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## **1 11.11.20**

### **1.1 Cannabis & Sustaibility**

- Now that cannabis legalization is sweeping North America, we need to better understand its impact on freshwater systems
- 2/3 of Americans believe that marijuana should be legalized

### **1.2 Cannabis & The Economy**

- Cannabis may be key to economic recovery, potentially post COVID, similar to how ending prohibition helped end the Great Depression
- 10s to 100s of Millions made off of Marijuana tax revenue
- California is the biggest producer with Nevada as the runner up for marijuana

### **1.3 Cannabis & Society**

- Many states are now decriminalizing Marijuana and allow for medical Marijuana use
- Without legalization, marijuana feeds non-violent offenders into the prison system, perpetuates mass incarceration, and disproportionately affects POC
- California was the first state to allow medical use of Marijuana, many states have created laws since then

#### 1.4 Cannabis and the Environment

- California case study, Pot takes up very significant amounts of water, no regulation
- Groundwater use has triggered conflicts across areas of California
- Water rights are a large concern in the Marijuana industry, especially for California because unlicensed growers often steal other's water
- US DEA est. that 60% of cannabis consumed nationwide is grown in California
- Bulk of that comes from three upstate counties of the Emerald Triangle: Mendocino, Humboldt and Trinity.
- This is because the conditions there are perfect for Cannabis growth but this comes with problems for the environment, waterways, and wildlife
- Creek Diversions threaten fish habitats
- Road building erodes soil, streams
- 1 marijuana plant growing in a national forest uses 900 gallons of water per growing season
- In 2017, 1.25 Million plants were found growing in CA national parks
- Illegal marijuana growth therefore uses 1.1 Billion gallons of water

#### 1.5 Tristate Water Wars

- For 30 years, GA, AL, FL have fought over the sue of water in the Apalachicola-Chattahoochee- Flint River Basin (ACF) which is heavily influenced by the US Army Corps of Engineers' operation of Lake Lanier's Buford Dam. Lanier lies within Chattahoochee's headwaters, north of Atlanta
- 70: the number of attorneys on retainer by GA
- 4 Million: Pages of documents produced by GA agencies, universities and non-profits requested by FL.
- 660,000 emails give to GA by FL
- 45 people deposed by both GA and FL

## **2 11.02.20**

### **2.1 Triple Bottom Line**

- An assessment of the cost of a good or service should include more than just the economic costs; it should also include the social and environmental cost
- IPAT Equation:  $I = P * A * T$ ; I = Impact, P = Population size, A = Affluence(products/person), T = Tech Usage (impact/product)

### **2.2 Assumptions of Mainstream Economics**

- Environmental economists argue that mainstream economics will fail in the long run because it makes some assumptions that are inconsistent with the way nature operates

#### **1. Assumption:**

- Natural and human resources are infinite, substitutes can be found as necessary
- Economic growth will go on forever
- Something that benefits/harms us today is more important than something that might do so tomorrow

#### **2. Impacts:**

- Linear economic production models use inputs and produce waste without regard to sustainability; circular systems depend on renewable resources and see waste as a useful input
- Cradle to Cradle mentality creates sustainability whereas cradle to grave increases the amount of overall waste

### **2.3 Market solutions**

- Alternative: Command and Control
  - Command = establishment of performance standards by a government authority that must be complied with
  - Control = negative consequences that could result from non-compliance

- Performance Standards
- Tradeable permits
  - Important to consider the effect on environmental justice

#### Economic Incentives

- Seek to reduce or eliminate negative environmental externalities (such as pollution) by incorporating the external cost of production.
- The general focus is prevention rather than remediation
- Payment for Ecosystem Services
  - NYC protecting its water supply

## 2.4 Environmental Policy

- Environmental policy = A course of action adopted by a government or organization intended to improve the natural environment and public health and reduce human impact on the environment
- Collective action undertaken to manage natural resources and human impacts on the environment.
- Things like: – Laws – Regulations – International agreements – Funding decisions

## 2.5 Why is Environmental Policy Challenging

- Many environmental problems transcend boundaries
- Lots of WICKED problems, very complex with multiple stakeholders
- Lawmakers must juggle many factors
  - Effectiveness of the policy
  - Negative tradeoffs
  - Cost burden (internal, external costs)
  - Flexibility of the policy to accommodate changes
- Many times, voters and lawmakers don't agree that they are necessary

