The following items are required to complete all the activities in this lesson plan. Available from Forestry Suppliers, Inc.

- Electronic Balance **94003**
- Folding Pocket Magnifier **61122**

Supplied by Teacher/Student(s)

- Soil from 3 different areas
- Oven-safe baking dish
- Oven
- 3 regular size coffee cans with plastic lids

Grades 9-12

Background

Specific species of plants have particular needs for optimum growth; however, all plants need water, light and soil or a specific growing medium. Some species prefer an arid, hot environment while other plant types thrive in a moist, warm habitat such as a rain forest. Soil type varies within different environments since some soil types have a greater capacity for holding moisture. The moisture content of soil is key to determining which plant types may grow best within a particular environment. Agriculturists, crop farmers, as well as backyard gardeners must have an understanding of the soil requirements of the plants to ensure the greatest growth potential and crop yield. Great care and consideration must be given to crop site since soil type cannot be changed, although the nutrient composition of the soil can be enhanced by the introduction of fertilizers and supplements.

Understanding how to basically determine the moisture content of soil is important for many reasons. Global food concerns cause scientists to consider ways to obtain the highest crop yield from sometimes small areas of crop land. Knowing the specific soil needs of a species would definitely be important in this consideration.

By completing this lab activity, you will have a better understanding of the specific moisture content differences among various soil types.

Procedure

1. Select five different testing sites from which to collect soil to be analyzed: Your backyard, a field or garden spot, schoolyard, etc. Record observable differences seen among the soil site environments.
2. Dig approximately six inches into the site and collect enough soil to fill the coffee can or plastic bag and seal.
3. Remove enough of the soil (1/4 cup or less; or 57 grams), to form a thin layer in the bottom of the oven-safe dish.
4. Weigh the empty dish to be used and record the weight to the nearest 0.1g. For accuracy, you may want to weigh the dish three times and take the average. The balance being used should be sensitive enough to measure 0.1g differences.
5. Break the soil up as much as possible when placing in the bottom of the dish.
6. Weigh the dish with the soil sample. Record the weight to the nearest 0.1 gram.
7. Repeat step #6 three times to get an average. Record the final weight to the nearest 0.1 gram.
8. Heat the soil sample in the container by using one of the following methods: (Teacher must conduct the heating process.)
   a. Place in a conventional oven at 100° Fahrenheit for 24 hours.
   b. Place in a conventional oven at 350° Fahrenheit until it is apparent that the sample is dry throughout.
   c. Place in a microwave with a rotating tray, heat on high until the sample is completely dry; make sure that the container is microwave safe.
9. Allow the sample and container to cool completely to room temperature. (A dish not completely cooled will weigh more than one that is cooled to room temperature.)
10. Following the steps in #6 and #7, weigh the sample and container.
11. Find the weight difference between the sample/container before heating and after heating and cooling. The weight difference is the weight of the moisture contained in the soil sample. The heating causes an evaporation of the water held in the soil.
12. Use the following formula to calculate this difference:
    a. final weight of container and soil before heating: ____ grams (#7)
    b. final weight of container and soil after heating: ____ grams (#10)
    c. a - b. = ____ (weight of water)
13. Calculate the percent of water in the sample by:

$$\frac{\text{Weight of Water (\#12)}}{\text{Weight of Soil + Water (\#7)}} \times 100 = \text{\_\_\_\_ \% water in soil sample}$$

14. Repeat procedure for all soil samples. You can easily heat all samples at the same time if oven space permits.
15. If the soil samples specifically differ in the moisture content, you should note a definite weight difference.

Further Studies

- Students can compare possible textural differences among the different soil types utilizing the Forestry Suppliers' Soil Analysis F.I.E.L.D. Kit or the Soil Texture Kit. Definite textural differences should be noted; especially if moisture content varies greatly among the samples tested. (9-12)
- Students may measure the pH value of the various soil samples by using the correlated Lesson Plan activity Determining the pH of Soil. (9-12)
- Students may conduct research on specific soil and texture types by using the school or public libraries or by contacting a local soil and water conservation agency or a private soil lab. (9-12)
- Students can quickly measure the immediate water holding ability of the different soil types by obtaining equal amounts of sand and garden soil and placing the samples in a plastic cup with ten holes punched in the bottom. Equal amounts of water can be poured through the cups and retrieved by placing a measuring cup or graduated beaker under the soil cup. The students can then measure the amount of water which was not absorbed and make comparisons between the different soil types. (9-10)

Rubric

- Students should be able to discuss the importance of soil moisture content by relating this to plant type.
- Students should be able to distinguish between the textural differences among select soil types.
- Students should be able to apply the mathematical method used in determining the percent of water in each sample.
- Students should be able to make related global inferences concerning the importance of soil type and moisture holding ability.

Assessment

- Presented with several different soil types, students will make observations concerning the apparent textural differences.
- Students will list and explain the different soil types concerning the observable moisture-holding ability of each.
- Students will calculate the percent of water when given information concerning the drying of a soil sample.

These lesson plans are provided for the benefit of science educators and can be freely downloaded from our web site at www.forestry-suppliers.com. If you have an idea or other suggestions for future lesson plans, we'd like to hear from you! Send an e-mail to fsi@forestry-suppliers.com.

Content Standards Covered

A Science as inquiry
- Abilities necessary to do scientific inquiry
- Understanding about scientific inquiry

E Science and Technology
- Understandings about science and technology

G History and Nature of Science
- Science as a human endeavor

Required Materials

The following items are required to complete all the activities in this lesson plan. Available from Forestry Suppliers, Inc.

- Magnifier **61122**
- Electronic Balance **94003**

Supplied by Teacher/Student(s)

- Soil from 3 different areas
- Oven-safe baking dish
- Oven
- 5 regular size coffee cans with plastic lids

Forestry Suppliers Lesson Plan

Soil pH

Forestry Suppliers' Soil Analysis F.I.E.L.D. Kit™
Fundamental Investigation of the Environment Leading to Discovery™
Study Kit Correlated to National Science Education Content Standards

If you're interested in soil studies for classroom activities, consider the Forestry Suppliers' Soil Analysis F.I.E.L.D. Kit. Use the kit for the exercises outlined in this Lesson Plan, as well as other related activities (see "Further Studies" section for a few ideas).

This F.I.E.L.D. Kit is available exclusively from Forestry Suppliers and includes some of the items used in this lesson plan. All kit items may also be purchased individually. Call our Sales Department at 1-800-647-5368 or visit us on the web at www.forestry-suppliers.com.

Fields of Study:
- Earth Science
- Mathematics

National Science Education Content Standards Correlation

Grades	A	B	C	D	E	F	G
K-4	✓	✓			✓		✓
5-8	✓	✓			✓	✓	✓
9-12	✓	✓			✓		✓

Soil Analysis Kit Contents Stock Number 36845		Required For This Lesson Plan			
Qty.	Description	K-4	5-8	9-12	Stock Number
1	Soil Color Book, GLOBE Earth Colors				77369
1	Soil Texture Kit				77330
1	Soil N-P-K Kit				77960
1	Soil Thermometer				89028
1	Soil Sample Bags, 18 oz.				79227
1	Soil Sample Tube	✓	✓	✓	76971
1	Hydrion pH Papers, 0-13	✓	✓	✓	78105

Grades K-4

Background

Some of our favorite foods make our tongue curl up because they are so SOUR, like a dill pickle! Other fun foods have a "bite" of their own because of their somewhat bitter flavor. There is a scientific reason for this: these foods are either acidic or basic. Other substances besides foods have these and other characteristics; for example, soap. Soap of any kind is very slippery and if you ever by accident get a little bath soap in your mouth, (YUK!) it has a very bitter taste. Bases are very bitter and cause surfaces to become slippery. Acids are very sour and, if very strong or concentrated, can cause a burn on the skin. Strong bases can burn the skin, too. Some substances are not really an acid or a base, like pure water; however, many of the substances around us can be identified as either acidic or basic, even the dirt in our backyard! A special name is given to the acid or base characteristic that a substance has: it is called the pH of a substance. Scientists have come up with a way to measure the pH by using special strips of paper called pH paper. When the paper touches the substance being tested it turns a specific color to tell you if the substance is an acid or a base.

The activity found in this lesson plan will teach you how to measure the pH of soil. This information is very important to gardeners and farmers; even those who grow just a few tomatoes in their backyard. Knowing the pH of the soil helps the gardener know exactly what types of vegetables or flowers will grow well in that spot! Have fun!

Procedure

1. Select 3 test sites; places from which you want to collect soil.
2. Dig approximately 6 inches down into the area and place the bottom half of the sample into the plastic bag and label according to the site.*
3. Place one tablespoon of soil from the collection bag into a small plastic cup. Add 1/4 cup of distilled water.
4. Swirl the soil and water mixture three times.
5. Place the edge of a 2-inch piece of pH Hydrion paper into the mixture.
6. Observe the color change of the pH paper.
7. Try to match the resulting color to the colors listed on the outside of the pH Hydrion paper package.
8. The colors match with a correlated pH number. This number is the pH value of the soil.
9. If the number is less than 7, the soil has an acidic nature.
10. If the number is more than 7, the soil has a basic nature.
11. Repeat the procedure or test using soil collected from different test sites.
12. Compare your results to see if there are any differences in the pH of different areas tested.

* *NOTE: The teacher or instructor may use a soil sampling tube which is an easy way to retrieve the first six inches of soil in a concise manner.*

Further Studies

- Do different types of plants, trees or flowers grow in the different areas where you collected soil? (K-4)
- If the pH values were different, could one pH soil type be better for some plants? (3-4)
- How can the pH value of the soil be changed? (3-4)
- Call your local plant nursery or store and ask them about the importance of soil pH. (3-4)
- Using your school or public library or the Internet, find out what plants prefer acidic or basic soil types. (3-4)
- Using a hand held magnifier, observe the three soil samples for differences in particle size and texture. (K-4)
- Correlated Lesson Plan Series activity, Determining Moisture Content of Soil. (3-4)

Content Standards Covered:

A Science as Inquiry
- Abilities necessary to do scientific inquiry
- Understanding about scientific inquiry

B Physical Science
- Properties of objects and materials

E Science and Technology
- Abilities of technological design
- Understandings about science and technology

G History and Nature of Science
- Science as a human endeavor

Rubric

- Students know the difference between an acid and a base by definition.
- Students know how to use pH Hydrion™ paper to determine the numerical pH value.
- Students understand that different soils have different pH values and can support different types of plants depending on the needs of the plants.
- Students can repeat the sequential steps of the experiment.

Assessment

- Have students prepare a storyboard showing the steps of their experiments.
- Orally quiz students concerning the difference between an acid and a base.
- Have students list the foods they have tasted in the past, which can be categorized as either an acid or base.
- Allow students to safely taste foods you have provided and categorize as an acid or base.

These lesson plans are provided for the benefit of science educators and can be freely downloaded from our web site at www.forestry-suppliers.com. If you have an idea or other suggestions for future lesson plans, we'd like to hear from you! Send an e-mail to fsi@forestry-suppliers.com.

Required Materials

Supplied by Teacher/Student(s)

- Soil collected from five different test sites
- 1 gallon distilled water

Optional Items

Optional Items available from Forestry Suppliers, Inc., that can be used to enhance this lesson plan.

