

Earthrise – Taken by *Apollo 8* Astronaut William A. Anders
on December 24, 1968

Most influential environmental photograph ever taken!!



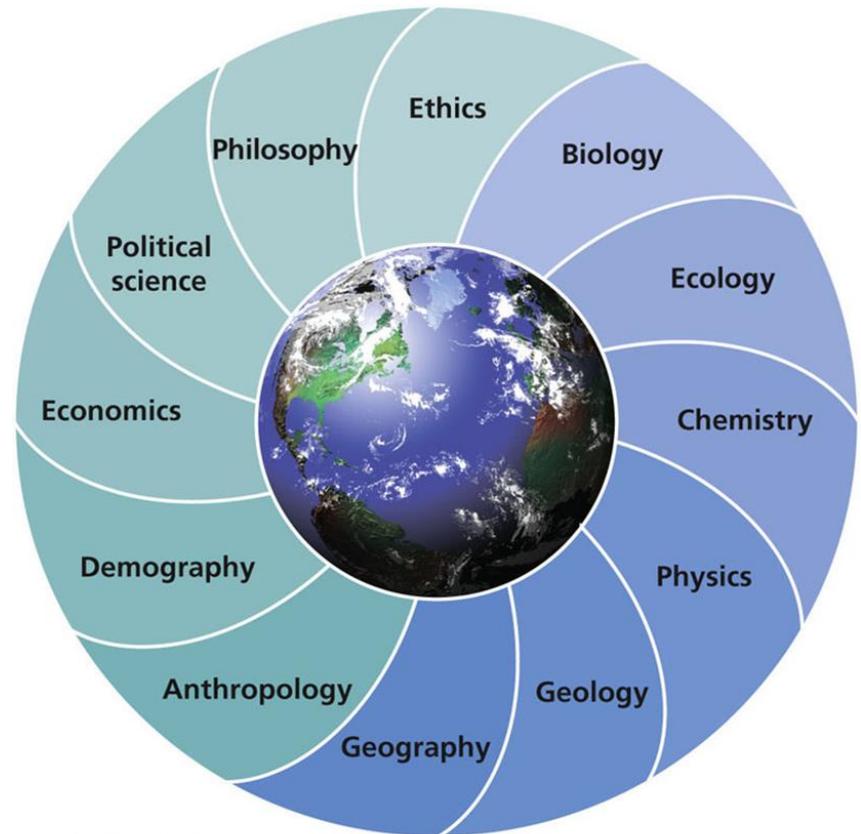
“Spaceship Earth” – Kenneth E. Boulding, Economist

The Environment

- Everything around us, living and non-living things with which we *interact*
- Despite scientific and technological advances, we depend on the environment!!
- **We are part of, not apart from, the rest of nature.**

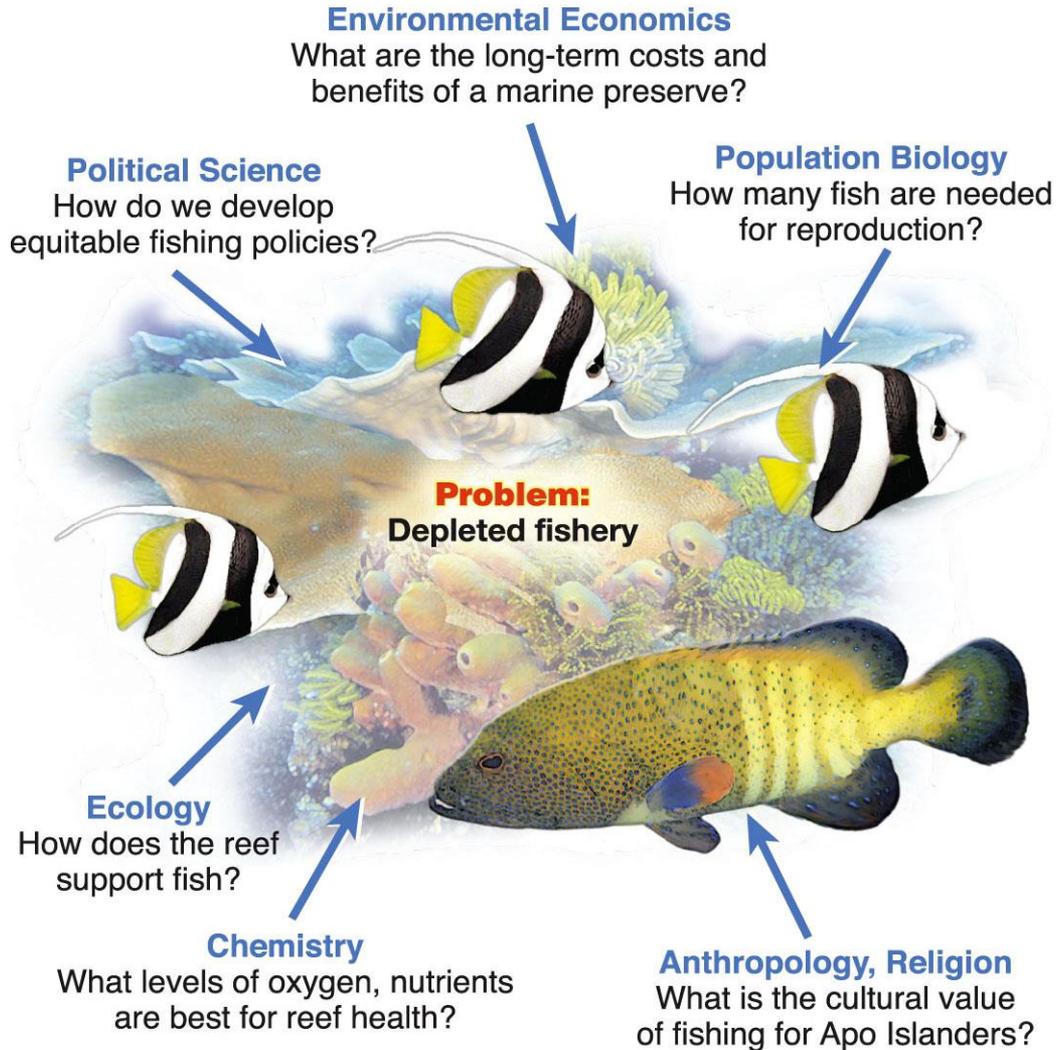
Environmental Science

- Systematic study of the environment, our place in it and how we interact with it
- Draws on many fields of knowledge as environmental problems are very complex!



Environmental Science

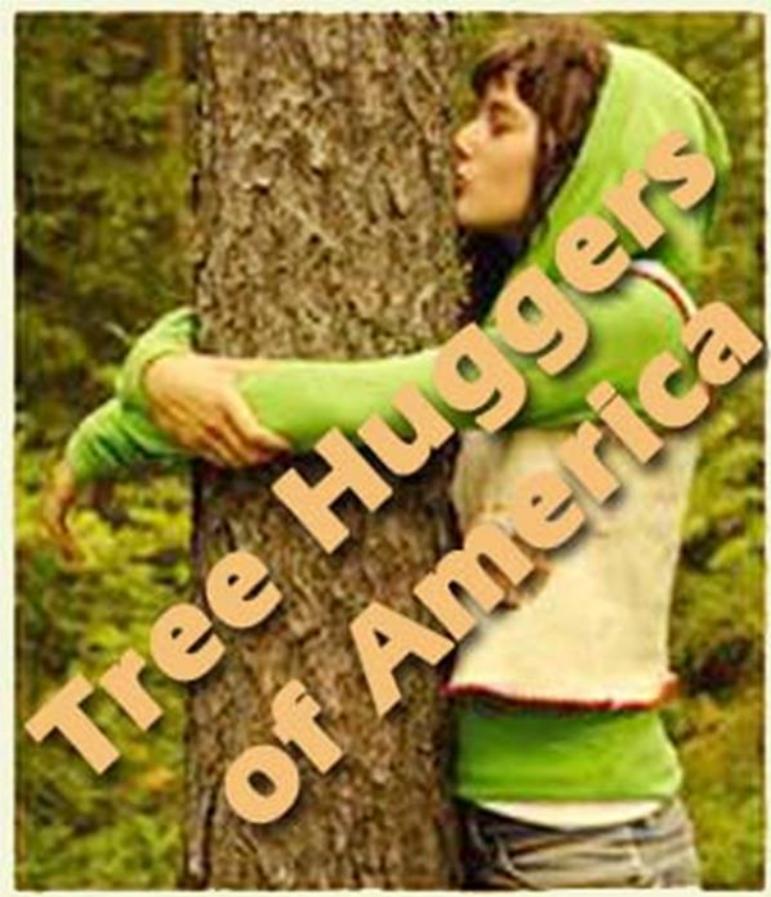
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Goals of Environmental Science

- To learn how nature works
- To learn how the environment affects us and how we affect the environment
- To learn how to deal with environmental problems and live more sustainably

Environmental Science (Science) vs. Environmentalism (Social Movement; Concern)!



