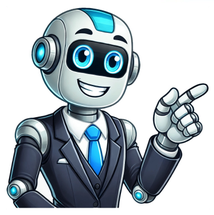
Click Here



In order to continue enjoying our site, we ask that you confirm your identity as a human. Thank you very much for your cooperation. Showing top 8 worksheets in the category - Acid Rain.Some of the worksheets displayed are Learning about acid rain, Acid rain effects work, Work a environmental problems, Energy resources, Earths atmosphere, Ks3 science revision work standard edition, The scientific method, Name.Once you find your worksheet, click on pop-out icon or print icon to worksheet to print or download. Worksheet will open in a new window. You can & download or print using the browser document reader options. Share — copy and redistribute the material in any medium or format for any purpose, even commercially. Adapt — remix, transform, and build upon the material for any purpose, even commercially. The licensor cannot revoke these freedoms as long as you follow the license terms. Attribution — You must give appropriate credit , provide a link to the license, and indicate if changes were made . You may do so in any reasonable manner, but not in any way that suggests the licensor endorses you or your use. ShareAlike — If you remix, transform, or build upon the material, you must distribute your contributions under the same license as the original. No additional restrictions — You may not apply legal terms or technological measures that legally restrict others from doing anything the license permits. You do not have to comply with the license for elements of the material in the public domain or where your use is permitted by an applicable exception or limitation . No warranties are given. The license may not give you all of the permissions necessary for your intended use. For example, other rights such as publicity, privacy, or moral rights may limit how you use the material. Rain that is unusually acidic For other uses, see Acid rain (disambiguation). Processes involved in acid deposition (only SO2 and NOx) play a significant role in acid rain Acid clouds can grow on SO2 emissions from refineries, as seen here in Curaçao. Part of a series onPollutionAir pollution from a factory Air Acid rain Air quality index Atmospheric dispersion modeling Chlorofluorocarbon Combustion Exhaust gas Haze Household air pollution Global dimming Global distillation Indoor air quality Non-exhaust emissions Ozone depletion Particulates Persistent organic pollutant Smog Soot Volatile organic compound Biological Biological hazard Genetic Illegal logging Introduced species Invasive species Digital Information Electromagnetic Light Ecological Overillumination Radio spectrum Natural Ozone Radium and radon in the environment Volcanic ash Wildfire Noise Transportation Health effects from noise Marine mammals and sonar Noise barrier Noise control Soundproofing Radiation Actinides Bioremediation Depleted uranium Nuclear fission Nuclear fallout Plutonium Poisoning Radioactivity Uranium Radioactive waste Soil Agricultural Land degradation Bioremediation Defecation Electrical resistance heating Illegal mining Soil guideline values Phytoremediation Solid waste Advertising mail Biodegradable waste Brown waste Electronic waste Food waste Green waste Hazardous waste Industrial waste Litter Mining Municipal solid waste Nanomaterials Plastic Packaging waste Post-consumer waste Waste management Space Space debris Visual Air travel Advertising clutter Overhead power lines Traffic signs Urban blight Vandalism War Chemical warfare Herbicidal warfare Agent Orange Nuclear holocaust Nuclear fallout Nuclear famine Nuclear winter Scorched earth Unexploded ordnance War and environmental law Water Agricultural wastewater Biosolids Diseases Eutrophication Firewater Freshwater Groundwater Hypoxia Industrial wastewater Marine Monitoring Nonpoint source Nutrient Ocean acidification Oil spill Pharmaceuticals Freshwater salinization Septic tanks Sewage Shipping Sludge Stagnation Sulfur water Surface runoff Turbidity Urban runoff Water quality Wastewater Topics History Pollutants Heavy metals Paint Misc Area source Brain health and pollution Debris Dust Garbology Legacy Thermal pollution Midden Point source Waste Toxic Lists Diseases Law by country Most polluted cities Least polluted cities by PM2.5 Treaties Most polluted rivers Categories By country Environment portal Ecology portalvte External audio "Whatever Happened to Acid Rain?", Science History Institute Acid rain is rain or any other form of precipitation that is unusually acidic, meaning that it has elevated levels of hydrogen ions (low pH). Most water, including drinking water, has a neutral pH that exists between 6.5 and 8.5, but acid rain has a pH level lower than this and ranges from 4–5 on average.[1][2] The more acidic the acid rain is, the lower its pH is.[2] Acid rain can have harmful effects on plants, aquatic animals, and infrastructure. Acid rain is caused by emissions of sulfur dioxide and nitrogen oxide, which react with the water molecules in the atmosphere to produce acids. Acid rain has been shown to have adverse impacts on forests, freshwaters, soils, microbes, insects and aquatic life-forms.[3] In ecosystems, persistent acid rain reduces tree bark durability, leaving flora more susceptible to environmental stressors such as drought, heat/cold and pest infestation. Acid rain is also capable of detrimenting soil composition by stripping it of nutrients such as calcium and magnesium which play a role in plant growth and maintaining healthy soil. In terms of human infrastructure, acid rain also causes paint to peel, corrosion of steel structures such as bridges, and weathering of stone buildings and statues as well as having impacts on human health.[4][5][6][7] Some governments, including those in Europe and North America, have made efforts since the 1970s to reduce the release of sulfur dioxide and nitrogen oxide into the atmosphere through air pollution regulations. These efforts have had positive results due to the widespread research on acid rain starting in the 1960s and the publicized information on its harmful effects.[8][9] The main source of sulfur and nitrogen compounds that result in acid rain are anthropogenic, but nitrogen oxides can also be produced naturally by lightning strikes and sulfur dioxide is produced by volcanic eruptions.[10] "Acid rain" is rain with a pH less than 5.[11] "Clean" or unpolluted rain has a pH greater than 5 but still less than pH = 7 owing to the acidity caused by carbon dioxide acid according to the following reactions: H2O + CO2 ⇌ H2CO3 H2O + H2CO3 ⇌ HCO−3 + H3O+ A variety of natural and human-made sources contribute to the acidity. For example nitric acid produced by electric discharge in the atmosphere such as lightning.[12] The usual anthropogenic sources are sulfur dioxide and nitrogen oxide. They react with water (as does carbon dioxide) to give solutions with pH < 5.[2] Occasional pH readings in rain and fog water of well below 2.4 have been reported in industrialized areas.[13] The examples and perspective in this section may not represent a worldwide view of the subject. You may improve this section, discuss the issue on the talk page, or create a new section, as appropriate. (February 2020) (Learn how and when to remove this message) Acid rain was first systematically studied in Europe in the 1960s, in the United States and Canada in 1970s, and in India in the late 1980s. The corrosive effect of polluted, acidic city air on limestone and marble was noted in the 17th century by John Evelyn, who remarked upon the poor condition of the Arundel marbles.