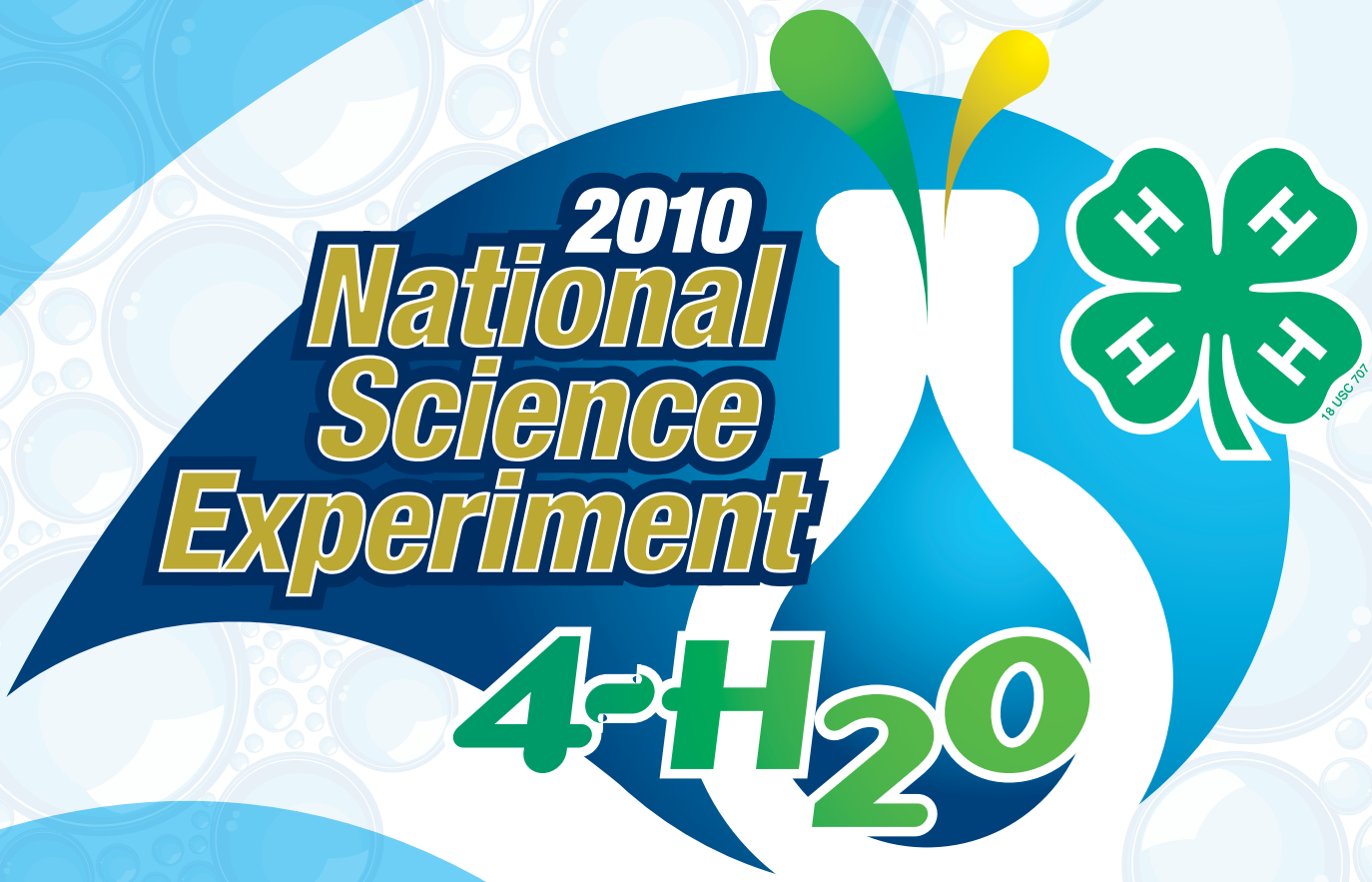


4-H National Youth Science Day

FACILITATOR GUIDE

4-H PLEDGE

I pledge my Head to clearer thinking,
my Heart to greater loyalty,
my Hands to larger service,
and my Health to better living,
for my club, my community, my country and my world.