## 2.6 History of Environmental Policy

- Before 1960's
  - How best to use resources
  - Pollution not key objective
  - Primarily dealt with at the state level
  - Environmental problems addressed after the fact through litigation, favored the polluter
- Changes
  - As industry, pollution increased, pollution crossed state lines
  - Massive outcry in the 60's and 70's led to federal legislation
  - Performance standards led to a prevention-focused regulation

## 2.7 Who Makes Environmental Policy?

- Elected Officials
- Federal and State Agencies
- Local departments: planning and zoning, public works, etc/
- Courts
- Corporations and other businesses

## 2.8 NEPA

- NEPA's key feature is the Environmental Impact Statement (EIS)—a report that details the likely impacts (positive and negative) of a proposed action.
- The goal of an EIS is to identify problems before they occur so that stakeholders can choose the most acceptable course of action.
- The findings are made available to everyone (citizens, policy makers, and special interest groups)—this keeps the process transparent and everyone is given a chance to respond



## 2.9 Policy Decision Making Process

- Identify problem -> Consider options -> Formulate Plan -> Adopt Law -> Implement Law -> Evaluate effectiveness
- Statutes:
  - Provide policies, goals
  - Typically mandate an agency to promulgate regulations according to statutory standards and enforce them
  - Often authorize states to enforce them
  - Often dictate funding allocations
- Regulations:
  - Regulation = rule = administrative law
  - The actual technical and programmatic standards for environmental protection
  - Standards usually in regulations instead of statutes because of ease of amendment
- Court Decisions
  - Rule on constitutionality of statute, regulation, or other deferential action
  - Rule on application of statute or regulation
  - Rule on meaning (language/intent)
- Executive Orders
  - Presidential directives to do something
  - Often involve internal affairs, Development of amendments to regulations

## 2.10 Misc

- Most environmental regulation passed between the 70's and 90's, no significant regulation since
- Enforcement and Definitions absolutely essential
- Trump and Environmental Policy

- Treaties
- Paris Climate Agreement
  - Agency heads, federal judges
  - Agency directives –rules/regulations
  - Rule rollbacks
  - No new rules or policies
  - More state authority

### **3 10.26.20**

- Disease cases from infected mosquitoes, ticks, and fleas have tripled in the last 13 years

#### **3.1 Malaria**

- Vector: Mosquito
- Transmission: Bite from infected mosquitoes
- Prevalence: Est 219M cases of Malaria, cases are mostly children w 660k Deaths
- US Prevalence: An average of 1,500 reported cases of malaria in the U.S. each year

#### **3.2 Dengue Fever:**

- Vector: Asian tiger mosquito (in 36 US states)
- Transmission: Bite from infected mosquito
- Prevalence: 100M cases worldwide, endemic in the Americas
- Occurs rarely, but there is a small risk for dengue outbreaks in the continental United States, mainly in the Southern US

### **3.3 Chikungunya**

- Transmitted by mosquitoes
- Mainly in Africa, Asia, Europe, Indian, and Pacific Oceans
- First found in the Americas on Caribbean islands in 2013
- Beginning in 2014, reported in US travelers

### **3.4 West Nile Virus**

- Vector: Mosquito
- Transmission: Bite from infected mosquito
- Prevalence: commonly found in Africa, Europe, Middle East, North America, West Asia
- U.S. Prevalence: Between 1999 and 2012, about 37,000 cases of West Nile Virus were reported in the U.S. Over 1,500 people died as a result.

### **3.5 Spread of Disease**

- Increased connectivity increases rate and spread of infectious diseases across the globe
- Correlation between travel advisory and amount of travel to infected areas for Zika
- Zika most likely to be found in the Southeast because of Zika-transmitting mosquito population residence
- High poverty rates correlated with high risk of disease spread due to high population density, potential lack of good healthcare
- Warmer average temps, longer growing seasons, changes in precipitation may lead to more standing water and conditions that may be better for disease spread
- Warmer temps could expose more than 1.3B people to Zika by 2050

### 3.6 Climate Change and Health

- Without effective responses, climate change will:
  - Water quality and quantity: Contributing to a doubling of people living in water-stressed basins by 2050.
  - Food security: In some African countries, yields from rain-fed agriculture may halve by 2020.
  - Control of infectious disease: Increasing population at risk of malaria in Africa by 170 million by 2030, and at risk of dengue by 2 billion by 2080s.
  - Protection from disasters: Increasing exposure to coastal flooding by a factor of 10, and land area in extreme drought by a factor of 10-30
- Rainfall: transports and disseminates infectious agents
- Flooding: sewage treatment plants overflow, water sources contaminated
- Sea levels rise: Increased risk of severe flooding
- Higher temps: increases growth and survival rates of infection
- Drought: increases concentration of pathogens, hurts hygiene