- Folding Pocket Magnifier **61122**

Grades 5-8 Middle Educational

Grades 5-8

Background

At an early age our taste buds indicate to us whether something we eat is sour or bitter. These characteristics of a food can be described as acidic or basic and are due to the "chemical" nature of a substance.

Some acids are rather weak and some are very strong. For example, small amounts of weak acids are found in our mouths and stomachs. These acidic solutions serve to help break down and digest the food we consume every day. A weak base is one of the major components found in dishwashing liquid and bath soap. Acids and bases are important in industry. Industrially, one of the most important acids is sulfuric acid. It is used in petroleum refining, steel processing and fertilizer production. Phosphoric and nitric acid are used in fertilizer production, too.

It is important to understand the role of the acidic or basic nature of the soils in which food crops and plants are grown. Some plants prefer acidic soils whereas others grow best in basic soil. The acidic or basic nature of the soil can even affect the color of the leaves and flowers as well as the overall health of the plant.

How do scientists or even farmers know whether the soil in which they plant seeds or young plants is basic or acidic? They can use special test paper strips or a meter to measure what is called the "pH" of the soil. Scientists devised a "pH scale" which determines whether a substance is an acid or a base. This pH scale is a numerical scale or a number line. The numbers on the scale range from 0 - 14, allowing 7 to be the mid-point. Any substance which has a pH value of less than 7 is considered an acid, and a pH value greater than 7 is a base. This leaves a pH of exactly 7 being neutral.

0————————7————————14
ACID———NEUTRAL———BASE

How are pH values determined? Simple. One can use a special pH paper (called Hydrion™ pH Paper or pH test paper) which, when placed in a solution, turns a specific color depending upon the pH value of the substance. The color of the test strip is matched to a color chart, which gives the pH value. A pH tester can also be used to measure the pH of soil, water, or other substances. A pH tester is an instrument that has a probe, which is inserted into a soil or liquid sample and gives a "readout" concerning the pH of the substance tested. Knowing the pH of the soil can help a farmer know what soil type is best in which to grow particular plants, vegetables, or flowers.

Procedure

1. Select 3 test sites; places from which you want to collect soil.
2. Dig approximately 6 inches down into the area and place the bottom half of the sample into the plastic bag and label according to the site.*
3. Place one tablespoon of soil from the collection bag into a small plastic cup. Add 1/4 cup of distilled water.
4. Swirl the soil and water mixture three times.
5. Place the edge of a 2-inch piece of pH Hydrion paper into the mixture.
6. Observe the color change of the pH paper.
7. Try to match the resulting color to the colors listed on the outside of the pH Hydrion paper package.
8. The colors match with a correlated pH number. This number is the pH value of the soil.
9. If the number is less than 7, the soil has an acidic nature.
10. If the number is more than 7, the soil has a basic nature.
11. Repeat the procedure or test by gathering soil from a different area and testing.
12. Compare your results to see if there are any differences in the pH of different areas tested.
13. Sprinkle a small amount of the soil sample on a white piece of paper or on a white index card.
14. Using the magnifying lens, look for the shape and texture of the soil particles.
15. Repeat steps #11 and #12 with soil from each collection site.
16. Compare your results to see if there are any differences in the different soil samples.

** NOTE: The teacher or instructor may use a soil sampling tube which is an easy way to retrieve the first six inches of soil in a concise manner.*

Further Studies

- Do different types of plants, trees or flowers grow in the different areas where you collected soil?
- Using your school or public library or the Internet, find out what plants prefer acidic or basic soils.
- Extend your soil study by testing and observing the soil samples concerning the texture and particle size by using a soil texture test kit.
- Call your local plant nursery or plant store and ask about the importance of soil pH.
- Find information concerning the industrial uses of acids and bases.
- Using a pH meter, test the soil pH and compare this to the pH values resulting from using the pH paper.
- Observe or test:
  1 Color comparison of soil samples
  2 Temperature differences among samples taken at the site
  3 Specific texture differences.

Content Standards Covered:

A Science as inquiry
- Abilities necessary to do scientific inquiry
- Understandings about scientific inquiry

B Physical Science
- Properties and changes of properties in matter

E Science and Technology
- Abilities of technological design
- Understandings about science and technology

F Science in Personal and Social Perspectives
- Science and technology in society

G History and Nature of Science
- Science as a human endeavor
- History of science

Rubric

- Students know the difference between an acid and a base by definition.
- Students know how to use pH hydrion paper to determine the numerical pH value.
- Students understand that different soils successfully support specific plant life depending upon the pH level.
- Students can successfully repeat the experiment steps.

Assessment

- Orally quiz students concerning the difference between an acid and a base.
- Have students list the foods they have tasted in the past, which can be categorized as either an acid or base.
- Have students prepare a summary concerning the pH differences and the texture differences found in the different soil samples.
- Have students design a similar experiment involving pH differences among household products or foods.

These lesson plans are provided for the benefit of science educators and can be freely downloaded from our web site at www.forestry-suppliers.com. If you have an idea or other suggestions for future lesson plans, we'd like to hear from you! Send an e-mail to fsi@forestry-suppliers.com.

Required Materials

The following items are required to complete all the activities in this lesson plan. Available from Forestry Suppliers, Inc.

- Union Trowel **33413**

Supplied by Teacher/Student(s)

- Soil collected from five different test sites
- 1 gallon distilled water

Optional Items

Optional Items available from Forestry Suppliers, Inc., that can be used to enhance this lesson plan.

- pH Tester **76164**
- Magnifying Lens **61122**

Background

Many of the foods we enjoy have an acidic or basic nature. Citrus fruits contain acid, which give them a desirable tart or sour taste. Many common household products are basic in composition, such as cleaners and soaps. Weak bases found in bath soaps help create a slippery effect on surfaces; this is experienced when washing your hands. Bases have a bitter taste that we may have experienced as young children when we accidentally got a little soap solution in our mouth when we washed our face. Basic solutions are sometimes called alkaline. Acids, weak and strong, have important industrial uses. Sulfuric acid is important in petroleum refining, steel processing as well as in the process of fertilizer production. Weak acids are found in saliva and gastric juices.

Chemically, acids are defined as substances when mixed with water form hydronium ions, H3O+. Bases are defined as substances which form hydroxide ions, OH-, when mixed with water. A color reaction with a special paper (called litmus paper) physically defines a solution as acidic or basic. Blue litmus paper turns red when exposed to an acidic solution and red litmus paper turns blue when in contact with a basic solution. To more specifically define an acidic or basic substance, scientists devised a numerical scale, called a pH scale, to categorize substances as an acid or base. Numerically, the scale is from 0 to 14, with 7 being the midpoint. Any solution or substance having a pH value of less than 7 is known as an acid and above 7 is considered a base. Seven is considered neutral. A special test paper, pH Hydrion, is used to numerically measure pH. Depending on the acidic or basic nature of the test solution, the paper turns a specific color which can be matched to a standard color chart correlated with pH values. A pH meter can also be used to measure the pH of a solution or substance. The meter consists of a probe, which is placed in the solution and the meter displays a digital readout of the pH.

0————————7————————14
ACID———NEUTRAL———BASE

Agriculturally, the pH value of soil is an important factor or consideration for farmers. Particular crops and plants require a specific pH to thrive and produce high yields. The pH of the soil can even affect the color of leaves or flowers. Whether it is growing tomatoes in a small garden or soybeans over many hundreds of acres, knowing and maintaining the correct soil pH is a must. By conducting the following experimentation, one can gain a better understanding of acids and bases and how pH is measured.

Procedure

1. Select 5 different soil-testing sites; make observations of the surroundings, which may lend to the possible resulting differences in pH of the soils tested.
2. Vertically dig 6 inches into the site and place the sample retrieved at that depth into the plastic bag and label.
3. Weigh out approximately 10 grams or measure about 1 tablespoon of the soil and place into a plastic cup or beaker.
4. Add 60 ml or 1/4 cup of distilled water.
5. Swirl the soil and water mixture 3 times; use a clean stirring rod or spoon to thoroughly mix the water and soil.
6. Place the edge of a 2-inch piece of pH Hydrion paper into the mixture.
7. Observe the color change of the pH paper.
8. Try to match the resulting color to the colors listed on the outside of the pH Hydrion paper package.
9. The colors match with a correlated pH number. This number is the pH value of the soil.
10. If the number is less than 7, the soil has an acidic nature.
11. If the number is more than 7, the soil has a basic nature.
12. Repeat the procedure or test by completing steps 3 through 11 using the other soil samples.
13. Compare your results to see if there are any differences in the pH of different areas tested.

Further Studies

- Using the Soil Analysis F.I.E.L.D. Kit, test for the following differences between the different soil test sites:
  a. Soil Texture
  b. Soil Color
  c. Temperature of soil at site
- Compare the moisture content of the selected soils by conducting a soil moisture analysis as outlined in the Lesson Plan, Determining Moisture Content of Soil.
- Contact your local Soil and Water Conservation Agency for information concerning soil pH as well as the local plant nursery.
- Research the following acid/base theories:
  a. Bronsted-Lowery
  b. Arrenhius
  c. Lewis
- Research and define the following terms:
  a. Buffer
  b. Acid-base neutralization
  c. Blood pH

Content Standards Covered:

A Science as inquiry
- Abilities necessary to do scientific inquiry
- Understanding about scientific inquiry

B Physical Science
- Structure and properties of matter

E Science and Technology
- Abilities of technological design
- Understandings about science and technology

G History and Nature of Science
- Science as a human endeavor
- Historical Perspectives

Rubric

- Students should understand the differences between an acid and a base.
- Students should be able to repeat experiment using other substances, such as household products.
- Students should be able to make correlations between different test sites and possible pH differences.

Assessment

- Quiz students concerning the theoretical differences between acids and bases and have them give examples.
- Have students use pH paper and a pH meter to test the pH values of selected solutions.
- Have students cite acid-base neutralizations reactions, which are common to everyday life, example: using an antacid to relieve heartburn.

These lesson plans are provided for the benefit of science educators and can be freely downloaded from our web site at www.forestry-suppliers.com. If you have an idea or other suggestions for future lesson plans, we'd like to hear from you! Send an e-mail to fsi@forestry-suppliers.com.

Required Materials

The following items are required to complete all the activities in this lesson plan. Available from Forestry Suppliers, Inc.

- Union Trowel **33413**

Supplied by Teacher/Student(s)

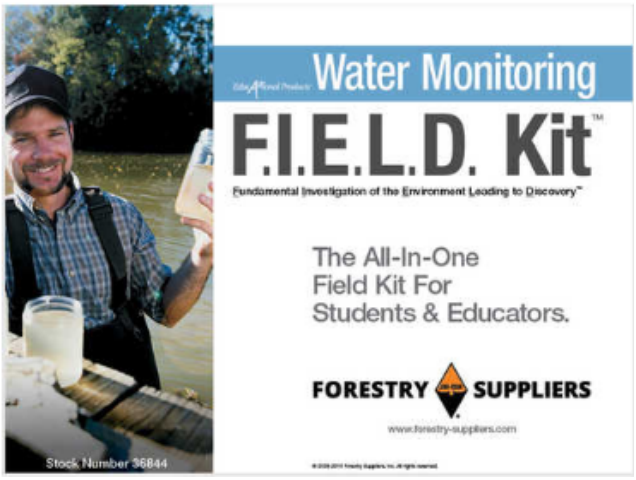
- Soil collected from five different test sites
- 1 gallon distilled water

Optional Items

Optional Items available from Forestry Suppliers, Inc., that can be used to enhance this lesson plan.