INTRODUCTION

FACILITATOR

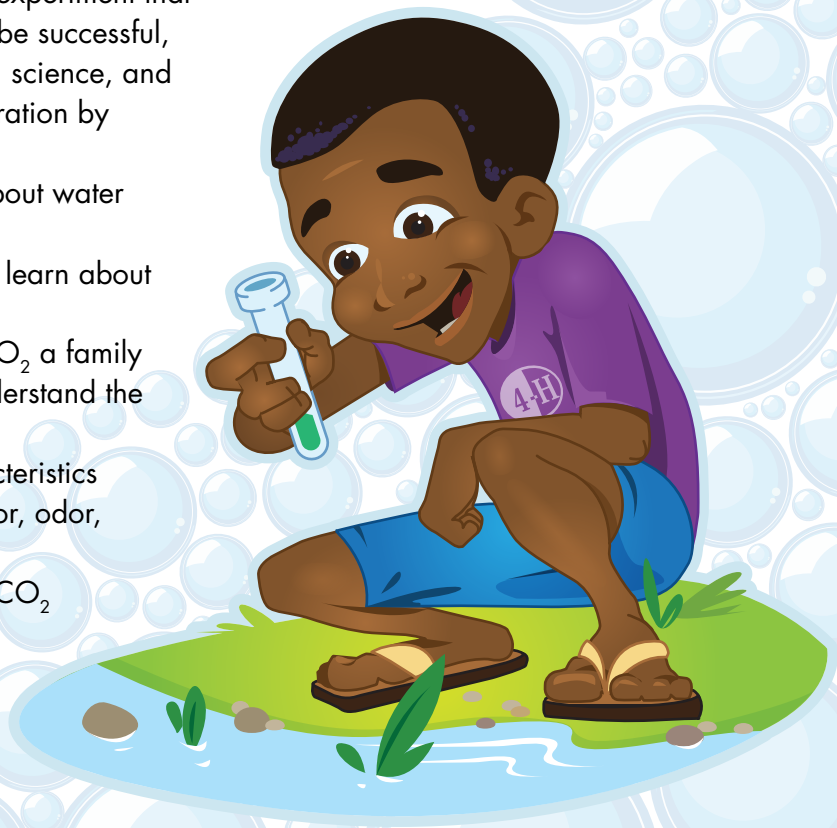
4-H is proud to introduce "4-H_2O," the National Science Experiment that will introduce youth across the nation to water quality and its connection to climate change.

Millions of young people will actively participate in a live demonstration of how carbon dioxide builds up in the atmosphere. They will also learn how increased carbon dioxide levels due to human action have led to global warming, which could raise the earth's temperature to the point where significant changes will take place. Examples include melting polar ice caps, tsunamis, floods, warmer than normal weather, increases in plant growth, and an impact on water quality.

The experiment, designed in conjunction with North Carolina A&T State University Extension and North Carolina 4-H, offers several activities to showcase, at the simplest level, how CO_2 can affect aquatic animals, plants, and other living organisms in lakes, streams, rivers, and oceans. 4-H_2O features a series of interactive activities and discussions to demonstrate the importance of water quality and its relevance to climate change. Using typical chemistry tools, worksheets, online guides, and Web-based demonstrations, the experiment will help youth learn and then connect back to their own lives by encouraging the measurement of their own personal impact on the environment, along with the impact of their families.

OBJECTIVES AND OUTCOMES:

- Youth across the nation will engage in an experiment that is simple enough for even the youngest to be successful, eye-catching enough to increase interest in science, and deep enough to allow for continued exploration by older participants.
- Participants will engage in a discussion about water quality and global climate change.
- Through experimentation, participants will learn about the effect of CO_2 levels on water quality.
- Participants will calculate the amount of CO_2 a family contributes to the atmosphere to better understand the human impact of the carbon footprint.
- Participants will understand the key characteristics used to observe water quality, such as color, odor, aquatic plants, and animals.
- Participants will understand the impact of CO_2 and nutrient runoff on the over-growth of algae in lakes, leading to changes in water quality.



BEFORE YOU BEGIN: SAFETY PRECAUTIONS

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As with all science experiment, youth and adults should be cautious while working with the various science materials. In this experiment, youth will be using a solution of 0.04% Bromothymol Blue (BTB).