www.treehuggersofamerica.com

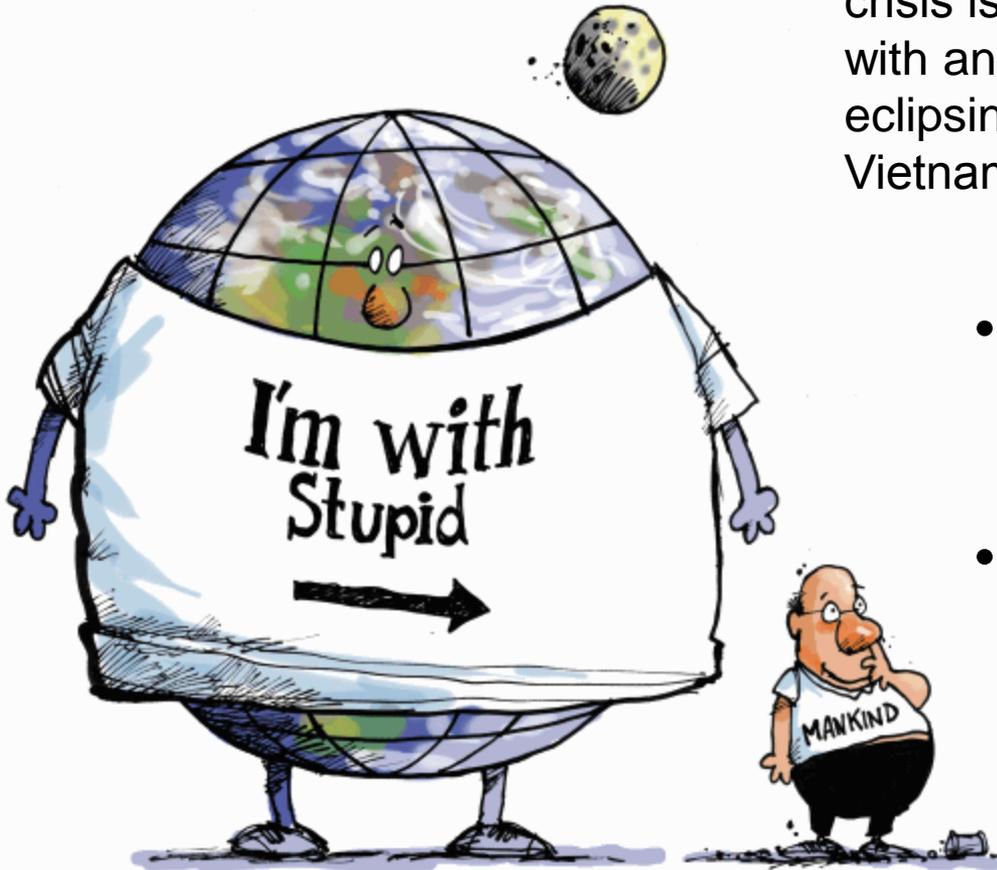


www.60sfurther.com/Communes.htm

Earth Day

April 22, 1970

Cartoons@Telus.net
caglecartoons.com



“Rising concern about the environmental crisis is sweeping [America’s] campuses with an intensity that may be on its way to eclipsing student discontent over the war in Vietnam.”
New York Times

- A belief in the need to redefine our relationship with nature
- Ecology = the field of study called upon to provide a road map for this new course of action

Ecology

- From the Greek word *oikos* meaning house or place to live, and *logos* meaning study
- The branch of biology that deals with organisms and how they interact with each other (biotic interactions) and with their environment (abiotic interactions)

Hierarchy of Ecological Organization



Biosphere Parts of the earth's air, water, and soil where life is found

Ecosystem A community of different species interacting with one another and with their nonliving environment of matter and energy

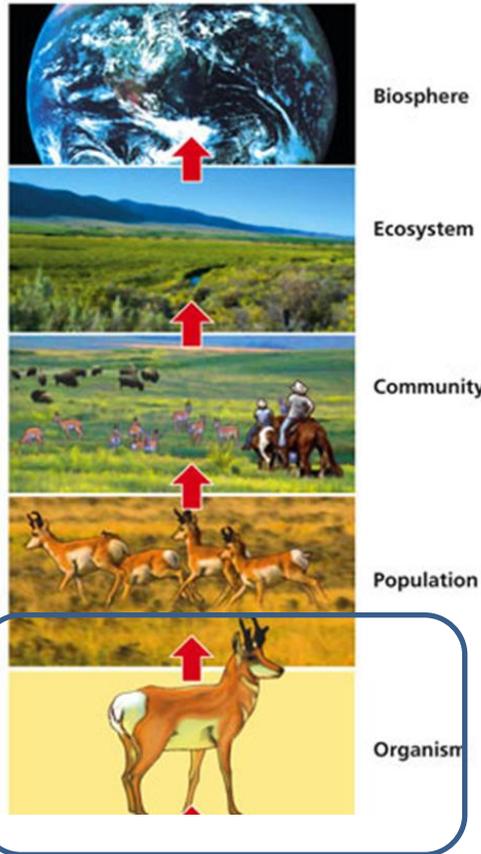
Community Populations of different species living in a particular place, and potentially interacting with each other

Population A group of individuals of the same species living in a particular place

Organism An individual living being

Organisms

Each a member of a species



- **Species:** group of organisms with distinctive traits, and for sexually reproducing organisms, can mate and produce fertile offspring.
- *Homo sapiens sapiens*

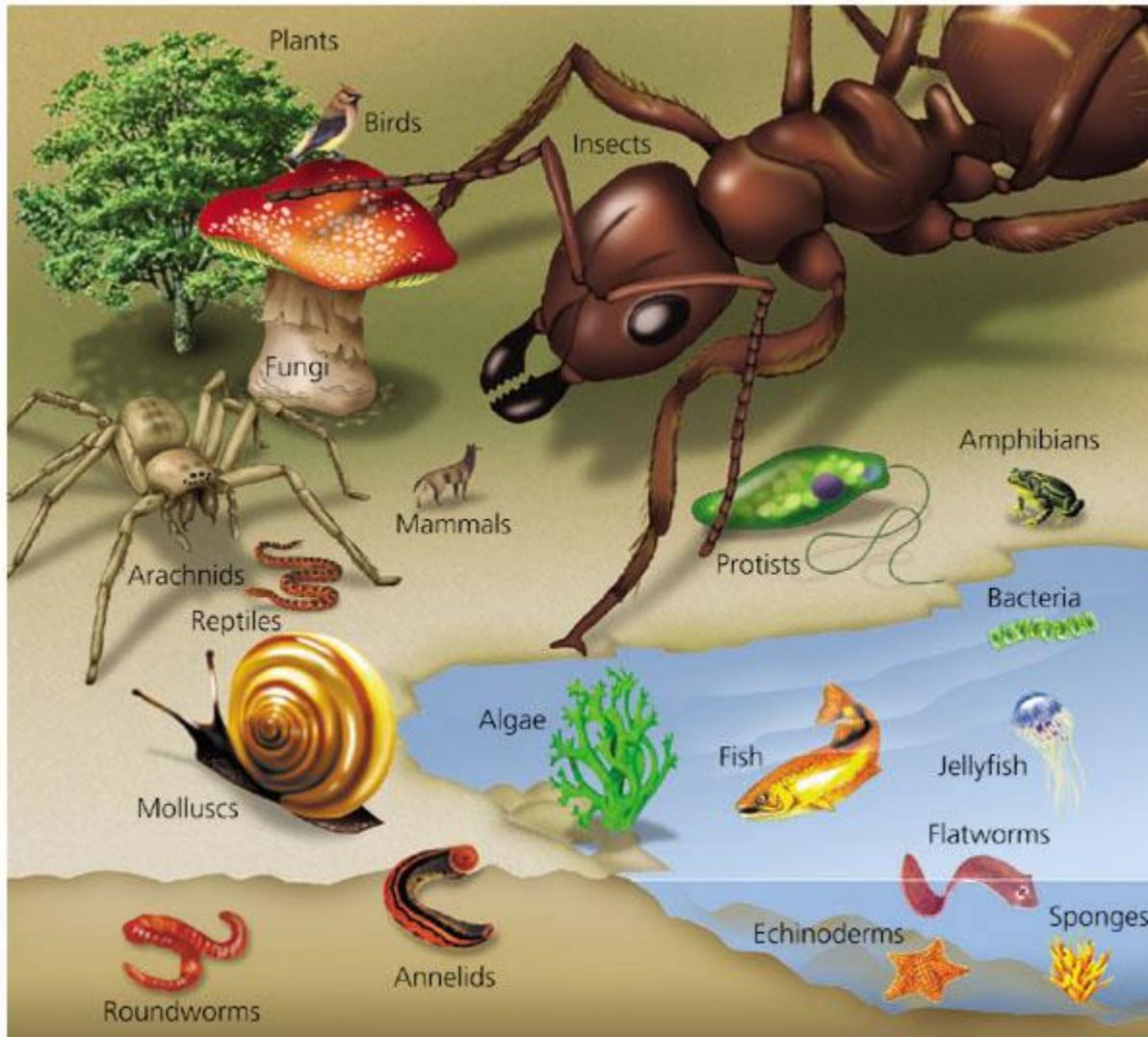


Organisms – Species Diversity

- We do not know the number of species on Earth!!
- About 4 million to 100 million
- Best guess is 10 – 14 million species.
- 1.8 million species identified so far

