GREEN GENERATION
(B&C) 2022-Year 1

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Ecology Events

- **Ecology** – principles of ecology related to terrestrial environments – 2 year rotation by biomes (1-tundra & forests & 2-deserts & grasslands)

- **Water Quality** – principles of ecology related to aquatic environments – 2 year rotation by aquatic biomes (1-freshwater & 2-marine & estuary)

- **Green Generation (Environmental Science)** – man’s impact on ecology and possible solutions – 2 year rotation by problem issues (1-Aquatic, Air, Climate & 2-Terrestrial, Population Growth)
EVENT COMPONENTS

- **Green Generation Content**
  - Part 1 – General Ecological Principles (1/3)
  - Part 2 – Ecological Issues (1/3)
  - Part 3 – Solutions (1/3)

- **Process skills** in data, graph and diagram analysis

- **Event parameters** – *check the event parameters in the rules for resources allowed.*

A. General Principles of Ecology - food webs and trophic pyramids, nutrient cycling, community interactions, population dynamics, species diversity, indicator species, and invasive species with life history strategies (age structure, survival curves, life tables, succession, R and K strategies for division C only)

B. Overview of Aquatic Environments – freshwater, estuaries, marine
Part 2: Problems from Human Impact on Environment

A. Aquatic Environment Issues — Water pollution, Ocean Dead Zones, Water Diversion, Overfishing, Habitat Destruction, Impacts of Excess Nutrients

B. Air Quality Issues — Acid rain, Air Pollution, Atmospheric Deposition, Nuclear Pollution

C. Climate Change Issues — Greenhouse Effect, Ozone Depletion
Part 3: Solutions to Reversing /Reducing Harmful Effects

A. Legislation and Economic Opportunity for Solving Problems (Div. C)

B. Sustainability Strategies – Aquatic Ecosystems

C. Pollution Prevention, Bioremediation Strategies, Green Infrastructure
TRAINING MATERIALS

- Training Power Point – content overview
- 3 Training Handouts – content information
- Sample Tournament – sample problems with key
- Event Supervisor Guide – prep tips, setup needs, and scoring tips
- Internet Resources & Training Materials – on the Science Olympiad website at www.soinc.org under Event Information
- A Biology-Earth Science CD, an Green Generations (updated-2016) CD, as well as the Division B and Division C Test Packets are available from SO store at www.soinc.org
Part I: Review of General Ecology

ECOLOGY – how organisms interact with one another and with their environment

ENVIRONMENT – living and non-living components

- ABIOTIC – non-living component or physical factors as soil, rainfall, sunlight, temperatures
- BIOTIC – living component are other organisms.
ECOLOGICAL ORGANIZATION

- **INDIVIDUAL** – individual organisms
- **POPULATION** – organisms of same species in same area (biotic factors)
- **COMMUNITY** – several populations in same area (biotic factors)
- **ECOSYSTEM** – community plus abiotic factors
- **BIOSPHERE** – all ecosystems on earth

Levels of Organization
ECOLOGY OF INDIVIDUALS

• **Homeostasis** – delicate balance

• **Components**
  
  – Physiological Ecology
  
  – Temperature and Water Balance
  
  – Light and Biological Cycles
  
  – Physiological Ecology and Conservation
ECOLOGY OF POPULATIONS

- Properties of populations
- Patterns of distribution and density
- Intraspecific competition
- Population dynamics
- Growth and regulation
- Altering population growth
- Human impact
Growth Curves

(a) Exponential (un-restricted) growth

- The growth rate of the population accelerates

(b) Logistic (restricted) growth

- Carrying capacity of environment
  - The rate slows down
- The rate accelerates
  - Point of maximum growth
Survivorship is the percentage of remaining survivors of a population over time; usually shown graphically.

**Type I survivorship curve:** most individuals live out their life span and die of old age (e.g., humans).

**Type II survivorship curve:** individuals die at a constant rate (e.g., birds, rodents, and perennial plants).

**Type III survivorship curve:** most individuals die early in life (e.g., fishes, invertebrates, and plants).
ECOLOGY OF COMMUNITIES

• Closed vs. Open communities
  – Closed – sharp boundaries
  – Open – Lack boundaries

• Species abundance and diversity

• Trophic Structure of Communities
  – Food chains
  – Food web
  – Trophic pyramid
INTERACTIONS AMONG SPECIES

• Interactions
• Interspecific competition
• Predation
• Exploitation
• Symbiosis
Types of Species Interactions

• **Neutral** – two species do not interact
• **Mutualism** – both benefit
• **Commensalism** – one benefits, other neutral
• **Parasitism** – one benefits, one harmed
  but not killed
• **Predation** – one benefits, other killed
Predator - Prey Relationship

The diagram shows the relationship between the number of wolves and moose over a period from 1955 to 1995. The number of wolves and moose exhibit a fluctuating pattern, with peaks and troughs indicating the dynamics of their predator-prey relationship.
Food Chain

- **Producer**
- **1st order Consumer or Herbivore**
- **2nd order Consumer or 1st order Carnivore**
- **3rd order Consumer or 2nd order Carnivore**
- **4th order Consumer or 3rd order Carnivore**
- **Decomposers – consume dead and decaying matter**
ECOLOGY OF ECOSYSTEMS

• **Energy Flow**
  – Energy Flow Pyramids
  – Bio-mass Pyramids

• **Community Succession and Stability**

• **Nutrient Recycling** – nutrient cycles
Energy vs Nutrient

- **Nutrients** – cyclic (Biogeochemical Cycles)
- **Energy flow** – one way
Ecologic Pyramids

Ecological pyramid - a graph representing trophic level numbers within an ecosystem. The primary producer level is at the base of the pyramid with the consumer levels above.

