High School Environmental Science Dieckman

4TH QUARTER CURRICULUM PACKET

Hayward Community School District
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#HurricaneStrong

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Google Classroom Code: 32tsy35

This is the packet that we will be doing for the 4th Quarter. We will cover the rest of our Water Unit and then go into Population Dynamics. We will do a quick recap on our Water Unit and I will up load videos of me explaining notes and labs on Google Classroom.

I am giving you all my contact information that I frequently check throughout my day. USE IT APPROPRIATELY!!! Like I always say in class, "It is literally my job to help all of you. Please ask questions."

To turn these assignments in, the easiest way is to take a picture of your work and send it to me. If that won't work please let me know and we will figure something out.

I hope all of you are staying safe and healthy!! We will get through this together!

Mr. Dieckman

April 2020

Mon	Tue	Wed	Thu	Fri
20 Watch You Tube Video: https://youtu.be/b52daa8oyBk	**21** FLOW Worksheet In Packet	**22** Clean Water Act Watch video (Google Classroom)	**23** Read Handout Clean Water Worksheet	**24** Watch Earth's Materials :Minerals, Rocks, Soil and Water video (Google Classroom) Worksheet #1
27 Watch Global Mineral Reserves:Sustainablility, Economic Implications and Environmental Effects Video (Google Classroom) Follow along with handout. WS #2 Five Questions	**28** Watch Mining Laws Regulations and Treaties Video (Google Classroom) WS #3 Mining Laws (in packet)	**29** Do short answer WS#4 Mining Laws	**30** Mining in Wisconsin Due Monday 5/6 Write an informative essay on the history of mining in Northern Wisconsin. Your essay must be at least 500 Words. You do not need to cite your sources.	

May 2019

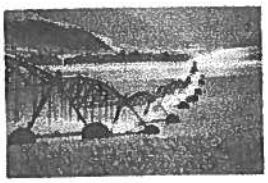
Mon	Tue	Wed	Thu	Fri
		1 Mining in Wisconsin Continue working on paper. Due Monday 5/6	2 Mining in Wisconsin Continue working on paper. Due Monday 5/6	3 Mining in Wisconsin Continue working on paper. Due Monday 5/6
6 Watch Population Ecology Video (Google Classroom) Follow along with handout (in packet)	7 Watch "White Wolf" (national geographic) first half of video with video guide https://www.youtube.com/watch?v=1lPqRY8pn3Q	8 Watch "White Wolf" (national geographic) second half of video with video guide/worksheet https://www.youtube.com/watch?v=1lPqRY8pn3Q	9 Other influences besides predator/prey Read Wolf and Moose Project overview (in packet) or view:http://www.isleroyalewolf.org/overview/overview/at_a_glance.html	10 Read most recent study of Wolf/Moose Report(in packet) Begin WS#5 Wolf and Moose Isle Royale
13 Continue WS#5 Wolf and Moose Isle Royale Start Graphing Exercise	14 Complete Graphing Exercise	15 Introduction to Exponential Growth Watch Video Exponential Growth (Google Classroom) Follow along with handout (all in packet) Complete WS#6 Exponential Growth Definition and Examples	16 Logistic Population Growth:Equation, Definition and Graph Watch Video(Google Classroom) Complete WS#7 while watching video (in packet)	17 Complete WS#8 Logistic Population (in packet)
20 African Lions Modeling Populations (Exponential vs. logistic growth activity) https://smartgraphs-activities.concord.org/activities/225-african-lions-modeling-populations/student_preview/	21 Notes on population-growth rate, doubling time practice. Discuss J-curve exponential vs. S surve logistic growth referring back to African Lion study	22 Watch Human Population Video (Google Classroom) Complete WS # 9 (In packet)	23 Complete WS #!0 Human Population (in packet) Look over Population Growth Handout (in packet)	24 Watch video Human Population Growth and Carrying Capicity (Google Classroom) Fill in the blank while watching WS#11 History of Human Population (in packet)

May 2019

Mon	Tue	Wed	Thu	Fri
27 MEMORIAL DAY	**28** Watch video. **Don't Panic – The truth about world population** https://www.youtube.com/watch?v=-UbmG8gtBPM&ebc=ANyPxKpJdHHLpB7ajm7RxeAVOTNV6kQMtCpxPRbibL4JvJcR2bm3xQn2Jtn-AVRQ81P60aN6m2gSpM_6mlY_TuTYk-gTIH5fwA	**29** **Don't Panic – The truth about world population** https://www.youtube.com/watch?v=-UbmG8gtBPM&ebc=ANyPxKpJdHHLpB7ajm7RxeAVOTNV6kQMtCpxPRbibL4JvJcR2bm3xQn2Jtn-AVRQ81P60aN6m2gSpM_6mlY_TuTYk-gTIH5fwA	**30** **Don't Panic – The truth about world population** https://www.youtube.com/watch?v=-UbmG8gtBPM&ebc=ANyPxKpJdHHLpB7ajm7RxeAVOTNV6kQMtCpxPRbibL4JvJcR2bm3xQn2Jtn-AVRQ81P60aN6m2gSpM_6mlY_TuTYk-gTIH5fwA	**31** Follow up on Video

Sustainable Future

Water: Human Use and Issues



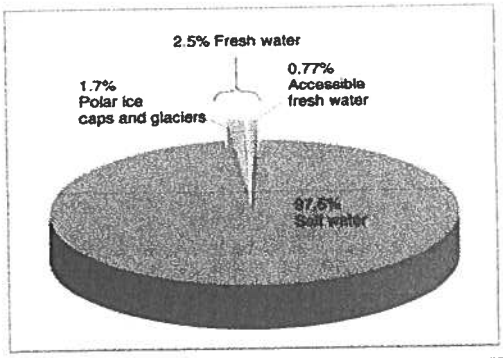
1

Water: Hydrologic Cycle and Human Use

- Water: a vital resource
- Hydrologic cycle: natural cycle, human impacts
- Water: a resource to manage, a threat to control
- Water stewardship: public-policy challenges

2

Water: A Vital Resource



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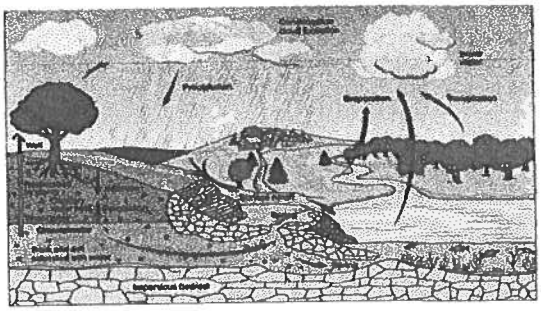
The Water Cycle

Animation #1 Animation #2



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Human Impacts on the Water Cycle

- Changing the Earth's surface
- Floods
- Climate change
- Atmospheric pollution
- Withdrawing water supplies

5

Regulating water as a common resource

- Clean Water Act
- National Pollutant Discharge Elimination System (NPDES)
- Compliance Monitoring

6

Issue: Human Development and Industrial Practices

- Mining (see article on Taconite Mining in Lake Superior Penokee Range, WI)
  - Concerns for landscape changes that would increase runoff
  - Contamination of groundwater supplies from tailings basins (from metals and minerals that have been exposed and mixed with waste rock – rock not being mined for)
  - Runoff contamination of surface waters from mining operations

7

Point Source Pollution

- Pollution from a known source
- An example would be the sewage draining into the local waters in the area of Bolivia shown in FLOW documentary
- Regulated in the US by The Clean Water Act

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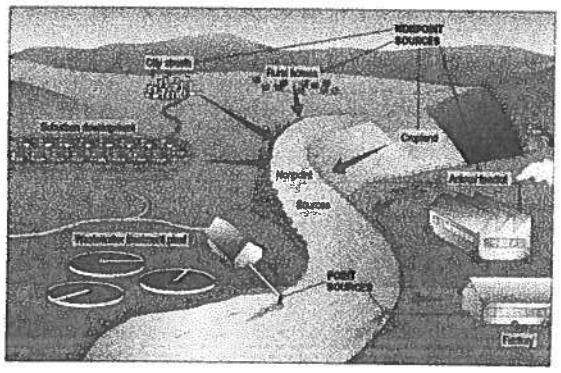

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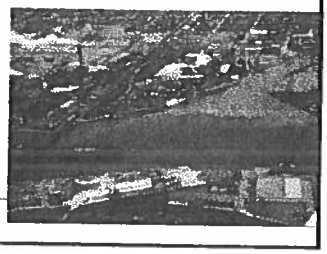
Non-point source pollution

- pollution with many sources for a combined effect
- (another example – chemical emissions from many cars)

The East River flows into theFox River in downtown Green Bay. Note the heavy load of muddy sediment and other pollutants carried by the East River currents.



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A Local Runoff Concern

- Bayfield CAFO proposal and its potential impacts
- (see "Farms not Factories" posting in Sustainability section on Moodle page)

11

Action Steps: Runoff Control Measures

- **Runoff Strategies**
- **(link to descriptions of possible action steps)**

12

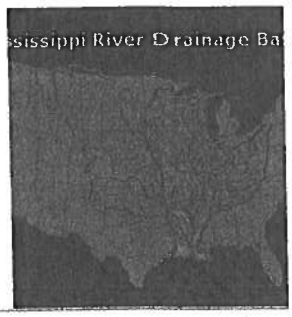
Post construction runoff control

13

Dead Zones

Mississippi River drainage basin

- Gulf of Mexico Dead Zone



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Action Steps:

- Managing Runoff

MN 50 foot buffer law
(See Buffer Map link on web page)

Public policy changes, permitting of CAFOs, farming policies, industrial oversight and regulation enforcement

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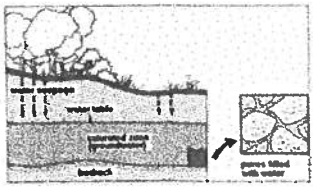
The Issue: Groundwater Impacts

- Groundwater: water beneath the earth's surface, often between saturated soil and rock, that supplies wells and springs



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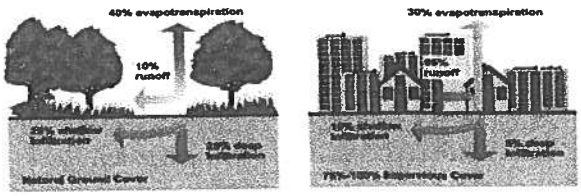
Groundwater Infiltration (recharge)

- Animation
- Soil particle size influences the rate of water infiltration into the groundwater supply and therefore the amount of runoff
- The slope of the landscape also influences the recharge rate/runoff level

17

Groundwater Recharge Issues

Impermeable surfaces do not allow water to filter into the ground to resupply groundwater. As water is pumped, it is not being recharged by precipitation to replenish usage.



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Groundwater Use and Contamination

Groundwater is being pumped out by large wells faster than it is being replenished by precipitation causing lakes and streams that are groundwater fed to go dry

Central Sands Region of WI

Animation of groundwater resupply and well pumping effects

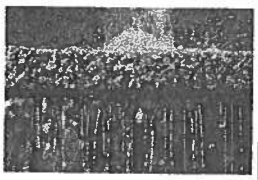
19

Groundwater Use and Contamination

- **Chemicals contamination (pesticides, oil spills, mining operations, industrial leaks/illegal dumping) of groundwater supply**
- **Contamination Animation**

20

Action Steps to help groundwater levels



- Pave less and when paving, use permeable pavement options
- Regulate pumping used for private industry/farming (Ex. Regulating the irrigation of farms or bottled water companies like Nestle)

21

The Issue: Dams

- Video of World Dams since 1800

22

Dams: Disrupt Integrity of River System

- Above the dam
  - Flooding (including residential/cultural areas)
  - Sediment and nutrient deposition
  - Loss of functional floodplain
- Below the dam
  - Loss of normal river flow patterns (changes distribution of nutrient flow through ecosystems)
  - Loss of river biota (temperature changes, spawning patterns, ecosystem flooding)
  - Loss of functional floodplain

23

Local Example

- The Chippewa Flowage

(See the Preface and Chapter 1 Intro)

-See the Moodle Page post for a map of the Flowage (in Resource Management section)

GLIFWC Manoomin (Wild Rice) Presentation

Chippewa Flowage History

24

Impacts around the world

12 dams that changed the world

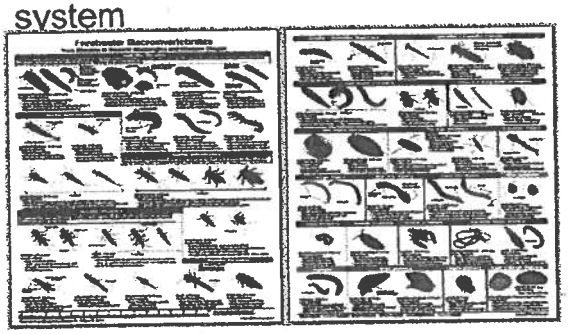
25

Action steps

- Many dams are being taken out as their original purposes have become obsolete
- Consideration should be made into other small scale actions steps that can provide water (local wells, collection sites, rainwater collection systems, etc.) prior to dam development

26

aquatic invertebrate – animals that indicate the health of the water system



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group I

- pollution sensitive organizations found in good quality water

28

group II :indicate fair water quality and are somewhat pollution tolerant

29

group III

- are pollution tolerant, considered indicators of poor water conditions (can be found in all qualities of water)

30

Watch The Lorax (1972) Movie on Google Classroom

Student Worksheet

The Lorax

Name _____ Date _____

1. Did you like the story? Why or why not?

2. What is the message of the story?

3. Why did the Once-ler cut down the Truffula trees?

4. What happens to the Once-ler when there are no more Truffula trees?

5. What happens to the Lorax?

6. Is bigger always better? Give an example to back up your opinion.

7. **A "Thneed" is defined as a thing that everyone thinks they need. What are some examples of thneeds - things that you think you need?**

8. **If you were the Once-ler, what would you have done differently to protect the environment?**

9. **What do YOU think the Lorax's message "Unless" means?**

10. **What can you do to help preserve natural resources?**

11. **The Lorax spoke for trees "for trees have no tongues." What would you choose to speak for, and what would you say?**

12. **Identify and research real-life examples of the following items in the story:**
Swomee-Swans, Truffula Trees, Brown Bar-ba-loots, Humming Fish, Thneeds.

13. Write a conclusion..."What happened next?"

Flow Questions

1. How many people die each year from water born diseases? _____

2. What percentage of water are we? _____

3. How many people might get sick each year from tap water? _____

4. What are we not removing from the water? _____

5. How many human made chemicals are there? _____

6. What percentage of water is used for agriculture? _____

7. What is the most common pesticide in the U.S.? _____

8. Where has this chemical been banned? _____

9. How many pounds are used yearly? _____

10. How is water being delivered in some parts of the world? _____

11. How many children in Bolivia die before the age of 5? _____

12. What are we trying to do before 2015? _____

13. How much would 10L a day per year cost? _____

14. California has how many years of water? _____

FLOW

15. What rivers don't flow to the sea? _____

16. Is bottled water safer then tap water? _____

17. How much money is spent each year on bottled water? _____

18. How much a year do we need to spend to have safe drinking water for the entire planet? _____

19. Society once lived on the resources we had. What replaced that idea? _____

20. What is the global impact of a water reservoir? _____

21. How many people were displaced in the 20th century due to dams? _____

22. How much does Nestle pump out of streams a minute in Michigan? _____

23. How much did they pay for the land for 99 years? _____

24. What did Coca Cola distribute free to communities? What was it? _____

25. What are the true solutions to the water problems?

_____

_____

_____

_____

DNR RESPONSE TO COVID-19: For details on adjustments to DNR services, visit this webpage (https://www.dnr.state.mn.us/covid-19.html). For information on the state's response, visit the Department of Health website (https://www.health.state.mn.us/diseases/coronavirus/index.html).

(/index.html)

Search for...

Home (/index.html) > Ecological and Water Resources (/ewr/index.html) > Water Management (/waters/watermgmt_section/index.html) >

Buffer Mapping Project

Minnesota's Buffer Protection Map

Minnesota's buffer law establishes new perennial vegetation buffers of up to 50 feet along rivers, streams and ditches that will help filter out phosphorus, nitrogen and sediment. The law provides flexibility and financial support for landowners to install and maintain buffers.

The DNR's role in Minnesota's buffer law is to produce and maintain a map of public waters and public ditch systems that require permanent vegetation buffers. The DNR released the buffer protection map in July 2016. The map is helping to guide the implementation of Minnesota's buffer law by landowners, with the help of the Board of Water and Soil Resources (BWSR), Soil and Water Conservation Districts (SWCDs), Drainage Authorities and other local governments.