- 100 ml Beaker **53609**
- 100 ml Graduated Cylinder **53643**
- Oakton pH Testr 1 **76164**
- Electronic Balance **94003**

Water Quality



ITEMS INCLUDED

For water quality there are two kits included. The field kit includes items for outdoor analysis such as: waders, sampling bottles, pH paper, and materials to measure dissolved oxygen, phosphates, nitrates, pH, turbidity, coliform bacteria, and temperature. The included water monitoring kit has additional tests for dissolved oxygen, biochemical oxygen demand, pH, nitrates, phosphates, coliform bacteria, and turbidity.

TESTING

Tests can be completed on samples that have been previously collected. If youth are sampling on location they can utilize the included waders, sample bottles, and pipettes. Samples should be collected in a variety of locations to compare water qualities. For example, compare agricultural field runoff with municipal water.

Program Applications

Water Quality Analysis

Utilizing the kit materials participants can determine water quality. By analyzing pH and the amount of dissolved oxygen the ability of the water system to sustain organisms can also be identified. For example, low dissolved oxygen levels will result in a decrease in organisms ability to thrive. Phosphates and Nitrates are often added to farmed soil to increase productivity; if these nutrients runoff into local water sources they will decrease the overall available dissolved oxygen levels. Water quality results can also be compared to show the distinct difference between municipal water sources and surface water. To enhance the educational experience you can visit a local water treatment system.

Water Quality Lesson Plan Addendum

Objectives: **Students will be able to use the field kit to collect samples, analyze macroinvertebrates, and measure several important parameters of water quality.**

Time to complete activity: **~60 minutes**

Background/Setting the Stage: **Use the background provided from the water sampling kit lesson plan; you were also provided with a "Low Cost Water Monitoring Kit" the information (a small yellow book) included in this kit is excellent at explaining each parameter, why it is important, step by step instructions on how to complete each test, and a results sheet for each parameter to determine the water quality.**

Materials: Water Field Kit & Low Cost Water Monitoring Kit

Activity: **This activity can be completed in several ways and each are listed below with various kit items. However, for every water quality program completed I recommend having each student record their initial impressions of the water that will be sampled (prior to any tests!).**

If you are only interested in studying Macroinvertebrates, you can complete the water testing using only the Water Field Kit, their lesson plan and included supplies. After taking samples, students will need to analyze them under a microscope to identify any present macroinvertebrates. There are included cards that show possible organisms that can be found; once macroinvertebrates are identified, water quality can be determined based off which organisms were present.

The next method for completing this activity is the use of the Low Cost Water Monitoring Kit. The benefit for using this kit alone would be samples can be collected prior to analysis and students can complete the tests in and indoor setting. Students can still certainly be the ones to collect the samples however, having them beforehand is an option. The booklet included in the Low Cost kit is excellent at describing why each parameter that is being tested is important and how it impacts the aquatic system; make sure the students read this information or explain it to them before each test. There are step by step instructions for completing each test along with a results table for analysis. Have students record the parameters as you complete each test.

The final option is utilizing the two materials together. Since the Low Cost kit is portable and small, it is very conducive to field work. Samples can be collected via this kit or items from the Water Field Kit. Again, have students record the parameters as they complete the testing.

Reflection Questions: (Discussion): **Results will depend upon the water source tested. Each student should have the results of the tests recorded in their notebooks, have them look over every result both individually and cumulatively and determine the quality of the water system. Have the students discuss their initial expectations of the water quality and the actual water quality determined with the tests.**

I think here is also a great place to discuss water treatment in a municipal system (you can talk about septic tanks as well if you wish!). Most students are unaware of how their water is treated and what processes are taken to clean waste water to generate drinkable water.

Forestry Suppliers Lesson Plan

Aquatic Life

Forestry Suppliers' Water Monitoring F.I.E.L.D. Kit™
Fundamental Investigation of the Environment Leading to Discovery™
Study Kit Correlated to National Science Education Content Standards

If you're interested in water monitoring for classroom activities, consider the Forestry Suppliers' Water Monitoring F.I.E.L.D. Kit. Use the kit for the exercises outlined in this Lesson Plan, as well as other related activities (see "Further Studies" section for a few ideas).

This F.I.E.L.D. Kit is available exclusively from Forestry Suppliers and includes some of the items used in this lesson plan. All kit items may also be purchased individually. Call our Sales Department at 1-800-647-5368 or visit us on the web at www.forestry-suppliers.com.

Fields of Study:
- Biology
- Ecology
- Environmental Science

National Science Education Content Standards Correlation

Grades	A	B	C	D	E	F	G
K-4	✓		✓		✓	✓	
5-8	✓		✓		✓	✓	
9-12	✓		✓		✓	✓	

Water Monitoring Kit Contents Stock Number 36844		Required For This Lesson Plan			
Qty.	Description	K-4	5-8	9-12	Stock Number
1	Eye Dropper	✓		✓	53679
1	GREEN Low Cost Water Monitoring Kit				76648
1	Turbidity & Transparency Tube	✓		✓	77107
1	Basic Water Sampler	✓	✓	✓	77222
1	Thermometer	✓	✓	✓	89319
1	Shovel				33486
1	Packable Chest Waders	✓	✓	✓	93962
1	Leaf Pack Flash Cards				76609
1	Sieve				53935
1	pH Paper				78105
1	Aquatic Net				53757

Grades K-4

Background

Water makes up about 70% of the Earth's surface. We cannot live without it. Our bodies are 50%-70% water. Through the processes of the water cycle, the water that is found in a particular source is recycled. Since we will not be receiving new supplies of water from outside the earth's environment, we must be good stewards of our aquatic sources.

Having a strong knowledge and understanding of our aquatic ecosystems enables us to know how to take the necessary steps in "taking care" of these important environments. Whether it is a small pond or a large winding river, each aquatic source provides a specific home for certain plants and animals. There are many aquatic species of plants and animals. The water is their home. A lot of "life" is found in just one drop of pond water. You can easily find euglena, paramecium, "water bears" (tardigrades), water fleas (daphnia), planaria, algae, and many other species of plants and animals. We tend to be unaware of all the organisms that exist within an aquatic system because they are not seen by our eyes without magnification. Sometimes we mistake a common aquatic plant, duckweed, for slime without taking an important second look. While passing by an aquatic source, we could easily think the green stuff floating on the water's surface is "slime" and not an aquatic plant that serves as an important food source for many organisms.

Ponds, lakes, streams, rivers, and marshes are affected by surrounding land areas. If farmland surrounds an aquatic system, attention and care must be given to the possible effects farming chemicals may have on the water source. Herbicides and pesticides are used by farmers to ensure the production of healthy and high yield crops. However, consideration must be given to the possible effects the use of herbicides and pesticides may have on aquatic life now and in the future.

Atmospheric pollution can also have an adverse effect on water sources. Acid rain is caused by the introduction of chemical compounds from the burning of petroleum products and other industrial pollution. Sulfur and nitrogen compounds originate from this pollution and are introduced into the atmosphere where they combine with water and "fall" as acidic precipitation in the form of rain, snow, or sleet.

It is important that even the youngest student has a true understanding of the aquatic ecosystems within his or her environment. Identifying the flora and fauna within an ecosystem as well as understanding the behavior and interrelationships will open a new area of enlightenment and understanding. The following activities will provide an introduction and foundation for continued aquatic studies. With this kind of knowledge base, young people can be and will become better stewards of their environment.

Procedure

1. Select an aquatic source site where safe collection of water and aquatic specimens can be performed. For safety reasons, students must be accompanied by the teacher at all times. A stream, creek, pond, or marsh area is desirable.
2. Secure the water sampler. Follow included instructions so that sampler can be thrown or "cast out" into the water source and then deployed for water collection. Younger students may need assistance with the sampler. Place water in a plastic container or bucket for later observations.
3. With an eyedropper, obtain a drop of the collected water. Using a field, student or standard microscope, view a drop of collected water that has been placed on a depression slide. If you do not have a depression (well) slide, then carefully place on a regular microscope slide. Do not use a cover slip. View the water droplet on low magnification, careful not to place objective into water droplet.
4. Look for movement of small organisms. When you have located this movement, increase the magnification and focus to view the organisms for possible identification. Use a guide (pictorial) for pond life identification. The following two sources are good for identification sources:

   LaMotte Leaf Pack Flash Cards
   LaMotte Bug Kit™
5. Commonly found aquatic organisms:

   Euglena has a whip-like tail called flagella.
   Daphnia (water fleas) resembles a flea. You can easily see internal movement caused by the circulatory system.
   Hydra equipped with tentacles for capturing food.
   Amoebae changes shape, projects a pseudopodia, false foot for movement.
   Paramecium about the size of a period at a sentence's end, elongated and resembles a slipper or footprint.
   Volvox a colony organism with hundreds of bi-flagellated cells embedded in a gelatinous wall.
6. If possible, take soil or sand samples at the water's edge. This can easily be accomplished by using a digging tool, shovel or aquatic suction sampler. After the sample has been obtained, place in a small opening sieve. "Wash" the soil or sand through the sieve with water. Retrieve the now visible, collected organisms carefully; use extra caution to avoid being pinched by crayfish or other similar organisms. Place collected organisms in bucket or plastic bag with a small amount of water if needed. Make sure that organisms are not retained in plastic bags for too long.
7. Contact your local Soil and Water Conservation Agency to find out what the normal expected pH level should be for such an aquatic source. Check and record the pH of the water from the aquatic source using Hydrion™ pH Paper or a pH meter. For accuracy, repeat the test twice. For background information on pH, see the Lesson Plan "Determining Soil pH", K-4 and 5-8.
8. Using an appropriate thermometer, measure the temperature of the aquatic source and record. For accuracy, repeat the process twice.
9. Prepare a data sheet for recording and analyzing the collected data. Include all observed aquatic plant and animal life, pH value, and temperature reading.

Further Studies

- Guide students in completing research concerning aquatic insect larvae and adult forms found in the water source. A listing of common aquatic insects would be helpful.
- For a good comparison, conduct the same procedure outlined at one or two additional aquatic sites. Attention should be given concerning the population of aquatic flora and fauna found at each site. If detectable differences are noted, then discuss whether pH and temperature variations may be affecting the presence and growth of particular species. Use a pH meter to test pH value for comparison.
- If possible, isolate daphnia and hydra found in the water sample and place together on depression slide. The hydra is a natural predator of the daphnia. Observe for possible aggressive behavior toward the daphnia by the hydra.
- A daphnia's heart rate can be measured or observed. Use a descriptive drawing of the daphnia's anatomy to find the heart area and measure the heart rate during 30 seconds, 60 seconds, etc. A watch with a sweep second hand or stopwatch will need to be used.
- Discuss an aquatic ecosystem and food chains, giving attention to the importance of all species within an ecosystem as well as the negative effect pollution run-off can have on a system.
- Using a Microscope, prepare a well slide with water samples to provide a more detailed view of the organism and plant life present.
- Students may study the turbidity of the selected aquatic source, perform a macroinvertebrate study, determine the dissolved oxygen level, phosphate and nitrate level, and presence of coliform bacteria by using the Forestry Suppliers Water Monitoring F.I.E.L.D. Kit. Other extended study kits include the LaMotte Leaf Pack Experiment Kit and the LaMotte Bug Kit.
- Viewing larger organisms through a DiscoveryScope® is an excellent optional activity. This provides 10x magnification while the organism is held in an enclosed clear plastic case.

