

*The poetry of the
earth is never dead.*
- John Keats

TOPICS INCLUDE:

- Earth Science
- Atmosphere
- Soil

AP ENVIRONMENTAL SCIENCE



UNIT 4: LAND & WATER USE

IV. LAND AND WATER USE(10-15%)

A. Agriculture–

1. Feeding a growing population
(Human nutritional requirements; types of agriculture; Green Revolution; genetic engineering and crop production; deforestation; irrigation; sustainable agriculture)
2. Controlling pests
(Types of pesticides; costs and benefits of pesticide use; integrated pest management; relevant laws)

B. Forestry

(Tree plantations; old growth forests; forest fires; forest management; national forests)

C. Rangelands

(Overgrazing; deforestation; desertification; rangeland management; federal management)

D. Other Land Use

1. Urban land development
(Planned development; suburban sprawl; urbanization)
2. Transportation infrastructure
(Federal highway systems; canals and channels; roadless areas; ecosystem impacts)
3. Public and federal lands
(Management; wilderness areas; national parks; wildlife refuges; forests; wetlands)
4. Land conservation options
(Preservation; remediation; mitigation; restoration)
5. Sustainable land-use strategies

E. Mining

(Mineral formation; extraction; global reserves; relevant laws and treaties)

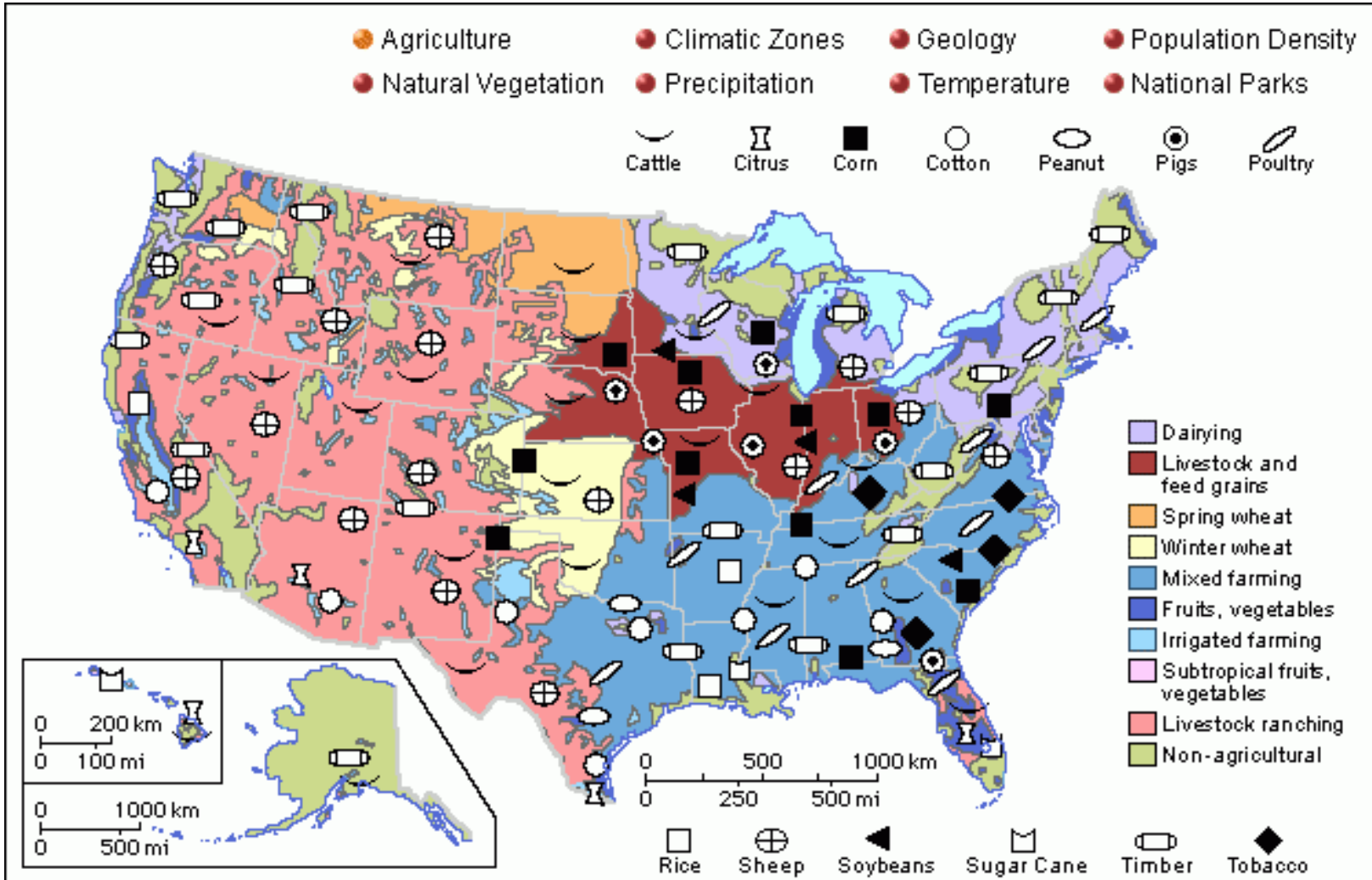
F. Fishing

(Fishing techniques; overfishing; aquaculture; relevant laws and treaties)

G. Global Economics

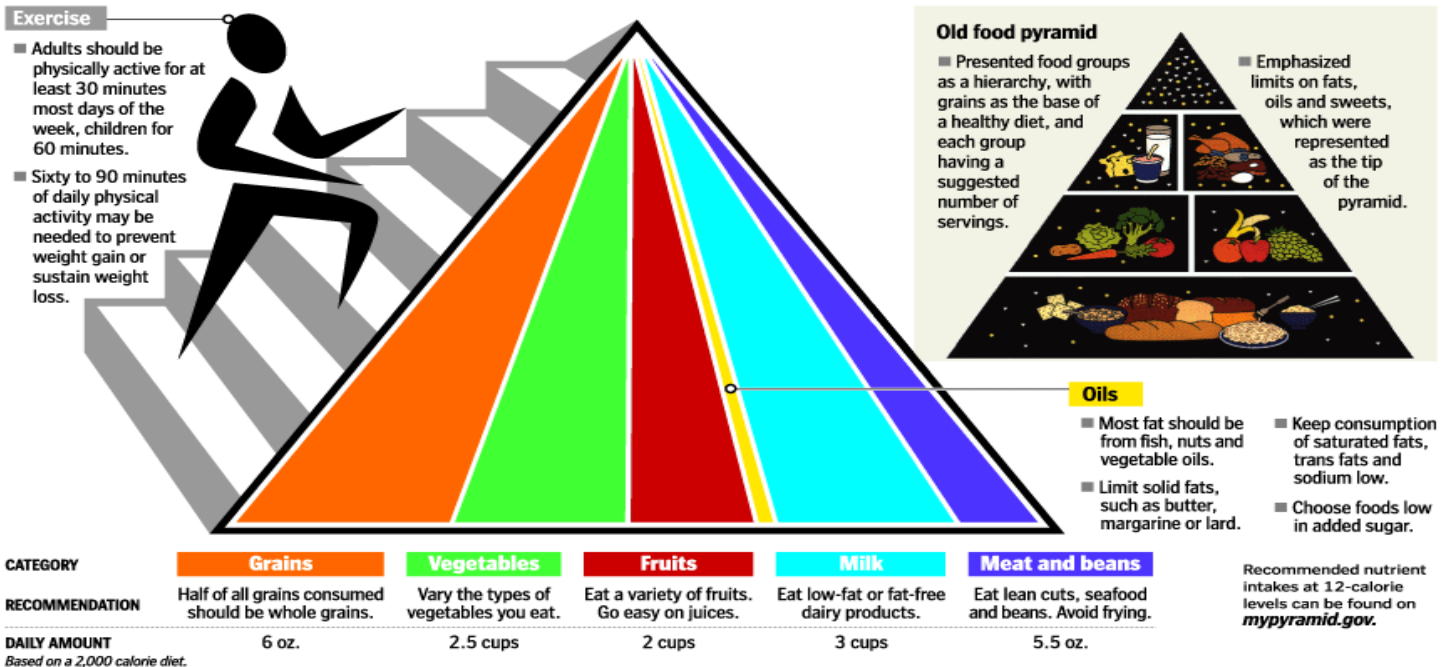
(Globalization; World Bank; Tragedy of the Commons; relevant laws and treaties)

AGRICULTURE



FEEDING A GROWING POPULATION

- people must consume 2,200 calories of food per day to live an active healthy life
- area of food production unevenly distributed among population
- 3 main crops
 - wheat, rice, corn
 - Use of grain (corn) as energy source has contributed to rising \$\$ (leads to hunger due to poverty)



