

Contents

1	10.12.20	3
1.1	Definitions of Diversity	3
1.2	Robust Redhorse	3
1.3	Species Diversity	3
1.4	Endemic Species	4
1.5	Hotspots	4
1.6	Habitat v Niche	4
1.7	Biodiversity Loss	4
1.8	Causes of Biodiversity Loss	5
1.9	Value of Biodiversity	5
1.10	Ecosystem Services	5
1.11	Isolation and Extinction Risk	6
2	10.09.20	6
2.1	Evolution and Resistance	6
2.2	Athens Water Quality	6
2.3	Gonorrhea & Resistance	7
2.4	Developing new Antibiotics	7
2.5	Post-antibiotic Era	7
3	10.07.20	8
3.1	Genetic Diversity & Natural Selection	8
4	10.05.20	8
4.1	Antibiotic Resistance:	8
4.2	Systems Thinking	8
4.3	Cycle of Infection	9
4.4	Bacteria	9
4.5	Explaining Resistance	9
4.6	Genetic Variation	9
4.7	Genetic Diversity	9
4.8	Sources of Genetic Variation	10
4.9	Natural Selection	10
5	09.18.20	10
5.1	Hurricanes	10
5.1.1	How Hurricanes Form	10
5.1.2	Climate Change & Hurricanes	11

5.1.3	Hurricane Harvey Intensification	11
5.1.4	General Impacts	11
6	09.16.20	12
6.1	Heat Waves	12
6.2	Wildfires	12
7	09.14.20	13
7.1	Coriolis Effect	13
7.2	Air circulation	13
7.2.1	Cells	13
7.3	Surface Ocean Currents	13
7.4	El Nino (Southern Oscillation)	14
7.5	La Nina	14
7.6	Heat Waves	14
8	09.11.20	14
9	09.09.20	16
9.1	The Earth's Atmosphere	16
9.2	The Keeling Curve	16
10	09.02.20	16
10.1	Demographic Transition Model	16
10.2	Social Justice: Education for Women	17
10.3	Environmental Impact	17
10.4	Sustainability	17
10.5	Worldviews	18
11	08.31.20	18
11.1	Human Populations	18
11.2	Population Ecology	19
11.3	Monitoring Population Dynamics	19
11.4	Exponential Growth & Populations	20
11.5	Monitoring Population Growth	20
11.6	Logistic Growth	20
11.7	Density-dependent/ Density-independent Factors	20
11.8	Regulation	21

12 08.28.20	21
12.1 What is Science?	21
12.2 White-Nose Syndrome Case Study	21
12.2.1 About WNS	21
12.2.2 Science with WNS	22
12.3 Summary	23
13 08.25.20	23
13.1 Applied v Empirical Science	23
13.2 Social Traps	23
13.3 Beginning with Data Interpretation	24
13.4 Observational v Experimental Studies	24
14 08.24.20	24
14.1 Definitions	24
14.2 Ecology != Environmentalism	25

1 10.12.20

1.1 Definitions of Diversity

- Genetic Diversity: Variations in the genes among individuals of the same species
- Species Diversity: The variety of species present in an area; includes the number of different species that are present as well as their relative abundance
- Ecological Diversity: The variety of habitats, niches, trophic levels, and community interactions

1.2 Robust Redhorse

- Thought to be extinct until rediscovered in the Oconee in 1991
- Extripated: Extinct in a local area

1.3 Species Diversity

- Richness: number of different species
- Evenness: relative abundance of each species

- Diversity: combined richness and evenness

1.4 Endemic Species

- Because areas w high ecological diversity offer many habitats and niches, they have a large number of endemic species
- Endemic species: a species that is native to a particular area and not usually found elsewhere
 - Most commonly found in small ecosystems

1.5 Hotspots

- Biodiversity hotspots: areas that have high endemism and have lost at least 70% of their original habitat
- These areas contain a large number of endangered species (species at high risk of becoming extinct)
- The Southeast US is a global hotspot of freshwater biodiversity supporting 2/3 of the country's fish species, over 90% of the US total species of mussels and nearly half of the global total of crayfish species