Facilitators must emphasize that youth should not ingest the solution. As a general safety precaution, youth should wear goggles, aprons and gloves. In the experiment, 4-H participants will blow bubbles into a BTB solution; clear plastic wrap will be used to help prevent the liquid from splashing.

Extracted information from the Material Safety Data Sheet (MSDS) for 0.04% BTB is provided below. A link to the full MSDS report is available at www.4-H.org/NYSD.

Product Identification

Synonyms: 3,3′,-Dibromothymolsulfonphthalein, sodium salt in aqueous solution; Bromothymol Blue 0.04% (w/v) Aqueous pH 6.0 to 7.6
CAS No.: 34722-90-2
Molecular Weight: 646.35
Chemical Formula: C27H27Br2O5SNa
Product Codes: D472

Composition/Information on Ingredients

INGREDIENT	CAS NO	PERCENT	HAZARDOUS
Bromothymol Blue Sodium Salt	34722-90-2	< 1%	No
Water	7732-18-5	> 99%	No

Hazards Identification

As part of good industrial and personal hygiene and safety procedure, avoid all unnecessary exposure to the chemical substance and ensure prompt removal from skin, eyes and clothing.

Potential Health Effects

Inhalation: No adverse health effects expected from inhalation.
Ingestion: Large doses may cause stomach upset.
Skin Contact: Not expected to be a health hazard. May cause slight irritation.
Eye Contact: Splashes may cause irritation.
Chronic Exposure: No information found.
Aggravation of Pre-existing Conditions: No information found.

First Aid Measures

Inhalation: Not expected to require first aid measures.
Ingestion: If large amounts were swallowed, give water to drink and get medical advice.
Skin Contact: Wash exposed area with soap and water. Get medical advice if irritation develops.
Eye Contact: Wash thoroughly with running water. Get medical advice if irritation develops.

Handling and Storage

Keep in a tightly closed container, stored in a cool, dry, ventilated area. Protect against physical damage, direct sunlight, and freezing. Containers of this material may be hazardous when empty since they retain product residues (vapors, liquid); observe all warnings and precautions listed for the product.

Exposure Controls/Personal Protection

Airborne Exposure Limits: None established.
Ventilation System: Not expected to require any special ventilation.
Personal Respirators (NIOSH Approved): Not expected to require personal respirator usage.
Skin Protection: Wear protective gloves and clean body-covering clothing.
Eye Protection: Safety glasses.

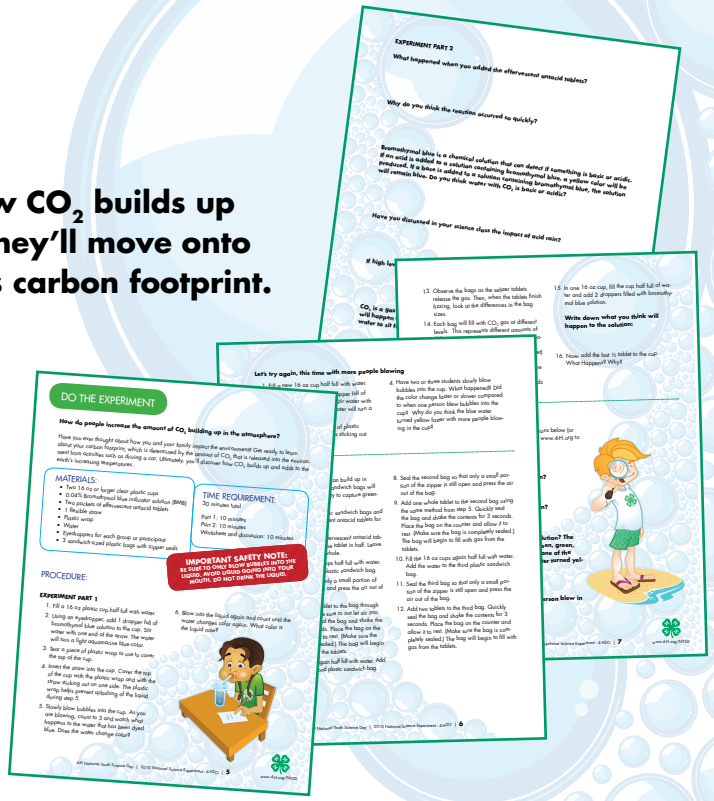
Disposal Considerations

Dilute with water and flush to sewer if local ordinances allow, otherwise, whatever cannot be saved for recovery or recycling should be managed in an appropriate and approved waste disposal facility. Processing, use or contamination of this product may change the waste management options. State and local disposal regulations may differ from federal disposal regulations. Dispose of container and unused contents in accordance with federal, state and local requirements.