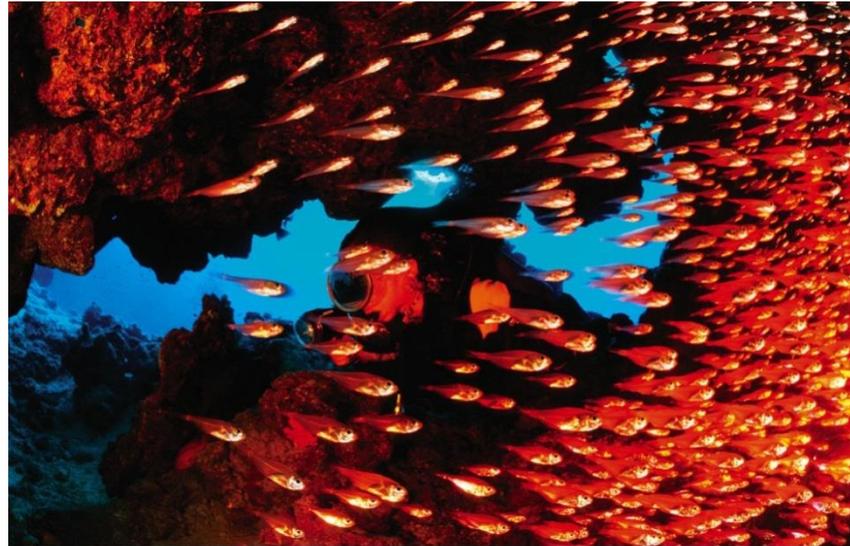
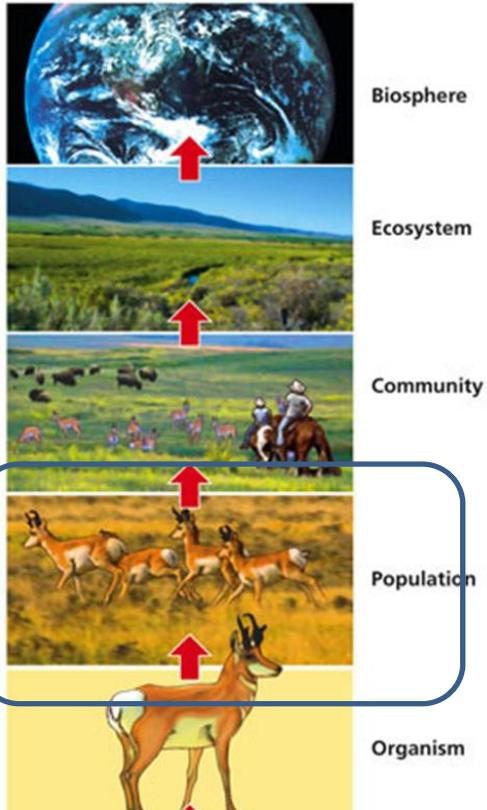
Organisms – Species Diversity

Insects make up the most of the world's known species!!



(a) Organisms scaled in size to number of species

Populations



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- A population of glassfish in a cave in the Red Sea

Genetic Diversity



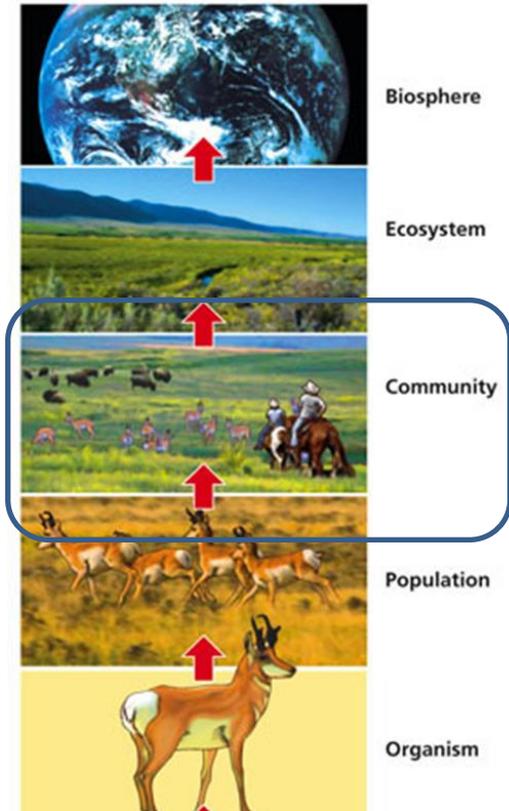
(b) Springer spaniel, golden retriever, mixed breed, Jack Russell terrier

Habitat

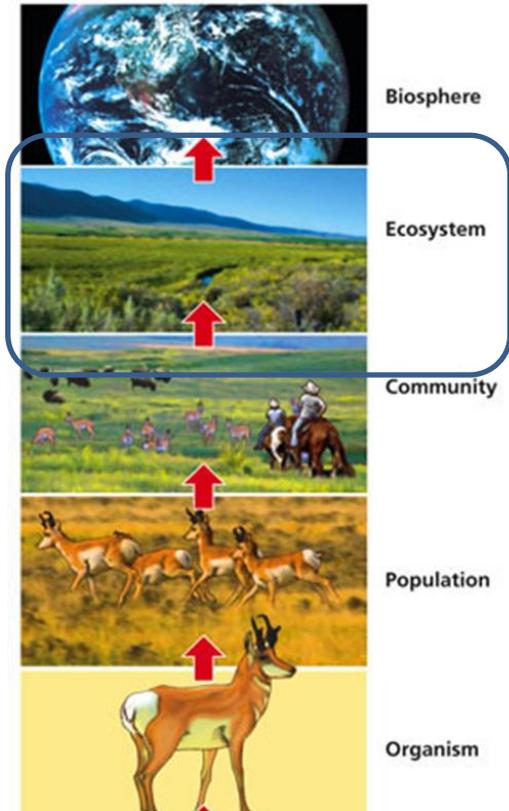
- Natural address; place where a population or an individual organism normally lives
- As large as the ocean or as small as the intestine of a termite
- Provide its inhabitants with resources as well as the appropriate environmental conditions needed by organisms to survive

Communities

- Organisms in a community interact with one another in feeding and other relationships.