[14] Since the Industrial Revolution, emissions of sulfur dioxide and nitrogen oxides into the atmosphere have increased.[13][15] In 1852, Robert Angus Smith was the first to show the relationship between acid rain and atmospheric pollution in Manchester, England.[16] Smith coined the term "acid rain" in 1872.[17] In the late 1960s, scientists began widely observing and studying the phenomenon.[18] At first, the main focus in this research lay on local effects of acid rain. Waldemar Christofer Brøgger was the first to acknowledge long-distance transportation of pollutants crossing borders from the United Kingdom to Norway – a problem systematically studied by Brynjulf Ottar in the 1970s.[19] Ottar's work was strongly influenced[20] by Swedish soil scientist Svante Odén, who had drawn widespread attention to Europe's acid rain problem in popular newspapers and wrote a landmark paper on the subject in 1968.[21][22][23] External audio "Whatever Happened to Acid Rain?", Distillations Podcast, Science History Institute Since 1998, Harvard University wraps some of the bronze and marble statues on its campus, such as this "Chinese stele", with waterproof covers every winter, in order to protect them from corrosion caused by acid rain and acid snow[24] The earliest report about acid rain in the United States came from chemical evidence gathered from Hubbard Brook Valley; public awareness of acid rain in the US increased in the 1970s after The New York Times reported on these findings.[25][26] In 1972, a group of scientists, including Gene Likens, discovered the rain that was deposited at White Mountains of New Hampshire was acidic. The pH of the sample was measured to be 4.03 at Hubbard Brook.[27] The Hubbard Brook Ecosystem Study followed up with a series of research studies that analyzed the environmental effects of acid rain. The alumina from soils neutralized acid rain that mixed with stream water at Hubbard Brook.[28] The result of this research indicated that the chemical reaction between acid rain and aluminium leads to an increasing rate of soil weathering. Experimental research examined the effects of increased acidity in streams on ecological species. In 1980, scientists modified the acidity of Norris Brook, New Hampshire, and observed the change in species' behaviors. There was a decrease in species diversity, an increase in community dominants, and a reduction in the food web complexity.[29] In 1980, the US Congress passed an Acid Deposition Act.[30] This Act established an 18-year assessment and research program under the direction of the National Acidic Precipitation Assessment Program (NAPAP). NAPAP enlarged a network of monitoring sites to determine how acidic precipitation was, seeking to determine long-term trends, and established a network for dry deposition. Using a statistically based sampling design, NAPAP quantified the effects of acid rain on a regional basis by targeting research and surveys to identify and quantify the impact of acid precipitation on freshwater and terrestrial ecosystems. NAPAP also assessed the effects of acid rain on historical buildings, monuments, and building materials. It also funded extensive studies on atmospheric processes and potential control programs. From the start, policy advocates from all sides attempted to influence NAPAP activities to support their particular policy advocacy efforts, or to disparage those of their opponents.[30] For the US Government's scientific enterprise, a significant impact of NAPAP were lessons learned in the assessment process and in environmental research management to a relatively large group of scientists, program managers, and the public.[31] In 1981, the National Academy of Sciences was looking into research about the controversial issues regarding acid rain.[32] President Ronald Reagan dismissed the issues of acid rain[33] until his personal visit to Canada and confirmed that the Canadian border suffered from the drifting pollution from smokestacks originating in the US Midwest. Reagan honored the agreement to Canadian Prime Minister Pierre Trudeau's enforcement of anti-pollution regulation.[34] In 1982, Reagan commissioned William Nierenberg to serve on the National Science Board.[35] Nierenberg selected scientists including Gene Likens to serve on a panel to draft a report on acid rain. In 1983, the panel of scientists came up with a draft report, which concluded that acid rain is a real problem and solutions should be sought.[36] White House Office of Science and Technology Policy reviewed the draft report and sent Fred Singer's suggestions of the report, which cast doubt on the cause of acid rain.[37] The panelists revealed rejections against Singer's positions and submitted the report to Nierenberg in April. In May 1983, the House of Representatives voted against legislation controlling sulfur emissions. There was a debate about whether Nierenberg delayed the release of the report. Nierenberg denied the saying about his suppression of the report and stated that it was withheld after the House's vote because it was not ready to be published.[38] In 1991, the US National Acid Precipitation Assessment Program (NAPAP) provided its first assessment of acid rain in the United States.[39] It reported that 5% of New England Lakes were acidic, with sulfates being the most common problem. They noted that 2% of the lakes could no longer support Brook Trout, and 6% of the lakes were unsuitable for the survival of many minnow species. Subsequent Reports to Congress have documented chemical changes in soil and freshwater ecosystems, nitrogen saturation, soil nutrient decreases, episodic acidification, regional haze, and damage to historical monuments. Meanwhile, in 1990, the US Congress passed a series of amendments to the Clean Air Act.[40] Title IV of these amendments established a cap and trade system designed to control emissions of sulfur dioxide and nitrogen oxides.[41] Both these emissions proved to cause a significant problem for U.S. citizens and their access to healthy, clean air.[42] Title IV called for a total reduction of about 10 million tons of SO2 emissions from power plants, close to a 50% reduction.[41] It was implemented in two phases. Phase I began in 1995 and limited sulfur dioxide emissions from 110 of the largest power plants to 8.7 million tons of sulfur dioxide. One power plant in New England (Merrimack) was in Phase I. Four other plants (Newington, Mount Tom, Brayton Point, and Salem Harbor) were added under other program provisions. Phase II began in 2000 and affects most of the power plants in the country. During the 1990s, research continued. On March 10, 2005, the EPA issued the Clean Air Interstate Rule (CAIR). This rule provides states with a solution to the problem of power plant pollution that drifts from one state to another. CAIR will permanently cap emissions of SO2 and NOx in the eastern United States. When fully implemented,[when?] CAIR will reduce SO2 emissions in 28 eastern states and the District of Columbia by over 70% and NOx emissions by over 60% from 2003 levels.[43] Overall, the program's cap and trade program has been successful in achieving its goals. Since the 1990s, SO2 emissions have dropped 40%, and according to the Pacific Research Institute, acid rain levels have dropped 65% since 1976.[44] Conventional regulation was used in the European Union, which saw a decrease of over 70% in SO2 emissions during the same period.