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1 10.14.20

- Exam Review

- Taxonomoc group with the most known species: insects
- Types of biodiversity
 - * Genetic
 - * Species
 - * Ecosystem
- Biodiversity in the Southeast
 - * Describe SE biodoviersity using the terms “richness,” “en-
demic,” and “hotspot”
- Mussels: diversity, life history, and ecosystem service (nutrient
cycling)
- What is diversity?

- Isolation & Extinction Risk

- Hawaii’s biodiversity is vulnerable to extinction - more than 90%
of native species on Hawaiian islands are endemic, one half of
indigenous species face extinction

1.1 Community Ecology

- Mutualism - A symbiotic relationship between individuals where both species benefit
- Parasitism - A symbiotic relationship between individuals of two species in which one benefits and the other is negatively affected (may or may not lead to death)
- Commensalism - A symbiotic relationship between individuals of two species in which one is benefitted and the other is unaffected
- All species contribute to their ecosystem but some are more important than others
- Keystone species influence community structure disproportionately to their abundance
 - Role: create/modify habitats, influence interactions between other species
 - Removal of a keystone species may lead to a loss of biodiversity and changes in community structure within the ecosystem
- Food web: complex and realistic representation of how species feed on each other in a community
- Food chains: a linear representation of how different species in a community feed on each other
- Producers and Consumers
 - Producers: photosynthetic organisms that capture energy directly from the sun and convert it into food
 - Consumers: organisms that gain energy and nutrients by eating other organisms
 - * Animals, fungi, most bacteria, and protozoa
- Trophic level - a level in a food chain or food web
 - Primary consumer: a species that eats producers
 - Secondary consumer: a species that eats primary consumers
 - Tertiary consumer: a species that eats secondary consumers
 - Decomposers can be put practically anywhere on the food web

- Conservation Status: IUCN Designations
 - The International Union for Conservation of Nature established the Red List of Threatened Species in 1963
- Single species conservation programs focus on an individual species, successfully protecting some high-profile species but are less often used for less visible or valued species
- CITES
 - Convention on International Trade in Endangered Species of Wild Flora and Fauna
- Lacey Act: First law protecting wildlife

2 10.12.20

2.1 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

2.2 Robust Redhorse

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

2.3 Species Diversity

- Richness: number of different species
- Evenness: relative abundance of each species
- Diversity: combined richness and evenness

2.4 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

2.5 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

2.6 Habitat v Niche

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

2.7 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

2.8 Causes of Biodiversity Loss

- Human actions are having significant impacts on biodiversity loss
- Threats include:
 - Habitat destruction

- Invasive Species introduction
- Pollution
- Overharvesting
- Climate change

2.9 Value of Biodiversity

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

2.10 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

2.11 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

3 10.09.20

3.1 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

3.2 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

3.3 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

3.4 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

3.5 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

4 10.07.20

4.1 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

5 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

5.1 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

5.2 Systems Thinking

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

5.3 Cycle of Infection

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

5.4 Bacteria

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

5.5 Explaining Resistance

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

5.6 Genetic Variation

- Variation in the susceptibility of bacteria to antibiotics allows for the propogation 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 populat
- 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

5.7 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.)

5.8 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

5.9 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

6 09.18.20

6.1 Hurricanes

6.1.1 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)
- Hurrican development requires warm water and low wind shear
 - Carribean has warm water all year but also high wind shear which isn't conducive to hurricanes

6.1.2 Climate Change & Hurricanes

- Storm surge more dangerous (accoutns for 90% of hurricane deaths)
- 40% increase with a 0.5 decree 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

6.1.3 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

6.1.4 General Impacts

- Storm Surge
- Extreme Rainfall
- Potential Wind Speed

7 09.16.20

7.1 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

7.2 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

8 09.14.20

8.1 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

8.2 Air circulation

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

8.2.1 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

8.3 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

8.4 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

8.5 La Nina

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

8.6 Heat Waves

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

9 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

10 09.09.20

10.1 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%)

10.2 The Keeling Curve

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

11 09.02.20

11.1 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

11.2 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

11.3 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

11.4 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

11.5 Worldviews

- Culture influences our beliefs through:
 - Knowledge
 - Beliefs
 - Values
 - Learned ways of life

- Worldviews are affected by:
 - Environmental Ethics

12 08.31.20

12.1 Human Populations

- 3 major sparks of growth
 - Agricultural Revolution
 - Industrial 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

12.2 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

12.3 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

12.4 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

12.5 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

12.6 Logistic Growth

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

12.7 Density-dependent/ Density-independent Factors

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

12.8 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

13 08.28.20

13.1 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

13.2 White-Nose Syndrome Case Study

13.2.1 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

13.2.2 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.

13.3 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

14 08.25.20

14.1 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

14.2 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

14.3 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

14.4 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.

15 08.24.20

15.1 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

15.2 Ecology != Environmentalism

- Distinguish between environmentalism & ecology

Environmentalism	Ecology
Activism to protect the environment	Scientific study of living and non-living things