DO THE EXPERIMENT

FACILITATOR

In "Do the Experiment," youth will learn how CO_2 builds up and is released into the atmosphere. Then, they'll move onto "Carbon Footprint" to measure their family's carbon footprint.



- Keep safety first. Make sure that participants only blow bubbles into the liquid. Advise them to avoid getting any liquid in their mouth. They should not drink the liquid. Check to see if there are any latex allergies.

- Use tap water and not store purchased bottled water for the bromothymol blue. When adding the bromothymol blue, the water should turn a light blue color. If the water is a dark blue, it will take too long for the participants to see the color change.

- If the water appears to be green or yellow after adding the bromothymol blue solution, pour out the water and rinse the cup or use a clean cup with clean water.

- Ask youth what they think will happen to the solution.

- After they add the last ½ tablet to the cup, ask participants what they think will happen.

- The color of the water will rapidly change from blue to yellow and the students will also see the gas produced.

- The bromothymol blue can be used for up to 50 trials. If using 1 dropper of solution (approximately 10 - 15 drops) for each time a student bubbles into a new cup of water (approximately 2 ml of BTB solution), the facilitator can run up to 50 or more tries with the solution. Less BTB solution can be added (example 5 – 10 drops) and the experiment will still work. The only difference will be the blue color will be lighter than the aquamarine color achieved when using 1 dropper full and described in the procedure.

- The water will turn from blue to green due to the BTB indicator and the amount of CO_2 that students blow into the water. If you continue to blow into the liquid, it will turn to from green to light yellow.

- For younger 4-H participants: If there is a concern about a participant accidentally drinking the liquid, add only a few drops of the BTB solution to the water and swirl the cup until the water turns a pale light blue. This will be approximately 5 to 8 drops for every 1/2 cup of water. Instruct the 4-H participant to blow over the surface of the liquid instead of inserting the straw completely into the liquid. The liquid will still turn from blue to green to yellow.

- Another option is for the facilitator to be the one that blows into the cup instead of the 4-H participant (based on the age and maturity level of the group).

- Have the students allow one of the cups that they have blown into (producing a yellow color) stay undisturbed on the table. Have participants observe what happens to the water a few hours later or the next day.

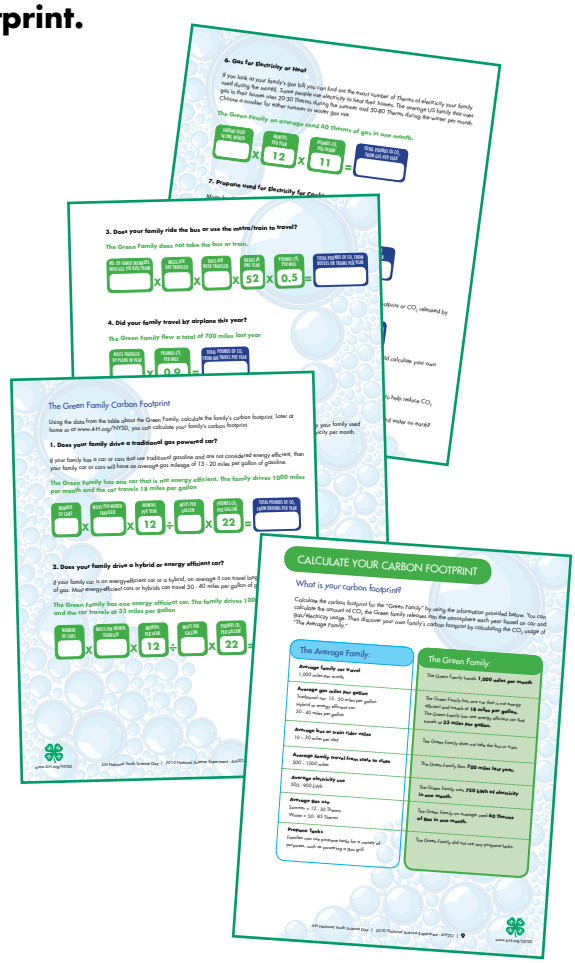
- Ask the participants to repeat the experiment by adding a few drops of bromothymol blue to water in a cup turning the water light blue. Then, have them add a few drops of lemon juice or soda. Ask them to observe and write down what happens.