[45] In 2007, total SO2 emissions were 8.9 million tons, achieving the program's long-term goal ahead of the 2010 statutory deadline.[46] In 2007 the EPA estimated that by 2010, the overall costs of complying with the program for businesses and consumers would be $1 billion to $2 billion a year, only one-fourth of what was initially predicted.[44] Forbes says: "In 2010, by which time the cap and trade system had been augmented by the George W. Bush administration's Clean Air Interstate Rule, SO2 emissions had fallen to 5.1 million tons."[47] The term citizen science can be traced back as far as January 1989 to a campaign by the Audubon Society to measure acid rain. Scientist Muki Haklay cites in a policy report for the Wilson Center entitled 'Citizen Science and Policy: A European Perspective' a first use of the term 'citizen science' by R. Kerson in the magazine MIT Technology Review from January 1989.[48][49] Quoting from the Wilson Center report: "The new form of engagement in science received the name "citizen science". The first recorded example of using the term is from 1989, describing how 225 volunteers across the US collected rain samples to assist the Audubon Society in an acid-rain awareness-raising campaign. The volunteers collected samples, checked for acidity, and reported to the organization. The information was then used to demonstrate the full extent of the phenomenon."[48][49] Canadian Harold Harvey was among the first to research a "dead" lake. In 1971, he and R. J. Beamish published a report, "Acidification of the La Cloche Mountain Lakes", documenting the gradual deterioration of fish stocks in 60 lakes in Killarney Park in Ontario, which they had been studying systematically since 1966.[50] In the 1970s and 80s, acid rain was a major topic of research at the Experimental Lakes Area (ELA) in Northwestern Ontario, Canada.[51] Researchers added sulfuric acid to whole lakes in controlled ecosystem experiments to simulate the effects of acid rain. Because its remote conditions allowed for whole-ecosystem experiments, research at the ELA showed that the effect of acid rain on fish populations started at concentrations much lower than those observed in laboratory experiments.[52] In the context of a food web, fish populations crashed earlier than when acid rain had direct toxic effects to the fish because the acidity led to crashes in prey populations (e.g. mysids).[52] As experimental acid inputs were reduced, fish populations and lake ecosystems recovered at least partially, although invertebrate populations have still not completely returned to the baseline conditions.[53] This research showed both that acidification was linked to declining fish populations and that the effects could be reversed if sulfuric acid emissions decreased, and influenced policy in Canada and the United States.[51] In 1985, seven Canadian provinces (all except British Columbia, Alberta, and Saskatchewan) and the federal government signed the Eastern Canada Acid Rain Program.[54] The provinces agreed to limit their combined sulfur dioxide emissions to 2.3 million tonnes by 1994. The Canada-US Air Quality Agreement was signed in 1991.[54] In 1998, all federal, provincial, and territorial Ministers of Energy and Environment signed The Canada-Wide Acid Rain Strategy for Post-2000, which was designed to protect lakes that are more sensitive than those protected by earlier policies.[54] Acid rain was first reported in Mumbai (then Bombay) in 1974. Acid rain has been a reported cause of decrease in soil pH, especially in the areas of northeast, coastal regions of Karnataka, Kerala, Odisha, Bihar, and West Bengal.[citation needed] The spread of acid rain over India was first studied by a team of researchers in 1989.[55] Increased risk might be posed by the expected rise in total sulphur emissions from 4,400 kilotonnes (kt) in 1990 to 6,500 kt in 2000, 10,900 kt in 2010 and 18,500 in 2020.[56] Damage to Taj Mahal is a popular example of acid rain's corrosive effect in India.[57] The most important gas which leads to acidification is sulfur dioxide. Emissions of nitrogen oxides which are oxidized to form nitric acid are of increasing importance due to stricter controls on emissions of sulfur compounds. 70 Tg(S) per year in the form of SO2 comes from fossil fuel combustion and industry, 2.8 Tg(S) from wildfires, and 7–8 Tg(S) per year from volcanoes.[58] Mean acidifying emissions (air pollution) of different foods per 100g of protein[59] Food Types Acidifying Emissions (g SO2eq per 100g protein) Beef 343.6 Cheese 165.5 Pork 142.7 Lamb and Mutton 139.0 Farmed Crustaceans 133.1 Poultry 102.4 Farmed Fish 65.9 Eggs 53.7 Groundnuts 22.6 Peas 8.5 Tofu 6.7 The principal natural phenomena that contribute acid-producing gases to the atmosphere are emissions from volcanoes.[60] Thus, for example, fumaroles from the Laguna Caliente crater of Poás Volcano create extremely high amounts of acid rain and fog, with acidity as high as a pH of 2, clearing an area of any vegetation and frequently causing irritation to the eyes and lungs of inhabitants in nearby settlements. Acid-producing gasses are also created by biological processes that occur on the land, in wetlands, and in the oceans. The major biological source of sulfur compounds is dimethyl sulfide. Nitric acid in rainwater is an important source of fixed nitrogen for plant life, and is also produced by electrical activity in the atmosphere such as lightning.[61] Acidic deposits have been detected in glacial ice thousands of years old in remote parts of the globe.[62] See also: Nitrogen cycle, Human impact on the nitrogen cycle, and sulfur cycleThe coal-fired Gavin Power Plant in Cheshire, Ohio The principal cause of acid rain is sulfur and nitrogen compounds from human sources, such as electricity generation, animal agriculture, factories, and motor vehicles.[63] These also include power plants, which use electric power generators that account for a quarter of nitrogen oxides and two-thirds of sulfur dioxide within the atmosphere.[64] Industrial acid rain is a substantial problem in China and Russia[65][66] and areas downwind from them. These areas all burn sulfur-containing coal to generate heat and electricity.[67] The problem of acid rain has not only increased with population and industrial growth, but has become more widespread. The use of tall smokestacks to reduce local pollution has contributed to the spread of acid rain by releasing gases into regional atmospheric circulation; dispersal from these taller stacks causes pollutants to be carried farther, causing widespread ecological damage.[62][68] Often deposition occurs a considerable distance downwind of the emissions, with mountainous regions tending to receive the greatest deposition (because of their higher rainfall). An example of this effect is the low pH of rain which falls in Scandinavia. Regarding low pH and pH imbalances in correlation to acid rain, low levels, or those under the pH value of 7, are considered acidic. Acid rain falls at a pH value of roughly 4, making it harmful to consume for humans. When these low pH levels fall in specific regions, they not only affect the environment but also human health. With acidic pH levels in humans comes hair loss, low urinary pH, severe mineral imbalances, constipation, and many cases of chronic disorders like Fibromyalgia and Basal Carcinoma.[69] Combustion of fuels and smelting of some ores produce sulfur dioxide and nitric oxides. They are converted into sulfuric acid and nitric acid.