1.6 Habitat v Niche

- Habitat: the physical location of an species
- Niche: the biotic and abiotic needs for a species to survive

1.7 Biodiversity Loss

- As much as 20% of the world's biodiversity may be lost in the next 30 years
- 50-66% of biodiversity may be lost by the end of the century
- Current rate of extinction is 1500 times greater than pre-human background rate

1.8 Causes of Biodiversity Loss

- Human actions are having significant impacts on biodiversity loss
- Threats include:
 - Habitat destruction
 - Invasive Species introduction
 - Pollution
 - Overharvesting
 - Climate change

1.9 Value of Biodiversity

- Provides key connections between species and their environment
- Provides direct protection against disease
- Provide food, fuel, building materials, and pharmaceuticals

1.10 Ecosystem Services

- Supportive Services:
 - Purification of air and water
 - Carbon sequestration
 - Erosion Prevention
 - Habitats for animals and Plants
- Provisioning Services: Food, resources, water, fuel
- Regulating Services: Pollination, seed dispersal, protection, biological control
- Cultural Services: Recreation, Spiritual Tourism, mental health
- Human Wellbeing:
 - Strong economic growth
 - Medicinal resources
 - Reduction in toxin exposure

1.11 Isolation and Extinction Risk

- Number of unique species increases with isolation
 - Isolation and high endemism makes remote islands particularly vulnerable to species loss
 - Human impact contributes to isolation in the form of habitat fragmentation
 - Habitat fragmentation: destruction of part of an area that creates a patchwork of suitable and unsuitable habitat areas that may exclude some species altogether

2 10.09.20

2.1 Evolution and Resistance

- Evolution happens to populations, not individuals
- Natural selection is the mechanism for evolution
- Genetic drift more likely with low population size
- The potential for antibiotic resistance to develop in bacteria is very high
- Improper waste disposal

2.2 Athens Water Quality

- 10/17 Athens watershed are impaired or unhealthy
- Athens drinking water comes from:
 - N Oconee River
 - Middle Oconee River
 - Cedar Creek
- Athens had E. Coli outbreaks in water, showing prevalence of bacteria

2.3 Gonorrhea & Resistance

- Gonorrhea treatment is done through antibiotics
- Shown increase in resistance to every drug used to treat Gonorrhea
- CDC currently recommending two-drug combination to preserve our last highly effective antibiotic
- Higher reported rates of Gonorrhea occur in SE US, on an overall upward trend with younger populations

2.4 Developing new Antibiotics

- First antibiotic developed by Alexander Fleming in 1928 after noticing the fungus penicillium could kill disease causing bacteria
- Antibiotics aren't profitable for drug companies
- Developing antibiotics are high risk, very expensive, and very difficult
- Low return on investment, development void since 1990

2.5 Post-antibiotic Era

- Currently:
 - 80% of gonorrhea infections now resistant to antibiotics- 440,000 new cases of resistant tuberculosis annually
- In the future
 - Strep throats to scraped knees could be deadly
 - Cost to treat drug resistant double that of the status quo
- Davos Declaration
 - Reducing the development of drug resistance.
 - Increasing investment in R&D that meets global public health needs.
 - Improve access to high-quality antibiotics for all.
 - Signed by 98 companies, 11 industrial associations in 21 countries

3 10.07.20

3.1 Genetic Diversity & Natural Selection

- Genetic diversity in a population is the raw material natural selection
- The larger the amount of genetic diversity, the higher probability that some individuals from that pool can survive changes to its environment
- Phenotype = expressed gene
- Natural selection acts directly on the phenotype, resulting in changes in allele frequencies from parental to offspring generations

4 10.05.20

- Following widespread usage of antibiotics on humans and animals, waste from livestock and humans is generating antibiotic-resistance bacteria
- These bacteria are getting back into the environment through out waste

4.1 Antibiotic Resistance:

- A complex problem that involves helping many actors see the big picture and not just their part of it
- Issues where an action affects (or is affected by) the environment surrounding the issue, either the natural environment or the competitive environment
- Problem whose solutions are not Obvious

4.2 Systems Thinking

- Considers the whole rather than parts of the whole:
 - Events
 - Patterns
 - Underlying Structure

4.3 Cycle of Infection

- Farm animals receive antibiotics often, developing resistant bacteria in their gut
- This can be transmitted through produce, waste, shared environments, etc.