CALCULATING YOUR CARBON FOOTPRINT

FACILITATOR

In "Do the Experiment," youth observed how carbon dioxide builds up and is released into the environment. Now, they'll expand to learn how to measure their family's carbon footprint.

- For this project, students will learn how to calculate their carbon footprint by practicing with the calculation of "The Green Family."
- Complete the worksheet for the Green Family together as a group.
- Point out to the students that the pounds of CO_2 released by the energy efficient car are less than the pounds of CO_2 released by the traditional gas powered car.
- Now, using a sample utility bill from your town, show students how they can calculate the kWh and Therms. Students will also need a calculator.
- Encourage students to later redo the activity, using their family's actual measurement of kWh and Therms.
- Some of the questions in the worksheet can be left blank. For example, some of the 4-Hers may not travel in an airplane this year or their families may not use propane tanks.



Did you know?

Facts about water quality and global warming:

- Water vapor (H_2O) and carbon dioxide (CO_2) are among the greenhouse gases responsible for the greenhouse effect. In recent years, environmental pollution with nutrients (especially nitrogen and phosphorus) has become a global problem, particularly the release of sewage effluent and agricultural runoff carrying fertilizers into natural waters.
- America is the largest contributor to global warming — releasing a quarter of the world's carbon dioxide – a major factor in global warming. What's coming from power plants, traffic jams and industrial smog is causing our ozone to disappear, ice caps to melt, and temperatures to rise.

JOIN THE DISCUSSION

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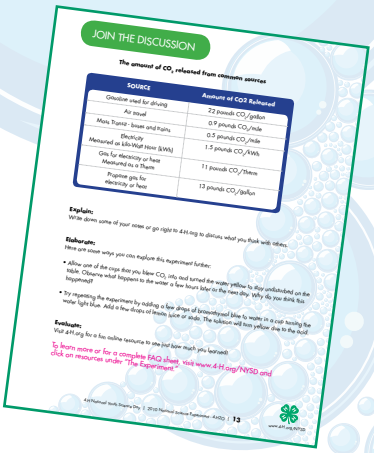
"Calculating Your Carbon Footprint" is a great way to help youth talk to others in the group as well as to peers online nationwide to learn more. Use the tips below to help youth expand beyond the previous activities and "Join the Discussion."

- Use the questions to help youth discuss their observations with each other.

- Ask youth to pay attention to the news leading up to 4-H National Youth Science Day and encourage them to bring in an article they find related to water to share with your club or class.

To learn more or for a complete FAQ sheet, visit www.4-H.org/NYSD


JOIN THE DISCUSSION

The amount of CO_2 released from common sources

SOURCE	Amount of CO_2 Released
Gasoline used for driving	22 pounds CO_2/gallon
Air travel	0.9 pounds CO_2/mile
Mass Transit - buses and trains	0.5 pounds CO_2/mile
Electricity Measured as kilowatt hour (kWh)	1.5 pounds CO_2/kWh
Gas for electricity or heat Measured as a Therm	11 pounds CO_2/therm
Propane gas for electricity or heat	13 pounds CO_2/gallon

Explain:
Write down some of your notes or go right to 4-H.org to discuss what you think with others.

Elaborate:
Here are some ways you can explore this experiment further:

- Allow one of the cups that you blew CO_2 into, and turned the water yellow to stay undisturbed on the table. Observe what happens to the water a few hours later or the next day. Why do you think this happens?
- Try repeating the experiment by adding a few drops of bromothymol blue to water in a cup having the water light blue. Add a few drops of lemon juice or shake. The solution will turn yellow due to the acid.

Evaluate:
Visit 4-H.org for a fun online testcycle to see just how much you learned!

To learn more or for a complete FAQ sheet, visit www.4-H.org/NYSD and click on resources under "The Experiment."

EXPAND YOUR LEARNING

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The Algae Experiment

The following is an additional experiment that youth can explore following 4-H National Youth Science Day.

- Have students write observations about algae systems and ask them to predict what will happen with the water.