[70] In the gas phase sulfur dioxide is oxidized to sulfuric acid: SO2 + 0.5 O2 + H2O → H2SO4 Nitrogen dioxide reacts with hydroxyl radicals to form nitric acid: This shows the process of the air pollution being released into the atmosphere and the areas that will be affected. NO2 + OH· → HNO3 The detailed mechanisms depend on the presence water and traces of iron and manganese. A number of oxidants are capable of these reactions aside from O2, these include ozone, hydrogen peroxide, and oxygen.[16] Wet deposition of acids occurs when any form of precipitation (rain, snow, and so on) removes acids from the atmosphere and delivers it to the Earth's surface. This can result from the deposition of acids produced in the raindrops (see aqueous phase chemistry above) or by the precipitation removing the acids either in clouds or below clouds. Wet removal of both gases and aerosols are both of importance for wet deposition.[2] Acid deposition also occurs via dry deposition in the absence of precipitation. This can be responsible for as much as 20 to 60% of total acid deposition.[71] This occurs when particles and gases stick to the ground, plants or other surfaces.[2] Acid rain has been shown to have adverse impacts on forests, freshwaters and soils, killing insect and aquatic life-forms as well as causing damage to buildings and having impacts on human health. Further information: Water pollution Not all fish, shellfish, or the insects that they eat can tolerate the same amount of acid; for example, frogs can tolerate water that is more acidic (i.e., has a lower pH) than trout. Sulfuric acid and nitric acid have multiple impacts on aquatic ecosystems, including acidification, increased nitrogen and aluminum content, and alteration of biogeochemical processes.[72] Both the lower pH and higher aluminium concentrations in surface water that occur as a result of acid rain can cause damage to fish and other aquatic animals. At pH lower than 5 most fish eggs will not hatch and lower pH can kill adult fish. As lakes and rivers become more acidic, biodiversity is reduced. Acid rain has eliminated insect life and some fish species, including the brook trout in some lakes, streams, and creeks in geographically sensitive areas, such as the Adirondack Mountains of the United States.[73] However, the extent to which acid rain contributes directly or indirectly via runoff from the catchment to lake and river acidity (i.e., depending on characteristics of the surrounding watershed) is variable. The United States Environmental Protection Agency's (EPA) website states: "Of the lakes and streams surveyed, acid rain caused acidity in 75% of the acidic lakes and about 50% of the acidic streams".[73] Lakes hosted by silicate basement rocks are more acidic than lakes within limestone or other basement rocks with a carbonate composition (i.e. marble) due to buffering effects by carbonate minerals, even with the same amount of acid rain.[74] Soil biology and chemistry can be seriously damaged by acid rain. Some microbes are unable to tolerate changes to low pH and are killed.[75] The enzymes of these microbes are denatured (changed in shape so they no longer function) by the acid. The hydronium ions of acid rain also mobilize toxins, such as aluminium, and leach away essential nutrients and minerals such as magnesium.[5] 2 H+ (aq) + Mg2+ (clay) ⇌ 2 H+ (clay) + Mg2+ (aq) Soil chemistry can be dramatically changed when base cations, such as calcium and magnesium, are leached by acid rain, thereby affecting sensitive species, such as sugar maple (Acer saccharum).[76] Soil acidification Diagram of nutrient leaching in soil with high levels of Soil acidity. Impacts of acidic water and soil acidification on plants could be minor or in most cases major. Most minor cases which do not result in fatality of plant life can be attributed to the plants being less susceptible to acidic conditions and/or the acid rain being less potent. However, even in minor cases, the plant will eventually die due to the acidic water lowering the plant's natural pH.[77] Acidic water enters the plant and causes important plant minerals to dissolve and get carried away; which ultimately causes the plant to die of lack of minerals for nutrition. In major cases, which are more extreme, the same process of damage occurs as in minor cases, which is removal of essential minerals, but at a much quicker rate.[6] Likewise, acid rain that falls on soil and on plant leaves causes drying of the waxy leaf cuticle, which ultimately causes rapid water loss from the plant to the outside atmosphere and eventually results in death of the plant.[78] Soil acidification can lead to a decline in soil microbes as a result of a change in pH, which would have an adverse effect on plants due to their dependence on soil microbes to access nutrients.[79][80][81] To see if a plant is being affected by soil acidification, one can closely observe the plant leaves. If the leaves are green and look healthy, the soil pH is normal and acceptable for plant life. But if the plant leaves have yellowing between the veins on their leaves, that means the plant is suffering from acidification and is unhealthy.[82] Moreover, a plant suffering from soil acidification cannot photosynthesize; the acid-water-induced process of drying out of the plant can destroy chloroplast organelles.[83] Without being able to photosynthesize, a plant cannot create nutrients for its own survival or oxygen for the survival of aerobic organisms, which affects most species on Earth and ultimately ends the purpose of the plant's existence.[84] Acid rain can have severe effects on vegetation. A forest in the Black Triangle in Europe. Adverse effects may be indirectly related to acid rain, like the acid's effects on soil (see above) or high concentration of gaseous precursors to acid rain. High altitude forests are especially vulnerable as they are often surrounded by clouds and fog which are more acidic than rain.[85] Plants are capable of adapting to acid rain. On Jinyun Mountain, Chongqing, plant species were seen adapting to new environmental conditions. The affects on the species ranged from being beneficial to detrimental. With natural rainfall or mild acid rainfall, the biochemical and physiological characteristics of plant seedlings were enhanced. However, once the pH decreases below the threshold of 3.5, the acid rain can no longer be beneficial and begins to have negative affects.[86] Acid rain can negatively impact photosynthesis in plant leaves, when leaves are exposed to a lower pH, photosynthesis is impacted due to the decline in chlorophyll.[87] Acid rain also has the ability to cause deformation to leaves at a cellular level, examples include; tissue scaring and changes to the stomatal, epidermis and mesophyll cells.[88] Additional impacts of acid rain includes a decline in cuticle thickness present on the leaf surface.[87][88] Because acid rain damages leaves, this directly impacts a plants ability to have a strong canopy cover, a decline in canopy cover can lead plants to be more vulnerable to diseases.[79] Dead or dying trees often appear in areas impacted by acid rain. Acid rain causes aluminum to leach from the soil, posing risks to both plant and animal life. Furthermore, it strips the soil of critical minerals and nutrients necessary for tree growth. At higher altitudes, acidic fog and clouds can deplete nutrients from tree foliage, leading to discolored or dead leaves and needles. This depletion compromises the trees' ability to absorb sunlight, weakening them and diminishing their capacity to endure cold conditions.