Grades K-4

Rubric

- Students should be able to identify the selected aquatic source as a river, stream, marsh, pond, etc.
- Students should be able to discuss and identify common aquatic plants and animals.
- Students should be able to explain the procedure(s) for determining pH and temperature of an aquatic source.

Assessment

- Teacher will ask students to list five common aquatic insects and three common aquatic plants.
- Teacher will have students discuss the definition and importance of an ecosystem.
- Students will describe in detail the life cycle habits and "uniqueness" of their favorite insect or plant found in the aquatic source.

These lesson plans are provided for the benefit of science educators and can be freely downloaded from our web site at www.forestry-suppliers.com. If you have an idea or other suggestions for future lesson plans, we'd like to hear from you! Send an e-mail to fsi@forestry-suppliers.com.

Content Standards Covered

A Science as inquiry
- Abilities necessary to do scientific inquiry
- Understanding about scientific inquiry

C Life Science
- Characteristics of organisms
- Life cycles of organisms
- Organisms and environments

E Science and Technology
- Abilities of technological design

F Science in Personal and Social Perspectives
- Changes in environments
- Science and technology in local challenges

Required Materials

Student Microscope	60099

Additional Materials Needed

Supplied by Teacher/Student(s)

- Microscope and Microscope slides
- Data Collection Sheet
- Collection Container

Optional Items

Optional Items that can be used to enhance the lesson plan.

DiscoveryScope	61098
Aquatic Suction Sampler	77254
Digital Stopwatch/Clock	92637
Lighted Portable Microscope	61232
LaMotte Leaf Pack Experiment Kit	76605
LaMotte Bug Kit	76606
Utility Bucket	54028
Soil Sample Bags	79147
Shaker Sieve	77252
pH Meter	76164
Slides	60002

Grades 5-8

Background

Water is very important to our lives. We cannot live without it! Water composes 70% of the Earth's surface environment. Our body weight is made up of 50%-70% water by weight. In our environment, we are surrounded by water; above us in the earth's atmosphere, water droplets compose clouds and eventually fall as rain, sleet, or snow. Below the surface of the earth, water can be found in aquifers. An aquifer is an underground formation of permeable rock or loose material that can produce useful quantities of water when tapped by a well. The rain that fell on early man thousands of years ago is still around today. It has been recycled thousands of times.

Water is known as the universal solvent because it successfully dissolves so many substances. Man has sometimes overlooked the value of water's composition and the great need for water. We have not always been sensitive enough to the responsible stewardship of natural resources, specifically water. Currently, there is much concern about water pollution, global warming of oceans, the introduction of acid rain into aquatic sources, and agricultural run-off composed of pesticides and herbicides. These sources of pollution can affect all types of aquatic sources including streams, rivers, lakes, ponds, and marshes.

Knowing the composition of an aquatic body or water source is very important. Significant compositional factors are temperature, pH level, dissolved oxygen level, nitrate levels and turbidity. Turbidity indicates the clarity or “clearness” of the water. The more “murky” the water, the higher the turbidity level. Visibility is limited in a very turbid water source. The ability of light to penetrate a body of water is directly related to the turbidity. If only a small amount of light can “pass through”, the light will not reach the entire depth of the water. Without light, plants cannot complete the photosynthetic cycle. If they are unable to complete this cycle, the plant cannot survive. A high turbidity level can be caused by suspended particles from a specific run-off source, over-growth of algae, or elevated activity of “bottom-dwellers”. An elevation in turbidity can cause depletion in oxygen content, thus having a negative effect on the ecosystem.

Dissolved oxygen content is crucial to the health of an aquatic ecosystem. The need for appropriate oxygen levels is vital for optimum growth and health of aquatic plants and animals. Some fish species prefer higher oxygen content while "bottom-dwellers" thrive in lower dissolved oxygen environments.

By completing this activity, students will learn how many different factors influence the overall health of an aquatic environment as well become better stewards of their own environment.

Procedure

1. Select an aquatic source site where safe collection of water and aquatic specimens can be performed. For safety reasons, students must be accompanied by the teacher at all times. A stream, creek, pond, or marsh area is desirable. Test three different sites if possible for comparative studies.
2. Secure the water sampler. Follow included instructions so that sampler can be thrown or “cast out” into the water source and then deployed for water collection. Place water into plastic container or bucket for later observations.
3. With an eyedropper, obtain a drop of collected water. Using a field, student or standard microscope, view a drop of collected water that has been placed on a depression slide. If you do not have a depression slide (well slide), use a regular microscope slide. Do not use a cover slip, and carefully view the water droplet on low magnification. Do not place the objective into the water droplet.
4. Look for movement of small organisms. When you have located this movement, increase the magnification and focus to view the organisms for possible identification, using a guide (pictorial) for pond life identification. The following two sources are good for identification sources:
   LaMotte Leaf Pack Flash Cards
   LaMotte Bug Kit
5. Commonly found aquatic organisms:
   Euglena has a whip-like tail called flagella.
   Daphnia (water fleas) resembles a flea. You can easily see internal movement caused by the circulatory system.
   Hydra equipped with tentacles for capturing food.
   Amoebae changes shape, projects a pseudopodia, false foot for movement.
   Paramecium about the size of a period at a sentence’s end, elongated and resembles a slipper or footprint.
   Volvox a colony organism with hundreds of bi-flagellated cells embedded in a gelatinous wall.
6. If possible, take soil or sand samples at the water’s edge. This can easily be accomplished by using a digging tool, shovel or aquatic suction sampler. After the sample has been obtained, place into a small opening sieve. “Wash” the soil or sand through the sieve with water. Retrieve the now visible, collected organisms carefully; use extra caution to avoid being pinched by crayfish or other similar organisms. Place collected organisms in bucket or plastic bag with a small amount of water if needed. Make sure that organisms are not retained in plastic bags for too long.
7. Check and record the pH of the water from the aquatic source by using Hydrion™ pH Paper or a pH meter. Determine if the measured pH is normal by contacting your local Soil and Water Conservation Agency. For accuracy, repeat the test twice. For background information on pH, see the Lesson Plan “Determining Soil pH”, K-4 and 5-8.
8. Using a thermometer that measures in Celsius degrees, take a temperature reading of the body of water. Repeat the process twice for accuracy.
9. Measure the dissolved oxygen level of the selected water source by completing the steps listed in the kit instructions. If possible, repeat the test twice for accuracy.
10. Using a secchi disc or a turbidity tube, measure the turbidity of the source. You will also want to repeat this test twice for accuracy.
11. Using an aquatic net, sweep through the water’s upper level taking care to collect surface organisms and plants. Remove organisms and place in plastic collection bags or a suitable container. Do the same for plants collected.
12. Record all readings and observations on a data sheet.
13. Review data when completed with all testing and observations. Make specific observations for any noted differences if two or three sites were involved in the testing. Using a reference book on aquatic plants, insects, macro-invertebrates and micro-invertebrates, attempt to identify as many species as possible.

Further Studies

- Have students sketch drawings of collected plants and organisms when viewed with the naked eye or microscope.
- Have students graph numerical data from each of the three sites and make correlated observations.
- Using the Forestry Suppliers’ Water Monitoring F.I.E.L.D. Kit, complete an extended study of the macro-invertebrates present in the selected aquatic sites.
- Using a depth recorder, compare the depth and temperature differences of the selected aquatic test sites.
- Using an aquatic suction sampler and a sieve, collect organisms which may burrow into the sand or mud found at the water’s edge. After collecting in the sieve, place organisms in a plastic bag or collection container.
- Using the LaMotte Pondwater Tour, complete the directed activities and record observations.
- Students will conduct research concerning the following terms:
  - Storm Run-off
  - Aquifers
  - Herbicide
  - Non-point Source Pollution
  - Pesticide
  - Acid Rain
  - Agricultural Run-off
  - Industrial Pollution
  - Hydrologic Cycle
  - Ground Water
  - Aquatic Ecosystems
  - Aquatic Food Chain
- Viewing larger organisms through a DiscoveryScope is an excellent optional activity. This provides 10x magnification while the organism is held in an enclosed clear plastic case.

Grades 5-8

Rubric

- Students should be able to describe the different categories of aquatic sources (marsh, pond, lake, etc).
- Students should be able to describe the testing procedures completed and the purpose of each.
- Students should exhibit a specific knowledge of what organisms would be found in a similar aquatic system to that which was tested.

Assessment

- Teacher will have students sketch three to five of the plant species found, as well as, three to five aquatic insects or other macro-organisms.
- Students will describe the different factors that can be measured and affect aquatic life.
- Teacher will have students explain how each observed or collected plant or organism plays an important role in the life of an aquatic system.

These lesson plans are provided for the benefit of science educators and can be freely downloaded from our web site at www.forestry-suppliers.com. If you have an idea or other suggestions for future lesson plans, we'd like to hear from you! Send an e-mail to fsi@forestry-suppliers.com.

Content Standards Covered

A Science as inquiry
- Abilities necessary to do scientific inquiry
- Understanding about scientific inquiry

C Life Science
- Structure and function in living systems
- Populations and ecosystems
- Diversity and adaptations of organisms

E Science and Technology
- Abilities of technological design

F Science in Personal and Social Perspectives
- Populations, resources, and environments

Required Materials

Student Microscope	60099

Additional Materials Needed

Supplied by Teacher/Student(s)

- Microscope slides
- Data Collection Sheet
- Collection Container

Optional Items

Optional Items that can be used to enhance the lesson plan.

DiscoveryScope	61098
Aquatic Suction Sampler	77254
Lighted Portable Microscope	61232
LaMotte Leaf Pack Experiment Kit	76605
LaMotte MacroMania	76696
LaMotte Bug Kit	76606
LaMotte Pond Water Tour	76620
Reference: Vernal Pools Natural History & Conservation	76595
Reference: Guide to Common Freshwater Invertebrates of North America	76591
Resource: Poster Ecology of Vernal Pools	76655
Utility Bucket	54028
Soil Sample Bags	79147
Shaker Sieve	77252
pH Meter	76164
Slides	60002

Grades 9-12

Background

Water is very important to our lives. We cannot live without it! Water composes 70% of the Earth's surface environment. Our bodies are 50%-70% water by weight. In our environment, we are surrounded by water; above us in the earth's atmosphere, water droplets compose clouds and eventually fall as rain, sleet, or snow. Below the surface of the earth, water can be found in aquifers. An aquifer is an underground formation of permeable rock or loose material that can produce useful quantities of water when tapped by a well. The rain that fell on early man thousands of years ago is still around today. It has been recycled thousands of times.

Water is known as the universal solvent because it successfully dissolves so many substances. Man has sometimes overlooked the value of water's composition and the great need for water. We have not always been sensitive enough to the responsible stewardship of natural resources, specifically water. Currently, there is much concern about water pollution, global warming of oceans, the introduction of acid rain into aquatic sources, and agricultural run-off composed of pesticides and herbicides. These sources of pollution can affect all types of aquatic sources including streams, rivers, lakes, ponds, and marshes.