Buffer Map (http://arcgis.dnr.state.mn.us/gis/buffersviewer/)

Statewide Data Layer (https://gisdata.mn.gov/dataset/env-buffer-protection-mn)

How was the map made?

With the help of a wide range of professionals inside and outside the agency, the DNR combined existing public water inventory data, shoreland classification data and public ditch data to produce the map. The DNR used an extensive public and professional review process to produce the map.

How is buffer protection map being used?

The map is now being used for implementation. It helps landowners determine where buffers or alternative water quality practices are required and what buffer widths are required.

- The map labels **public ditches** as requiring a 16.5-foot buffer (local ordinances may require wider buffers).
- The map labels **public waters** as requiring a 50-foot average buffer (local ordinances may require wider buffers).
- The map also labels a few sites as "needing field review." The DNR is organizing on-site verification of these

public water features and will change this temporary label as they are verified.
- The DNR excluded some public water wetlands from the map.

Local SWCDs are working with landowners to create the right size buffer or select an alternative water quality practice. If the SWCDs, Drainage Authorities or other local governments identify errors in the map during landowner conversations, they notify the DNR. The DNR is making corrections where appropriate and will maintain an accurate map. The DNR last updated the buffer protection map in August 2017.

The DNR wants to thank all the individuals and organizations that helped us produce the map, with special thanks to those landowners and organizations that are going beyond the minimum buffer requirement to protect one of our most important natural resources: water.

Additional Resources

Guidance on Buffer and Shoreland Ordinances

Guidance on model ordinance language developed by BWSR and DNR is available on the Shoreland Management Program (/waters/watermgmt_section/shoreland/index.html) page.

Board of Water and Soil Resources

2015 Buffer Legislation (http://www.bwsr.state.mn.us/buffers/) provides information on implementation of the buffer law.

Soil and Water Conservation Districts

To suggest a correction to the buffer map, contact your local Soil and Water Conservation District (http://www.maswcd.org/SWCDs_On_The_Web/swcds_on_the_web.htm). SWCDs are able to work directly with landowners on these issues.

Common Buffer Questions

Click on questions below to show answers. Click again to hide.

+ What are Public Waters?

+ How are Public Waters mapped?

+ Why aren't all wetlands shown on the buffer map?

+ Does the clarification bill make it clear that private ditches are exempt from the new buffer law?

Landowner Questions

+ What are public waters and how were they designated?

+ How are changes made to the Public Waters Inventory?

+ I understand buffer requirements on the map, but I want technical assistance about buffer requirements on my land.

+ I am uncertain whether my waterway requires a buffer when viewing the map.

+ I have a question about a public ditch designation on the map.

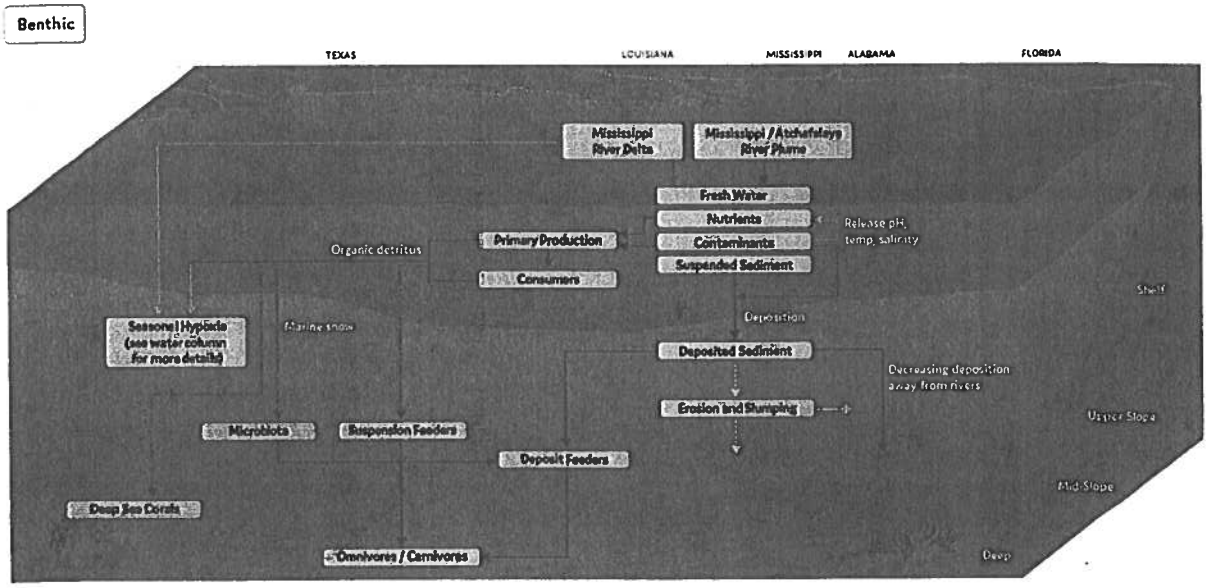
+ I believe the public ditch going through my land should require a 16.5-foot buffer and not a 50-foot buffer.

+ I (or a previous landowner) placed tile in the bed of the public watercourse, so a buffer should not be required.

+ The public drainage system on my land has been tiled where the public water used to be, so a

EXPLAINING THE GULF OF MEXICO DEAD ZONE

Every summer, a low-oxygen area, often referred to as a Dead Zone, develops off of the Texas-Louisiana shelf when nutrient-laden fresh water from the Mississippi and Atchafalaya Rivers flows into the Gulf of Mexico. While it seems contradictory, nutrients brought in from the river that fuel the region's plant, wildlife and fisheries productivity are the same nutrients that contribute to the formation of a low-oxygen area along parts of the Gulf's seafloor. Mobile fish and marine mammals are able to swim away from the low oxygen area, but weaker swimming organisms can be trapped and die, leaving behind a barren area that would typically be teeming with life.



WHAT CAUSES THE DEAD ZONE?

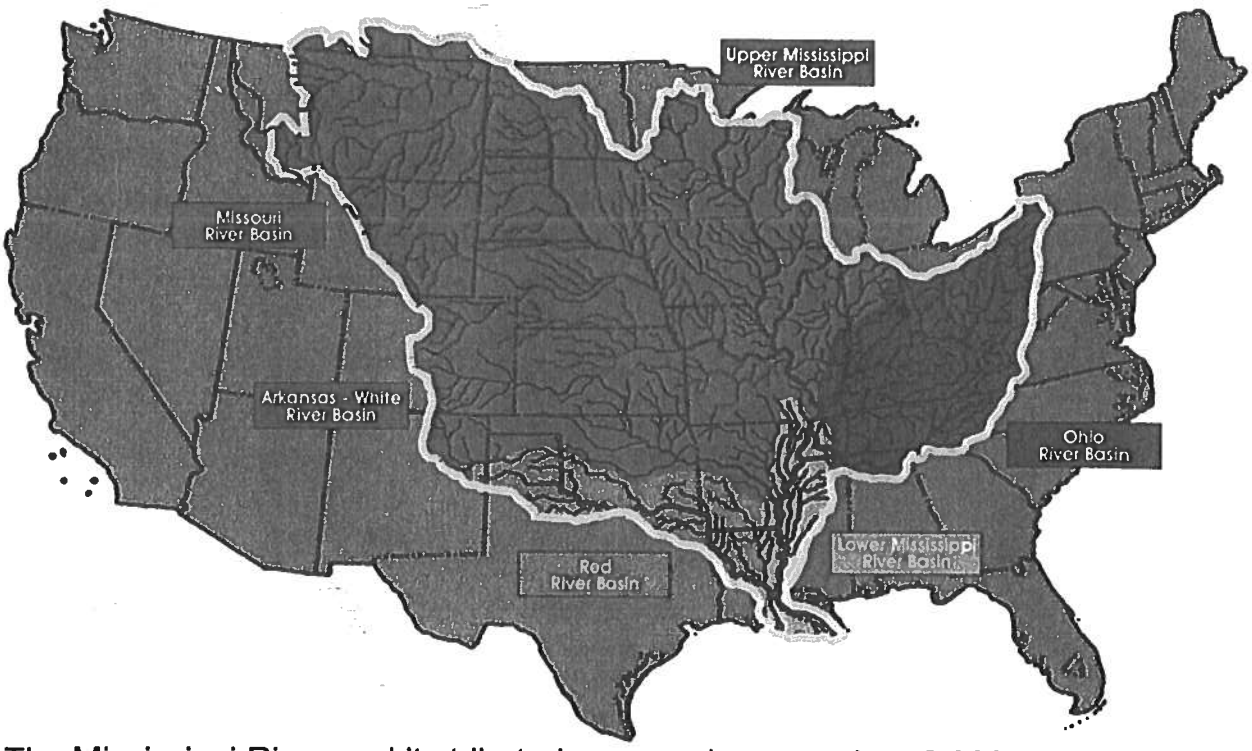
The Dead Zone develops, somewhat ironically, as a result of the nutrients that fuel the high productivity in the Gulf's surface waters. As dead plant material falls from the surface through the water column deeper into the Gulf, bacteria consume it using oxygen. This lack of oxygen creates the Dead Zone in bottom waters on the Texas-Louisiana shelf throughout warm summer months. This

occurs when there are fewer storms and strong winds to mix the warm, oxygenated surface waters and the cooler, deeper waters. At other times during the year, winds, weather fronts and storms in the area mix the water, replenishing the oxygen used by the bacteria in the deeper water.

WHAT IMPACTS DOES THE DEAD ZONE HAVE?

The size of the Dead Zone generally depends on the quantity of fresh water and nutrients entering the Gulf of Mexico from the Mississippi and Atchafalaya Rivers. This year, the river was in flood stage for more than 240 days at Red River Landing, an unprecedented length of time. Results released from the annual cruise, led by Louisiana State University scientists found the Dead Zone was nearly 7,000 square miles – the 8th largest ever measured. Non-swimming and weak-swimming animals can die if they are trapped in the low-oxygen area. For fish and marine mammals, the Dead Zone can cause them to move away into deep waters.

WHERE DO THE NUTRIENTS COME FROM?



The Mississippi River and its tributaries meander more than 2,000 miles through parts of 32 U.S. states, collecting the sediment, fresh water and nutrients from the one-million-square-mile drainage basin, bringing them south to Louisiana and the Gulf of Mexico. Sediment, fresh water and nutrients can all be good things, but too much of a good thing can have unwanted consequences.

Nutrients, such as nitrogen and phosphorous, are essential for an abundant food supply, but crops take up on average just 40% of the nitrogen that is applied each season. The excess can run off into waterways, leading to a high nutrient load in the Mississippi River. Many efforts are underway throughout the Corn Belt to improve fertilizer efficiency and increase adoption of practices like cover crops and buffer strips that protect water quality.

HOW CAN WE HELP REDUCE THE DEAD ZONE?

Reducing nutrient input is important for reducing the size of the Dead Zone. For example, Louisiana has a nutrient reduction strategy that includes using river diversions. River diversions are restoration projects designed to build and sustain Louisiana's coastal wetlands. These wetlands can also help filter and remove nutrients from the river, fueling wetland plant growth while also reducing nutrients that cause the Gulf of Mexico Dead Zone.

Reducing nutrient input in the Mississippi River itself is critical to reducing the size of the Dead Zone in the Gulf, but Louisiana alone didn't create the problem and Louisiana alone can't solve it. While most Restore the Mississippi River Delta efforts focus on coastal restoration here in Louisiana, our individual organizations also work throughout the Mississippi River Basin to improve the management of the Mississippi River system.

We all work to defend the Clean Water Act. The best way to improve water quality is to prevent pollution at its source, which is much cheaper than trying to remove pollution downstream. We are working to protect and defend the Clean Water Act (CWA) against various attacks and attempts to remove clean water safeguards that have protected our nation's wetlands and streams since the 1970s.

Here are some other examples of some of the work some organizations are doing for the health of the entire Mississippi River Basin.

National Wildlife Federation:

The National Wildlife Federation is working to minimize impacts on water quality of the excess fertilizer we send downriver can be mitigated before the water reaches the Gulf. Agricultural practices such as planting cover crops and preventing drainage from farm fields into the river can reduce the load of fertilizer at its source. Broad floodplains filled with wetlands can filter nutrients in the river water before it reaches the Gulf. The river that was cut off from its floodplain by

levees for flood control and channels for navigation can be reconnected via controlled diversions of water and sediment.

- **WORKING WITH FARMERS:** We work with farmers and landowners upriver to promote responsible conservation practices, like planting cover crops and protecting prairie potholes and other marginal farmland important to wildlife, all of which protects acres that help absorb excess fertilizer bound for the Gulf.
- **MAINTAINING CONNECTIONS BETWEEN RIVERS AND FLOOD PLAINS:** We work to prevent the construction, with tax dollars, of Corps of Engineers water projects that sever yet more of the connections between the river and its floodplain, destroying wetlands that absorb fertilizer and replacing them with farms and developments that increase fertilizer run-ff. One example is a scheme to drain wetlands in the **New Madrid Floodway** one of the last connections between the river and its floodplain, providing important fish and wildlife habitat and critical flood protection.

Environmental Defense Fund:

The Environmental Defense Fund is working with farmers to adopt practices that reduce fertilizer runoff, including partnering with the **National Corn Growers Association** to improve environmental outcomes while optimizing productivity and profitability. **EDF scientists discovered** that – with a combination of efficient fertilizer practices, cover crops and restoring wetlands and other natural infrastructure across the Corn Belt to trap and treat nitrogen lost from farms – we can reach the Environmental Protection Agency's goal of shrinking the Gulf of Mexico's dead zone to a safe level.

These findings, along with **parallel research** highlighting the primary reasons for nitrogen losses in the Corn Belt, are helping inform policy and target agricultural funding where it is needed most. EDF has also:

- Worked with farmers and their advisors to establish farmer networks that conduct real-world testing of fertilizer applications on farms.
- Helped farmers share the results to determine best practices for delivering the highest yield with the greatest conservation benefits.
- Helped reduce fertilizer loss by an average of 25% on 750,000 acres across the U.S. while maintaining or increasing crop yields.

Now, EDF and partners have used this knowledge to create a **Farmer Network Manual** for agricultural practitioners interested in conducting their own on-farm research.

National Audubon Society:

The National Audubon Society conservation program works through science, education, advocacy and on-the-ground conservation to ensure that birds and people have a healthy environment to live and thrive. Audubon's water strategy works to enhance water quality and quantity while our coastal strategy promotes restoration of coastal habitat like wetlands, which filter harmful contaminants from water. The combination of both strategies enhances habitat for birds and reverses harmful algal bloom events, while providing healthy drinking water for people.

- From **restoring wetlands** to advocating for state policies like Ohio's **H2Ohio** and federal programs including the **Great Lakes Restoration Initiative**, our Audubon Great Lakes office is ensuring that safe and clean water runs throughout the Mississippi River into the Gulf of Mexico.
- At the federal level, there are various programs that fund hazard mitigation and infrastructure development to protect communities from storms. Audubon's **advocating for changes** to allow these programs (such as the Federal Emergency Management Agency's Pre-Disaster Hazard Mitigation Grant Program) to fund natural infrastructure projects alone or alongside grey infrastructure (sea walls, jetties, etc.) to enhance habitat, increase the lifetime of grey infrastructure, absorb flood water, and filter contaminants from the environment.

In this lesson, you will learn about the Clean Water Act of 1972 and the Safe Drinking Water Act of 1974. You'll discover how both laws help keep our waters free of pollution and safe for everyday use.

Living with Clean Water

Try to go one day without using water for anything other than drinking and you'd have a pretty difficult time! We use water for so many things - washing dishes, doing laundry, cooking, drinking, watering houseplants, washing our cars, flushing the toilet, brushing your teeth - it all adds up pretty quickly!

If you then add up the water use for all of your friends and family, the consumption becomes even larger. Add that up for all the people in the U.S... well, you get the idea. So, with an ever-growing number of people using a finite supply of water, how do we ensure that it stays clean?

In 1970, the **Environmental Protection Agency** (or EPA) was created with environmental issues like this in mind. The EPA was designed with the idea that environmental problems are all interrelated and that an integrated approach to environmental policymaking was needed. They were charged with conducting research, monitoring environmental quality, setting standards for pollution levels, enforcing these standards, and educating the public. Much legislation has come from the EPA since it was created, and we'll discuss two of those laws here.