4.4 Bacteria

- Bacteria are single celled organisms that can grow in colonies
- Many different kinds of bacteria can grow together in similar environments

4.5 Explaining Resistance

- Antibiotics kill almost all antibiotic sensitive bacteria, leaving few sensitive and many unsensitive
- Reproduction occurs with the mostly-unsensitive remaining bacteria, leaving too many unsensitive offspring. This increases the amount of resistant bacteria as a whole.

4.6 Genetic Variation

- Variation in the susceptibility of bacteria to antibiotics allows for the propagation of these genes in bacterial communities
- Individuals of the same species have the same basic gene
- Alleles: variants of genes that account for the diversity of traits seen in a population
- Adaptation: traits that promote the success of a species
- An adaptive trait for one environmental condition does not mean that it is adaptive for all conditions

4.7 Genetic Diversity

- Within populations, biodiversity is measured by genetic diversity
- Genetic diversity improves survival of a population

- Outbreeding, through sexual reproduction of not closely related individuals, maximizes genetic diversity
- Inbreeding, or mating between closely related individuals, results from small populations, and increases chances of genetic diseases (e.g., hemophilia, cystic fibrosis, etc.)

4.8 Sources of Genetic Variation

- Mutation: A change in the DNA sequence of sex cells that alter a gene
 - Can be neutral, beneficial, or harmful
- Genetic Recombination: The production of eggs and sperm that results in a shuffling of alleles, creating new combinations in offspring

4.9 Natural Selection

- Constant struggle of organisms to survive and mate
- Organisms tend to produce more offspring that can survive
- Individuals of the same species are not identical
- Evidence of Natural Selection: Selective breeding (artificial selection) of dogs and cats
- Natural selection results in changes in gene frequencies
 - Some individuals will be able to obtain more resources and can produce more offspring
 - * Differential reproductive success results in changes to gene frequencies

5 09.18.20

5.1 Hurricanes

5.1.1 How Hurricanes Form

- Water evaporates over the ocean and forms clouds when it touches cold air

- A column of low pressure develops at the center with winds around the column
- Speed of the wind around it increases
- Categorized based on wind speed (1-5)
- Hurricane development requires warm water and low wind shear
 - Caribbean has warm water all year but also high wind shear which isn't conducive to hurricanes

5.1.2 Climate Change & Hurricanes

- Storm surge more dangerous (accounts for 90% of hurricane deaths)
- 40% increase with a 0.5 degree C inc in temperature
- Increasing of North Atlantic hurricane season
- Climate change is expected to shift the Bermuda high westward
 - Bermuda High is a pressure system over the Atlantic
 - Has the ability to move hurricanes on the Atlantic

5.1.3 Hurricane Harvey Intensification

- Went from a tropical depression to a Cat 4 Hurricane in 57 hours
- Soil in TX affected the amount of water maintained in the Earth
- Huge economic impacts

5.1.4 General Impacts

- Storm Surge
- Extreme Rainfall
- Potential Wind Speed

6 09.16.20

6.1 Heat Waves

- Heat extremes doubled in frequency from 1980-1999 to 2000-2019
- Climate change affecting heat waves
 - Shifting the frequency of hot and cold weather, heat waves are more frequent
 - Exacerbating heat inducing droughts, dry land leads to even hotter temps
- Causes: Global warming ->
 - Large scale global circulation change
 - Atmospheric Blocking increase
 - Air mass temp increase
- Effects and Consequences
 - Decreased human productivity
 - Increased tropical disease and death
 - Environmental racism
 - Crop productivity decreases
 - Lower biodiversity
 - Decreased water availability
 - Increased fire risk