[89] Other plants can also be damaged by acid rain, but the effect on food crops is minimized by the application of lime and fertilizers to replace lost nutrients. In cultivated areas, limestone may also be added to increase the ability of the soil to keep the pH stable, but this tactic is largely unusable in the case of wilderness lands. When calcium is leached from the needles of red spruce, these trees become less cold tolerant and exhibit winter injury and even death.[90][91] Acid rain may also affect crop productivity by necrosis or changes to soil nutrients, which ultimately prevent plants from reaching maturity.[92][93] Main article: Ocean acidification This section needs expansion. You can help by making an edit requestadding to it . (July 2013) Acid rain has a much less harmful effect on oceans on a global scale, but it creates an amplified impact in the shallower waters of coastal waters.[94] Acid rain can cause the ocean's pH to fall, known as ocean acidification, making it more difficult for different coastal species to create their exoskeletons that they need to survive. These coastal species link together as part of the ocean's food chain, and without them being a source for other marine life to feed off of, more marine life will die.[95] Coral's limestone skeleton is particularly sensitive to pH decreases, because the calcium carbonate, a core component of the limestone skeleton, dissolves in acidic (low pH) solutions. In addition to acidification, excess nitrogen inputs from the atmosphere promote increased growth of phytoplankton and other marine plants, which, in turn, may cause more frequent harmful algal blooms and eutrophication (the creation of oxygen-depleted "dead zones") in some parts of the ocean.[94] Acid rain can negatively impact human health, especially when people breathe in particles released from acid rain.[1] The effects of acid rain on human health are complex and may be seen in several ways, such as respiratory issues for long-term exposure and indirect exposure through contaminated food and water sources. Exposure to air pollutants associated with acid rain, such as nitrogen dioxide (NO2), may have a negative impact on respiratory health.[3] Water-soluble nitrogen dioxide accumulates in the tiny airways, where it is transformed into nitric and nitrous acids.[4] Pneumonia caused by nitric acids directly damages the epithelial cells lining the airways, resulting in pulmonary edema.[8] Exposure to nitrogen dioxide also reduces the immune response by inhibiting the generation of inflammatory cytokines by alveolar macrophages in response to bacterial infection.[10] In animal studies, the pollutant further reduces respiratory immunity by decreasing mucociliary clearance in the lower respiratory tract, which results in a reduced ability to remove respiratory infections.[12] The effects of sulfur trioxide and sulfuric acid are similar because they both produce sulfuric acid when they come into touch with the wet surfaces of your skin or respiratory system.[96] The amount of SO3 breath through the mouth is larger than the amount of SO3 breath through the nose.[96] When humans breathe in sulfur trioxide, small droplets of sulfuric acid will form inside the body and enter the respiratory tract to the lungs depending on the particle size.[96] The effects of SO3 on the respiratory system lead to breathing difficulty in people who have asthma symptoms. Sulfur trioxide also causes very corrosive and irritation on the skin, eye, and gastrointestinal tracts when there is direct exposure to a specific concentration or long-term exposure.[96] Consuming concentrated sulfuric acid has been known to burn the mouth and throat, erode a hole in the stomach, burns when it comes into contact with skin, make your eyes weep if it gets into them, and mortality.[96] A 25 parts per million (ppm) maximum for nitric oxide in working air has been set by the Occupational Safety and Health Administration (OSHA) for an 8-hour workday and a 40-hour workweek.[97] Additionally, OSHA has established a 5-ppm nitrogen dioxide exposure limit for 15 minutes in the workplace.[97] The not-to-exceed limits in the air, water, soil, or food that are recommended by regulations are often based on levels that affect animals before being modified to assist in safeguarding people. Depending on whether they employ different animal studies, have different exposure lengths (e.g., an 8-hour workday versus a 24-hour day), or for other reasons, these not-to-exceed values can vary between federal bodies.[96] The amount of sulfur dioxide that can be emitted into the atmosphere is capped by the EPA. This reduces the quantity of sulfur dioxide in the air that turns into sulfur trioxide and sulfuric acid.[14] Sulfuric acid concentrations in workroom air are restricted by OSHA to 1 mg/m3. Moreover, NIOSH advises a time-weighted average limit of 1 mg/m3.[96] Effect of acid rain on statues Acid rain and weathering Acid rain can damage buildings, historic monuments, and statues, especially those made of rocks, such as limestone and marble, that contain large amounts of calcium carbonate. Acids in the rain react with the calcium compounds in the stones to create gypsum, which then flakes off. CaCO3 (s) + H2SO4 (aq) ⇌ CaSO4 (s) + CO2 (g) + H2O (l) The effects of this are commonly seen on old gravestones, where acid rain can cause the inscriptions to become completely illegible. Acid rain also increases the corrosion rate of metals, in particular iron, steel, copper and bronze.[98][99] Places significantly impacted by acid rain around the globe include most of eastern Europe from Poland northward into Scandinavia,[100] the eastern third of the United States,[101] and southeastern Canada. Other affected areas include the southeastern coast of China and Taiwan.[102] Many coal-firing power stations use flue-gas desulfurization (FGD) to remove sulfur-containing gases from their stack gases. For a typical coal-fired power station, FGD will remove 95% or more of the SO2 in the flue gases. An example of FGD is the wet scrubber which is commonly used. A wet scrubber is basically a reaction tower equipped with a fan that extracts hot smoke stack gases from a power plant into the tower. Lime or limestone in slurry form is also injected into the tower to mix with the stack gases and combine with the sulfur dioxide present. The calcium carbonate of the limestone produces pH-neutral calcium sulfate that is physically removed from the scrubber. That is, the scrubber turns sulfur pollution into industrial sulfates. In some areas the sulfates are sold to chemical companies as gypsum when the purity of calcium sulfate is high. In others, they are placed in landfill. The effects of acid rain can last for generations, as the effects of pH level change can stimulate the continued leaching of undesirable chemicals into otherwise pristine water sources, killing off vulnerable insect and fish species and blocking efforts to restore native life. Fluidized bed combustion also reduces the amount of sulfur emitted by power production. Vehicle emissions control reduces emissions of nitrogen oxides from motor vehicles. Governmental action to combat the effects of acid rain International treaties on the long-range transport of atmospheric pollutants have been agreed upon by western countries for some time now. Beginning in 1979, European countries convened in order to ratify general principles discussed during the UNECE Convention. The purpose was to combat Long-Range Transboundary Air Pollution.