The Clean Water Act of 1972

By far, one of the most important laws that has come from the EPA is the **Clean Water Act of 1972**. This law made it illegal to discharge pollution from a point source without a permit, set new standards for industrial wastewater and contamination levels, and provided funding for sewage treatment plant construction. It also requires that wastewater that ends up in rivers, lakes, streams, and oceans be treated to remove toxins and bacteria. This law is the primary law that regulates water pollution in America.

The Clean Water Act is essentially a modified and expanded version of the **Federal Water Pollution Control Act of 1948**, which was the first major law that dealt with U.S. water pollution issues. The Clean Water Act was revolutionary because it directly addressed the issue of **point source pollution**, which is pollution from a discrete location, such as industrial waste, agricultural runoff, and sewage pipes. The act set forth a new national permitting system for such sources of pollution, which standardized not only the rules regarding pollution but also the enforcement of those rules.

So, how bad was pollution before the Clean Water Act? During the 1950s and '60s, pollution was rampant in the Cuyahoga River in Ohio. Oil and industrial waste had been entering the river without regulation and not only had created unsafe drinking water for local residents, but actually caught fire several times! This disaster was instrumental in inciting the public to push for new and better water pollution legislation.

The Safe Drinking Water Act of 1974

Another critical piece of legislation was the **Safe Drinking Water Act of 1974**. This law set new standards for protecting groundwater and for the safety of the public drinking water supply. It's the primary law that ensures safe drinking water in America. One of the main differences between this Act and the Clean Water Act is that it addresses groundwater; the Clean Water Act does not.

Originally, the Safe Drinking Water Act was mainly concerned with treating water that came out of the tap and into homes. However, an amendment was passed in 1996 that added additional focus on protecting water at the source. This amendment gave the law a more integrated, holistic approach.

The Safe Drinking Water Act applies to every public water system in the country (so this doesn't include private wells). This means that it not only applies to you but everyone before and after you since 1974 that has used water from a public source. It requires minimum safety standards for all of these public water systems and regulates pollutants such as bacteria, nitrates, lead, mercury, and pesticides, which can all lead to harmful effects on both people and the environment.

Lesson Summary

Disastrous situations, like the Cuyahoga River fires, inspired the public to push for stronger, better water quality legislation. Through this public urging, the government created the **Environmental Protection Agency**, which addresses environmental concerns as interrelated issues and aims to create environmental policy through an integrated approach.

It is hard to imagine that only a few decades ago, anything that went down your drain was not required to be cleaned before going back into the drinking water supply! Today, the **Clean Water Act** regulates water pollution in the U.S. by making it illegal to discharge pollution from a point source without a permit, setting new standards for industrial wastewater and contamination levels and providing funding for sewage treatment.

While the Clean Water Act addresses pollution that goes into the water, the **Safe Drinking Water Act** ensures clean drinking water in the U.S. by setting standards for protecting groundwater and for the safety of the public drinking water supply. The Safe Drinking Water Act applies to all public systems in the U.S. and regulates contaminants at both the source and the tap.

So, the next time you turn on your faucet for a drink of water, to wash your dishes, or to brush your teeth, be thankful that the Clean Water and Safe Drinking Water Acts provide clean, fresh water for you to do so!

Learning Outcomes

After you have finished with this lesson, you'll be able to:

- Describe the history and function of the Environmental Protection Agency
- Explain the regulations provided by the Clean Water Act and the Safe Drinking Water Act
- Summarize the impact of the Cuyahoga River fires

The Clean Water Act Fact Sheet

- ✓ The Clean Water Act was enacted by Congress in 1972 to address water pollution in the US.

- ✓ The Clean Water Act was passed when 60% of waterways in the US were **not** "fishable or swimmable". Today, because of the Clean Water Act, roughly 40% of waterways are not "fishable or swimmable", reflecting a 20% improvement in the quality of our waterways.

- ✓ Only three years before the passage of the Clean Water Act, the Cuyahoga River in Cleveland was so polluted that it caught fire. It is believed that sparks from a passing train ignited oil and other pollutants in the water.

- ✓ The goal of the Clean Water Act was to restore and maintain the chemical, physical, and biological integrity of the Nation's waters.

- ✓ The interim goals of the Clean Water Act were to achieve "fishable and swimmable" waters by 1983, and eliminate all discharges of pollutants into navigable waters by 1985.

- ✓ According to USEPA, "fishable and swimmable" meant that a level of water quality should be achieved "for the protection and propagation of fish, shellfish, and wildlife, and to provide for recreation in and on the water."

- ✓ The Clean Water Act was passed by the federal government; however, each state is responsible for enacting it through a Water Quality Standards Program (WQS).

- ✓ The Water Quality Standards program acts as a road map for achieving the goals of the Clean Water Act by doing three specific things: **designating uses** of each water body in the state, establishing **numeric, biological, and narrative criteria** to protect those uses, and protecting levels of good water quality in waters that already meet their designated uses.

- ✓ Possible designated uses of waters in your state include, **primary contact recreation** (swimming), **secondary contact recreation** (boating and wading), **municipal water source** (water to be treated for drinking water), and **aquatic habitat**.

- ✓ If a business, industry, or other entity wants to discharge into a waterway, it has to obtain a permit from the state. The permit should limit pollution amounts according to the **water quality criteria** established for the designated use of the waterway. For example, a waste water treatment plant would not be

allowed to discharge more than 130 colonies of *E. Coli* (a fecal coliform bacteria) per 100 milliliters of water into a stream designated for primary contact recreation.

- ✓ In the case of an interstate waterway, such as the Ohio River, a business or industry that wants to discharge into the Ohio River must obtain a permit from the state agency where its facility will be located. Then an interstate agency, such as the Ohio River Valley Water Sanitation Commission, will review the permit to ensure that it meets numeric, biological, and narrative criteria that they have established for the Ohio River.

- ✓ If a waterway is assessed and doesn't meet the water quality criteria established to protect its designated use, it is considered **impaired.**

- ✓ Each state is responsible for identifying and writing clean up plans for impaired waters.

- ✓ State and interstate agencies are required to send out **public notices** on water quality decisions, including permits or changes in water quality standards. It is **your responsibility** to make sure the Clean Water Act is enacted properly by submitting your written or oral comments on water quality decisions. Information about water quality decisions in your state can be found on your state agency's website.

  Kentucky: http://www.water.ky.gov/
  Ohio: www.**epa**.state.oh.us
  Indiana: www.in.gov/idem

The Clean Water Act & Safe Drinking Water Act: Legislation for Clean Water

Circle the correct answer:

1. The Clean Water Act of 1972:

- is the primary law that ensures safe drinking water in America.
- is the primary law that regulates water pollution in America.
- set new standards for protecting groundwater.
- set new standards for the safety of the public drinking water supply.

2. What was the significance of the Cuyahoga River fires?

- A minimum safety standard for mercury and pesticides in water was established.
- They led to a national conversation about the harsh chemicals contained in oil.
- A new focus was placed on protecting water at its source.
- They inspired the public to push for stronger water quality legislation.

3. Regulation of groundwater pollution is controlled by which of the following?

- The Pollution Prevention Act
- The Safe Drinking Water Act
- The Federal Water Pollution Control Act
- The Clean Water Act

4. The Environmental Protection Agency was designed to:

- create the Clean Water Act of 1972.
- determine the source of our tap water.
- create the Safe Drinking Water Act of 1974.
- create environmental policy through an integrated approach.

5. The issue of point source pollution was directly addressed by the _____, which was revolutionary.

- Pollution Prevention Act
- Clean Water Act
- Safe Drinking Water Act
- Federal Water Pollution Control Act

Earth's Materials:

Minerals, Rocks, Soil & Water

Fill in the blanks as you watch the video:

Although the earth is a very complex system, there are only four main components of Earth that are the building blocks of life. These components are referred to as Earth's materials and include minerals, rocks, soil and water.

What Are Earth's Materials?

The next time you take a walk, think about what you are walking on. What is the earth made of? The outermost layer of the earth is known as the crust, and this layer is responsible for the majority of life on Earth. It supports the growth of plants, the survival of animals, the structure of our land, and the development of the human civilization.

The earth's crust has four main components, which are referred to as Earth's materials. These materials include minerals, rocks, soil and water. It is the combination of these materials that makes life on Earth possible.

Minerals

Let's start with minerals and look at them in more depth. _____ are naturally occurring inorganic solids that have a crystalline structure and definite chemical composition. Minerals are referred to as naturally occurring because they are formed though natural geological processes. Minerals are non-living and have a crystalline structure, meaning the atoms that make up the mineral are arranged in an orderly, three-dimensional pattern that repeats itself. Minerals are said to have a definite composition because all minerals are made up of specific proportions of certain elements.

There are over 4,500 different minerals identified on Earth. Each has a unique combination of crystalline structure and chemical composition. Salt is an example of a mineral. If you look closely at a grain of salt, you will see that it is a solid that has a specific shape and pattern.

Rocks

Now that we know what minerals are, we can discuss rocks. _____ are defined as naturally formed aggregates of minerals or mineral-like substances. Rocks can be made up of one type of mineral, several minerals, or no minerals at all. Limestone is a rock that is comprised of the mineral calcite. Many crystals of calcite are cemented together to form the limestone. Granite is a rock that is comprised of several different

minerals, including quartz, biotite, potassium feldspar, and plagioclase feldspar. Coal is an example of a rock that isn't comprised of any minerals, but instead is made of decomposed organic matter.

Rocks are often classified by how they are formed. The three types of rocks are sedimentary, igneous, and metamorphic. _____ are formed by the accumulation of sediment that is deposited over time. _____ are formed when molten magma cools and solidifies. _____ are formed when an existing rock changes due to heat, pressure, or some other physical force.

Soil

Soil is another of Earth's materials. _____ is a mixture of decomposed organic matter and broken down rocks and minerals. The decomposed organic matter is mainly dead plant material. The broken down rocks and minerals are formed when larger rocks and minerals are made into smaller pieces due to erosion or weathering. On average, soil is made up of 45% rock and mineral pieces, 5% decomposed organic matter, and 50% pore space. The rock and mineral pieces are what plants attach their roots to in order to anchor themselves in place. The decomposed organic matter is responsible for producing nutrients for plants and increasing water retention. The pore spaces in soil are very important because they allow water and air to circulate through the soil. The water and air transport nutrients and carbon dioxide, which are essential for the growth of plants.

Water

The final component of Earth's crust is water. _____is defined as a clear, colorless, odorless, and tasteless liquid, which is comprised of hydrogen and oxygen. The earth is often called the 'Blue Planet' because the majority of its surface is covered in water. Naturally, water comes in two different forms, which are saltwater and freshwater. On Earth, 97.2% of water is considered saltwater because it has a high level of saline. The remaining 2.8% of the total volume of water on Earth is freshwater and can be used by humans and most other organisms. Of all the freshwater on Earth, most of it is stored in the form of ice. The rest is stored as groundwater, which is under the surface, and a small amount is stored as surface water, which is water in lakes, streams, and rivers. Water is a very valuable resource because every living thing needs it to survive.

Lesson Summary

Now, let's review the earth's materials, which are the main components that make up the outer crust of the earth. These four materials include minerals, rocks, soil and water.

_____ are naturally occurring inorganic solids that have a crystalline structure and definite chemical composition. _____ are naturally formed aggregates of minerals or mineral-like substances. Rocks can be made up of one type of mineral, several minerals, or no minerals at all. The three types of rocks are _____, which are formed by the accumulation of sediment that is deposited over time, _____, which are formed when molten magma cools and solidifies, and _____, which are formed when an existing rock changes due to heat, pressure, or some other physical force. _____ is a mixture of decomposed organic matter and broken down rocks and minerals. Soil also contains important pore spaces that allow water and air to circulate. The final material is _____, which is a clear, colorless, odorless, and tasteless liquid, which is comprised of hydrogen and oxygen. The majority of water on Earth is in the form of saltwater and a small amount is freshwater.

All four materials are very important alone, but together they are even more impressive. They interact with each other and the combinations of these materials are what make life on Earth possible.

Learning Outcomes

You should have the ability to do the following after watching this video lesson:

- Describe the four materials that make up Earth's outer crust
- Explain the importance of these materials
- Identify the three types of rocks

Global Mineral Reserves: Sustainability, Economic Implications, and Environmental Effects

Minerals are vital components of our everyday lives, but each mineral only exists in a finite amount on Earth. How do we find a balance between supporting economies while also protecting the environment and ensuring the use of minerals for future generations?

Mineral Reserves

Our daily lives are highly dependent on minerals, which include metals like gold and silver, but also diamonds and other gems, coal, and even oil. But while these resources are important to us, like most other things on Earth, there's only a limited amount available for our use.

Something you may hear people talk about is **mineral reserves**. These are the mineral resources that are economically reasonable to extract from the ground. It's not possible to extract all of a mineral from the earth because eventually it becomes too expensive and difficult to extract. The reserves are what we extract up to this point.

When this happens, we will likely look for an alternative mineral to replace it, but this is not really a reasonable solution because these alternatives will eventually run out as well, and then we're back to the same problem we started with. Instead, we need to consider sustainable ways to extract and use minerals. This includes thinking about both the economic and environmental effects of mining our reserves, and how we can make changes that help conserve mineral resources for the long haul.

Economic Role of Minerals

Our global mineral reserves are directly tied to local, national, and global economies. It's difficult to fully grasp just how many minerals you utilize in just one day. For example, when you drive your car, you might think of the gasoline you use to power it, but the vehicle itself is made of more than a ton of iron and steel, 240 pounds of aluminum, 50 pounds of carbon, 42 pounds of copper, and upwards of 30 other minerals, such as zinc, gold, and platinum.

Your house is also another major player in mineral use. The copper wires and pipes, stainless steel faucets, drywall, and paint are just a scant few examples of minerals that make up the place you call home. Do you play sports? A baseball bat, bicycle, and even the playing surfaces of tennis courts are made of minerals. Agricultural fertilizers that grow the food you eat also come from minerals - things like phosphate and potash.

As you can see, if we are no longer able to extract and use these minerals, it could have serious economic implications because it would affect manufacturing, production, and general living. Many jobs would be lost, and both national and international trade would suffer.

But our demand for and dependence on minerals continues to grow through an expanding human population, as well as things like medical and technological advances. Because of this, efforts are in place to lead to a better understanding of global mineral reserves and their uses, including an increase in funding for scientific research and inclusion of more scientific data and analyses.

Environmental Effects

We certainly can't talk about mineral reserves without discussing the environment. Mining itself is very physically destructive to the earth, and it also creates a lot of pollution and waste. Extracting mineral reserves produces air pollution, affects water quality through chemical runoff, contributes to acid rain, and mines themselves can leak heavy metals that are toxic to us and other organisms.

As we work our way through our global mineral reserves, it takes a greater amount of energy to extract the minerals. Water is also used in a variety of ways in mining operations, often by diverting surface water and pumping groundwater. This can reduce water quality and quantity, which affects not only local aquatic ecosystems, but also those downstream as well.

While the amount of land affected by mines is small when compared to the total amount of land on Earth, the land disruption they cause is quite substantial. In order to mine, the vegetation must be cleared, buildings, roads, and power lines need to be constructed, and of course, pits and tunnels are created to access the mineral itself. And, unfortunately, once the mine has served its purpose, the land can't really be used for anything else.

Sustainable Mining

The good news in all of this is that there are better ways to mine so that we can continue to protect both our economies and the environment. You've probably heard the term **sustainable**. It's kind of a buzzword these days, but what it means is meeting current needs without compromising the needs of future generations. Sustainable practices are applicable to many industries, and mining is no exception.

We can mine more sustainably in a number of ways - for example, by reducing both mining inputs (energy and water) and outputs (waste and pollution). We can also reduce a mine's environmental footprint by minimizing the amount of on-site destruction. Maintaining local biodiversity helps with vegetative impacts, planning mines around existing infrastructure reduces the need to construct new roads and buildings, and **biomining**, which uses microbes to extract minerals from ores, is an innovative way to mine with minimal land disruption.

Recycling is another major player in sustainable mining. By recycling minerals, such as copper and steel, we can reduce the need to extract more from the ground. This not only allows mineral reserves to last longer but also reduces the environmental impact of extraction.

Lesson Summary

Earth's minerals are of great importance to us. We depend on them throughout our daily lives in more ways than you can probably imagine. We can't extract every single bit of a mineral, but those mineral resources that are economically reasonable to extract from the ground are what we refer to as **mineral reserves**. These reserves play a vital role in local, national, and global economies as they supply us with the numerous goods we use on a regular basis.