6.2 Wildfires

- Climate change is increasing the size, intensity, and frequency of wildfires
- Wildfires create more climate change through the increase of carbon expulsion through wildfires
- Wildfires have global impacts due to smoke and temperature changes
- Wildfire season has gotten longer due to climate change

7 09.14.20

7.1 Coriolis Effect

- Deflection of an object's path due to the rotation of the Earth
- North and south poles have different deflections of wind patterns
- Little/no deflection at the equator

7.2 Air circulation

- Hottest air at the equator, moves north or south, cools, then comes back into equator

7.2.1 Cells

- Hadley cells: 0-30 degrees North and South
- Ferrell Cell: 30-60 degrees North
- Polar cells: North and South poles
- Northeast and Southeast trade winds (remember directions!)
- Westerlies: bring rain and precipitation

7.3 Surface Ocean Currents

- Ocean currents also affect the distribution of climates
- Surface ocean currents generated by wind, Coriolis effect, heat, and continents
- Heat redistribution from the Tropics
 - Trade winds push warm surface waters west
 - Water reaches continents and flows north and south
 - water cools
 - Westerlies push cooler water east
 - Water reaches continents and flows to equator

7.4 El Nino (Southern Oscillation)

- Recurring climate pattern involving changes in the temperature of waters in the central and eastern tropical Pacific Ocean.
- The ocean and atmosphere can interact to affect climate
 - Water in the eastern pacific warms up
 - Sea level pressure drops but rises in the W pacific
 - Trade winds weaken
 - Upwelling in the Pacific is reduced
 - Warmer waters - increased rainfall in Peru
 - Cooler waters, drought in Australia/Indonesia
- Critical because of its ability to change atmospheric circulation, temps, and precipitation
- Significantly hurts fisheries and developing countries

7.5 La Nina

- exacerbates normal conditions and leads to cooling in the Eastern pacific

7.6 Heat Waves

- Global warming has amplified the intensity, duration, and frequency of extreme heat and heat waves.

8 09.11.20

- Northern latitudes experience greater seasonality in CO₂ concentrations
 - This is due to variation in photosynthetic activity by plants
- Greenhouse effect
 - Some incoming solar radiation is absorbed
 - Other amounts are reflected back into the atmosphere

- Greenhouse gases capture and reradiate some heat over and over, warming the Earth
 - More gases, more heat
- Albedo: measure of the reflectivity of a surface
 - light surfaces have a higher albedo, darker surfaces have a lower albedo
 - surfaces with a low albedo release more heat into the atmosphere
- Positive Feedback Loops
 - applied to albedo:
 - temps rise -> more ice melting -> more water warming -> temps rise
- Urban Heat Island Effect
 - cities will be inc their population, inc energy and temperature
 - cities in particular have higher temperatures
 - tree cover -> cooler temperatures
- Small changes in overall global temp can cause significant changes in weather creating more extreme storms and more record temps
 - roughly twice as many heat records
 - alterations in global jet streams
 - frost comes later and begins earlier
- General climate change impacts:
 - Health impacts
 - Crop productivity
 - Coastal erosion
 - Biodiversity
 - Water availability
 - Fire risk
- Weather events getting more extreme with
 - sea levels

- wildfires
- Need both adaptation and mitigation
 - Adaptation: Responding to warming that has already happened
 - Mitigation: Preventing further warming by addressing climate change causes

9 09.09.20

9.1 The Earth's Atmosphere

- Climate change is a serious environmental problem impacting species, ecosystems, and the globe
- The atmosphere helps protect the Earth from the sun and keeps the temperature of the Earth cool
- Atmosphere has a significant impact on climate
- Earth's Atmosphere Composition
 - Nitrogen (78%)
 - Oxygen (21%)
 - Other - Greenhouse Gases (1%)

9.2 The Keeling Curve

- Curve developed to track atmospheric CO₂ levels in Earth's atmosphere since 1952

