Objectives, EKs & Skills

Unit 5 - Land Use

LEARNING OBJECTIVE

EIN-2.A

Explain the concept of the tragedy of the commons.

ESSENTIAL KNOWLEDGE

EIN-2.A.1

The tragedy of the commons suggests that individuals will use shared resources in their own self-interest rather than in keeping with the common good, thereby depleting the resources.

SUGGESTED SKILL

Concept Explanation

1.B

Explain environmental concepts and processes.

5.10 Urbanization

Objectives, EKs, Skill

LEARNING OBJECTIVE

EIN-2.M

Describe the effects of urbanization on the environment.

SUGGESTED SKILL

Environmental Solutions

7.C

Describe disadvantages, advantages, or unintended consequences for potential solutions.

ESSENTIAL KNOWLEDGE

EIN-2.M.1

Urbanization can lead to depletion of resources and saltwater intrusion in the hydrologic cycle.

EIN-2.M.2

Urbanization, through the burning of fossil fuels and landfills, affects the carbon cycle by increasing the amount of carbon dioxide in the atmosphere.

EIN-2.M.3

Impervious surfaces are human-made structures—such as roads, buildings, sidewalks, and parking lots—that do not allow water to reach the soil, leading to flooding.

EIN-2.M.4

Urban sprawl is the change in population distribution from high population density areas to low density suburbs that spread into rural lands, leading to potential environmental problems.

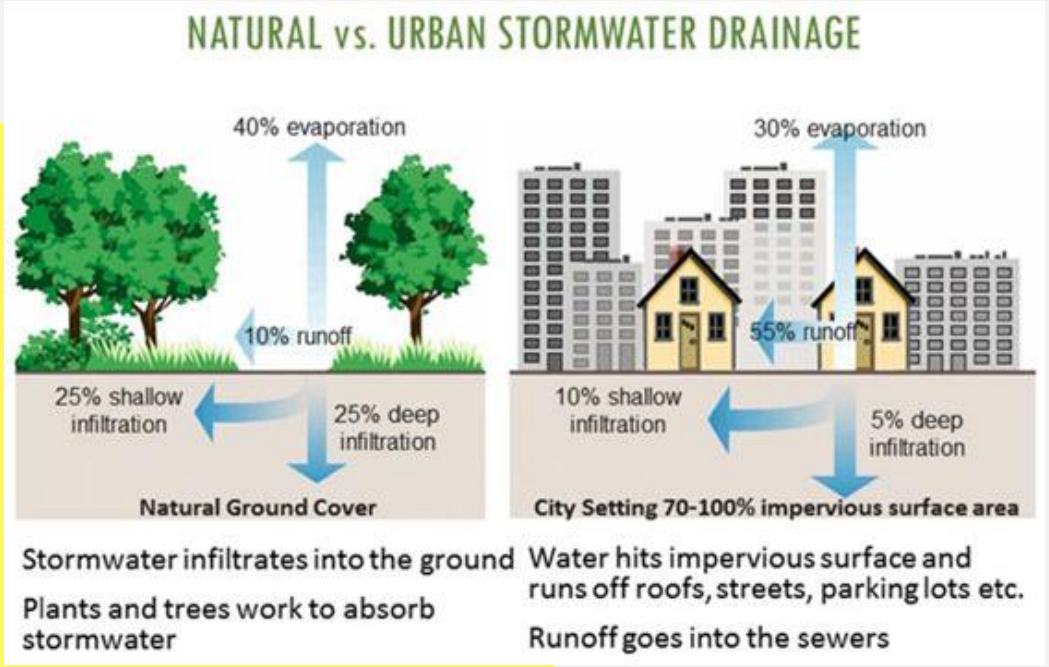
Urbanization

Removing of vegetation to convert natural landscape to city (urban)

Replaces soil, vegetation, wetlands , with impervious surfaces (concrete, asphalt, cement) which don't allow water to infiltrate into the ground

CO_2 emissions:

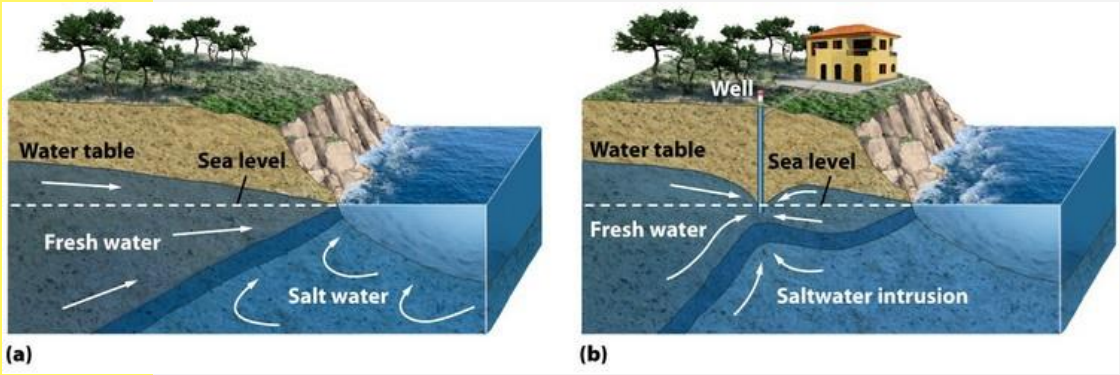
- Cement production
- Construction machinery
- Deforestation (loss of future carbon sequestration + decomposition of cut trees)
- Landfills needed for disposing trash from large pop.



Urbanization prevents groundwater recharge, causing precipitation to runoff into local bodies of water

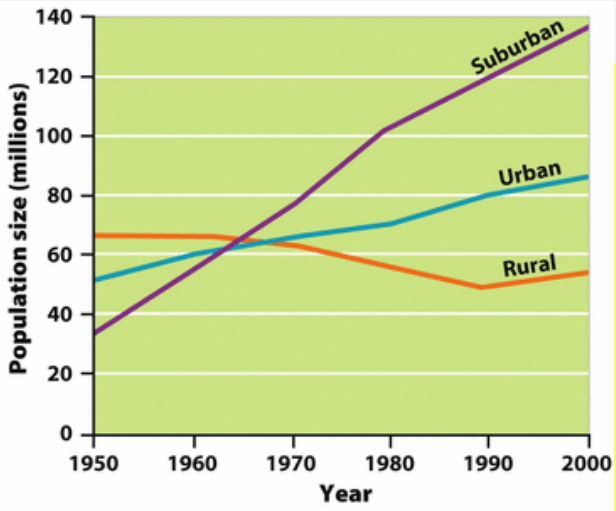
Urbanization in Coastal Cities

Population growth in coastal cities can lead to **saltwater intrusion** due to:



Sea level rise due to warming of ocean (thermal expansion) and melting of ice caps (increasing ocean volume) can contaminate fresh groundwater with salt

Excessive groundwater withdrawal near coast lowering water table pressure, allowing saltwater to seep into groundwater



Overall trend in US & many other nations is away from less dense rural (country) areas and toward more urban (city) areas

- Suburbs less dense areas surrounding urban areas *Ex: Kentwood Forest Hills*

Trends in Pop.

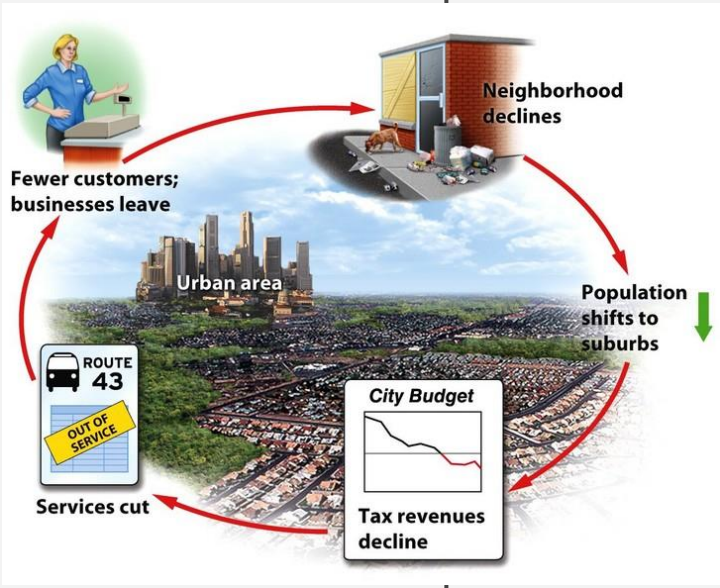
People move from rural → urban areas for jobs, entertainment, cultural attractions

Urban areas are more densely populated, minimizing driving & land use per person (decreases env. Impact per person)

Highest growth currently is **suburban** population

Urban Sprawl

Pop. movement out of dense, urban centers to less dense suburban areas surrounding the city (GR → Kentwood, Wyoming, F. Hills, ect.)