As with most things, there's only a limited amount of each mineral on Earth. Once a mineral's reserves have been used up, we may seek alternatives, but if we're not careful, this will only lead us down the same dead-end path. Instead, we need to implement more **sustainable** mining practices, which allow us to meet current needs without compromising the needs of future generations. Reducing mining inputs and outputs, recycling minerals, and maintaining local biodiversity are just a few ways that we can help lessen the environmental impacts of mining while preserving mineral resources for future use.

Learning Outcomes

The video lesson on global mineral reserves could help you to:

- Provide the definition of mineral reserves
- Indicate some of the many uses for minerals in everyday life
- Describe the negative consequences of extracting minerals
- Note the importance of sustainable mining and convey ways to reduce the environmental effects of extracting minerals

Worksheet

Global Mineral Reserves: Sustainability, Economic Implications, and Environmental Effects

1. What are mineral reserves?

2. Which of the following statements about minerals is TRUE?

3. Which of the following is NOT a way that minerals are economically important to society?

4. How does biomining differ from more traditional forms of mining?

5. What does it mean for something to be sustainable?

Mining Laws, Regulations, and Treaties: Safety and Reclamation

Mining is big business, but mines can pose numerous hazards. Because of this, both national and international laws are in place to protect miners and the environment while still allowing the products of mining to play a role in our everyday lives.

Mining Operations

Mining is an important business locally, nationally, and globally. Mining operations all over the world create jobs and provide us with the minerals that are vital to our everyday lives. There are minerals in just about everything you come across each day - things like the components of your cell phone and computer, the gas that powers your car, and even fertilizers on agricultural crops.

But mines are both dangerous places to work and have serious implications for the environment. Because of this, there are a number of international, national, and even state regulations in place to make mines safe for workers as well as reduce the harmful effects mining can have on the environment.

Safety & Health in Mines Convention

Being a miner is dangerous work. There are safety issues concerning exposure to poisonous gases and dust, mine cave-ins, equipment problems, explosions, hearing loss from loud machinery, and heat stroke, just to name a few.

Because of this, the **International Labour Organization** (ILO), which is an agency under the UN concerned with international labor issues that promotes the rights of workers, determined a convention was needed to protect the health and safety of mine workers. The convention that was eventually adopted for this purpose was the **Safety and Health in Mines Convention of 1995**.

You may be thinking that 1995 is fairly recent for such regulations to be outlined for miners. Unfortunately, there were previous conventions that did address miner health and safety issues but did not outline enough laws that specifically dealt with these topics. And that's where the 1995 convention comes in - it directly tackled the issues that miners face, providing much more legal protection for their health and safety.

As of 2014, 29 different countries have ratified this convention, which means that they agree to follow the rules and regulations it outlines. The U.S. is one of these countries, and we signed the convention in 2001, making us the 16th country to do so. However, there was considerable overlap with the many federal laws that the U.S. already implements for mine safety. In fact, there was so much overlap that the convention did not really contribute any notable changes to our mining practices. Instead, it served as a political strategy, allowing us to put pressure on other nations by holding them accountable for their own mine workers' health and safety.

U.S. Laws - Health and Safety

In the U.S., mine safety is regulated by the **Mine Safety and Health Administration**, or MSHA, which is an agency of the U.S. Department of Labor. This agency is responsible for enforcing the regulations of the **Federal Mine Safety and Health Act of 1977**. Often just called the Mine Act, this law sets safety and health standards for miners and requires annual inspections of all U.S. mines by MSHA. It's an amended version of the **Coal Mine Safety and Health Act of 1969**, usually just called the Coal Act, which was the most comprehensive and strict federal legislation for mining at that time.

The Mine Act made some significant improvements to the Coal Act. Not only did it consolidate federal regulations for the health and safety of all mining operations (coal and non-coal), but it also provided greater protection for miners, as well as expanded their rights.

In 2006 came even stronger federal legislation, in the form of the **MINER Act**, or the Mine Improvement and New Emergency Response Act. Previously, an emergency response plan was developed after an accident occurred, which wasted both time and resources. One major change seen in the MINER Act was the requirement that mine-specific emergency response plans be developed ahead of time and are continuously updated as appropriate. The MINER Act also required emergency responders to be better trained and be more readily available to respond to mine accidents.

U.S. Laws - Reclamation

Miner health and safety is an important issue, but when we talk about mining, there's no way to ignore the multiple environmental issues that come up as well. Mines are physically destructive to the local landscape, biodiversity, and vegetation, and they can be significant sources of air, water, and ground pollution.

One way to mitigate these issues is through **reclamation**, or restoring an area that has been disturbed by surface or underground mining. The word means just what it sounds like - reclaiming the land for future use. There are a number of ways to reclaim a mine site, but no matter how you do it, if it's a surface mine, you're bound by the **Surface Mining Control and Reclamation Act of 1977**. This federal law regulates environmental effects from coal mining by setting guidelines for coal mines. It also established a trust fund to provide financial support for reclamation activities.

This was an important piece of legislation because prior to 1977, there were no federal laws regarding environmental issues for surface mining, and over a million coal mine sites in the U.S. had simply been abandoned. Some states had voluntary reclamation programs, but there were no federal regulations specifically dealing with this issue. Since that time, many states have developed their own laws regarding mine reclamation for both coal and non-coal surface mines, and mining operations must now specifically outline their reclamation plan when they apply for mining permits (before they even start digging!).

In addition to these mine-specific laws, there are numerous other federal environmental laws that impact mining operations and their environmental effects. For example, the **Safe Drinking Water Act** sets drinking water quality standards, and the **Clean Air Act** sets standards for air quality. Since mines are sources of both air and water pollution, these laws help reduce the negative effects from mines on our air and water quality in the U.S.

Lesson Summary

Though we use minerals all the time in our everyday lives, we don't often stop to think about the workers who supplied us with those minerals or the environmental effects from the mine itself. But mining is both dangerous work and hard on the environment, and both international and federal legislation has come a long way to increase the protection and rights of workers as well as minimize environmental impacts of mines.

In 1995, the International Labour Organization of the UN adopted the **Safety and Health in Mines Convention**, an international convention to protect the health and safety of mine workers. As of 2014, 29 nations have ratified the convention (including the U.S.), agreeing to be held to its regulations.

The U.S. was a little ahead of this international legislation, since in 1977, **The Coal Act of 1969** was amended to become **The Mine Act**, which set stricter safety and health standards for U.S. miners. This was amended even further in 2006 to become the **MINER Act**, appropriately named because this Mine Improvement and New Emergency Response Act outlined new provisions for emergency response and miner safety during mine accidents.

1977 was also good year for environmental mining legislation in the U.S. While other federal environmental legislation exists that affects mining operations, this is when we saw the implementation of the **Surface Mining Control and Reclamation Act**. This landmark law not only regulates environmental effects from coal mining, but also set up a trust fund specifically for financing reclamation activities.

Learning Outcomes

After reviewing this lesson, display your ability to:

- Interpret the provisions of the Safety and Health in Mines Convention and identify the number of countries that have ratified it
- Determine how the Mine Act improved on the Coal Act of 1969 and remember the further protections that were added by the MINER Act
- Discuss federal legislation in the United States, including the provisions and importance of the Surface Mining Control and Reclamation Act of 1977

Worksheet

Mining Laws, Regulations, and Treaties: Safety and Reclamation

1. The first international Convention to specifically deal with miner health and safety was adopted in:

2. To date, how many countries have ratified the Safety and Health in Mines Convention of 1995?

3. Reclamation refers to:

4. Federal miner health and safety legislation has gone through many changes over the years. Which is the correct order of U.S. laws dealing with this topic, from oldest to most recent?

5. The Surface Mining Control and Reclamation Act of 1977 was important because:

Population Dynamics: Human Population Growth

1

Population Growth Rates

(b) crude birth rate= number birth per 1000 individuals
(d) crude death rate= number death per 1000 individuals
(r) growth rate = natural increase in population expressed as percent per years (If this number is negative, the population is shrinking.)

equation:

$r = b - d$

But other factors affect population growth in a certain area…

2

Rates cont'

increase population
births →
immigration →

decrease population
→ deaths
→ emigration (exit)

r = (birth - death)+ (immigration-emigration)
immigration = migration of individuals into a population from another area or country
emigration = migration of individuals from a population bound for another country

3

Growth Rate Example

r = (b - d)+ (i - e)

example: population of 10,000 has
100 births (10 per 1000)
50 deaths (5 per 1000)
10 immigration (1 per 1000)
100 emigration (10 per 1000)

You try.

B D I E
r=(10/1000) – (5/1000) + (1/1000) – (10/1000)
r=(0.01-0.005) + (0.001 – 0.01)
r = 0.005 – 0.009 = -0.004 or –0.4% per year

4

Doubling Time

Doubling time = 70 / % growth rate

Use this equation to answer this question:

How long will it take for a population to reach a certain size?

5

Practice

In the year 2010 there are 1,000 people living in Paradise. Every year, 10 people emigrate from paradise and 10,000 people immigrate to paradise. 100 people are born each year and 100 people die each year.

a) Calculate the doubling time for the population of Paradise.

b) How many years will it take for Paradise to have 400,000 people?

c) If you were the President of Paradise what would be your policy for population control. (major problem in Paradise)

6

Doubling Time Example

If the growth rate is 1% and the population size is 10,000, how many years will it take to get to a population of 40,000?

Population doubling: 70/rate =70/1% =70 years to double

In 70 years the population will be 20,000

1 D.T. ⇒ 20,000

2 D.T. ⇒ 40,000

(70 years)(2) =140 years

In 140 years, the population will be 40,000 people.

7

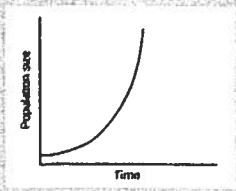
R-selected Species

- Have many offspring each time they reproduce
- Reach reproductive age rapidly
- Short generational time
- Little or no parental care to offspring
- Are short-lived (usually <1 year)

8

R-selected population growth

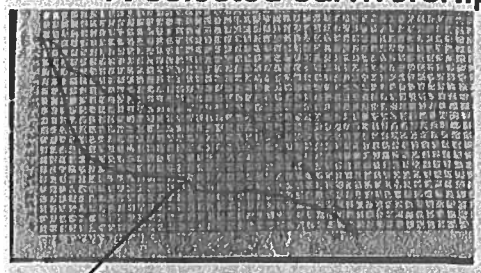
J curve



Exponential growth

9

R-selected survivorship



Type III: little/no parental care/protection

10

K-selected species

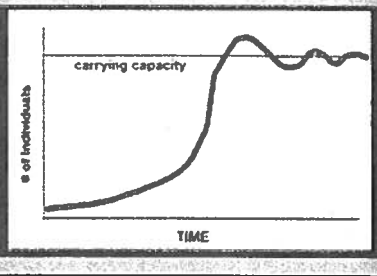
- Little energy into reproduction
- Tend to reproduce later in life
- Have few offspring w/ long generational time
- Put most of energy into nurturing and protecting young

11

K-selected population growth

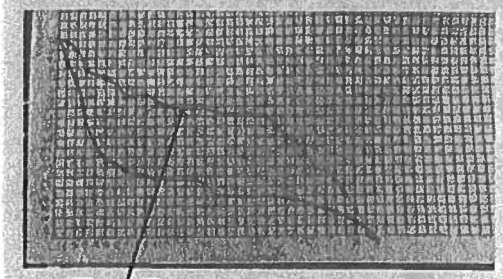
Reproductive Strategies

S-curve (Logistic) = *K-selected*



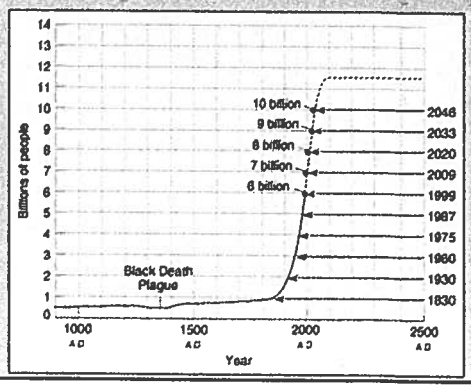
12

K-selected survivorship



Type I: parental care/protection

13



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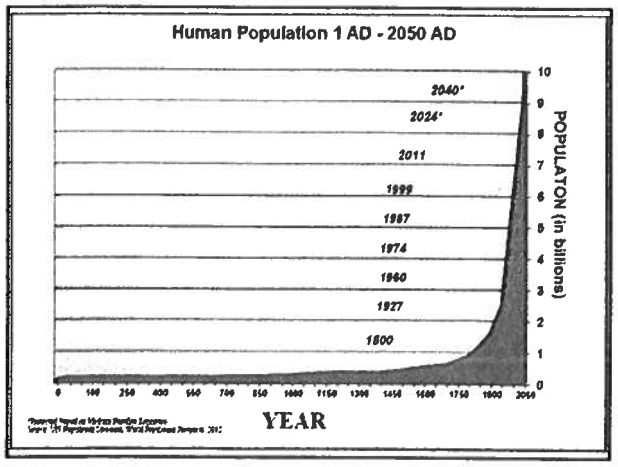

15

What enabled human population growth?

Agriculture: shift from hunting gathering to farming. Controlling food supply led to population growth

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Technology: Major advances collectively called Industrial Revolution

→Advances in medicine, nutrition, and sanitation led to longer life spans

→ Mechanization of farming/improvements in food preservation; more food production and availability

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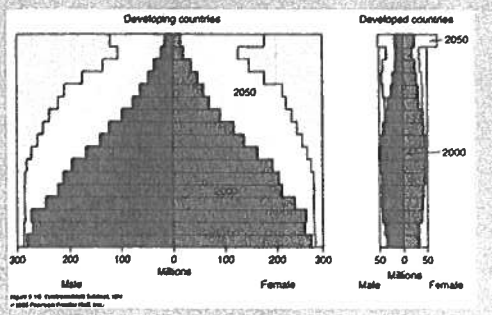
Fertility Rates

- Total fertility = avg. # of children born per woman
- Fertility of 2.0 = replacement level (theoretical)
  - About 2.1 in reality
  - Under 2.0 = shrinking population
  - Over 2.0 = growing pop.

18



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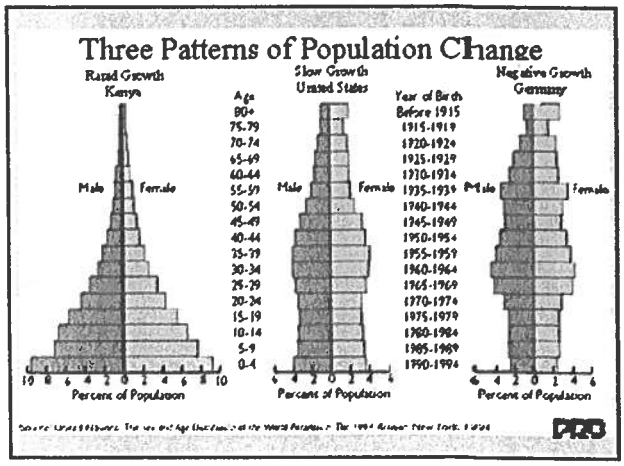

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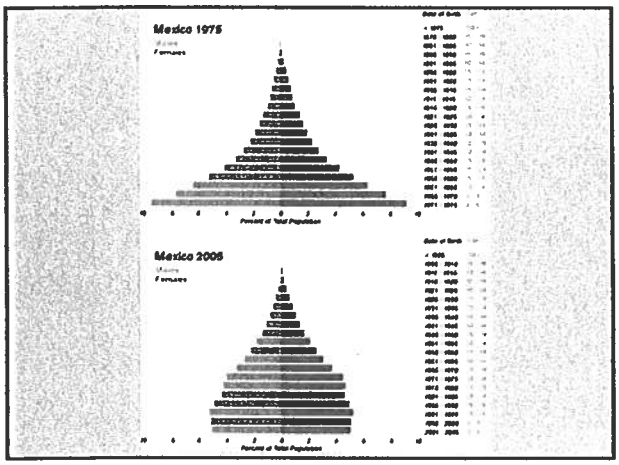

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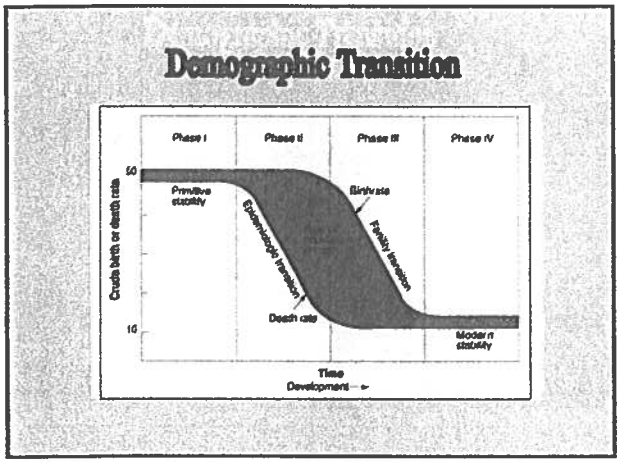
Basics of Global Population

See "Basics of Population Education" file posted in the "Population Dynamics" section of the Moodle page

→What enabled population growth?