TYPES OF AGRICULTURE

○ Industrialized agriculture

- provides most of world's food
- use of heavy equipment (fossil fuel usage)
- fertilizers, pesticides
- high-yield monocultures

○ Plantation agriculture

- used in developing countries
- grow cash crops (coffee, sugar cane, bananas, and cacao)
- require large input of fertilizers & pesticides
- often located on cleared land (tropical forests)

○ Traditional or subsistence agriculture

- provide for ONLY 1 family's food needs w/enough to trade or sell remaining yield for additional necessities
- relies on hard work of humans & draft animals

○ Slash-and-burn agriculture

- Cutting down & burning tropical forests to clear land for planting crops & raising cattle
- Farming in nutrient-poor tropical soils leads to slash-burn other section of forests



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IMPACT OF AGRICULTURE

◉ Habitat Destruction

→ Displaced herbivores feed off crops

◉ Eutrophication

→ chemicals leach into soil & groundwater

→ rains wash them into streams & rivers

→ nutrients (phosphate) stimulate algal bloom

→ algae prevent oxygen from reaching water beneath

→ aquatic organisms die

◉ Nutrient Depletion

→ single crops deplete soil of vital nutrients

→ must replace nutrients artificially

→ field must be allowed to regain nutrients

◉ Erosion

→ Bare field susceptible to wind and rain

◉ Excess Costs

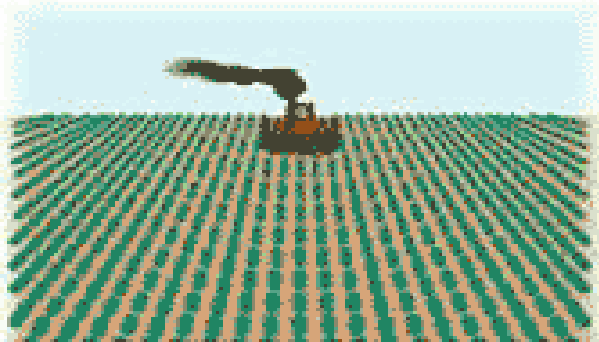
→ commercial seeds, fertilizer, herbicides, pesticides are expensive



Photo by Jesse Van Dyke

Eutrophication - an algal bloom resulting from too much nutrient from sources such as phosphorus and nitrogen in fertilizers.





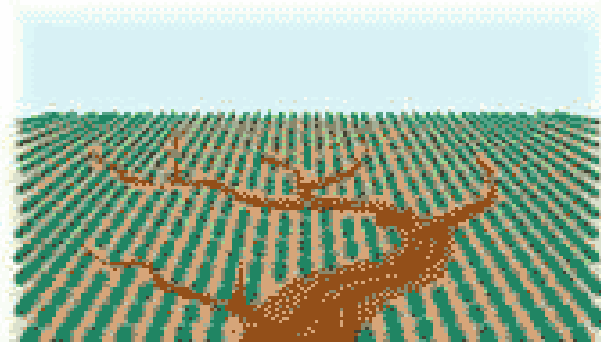
Biodiversity Loss

Loss and degradation of habitat from clearing grasslands and forests and draining wetlands

Fish kills from pesticide runoff

Killing of wild predators to protect livestock

Loss of genetic diversity from replacing thousands of wild crop strains with a few monoculture strains