Causes:

- Cheaper property in suburbs than in cities (larger home for same price)
- Cars make it easy to still get from the suburbs into the city for work, entertainment, cultural attractions
- Domino effect (neighbors leave, so you leave)
- Fewer residents in cities leads to decline in tax revenue for city (decrease in city services)
- Residents leave, so businesses follow
- Abandoned homes + businesses create **blight** (unsightly, rundown infrastructure) so more people leave

Urban Sprawl Causes

- Expanded highway system makes travel eas
  increases driving
- Increase in driving increases fuel tax revenu
  is used to build more highways
- Highway expansion makes it easier and easi
  commute from suburbs into urban areas

Solutions

+ <u>Urban growth boundaries</u>: zoning laws set by cities preventing development beyond a certain boundary
+ Public transport & walkable city design that attract residents to stay
+ <u>Mixed land use:</u> residential, business, and entertainment buildings all located in the same area of a city
  + Enables walkability & sense of place

SUGGESTED SKILL

Environmental Solutions

7.C

Describe disadvantages, advantages, or unintended consequences for potential solutions.

Practice FRQ 5.10

Describe a possible solution to the issue of urban sprawl. **Identify** one possible economic consequence of this solution

5.11 Ecological Footprint

Objectives, EKs, and Skill

SUGGESTED SKILL

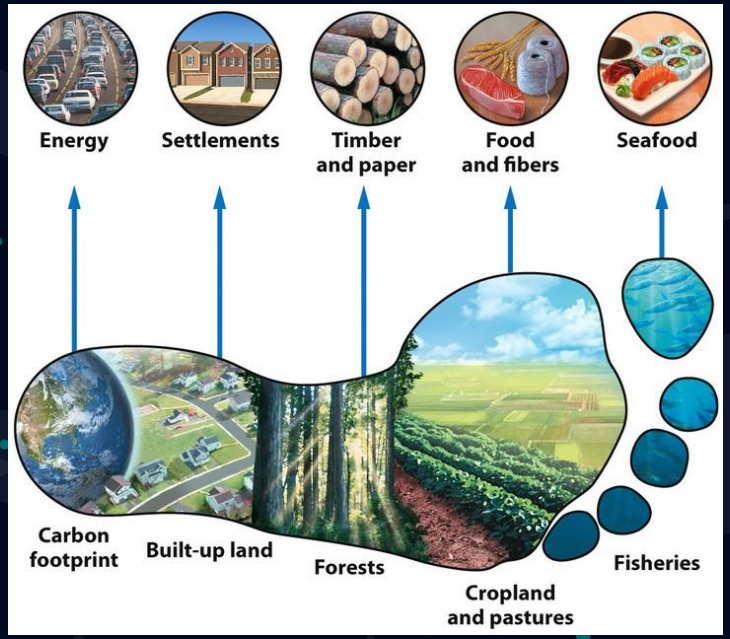
Data Analysis

5.E

Explain what the data implies or illustrates about environmental issues.

LEARNING OBJECTIVE	ESSENTIAL KNOWLEDGE
EIN-2.N Explain the variables measured in an ecological footprint.	**EIN-2.N.1** Ecological footprints compare resource demands and waste production required for an individual or a society.

Ecological Footprint



Measure of how much a person/group consumes, expressed in area of land

<u>Factors (Land required for):</u>

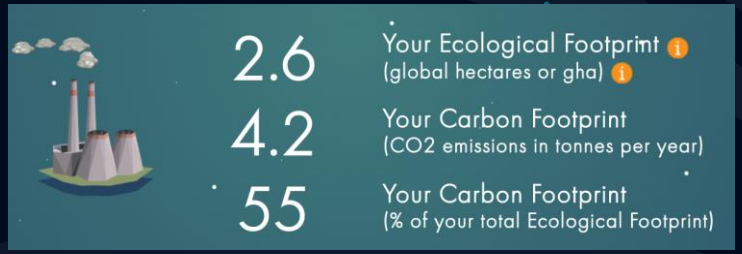
- food production
- Raw materials (wood, metal, plastic)
- Housing
- Electricity production
  - Coal, Natural gas, solar, wind, etc.
- Disposing waste produced (landfill space)

Ecological Footprint vs. Carbon Footprint

Ecological Footprint: Measured in land (gha - global hectare) which is a biologically productive hectare (2.47 acres)

Carbon Footprint: Measured in tonnes of CO_2 produced per year

- All CO_2 released from an individual or groups consumption & activities
    - Material goods
    - Food production
    - Energy use (gasoline, heat, electricity)



Factors That Affect Footprint

Increase Footprint

- Affluence (wealth) increases carbon & ecological footprint
  - Larger houses
  - More travel (gas)
  - More resources needed for material goods (cars, etc.)
- Meat consumption - more land, more water, more energy
- Fossil fuel usage (heating, electricity, travel, plastic)

Decrease Footprint

- Renewable energy use (wind, solar, hydroelectric)
- Public transportation (less gas)
- Plant-based diet
- Less consumption, less travel, less energy use

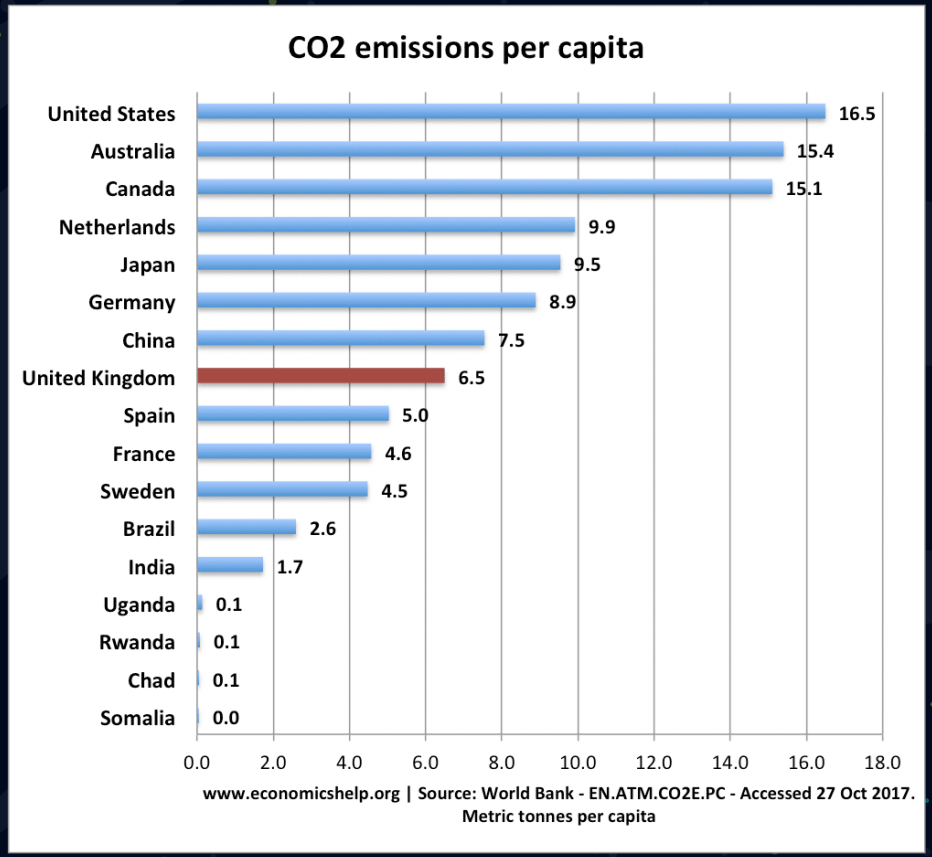
If The Whole World Lived Like Us

Ecological footprint can also be expressed in "number of earths" required if the entire world consumed same level of resources as a given individual or group

- Current average US footprint is 5.1 earths
  - 5.1 earth's worth of resources needed if the entire world consumed resources of avg. American

- Current global footprint is 1.85 earths
  - Meaning each year humanity consumes 1.85 x what the Earth can produce in a year

Practice FRQ 5.11



SUGGESTED SKILL

Data Analysis

5.E

Explain what the data implies or illustrates about environmental issues.

Describe one factor that accounts for the difference in carbon footprint between the United States and Uganda.
Explain one environmental consequence of this factor.


5.12
SUSTAINABILITY

OBJECTIVES, EKS, SKILL

LEARNING OBJECTIVE

STB-1.A

Explain the concept of sustainability.