[103] The 1985 Helsinki Protocol on the Reduction of Sulfur Emissions under the Convention on Long-Range Transboundary Air Pollution furthered the results of the convention. Results of the treaty have already come to fruition, as evidenced by an approximate 40 percent drop in particulate matter in North America.[104] The effectiveness of the Convention in combatting acid rain has inspired further acts of international commitment to prevent the proliferation of particulate matter. Canada and the US signed the Air Quality Agreement in 1991. Most European countries and Canada signed the treaties. Activity of the Long-Range Transboundary Air Pollution Convention remained dormant after 1999, when 27 countries convened to further reduce the effects of acid rain.[105] In 2000, foreign cooperation to prevent acid rain was sparked in Asia for the first time. Ten diplomats from countries ranging throughout the continent convened to discuss ways to prevent acid rain.[106] Following these discussions, the Acid Deposition Monitoring Network in East Asia (EANET) was established in 2001 as an intergovernmental initiative to provide science-based inputs for decision makers and promote international cooperation on acid deposition in East Asia.[107] In 2023, the EANET member countries include Cambodia, China, Indonesia, Japan, Lao PDR, Malaysia, Mongolia, Myanmar, the Philippines, Republic of Korea, Russia, Thailand and Vietnam.[108] Main article: Emissions trading See also: Acid Rain Program In this regulatory scheme, every current polluting facility is given or may purchase on an open market an emissions allowance for each unit of a designated pollutant it emits. Operators can then install pollution control equipment, and sell portions of their emissions allowances they no longer need for their own operations, thereby recovering some of the capital cost of their investment in such equipment. The intention is to give operators economic incentives to install pollution controls. The first emissions trading market was established in the United States by enactment of the Clean Air Act Amendments of 1990.[109] The overall goal of the Acid Rain Program established by the Act[110] is to achieve significant environmental and public health benefits through reductions in emissions of sulfur dioxide (SO2) and nitrogen oxides (NOx), the primary causes of acid rain. To achieve this goal at the lowest cost to society, the program employs both regulatory and market based approaches for controlling air pollution. Alkaline precipitation Citizen science – one of two 'first uses' of the term was in an acid rain campaign in 1989. List of environmental issues Lists of environmental topics Ocean acidification Rain dust (an alkaline rain) Soil retrogression and degradation

^ a b "Drinking Water Regulations and Contaminants". US EPA. September 3, 2015. Retrieved October 19, 2021. ^ a b c d e "What is Acid Rain?". US EPA. February 9, 2016. Archived from the original on May 23, 2020. Retrieved April 14, 2020. ^ a b US EPA, OAR (March 16, 2016). "Effects of Acid Rain". epa.gov. Retrieved March 29, 2022. ^ a b Magaino, S. (January 1997). "Corrosion rate of copper rotating-disk-electrode in simulated acid rain". Electrochimica Acta. 42 (3): 377–382. doi:10.1016/S0013-4686(96)00225-3. ^ a b US EPA: Effects of Acid Rain – Forests Archived July 26, 2008, at the Wayback Machine ^ a b Markewitz, Daniel; Richter, Daniel D.; Allen, H. Lee; Urrego, J. Byron (September 1998). "Three Decades of Observed Soil Acidification in the Calhoun Experimental Forest: Has Acid Rain Made a Difference?". Soil Science Society of America Journal. 62 (5): 1428–1439. Bibcode:1998SSASJ..62.1428M. doi:10.2136/sssaj1998.03615995006200050040x. ^ Effects of Acid Rain – Human Health Archived January 18, 2008, at the Wayback Machine. Epa.gov (June 2, 2006). Retrieved on 2013-02-09. ^ a b P. Rafferty, John. "What Happened to Acid Rain?". Encyclopædia Britannica. Retrieved July 21, 2022. ^ Kjellstrom, Tord; Lodh, Madhumita; McMichael, Tony; Ranmuthugala, Geetha; Shrestha, Rupendra; Kingsland, Sally (2006), Jamison, Dean T.; Breman, Joel G.; Measham, Anthony R.; Alleyne, George (eds.), "Air and Water Pollution: Burden and Strategies for Control", Disease Control Priorities in Developing Countries (2nd ed.), World Bank, ISBN 978-0-8213-6179-5, PMID 21250344, archived from the original on August 7, 2020, retrieved April 22, 2020 ^ a b Sisterson, D. L.; Liaw, Y. P. (1990). "An evaluation of lightning and corona discharge on thunderstorm air and precipitation chemistry". Journal of Atmospheric Chemistry. 10 (1): 83–96. Bibcode:1990JAtC...10...83S. doi:10.1007/BF01980039. S2CID 97714446. ^ "Acid rain". IUPAC GoldBook: Acid rain. Research Triangle Park, NC: International Union of Pure and Applied Chemistry (IUPAC). 2008. doi:10.1351/goldbook.A00083. ^ a b Likens, Gene E.; Keene, William C.; Miller, John M.; Galloway, James N. (November 20, 1987). "Chemistry of precipitation from a remote, terrestrial site in Australia". Journal of Geophysical Research: Atmospheres. 92 (D11): 13299–13314. Bibcode:1987JGR....9213299L. doi:10.1029/JD092iD11p13299. ^ a b Glossary, United States: NASA Earth Observatory, acid rain, archived from the original on December 13, 2011, retrieved February 15, 2013 ^ a b E. S. de Beer, ed. The Diary of John Evelyn, III, 1955 (September 19, 1667) p. 495. ^ Weathers, K. C. and Likens, G. E. (2006). "Acid rain", pp. 1549–1561 in: W. N. Rom and S. Markowitz (eds.). Environmental and Occupational Medicine. Lippincott-Raven Publ., Philadelphia. Fourth Edition, ISBN 0-7817-6299-5. ^ a b Seinfeld, John H.; Pandis, Spyros N (1998). Atmospheric Chemistry and Physics — From Air Pollution to Climate Change. John Wiley and Sons, Inc. ISBN 978-0-471-17816-3 ^ Acid Rain in New England, A Brief History Archived September 25, 2010, at the Wayback Machine. Epa.gov. Retrieved on February 9, 2013. ^ Likens, Gene E.; Bormann, F. Herbert; Johnson, Noye M. (March 1972). "Acid Rain". Environment: Science and Policy for Sustainable Development. 14 (2): 33–40. Bibcode:1972ESPSD..14b..33L. doi:10.1080/00139157.1972.9933001. ^ Brøgger, Waldemar Christofer (1881). "Note on a contaminated snowfall under the heading Mindre meddelelser (Short communications)". Naturen. 5: 47. ^ Ottar, Brynjulf (1976). Dochinger, Leon; Seliga, Thomas (eds.). "Organization of long range transport of air pollution monitoring in Europe". Water, Air, and Soil Pollution. 6 (2–4). Upper Darby, PA: USDA Forest Service: 105. Bibcode:1976WASP....6..219O. doi:10.1007/BF00182866. S2CID 97680751. Large amounts of sulfuric acid can be transported over distances up to a few thousand kilometers. ^ Odén, Svante (1968). "The Acidification of Air and Precipitation and its Consequences for the Natural Environment". Ecology Committee, Bul. 1. Nat. Sci. Res. Council of Sweden. Retrieved December 5, 2021. ^ Satake, Kenichi