→Where is most of the world's population growth taking place in the world? Why is this the case?

22



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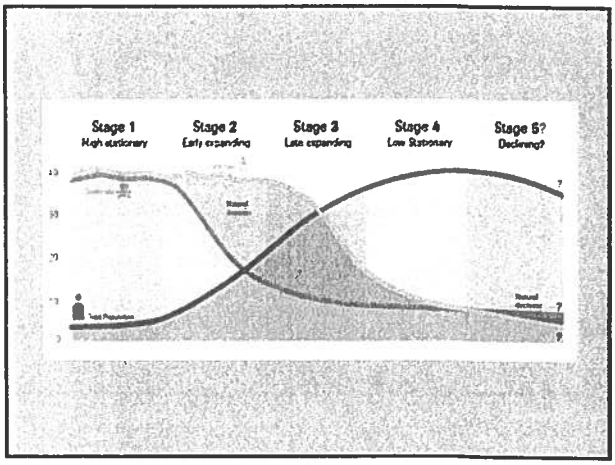

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Demographic Transition

The transition from a primitive or developing society to a "modern" or developed society

Phase 1 **= deaths and births are high**

(epidemiological) Phase 2 **= death rate begins to decrease**

(fertility) Phase 3 **= birth rate drops and death rate flattens out**

Phase 4 **= modern stability**

There is little population growth in phase 1 but in phase 4 people live longer and have fewer children and the population grows.

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Demographic Transition

Bottom Line= as countries develop, first their death rate drops and then their birth rate drops

Reasons for the phases:

Phase II: • medical care
- nutrition (births still high)
- technology

Phase III: • birth control
- education (of women)
- lower mortality rate of infants
- less child labor

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Population Data for Selected Countries (Table 5-2)

Country	Total Fertility Rate	Doubling Times (Years)
World	2.7	58
Developing Countries	2.9	47
Developed Countries	1.6	700

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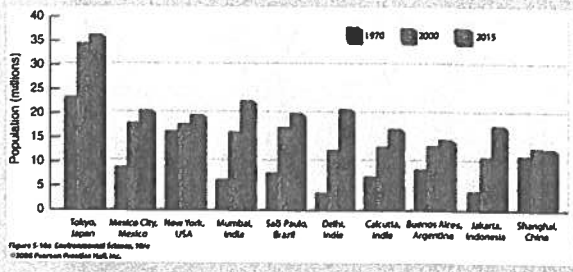
Growing Cities



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Disparities

(see "Population Graphics" file on Moodle page)

- Developed countries
  - 15% of the world's population
  - Control 80% of the world's wealth
- Low-income developing countries
  - 37% of the world's population
  - Control 3.0% of the world's gross national income
- Difference in per capita income: 63 to 1!

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Developed vs. Developing

Developed Countries

➢ Ex. Canada, U.S., Australia, Denmark

Developing Countries

➢ Brazil, China, Kenya

➢ 1/5 of the world's population lives in absolute poverty (which means they are: illiterate, lack clean H_2O and don't have enough food to survive)

➢ 80% of world's population lives in developing countries and this number is growing . . .

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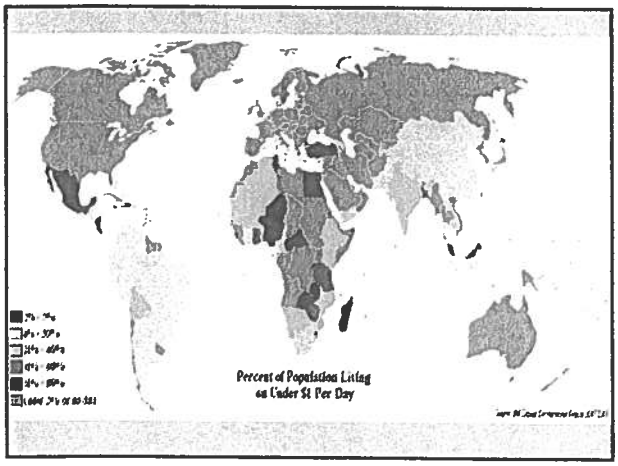
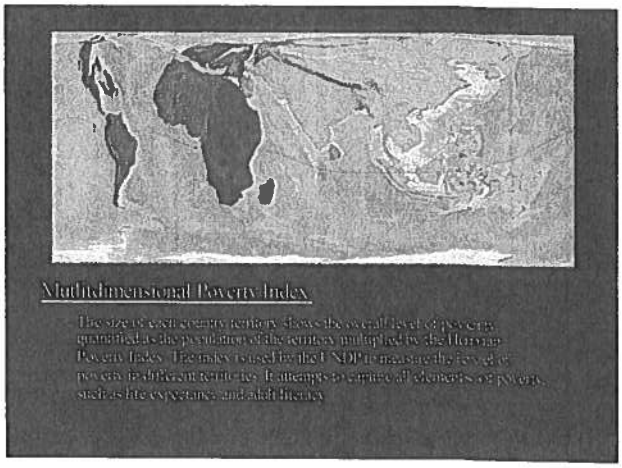

Percent of Population Living
on Under $1 Per Day

31


Multidimensional Poverty Index

32

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POPULATION ECOLOGY

In this lesson, learn how population ecologists study populations and their interactions with their environment. You will learn about the various terms and models they use to describe and understand this complex field of study.

******IF ABLE WATCH THE VIDEO IN GOOGLE CLASSROOM ENTITLED *******

Population Ecology: Definition, Theory & Model

What is Population Ecology?

Ecologists study many different aspects of ecosystems. One aspect that is of particular importance is **population ecology**. This field of study is concerned with populations and how they interact with their environment.

A **population** is all of the individuals of the same species within an ecological community. Ecologists are interested in the growth of a population, fluctuations in population size, the spread of the population, and any other interactions with the population or between it and other populations.

Ecologists may also study different groups of populations that are not located in the same area but interact at certain times throughout the year. If this group of populations are the same species and can still interbreed, they are a **metapopulation**. Individuals within a metapopulation may migrate from one population to the other, which can help stabilize the size of the overall population.

Population Factors

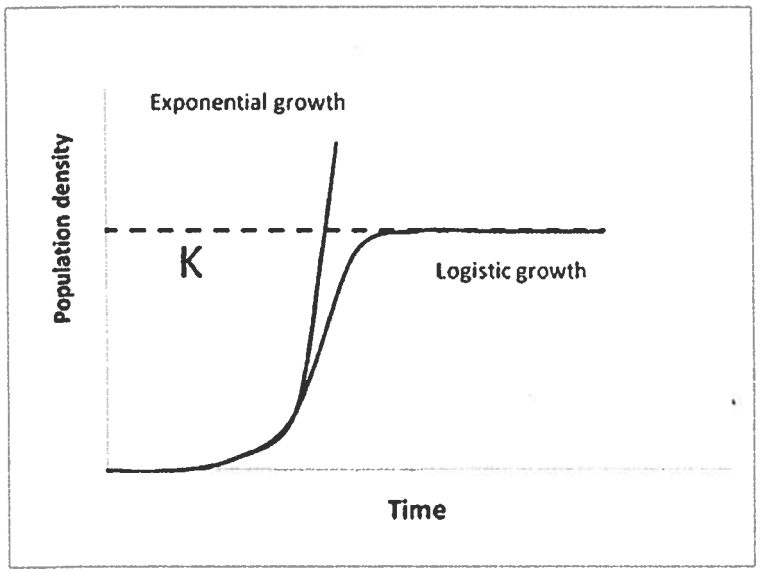
Ecologists describe the organisms of populations in several different ways. The **distribution** of a population is the total area that population covers. The **abundance** of a population is the number of individuals within that population. Ecologists may also define the number of individuals within a certain space, which is the **density** of the population.

Ecologists also identify the age structure or sex ratio of a population. The **age structure** describes the number of individuals in different age classes, while the **sex ratio** describes the proportion of males to females in that population.

Population Growth

Within any population, individuals are born and individuals die. If there are more individuals being born than dying, the population grows in size, while if more individuals are dying than being born, the population shrinks. Individuals may also enter or leave a population, which is referred to as **immigration** and **emigration**.

To better understand population growth, ecologists have created models to study how birth, death, immigration, and emigration affect population size. The simplest model is called the **exponential growth model**. It says that the change in population size is exponential, or growing at an increasing rate. This is not a very realistic model because most populations do not continue to grow without slowing down.



Another model is the **logistic growth model**. This is a much more realistic way to represent population growth. This model takes into account how the available resources in the environment, such as food, water, and shelter, affect population size. The logistic growth model describes a point at which the population growth rate levels off, called the **carrying capacity** (represented on the graph as *K*). The carrying capacity is the maximum sustainable population size given the available resources in the environment.

The logistic growth model is also more realistic because it takes into account the density of the population. While a population may grow in size, the resources available do not necessarily increase to meet this increased demand. When resources become scarcer, deaths increase because of competition for resources. The spread of diseases also increases, as does predation and starvation.

Lesson Summary

Let's review. **Population ecologists** study populations within ecosystems, and **population ecology** is a very complex field. This is because ecologists look at interactions between individuals within a population as well as interactions between the population and its environment. Population ecologists have developed models to help them better understand these interactions, although in reality, population growth is far more complicated than what is outlined in these simplified models. Populations are affected by numerous factors, and it is important for ecologists to study and understand the process as a whole.

National Geographic: White Wolf **Name** _____ **Per** _____

As you watch…

1….take notes on the relationships you observe between the wolves and other animals and those between other animals. Include how they interact and the role each plays in the relationship.

2…take notes on the habitat of the wolves. Explain the importance of the parts of the habitat including landscape and physical features of the land.

3…take notes on the behaviors of the wolves and other animals. Include basic survival behaviors and well as social behaviors among the animals.

4…take notes on the wildlife biologists as they do their study. What actions did they take or not take? Explain the reason for these actions/inactions.

Wolf and Moose Project Overview

Go to: https://isleroyalewolf.org/overview/overview/at_a_glance.html

About The Project: Overview

Isle Royale is a remote wilderness island, isolated by the frigid waters of Lake Superior, and home to populations of wolves and moose. As predator and prey, their lives and deaths are linked in a drama that is timeless and historic. Their lives are historic because we have been documenting their lives for more than five decades. This research project is the longest continuous study of any predator-prey system in the world.

Humans inadvertently introduce canine parvovirus, a wolf disease. The wolf population crashes.With a reprieve from wolf predation, the moose population explodes. We begin to think, but cannot yet prove, that inbreeding among wolves explains why they languor in low abundance for over a decade.

The purposes of this project are to better understand the ecology of predation and what that knowledge can teach us about our relationship with nature. Much of what we have learned is associated with having been patient enough to observe and study the fluctuations in wolf and moose abundances summarized above.

Isle Royale has offered many discoveries... how wolves affect populations of their prey, how population health is affected by inbreeding and genetics, what moose teeth can tell us about long-term trends in air pollution, how ravens give wolves a reason to live in packs, why wolves don't always eat all the food that they kill, and more. The wolves and moose of Isle Royale also frequently reveal intimate details of their daily life experiences and they have inspired numerous artistic expressions. If we pay attention, they all tell us something important about our relationship with nature. These insights and discoveries are all presented here for you.

Building on the graph above and to develop a deeper understanding, here is more on the history of wolves and moose on Isle Royale. Moose first came to Isle Royale in the early 20th century, and for fifty years, their numbers fluctuated with weather conditions and food abundance. Wolves first arrived in the late 1940s by crossing an ice bridge from Canada. The lives of Isle Royale moose would never be the same.

Table H
Small island developing States

United Nations members		Non-UN Members/Associate Members of the Regional Commissions
Antigua and Barbuda	Marshall Islands	American Samoa
Bahamas	Mauritius	Anguilla
Bahrain	Nauru	Aruba
Barbados	Palau	Bermuda
Belize	Papua New Guinea	British Virgin Islands
Cabo Verde	Saint Kitts and Nevis	Cayman Islands
Comoros	Saint. Lucia	Commonwealth of Northern Marianas
Cuba	Saint Vincent and the Grenadines	Cook Islands
Dominica	Samoa	Curacao
Dominican Republic	São Tomé and Príncipe	French Polynesia
Federated States of Micronesia	Seychelles	Guadeloupe
Fiji	Singapore	Guam
Grenada	Solomon Islands	Martinique
Guinea-Bissau	Suriname	Montserrat
Guyana	Timor-Leste	New Caledonia
Haiti	Tonga	Niue
Jamaica	Trinidad and Tobago	Puerto Rico
Kiribati	Tuvalu	Turks and Caicos Islands
Maldives	Vanuatu	U.S. Virgin Islands

Table I
Landlocked developing countries

Landlocked developing countries		
Afghanistan	Lesotho	Mongolia
Armenia	Malawi	Nepal
Azerbaijan	American Samoa	Niger
Bhutan	Anguilla	Paraguay
Bolivia (Plurinational State of)	Aruba	Rwanda
Botswana	Bermuda	South Sudan
Burkina Faso	British Virgin Islands	Swaziland
Burundi	Cayman Islands	Tajikistan
Central African Republic	Commonwealth of Northern Marianas	The former Yugoslav Republic of Macedonia
Chad	Cook Islands	Turkmenistan
Ethiopia	Curacao	Uganda
Kazakhstan	French Polynesia	Uzbekistan
Kyrgystan	Mali	Zambia
Lao People's Democratic Republic	Republic of Moldova	Zimbabwe

Table F
Least developed countries (*as of November 2013*)

Africa		East Asia	South Asia	Western Asia	Latin America & the Caribbean
Angola	Madagascar	Cambodia[a]	Afghanistan[a]	Yemen	Haiti
Benin	Malawi	Kiribati[a]	Bangladesh		
Burkina Faso	Mali	Lao People's Democratic Republic[a]	Bhutan[a]		
Burundi	Mauritania	Myanmar	Nepal		
Central African Republic	Mozambique	Samoa[a, b]			
Chad	Niger	Solomon Islands[a]			
Comoros	Rwanda	Timor Leste[a]			
Democratic Republic of the Congo	Sao Tome and Principe	Tuvalu[a]			
Djibouti	Senegal	Vanuatu[a]			
Equatorial Guinea	Sierra Leone				
Eritrea	Somalia				
Ethiopia	South Sudan[a]				
Gambia	Sudan				
Guinea	Togo				
Guinea-Bissau	Uganda				
Lesotho	United Republic of Tanzania				
Liberia	Zambia				

a Not included in the WESP discussion because of insufficient data.
b Samoa will graduate from the list of the least developed countries in January 2014.

Table G
Heavily indebted poor countries (*as of September 2013*)

Post-completion point HIPCs[a]		Interim HIPCs[b]	Pre-decision point HIPCs[c]
Afghanistan	Honduras	Chad	Eritrea
Benin	Liberia	Comoros	Somalia
Bolivia	Madagascar		Sudan
Burkina Faso	Malawi		
Burundi	Mali		
Cameroon	Mauritania		
Central African Republic	Mozambique		
Congo	Nicaragua		
Côte D'Ivoire	Niger		
Democratic Republic of the Congo	Rwanda		
Ethiopia	Sao Tome and Principe		
Gambia	Senegal		
Ghana	Sierra Leone		
Guinea	Togo		
Guinea-Bissau	Uganda		
Guyana	United Republic of Tanzania		
Haiti	Zambia		

a Countries that have qualified for irrevocable debt relief under the HIPC Initiative.
b Countries that have qualified for assistance under the HIPC Initiative (that is to say, have reached decision point), but have not yet reached completion point.
c Countries that are potentially eligible and may wish to avail themselves of the HIPC Initiative or the Multilateral Debt Relief Initiative (MDRI).