### 3.7 Health Outcomes from Climate Change

- Some expected impacts will be beneficial but most will be adverse. Expectations are mainly for changes in frequency or severity of familiar health risks
- See Zika Climate Final for diagrams

### 3.8 Poverty and Disease

- Diarrhea is related to temperature and precipitation; Diarrhea increased 8% for each 1 degree C temp increase
- Health impacts of climate change unfairly distributed, hurt mortality of developing, low-income countries, especially in Africa

### 3.9 Temperature Effects on Vectors and Pathogens

- Vector:
  - Survival inc/dec depending on species
  - Changes susceptibility of vectors to some pathogens
  - Changes in rate of vector population growth
  - Changes in feeding rate and host contact
- Pathogen:
  - Decreased incubation period at higher temps
  - Changes in transmission season
  - Changes in geographical distribution
  - Decreased viral replication

### 3.10 Precipitation Effects on Vectors

- Survival: increased rain may increase larval habitat
- Excess rain can eliminate habitat by flooding•Low rainfall can create habitat as rivers dry into pools (dry season malaria)
- Decreased rain can increase container-breeding mosquitoes by forcing increased water storage
- Heavy rainfall events can synchronize vector host-seeking and virus transmission
- Increased humidity increases vector survival and vice-versa

### 3.11 IPCC

- Intergovernmental Panel on Climate Change, intl body for assessing the science related to climate change
- Set up in 1988 by the World Meteorological Organization and the UN Environmental Programme
- Provide policymakers w regular assessments about climate change, impacts and future risks, options for mitigation and adaptation

## 4 10.14.20

- Exam Review
  - Taxonomic group with the most known species: insects
  - Types of biodiversity
    - \* Genetic
    - \* Species
    - \* Ecosystem
  - Biodiversity in the Southeast
    - \* Describe SE biodiversity using the terms “richness,” “endemic,” 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

### 4.1 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

## **5 10.12.20**

### **5.1 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

### **5.2 Robust Redhorse**

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

### **5.3 Species Diversity**

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

### **5.4 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

### **5.5 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

## 5.6 Habitat v Niche

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

## 5.7 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

## 5.8 Causes of Biodiversity Loss

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

## 5.9 Value of Biodiversity

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

## 5.10 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

## 5.11 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

# 6 10.09.20

## 6.1 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

## **6.2 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

## **6.3 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

## **6.4 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

## 6.5 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

## 7 10.07.20

### 7.1 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

## 8 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

### **8.1 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

### **8.2 Systems Thinking**

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

### **8.3 Cycle of Infection**

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

### **8.4 Bacteria**

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

### **8.5 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 offspring. This increases the amount of resistant bacteria as a whole.

## 8.6 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

## 8.7 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.)

## 8.8 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

## 8.9 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

## 9 09.18.20

### 9.1 Hurricanes

#### 9.1.1 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

#### 9.1.2 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

### **9.1.3 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

### **9.1.4 General Impacts**

- Storm Surge
- Extreme Rainfall
- Potential Wind Speed

## **10 09.16.20**

### **10.1 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



## **10.2 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

## **11 09.14.20**

### **11.1 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

### **11.2 Air circulation**

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

#### **11.2.1 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

### **11.3 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

#### **11.4 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

#### **11.5 La Nina**

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

#### **11.6 Heat Waves**

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

## 12 09.11.20

- Northern latitudes experience greater seasonality in CO<sub>2</sub> 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

## **13 09.09.20**

### **13.1 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%)

### **13.2 The Keeling Curve**

- Curve developed to track atmospheric CO<sub>2</sub> levels in Earth's atmosphere since 1952

## **14 09.02.20**

### **14.1 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

### **14.2 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

### **14.3 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

#### 14.4 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

#### 14.5 Worldviews

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

## 15 08.31.20

### 15.1 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

### 15.2 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

### 15.3 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

### 15.4 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

### 15.5 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

### 15.6 Logistic Growth

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



### 15.7 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

### 15.8 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

## 16 08.28.20

### 16.1 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

## **16.2 White-Nose Syndrome Case Study**

### **16.2.1 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

### **16.2.2 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.

### 16.3 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

## **17 08.25.20**

### **17.1 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

### **17.2 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

### **17.3 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

### **17.4 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.

## 18 08.24.20

### 18.1 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

### 18.2 Ecology != Environmentalism

- Distinguish between environmentalism & ecology

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