Soil

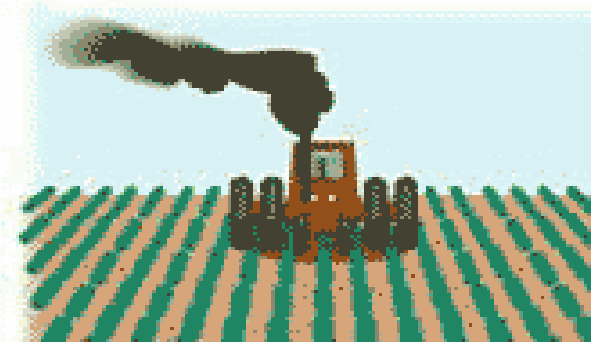
Erosion

Loss of fertility

Salinization

Waterlogging

Desertification

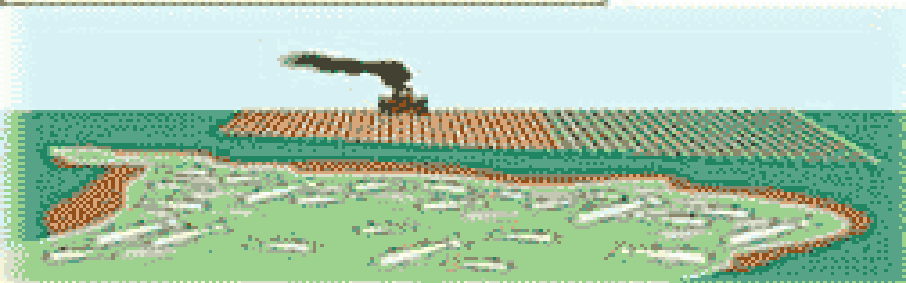


Air Pollution

Greenhouse gas emissions from fossil fuel use

Other air pollutants from fossil fuel use

Pollution from pesticide sprays



Water

Aquifer depletion

Increased runoff and flooding from land cleared to grow crops

Sediment pollution from erosion

Fish kills from pesticide runoff

Surface and groundwater pollution from pesticides and fertilizers

Overfertilization of lakes and slow-moving rivers from runoff of nitrates and phosphates from fertilizers, livestock wastes, and food processing wastes



Human Health

Nitrates in drinking water

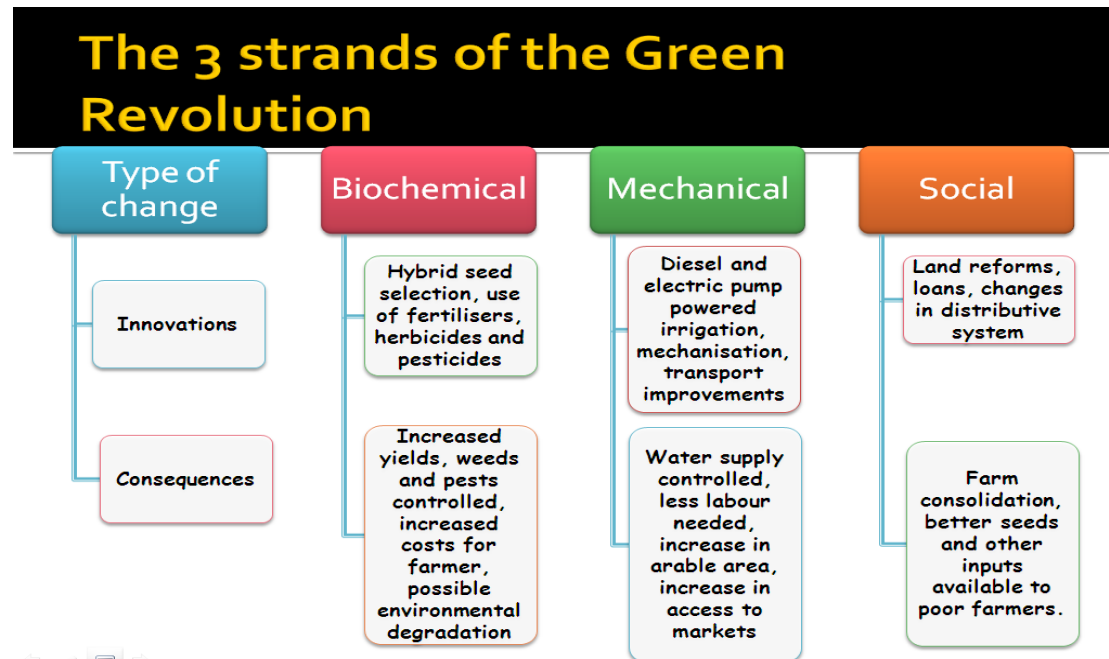
Pesticide residues in drinking water, food, and air

Contamination of drinking and swimming water with disease organisms from livestock wastes