Knowing the composition of an aquatic body or water source is very important. Significant compositional factors are temperature, pH level, dissolved oxygen level, nitrate levels and turbidity. Turbidity indicates the clarity or "clearness" of the water. The more "murky" the water, the higher the turbidity level. Visibility is limited in a very turbid water source. The ability of light to penetrate a body of water is directly related to the turbidity. If only a small amount of light can "pass through", the light will not reach the entire depth of the water. Without light, plants cannot complete the photosynthetic cycle. If they are unable to complete this cycle, the plant cannot survive. A high turbidity level can be caused by suspended particles from a specific run-off source, over-growth of algae, or elevated activity of bottom-dwellers. An elevation in turbidity can cause depletion in oxygen content, thus having a negative effect on the ecosystem.

Dissolved oxygen content is crucial to the health of an aquatic ecosystem. The need for appropriate oxygen levels is vital for optimum growth and health of aquatic plants and animals. Some fish species prefer higher oxygen content while bottom-dwellers thrive in lower dissolved oxygen environments.

Acid rain pollution also affects an aquatic system in a negative manner. The optimum pH level is important for the survival of aquatic plants and animals.

An aquatic system is a complex ecosystem of interdependence between plants and animals and a delicate balance of compositional factors. Only with a specific knowledge of this can we really take care of these systems. By completing this activity, students will learn how many different factors influence the overall health of an aquatic environment as well become better stewards of their own environment.

Procedure

1. Select three different aquatic source sites where safe collection of water and aquatic specimens can be performed. For safety reasons, students must be accompanied at all times. A stream, creek, pond or marsh area is desirable. Test three different sites if possible for comparative studies.

2. Secure the water sampler. Follow included instructions so that sampler can be thrown or "cast out" into the water source and then deployed for water collection. Place water into plastic container or bucket for later observations.

3. With an eyedropper, obtain a drop of the collected water. Using a field, student or standard microscope, view a drop of collected water that has been placed on a depression slide. If you do not have a depression slide (well slide) then carefully place on a regular microscope slide. Do not use a cover slip. View the water droplet on low magnification, careful not to place objective into water droplet.

4. Look for movement of small organisms. When you have located this movement, increase the magnification and focus to view the organisms for possible identification, using a guide (pictorial) for pond life identification. The following two sources are good for identification sources:
   LaMotte Leaf Pack Flash Cards
   LaMotte Bug Kit

5. Commonly found aquatic organisms:
   Euglena has a whip-like tail called flagella.
   Daphnia (water fleas) resembles a flea. You can easily see internal movement caused by the circulatory system.
   Hydra equipped with tentacles for capturing food.
   Amoebae changes shape, projects a pseudopodia, false foot for movement.
   Paramecium about the size of a period at a sentence's end, elongated and resembles a slipper or footprint.
   Volvox a colony organism with hundreds of bi-flagellated cells embedded in a gelatinous wall.

6. If possible, take soil or sand samples at the water's edge. This can easily be accomplished by using a digging tool, shovel or aquatic suction sampler. After the sample has been obtained, place into a small opening sieve. "Wash" the soil or sand through the sieve with water. Retrieve the now visible, collected organisms carefully; use extra caution to avoid being pinched by crayfish or other similar organisms. Place collected organisms in bucket or plastic bag with a small amount of water if needed. Make sure that organisms are not retained in plastic bags for too long.

7. Check and record the pH of the water from the aquatic source by using Hydrion pH Paper or a pH meter. Determine if the measured pH is normal by contacting your local Soil and Water Conservation Agency. For accuracy, repeat the test twice. For background information on pH see the Lesson Plan "Determining Soil pH", K-4 and 5-8.

8. Using a thermometer that measures in Celsius degrees, take a temperature reading of the body of water. Repeat the process twice for accuracy.

9. Measure the dissolved oxygen level of the selected water source by completing the steps listed in the kit instructions. If possible, repeat the test twice for accuracy.

10. Using a secchi disc or a turbidity tube, measure the turbidity of the source. You will also want to repeat this test twice for accuracy.

11. Using an aquatic net, sweep through the water's upper level taking care to collect surface organisms and plants. Remove organisms and place in plastic collection bags or a suitable container. Do the same for plants collected.

12. Record all readings and observations on a data sheet.

13. Review data when completed with all testing and observations. Make specific observations for any noted differences if two or three sites were involved in the testing. Using a reference book on aquatic plants, insects, macro-invertebrates and micro-invertebrates, attempt to identify as many species as possible.

Further Studies

- Guide students in completing research concerning the following topics:
  - Total water supply of earth
  - How much water evaporates into the atmosphere?
  - Hydrologic cycle
  - Where is freshwater stored?
  - Water table
  - Aquifers
  - Urbanization
  - How much water is stored in glaciers and icecaps?
  - Storm run-off
  - Sinkholes
  - Storm sewers
  - Urban run-off
  - Pesticides present in groundwater
  - Waterborne pathogens
- Have students research the aquatic needs of trout versus catfish.
- Have students specifically compare the population make-up of each of the selected sites. Cite plants, insects, micro and macro invertebrates present.
- Viewing larger organisms through a DiscoveryScope is an excellent optional activity. This provides 10x magnification while the organism is held in an enclosed clear plastic case.

Grades 9-12

Rubric

- Students should be able to specifically describe, based on population make-up, three aquatic macro-invertebrates.
- Students should be able to describe and give the life cycle of three aquatic plant species and three aquatic macro-invertebrates.
- Students should be able to discuss possible pollution sources that may affect the test sites.

Assessment

- Teacher will quiz students concerning importance of the factors tested (dissolved oxygen, pH level, etc.).
- Teacher will have students explain the importance and delicate balance of an ecosystem.
- Teacher will have students explain and define pollution sources, specifically those that may affect their local aquatic sources.

These lesson plans are provided for the benefit of science educators and can be freely downloaded from our web site at www.forestry-suppliers.com. If you have an idea or other suggestions for future lesson plans, we'd like to hear from you! Send an e-mail to fsi@forestry-suppliers.com.

Content Standards Covered

A Science as inquiry
- Abilities necessary to do scientific inquiry
- Understanding about scientific inquiry

C Life Science
- Interdependence of organisms
- Behavior of organisms

E Science and Technology
- Abilities of technological design

F Science in Personal and Social Perspectives
- Natural resources
- Environmental quality

Required Materials

Student Microscope	60099

Additional Materials Needed

Supplied by Teacher/Student(s)

- Microscope slides
- Data Collection Sheet
- Collection Container, Bucket or Re-sealable Bags

Optional Items

Optional Items that can be used to enhance the lesson plan. Available from Forestry Suppliers, Inc.

DiscoveryScope	61098
Aquatic Suction Sampler	77254
Lighted Portable Microscope	61232
LaMotte Leaf Pack Experiment Kit	76605
LaMotte MacroMania	76696
LaMotte Bug Kit	76606
pH Meter	79164
Reference: Vernal Pools Natural History & Conservation	76595
Reference: Guide to Common Freshwater Invertebrates of North America	76591
Resource: Poster Ecology of Vernal Pools	76655
Utility Bucket	54028
Soil Sample Bags	79147
Shaker Sieve	77252
Slides	60002

Water Quality Assessment

WATER MONITORING STEP BY STEP GUIDE

1. Choose the curriculum that is appropriate for the age group participating in the workshop.
2. Find a local water resource for water collection. Students may use the waders to collect the water sample or simple collect the sample at the waters edge.
3. The water collection tube can be utilized when access is limited to in-water sampling.
4. To use the collection device open each end- sliding the smaller metal end into the larger end and securing with the attached pin. Tie the included rope to the pin and lower the open sample bottle into the water resource. Once the bottle is sufficiently in the stream pull the rope- releasing the pin and closing the sample bottle. This is also an effective method for sampling if the water source is suspected to be contaminated. If contamination is suspect proper appropriate safety gear should be utilized and equipment should be thoroughly cleaned. Once the sample has been collected normal testing can be completed.
5. Use the sample to test for pH with the pH dip strip paper. pH is a measure of how acidic or basic (non-acidic) water samples are. Since aquatic life can be directly impacted by slight pH changes, this is important to understand for impacts on water quality. pH can also be impacted by water pollution and runoff. The included Hydrion pH film can be used in sections to determine pH. Orange film is used for samples that are 0-6.0 and green film is for samples that are ranging from 6.5-13.

Water Quality Assessment

WATER MONITORING STEP BY STEP GUIDE

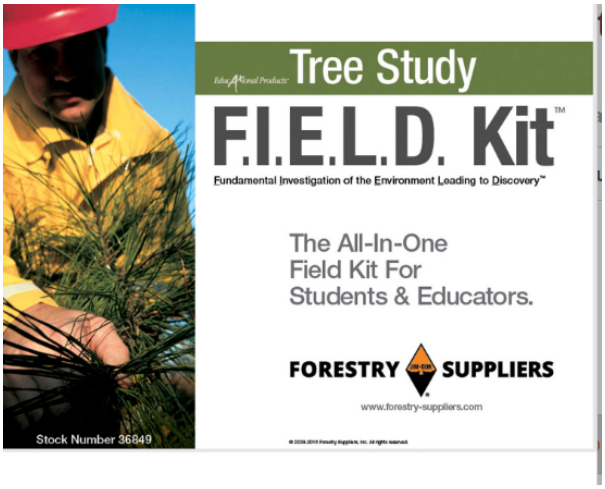
6. Record the pH results and then utilize a small glass slide, sample dish, or other container and the Q-scope microscope to try and identify any visible macroinvertebrates. These organisms are indicative of water quality and health; the supplied flash cards can help identify any organisms.
7. Using the sieve and shovel, take a soil sample at the waters edge (make sure it is in the saturated zone). Gently rinse the soil sample with water and analyze any organisms found (crayfish, worms, etc).
8. The water monitoring small kit (included) also has measurements for water quality parameters. Follow the collection procedures outlined in the included handbook. Sampling equipment should be clean (washed with a phosphate free soap) and not be contaminated from previous use.
9. The first test completed should be dissolved oxygen. A short description of each test is given before the parameters in the handbook. Go over the importance of each parameter with participants before sampling.
Dissolved Oxygen is the amount of oxygen readily available to aquatic life exiting in the system being sampled. Check out the Gulf of Mexico dead zone for further reading on the importance of dissolved oxygen!
10.Keep track of the temperature when analyzing dissolved oxygen. Use the included thermometer to check and record temperature measurements. Drop two dissolved oxygen tabs into the sample tube and compare results to the key included in the kit. Record results

Water Quality Assessment

WATER MONITORING STEP BY STEP GUIDE

10. Coliform bacteria is an indicator of pollution- especially in combined sewer overflow systems. If you suspect the stream contains, or find out it does contain, coliform bacteria utilize proper safety precautions.
11. Turbidity (the measure of how much material is suspended in the water. This is measured by placing a water sample in the turbidity tube and analyzing at what depth the secchi (black and white colored disc) is visible.
12. The curriculum accompanying the kit is a great resource when planning your SPARK.
13. The curriculum has several steps where “slides” or “well slides” are referred to for analysis. These are simply glass microscope slides to place samples on for examination under a microscope. If you choose to analyze water/soil/organism samples you can utilize the Q-scope or an additional microscope.
14.Curriculum can be supplemented with Nature of Teaching watershed and healthy water lesson plans (younger age group appropriate).
15. 4-H soil and water science lesson plans also correlate well with water monitoring. Level 3 Soil and Water science has participants identify their watershed, water quality, and local pollutant levels via EPA online database and other.