Ecosystems



- As small as a puddle of water to as big as the ocean
- Natural or artificial

Ecosystems Taanayel Lake



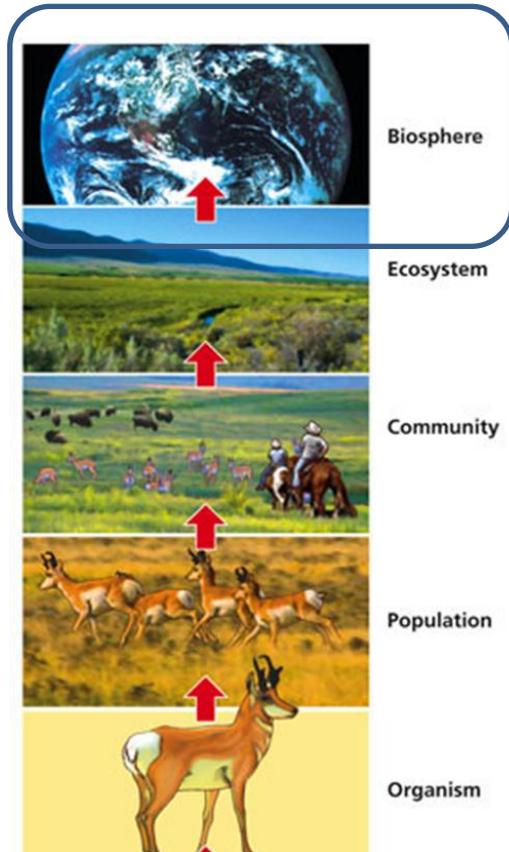
Ecosystems

Chouf Cedars Forest



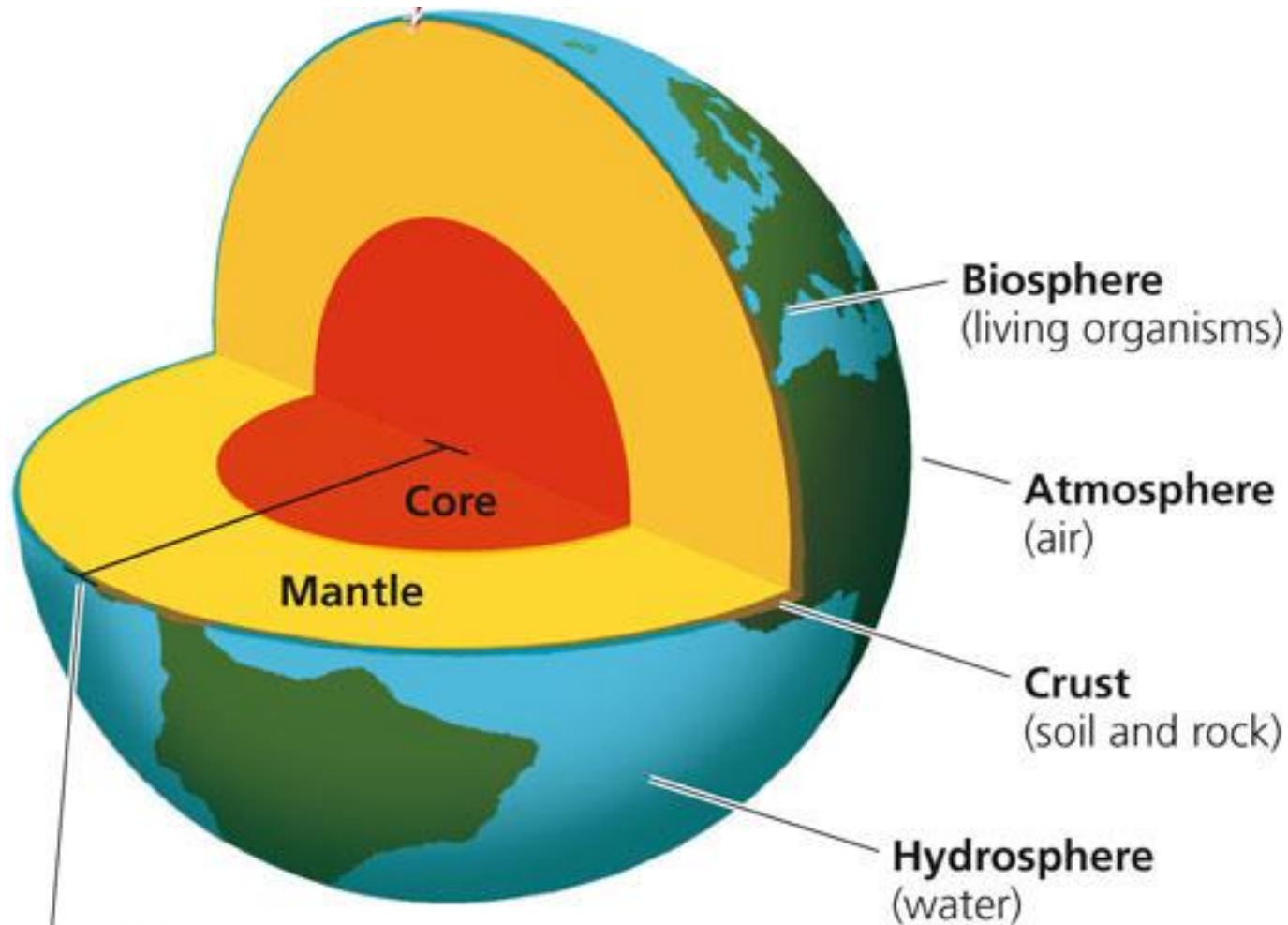
Biosphere

- The global ecosystem in which all organisms exist and can interact with one another



Earth's Life Support Systems

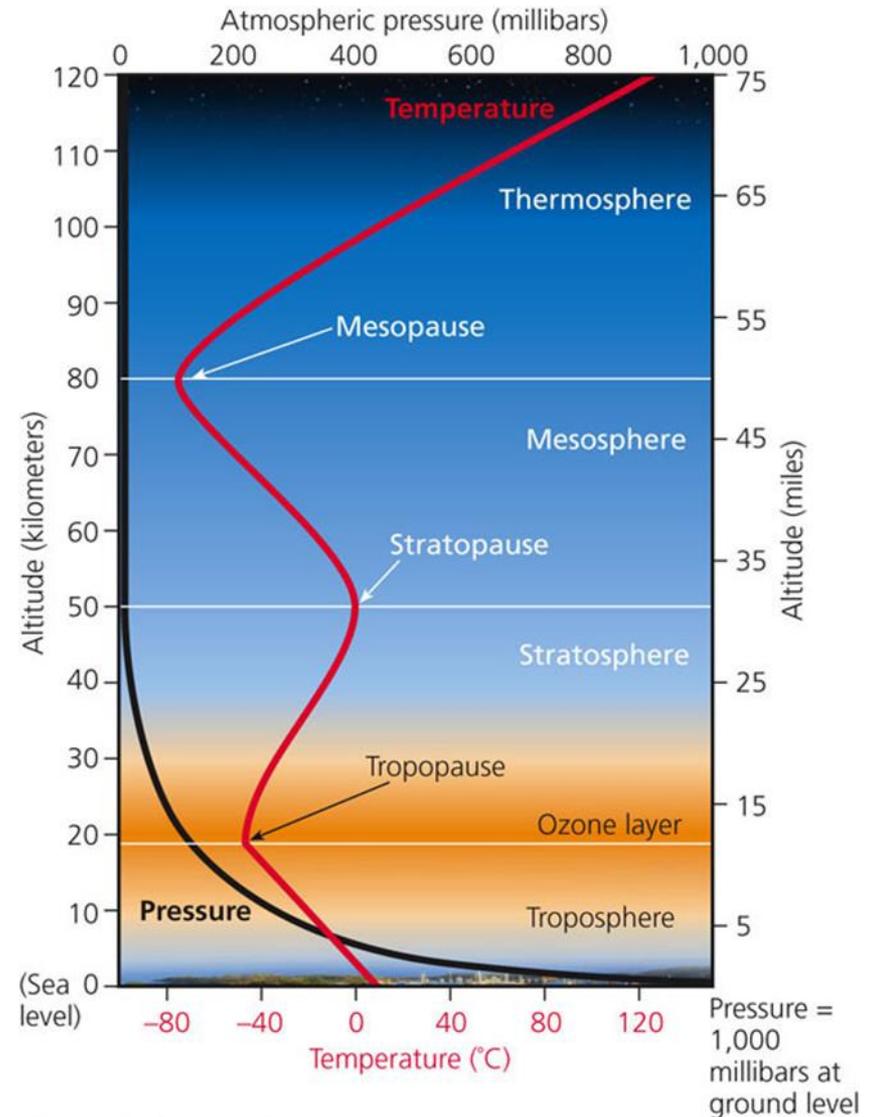
Four main spherical systems



Geosphere
(crust, mantle, core)

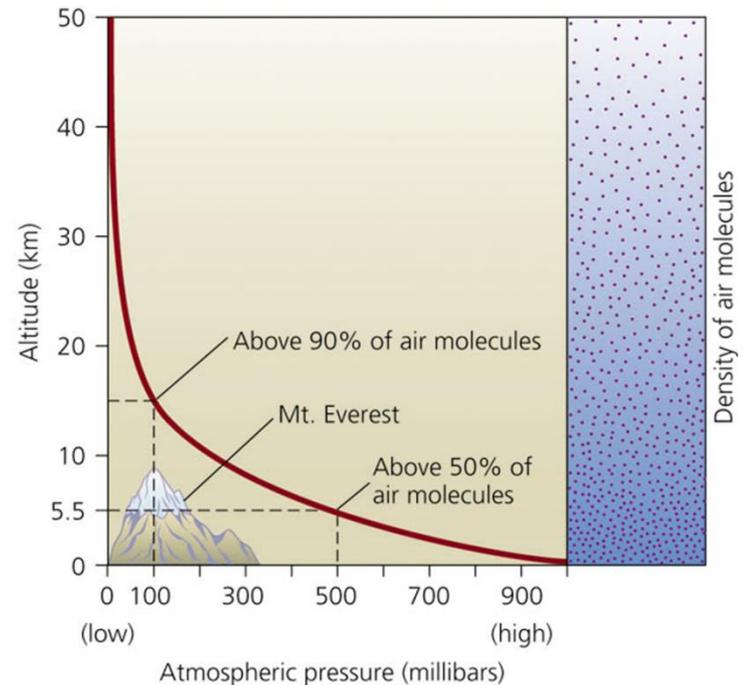
The Atmosphere

- Thin envelope of gasses surrounding the earth
- Divided into several spherical layers, each characterized by abrupt changes in temperature caused by differences in the absorption of incoming solar radiation



The Atmosphere

- Density and atmospheric pressure both influenced by gravity, which pulls the gas molecules in the atmosphere towards the earth's surface
- Density (molecules per liter) higher at sea level than on top of the world's highest mountain
- Atmospheric pressure (force or mass per unit area of a column of air) also higher at sea level