Bacterial contamination of meat

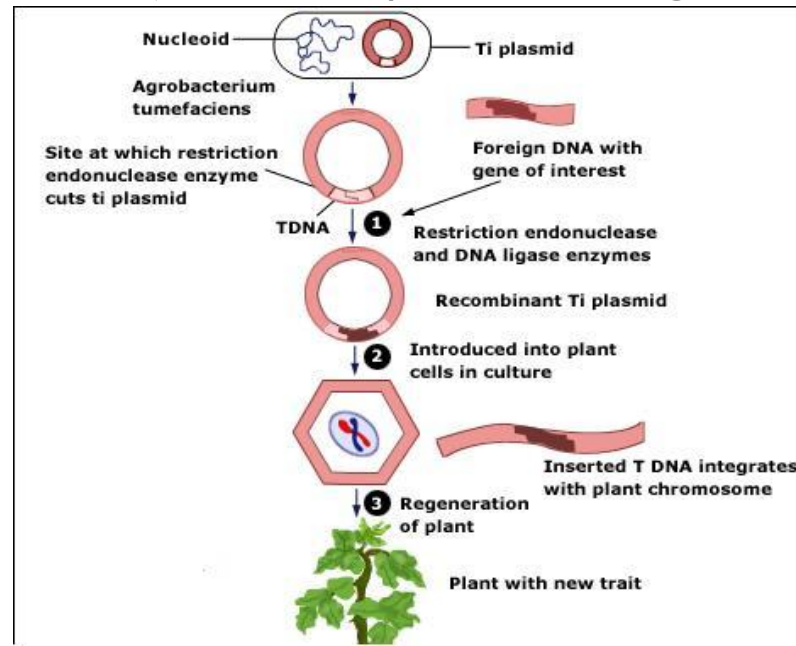
GREEN REVOLUTION

- ◉ technologically advanced agricultural practices that increased crop yield after WWII
- ◉ Advancements:
 - development of high-yielding monoculture crops
 - heavy use of pesticides
 - large inputs of inorganic fertilizer
 - intensive irrigation
 - growing multiple crops on the same plot of land during the year



GENETIC ENGINEERING

- ◉ Genetic Engineering: isolation of a gene from one source (plant, bacteria) for a desired trait (insect resistance), make copies of gene, then place those genes in another plant
- ◉ **EXAMPLE: Tomatoes**
 - ethylene production (gas produced which makes them ripen quickly)
 - grocers spray fruit with ethylene to start ripening process
 - STRATEGY: isolate gene responsible for ethylene
 - GE tomato (Endless Summer) does not ripen as fast longer shelf-life



CROP PRODUCTION

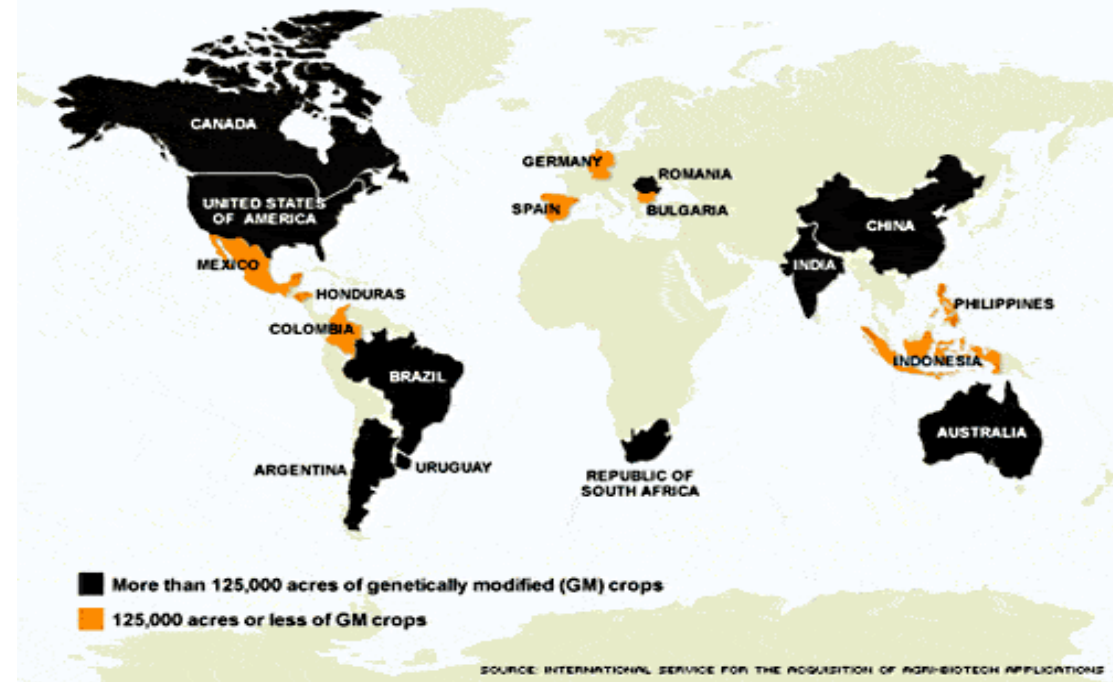
○ GE Crops

- Insect resistance
- Herbicide resistance
- Virus resistance
- Delayed fruit ripening
- Altered oil content
- Pollen control