Numbers pyramid - compares the number of individuals in each trophic level.

Biomass pyramid - compares the total dry weight of the organisms in each trophic level.

Energy pyramid - compares the total amount of energy available in each trophic level. This energy is usually measured in kilocalories.
Numbers Pyramid

Number of individual organisms

- 3
- 354,904
- 708,624
- 5,842,424

Trophic level

- Tertiary consumers
- Secondary consumers
- Primary consumers
- Primary producers

Michigan bluegrass field
Biomass & Energy Flow Pyramids

Biomass (grams/m²)
- Carnivores
- Herbivores
- Producers

Energy flow (calories/m²/day)
- Carnivores
- Herbivores
- Producers
Freshwater Ecosystems

Lentic ecosystems – still water

- **Ponds** - small body of freshwater, with no stream draining it - often fed by an underground spring
- **Lakes** - larger body of freshwater, usually drained by a stream. May be naturally occurring or man made.
- **Wetlands** - region of land that holds a great deal of water for significant periods of time, and that contains specialized plants able to grow in these wet conditions

Lotic ecosystems – flowing water

- **Streams** - bodies of moving water, contained within a bank (sides) and bed (bottom).
- **Rivers** - natural streams of water of fairly large size flowing in a definite course or channel or series of diverging and converging channels
Estuaries

- An *estuary* is the areas of water and shoreline where a freshwater stream or river merges with the ocean.
- **Estuaries** can be partially enclosed body of water (such as bays, lagoons, sounds or sloughs) where two different bodies of water meet and mix.
PART 2 – PROBLEMS

Problems resulting from human impacts on the quality of our environment

A. Aquatic Environment Issues – Water pollution, Ocean Dead Zones, Water Diversion, Overfishing, Habitat Destruction, Impacts of Excess Nutrients

B. Air Quality Issues – Acid rain, Air Pollution, Atmospheric Deposition, Nuclear Pollution

C. Climate Change Issues – Greenhouse Effect, Ozone Depletion
Pollution

- Harmful materials entering the environment
- Point source pollution – from a clearly identifiable source
- Nonpoint pollution comes from many different sources.
- Four main categories – industrial, residential, commercial, and environmental
Sources of pollution

- **organic pollution** – decomposition of living organisms and their bi-products
- **inorganic pollution** – dissolved and suspended solids as silt, salts, and minerals
- **toxic pollution** – heavy metals and other chemical compounds that are lethal to organisms
- **thermal pollution** – waste heat from industrial and power generation processes
- **radiation pollution** – radioactive materials
Environmental Pollution

• Air Pollution
• Water Pollution
• Soil Pollution
• Noise Pollution
• Radioactive Pollution
• Thermal Pollution
• Light Pollution
Aquatic Environmental Issues (2015)

- Water pollution
- Eutrophication
- Ocean Dead Zones
- Thermal Pollution
- Water Diversion
- Overfishing
Water Pollution
Safe Drinking Water Act - Protecting America's Public Health

Multiple Risks Require Multiple Barriers

Safe drinking water is essential to the health of American citizens and the economic health of our communities. However, drinking water is vulnerable to contamination from many potential threats. There are programs and activities that can be implemented to protect our nation's water supply, but the success of these barriers relies on the involvement and vigilance of local, state, and federal officials, the private sector, public interest groups, and individual citizens.

This poster identifies examples of:
1. Surface and groundwater sources of drinking water (in blue).
2. Potential threats to those drinking water sources (in red), and
3. The multiple barriers that together protect our nation's public health (in green).

- Risk Prevention Barrier
- Risk Management Barrier
- Risk Monitoring and Compliance Barrier
- Individual Action Barrier

Safe Drinking Water Hotline: (800) 426-4781 Safewater Web Site: www.epa.gov/safewater
Eutrophication – bodies of water becomes enriched with nutrients. This can be a problem in marine habitats such as lakes as it can cause algal blooms.

- run-off from fertilizers, into nearby water causing an increase in nutrient levels.
- It causes phytoplankton to grow and reproduce more rapidly, resulting in algal blooms.
- This bloom of algae disrupts normal ecosystem functioning and causes many problems.
- The algae may use up all the oxygen in the water, leaving none for other marine life. This results in the death of many aquatic organisms such as fish, which need the oxygen in the water to live.
- The bloom of algae may also block sunlight from photosynthetic marine plants under the water surface.
- Some algae even produce toxins that are harmful to higher forms of life. This can cause problems along the food chain and affect any animal that feeds on them.
Eutrophication is magnified as rivers lead into larger rivers and eventually into the ocean – as the Mississippi River network. This leads to ocean dead zones.
Spills or Dumping in Oceans

Chemical spills and dumping of waste in the oceans or near coral reefs and ocean shelf areas causes major environmental problems.