Forestry Kit



KIT MATERIALS

This kit includes a tree identification book, a tangent height gauge to determine relative height of the sample tree, measuring tape, tree scale stick, materials to mark the study area, an increment borer to sample and core trees, pre-cut tree biscuits, six plastic handheld magnifiers, six 12˝ rulers, and carrying case.

UTILIZING MATERIALS

Youth can set up and create a study area and learn about the included trees using the identification manual and study area marking materials. Using the provided tree samples, participants can learn about tree rings and growth. Next, using the increment borer tree core samples can be taken for youth to count the rings . Handheld magnifiers and rulers can assist in ring identification.

Program Applications

Tree Education

Students can learn about tree growth and tree stress using the included tree samples. Using the handheld magnifiers, they can count tree rings and determine their relative size. For example, small rings might indicate a slow growth year where large rings indicate the tree grew very rapidly that year. Tree growth can be impacted by several factors including heat stress, drought, flooding, and numerous other circumstances. Participants can then identify trees in their study area and take core samples to gain hands-on experience dating trees.

Program Adaptability

The tree analysis kit can be paired with numerous other kit materials; for example, use the handheld microscope to help analyze tree rings or include a tree study when sampling local soils.

Forestry Kit Lesson Plan Addendum

Uses: **Students should utilize the provided F.I.E.L.D Kit curriculum. This lesson plan is utilized as an addendum to provided content.**

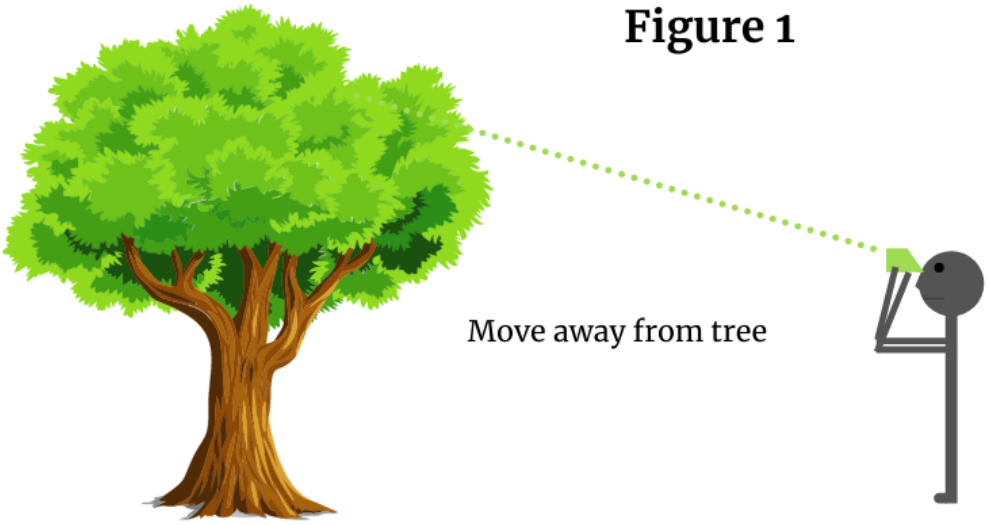
Activity Information : **Students should be in an outdoor environment. Utilize the correct age range for curriculum (9-12th grade). Go over the background material with students and start the procedure for utilizing kit materials. You will be taking tree core samples; directions for how to use the increment borer are included. You will also need to use the tangent height guide to determine the height of the tree; instructions for it's use are also included.**

Have students complete the attached worksheet on their selected sample tree. They will gather all the information from completing a tree core.

You may have students complete the number of logs available in a given tree. The guide to the log stick is included. If you will be having youth complete this process it will be beneficial to go through the procedures prior to the program as there are several detailed steps.

Tangent Height Guide

Figure 1

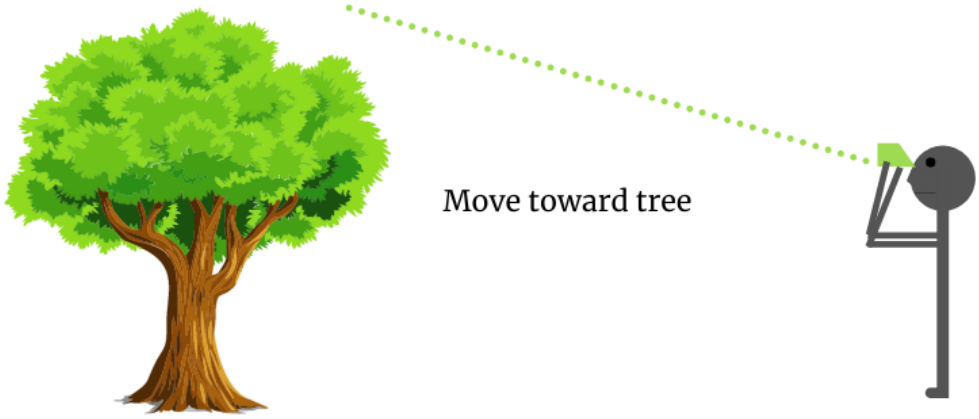


1. Stand directly in front of the tree with no obstacles obstructing your view. Look through the two round sights (on the triangular side) and align the sights with the top of the tree.

2. Move backwards/ forwards as needed to align the top of the tree within the sights; additionally, adjust your placement as needed to ensure the level is centered in the mirror. You will want to ensure that when looking at the tree top through the sites that the bubble in the level is centered.

3. If the top of the tree is below your view when aligning the sights move towards the tree (Figure 1) If the top of the tree is above your view move away from the tree (Figure 2).

Figure 2



4. Once the tree top is aligned with the sites and the bubble is centered, measure the distance from your location to the base of the tree.

5. Measure the distance from the ground to your eye; add this number to the measured distance from the tree and you now have the height of the tree!

Forestry Suppliers Lesson Plan

Tree Study

Forestry Suppliers' Tree Study F.I.E.L.D. Kit™
Fundamental Investigation of the Environment Leading to Discovery™
Study Kit Correlated to National Science Education Content Standards

If you're interested in tree studies for classroom activities, consider the Forestry Suppliers' Tree Study F.I.E.L.D. Kit. Use the kit for the exercises outlined in this Lesson Plan, as well as other related activities (see "Further Studies" section for a few ideas).

This F.I.E.L.D. Kit is available exclusively from Forestry Suppliers and includes some of the items used in this lesson plan. All kit items may also be purchased individually. Call our Sales Department at 1-800-647-5368 or visit us on the web at www.forestry-suppliers.com.

Fields of Study:

- Biology
- Forestry
- History
- Mathematics

National Science Education Content Standards Correlation

Grades	A	B	C	D	E	F	G
K-4	✓		✓		✓		✓
5-8	✓		✓			✓	✓
9-12	✓					✓	✓

Tree Study Kit Contents Stock Number 36849		Required For This Lesson Plan			
Qty.	Description	K-4	5-8	9-12	Stock Number
1	Increment Borer - 8″, 3-Thread	✓	✓	✓	63081
1	Tangent Height Gauge				36953
1	Diameter Tape	✓	✓	✓	39480
1	Tree Finder Book				94711
1	Doyle Tree and Log Scale Stick	✓	✓	✓	59750
1	100' Tape				40057
1	Increment Core Holders, Pack of 10	✓	✓	✓	63395
3	Enviro Flagging, Blue				58036
3	Enviro Flagging, Orange				58037
1	Stake Flags, Blue				39287
1	Stake Flags, Orange				39288
6	English/Metric Ruler - 12″/30cm Long				47460
6	Tree Cookies, Pack of 6				36858
6	Handheld Magnifiers				61233

Grades K-4

Background

In a group of similar trees, are the tallest trees really the oldest? Since some trees are naturally taller than others are, several factors must be considered. Pine, oak, sweet gum, cottonwood, Douglas fir and the giant sequoia are all examples of tall trees. Trees that when full-grown are not very tall include the apple tree, peach tree, hackberry, elm, Osage orange and horseapple. To determine if there is a correlation between age and height, several factors must be considered. The height of the tree must first be found. This can be done by using a clinometer or a tangent height gauge. The diameter of the tree must also be determined.

Next, a core sample must be taken and viewed to determine the actual age of the tree. When studying a core, you will notice that the wood has light and dark bands. These are used to determine the age of the tree. Just as the growth rings of a tree are visible in a crosscut log, each light or dark band visible on the core represents a year in the life of a tree. The light bands are the springwood that the tree added during the growing season in spring. The dark bands beside each light band represent the late summer and fall growing season for each tree. Trees grow very little if any during the cold months of winter.

When studying trees it is important to consider the total value of the tree. All trees are valuable. Trees are a very important part of many ecosystems and our total environment. Some trees are valued because of the great beauty that they add to the forest or landscape. Other trees provide a much needed home or niche for certain small animals or insects. Particular trees yield compounds or substances that are used as medicines and in chemical products. Specific types of trees are used to build our homes and other wood structures and products. Tree farmers and foresters need to know the market value of the trees that are used to supply wood for human use. Much consideration must be given to the cutting of trees prior to the actual cutting. Experienced and knowledgeable foresters can best determine which trees should be harvested. A Tree and Log Scale Stick may be used for many applications including diameter measurements, determining merchantable tree height and finding volumes for standing and felled trees. Even younger students need to understand the basics of determining the age and value of a specific tree. Understanding this can truly make students of all ages better stewards of our environment.

Procedure

1. In a group of similar trees, are the tallest trees necessarily the oldest? To study this, locate 4 to 7 trees of the same species growing near each other that are no more than 14 inches in diameter. (Note: Before you bore trees on private property, be sure to obtain the permission of the landowner.)
2. Measure the heights of the trees using a clinometer, a tangent height gauge or a classroom-made height finder. (Older students will be able to follow the instructions given on the tangent height gauge.)
3. Measure the diameter of the trees using a diameter tape or a log scale stick. (Older students will be able to use the log scale stick on their own; refer to Correlated Lesson Plan for grades 5-8 for detailed use of a Tree and Log Scale Stick.)
4. Capture a core sample using an increment borer. Bore the tallest tree at about 4.5 feet above the ground. Teachers may need to assist students in lower grades in obtaining the core sample.
5. Store the core in an increment core holder or in a standard soda straw. Be sure to label the sample appropriately and to handle the cores very carefully so that they don't break.
6. Count the rings on the bored trees. When counting the rings it is helpful to use a pen or marker to note every five or ten rings on older trees. If the rings are difficult to see wet them with water or rub lightly with a highlighter pen or a light-colored marker.
7. Once the rings are counted, 5 to 10 years is often added to the total age of a tree. This makes allowance if the very center of the tree is missed during boring. For this exercise, add 8 years to the age of each tree.
8. Next, examine the last ten years of growth rings (closest to the borer handle) for each tree. This is a gauge of how well the tree is growing now.
9. Compare these rings with the first and middle 10 years of growth.
10. When you are through with the cores, return them back into the tree. This will help deter rot and insect invasion of the tree.
11. Use the Data Collection Sheet provided to record your results. For additional study and to introduce new hypotheses, repeat the exercise for other tree species on your site.