SUGGESTED SKILL

Data Analysis

5.E

Explain what the data implies or illustrates about environmental issues.

ESSENTIAL KNOWLEDGE

STB-1.A.1

Sustainability refers to humans living on Earth and their use of resources without depletion of the resources for future generations. Environmental indicators that can guide humans to sustainability include biological diversity, food production, average global surface temperatures and CO_2 concentrations, human population, and resource depletion.

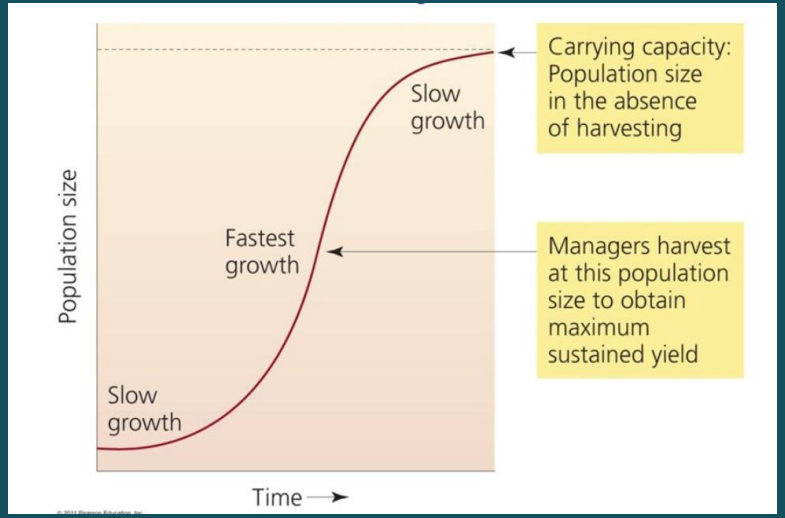
STB-1.A.2

Sustainable yield is the amount of a renewable resource that can be taken without reducing the available supply.

SUSTAINABILITY

Consuming a resource or using a space in a way that does not deplete or degrade it for future generations

Ex: *using compost (renewable) over synthetic fertilizer (fossil fuel dependent)*



MAXIMUM SUSTAINABLE YIELD

The maximum amount of a renewable resource that can be harvested without reducing or depleting the resource for future use

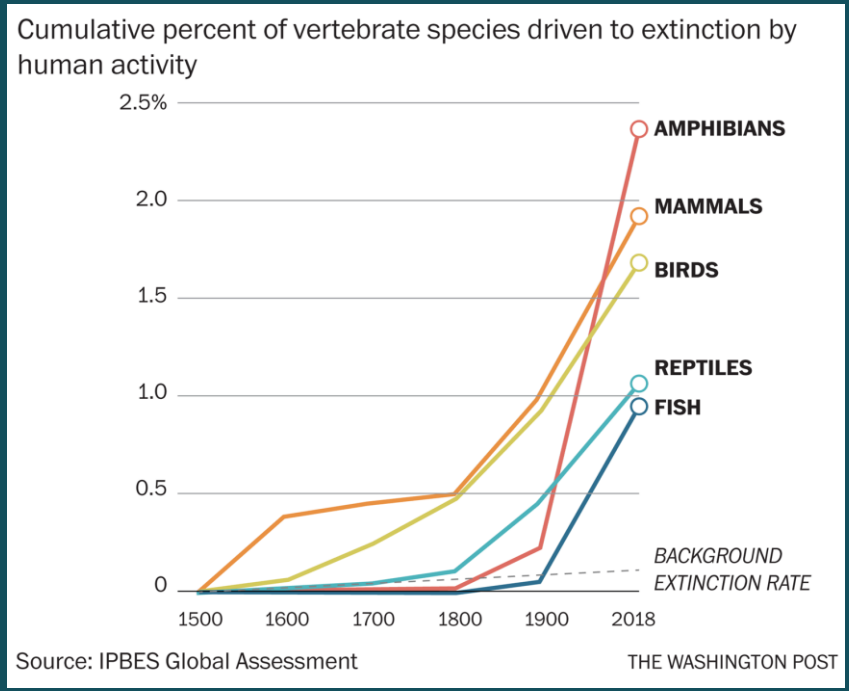
Roughly ½ carrying capacity. Maximizes yield (resource harvest) and regeneration rate of population

ENV. INDICATORS OF SUSTAINABILITY

Factors that help us determine the health of the environment and guide us towards sustainable use of earth's resources

BIODIVERSITY

- Genetic, species, and ecosystem
- Higher biodiv. = healthier ecosystems
- Declining biodiv. can indicate pollution, habitat destruction, climate change
- Global extinction rate = strong env. indicator since species extinction decreases species richness of earth

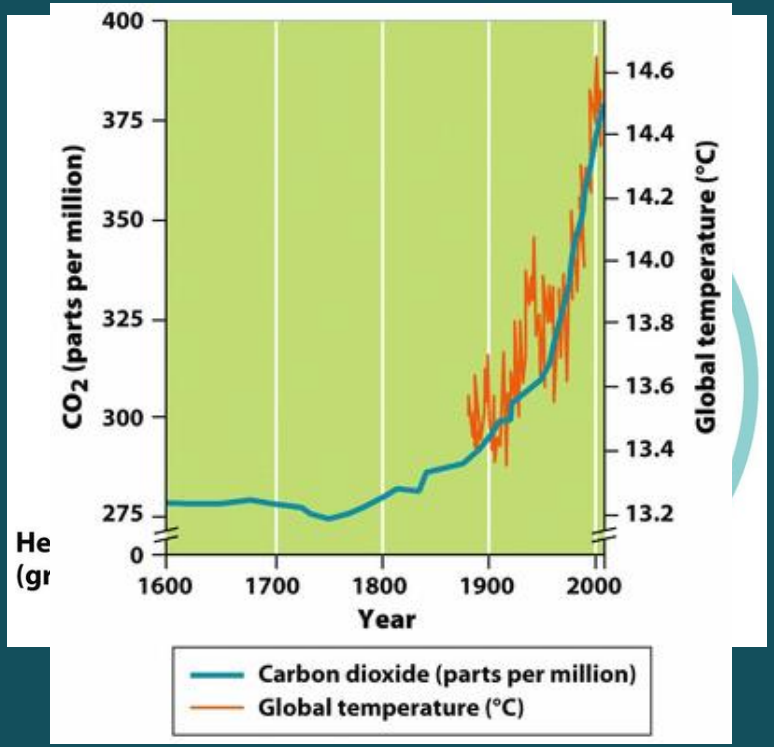


FOOD PRODUCTION

- Indicates ability of earth's soil, water, and climate to support ag.
- Major threats to food prod. = Climate change, soil degradation (desertification, topsoil erosion), groundwater depletion
- Increasing meat consumption = further strain on food prod. (takes away water and land from grain production)
- Global grain production per capita has leveled off & sown signs of decline recently

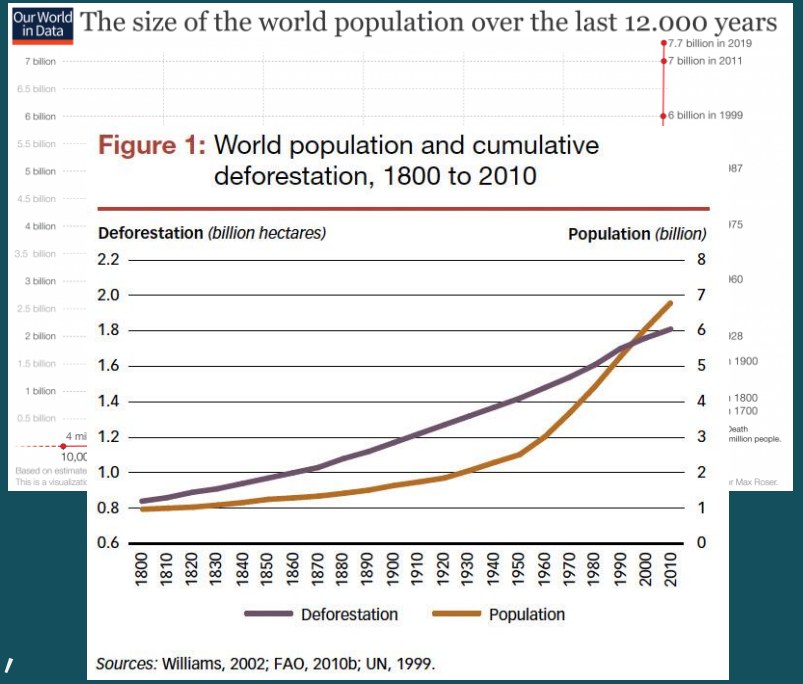
ATMOSPHERIC TEMP. & CO_2

- Life on earth depends on very narrow temperature range
- CO_2 is a GHG (traps infrared radiation & warms earth's atm.)
  - Increased CO_2 = increased temp.
- Deforestation (loss of CO_2 sequestration) & combustion of FF (emission of CO_2) increase atm. CO_2
- Increasing CO_2 = unsustainable (Dries out arable (farmable) land, destroys habitats, worsense storm intensity)



HUMAN POP. & RESOURCE DEPLETION

- As human pop. grows, resource depletion grows
- Resources are harvested unsustainably from natural ecosystems & degrade ecosystem health
  - More paper (lumber) = deforestation
  - More food = soil erosion, deforestation, groundwater depletion
  - More travel = FF mining = air, water, soil pollution, habitat destruction



PRACTICE FRQ 5.12

SUGGESTED SKILL

Data Analysis

5.E

Explain what the data implies or illustrates about environmental issues.