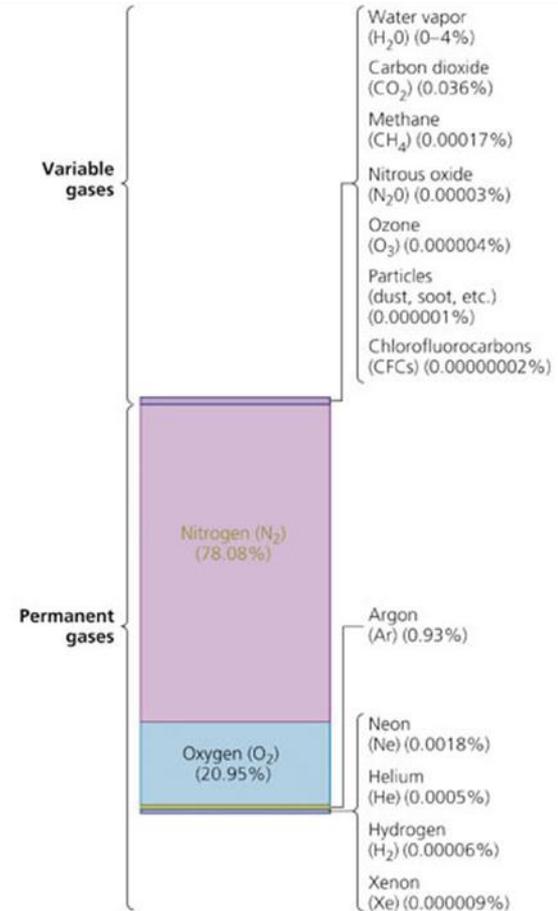


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The Atmosphere

Troposphere

- Layer of the atmosphere closest to the surface of earth
- 17 km above sea level at the equator; 8 km at the poles
- Around 75–80% of the earth's air mass
- Contains the air we breathe: Nitrogen gas 78%; Oxygen gas 21%; Water vapor at poles 0.01%; Water vapor in tropics 4%
- Rising and falling air currents in the troposphere largely responsible for weather and climate
- Involved in chemical cycling of the earth's nutrients

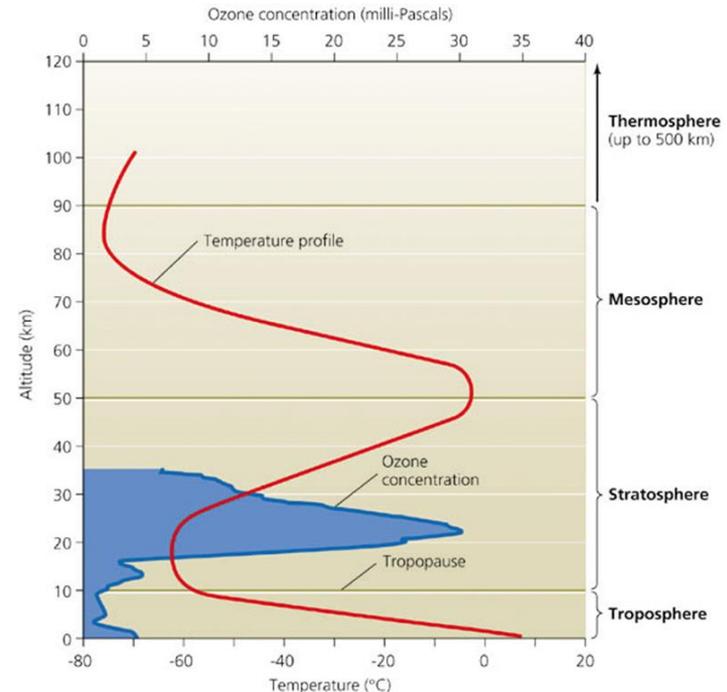


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The Atmosphere

- **Stratosphere**

- Second layer of the atmosphere (starting from the Earth's surface)
- From 17 to 48 km above the earth's surface
- Although much thinner (less matter), similar in composition to the troposphere, with two exceptions
 - Much less water (1/1000 that of troposphere)
 - Higher concentration of O₃ (Ozone; filters UV!!)



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The Blue Planet

Over 71% of the earth's surface covered by water

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© Spacescapes/PhotoDisc

The Hydrosphere

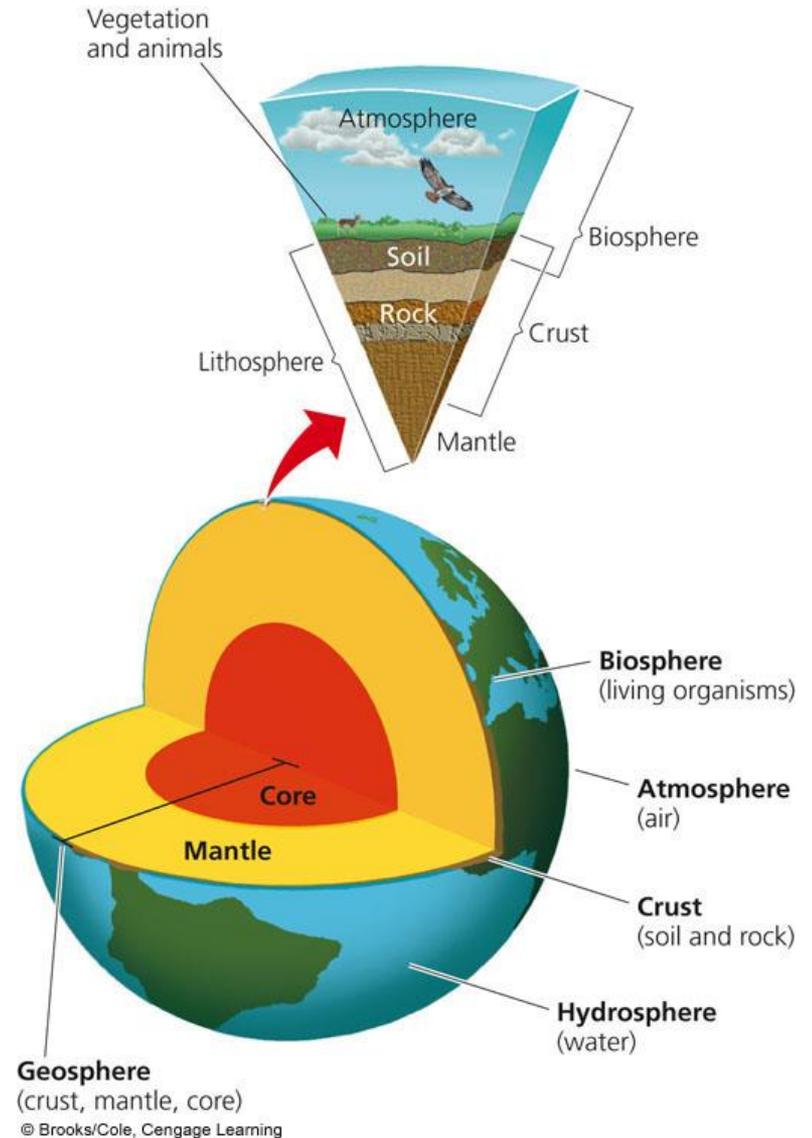
- All the water on or near Earth's surface
- Includes liquid water (surface and underground), ice (polar ice, icebergs, glaciers and ice in frozen soil layers "permafrost") and water vapor in the atmosphere

The Hydrosphere

- Most of the water in the biosphere is seawater.
- Thus Samuel Taylor Coleridge's "Water, water, everywhere, nor any drop to drink."

The Geosphere

- Includes Earth's intensely hot **core**, a thick **mantle** mostly composed of rock and a thin outer **crust**
- **Lithosphere**: crust + portion of outer mantle; contains non-renewable fossil fuels and minerals as well as renewable soil chemicals that organisms need



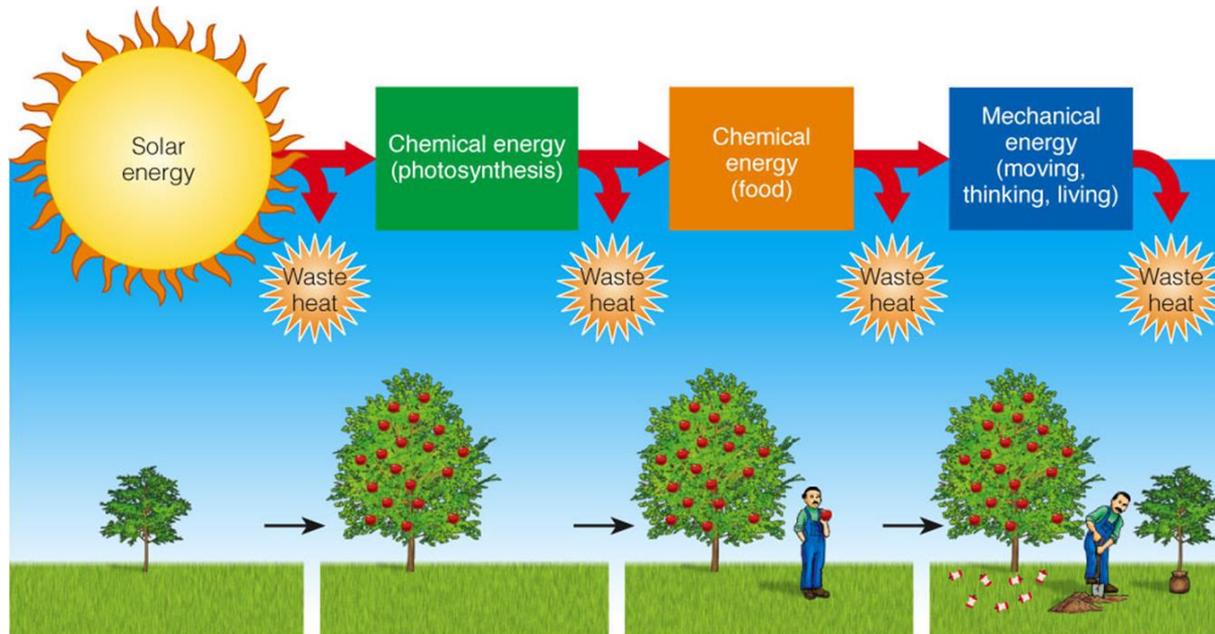
The Biosphere

- To the earth like the skin to the apple
- Lower atmosphere, most of the hydrosphere and the uppermost part of the geosphere (where life exists)
- From the bottom of the ocean to ca. 9 km above Earth's surface