○ GE Crops Drawbacks

- Pests & weeds could evolve resistance to GE genes (reduce effectiveness of the GE crops)
- Genes can contain allergens that can be transferred

GENETICALLY MODIFIED CROPS, 2003

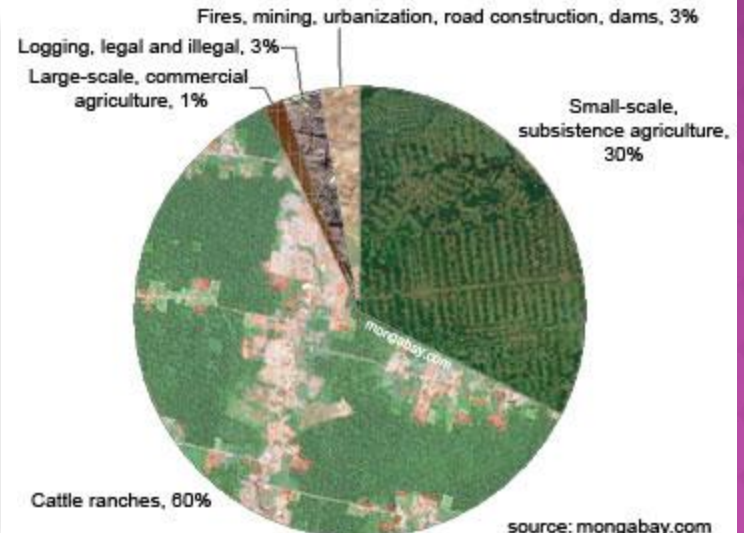


DEFORESTATION

- ◉ trees are cut down and/or burned
- ◉ mostly occurs for agricultural reasons
- ◉ in tropical LDCs slash and burn technique
 - soil nutrients lie within biomass of trees NOT the soil
 - land becomes infertile quickly
- ◉ Negative Consequences
 - tropical rainforests take up CO₂; removal of trees causes CO₂ to stay in atmosphere
 - reduces evapotranspiration; disrupts water cycle
 - eliminates the tropical rainforest ecosystem and species that live there (loss of biodiversity)









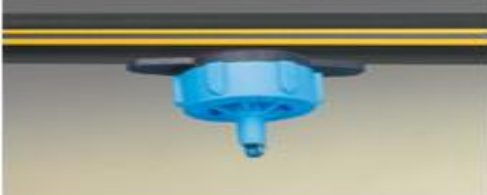
Causes of Deforestation in the Amazon, 2000-2005



IRRIGATION

- ◉ Brings water to agricultural crops
- ◉ uses about 60% of the world's freshwater supplies
- ◉ Techniques
 - Flood or Furrow Irrigation
 - water pumped into trenches that are dug in the field & flows along the ground to the crops
 - Simple & cheap
 - over 50% of water does NOT reach crop
 - Drip Irrigation
 - water flows through pipes with holes in them
 - pipes laid alongside the crops allows water to sustain them
 - Improves efficiency by delivering smaller amounts of water more directly to crop roots for absorption
 - More expensive
 - Spray Irrigation
 - Long hoses w/spray attachments are placed in field
 - Machinery for pumping & spraying

Irrigation Types

Surface Irrigation	Flood Irrigation		[1]
	Furrow Irrigation		[1]
Sprinkler Irrigation	Center-Pivot System		[1]
	LEPA Irrigation		[1]
	LESA Irrigation		[1]
Microirrigation	Line-Source Emitters		[1]
	Point-Source Emitters		[2]

SUSTAINABLE AGRICULTURE

- ◉ No clear-cutting to maintain natural biodiversity
- ◉ Planting many crops in the same field with different harvest times
- ◉ Planting diverse crops helps build or retain disease resistance
- ◉ Use of natural fertilizers
- ◉ Self-sustaining farm requires less energy from farmers
- ◉ Use of natural components (seeds, fertilizer, pest & weed control) reducing operating cost of farm

TYPES OF PESTICIDES

- herbicide: controls weeds
- fungicide: controls fungus
- rodenticide: controls rodents
- insecticide: controls insects