10 09.02.20

10.1 Demographic Transition Model

- Demographers use age structure diagrams to predict future growth potential of a population
 - Pyramid structures indicate fast growth
 - House-shaped structures have moderate growth
 - Diamond structures have low/negative growth

- Development leads to smaller families
- Demographic transitions happen country by country
- Industrialization might not lead to a demographic transition in all countries
 - May not be linked to quality of life
 - Religion/Cultural beliefs
 - Social justice issue, improving the well-being of women and children key to dec. fertility

10.2 Social Justice: Education for Women

- Education of girls & economic opportunities for women are correlated with lower birth rates
- Education empowers women to take control over their own fertility through:
 - Birth control
 - Marrying later
 - Delaying childbirth for career opportunities
- Women earning more money is correlated to lower child mortality

10.3 Environmental Impact

- Slowing population growth is critical to sustainability and reducing our population impact
- Our impact on the population is a result of (1) our population size and (2) our consumption habits - both must be addressed
- Ecological footprint: the land area needed to provide the resources for, and assimilate the waste of, a person or population

10.4 Sustainability

- A dynamic process between the economy, society, and environment
- Sustainable: The process or the activity can be maintained without exhaustion or collapse

- Intra & Inter-generational issue
- Capacity of a system to accomodate changes:
 - * rates of renewable resource use should not exceed regeneration rate
 - * rates of non-renewable resource use should not exceed rate of renewable substitute dev
 - * rates of pollution should not exceed ssimilative capacity of the environment
- Sustainable development has three factors:
 - Social equity
 - Economic efficiency
 - Environmental responsibility

10.5 Worldviews

- Culture influences our beliefs through:
 - Knowledge
 - Beliefs
 - Values
 - Learned ways of life
- Worldviews are affected by:
 - Environmental Ethics

11 08.31.20

11.1 Human Populations

- 3 major sparks of growth
 - Agricultural Revolution
 - Industrual Revolution
 - Green Revolution
- With more food and technology, the population and need for more human labor increased

- The human population is rapidly increasing and the impact of humans is due to:
 - More humans overall
 - Greater growth / person
- To address population growth, we need to pursue a variety of approaches that address factors encouraging high birth rates
- Zero population growth: the absence of population growth, occurs when birth rates = death rates
 - Replacement fertility is reached

11.2 Population Ecology

- Analyze and categorize human populations using population ecology techniques
- Population Ecology: a branch of biology dealing with the number of individuals in a particular species in an area over time
- Ecologists study populations to understand what makes them survive and thrive
- Size, distribution, and growth rate is influenced by a variety of factors and are important to understanding population ecology

11.3 Monitoring Population Dynamics

- Population Dynamics: Changes over time in population size and composition
- Important metrics:
 - Minimum viable population - min number of individuals that would still allow population to persist or grow
 - Carrying Capacity (K) - the maximum population size that a particular environment can support indefinitely
- Population Density - the overall density a particular population can sustain

11.4 Exponential Growth & Populations

- Exponential growth occurs in populations when growth is unrestricted. This is, overall, unsustainable
- Growth which becomes progressively larger each breeding cycle
- Produces a J curve when plotted

11.5 Monitoring Population Growth

- Population growth rate - the rate at which a population of a species grows over time
- Growth factors - factors which assist in the growth of a population
- Resistance factors - factors which inhibit the growth of a population
- Limiting factors: resources needed for survival but that may be in short supply

11.6 Logistic Growth

- Occurs when a population nears carrying capacity (k)
 - Maximum sustainable population size
 - Determined by limiting factors

11.7 Density-dependent/ Density-independent Factors

- Density dependent factors increase as populations grow, typically biotic
 - Disease
 - Competition
 - Predation
- Density independent factors affect population growth regardless of population size
 - Storm
 - Fire/Flood
 - Avalanche

11.8 Regulation

- Tendency for populations to decrease in size when above a certain level, and increase in size below that level
- Populations can only be regulated by density-dependent factors
- Top down Regulation
 - Predation
 - Disease
- Bottom up Regulation
 - Nutrients
 - Water
 - Sunlight