Further Studies

- Students will list the most commonly found trees within the area that they are observing.
- Students will complete library or Internet research, finding facts about trees that grow tallest within a given period of time.
- Students will attempt (with their teacher's help) to locate the oldest and tallest tree within a second group or stand of trees using the procedure used in the first study.
- Students will compare differing characteristics between hard and soft woods when presented with tree cookies of hard and soft wood.

Rubric

- Students will be able to explain the value of various species of trees.
- Students will list trees that are considered tall or short at maturity.
- Students will demonstrate how an increment borer is used.
- Students will demonstrate how a tree height tangent and a clinometer are used. (3-4)

Assessment

- The teacher will have the students prepare a storyboard explaining why taller trees are not necessarily the oldest trees.
- The teacher will provided sample cores and have students judge the age of the tree from the sample.
- The teacher will have the students use the tree height tangent in determining the height of a flagpole, another type of pole or a tree present on the school playground or campus. (3-4)

These lesson plans are provided for the benefit of science educators and can be freely downloaded from our web site at www.forestry-suppliers.com. If you have an idea or other suggestions for future lesson plans, we'd like to hear from you! Send an e-mail to fsi@forestry-suppliers.com.

Content Standards Covered

A Science as inquiry
- Abilities necessary to do scientific inquiry
- Understanding about scientific inquiry

C Life Science
- Characteristics of organisms
- Life cycles of organisms

E Science and Technology
- Abilities of technological design
- Understandings about science and technology

G History and Nature of Science
- Science as a human endeavor

Additional Materials Needed

Supplied by Teacher/Student(s)

- Data Collection Sheet
- Clear Straws

Optional Items

Optional items available from Forestry Suppliers that can be used to enhance this lesson plan.

- Clinometer **43830**

Grades 5-8

Background

When studying trees, it is important to consider the total value of the tree. All trees are valuable. Trees are a very important part of many ecosystems and our total environment. A forest provides an efficient cooling system as the trees and plants respire or release amounts of water and produce oxygen. Understanding what trees need for optimum growth and health is essential in maintaining a balance in our environment. Some trees are valued because of the great beauty that they add to the forest or landscape. Other trees provide much needed homes or niches for certain small animals or insects. Particular trees yield compounds or substances that are used as medicines and in chemical products. These trees are part of complex ecosystems, which are sustained by the continual presence of all species.

Specific types of trees are used to build our homes and other wood structures and products. Tree farmers and foresters need to know the market value of the trees that are used to supply wood for human use. Much consideration must be given to the cutting of trees prior to the actual cutting. Experienced and knowledgeable foresters can best determine which trees should be harvested. A Tree and Log Scale Stick may be used for many applications including diameter measurements, determining merchantable tree height and finding volumes for standing and felled trees. Even younger students need to understand the basics of determining the age and value of a specific tree. Understanding this can truly make students of all ages better stewards of our environment.

In a group of similar trees, are the tallest trees really the oldest? Since some trees are naturally taller than others are, several factors must be considered. Pine, oak, sweet gum, cottonwood, Douglas fir and the giant sequoia are all examples of tall trees. Trees that when full-grown are not very tall include the apple tree, peach tree, hackberry, elm, Osage orange and horseapple. To determine if there is a correlation between age and height, several factors must be considered. The height of the tree must first be found. This can be done by using a clinometer or a tangent height gauge. The diameter of the tree must also be determined.

A core sample must be taken and viewed to determine the age of the tree. When studying a core, you will notice that the wood has light and dark bands. These are used to determine actual the age of the tree. Just as the growth rings of a tree are visible in a crosscut log, each light or dark band visible on the core represents a year in the life of a tree. The light bands are the springwood that the tree added during the growing season in spring. The dark bands beside each light band represent the late summer and fall growing season for each tree. Trees grow very little if any during the cold months of winter.

Procedure

1. In a group of similar trees, are the tallest trees necessarily the oldest? To study this, locate 4 to 7 trees of the same species growing near each other that are no more than 14 inches in diameter. (Note: Before you bore trees on private property, be sure to obtain the permission of the landowner.)
2. Measure the heights of the trees using a clinometer, a tangent height gauge or a classroom-made height finder. (Older students will be able to follow the instructions given on the tangent height gauge.)
3. Measure the diameter of the trees using a diameter tape or a log scale stick. (Older students will be able to use the log scale stick on their own.)
4. Capture a core sample using an increment borer. Bore the tallest tree at about 4.5 feet above the ground. Teachers may need to assist students in lower grades in obtaining the core sample.
5. Store the core in an increment core holder or in a standard soda straw. Be sure to label the sample appropriately and to handle the cores very carefully so that they don't break.
6. Count the rings on the bored trees. When counting the rings, it is helpful to use a pen or marker to note every five or ten rings on older trees. If the rings are difficult to see, wet them with water or rub lightly with a highlighter pen or a light-colored marker.
7. Once the rings are counted, 5 to 10 years is often added to the total age of a tree. This makes allowance if the very center of the tree is missed during boring. For this exercise, add 8 years to the age of each tree.
8. Next, examine the last ten years of growth rings (closest to the borer handle) for each tree. This is a gauge of how well the tree is growing now.
9. Compare these rings with the first and middle 10 years of growth.
10. When you are through with the cores, return them back into the tree. This will help deter rot and insect invasion of the tree.
11. Use the Data Collection Sheet provided to record your results. For additional study and to introduce new hypotheses, repeat the exercise for other tree species on your site.

Further Studies

- Students may make comparisons among different species of trees concerning the merchantable value. These observations can be made within their own school or home environment. A field study may be necessary if a forested area is not present within the school setting.
- Students can calculate felled log volume and value by using the Tree Scale Stick.
- Students will compare differing characteristics between hard and soft woods when presented with tree cookies of hard and soft wood.

Rubric

- Students should be able to measure the height of a pole or tree using a tangent height gauge.
- Students should be able to determine: tree diameter, merchantable tree height, and volume of tree in board feet.
- Students should be able to determine the board foot volume of a tree that has been felled and cut.

Assessment

- Students will be quizzed concerning how the age of a tree is determined.
- Students will be expected to give the age of a tree if supplied with a core sample as well as give other characteristics that can be determined from such a sample.
- Students will explain how to determine the merchantable value of a tree.
- Students will give examples of trees which, at maturity, are tall or short.

These lesson plans are provided for the benefit of science educators and can be freely downloaded from our web site at www.forestry-suppliers.com. If you have an idea or other suggestions for future lesson plans, we'd like to hear from you! Send an e-mail to fsi@forestry-suppliers.com.

Content Standards Covered

A Science as inquiry
- Abilities necessary to do scientific inquiry
- Understanding about scientific inquiry

C Life Science
- Structure and function in living systems

F Science in Personal and Social Perspectives
- Populations, resources and environments

G History and Nature of Science
- Science as a human endeavor
- History of science

Additional Materials Needed

Supplied by Teacher/Student(s)

- Data Collection Sheet
- Clear Straws

Optional Items

Optional items available from Forestry Suppliers that can be used to enhance this lesson plan.

- Clinometer **43830**

Grades 9-12

Background

When studying trees, it is important to consider the total value of the tree. All trees are valuable. Trees are a very important part of many ecosystems and our total environment. A forest provides an efficient cooling system as the trees and plants respire or release amounts of water and produce oxygen. Understanding what trees need for optimum growth and health is essential in maintaining a balance in our environment. Some trees are valued because of the great beauty that they add to the forest or landscape. Other trees provide much needed homes or niches for certain small animals or insects. Particular trees yield compounds or substances that are used as medicines and in chemical products. These trees are part of complex ecosystems, which are sustained by the continual presence of all species.

Specific types of trees are used to build our homes and other wood structures and products. Tree farmers and foresters need to know the market value of the trees that are used to supply wood for human use. Much consideration must be given to the cutting of trees prior to the actual cutting. Experienced and knowledgeable foresters can best determine which trees should be harvested. A Tree and Log Scale Stick may be used for many applications including diameter measurements, determining merchantable tree height and finding volumes for standing and felled trees. Even younger students need to understand the basics of determining the age and value of a specific tree. Understanding this can truly make students of all ages better stewards of our environment.

In a group of similar trees, are the tallest trees really the oldest? Since some trees are naturally taller than others are, several factors must be considered. Pine, oak, sweet gum, cottonwood, Douglas fir and the giant sequoia are all examples of tall trees. Trees that when full-grown are not very tall include the apple tree, peach tree, hackberry, elm, Osage orange and horseapple. To determine if there is a correlation between age and height, several factors must be considered. The height of the tree must first be found. This can be done by using a clinometer or a tangent height gauge. The diameter of the tree must also be determined.

A core sample must be taken and viewed to determine the age of the tree. When studying a core, you will notice that the wood has light and dark bands. These are used to determine actual the age of the tree. Just as the growth rings of a tree are visible in a crosscut log, each light or dark band visible on the core represents a year in the life of a tree. The light bands are the springwood that the tree added during the growing season in spring. The dark bands beside each light band represent the late summer and fall growing season for each tree. Trees grow very little if any during the cold months of winter.

Procedure

1. In a group of similar trees, are the tallest trees necessarily the oldest? To study this, locate 4 to 7 trees of the same species growing near each other that are no more than 14 inches in diameter. (Note: Before you bore trees on private property, be sure to obtain the permission of the landowner.)
2. Measure the heights of the trees using a clinometer, a tangent height gauge or a classroom-made height finder.
3. Measure the diameter of the trees using a diameter tape or a log scale stick. (Older students will be able to use the log scale stick on their own.)
4. Capture a core sample using an increment borer. Bore the tallest tree at about 4.5 feet above the ground.
5. Store the core in an increment core holder or in a standard soda straw. Be sure to label the sample appropriately and to handle the cores very carefully so that they don't break.
6. Count the rings on the bored trees. When counting the rings, it is helpful to use a pen or marker to note every five or ten rings on older trees. If the rings are difficult to see, wet them with water or rub lightly with a highlighter pen or a light-colored marker.
7. Once the rings are counted, 5 to 10 years is often added to the total age of a tree. This makes allowance if the very center of the tree is missed during boring. For this exercise, add 8 years to the age of each tree.
8. Next, examine the last ten years of growth rings (closest to the borer handle) for each tree. This is a gauge of how well the tree is growing now.
9. Compare these rings with the first and middle 10 years of growth.
10. When you are through with the cores, put them back into the tree. This will help deter rot and insect invasion of the tree.
11. Use the Data Collection Sheet provided to record your results. For additional study and to introduce new hypotheses, repeat the exercise for other tree species on your site.

Further Studies

- Students may make comparisons among different species of trees concerning the merchantable value. These observations can be made within their own school or home environment. A field study may be necessary if a forested area is not present within the school setting.
- Students can calculate felled log volume and value by using the Tree Scale Stick. Comparisons should be made using different tree species.
- Students may complete library research to determine what species of tree has historically had the highest merchantable value.
- Students may complete research concerning rainforest tree species that produce known medicinal compounds.
- Students will compare differing characteristics between hard and soft woods when presented with tree cookies of hard and soft wood.

Rubric

- Students should be able to measure the height of a pole or tree using a tangent height gauge.
- Students should be able to determine tree diameter, merchantable tree height, and volume of tree in board feet.
- Students should be able to determine the board foot volume of a tree that has been felled and cut.
- Students should be able to categorize tree species as tall or short at maturity.
- Students should be able to use a clinometer and make accurate measurements.