BP Oil Rig Explosion 2010
Thermal Pollution & Rising Ocean Temperatures

- Change in the water temperatures of lakes, rivers, and oceans caused by made-man industries or practices
- Water as coolant is warmed returned & to body of water
- Ocean warming from climate changes

Coral Bleaching
Water Diversion

Dams are a major factor in water diversion. Dams are built along rivers to produce reservoirs.

This affects the ecology of the river and the surrounding environment including Habitat Loss, Habitat Fragmentation, and Loss of Biodiversity.

The Colorado River is a good example.
Overfishing

Fish catch has risen from 20 million tons/year to over 90 million tons/year

World Fish Catch
Air Quality Issues

• Acid rain
• Air Pollution
• Nuclear Pollution
Acid Rain

\[ \text{NO}_x + \text{H}_2\text{O} \rightarrow \text{NITRIC ACID (HNO}_3\text{)} \]
\[ \text{SO}_2 + \text{H}_2\text{O} \rightarrow \text{SULFURIC ACID (H}_2\text{SO}_4\text{)} \]

- SULFUR DIOXIDE (SO₂)
- NITROGEN OXIDE (NOₓ)
- NO & NO₂

ACID PARTICLES & GASES

ACID SNOW

ACID RAIN
Nuclear Pollution

- Nuclear pollution is pollution that is radioactive.
- Fallout can lead to radiation sickness and death.
- Nuclear fallout can destroy environmental features and animal life.

Fukushima Daiichi Disaster - 2011
Climate Change Issues

• **Greenhouse Effect** - warming that results when the atmosphere traps heat radiating from Earth toward space.

• **Ozone Depletion** - ozone layer is deteriorating due to the release of pollution containing the chemicals chlorine and bromine (chlorofluorocarbons or CFCs)
Greenhouse Effect

The Greenhouse Effect

- Some energy is reflected back out to space
- Earth's surface is heated by the sun and radiates the heat back out towards space

Solar energy from the sun passes through the atmosphere

Greenhouse gases in the atmosphere trap some of the heat
**Ozone Depletion**

1. CFCs released
2. CFCs rise into ozone layer
3. UV releases Cl from CFCs
4. Cl destroys ozone
5. Depleted ozone \(\rightarrow\) more UV
6. More UV \(\rightarrow\) more skin cancer
Ozone Hole over Antarctica

Source: NASA
Part 3 – Solutions – Year 1

A. Environmental Remediation Strategies – Aquatic Environments and Air Quality

B. Sustainability Strategies – Aquatic Ecosystems and Air Quality

C. Pollution Prevention, Bioremediation Strategies, and Green Infrastructure

C. Legislation and Economic Opportunity for Solving Problems (Division C)
Tragedy of the Commons

- Conflict between individual interest and the common good
- When individuals use a public good, they do not bear the entire cost of their actions
- Who takes responsibility for protecting the environment?
Environmental Remediation

Strategies

• **Environmental remediation** is the removal of pollution or contaminants from the environment

• **Strategies and techniques include (coordinated by EPA)**
  - Site assessment and mapping
  - Excavation and dredging
  - Pump and treat
  - Solidification and stabilization
  - Oxidation
  - Soil vapor extraction
  - Bioremediation – using microbes to remove pollutants
Sustainability Strategies

**Sustainability** - biological systems enduring and remaining diverse and productive

**Strategies include**

- Minimize energy consumption & using alternate energy
- Minimize water consumption
- Minimize negative environmental impacts
- Minimize waste generation and recycling
- Develop eco-friendly products and processes
Strategies for a Sustainable World

- advancing technologies to reduce waste
- increasing recycling and reuse
- creating even safer treatment and disposal options
- developing sources of renewable energy
- sharing the benefits of our learning and innovation
Everyday Solutions

• Conserve
• Increase Efficiency
• Recycle
Economic Opportunity

• Support careers in Environmental Remediation
• Development of Environmentally Safe Products and Processes which are economically sound.
• Encourage Economic Growth that is environmentally beneficial
Legislation – Role of EPA - Div.C

1. Clean Air Act (CAA)
2. Clean Water Act (CWA)
3. Emergency Planning & Community Right-To-Know Act (EPCRA)
4. Endangered Species Act
5. Federal Insecticide, Fungicide and Rodenticide Act (FIFRA)
6. Freedom of Information Act (FOIA)
7. National Environmental Policy Act (NEPA)
8. Occupational Safety and Health Act (OSHA)
9. Oil Pollution Act of 1990 (OPA)
10. Pollution Prevention Act (PPA)
11. Resource Conservation and Recovery Act (RCRA)
12. Safe Drinking Water Act (SDWA)
13. Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA or Superfund)
14. Superfund Amendments and Reauthorization Act
15. Toxic Substances Control Act (TSCA)