12 08.28.20

12.1 What is Science?

- Science: a body of knowledge that allows us to understand the world around us
- Science is based on empirical evidence
- Science allows us to test our ideas and evaluate the evidence
- Scientific knowledge, including facts, theories, and laws, is subject to change
- Scientific claims change as new evidence is made available

12.2 White-Nose Syndrome Case Study

12.2.1 About WNS

- White-Nose Syndrome
 - 2007-2016, 6+ million bats dead as a result of White Nose Syndrome
 - The reason for the deaths was White-Nose Syndrome

- Chytridiomycosis
 - Infectious, fungal disease affecting amphibians
 - Helped understand white-nose syndrome with bats

12.2.2 Science with WNS

- Scientific Method: the procedure used to empirically test a hypothesis
 1. Observations generate questions
 2. Choose a question to investigate
 3. Consult literature
 4. Develop a hypothesis and make a testable prediction
 5. Design and carry out a study
 6. Analyze data
 7. Draw a conclusion
- Inferences: Conclusions drawn based on observations
- Hypothesis: An inference that proposes possible explanation that includes previous knowledge/observation
- Testing a Hypothesis: Hypotheses can be tested through an observational or experimental study
- Scientific Studies: A fair test with results that could support or falsify the research prediction
 - Experimental Studies: Conditions are manipulated intentionally
 - * Test Group: the group in an experimental study such that it differs from the control in only one way
 - * Control Group: the group in an experimental study to which the test group's results are compared
 - Observational Studies: Gather real-world data without any intentional variable manipulation
- Theory: A hypothesis that survives repeated testing by significant research can become a theory
- Correlation v Causation

- Correlation: two things occurring together but not necessarily having a cause-effect relationship
- Cause-Effect Relationship: the association of two variables that identifies one variable occurring as a result of the other
- Observational studies can derive correlation but not causation
- Experimental studies can derive causal relationships
- Policy: a formalized plan that addresses a desired outcome or goal
 - policies need to be flexible, adapt to new findings, address the environmental problem, fit social need and be economically viable in order to work effectively.

12.3 Summary

- Scientific knowledge, though reliable and durable, is never absolute or certain
- This knowledge, including facts, theories, and laws, is subject to change
- Physical evidence, systematically collected and logically analyzed, helps scientists understand environmental issues and guide policy decisions

13 08.25.20

13.1 Applied v Empirical Science

- Applied Science = research whose findings are used to solve practical problems
- Empirical science: A scientific approach that investigates the natural world through case studies

13.2 Social Traps

- Occurs when a large amount of people are using a shared resource
- Seem good in the short term but are actually bad in the long term
- 3 Types:
 - Tragedy of the Commons: When resources are shared, individuals try to maximize personal benefit which hurts the resource itself

- Time delay: Collective decisions that are good today but gone tomorrow
- Sliding reinforcer: related to the evolution of natural organisms and GMOs

13.3 Beginning with Data Interpretation

- Variables represent factors that can be manipulated, controlled, or merely measured for research
- Variation = how much a variable changes
- Independent var is controlled to see effects in the Dependent var
- Graphs explore relationships with data and report this data

13.4 Observational v Experimental Studies

- Observational studies can observe a correlation but are unable to derive a causational reln.
- Experimental studies have a control var (required) and are able to derive causational relns.

14 08.24.20

14.1 Definitions

- Ecology: the branch of science dealing with the relationships of living things to one another & the environment
- Environmental Science: The study of all aspects of the environment, including physical, chemical, and biological factors, particularly with respect to how these aspects affect humans, and vice versa
- Environmental Ethics: Personal philosophy that influences how a person interacts with their natural environment and thus influences how one responds to environmental problems

14.2 Ecology != Environmentalism

- Distinguish between environmentalism & ecology

Environmentalism

Ecology

Activism to protect the environment

Scientific study of living and non-living things