Assessment

- Students will be asked to give the steps in determining the age of a tree.
- Students will be expected to give the age of a tree if supplied with a core sample as well as give other characteristics that can be determined from such a sample, such as possible information concerning the moisture availability during a particular year.
- Students will explain how to determine the merchantable value of a tree.
- Students should be familiar with the merchantable value of local species of trees.

These lesson plans are provided for the benefit of science educators and can be freely downloaded from our web site at www.forestry-suppliers.com. If you have an idea or other suggestions for future lesson plans, we'd like to hear from you! Send an e-mail to fsi@forestry-suppliers.com.

Content Standards Covered

A Science as inquiry
- Abilities necessary to do scientific inquiry
- Understanding about scientific inquiry

F Science in Personal and Social Perspectives
- Natural Resources
- Environmental Quality

G History and Nature of Science
- Science as a human endeavor
- Historical perspectives

Additional Materials Needed

Supplied by Teacher/Student(s)

- Data Collection Sheet
- Clear Straws

Optional Items

Optional items available from Forestry Suppliers that can be used to enhance this lesson plan.

- Clinometer **43830**

Instructions

⚠ Keep this sheet for your records.

Forestry Suppliers, Inc.
www.forestry-suppliers.com

Using an Increment Borer

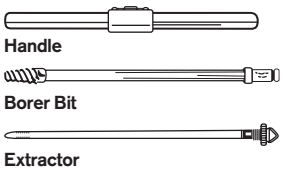
Tech Support
800-430-5566
If you need more information or would like advice from an experienced professional, call our Technical Support team.

Sales
800-647-5368
Our sales department will gladly fax you an order form, update you on pricing, or take your order over the phone.

Online
www.forestry-suppliers.com
For credit card and open account orders, visit our web site to place your order.

Forestry Suppliers, Inc.
www.forestry-suppliers.com
205 West Rankin Street
Jackson, MS 39201

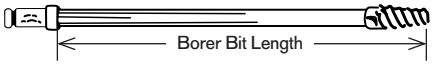
The Increment Borer is essential for extracting a core of wood from trees, logs, poles or timbers. The core extracted is used for many purposes including determination of growth rate, age, tree soundness, penetration of chemicals in the wood treating business, and specific gravity studies of wood.



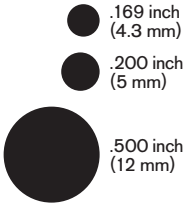
An increment borer consists of three parts: a handle, a borer bit, and an extractor. When not in use, the borer bit and extractor fit inside the handle and form a compact unit. Most increment borers have Teflon® coated bits. This coating helps reduce friction, protects against rust, and keeps the bit clean to extend bit life.

Making the Right Selection

There are three things to consider when you choose an increment borer. They are length, diameter, and style.



Borer bit length depends on the size of the trees you will be boring. Length is measured from the tip of the threads to the end of the round section of the borer bit. This is the maximum depth the bit will penetrate.



Core Diameter of the wood sample is determined by the inside diameter of the opening at the threaded end of the bit. .169˝ is commonly used for general forestry use, .200˝ for wood preserving testing and .500˝ for large amounts of wood for qualitative analysis.

2- or 3-Thread style is a matter of personal preference. A 2-thread borer has two threads on the cutting edge of the bit, each originating 180˚ apart.

A 3-thread borer has three threads, each originating 120˚ apart. The 3-thread borer, due to its higher pitch, will penetrate the wood deeper per revolution than a 2-thread and also produce less friction because more threads are pushing against the wood.

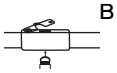
It is important to remember, the ease at which a borer penetrates wood depends on wood hardness, friction properties and capability/strength of the user.

Taking an Increment Core

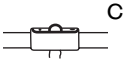
Follow these seven steps to take a core:

1. Remove the borer bit and extractor from inside the handle. Place the extractor in a pocket of your cruiser vest for convenience and protection of the extractor.
2. Assemble the handle and borer bit by:

A Pushing the locking latch away from the handle with your thumb



B Inserting the square end of the borer bit into the handle, then



C Returning the locking latch completely around the borer bit "collar."

You're now ready to start boring. However, we suggest you apply beeswax to the threads and shank before you begin.

3. Align the borer bit and the handle so that the bit will penetrate through or towards the center of the tree and at right angles to the tree. In any other alignment, the annual growth rings seen in the extracted core will be distorted and could result in erroneous growth rate analysis.

4. Place the borer bit threads against the tree (Fig.1), preferably in a bark fissure where the bark is thinnest.

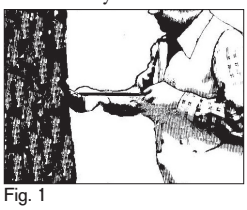


Fig. 1

Hold the threads in place with one hand. With your other hand, push forward on the handle and simultaneously turn it clockwise until the bit threads penetrate the wood enough to hold the bit firmly in place.

5. Place both hands, palms open, on the ends of the handle and turn the handle clockwise until the bit reaches the desired depth (Fig. 2).

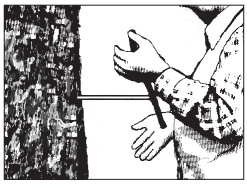


Fig. 2

6. With the bit at the desired depth, insert the full length of the extractor, concave side down "◠" (Fig. 3).

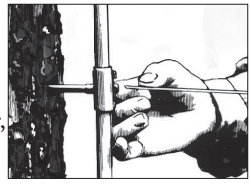


Fig. 3

Then turn the handle one-half turn counterclockwise to break the core from the tree and also to turn the extractor concave side up like this: "◡."

7. Pull the extractor from the borer bit (Fig. 4). The core will be resting in the channel and held in place by the small "teeth" at the tip of the extractor. Before examining the core sample, promptly remove the borer bit from the tree. Clean it and place it and the extractor back in the handle.


Fig. 4

Care and Maintenance

Follow these suggestions to maintain the efficiency and extend the life of your increment borer.

Lubricate with Beeswax

A block of beeswax is provided with every increment borer. Penetration and removal of the borer bit will be easier if beeswax is liberally applied to the threads and shank before each boring.

Clean with WD-40

WD-40 is an excellent cleaner and rust preventative for an increment borer. It will also prevent sap acid-etching of the borer. Spray it on as well as inside the bit and on the extractor at the end of each working day. Wipe clean.

Be Quick!

Obtain your core samples as rapidly as possible. It's best to remove the bit from the tree even before examining the core sample. This will reduce the possibility of the bit becoming stuck or locked in the tree.

Avoid Compression & Tension Wood

Never bore into suspected compression or tension wood. To explain: a tree leaning towards the North will have compression wood on the North side. If you bore into compression wood, the bit could be locked into the tree by the force of the "compressed" wood. If you bore into the South side, you are boring into "tension" wood, where the ring width may not be representative. We recommend boring on the East or West side, or if possible, select another tree.

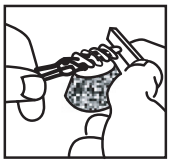
Increment Borer Sharpening

Increment borers become dull or nicked with use. A borer is dull if it does not easily engage the wood and if it will not cut a clean-edged hole when rotated on a sheet of paper.

How to Sharpen Borer Bits

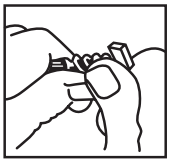
See Increment Borer Sharpening Kit for stones described here.

1. True Cutting Edge Using Pocket Stone



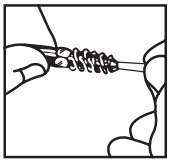
If cutting edge is uneven when placed lightly against a flat surface, it needs to be trued up. Place a few drops of oil on wide face of pocket stone. Hold borer bit steady on cork rest and pass stone back and forth across cutting edge, turning bit slightly after each pass. Repeat until true.

2. Sharpen Cutting Edge Using India Stone



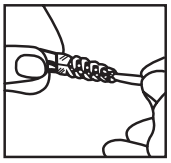
Holding bit in left hand and India stone in right hand, slowly rotate bit away from you and against stone while holding stone parallel to and firmly on beveled edge of bit. Continue until sharp. If nicks are present, use pocket stone to work them out, then follow with the India stone.

3. Hone Inside of Cutting Edge Using Conical Stone



Put a few drops of oil on conical stone and insert tip of stone into cutting end of bit until it occupies about 3/4ths of core hole. Very lightly rotate stone against inside of cutting edge, keeping the edge of the stone parallel to the long axis of the bit.

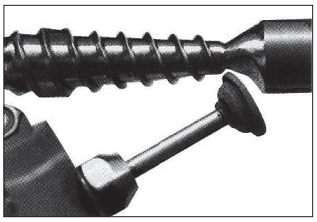
4. Hone Outside Beveled Portion of Cutting Edge Using Conical Stone



Hold borer bit with threads on cork rest and place just the tip of conical stone on and parallel to bevel. Use very light strokes back and forth over a small arc of beveled edge. Turn bit and repeat until entire edge has been honed. To test sharpening, cut circular holes in a sheet of paper.

Increment Borer Sharpening Kit

Includes everything needed to sharpen borers: India Stone to sharpen lead cutting edge; Conical Stone to sharpen inside cutting edge, outside beveled edge; Pocket Stone to "true" cutting edge, remove chips and nicks; can of Sharpening Stone Oil to lubricate, clean stones; and Cork to use as a work rest. To order, specify number 63399, Sharpening Kit.



Professional Increment Borer Repair Service

Extend the life of your increment borer. Have the cutting edge sharpened, threads reshaped near cutting tip, and nicks removed. Your bit will be returned to you in "like-new" condition. Note: Nicks, chips and cracks greater than 1/16" deep cannot be repaired. For more information, call our Customer Service Department toll-free at (800) 752-8460.

Worksheet

Student Name: _____ **Date:** _____

	Tree #1	Tree #2	Tree #3	Tree #4	Tree #5	Tree #6	Tree #7
Height (inches)	_____	_____	_____	_____	_____	_____	_____
Diameter (inches)	_____	_____	_____	_____	_____	_____	_____
Total Age (from core + 8)	_____	_____	_____	_____	_____	_____	_____
Core Growth	_____	_____	_____	_____	_____	_____	_____
Length of first 10 years (inches)	_____	_____	_____	_____	_____	_____	_____
Length of middle 10 years (inches)	_____	_____	_____	_____	_____	_____	_____
Length of last 10 years (inches)	_____	_____	_____	_____	_____	_____	_____

Conclusions and Questions	**Yes**	**No**
1. Does the tallest tree have the largest diameter?	☐	☐
2. Did the tallest tree have the longest core length during its first ten years?	☐	☐
3. Did the tallest tree have the longest core length during its middle ten years?	☐	☐
4. Did the tallest tree have the longest core length during its last ten years?	☐	☐
5. How many dark rings did you count from the bark to the center ring?	☐	☐
6. Was the tree alive when World War II ended?	☐	☐
7. Was the tree alive when you were born?	☐	☐

Year you were born _____

8. How many inches did your borer have to travel to reach the center of the tree? _____

9. Does this have any relationship to its diameter?	☐	☐

If yes, what is it? _____

10. Does taller also mean older?	☐	☐

Why/why not? _____

_____

_____

11. List any other conclusions you determined: _____

_____

_____

_____

18 U.S.C. 707

ENVIRONMENTAL SCIENCE FIELD KITS

TRAINER GUIDE