Table E
Economies by per capita GNI in 2012[a]

High-income		Upper middle income		Lower middle income	Low-income
Australia	Lithuania[b]	Albania[b]	Jordan	Armenia	Bangladesh
Austria	Luxembourg	Algeria	Kazakhstan	Bolivia	Benin
Bahrain	Malta	Angola	Lebanon	Cameroon	Burkina Faso
Barbados	Netherlands	Argentina	Libya	Cape Verde	Burundi
Belgium	New Zealand	Azerbaijan	Malaysia	Congo	Central African Republic
Brunei Darussalam	Norway	Belarus	Mauritius	Côte d'Ivoire	Chad
Canada	Oman	Bosnia and Herzegovina	Mexico	Djibouti	Comoros
Chile[b]	Poland	Botswana	Montenegro	Egypt	Democratic Republic of the Congo
Croatia	Portugal	Brazil	Namibia	El Salvador	Eritrea
Cyprus	Qatar	Bulgaria	Panama	Georgia	Ethiopia
Czech Republic	Republic of Korea	China	Peru	Ghana	Gambia, The
Denmark	Russian Federation[b]	Colombia	Romania	Guatemala	Guinea
Equatorial Guinea	Saudi Arabia	Costa Rica	Serbia	Guyana	Guinea-Bissau
Estonia	Singapore	Cuba	South Africa	Honduras	Haiti
Finland	Slovak Republic	Dominican Republic	Thailand	India	Kenya
France	Slovenia	Ecuador	The former Yugoslav Republic of Macedonia	Indonesia	Kyrgyz Republic
Germany	Spain	Gabon	Tunisia	Lesotho	Liberia
Greece	Sweden	Hungary[c]	Turkey	Mauritania[b]	Madagascar
Hong Kong SAR[d]	Switzerland	Iran, Islamic Republic	Turkmenistan	Moldova	Malawi
Iceland	Taiwan Province of China	Iraq[b]	Venezuela, RB	Morocco	Mali
Ireland	Trinidad and Tobago	Jamaica		Nicaragua	Mozambique
Israel	United Arab Emirates			Nigeria	Myanmar
Italy	United Kingdom			Pakistan	Nepal
Japan	United States			Papua New Guinea	Niger
Kuwait	Uruguay[b]			Paraguay	Rwanda
Latvia[b]				Philippines	Sierra Leone
				São Tomé and Principe	Somalia
				Senegal	Tajikistan
				Sri Lanka	Tanzania
				Sudan	Togo
				Syrian Arab Republic	Uganda
				Ukraine	Zimbabwe
				Uzbekistan	
				Vietnam	
				Yemen, Rep.	
				Zambia	

[a] Economies systematically monitored for the World Economic Situation and Prospects report and included in the United Nations' global economic forecast.
[b] Indicates the country has been shifted upward by one category from previous year's classification.
[c] Indicates the country has been shifted downward by one category from previous year's classification.
[d] Special Administrative Region of China.

Table D
Fuel-exporting countries

Economies in transition	Developing countries				
	Latin America and the Caribbean	Africa	East Asia	South Asia	Western Asia
Azerbaijan	Bolivia (Plurinational State of)	Algeria	Brunei Darussalam	Iran (Islamic Republic of)	Bahrain
Kazakhstan	Colombia	Angola	Indonesia		Iraq
Russian Federation	Ecuador	Cameroon	Viet Nam		Kuwait
Turkmenistan	Trinidad and Tobago	Chad			Oman
Uzbekistan	Venezuela (Bolivarian Republic of)	Congo			Qatar
		Côte d'Ivoire			Saudi Arabia
		Egypt			United Arab Emirates
		Equatorial Guinea			Yemen
		Gabon			
		Libya			
		Nigeria			
		Sudan			

Table C
Developing economies by region[a]

Africa		Asia	Latin America and the Caribbean
North Africa	**Southern Africa**	**East Asia**	**Caribbean**
Algeria	Angola	Brunei Darussalam	Barbados
Egypt	Botswana	China	Cuba
Libya[b]	Lesotho	Hong Kong SAR[c]	Dominican Republic
Mauritania	Malawi	Indonesia	Guyana
Morocco	Mauritius	Malaysia	Haiti
Sudan	Mozambique	Myanmar	Jamaica
Tunisia	Namibia	Papua New Guinea	Trinidad and Tobago
Central Africa	South Africa	Philippines	**Mexico and Central America**
Cameroon	Zambia	Republic of Korea	Costa Rica
Central African Republic	Zimbabwe	Singapore	El Salvador
Chad	**West Africa**	Taiwan Province of China	Guatemala
Congo	Benin	Thailand	Honduras
Equatorial Guinea	Burkina Faso	Viet Nam	Mexico
Gabon	Cabo Verde	**South Asia**	Nicaragua
Sao Tome and Prinicipe	Côte d'Ivoire	Bangladesh	Panama
East Africa	Gambia	India	**South America**
Burundi	Ghana	Iran (Islamic Republic of)	Argentina
Comoros	Guinea	Nepal	Bolivia (Plurinational State of)
Democratic Republic of the Congo	Guinea-Bissau	Pakistan	Brazil
Djibouti	Liberia	Sri Lanka	Chile
Eritrea	Mali	**Western Asia**	Colombia
Ethiopia	Niger	Bahrain	Ecuador
Kenya	Nigeria	Iraq	Paraguay
Madagascar	Senegal	Israel	Peru
Rwanda	Sierra Leone	Jordan	Uruguay
Somalia	Togo	Kuwait	Venezuela (Bolivarian Republic of)
Uganda		Lebanon	
United Republic of Tanzania		Oman	
		Qatar	
		Saudi Arabia	
		Syrian Arab Repuplic	
		Turkey	
		United Arab Emirates	
		Yemen	

[a] Economies systematically monitored by the Global Economic Monitoring Unit of DPAD.

[b] The name of the Libyan Arab Jamahiriya was officially changed to Libya on 16 September 2011.

[c] Special Administrative Region of China.

2005 in national currencies were converted into dollars (with selected adjustments) and extended forwards and backwards in time using changes in real GDP for each country. This method supplies a reasonable set of aggregate growth rates for a period of about 15 years, centred on 2005.

The exchange-rate based method differs from the one mainly applied by the IMF and the World Bank for their estimates of world and regional economic growth, which is based on purchasing power parity (PPP) weights. Over the past two decades, the growth of world gross product (WGP) on the basis of the exchange-rate based approach has been below that based on PPP weights. This is because developing countries, in the aggregate, have seen significantly higher economic growth than the rest of the world in the 1990s and 2000s and the share in WGP of these countries is larger under PPP measurements than under market exchange rates.

Table A
Developed economies

Europe				
European Union	New EU member States	Other Europe	Other countries	Major developed economies (G7)
EU-15	Bulgaria	Iceland	Australia	Canada
Austria	Croatia	Norway	Canada	Japan
Belgium	Cyprus	Switzerland	Japan	France
Denmark	Czech Republic		New Zealand	Germany
Finland	Estonia		United States	Italy
France	Hungary			United Kingdom
Germany	Latvia			United States
Greece	Lithuania			
Ireland	Malta			
Italy	Poland			
Luxembourg	Romania			
Netherlands	Slovakia			
Portugal	Slovenia			
Spain				
Sweden				
United Kingdom				

Table B
Economies in transition

South-Eastern Europe	Commonwealth of Independent States and Georgia[a]	
Albania	Armenia	Republic of Moldova
Bosnia and Herzegovina	Azerbaijan	Russian Federation
Montenegro	Belarus	Tajikistan
Serbia	Georgia[a]	Turkmenistan
The former Yugoslav Republic of Macedonia	Kazakhstan	Ukraine
	Kyrgyzstan	Uzbekistan

a Georgia officially left the Commonwealth of Independent States on 18 August 2009. However, its performance is discussed in the context of this group of countries for reasons of geographic proximity and similarities in economic structure.

In parts of the analysis, a distinction is made between fuel exporters and fuel importers from among the economies in transition and the developing countries. An economy is classified as a fuel exporter if the share of fuel exports in its total merchandise exports is greater than 20 per cent and the level of fuel exports is at least 20 per cent higher than that of the country's fuel imports. This criterion is drawn from the share of fuel exports in the total value of world merchandise trade. Fuels include coal, oil and natural gas (table D).

For other parts of the analysis, countries have been classified by their level of development as measured by per capita gross national income (GNI). Accordingly, countries have been grouped as high-income, upper middle income, lower middle income and low-income (table E). To maintain compatibility with similar classifications used elsewhere, the threshold levels of GNI per capita are those established by the World Bank. Countries with less than $1,035 GNI per capita are classified as low-income countries, those with between $1,036 and $4,085 as lower middle income countries, those with between $4,086 and $12,615 as upper middle income countries, and those with incomes of more than $12,615 as high-income countries. GNI per capita in dollar terms is estimated using the World Bank Atlas method,[2] and the classification in table E is based on data for 2012.

The list of the least developed countries (LDCs) is decided upon by the United Nations Economic and Social Council and, ultimately, by the General Assembly, on the basis of recommendations made by the Committee for Development Policy. The basic criteria for inclusion require that certain thresholds be met with regard to per capita GNI, a human assets index and an economic vulnerability index.[3] As at 29 November 2013, there were 49 LDCs (table F).

WESP also makes reference to the group of heavily indebted poor countries (HIPCs), which are considered by the World Bank and IMF as part of their debt-relief initiative (the Enhanced HIPC Initiative).[4] In September 2013, there were 39 HIPCs (see table G).

Aggregation methodology

Aggregate data are either sums or weighted averages of individual country data. Unless otherwise indicated, multi-year averages of growth rates are expressed as compound annual percentage rates of change. The convention followed is to omit the base year in a multi-year growth rate. For example, the 10-year average growth rate for the decade of the 2000s would be identified as the average annual growth rate for the period from 2001 to 2010.

WESP utilizes exchange-rate conversions of national data in order to aggregate output of individual countries into regional and global totals. The growth of output in each group of countries is calculated from the sum of gross domestic product (GDP) of individual countries measured at 2005 prices and exchange rates. Data for GDP in

2 See http://data.worldbank.org/about/country-classifications.

3 *Handbook on the Least Developed Country Category: Inclusion, Graduation and Special Support Measures* (United Nations publication, Sales No. E.07.II.A.9). Available from http://www.un.org/esa/analysis/devplan/cdppublications/2008cdphandbook.pdf.

4 IMF, Debt Relief Under the Heavily Indebted Poor Countries (HIPC) Initiative Available from http://www.imf.org/external/np/exr/facts/pdf/hipc.pdf

Country classification

Data sources, country classifications and aggregation methodology

The statistical annex contains a set of data that the *World Economic Situation and Prospects (WESP)* employs to delineate trends in various dimensions of the world economy.

Data sources

The annex was prepared by the Development Policy and Analysis Division (DPAD) of the Department of Economic and Social Affairs of the United Nations Secretariat (UN/DESA). It is based on information obtained from the Statistics Division and the Population Division of UN/DESA, as well as from the five United Nations regional commissions, the United Nations Conference on Trade and Development (UNCTAD), the United Nations World Tourism Organization (UNWTO), the International Monetary Fund (IMF), the World Bank, the Organization for Economic Cooperation and Development (OECD), and national and private sources. Estimates for the most recent years were made by DPAD in consultation with the regional commissions, UNCTAD, UNWTO and participants in Project LINK, an international collaborative research group for econometric modelling coordinated jointly by DPAD and the University of Toronto. Forecasts for 2014 and 2015 are primarily based on the World Economic Forecasting Model of DPAD, with support from Project LINK.

Data presented in *WESP* may differ from those published by other organizations for a series of reasons, including differences in timing, sample composition and aggregation methods. Historical data may differ from those in previous editions of *WESP* because of updating and changes in the availability of data for individual countries.

Country classifications

For analytical purposes, *WESP* classifies all countries of the world into one of three broad categories: developed economies, economies in transition and developing economies. The composition of these groupings, specified in tables A, B and C, is intended to reflect basic economic country conditions. Several countries (in particular the economies in transition) have characteristics that could place them in more than one category; however, for purposes of analysis, the groupings have been made mutually exclusive. Within each broad category, some subgroups are defined based either on geographical location or on ad hoc criteria, such as the subgroup of "major developed economies", which is based on the membership of the Group of Seven. Geographical regions for developing economies are as follows: Africa, East Asia, South Asia, Western Asia, and Latin America and the Caribbean.[1]

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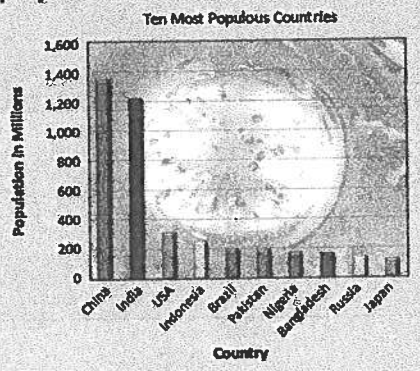
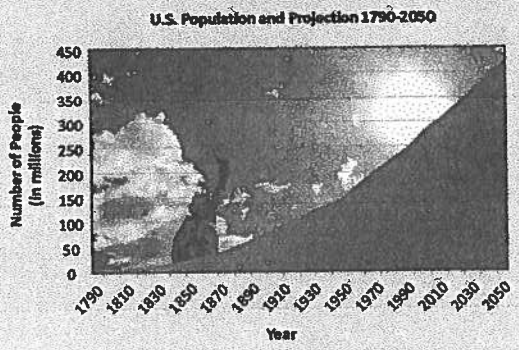
1 Names and composition of geographical areas follow those specified in the statistical paper entitled "Standard country or area codes for statistical use" (ST/ESA/STAT/SER.M/49/Rev. 4).

The United States is one of the most populous countries in the world.



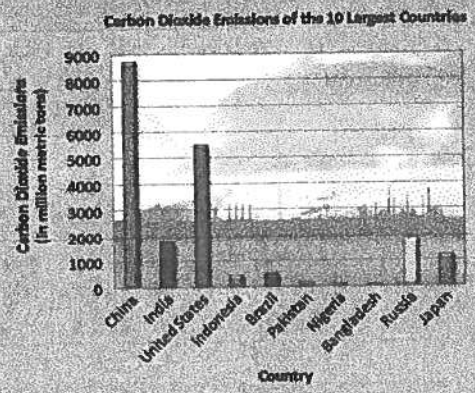
Source: U.S. Census Bureau, 2013

The U.S. population has been growing steadily upwards...



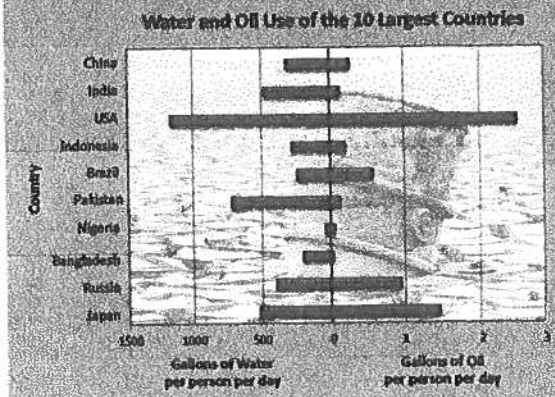
Source: U.S. Census Bureau, 2013

We create some of the most pollution.



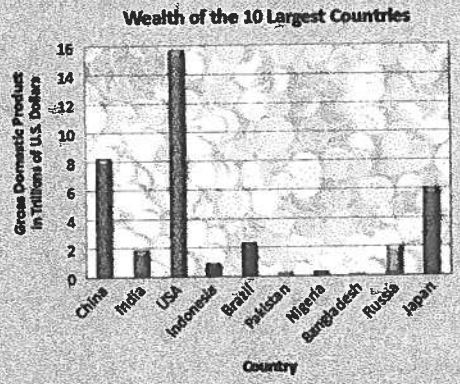
Source: U.S. Energy Information Administration (EIA), 2011

We use the most resources.



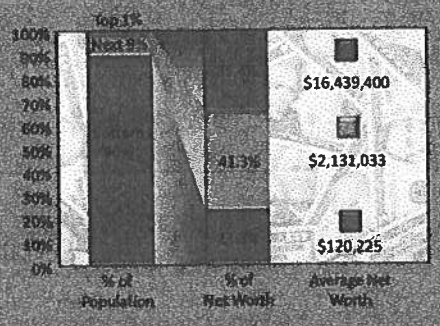
Source: Pacific Institute 2011; Oil World Factbook, 2013

We're the wealthiest country by far.