Factors Sustaining Life on Earth

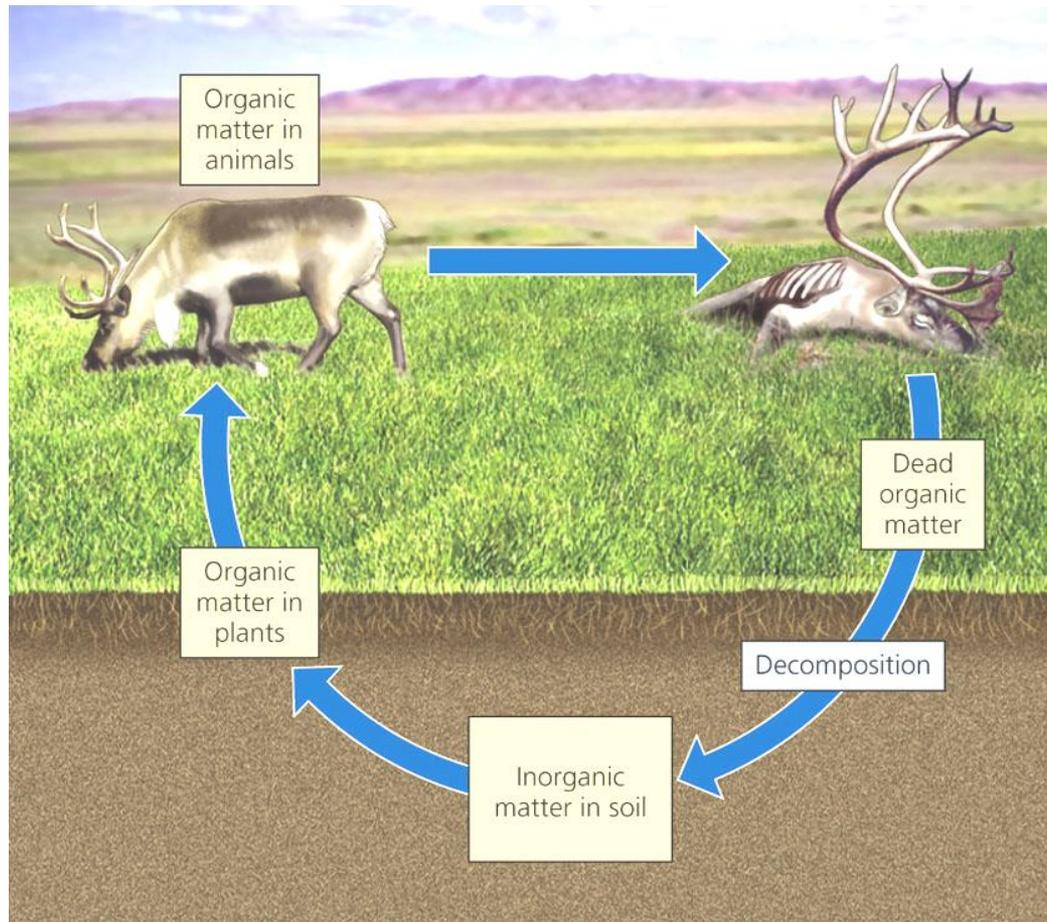
1. Energy:

- One-way flow of high quality energy from the sun through living things in their feeding interactions into the environment mostly as heat dispersed into the water and air at low temperature (low quality energy) and eventually back into space as heat



Factors Sustaining Life on Earth

2. Matter or Nutrient Cycling



Factors Sustaining Life on Earth

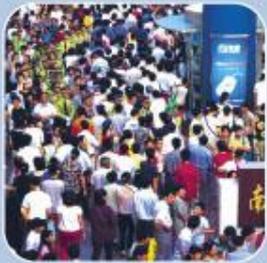
- **Matter or nutrient cycling:**
 - Essential since Earth is closed to significant input of matter from outer space
 - In compliance with the law of conservation of matter, the fixed supply of nutrients must be continually recycled to support life.
 - Cycles take seconds to centuries to complete.

Factors Sustaining Life on Earth

3. Gravity:

- Allows the planet to hold onto its atmosphere
- Allows the cycling of chemicals the air, water, soil and organisms

Causes of Environmental Problems



Population growth



Unsustainable resource use



Poverty



Excluding environmental costs from market prices



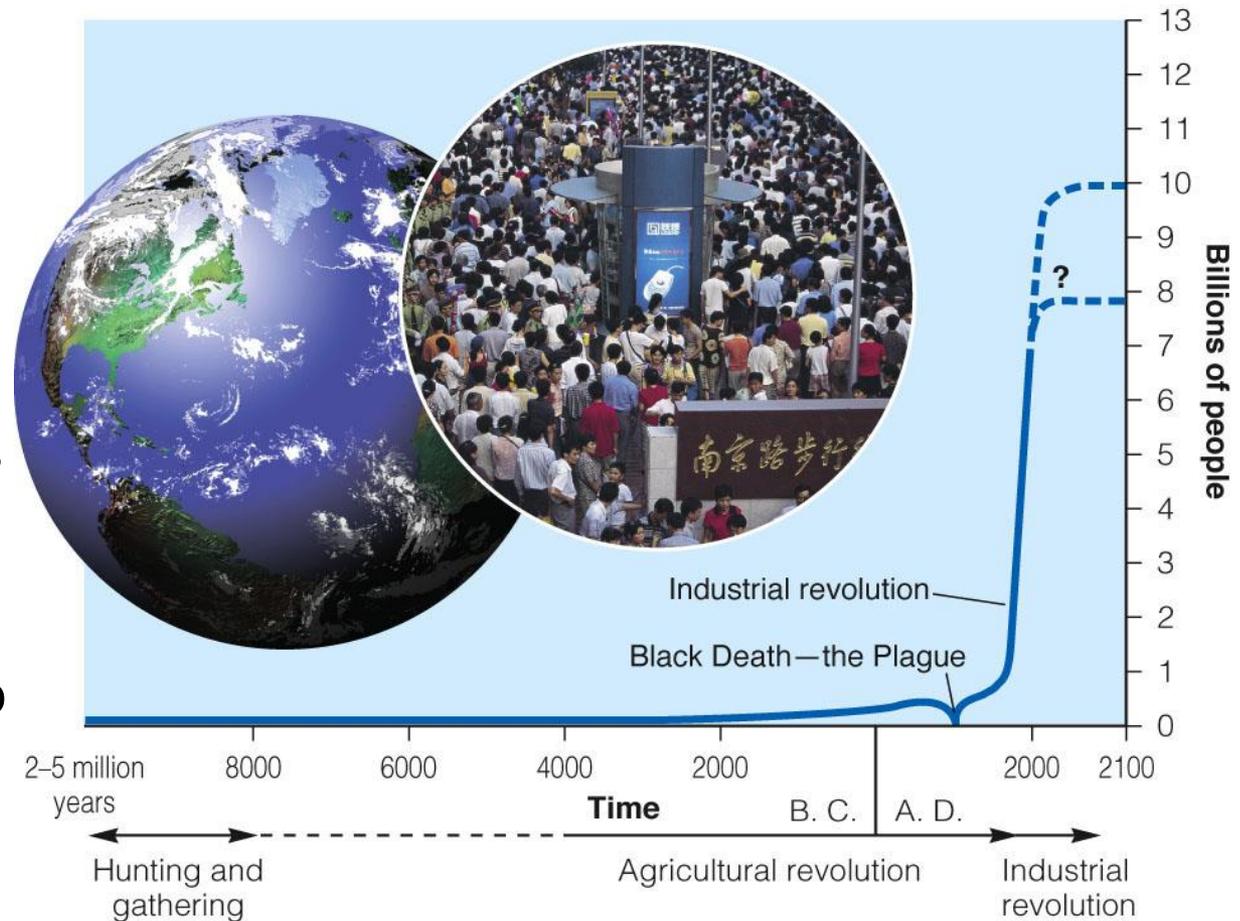
Trying to manage nature without knowing enough about it

Expanding Human Population

Major Cause of Environmental Problems

The Cause Behind All Causes!!

- **Exponential Growth**
- Deceptive as it starts off slowly, but after a few doublings, it grows to enormous numbers
- Analogy of the two kings playing chess!!
- Analogy of paper folding!!