enviropedia.org.uk. Archived from the original on October 22, 2021. Retrieved October 22, 2021. ^ "Talks start to form network to monitor Asia's acid rain". The Japan Times. October 26, 2000. Retrieved October 22, 2021. ^ Totsuka, Tsumugu; Sase, Hiroyuki; Shimizu, Hideyuki (2005). "Major activities of acid deposition monitoring network in East Asia (EANET) and related studies". Plant Responses to Air Pollution and Global Change: 251–259. doi:10.1007/4-431-31014-2_28. ISBN 978-4-431-31013-6. ^ "EANET National Focal Points" retrieved February 16, 2023. ^ Former Deputy Administrator Hank Habicht talks about management at EPA. An Interview with Hank Habicht Video, Transcript Archived April 12, 2019, at the Wayback Machine (see p6). December 21, 2012. ^ Clean Air Act Amendments of 1990, 42 U.S. Code 7651 Archived March 28, 2021, at the Wayback Machine Ritchie, Hannah, "What We Learned from Acid Rain: By working together, the nations of the world can solve climate change", Scientific American, vol. 330, no. 1 (January 2024), pp. 75–76. "[C]ountries will act only if they know others are willing to do the same. With acid rain, they did act collectively.... We did something similar to restore Earth's protective ozone layer.... [T]he cost of technology really matters.... In the past decade the price of solar energy has fallen by more than 90 percent and that of wind energy by more than 70 percent. Battery costs have tumbled by 98 percent since 1990, bringing the price of electric cars down with them....[T]he stance of elected officials matters more than their party affiliation.... Change can happen – but not on its own. We need to drive it." (p. 76.) Wikimedia Commons has media related to Acid rain. National Acid Precipitation Assessment Program Report – a 98-page report to Congress (2005) Acid rain for schools Acid rain for schools – Hubbard Brook United States Environmental Protection Agency – New England Acid Rain Program (superficial) Acid Rain (more depth than ref. above) U.S. Geological Survey – What is acid rain? Acid Rain: A Continuing National Tragedy – a report from The Adirondack Council on acid rain in the Adirondack region (1998) What Happens to Acid Rain? Acid Rain and how it affects fish and other aquatic organisms Fourth Report for Policy Makers (RPM4): Towards Clean Air for Sustainable Future in East Asia through Collaborative Activities- a report for policy-makers, Acid Deposition Monitoring Network in East Asia, EANET, (2019). Retrieved from " Enjoy sharper detail, more accurate color, lifelike lighting, believable backgrounds, and more with our new model update. Your generated images will be more polished than ever.See What's NewExplore how consumers want to see climate stories told today, and what that means for your visuals.Download Our Latest VisualGPS ReportData-backed trends. Generative AI demos. Answers to your usage rights questions. Our original video podcast covers it all—now on demand.Watch NowEnjoy sharper detail, more accurate color, lifelike lighting, believable backgrounds, and more with our new model update. Your generated images will be more polished than ever.See What's NewExplore how consumers want to see climate stories told today, and what that means for your visuals.Download Our Latest VisualGPS ReportData-backed trends. Generative AI demos. Answers to your usage rights questions. Our original video podcast covers it all—now on demand.Watch NowEnjoy sharper detail, more accurate color, lifelike lighting, believable backgrounds, and more with our new model update. Your generated images will be more polished than ever.See What's NewExplore how consumers want to see climate stories told today, and what that means for your visuals.Download Our Latest VisualGPS ReportData-backed trends. Generative AI demos. Answers to your usage rights questions. Our original video podcast covers it all—now on demand.Watch Now ReviewsThis product has not yet been rated. What is acid rain?Acid Rain is a term used to describe the phenomena of rainfall that contains lower than normal readings of pH due to inputs of sulfur dioxide and nitrogen oxide compounds into the atmosphere. These compounds come from power plants and other industries that burn fossil fuels for energy. Scientists are concerned about acid rain and its impact on the environment. For this lesson we will focus specifically on the affects of acid rain on lakes and aquatic life although acid rain's impacts are much broader. How Acidic is Rain in New York State?A pH scale is used to measure acidity, with 0 being the most acidic and 14 the most alkaline. A value of 7 is neutral. Solutions with a pH of less than 7 are acids, while those with a pH greater than 7 are bases. A decrease in pH represents an increase in acidity, and an increase in pH represents a decrease in acidity. The scale also is logarithmic, meaning that a one-unit change actually represents a tenfold change. Rainfall is somewhat acidic by nature, due to atmospheric carbon dioxide (gas) reacting with precipitation (rain drops) to make carbonic acid, a weak acid. The acidity of rainfall is critical for the weathering of rocks and formation of soils on land. Without it there would not be the needed minerals and nutrients in soils to grow plants. However, acid rain is intensifying this weathering process and can have negative impacts on the landscape and surface waters where transported ions and sediments end up. While normal rainfall is slightly acidic (about 5.5) the average pH of rainfall in New York State ranges from 4.0 to 4.5 - 30 times more acidic than "normal". Below is a graph that illustrates the acid rain cycle. Acid Rain and the EnvironmentWhen acid rain falls to the earth it interacts with landscape features which affects how it will impact the environment. Much of the research on the detrimental effects of acid rain has been conducted in the Adirondack region of New York State where the igneous/metamorphic bedrock in this region and the thin, slightly acidic soils lack the ability to neutralize the inputs from acid rain. In the Finger Lakes region however, calcareous soils and limestone outcrops which contain Ca CO 3 (calcium carbonate) are dominant in the landscape and provide a "buffer" against acid rain. Source: Lajewski, C. K. et. al. Geological Society Bulletin 2003. Below are links to bedrock maps of the regions discussed: Finger LakesAdirondacks Acid rain has many negative impacts on the environment. Acid rain can alter the pH of surface water such as lakes and streams stressing aquatic life that is adapted to certain pH levels. Acid rain also can erode to concrete buildings and monuments. And the particles in acid rain can contribute to health problems for people with respiratory illness like asthma or bronchitis. Below are links that provide some good background information about water quality and pH and the impacts of acid rain. You may ask students to do some of their own research as well. Glossary of TermspH and Water QualityWhat is Acid Rain?Acid Rain Impacts on the Environment Lesson Outcomes Through this lesson and accompanying activity students will: Understand the dynamics of acid rain and its impact on the living and non-living environment. Hypothesize how acid rain affects water pH levels in two lake systems with differing watershed features. Learn to make scatter plot charts of data sets using MS Excel computer software. Analyze trends in charts. Interpret data from charts and table. MST Standards Standard 1 Key 1, Key 3 Standard 2 Key 1 Standard 4 Key 2, Key 6 Standard 5 Key 3, Key 6 Lesson Objectives In this lesson you will be investigating the relationship between acid rain and pH levels in two lakes: Morehouse Lake in the Adirondacks and Seneca Lake in the Finger Lakes. To do this you will be using data on pH levels collected from both lakes for the years 1993-2007 and making two charts. You will be using these charts along with the