- During the week of observation, the CO_2 bag replicated a sunroom, so the temperature in the bag will be higher than the temperature for the open bags. Students may observe water droplets or water vapor present on the surface of the sealed bags. The sealed bag acts like a closed ecosystem or a "mini" solar room; its action is similar to what happens on earth during global warming. The experiment adds extra algae to the water sample so students can see rapid and consistent results.

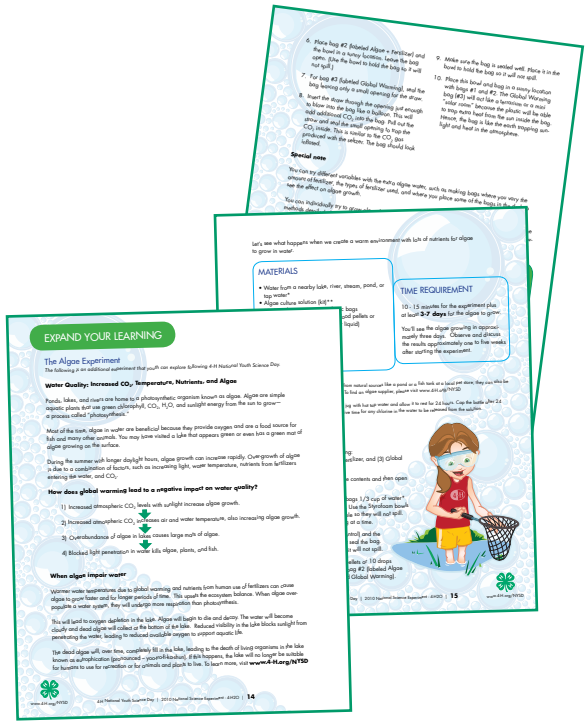
- If you attempt this experiment during the summer, it may be possible to see algae growth in water samples without the need to add algae culture solution.

- This experiment can also be done using water from a fish tank that has visible algae present in the water.

- After one week, students should seal the bags to prevent spilling. They should see green or brown algae collecting on the bottom and sides of the bags.

- Students should observe that the water control will have some algae growth but will not have as much algae as the CO_2 and fertilizer bags. The control should be a lighter green than the other bags. The bag with the sealed CO_2 biome system should have more algae growth, and hence be a darker green. They will observe color differences and may see algae collecting on the bottom of the bag. If these algae (alive or dead) build up over time in a natural system, they will lead to cloudier water that is more impaired.

- Eventually this biomass can pile up and collect until it fills the lake and leads to the death of the lake or what is a process called eutrophication. A discussion about fertilizers is also possible because human use of fertilizers will travel to natural water systems and stimulate plant growth in the water, which is amplified with warmer water temperatures due to global warming.



SPECIAL NOTE:

Participants can try different variables with the extra algae water, such as making bags where they vary the amount of fertilizer, the types of fertilizer used, and where they place some of the bags in the dark to see the effect on algae growth.

If 4-H groups are interested in each student setting up their own individual algae cultures, there are larger one-quart quantities of algae culture available from the supplier. The cost for the one-quart culture exceeds the target goal of maintaining a $10 to $20 total price for the kit. Therefore we suggest the group algae culture procedure so students can see rapid results during the National 4-H Experiment.

Students can individually try to grow algae from samples that they collect from natural water sources using the same methods detailed above in the experiment without the need to purchase algae cultures. If participants are growing algae from natural water, it's best to do it during the summer months when water temperatures are favorable for natural algae growth. Most pet stores will also supply a small amount of water from their fish tanks, another natural source for algae cultures.

GLOSSARY OF TERMS

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Water Quality:
A term that is based upon the characteristics of water in relation to the standards of what is suitable for human consumption and for all usual domestic purposes, including personal hygiene

Carbon Dioxide:
A colorless gas that is a minor component of the Earth's atmosphere, formed in combustion of carbon-containing materials, in fermentation, and in respiration of animals and used by plants in the photosynthesis.

Oxygen:
A colorless and odorless gas essential to living organisms that convert it to carbon dioxide.

Algae:
Members of a group of mostly aquatic, photosynthetic organisms.

Eutrophication:
The gradual increase in the concentration of phosphorus, nitrogen, and other plant nutrients in an aging aquatic system such as a lake.

Kilowatt Hour (kWh):
A measure of electrical energy equivalent to a power consumption of 1000 watts for one hour. Electricity is sold as kilowatt-hours.