Poverty

- Occurs when people are unable to meet their basic needs for adequate food, water, shelter, health and education
- 48% of the people worldwide are living on less than 2 USD a day!!



Poverty

Lack of access to

Number of people (% of world's population)

Adequate sanitation facilities 2.6 billion (38%)

Enough fuel for heating and cooking 2 billion (29%)

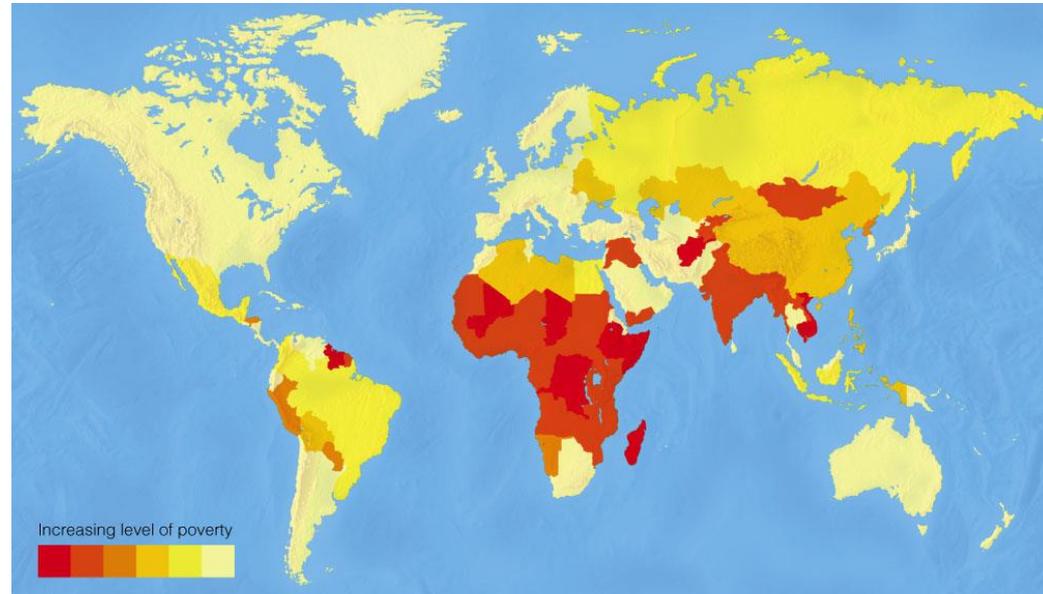
Electricity 2 billion (29%)

Clean drinking water 1.1 billion (16%)

Adequate health care 1.1 billion (16%)

Adequate housing 1 billion (15%)

Enough food for good health 0.86 billion (13%)



Poverty

- People living on less than 2 USD a day are focused on getting enough food, water and cooking and heating fuel to survive.
- Desperate for short-term survival, they do not care about the environment: they deplete and degrade forests, soil, grasslands, fisheries, wildlife....
- They do not worry about long term environmental quality and sustainability.

Poverty

- Poverty affects population growth.
- Children help gather fuel (wood and animal dung), haul drinking water and tend crops and livestock.
- Children also help take care of the parents in their old age because they do not have social security, health care and retirement funds.

Poverty

Many desperately poor people die prematurely from several preventable health problems!!

Malnutrition

- Due to lack of proteins and other nutrients needed for good health
- Increases the chances of death from normally non-fatal illnesses like diarrhea and measles

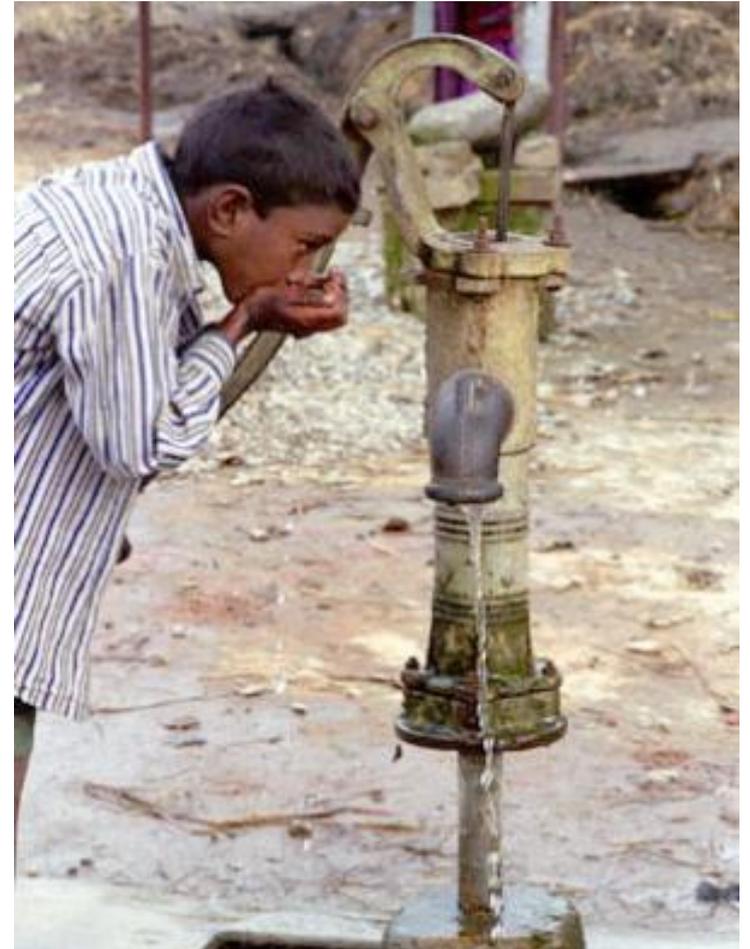


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Poverty

Many desperately poor people die prematurely from several preventable health problems!!

Limited access to adequate sanitation facilities and clean drinking water!!



Poverty

Many poor people suffer from **severe respiratory diseases and premature death** due to inhaling indoor air pollutants produced by burning wood or coal in open fires or in poorly vented stoves for heat or cooking.

Children Working
in a Plastic
Factory in an
Urban Slum in
Bangladesh



Poverty

- **Bad news:** These factors cause premature death for at least seven million people each year!! Two thirds of those dying are children younger than five years old.
- **Good news:** We can solve the problems resulting from poverty in two to three decades if we act!!

Affluence

- The addiction to over-consumption of material goods
- Its effects much worse and more serious than the effects of poverty
- Increases our environmental impact just as population growth does
- Affluence mostly based on the assumption that buying more and more things will bring happiness (advertising!!)

Affluence

Typical American family of four with all their possessions, Texas, USA



Affluence

Family of five farmers with ALL their possessions, Himalaya Mountains



Affluence

- In 1999, the richest one-fifth of the world's people possessed 82 times the income of the poorest one-fifth.
- They also used 86% of the world's resources.
- 80% of the world's population lives on 14% of the global resources – energy, food, water,

**INCREASING TENSION BETWEEN THE HAVES
AND THE HAVE-NOTS**

Affluence

- Solutions:
 - Admit the problem
 - Shop less
 - Avoid malls and shopping centers
- **Toynbee's law of progressive simplification:**
transfer energy and attention to the nonmaterial side of life!!

Affluence

- Can lead people to become more concerned about environmental quality
- Provides money for developing technologies to reduce pollution, environmental degradation and resource waste
- Financed improvements in environmental qualities based on increased scientific research and technological advances

Affluence

In most affluent countries (compared to the 1970s):

- The air is cleaner.
- Drinking water is purer.
- Most rivers and lakes are cleaner.
- Food supply is more abundant and safer.
- The incidence of life-threatening infectious diseases has been greatly reduced.
- Lifespan is longer.
- Some endangered species are being rescued from premature extinction!!

Excluding Environmental Costs from Market Prices

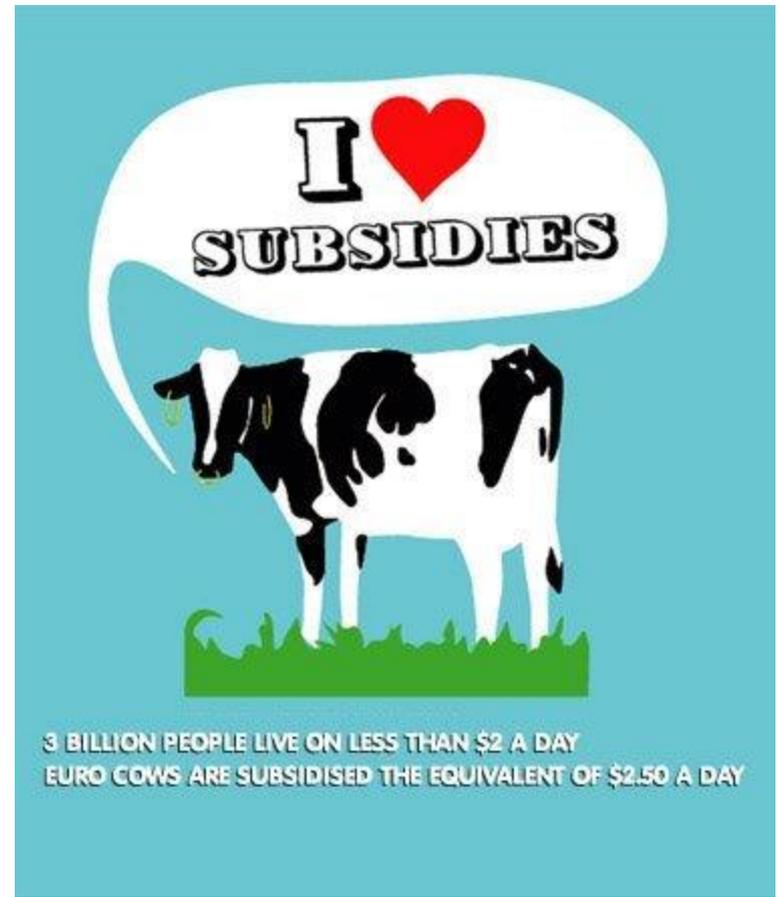
- When companies use resources to create goods and services for consumers, they are usually not required to pay the environmental costs of resource use.
- Fishing companies pay the cost of catching fish but not the cost of depletion of fish stocks.
- Timber companies pay for clear-cutting forests but not for the resulting environmental degradation and loss of wildlife habitat.