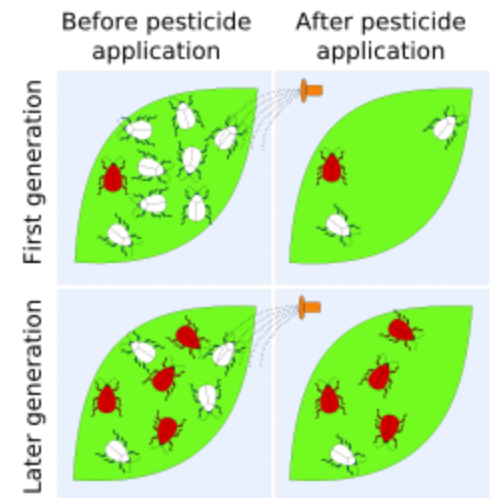


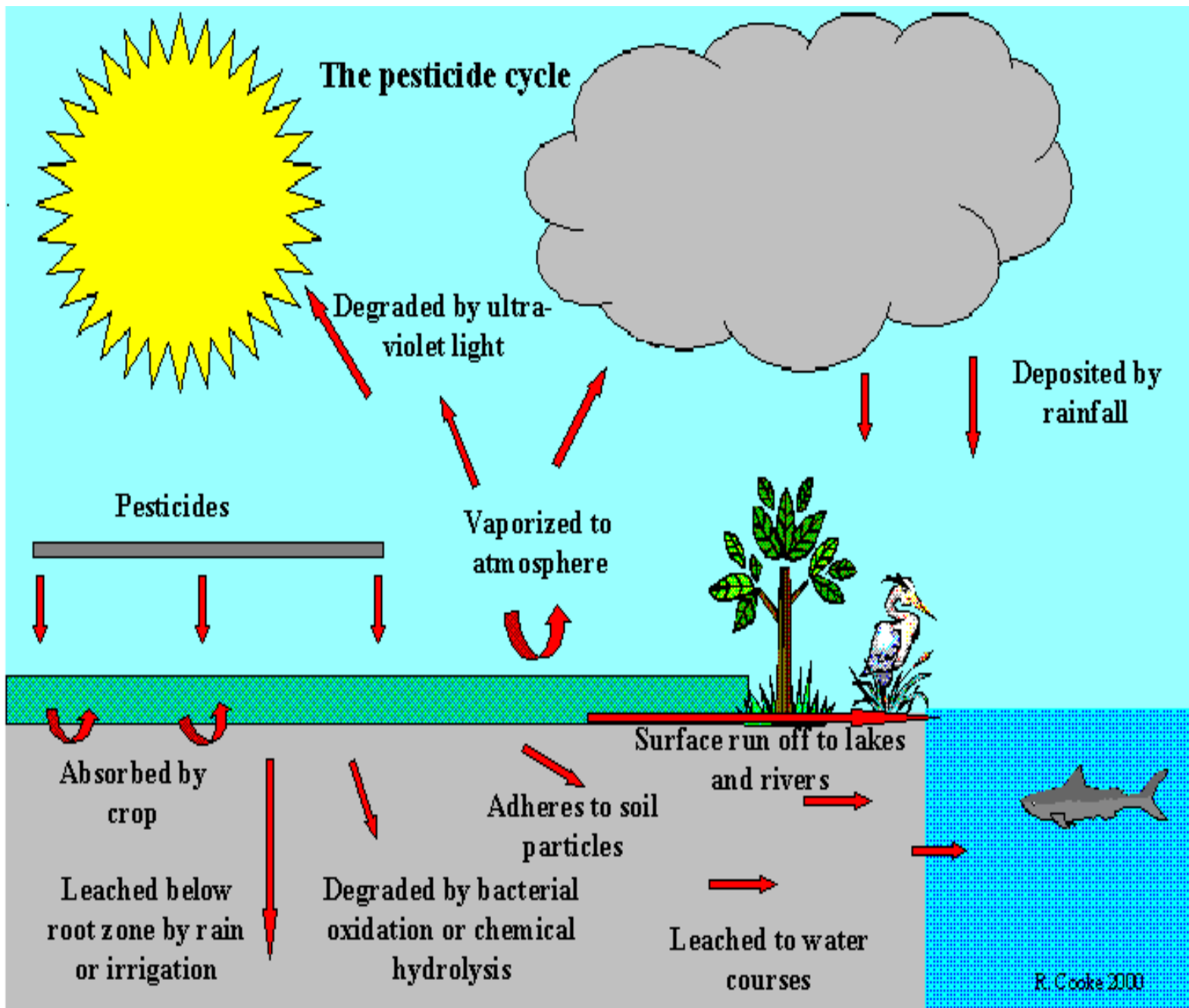
Broad-Spectrum	Narrow-Spectrum
Kills many different species	Selected to kill only the target
<ul style="list-style-type: none">•Can kill good species (bees, spiders, ladybugs)•Chlorinated hydrocarbons (DDT)•Organophosphates (malathion & parathion)	