Table 1. Ecological Footprints of Five Different Students (hectares)

	Food	Carbon Emissions	Housing	Goods and Services	Total
Student 1	1.2	3	2	1.5	7.7
Student 2	2.5	3	1.8	1.8	9.5
Student 3	2.3	2.8	2	1.7	8.8
Student 4	2.4	3	1.9	1.9	9.2
Student 5	3.1	3	3.8	3.9	15.8

Explain which student most likely lives in a highly developed country. **Describe** how one of the four categories of ecological footprint can serve as an environmental indicator.

5.13

REDUCING URBAN RUNOFF

OBJECTIVES, EKS, AND SKILL

SUGGESTED SKILL

Scientific Experiments

4.B

Identify a research method, design, and/or measure used.

LEARNING OBJECTIVE

STB-1.B

Describe methods for mitigating problems related to urban runoff.

ESSENTIAL KNOWLEDGE

STB-1.B.1

Methods to increase water infiltration include replacing traditional pavement with permeable pavement, planting trees, increased use of public transportation, and building up, not out.

*Mitigate = reduce

ENV. CONSEQUENCES OF URBAN RUNOFF

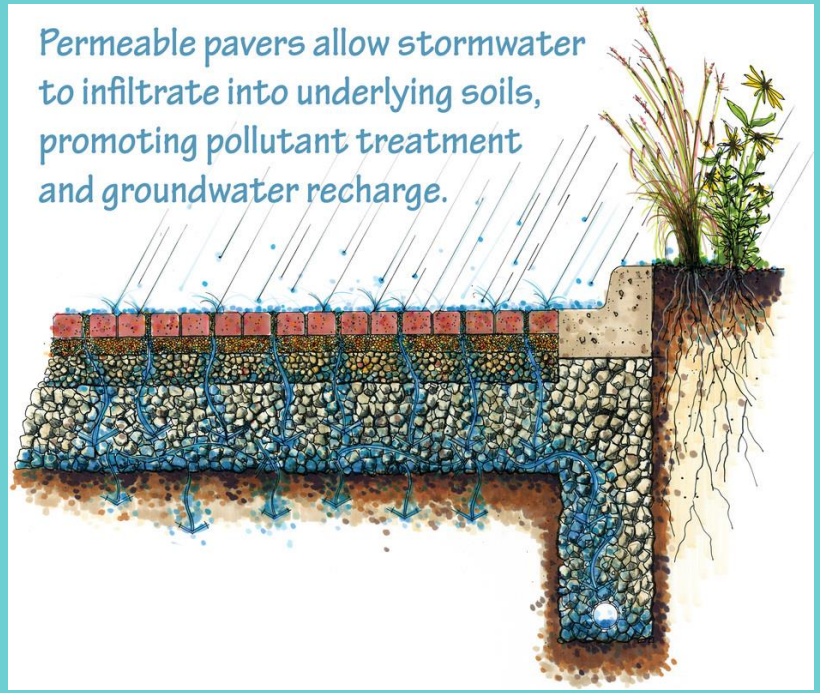
- Decreased infiltration (groundwater recharge)
- Rain washes pollutants into storm drains & into local surface waters:

Pollutants & effects

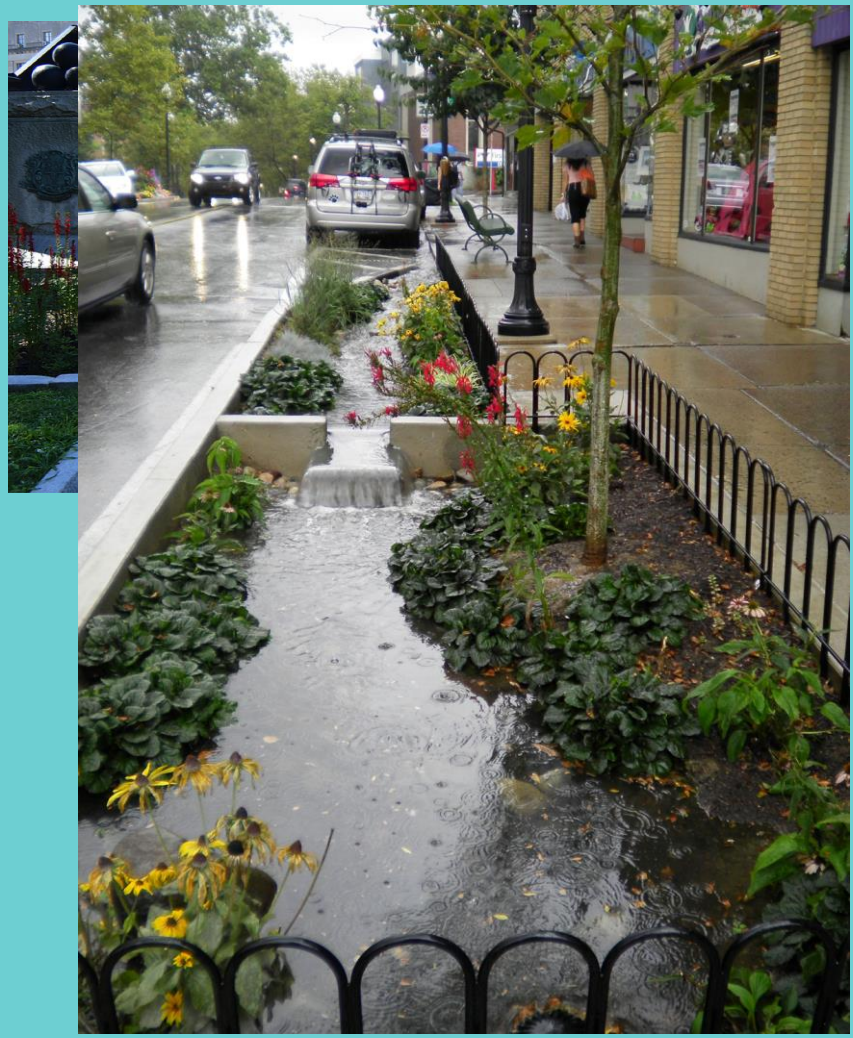
- Salt (plant & insect death)
- Sediment (turbidity)
- Fertilizer (eutrophication)
- Pesticides (kill non target species)
- Oil & gasoline (suffocate fish/kill aq. insects)

SOLUTION: PERMEABLE PAVEMENT

- Specially designed to allow stormwater to infiltrate & recharge ground water
  - Decreases runoff, decreasing pollutants carried into storm drains & into local surface water
  - Decreases likelihood of flooding during heavy rainfall
- More costly than traditional pavement