Excluding Environmental Costs from Market Prices

- The primary goal of companies is to maximize their profits, so they do not pay the harmful environmental costs (or even assess them) except if they are required by the government laws or regulations to do so.
- The prices of goods and services do not include their harmful environmental costs; consumers are generally not aware of them!!

Excluding Environmental Costs from Market Prices

Some governments give tax breaks and payments called **subsidies** to assist companies in using resources to run their businesses.

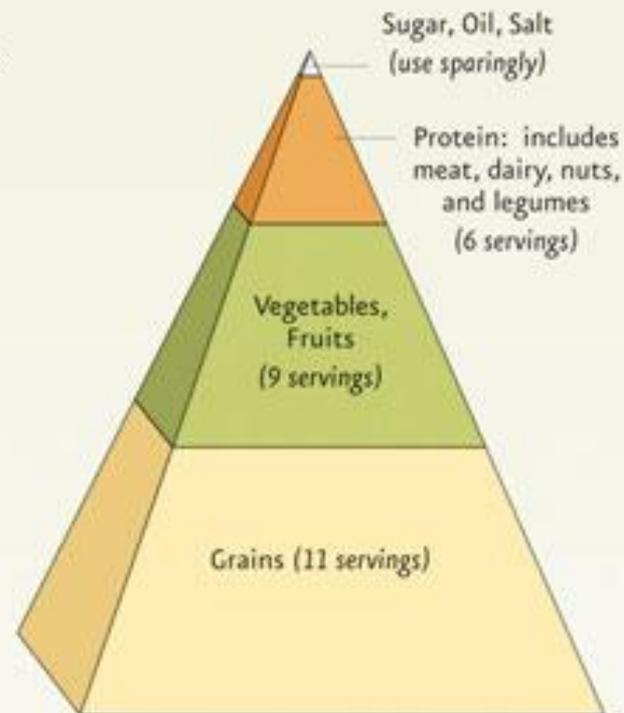
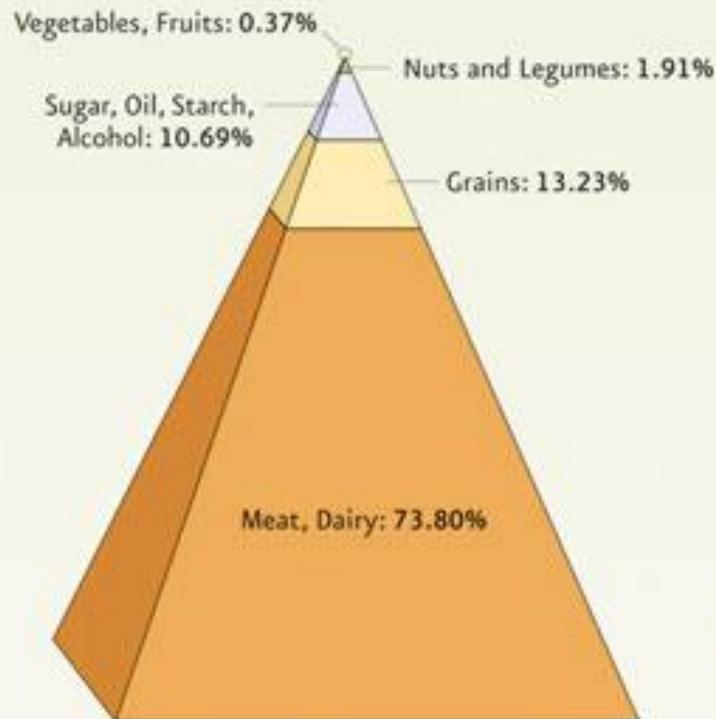


Excluding Environmental Costs from Market Prices

Why Does a Salad Cost More Than a Big Mac?

Federal Subsidies for Food Production, 1995-2005*

Federal Nutrition Recommendations



Excluding Environmental Costs from Market Prices

- Subsidies help create jobs and stimulate economies.
- They also result in degradation of the natural environment because its value is not included in market prices!!

Environmental Decision Making

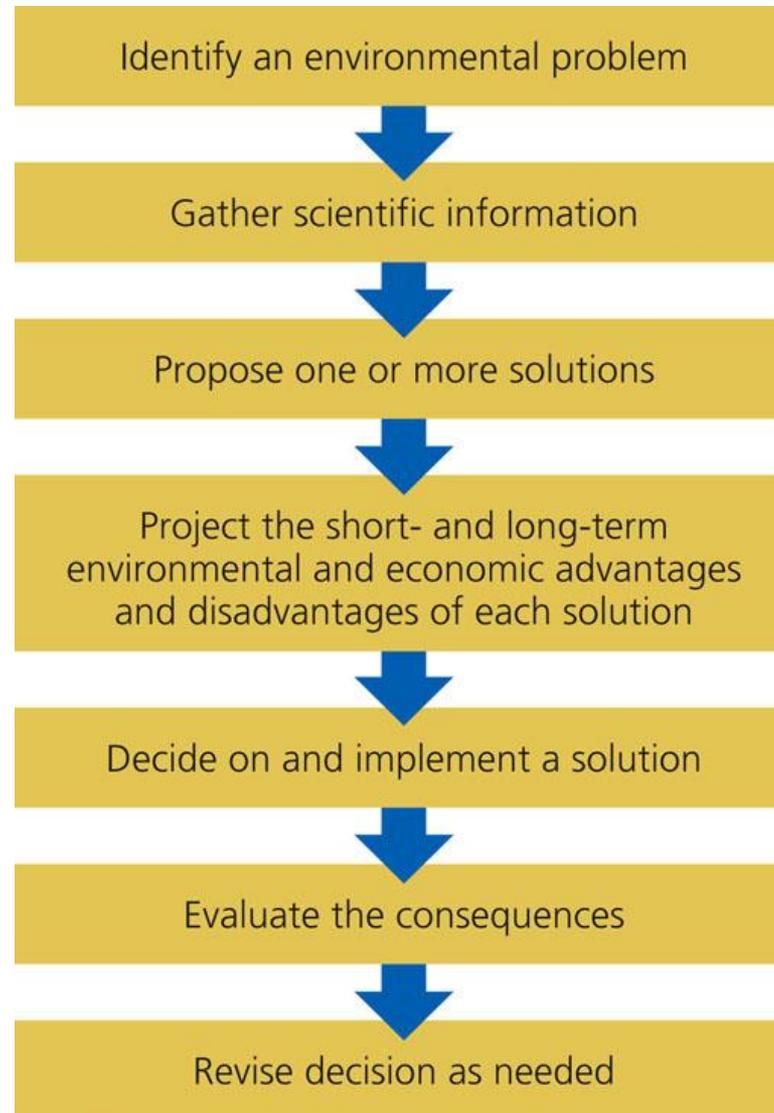
- When dealing with an environmental problem, one should start by carrying out scientific research on the problem and evaluating the possible solutions to the problem.

Environmental Decision Making

Each proposed solution must be evaluated:

- Any human values involved?
- Projected short-term and long-term beneficial and harmful environmental, economic and health effects
- Costs?
- Is the solution ethical?

Environmental Decision Making



Environmental Decision Making

- **Marine resources:** Around the world, people who depend on seafood for their livelihood and sustenance are finding that setting aside marine reserves can restore fish populations as well as promote human development.



© Greenpeace

Figure 3. Aerial view of the site where the Marine Reserve is considered. a: Hard bottom; b: Vermetid reefs; c: Seagrass meadow and sand; d: Fishing port and embankment; e: beach (pebbles).



Figure 9. Stars showing the suggested borders of the marine reserve.

Environmental Decision Making

- Solutions to environmental problems are not black and white but rather all shades of gray!!
- Proponents of all sides of these issues have at least some legitimate and useful insights.
- Any proposed solution has advantages and disadvantages (long-term and short-term).
- Search for **trade-off solutions!!**