Therm:
A therm is a unit of measure for natural gas, and is a measurement used on a gas bill. 1 Therm is equal to 100,000 British thermal units (Btu).

Here are 5 easy ways you can conserve water:

1. Don't let the water run while washing dishes. Fill one sink with wash water and the other with rinse water.
2. For cold drinks keep a pitcher of water in the refrigerator instead of running the tap.
3. Wash fruits and vegetables in a pan of water instead of running water from the tap.
4. Shorten your shower by a minute or two and you'll save up to 150 gallons per month.
5. Turn off water faucets tightly after each use.

THE WHY OF WATER QUALITY

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This year's National Science Experiment—4-$H_2$0—is designed to engage youth around the country by asking the question: **Why is water quality important and why is it important to study now?**

Water quality is a term used to describe the chemical, physical and biological characteristics of water. Today, as our population evolves, we face a growing concern that our sources of clean water are becoming contaminated by warming temperatures, carbon dioxide emissions and dangerous run off. These changes in the water quality affect not only our drinking water supply, but also the natural habitats of aquatic plants, animals and organisms.

Most of both naturally-produced and made-man carbon dioxide is absorbed by the ocean, forming carbonic acid. While some of this CO_2 is consumed by organisms in the water during photosynthesis, a small proportion of that remains in the water.

Increased CO_2 in the atmosphere has led to decreasing alkalinity of seawater, sparking concern that this may adversely affect organisms living in the water. A growing number of studies have demonstrated adverse impacts on marine organisms, including:

- A decrease in the rate at which reef-building corals can produce their skeletons.
- Reduced ability of marine algae and free-swimming zooplankton to maintain protective shells
- The survival of larval marine species, including commercial fish and shellfish, is reduced.

By learning how to protect our water quality we also learn how to protect natural resources necessary to sustain our local and global ecosystems, businesses and families.

NOTES

For more than 100 years, 4-H has been at the forefront of teaching youth about science, engineering, and technology. 4-H National Youth Science Day is an annual event – and is part of 4-H's national *One Million New Scientists. One Million New Ideas.* campaign, with a bold goal of attracting one million new youth to science, engineering, and technology programs by the year 2013.

This experiment is a joint project of North Carolina 4-H, North Carolina Extension, North Carolina Agricultural & Technical State University, National 4-H Council, 4-H National Headquarters, NIFA, USDA, and the National 4-H Science Management Team.

Special thanks to Claudette Smith, Ph.D., Family and Consumer Sciences/4-H Program Leader, North Carolina Cooperative Extension Program, NC A&T State University; Stephanie Luster-Teasley, Ph.D. (NSF Grants #0813631 and #0935154), College of Engineering, NC A&T State University; and Gregory D. Goins, Ph.D., Department of Biology, College of Arts & Sciences, NC A&T State University for their joint efforts to raise awareness and education around water quality and climate change for our nation's youth.

North Carolina A&T State University

NC State University A&T State University Cooperative Extension
Empowering People · Providing Solutions

4-H National Headquarters USDA

National 4-H Council

Learn more about 4-H at www.4-H.org or find us on Facebook at www.facebook.com/4-H.

4-H is a community of six million young people across America learning leadership, citizenship, and life skills. National 4-H Council works to advance the 4-H Youth Development movement, building a world in which youth and adults learn, grow and work together as catalysts for positive change. National 4-H Council partners with the Cooperative Extension System of Land-Grant Universities, 4-H National Headquarters located at the National Institute of Food and Agriculture (NIFA) within USDA, communities, and other organizations to provide technical support and training, develop curricula, create model programs and promote positive youth development to fulfill its mission. National 4-H Council also manages National 4-H Youth Conference Center, a full-service conference facility, and National 4-H Supply Service, the authorized agent for items bearing the 4-H Name and Emblem. National 4-H Council is a nonprofit 501(c)(3) organization. National 4-H Council is committed to a policy that all persons shall have equal access to its programs, facilities and employment without regard to race, color, sex, religion, religious creed, ancestry or national origin, age, veteran status, sexual orientation, marital status, disability, physical or mental disability. Mention or display of trademark, proprietary product or firm in text or figures does not constitute an endorsement by National 4-H Council or National 4-H Headquarters and does not imply approval to the exclusion of suitable products or firms.