charts provided in the lesson to answer the questions A-E. Although the charts will help you to answer some of the questions you will need to refer to the website links found at the bottom of the page for further information. At the end of this lesson you should have completed: Two charts: Avg pH in Morehouse Lake; Avg pH Seneca Lake Answered questions A-E using your generated charts, the charts and table provided and the website links as references. Activity In this activity you will make two charts showing a line graph of the average pH concentrations in the surface waters of a lake in the Adirondacks - Morehouse Lake, and for a lake in the Finger Lakes region - Seneca Lake, for the years 1993-2007. Follow the steps below to complete the activity. Step 1) Copy and paste to copy the data sets (including the headers) shown here into an Excel file. Data Morehouse and Seneca lakes data Activity for Users of Excel Before 2007 Activity for Users of Excel Version 2007 The two charts that students generate should look like this: Answer the questions below. Additional information can be found at the websites listed. A. What is the general trend of the pH levels in the lakes over the past ten years?The general trend has been for the pH levels to increase. The magnitude of these increases may not seem apparent to the students when they view the charts and see only a unit increase in pH levels from one year to the next. Remind students however that the increase in pH from one unit to the next is logarithmic or exponential. The articles emphasize that scientists are claiming the increase in pH levels are apparent but may not keep going up if there are not more restrictions placed on emissions from power plants and vehicles. B. How would you explain this trend?The increase in pH values over the past ten years has been linked to the Amendments to the Clean Air Act of 1990. Although scientists agree that the 1990 Amendments have helped reduce the impacts of sulfur dioxide emissions, they are unclear whether the Amendments have had as great an impact on Nitrogen Oxide emissions. Scientists from Syracuse University and the University of Maine caution that further reductions in emissions may be needed to bring the lakes in the Northeast back to health. C. Which lake system has a greater potential to buffer the effects of acid rain and why?Recent research conducted by scientists from Syracuse University has shown that the soils and underlying bedrock in the Finger Lakes region buffer the effects of acid rain and actually contribute to an "alkalization" of the lakes. Scientists call this phenomena a "chemical weathering" of the bedrock in the region which increased rapidly in the 1820s when the region was deforested, leveling off and then beginning again after World War II and into the 1990s. See links below for the actual study and the a synthesis of the study for the student handout. Lajewski Study of Finger Lakes and Acid RainAcid Rain in the Finger LakesAcid Rain in the Adirondacks D. Charts A & B show the annual average pH of rainfall at a monitoring site in Huntington NY (Adirondacks) and Aurora NY (Finger Lakes) over the past ten years. What trend do you see in these charts? For each region acid rain precipitation shows an increase in pH levels. Explain the possible reasons for this trend. The reductions of sulfur emissions due to the Clean Air Act Amendments of 1990 which reduced the amount of sulfur dioxide into the atmosphere reducing the amount of sulfur in acid rain. Are there differences or similarities between acid precipitation in the Adirondacks and the Finger Lakes? The data show the most obvious upward trends for both regions. In the 1990's the pH levels of the acid rain were actually lower in the Finger Lakes region than in the Adirondacks. Students are then asked to observe why then would we see lower pH levels in Morehouse Lake in the Adirondacks vs. Seneca Lake during this period of time? Using the charts you just generated on Morehouse and Seneca Lakes explain how acid rain precipitation in both regions impacts pH levels in the lakes. As the pH levels in the acid precipitation have increased for both regions, the pH levels in the lakes reflect this trend with higher pH levels in the surface waters. Why are there differences in how the acid rain precipitation affects the pH levels in Morehouse Lake vs. Seneca Lake? When acid precipitation falls in the Adirondacks the soils and bedrock lack the ability to buffer the effects of the acids. Morehouse Lake is also more acidic to begin with so the pH levels have remained acidic. However, in the Finger Lakes region the limestone bedrock and calcareous soils are able to buffer the effects of acid rain by the chemical weathering of calcium carbonate and the pH levels of the lake have remained basic. During the years 1993-1999 what would the health level of aquatic life have been in Morehouse Lake and how would this have affected aquatic life found in the lake? 1993-1999 were critical years for Morehouse Lake as pH levels dipped to 4.0 at one point before going back up to 6.0. The health level of the lake was at an all time low of 4 where insects and frogs and some fish may have been affected. Fish eggs would not have hatched. How does the health level of Seneca Lake compare to Morehouse Lake? Seneca Lake pH levels were at or slightly above 8.0 during this time period so the health level of the lake would have been 7 or optimal. Species of fish and other aquatic life would not be affected by the pH levels. E. Using the charts you made on pH levels in Seneca Lake and Morehouse Lake and the table below answer the following questions about the health of the water body if pH is the only factor. pH and Effect on Aquatic Organisms Health Level pH Effect Unlikely that fish can survive for more than a few hours in this range. Known to be lethal to salmon species. All fish, most frogs, and insects are absent. Mayfly and many other insects absent. Most fish eggs will not hatch. Bottom dwelling bacteria (decomposers) begin to die. Leaf litter and detritus begin to accumulate, locking up essential nutrients and interrupting chemical cycling. Plankton begin to disappear. Snails and clams absent. Mats of fungi begin to replace bacteria in the substrate. Metals (aluminum, lead) normally trapped in sediments are released in the acidified water, which are toxic to aquatic life. Freshwater shrimp absent. Unlikely to be directly harmful to fish. Optimal range for most organisms. Unlikely to be directly harmful to fish. Indirect effects could occur due to chemical changes of the water. Likely to be harmful to salmon species and perch if level persists. Rapidly lethal to salmon species. Prolonged exposure is lethal to species such as carp and perch. Lethal to all species of fish. Source: Center for Earth and Environmental Science at Indiana University - Purdue University Indianapolis. Bonus Question:Hypothesize and explain two factors that may cause a body of water to change pH.pH levels are also affected by photosynthesis and respiration of plant life in the lakes. During photosynthesis plants take up CO_2 which causes the pH levels to increase,at night when plants are respiring the pH levels will naturally decrease as CO_2 is released. Episodic acidification is also possible when there is a sudden snow melt or rainfall releasing acidic pollutants into watersheds. Other factors that will affect pH are the release of chemicals from industrial pollution and vehicle emissions.