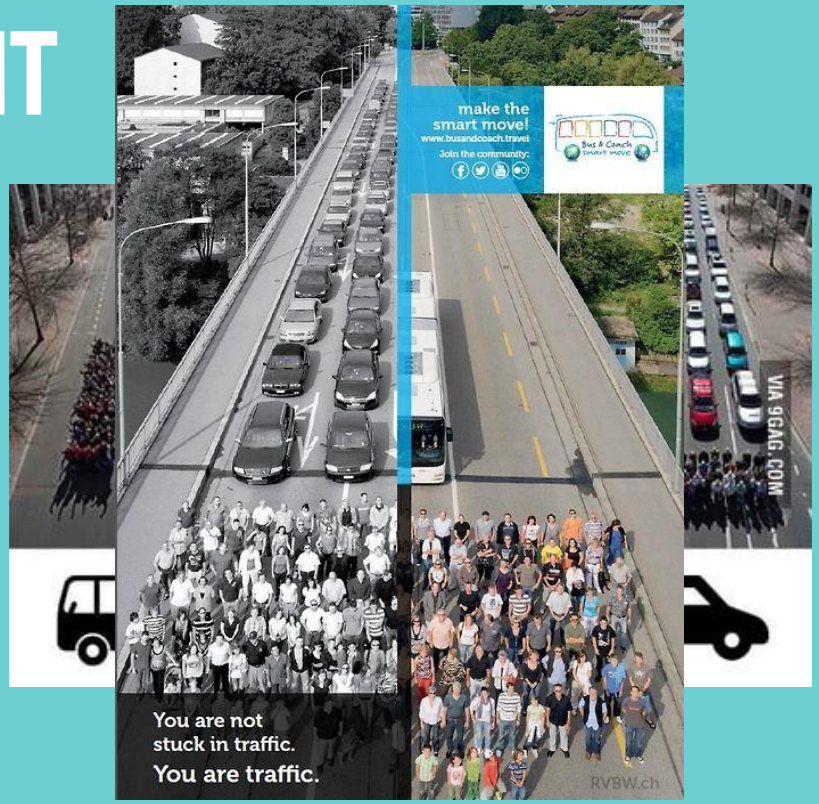
SOLUTION: RAIN GARDEN



- Creates hab. for pollinators, sense of place & stores CO_2

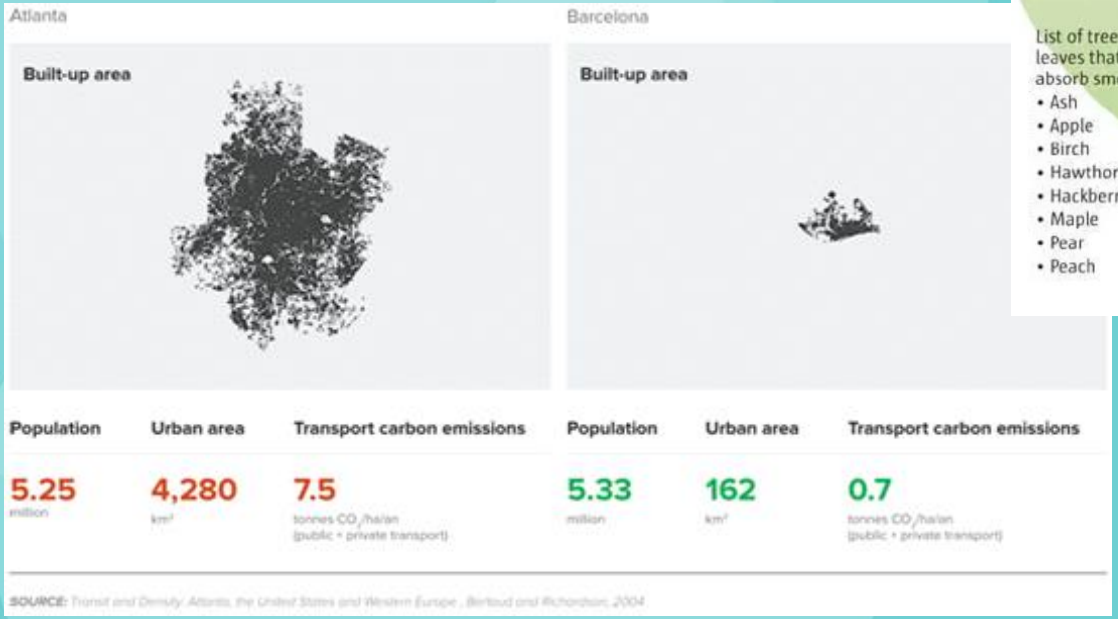
SOLUTION: PUBLIC TRANSIT

- More cars on the road = more pollutants on streets to runoff into storm drains & local waters
  - Motor Oil
  - Gasoline
  - Tire pieces
  - Antifreeze
- More cars = more lanes & parking lots (impervious surfaces) & more stormwater runoff
- Public transit decreases urban runoff, pollutants on road, CO_2 emissions & even traffic!



SOLUTION: BUILDING UP, NOT OUT

- Building vertically decreases impervious surfaces (decreasing urban runoff)



PRACTICE FRQ 5.I3

SUGGESTED SKILL

Scientific Experiments

4.B

Identify a research method, design, and/or measure used.

Design an investigation to measure the relationship between the number of trees in a city and amount of stormwater runoff the city produces

a) **Propose a hypothesis** for your investigation.

b) **Outline a procedure** for your investigation.

c) **Identify** your independent variable.

d) **Identify** your dependent variable

5.14

Integrated Pest Management (IPM)

Objective, EKs, and Skill

LEARNING OBJECTIVE

STB-1.C

Describe integrated pest management.

SUGGESTED SKILL

Environmental Solutions

7.D

Use data and evidence to support a potential solution.

STB-1.D

Describe the benefits and drawbacks of integrated pest management (IPM).

ESSENTIAL KNOWLEDGE

STB-1.C.1

Integrated pest management (IPM) is a combination of methods used to effectively control pest species while minimizing the disruption to the environment. These methods include biological, physical, and limited chemical methods such as biocontrol, intercropping, crop rotation, and natural predators of the pests.

STB-1.D.1

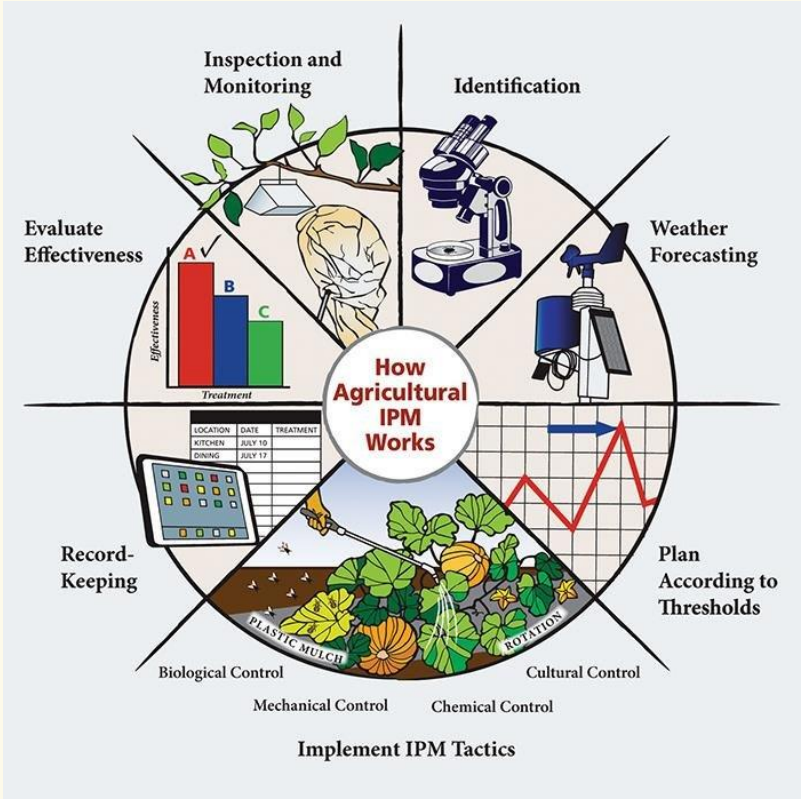
The use of integrated pest management (IPM) reduces the risk that pesticides pose to wildlife, water supplies, and human health.

STB-1.D.2

Integrated pest management (IPM) minimizes disruptions to the environment and threats to human health but can be complex and expensive.