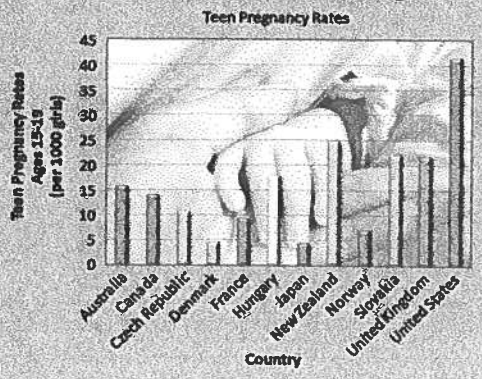
Source: The World Bank 2013

There is a great disparity of wealth in the United States



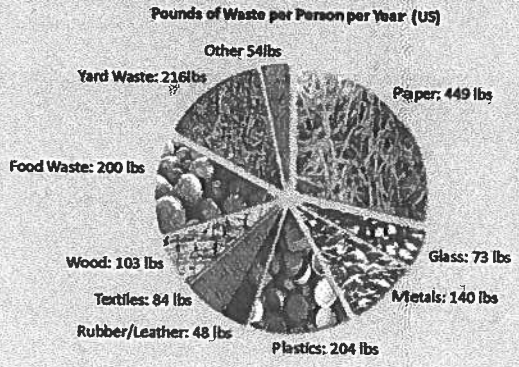
Source: Economic Policy Institute, 2012

Even with our wealth, we have surprising challenges.



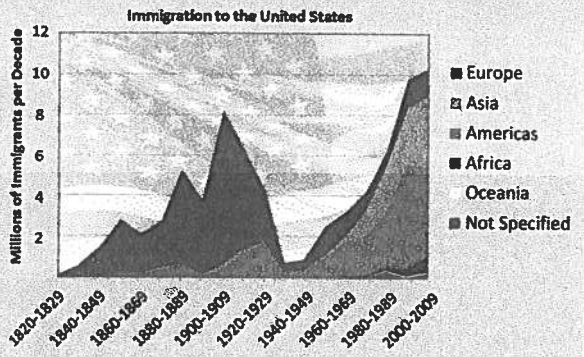
Source: United Nations, 2012

Each of us generates hundreds of pounds of trash each year



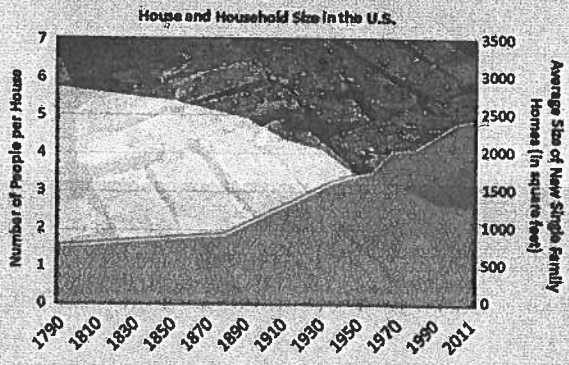
Source: Environmental Protection Agency (EPA), 2013

Immigration has gone up and down, and up again



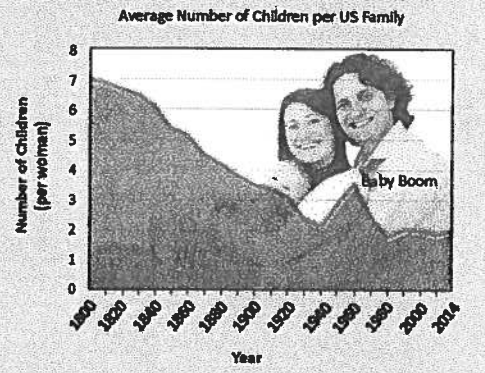
Source: U.S. Department of Homeland Security, 2013

Our houses have grown, even while the number of occupants has shrunk.



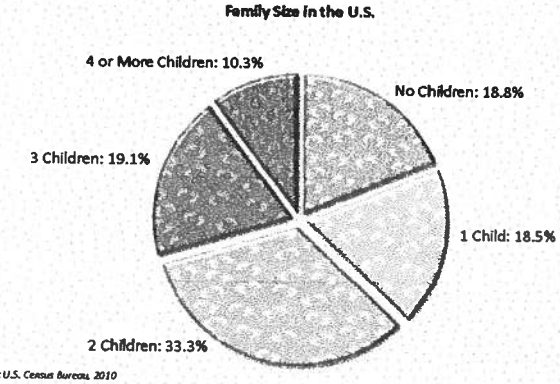
Source: U.S. Census Bureau, 2012; NAHB, 2006

...Even while family sizes have fallen.

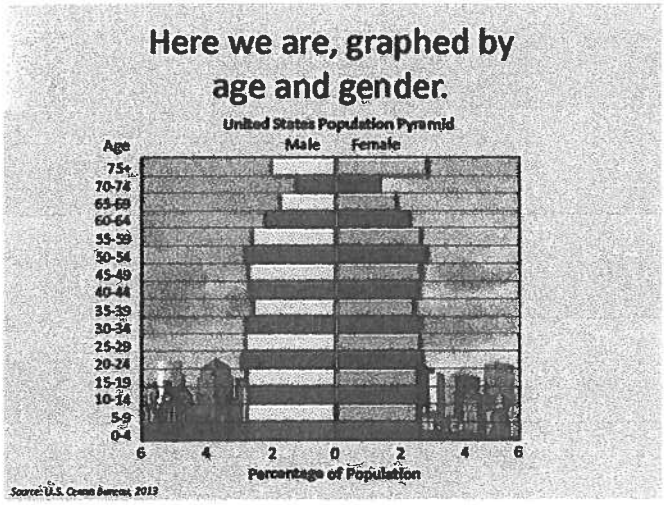


Source: World Bank, 2013; Michael R. Haines and J. David Hacker, 2011

The average woman in the U.S. will have two children. What goes into that average?



Source: U.S. Census Bureau, 2010


Here we are, graphed by age and gender.
United States Population Pyramid
Age
Male
Female
75+
70-74
65-69
60-64
55-59
50-54
45-49
40-44
35-39
30-34
25-29
20-24
15-19
10-14
5-9
0-4
6
4
2
0
2
4
6
Percentage of Population
Source: U.S. Census Bureau, 2013

Worksheet: Logistic Population Growth: Equation, Definition & Graph

Circle the correct answer:

1. If N is less than K, the _____.

- population growth rate will be positive
- all of these
- population growth rate will be zero
- population growth rate will be negative
- none of these

2. If N is greater than K, the _____.

- population growth rate will be negative
- all of these
- population will have to get smaller
- none of these
- population size is larger than the carrying capacity

3. The maximum population size an environment can support is called _____.

- logistic growth
- population
- growth rate
- carrying capacity
- none of these

4. The graph of logistic growth is usually shaped like which letter?

- U
- J
- S
- I
- none of these

5. The correct equation for logistic growth is

- dN/dt=rN((N-K)/N)
- none of these
- dt/dN=rN((K-N)/r)
- dN/dt=rN((K-N)/K)
- dN/dt=r/N((K-N)/N)

Population Size Larger Than Carrying Capacity

If N happens to be higher than K, then the population will lose individuals until N is equal to K. Population growth will be negative during this time because there will be more deaths than births. If N = 105 (the carrying capacity is 100), then the growth rate will be -2.6. The growth rate will continue to be negative until the population has decreased in size to carrying capacity. Then remember that at carrying capacity, the population growth rate will be zero.

$$\frac{dN}{dt}=0.5(105)\left(\frac{100-105}{100}\right)=-2.6$$

Logistic Growth Equation When N=105

Lesson Summary

Let's review. _____ occurs when the growth rate decreases as the population reaches carrying capacity. _____ is the maximum number of individuals in a population that the environment can support. A _____ of logistic growth is shaped like an S. Early in time, if the population is small, then the growth rate will increase. When the population approaches carrying capacity, its growth rate will start to slow. Finally, at carrying capacity, the population will no longer increase in size over time.

Learning Outcomes

After watching this lesson on logistic population growth, measure your ability to:

- Contrast logistic population growth and carrying capacity
- Interpret a graph of logistic growth
- Use the equation for logistic population growth to explain the relationship between population size and carrying capacity

Logistic Growth Equation When N=2

For a while, as N increases, so does the growth rate of the population. If N = 50, then the growth rate has increased to 12.5. This means the population is rapidly getting larger. However, remember in logistic growth the population does not continue to grow forever.

$$\frac{dN}{dt}=0.5(50)\left(\frac{100-50}{100}\right)=12.5$$

Logistic Growth Equation When N=50

Population Size Near Carrying Capacity

As N gets closer to K, the population growth rate decreases and approaches zero. In our example, if N = 98, then the growth rate has decreased to 0.98 again, which means the population is still getting larger but not as quickly.

$$\frac{dN}{dt}=0.5(98)\left(\frac{100-98}{100}\right)=0.98$$

Logistic Growth Equation When N=98

A growth rate of zero means that the population is not growing, which is what happens at carrying capacity because the birth rate usually equals the death rate. When N is equal to K, a population has reached carrying capacity.

If we look at a graph of a population undergoing logistic population growth, it will have a characteristic S-shaped curve. The population grows in size slowly when there are only a few individuals. Then the population grows faster when there are more individuals. Finally, having lots of individuals in the population causes growth to slow because resources are limited. In logistic growth, a population will continue to grow until it reaches _____, which is the maximum number of individuals the environment can support.

Equation for Logistic Population Growth

We can also look at logistic growth as a mathematical equation. Population growth rate is measured in number of individuals in a population (N) over time (t). The term for population growth rate is written as (dN/dt). The d just means change. K represents the carrying capacity, and r is the maximum per capita growth rate for a population. _____ means per individual, and the _____ involves the number of births and deaths in a population. The logistic growth equation assumes that K and r do not change over time in a population.

$$\frac{dN}{dt}=rN\left(\frac{K-N}{K}\right)$$

Logistic Growth Equation

Let's see what happens to the population growth rate as N changes from being smaller than K, close or equal to K and larger than K. We will use a simple example where r = 0.5 and K = 100.

Populations Size Smaller Than Carrying Capacity

If N is very small compared to K, then the population growth rate will be a small positive number. This means the population is slowly getting larger because there are a few more births than deaths. For example, if N = 2, the population growth rate is 0.98. (Remember the units are individuals per time. We didn't specify time in this example because it depends upon the species, but it is often measured in years or generation times.)

$$\frac{dN}{dt}=0.5(2)\left(\frac{100-2}{100}\right)=0.98$$

Logistic Population Growth: Equation, Definition & Graph

Populations tend to get larger until there is no longer enough food or space to support so many individuals. This type of growth is called logistic population growth, and you can learn more about it in this lesson.

What Is Logistic Population Growth?

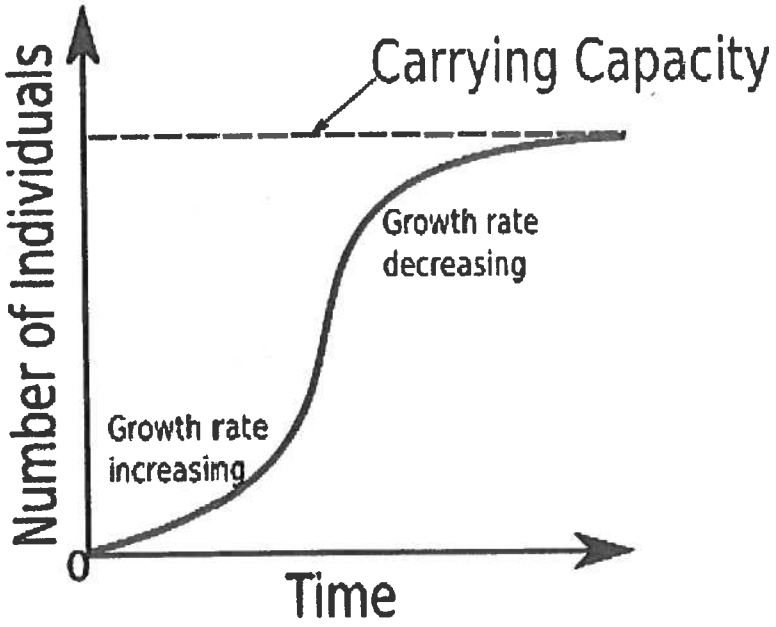
A group of individuals of the same species living in the same area is called a _____. The measurement of how the size of a population changes over time is called

the _____, and it depends upon the population size, birth rate and death rate. As long as there are enough resources available, there will be an increase in the

number of individuals in a population over time, or a _____out of water, food, sunlight, space or other resources. As these resources begin to run out, population growth will start to slow down. When the growth rate of a population decreases as the number of

individuals increases, this is called _____.

Graphing Logistic Population Growth



Logistic Growth

Worksheet: Exponential Growth: Definition & Examples

Circle the correct answer:

1. Which of the following statements is NOT true?

- Exponential growth adds more to the population or quantity over time.
- Exponential growth is always very slow.
- Money earning interest may grow at an exponential rate.
- Bacteria in a petri dish may multiply at an exponential rate.

2. Which of the following is exponential growth?

- A child growing taller
- Muddy footprints in the kitchen
- Pouring water into a glass
- Multiplication of rabbits with nothing stopping their growth

3. When growth can't go on forever and starts to slow down, this is called:

- None of the answers are correct
- Logistic growth
- Exponential decay
- Exponential growth

4. Which of the following statements is true?

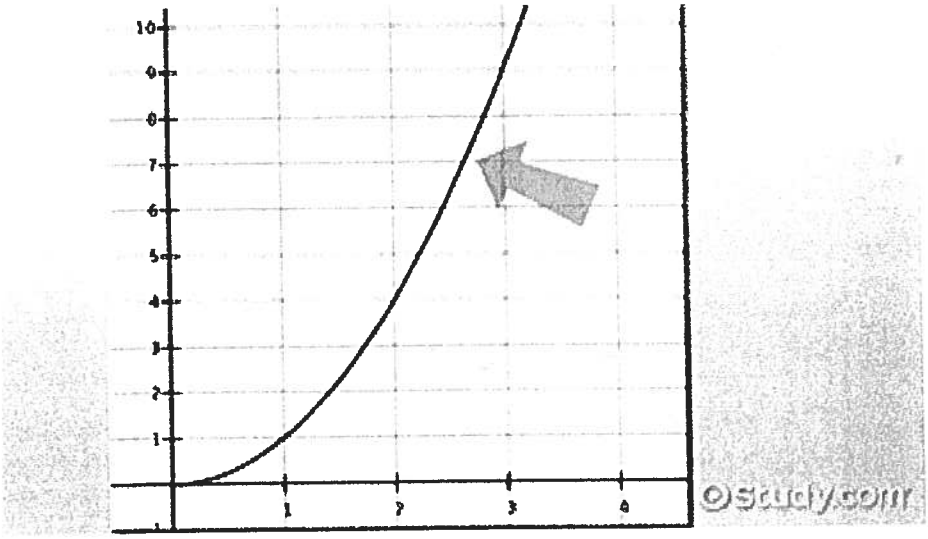
- All exponential growth increases at the same rate.
- Exponential growth is growth that becomes more rapid as as total number grows
- Exponential growth can slow down over time.
- Exponential growth rarely happens in the real world.

5. Which of the following could be considered exponential growth?

- A sequence of doubling numbers
- A sequence of tripling numbers
- All of the answers are correct
- The 1% interest rate of a bank account

When growth becomes more rapid in relation to the growing total number, then it is **exponential**. With exponential growth, the actual quantity added over time gradually increases. There is no force that slows down or stops the growth to any noticeable degree.

Exponential Growth Overview



Exponential growth

Terms	Definitions
Exponential	when growth becomes more rapid in relation to the growing total number
Logistic growth	starts off looking exponential but eventually levels out

Learning Outcomes

The process of learning about exponential growth while viewing this lesson could result in your ability to:

- Define the term 'exponential growth'
- Explain the speed at which exponential growth might occur
- Analyze fast vs. slow exponential growth through examples

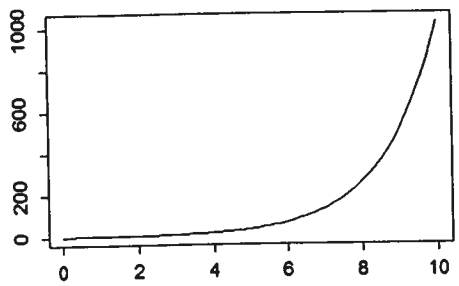
There are a variety of examples of exponential growth as it applies to the real world. For example, a man is believed to have brought 24 rabbits to Australia in the 1800s so that he could hunt them; however, rabbits have no natural predators in Australia, and so the population grew out of control. Within ten years, so many rabbits had descended from these 24 first rabbits that millions could be killed without making a dent in the population.

The real secret to exponential growth is this - not only do rabbits have children, but their children have children, as do their children's children. The new growth increases just as fast as the growth you started with. There is nothing to slow the growth down or bring it to a halt.

When graphed, exponential growth always looks like it is starting off slowly and then rapidly becomes steeper:

It's a lot like spreading gossip about your ex: you might only tell your two best friends that he cries during chick flicks, but each of them tells a couple others, and pretty soon there is no one in the Western Hemisphere that doesn't know his secret - thanks to the power of exponential growth.