IPM Basics

- Using a variety of pest control methods that minimize env. disruption and pesticide use
  - Researching & monitoring pests and targeting methods to specific pest life cycles
  - **Biocontrol** (Bringing in a natural predator or parasite to control the pest)
  - **Crop rotation**
  - **Intercropping**



Biocontrol

- Introducing a natural predator, parasite, or competitor to control the pest population
- Can include actually purchasing & spreading the control organisms in fields, or building homes for them/planting habitat they need to attract them naturally
    - Ladybugs for aphids
    - Spiders for many pest insects
    - Parasitic wasps for caterpillars

Crop Rotation

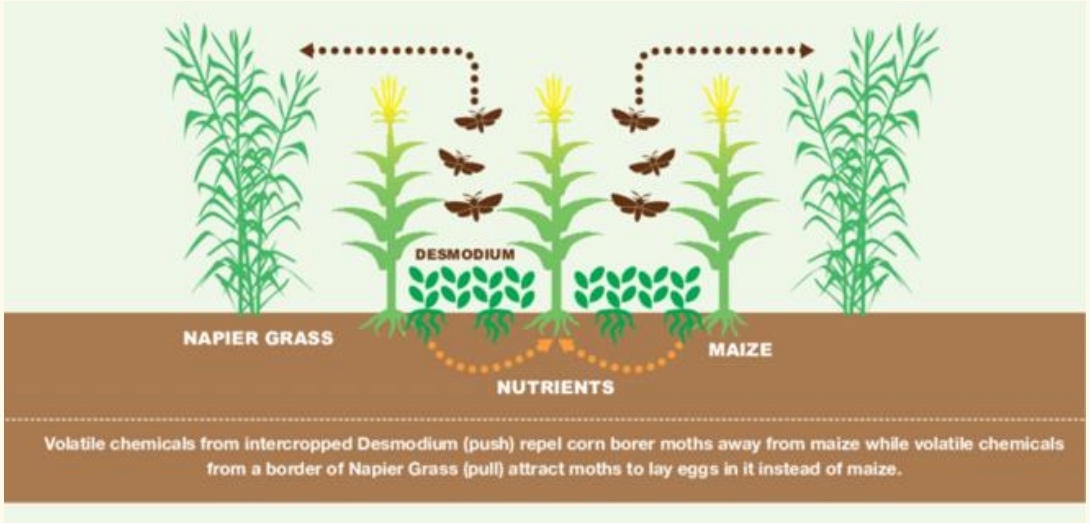
Many pests prefer one specific crop or crop family. They lay eggs in the soil, so when larvae hatch, they have preferred food source.

- Rotating crops (planting a different crop each season) can prevent pests from becoming established since it disrupts their preferred food choice
- Also disrupts weed growth since diff. crops can be planted at different times, preventing bare soil from being taken over by weeds

Intercropping

"Push-pull" system can be used

- "Push" plants emit volatile chemicals that naturally repel pests away from crop
- "Pull" plants emit chemicals that attract moths to lay eggs in them, instead of crop



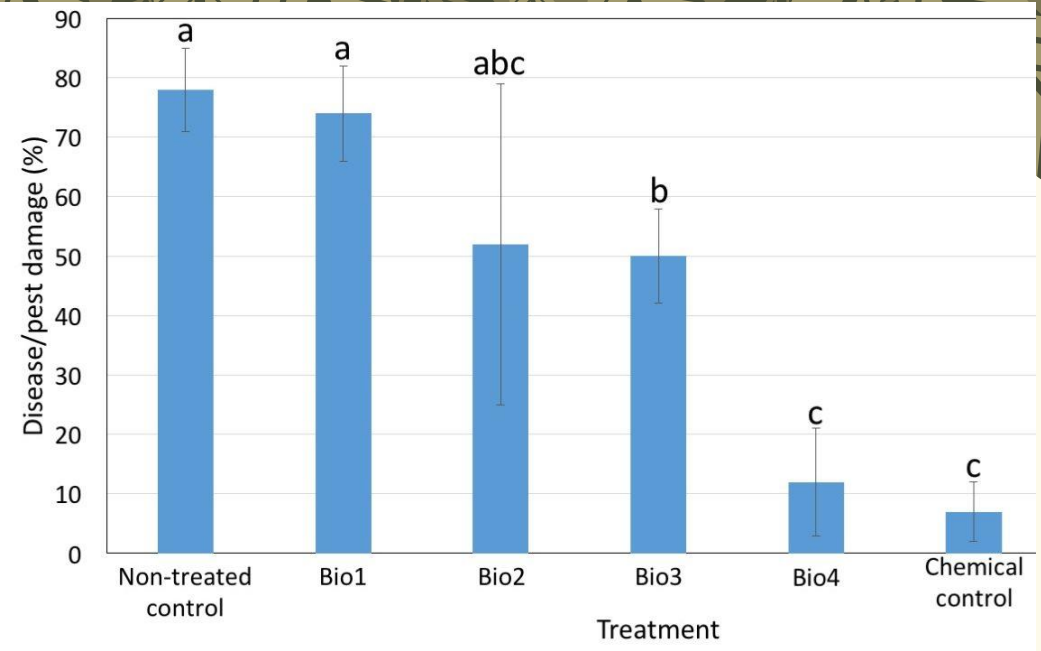
- Canprovide habitat, or "pull" plants that emit chemicals that attract natural pest predators

Benefits & Drawbacks of IPM

+ Reduces death & mutation of non-target species from
  + *Ex: intersex frogs (atrazine)*
    Eagle death (DDT)
    Bee die offs (glyphosate)
+ Reduces effects on human consumers of produce
  + *Ex: many pesticides are carcinogens (cause cancer)*
+ Reduces contamination of surface & ground water by agricultural runoff with pesticides

Can be more time consuming & costly than just crop dusting pesticides

- *Ex: researching specific pests & planting numerous species of crops*



SUGGESTED SKILL

Environmental Solutions

7.D

Use data and evidence to support a potential solution.

Justify whether or not these data support the use of a biocontrol method of limiting pest damage

5.15

Sustainable Agriculture

Objectives, EKs & Skills

LEARNING OBJECTIVE

STB-1.E

Describe sustainable agricultural and food production practices.

SUGGESTED SKILL

Environmental Solutions

7.E

Make a claim that proposes a solution to an environmental problem in an applied context.

ESSENTIAL KNOWLEDGE

STB-1.E.1

The goal of soil conservation is to prevent soil erosion. Different methods of soil conservation include contour plowing, windbreaks, perennial crops, terracing, no-till agriculture, and strip cropping.

STB-1.E.2

Strategies to improve soil fertility include crop rotation and the addition of green manure and limestone.

STB-1.E.3

Rotational grazing is the regular rotation of livestock between different pastures in order to avoid overgrazing in a particular area.

Soil Conservation

Agricultural techniques that minimize erosion
(US is losing topsoil to erosion 10x faster than it forms)

Prevents loss of:

- **Nutrients in topsoil**
- **Soil moisture**
- **Decomposers in topsoil**
- **Organic matter that traps soil moisture**

Contour Plowing

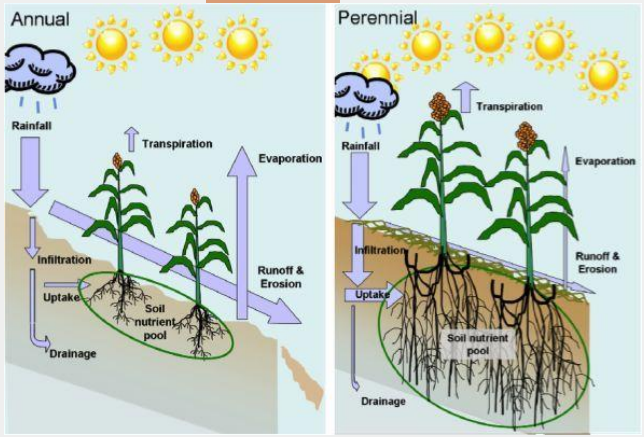
- Plowing parallel to natural slopes of the land instead of down slopes prevents water runoff & soil erosion
- Forms mini terraces that catch water running off, conserving soil & water

Terracing

- Cutting flat “platforms” of soil into a steep slope
- Flatness of terraces catches water & prevents it from becoming runoff and eroding soil

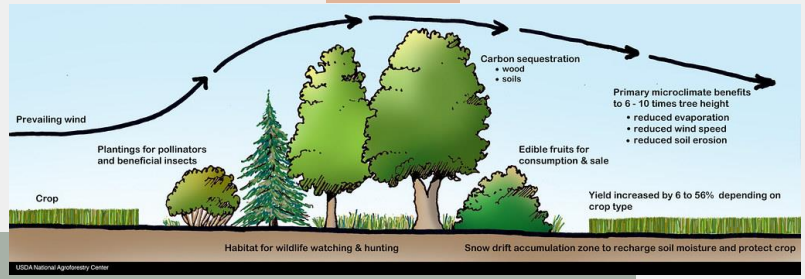
Perennial Crops

- Crops that live year round and are harvested numerous times
- Longer, more established roots & prevention of bare soil between harvest



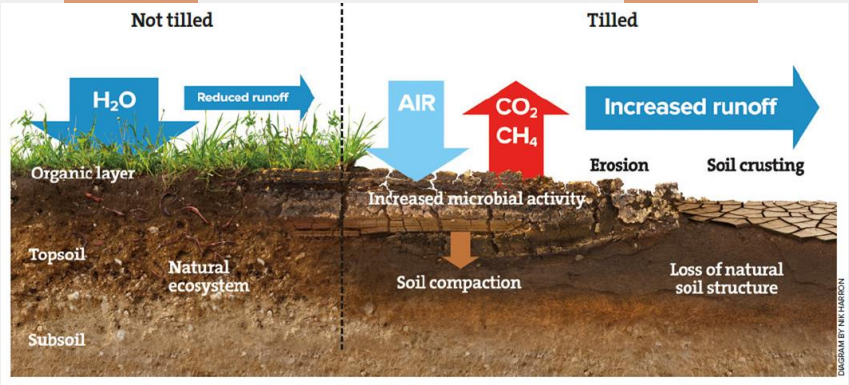
Windbreaks

- Using trees or other plants to block the force of the wind from eroding topsoil
- Can be used as a source of firewood, fruit (income)
- Can provide habitat for pollinators & other species



No Till

- Leaving leftover crop remains in soil instead of tilling under
- Adds org. matter to soil (nutrients, soil cover, moisture)
- Prevents erosion from loosened soil



Strip Cropping

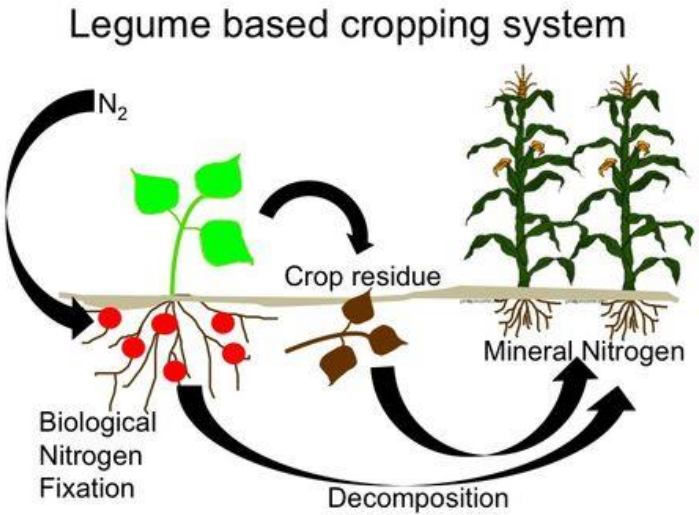
- Another name for intercropping
- Alternating rows of dense crops (hay, wheat) with rows of less dense crops (corn, soy, cotton) to prevent runoff from eroding soil from less dense rows of crops

Improving Soil Fertility

Methods of restoring nutrient levels in the soil (N, P, Ca, Mg)

Crop Rotation

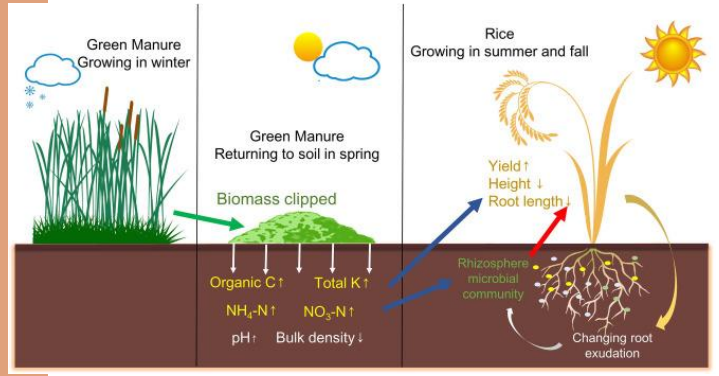
- Replanting same crops continuously depletes soil of the same nutrients
- Crop rotation can allow soil to recover from nitrogen-demanding crops like corn
- Peas/beans (legumes) have nitrogen fixing bacteria in their root nodules that can return nitrogen to the soil



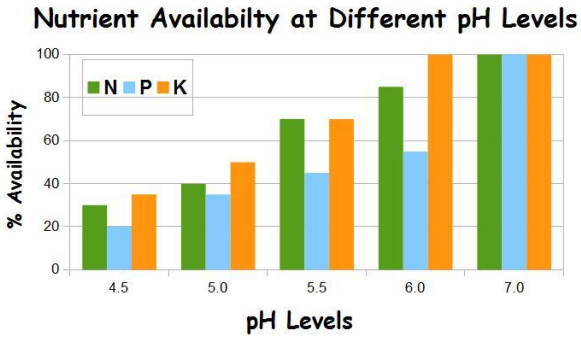
Improving Soil Fertility

Green Manure

- Green manure is leftover plant matter from a cover crop - a crop planted in the offseason, between harvest & replanting of main crop
  - Cover crop roots stabilize soil limiting topsoil erosion
  - Remains of cover crops (green manure) left on field breakdown to release nutrients into the soil

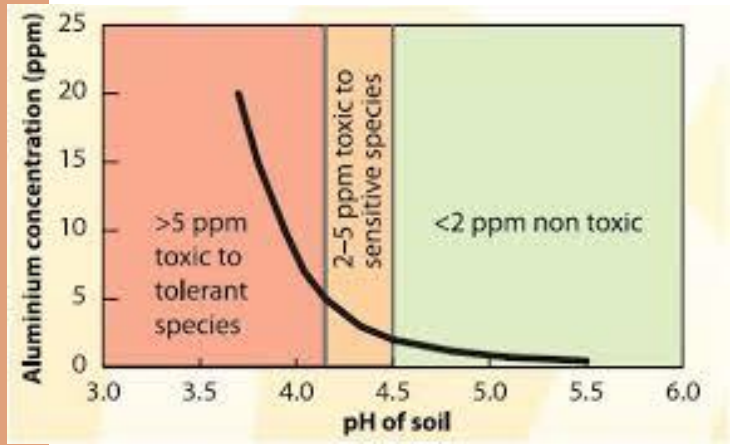


Improving Soil Fertility



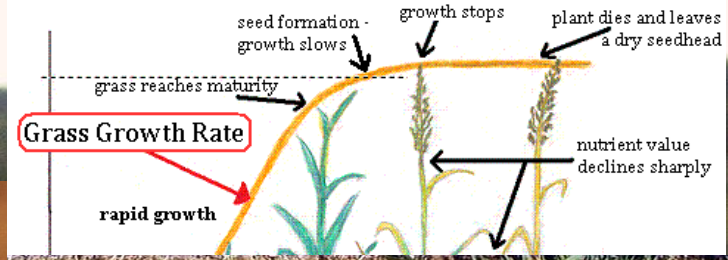
Limestone

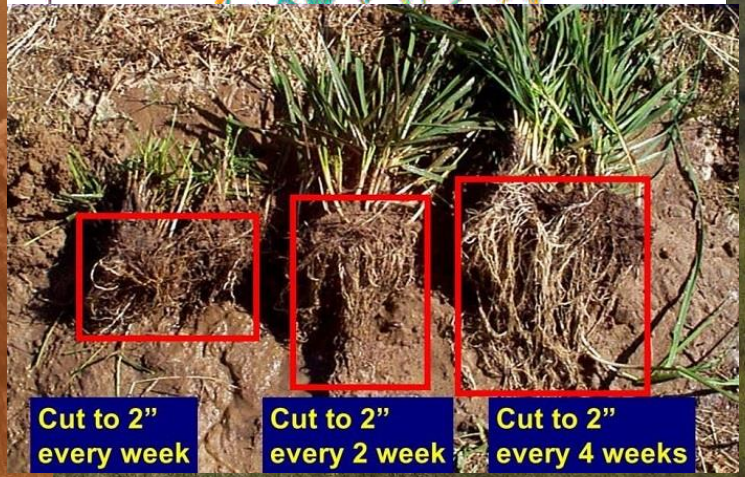
- Limestone releases calcium carbonate (base) which neutralizes acidic soil
  - Acidic soil has high H+ ion concentration, which displaces + charge nutrients from soil (leeching them out)
  - Acidic soil also makes toxic metals (aluminum) more soluble in soil
  - Calcium is a needed plant nutrient as well



Rotational Grazing

- Regular rotation of livestock to different pastures to prevent overgrazing
  - Overgrazing can kill plants, compact soil, and lead to erosion of topsoil
  - Rotational grazing can actually promote pasture growth at faster than normal rate
  - Clips grass back to length where growth is fastest & encourages deeper root growth





Practice FRQ 5.15

SUGGESTED SKILL

Environmental Solutions

7.E

Make a claim that proposes a solution to an environmental problem in an applied context.

Describe TWO soil conservation strategies that could be used to prevent soil erosion in agricultural fields that are established in this landscape.

5.16 Aquaculture

Objectives, EKs, Skills

LEARNING OBJECTIVE

STB-1.F

Describe the benefits and drawbacks of aquaculture.

SUGGESTED SKILL

Environmental Solutions

7.C

Describe disadvantages, advantages, or unintended consequences for potential solutions.