Graph of Exponential Growth



Let's take a look at another example: suppose you have bacteria in a Petri dish. Maybe each bacteria splits in two; each of those splits in two and so forth. Since the bacteria are tiny and the dish is much bigger in comparison, there is nothing to stop the growth for a very long time. Like the rabbits in Australia, there is no force to stop the growth. In other real-world situations, of course, there might be predators or limits to food sources so that growth can't go on forever at the same rate but, instead, slows down. In this case, you have **logistic growth**. It starts off looking exponential but eventually levels out.

Rates of Exponential Growth

Not all exponential growth is the same. The rice in the chessboard story doubled from square to square. It would still be exponential growth if they tripled instead, but the world would run out of rice faster. Or the rule might be that each square only has ten percent more rice than the previous one. In this case, the growth is slower, but it is still exponential.

One example of slow exponential growth is money in a savings account. Suppose you are getting one percent interest each year, paid at the end of the year (which is much simpler than what really happens). This means that you get one dollar for every $100 you have in the account. Or, you get one cent for every 100 cents. If you start off with $452.10, then the interest you get at the end of the year is $4.52 - very simple. But, the second year you get interest not only on your original $452.10, but also on the $4.52 interest you earned in year one. So, the amount that gets added to your account is slightly bigger in year two and increases year after year. The interest rate may be small, but the growth of your funds is still exponential - the amount earned in interest increases year to year even though the rate remains the same.

Lesson Summary

Factors that Decrease Population Size

Now that we have learned about the factors that increase population size, let's investigate the factors that have the opposite influence. The first factor that results in a decrease in the population size is mortality. _____ is the number of individual deaths in a population over a period of time. In terms of the human population, mortality is often described as the _____, which is the number of individuals that die per 1,000 individuals per year.

Death rates are often used to describe how many individuals die in specific age groups. For example, the death rate of infants is often an important statistic to investigate when looking at changes in the population. Similar to birth rates, the death rate is also often described as a percentage of the population. In 2010, the death rate for infants in the United States was 0.6%, while in Ethiopia the infant death rate was 7.1%.

The second factor that can decrease the size of a population is emigration. _____ is the migration of an individual from a place. When an individual emigrates from a location, they decrease the population within that area. If you think back on the immigration example, with the person moving from London to New York, we said that the person was immigrating to the United States. Using this same example, the person would also be emigrating from England. Similar to immigration, emigration also does not have an influence on the overall human population on Earth because people are not leaving Earth to move to a new planet.

The Population Growth Rate

Although there are factors that either increase or decrease the human population, when these factors are combined, they represent the overall population growth rate. The _____is the rate at which the population changes in size. The rate of change is determined by subtracting the number of people that leave the population, through death or emigration, from the number of individuals that enter the population,

through birth or immigration. This calculation makes it possible to combine all of the statistics that influence population size and to determine how the overall population is changing over time. The population growth rate can result in either a positive or negative rate depending on the factors.

Lesson Summary

Let's review _____, which are a group of individuals of the same species that inhabit the same area, and the factors that influence changes in populations. Over time, the human population has increased, which results in a positive _____, which is the rate at which the population changes in size. Although the human population has increased overall, there are many factors that contribute to the rate.

The two factors that increase the size of a population are _____, which is the number of individuals that are added to the population over a period of time due to reproduction, and _____, which is the migration of an individual into a place. The two factors that decrease the size population are_____, which is the number of individual deaths in a population over a period of time, and _____, which is the migration of an individual from a place.

For the human population, natality is often described in terms of _____, which is the number of individuals born per 1,000 individuals per year, and mortality is described in terms of _____, which is the number of individuals that die per 1,000 individuals per year. When you combine the rates of births, deaths, immigration, and emigration, you can determine whether a population is growing, shrinking, or remaining the same. All of these statistics are important because they make it possible for us to determine how our population is changing and may provide insight into how our growing population may influence the environment we live in.

Learning Outcomes

When this lesson is done, you should be able to:

Explain what a population is
Identify some of the factors that have enabled the human population to increase Recognize the events that decrease population
Recall what is meant by 'birth rate' and 'death rate'
Define population growth rate and know how to calculate it

Worksheet

The Human Population: Factors that Affect Population Size

Circle the correct answer:

1. Deduce the formula that represents the population growth rate.

- Population growth rate = (birth + immigration) - (death + emigration)
- Population growth rate = (death + emigration) - (birth + immigration)
- Population growth rate = (death + emigration) - (birth - immigration)
- Population growth rate = (birth - death) + (immigration - emigration)

2. What was the approximate size of the human population in the 1960s and in 2011?

- 6 billion in the 1960s and 9 billion in 2011
- 3 billion in the 1960s and 7 billion in 2011
- 3 billion in the 1960s and 9 billion in 2010
- 3 billion in the 1960s and 6 billion in 2011

3. Last Saturday, Ben permanently moved from Louisiana to Belgium. Identify the statement that is correct, following Ben's movement.

- The population of Belgium would decrease.
- Ben emigrated from Louisiana and immigrated to Belgium.
- The overall human population would change.
- Ben emigrated from Belgium and immigrated to Louisiana.

4. _____ is a factor that is in associated with natality.

- Death rate
- Emigration
- Immigration
- Birth rate

5. Define death rate.

- The ratio of infants to adults that die in a population.
- The percentage of individuals that die per 1,000 individuals per year.
- The number of individuals that die per 5,000 individuals per year.
- The number of individuals that die per 1,000 individuals per year.

Population Growth: Problems & Logistics

What is a population? What can happen to the environment and the organisms if the population grows too fast? You will learn the answers to these questions and other facts related to populations and their growth in this lesson.

POPULATIONS

A **population** is any group of organisms of the same species, living in and depending on, a specific area for all of its needs. Did you know that in the late 1800s the average American Family consisted of five family members? By the early 1900s the average family in the U.S. had dropped to four family members. By the mid to late 1900s the average American family had dropped to three and then closer to two family members. What was contributing to the changes in family and population in the U.S? Did you know that in China the government actually adopted a policy that limits most couples to only have one child? Both the U.S. and Chinese occurrences are examples of limits that were being placed on a population, one was government enforced and the other was self inflicted. Why would an organism want to restrict population growth? Are there limits placed on the populations of other organisms that occur naturally? In this lesson, we'll take a look at the answers to population growth issues.

What Is a Limiting Factor?

No population of organisms can grow uncontrollably. **Limiting factors**, are anything that places restrictions on how large a population can grow. The example above demonstrates a trend that occurred in American families. Nuclear families in America have shrunk over time. Why? What problems do large families face? Could it be the cost of food? What about the cost of housing? All organisms have a 'cost' associated with obtaining their needs. Humans have to spend money on their needs, while animals spend different resources, like time and energy, obtaining their needs. These are all 'cost.' These costs often act as limiting factors.

If a family does not have the means to obtain a substantial amount of money, having a large family can become a disadvantage. If the food an animal eats starts to become scarce, having many offspring can become a disadvantage. This is how limiting factors influence population numbers. Resources are limited in every environment. Food, water, shelter, soil and hunting space are all examples of resources. When a population grows, these things become even more limited. Could this be why China has taken such drastic steps to control its human population? How will the government afford healthcare, work on roads or facilitate efficient transportation if one of the most populous countries has even more inhabitants?

Carrying Capacity

What will happen initially to any population if they have all of the food, water, air, and living space (limiting factors) they need for the time being? Well, the population will grow! However, as a population grows, resource, such as jobs, food, water, shelter, soil, and hunting space, can become depleted. No environment has an unlimited amount of resources. As a population gets larger, the organisms in the population start to compete for the limited resources. Some organisms win the fight, but others lose. Think about the things that can happen to a population when they

start to run out of living space and become over-crowed. Disease is one of the limiting factors that grows as a population reaches its environments' upper limit for that population, or **carrying capacity**. What happens to the population as more of its members carry disease and lose the competition for resources? As an environment reaches its carrying capacity, some of them will die, and the population will decrease.

In the 1300s, the bubonic plague effected the human population in Europe very much like we have discussed. The population became very large for the environment. As the human population increased, space decreased, and they began living in close quarters. As humans began to live closer, so did the organisms that depended on them, namely rats. As the rats continued to interact with the humans, a disease they carried (the bubonic plague) began to infect the humans. As more humans died, more humans came in contact with the diseased bodies, and they died as well. The human population in Europe plummeted drastically; it's believed that anywhere from 30-60% of Europeans died. Eventually the population rebounded.

Flows Like a River

As you can see from the explanations above, population is a not a static thing. It does not stay constant. Environmental changes and limiting factors keep the population from growing out of control, but it does not keep the population at a constant number. The population of any organism can grow sharply, perhaps because of the introduction of a new food source. The population will then eventually decrease because of other limiting factors. The population of a wild animal or plant can also go through a large decrease because of loss of habitat to construction or other human activity. As long as the population of an organism is not driven to extinction, it it will continue to rise, fall and fluctuate. Governments keep a close eye on its population numbers because they want to make sure their inhabitants can be healthy, safe, and productive citizens. Unchecked rises in population numbers can effect these goals.

Lesson Summary

All population numbers are controlled by limiting factors. **Limiting factors** are environmental factors that keep a population's numbers from growing out of control. Some examples of limiting factors are food, water, living space, and disease. The maximum number of any one organism that an environment can support is the **carrying capacity**. Population numbers are not static, they go up and down based on limiting factors and other environmental occurrences.

The History of Human Population Growth and Carrying Capacity

Fill in the blanks as you watch the video:

Most of us are used to the current size of the human population but it was not always this large. In this lesson, we will explore the history of human population growth and the future of its growth.

Human Population Growth

How many people do you think the human population grows by each year? Maybe one million? Ten million? More? As of 2012, over 80 million people were added to the human population each year. To give you perspective, this would be equivalent to the populations of California, Texas and New York combined. On a shorter scale, we add 2.6 people to the population every second! This would mean that each day you could fill two large football stadiums with the number of people that were added to the human population.

As of 2013, the human population is around 7 billion people, and it has taken many years for the population to grow to this size. Over this long amount of time, some periods have had slow growth while others have had more rapid growth. Due to these fluctuations and how large the human population has become, scientists have begun to investigate the growth of the human population.

_____is the study of the size, density and distribution of the human population. This area of study takes into account birth rates, death rates, age distribution and any other factors that influence the size and growth of a population. Demographers have identified three distinct periods of human population growth that help explain the history of how our population has changed.

Pre-Agricultural Period

The _____is the first period of human population growth. This period is considered anything before 10,000 years ago. During the pre-agricultural period, human population growth was very slow, and it took tens of thousands of years for the human population to double.

Although growth was slow, the population was able to increase due to the development of tools. As people developed more advanced tools, they were able to travel to new lands and use their skills to adapt. This made it possible for people to spread to new regions of the world and expand the coverage of the human population. When the pre-agricultural period ended around 10,000 years ago, the human population was estimated to be somewhere between five and ten million people.

Agricultural Period

The _____ is the second period of human population growth. This period ranges from 10,000 years ago to about 1,000 years ago. During this time period, the human population started to grow more rapidly due to advances in agriculture. It was during this time that plants and animals were domesticated for farming. There were also advances in irrigation and plowing techniques that increased overall crop yield. As a result of increased food availability and more nutritious food, the human population grew faster than ever.

Unlike during the pre-agricultural period, when it took tens of thousands of years for the human population to double, during the agricultural period, it only took around 1,000 years for it to double in

size. At the end of the agricultural period, the human population had increased a great deal to around 500 million people.

Industrial Period

The _____was the third period of human population growth. This period is from 1,000 years ago to current day and is characterized by advances in technology. Although there were advances in technology during the early part of this period, it wasn't until the Industrial Revolution in the 1800s that the advances in technology started to have a profound influence on the human population.

During this time period, there were technological advances in agricultural techniques that made it possible to grow crops on land that had previously been unusable. This resulted in another increase in the amount of food available, and therefore increased the number of humans that could survive. Technology was also used to improve medicine and sanitation, which helped save lives and increase the lifespan of the average person.

As a result of the technological advances of the industrial period, the human population grew at a rapid pace. Over the industrial period, the time it takes to double the population decreased a great deal. During the beginning of the period, it took around 500 years to double the population, but more recently, the number has decreased to 50 years to double. During the industrial period, the human population grew from 500 million people to the 7 billion people we now have on earth.

Human Population Carrying Capacity

Now that we have examined the history of the human population, what do you think the future holds? Will the human population continue to grow at the same rate, slower or stay stable? For most species, their population growth is controlled by their _____, which is the maximum population size of a species that an ecosystem can support indefinitely. For example, if a forest only has enough food to support 50 individuals of a species and the population grows larger, not all the individuals will survive. The population will decrease until it is at or under the carrying capacity, which is where there would be enough food for all individuals.

Although many people are interested or concerned about the future growth of the human population, unfortunately it is not possible to precisely determine the carrying capacity of humans on earth. Some scientists estimate that the world could support between 1-2 billion people if they are living prosperously and in a healthy environment. On the other hand, they also estimate that the world could support over 33 billion people if people are living in extreme poverty with very degraded environments.

There are many factors and characteristics about human life that make it difficult to determine how many people Earth can support, but the most powerful factor is technology. Humans have the intelligence to create technology that helps save lives, increase food availability, increase lifespan, and therefore challenge the carrying capacity. There were times in human history where there were mass starvations and some thought we had reached our carrying capacity. But, due to technology, we were able to combat the starvation by producing more food, and therefore helping the population continue to grow.

Lesson Summary

Now, let's review the history of human population growth and the human carrying capacity.

_____ is the study of the size, density and distribution of the human population. This area of study has been used to determine three distinct periods of human population growth. The _____ is the first period of human population growth and was characterized by the development of tools. With new tools and skills, humans were able to adapt to new environments and expand their range to new habitats, which resulted in a slow population increase to between 5-10 million people.

The _____ was the second period of human growth and was characterized by advances in agriculture. As a result of increased food production and healthy food, the human population grew more rapidly to around 500 million people.

The _____was the third period of human population growth and was characterized by advances in technology. This period brought about technological advances in medicine, food production and sanitation that helped support a rapid increase in the human population to the nearly 7 billion people that now inhabit the earth.

Due to the rapid increase in the human population, many people wonder about the _____, which is the maximum population size of a species that an ecosystem can support indefinitely. Unlike other species, humans have been able to exceed their estimated carrying capacity due to technology. Human intelligence and advances in technology have made it possible for humans to find ways to support the population and ensure increase despite natural pressures to decrease the population. This might always be the case, or someday our population may become so large that the earth cannot support us all.

Learning Outcomes

When this lesson has been completed, you could be able to:

Understand the history of the world population
Restate the three time periods that stand out
Convey the fact that every species has a 'carrying capacity'

Overpopulated – "Don't Panic: The truth about population"

BBC with Professor Hans Rosling

Name: _____

1. What is Earth's current population size? _____

2. What was the average number of babies that women of Bangladesh had in 1970 and how long was the child predicted to live?

   _____

3. What is the average number of babies that women of Bangladesh have now and how long is the child predicted to live?

   _____

4. In 1963, what made the biggest difference in population size and number of offspring a woman had?

   _____

5. Globally from 1963 to 2012, babies born per woman changed from 5 per woman to _____ per woman in 2012.

6. What has helped to decrease the number of children born per woman globally?

   _____

7. List two things that have helped save the life of children (increase their lifespan) in Bangladesh?

   _____

8. How many people are predicted to be on Earth before the growth rate starts to flatten?

   _____

9. How can the population of the Earth increase if the number of children being born is less?

   _____

10. In the year 2100, which countries of the world will have the smallest population? Largest?

    _____

11. How has life in Mozambique improved for the people there, list some examples?

_____

12. How do the people making $100 per day view the people below them?

_____

13. How do the people making $1 per day view the people above them?

_____

_____

14. What does literate mean? And how many of the world's current population of adult's are literate?

_____

15. In 2012, which country (blue on graph) has the most people that live in extreme poverty?

_____

16. What could help Africa's agriculture? _____

17. What does a good life mean for most people in the world?

_____

18. How much energy used today is still harvested from fossil fuels? _____

19. What is the correlation between use of fossil fuels and wealth? _____

20. What is the conclusion regarding the overpopulation of the Earth (in other words, is it possible for the Earth to continue at this rate)?

_____

_____

Take the Ignorance Quiz to see how you stack up against the UK citizens.
(http://www.bbc.com/news/magazine-24836917)