ESSENTIAL KNOWLEDGE

STB-1.F.1

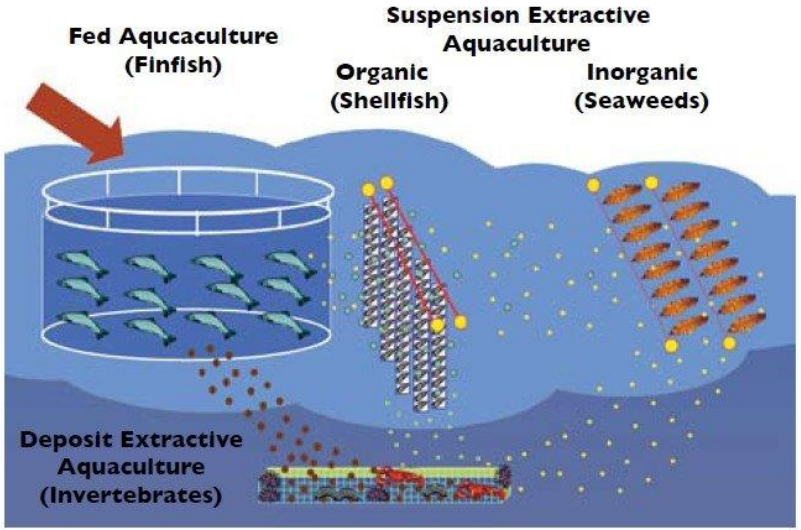
Aquaculture has expanded because it is highly efficient, requires only small areas of water, and requires little fuel.

STB-1.F.2

Aquaculture can contaminate wastewater, and fish that escape may compete or breed with wild fish. The density of fish in aquaculture can lead to increases in disease incidences, which can be transmitted to wild fish.

Aquaculture Benefits

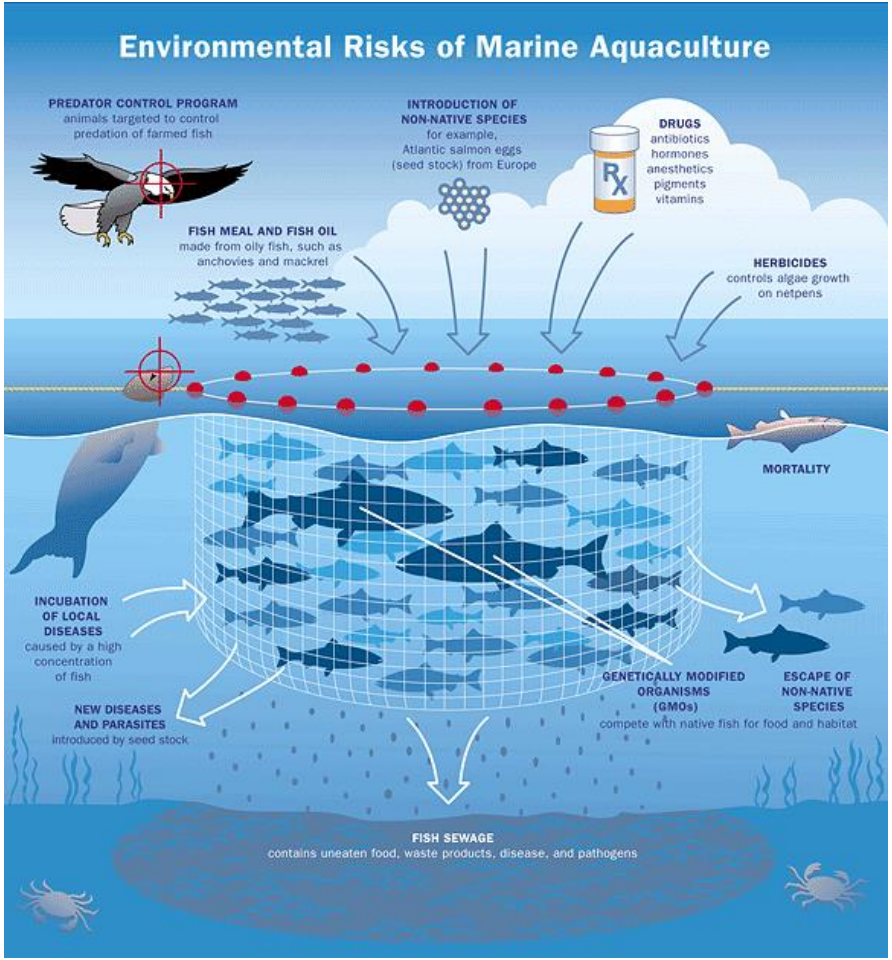
Raising fish, or other aquatic species in cages/enclosures underwater



+ Requires only small amount of water, space, and fuel
+ Reduces risk of Fishery collapse (90% population decline in a fishery)
+ Doesn't take up any land space (compared to beef, pork, chicken)

Aquaculture Drawbacks

- High density produces high concentration of waste (e. coli & eutrophication risks)
- High density increases disease risk, which can be transmitted to wild populations as well
- May introduce non-native species or GMOs to local ecosystem if captive fish escape
- Fish are fed antibiotics which can contaminate water via their waste



SUGGESTED SKILL

Environmental Solutions

7.C

Describe disadvantages, advantages, or unintended consequences for potential solutions.

Practice FRQ 5.16

Identify an advantage that aquaculture has over net fishing.

Explain one environmental consequence of aquaculture.

5.17 Sustainable Forestry

Objectives, EKs, and Skills

LEARNING OBJECTIVE

STB-1.G

Describe methods for mitigating human impact on forests.

SUGGESTED SKILL

Environmental Solutions

7.F

Justify a proposed solution, by explaining potential advantages.

ESSENTIAL KNOWLEDGE

STB-1.G.1

Some of the methods for mitigating deforestation include reforestation, using and buying wood harvested by ecologically sustainable forestry techniques, and reusing wood.

STB-1.G.2

Methods to protect forests from pathogens and insects include integrated pest management (IPM) and the removal of affected trees.

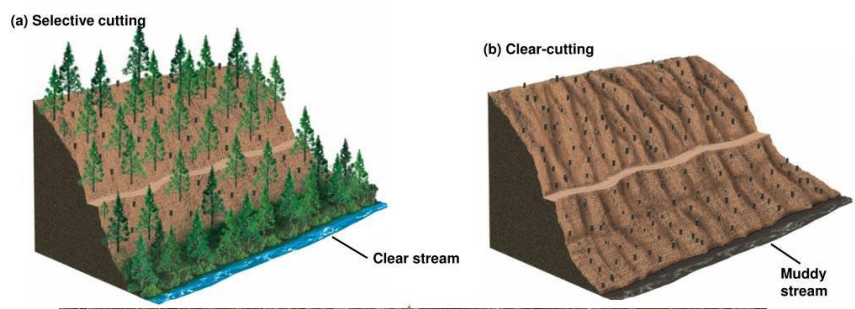
STB-1.G.3

Prescribed burn is a method by which forests are set on fire under controlled conditions in order to reduce the occurrence of natural fires.

***Mitigate = reduce**

Ecologically Sustainable Forestry

- Forestry (using trees for lumber) that minimizes damage to ecosystem (habitats destruction, soil erosion, etc.)
- Selective cutting or strip cutting
    - Only cutting some of the trees in an area (biggest & oldest) to preserve habitat (biodiv.) and topsoil
- Using human & pack animal labor to minimize soil compaction from machinery
- Replanting same species being logged
- Maximizes long-term productivity of land & preserves forest for future generations



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Sustainable Forestry Practices

- Using recycled wood, or simply reusing without recycling (furniture, decoration)
- Wood can be chipped and used as mulch for gardens or agricultural fields
- Reforestation: replanting of trees in areas that have been deforested
- Selectively removing diseased trees to prevent spread of infection through entire forest
    - Removes host for disease
    - Decreases density, making spread less likely

Fire Suppression

1 Stopping Natural Fires

Fire supressionsion is the practice of putting out all natural forest fires as soon as they start

2 Leads to more biomass buildup

Putting out fires immediately leads to more dry biomass buildup

Makes future fires worse

3 Monitoring Instead

Close monitoring can prevent fire damage & worse fires in the future

Prescribed Burns

1 Dead biomass builds up

Fuel for large forest fires

Stored nutrients trapped in dead biomass

Dead trees = susceptible to disease & pest spread

2 Small, controlled fires burn lots of dead biomass

Uses up dead biomass (fuel) preventing larger forest fires later

3 Promotes nutrient recycling

Nutrients in dead biomass are recycled → new growth

Practice FRQ 5.17

Identify TWO characteristics of a forest that develop when fires are suppressed, and **explain** how prescribed burns could address each of these characteristics.