PESTICIDE TREADMILL

- ◉ occurs within specific insect populations in response to the application of a pesticide
- ◉ random genetic mutation might allow a few individuals to be resistant to a pesticide
 - does not favor (nor harm) these species until that pesticide is widely applied
 - after pesticide application, this small subgroup of the population is better equipped to survive and reproduce, therefore future generations will likely contain greater percentages of members that are resistant to the pesticide.
- ◉ Because insect generations are relatively short, the pesticide might be rendered ineffective within a few growing seasons due to heightened genetic resistance.
 - force farmers to spend more money on increased amounts of the pesticide or on a different pesticide altogether
 - commonly referred to as the pesticide treadmill

In the worst-case scenario, increased resistance, increased cost for more or different pesticides, further increased resistance, further cost ?, continues indefinitely (hence the term treadmill).





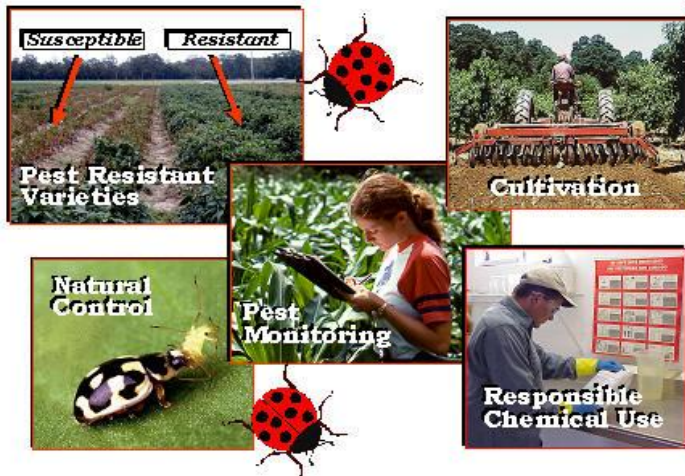
INTEGRATED PEST MANAGEMENT

- GOAL: reduce the number of pests to a economically tolerable level

WHAT IS IPM?

Farmers use **Integrated Pest Management (IPM)** strategies to prevent crop damage from insect, weed, and disease pests.

IPM PRACTICES INCLUDE:



EXAMPLES IPM STRATEGIES

- Natural enemies of pests
- Crop rotation
- Use of pheromones or sterile males into population to interfere with reproduction
- Limited use of narrow-spectrum or natural pesticides

WHY SHOULD YOU CARE?

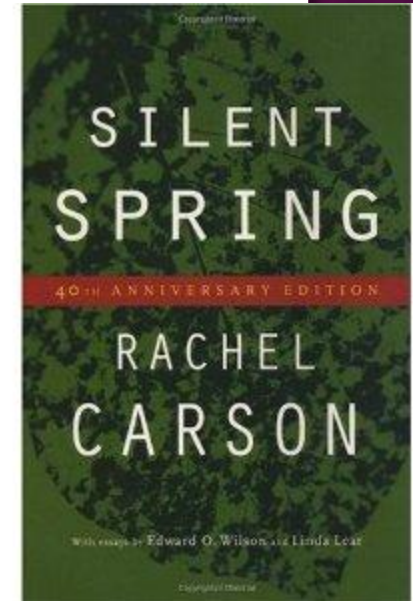
Because IPM practices help farmers:

- conserve our environment
- produce quality crops
- maintain farm profitability

PESTICIDE LEGISLATION

RACHEL CARSON “Silent Spring”

- 1962 book “Silent Spring
- Raised public awareness of the environmental consequences of DDT use
- Played key role in environmental issues at the beginning of the modern environmental movement in the US



FEDERAL INSECTICIDE, FUNGICIDE, RODENTICIDE ACT

- Regulates the effectiveness of pesticides

FOOD QUALITY PROTECTION ACT

- Sets pesticide limits in food, and all active & inactive ingredients must be screened for estrogenic/endocrine effects

PERSISTENT ORGANIC POLLUTANTS (POP_s TREATY)

- International treaty (not ratified by US in 2009) to phase out 12 organic persistent pollutants known as the “dirty dozen” such as DDT and PCBs

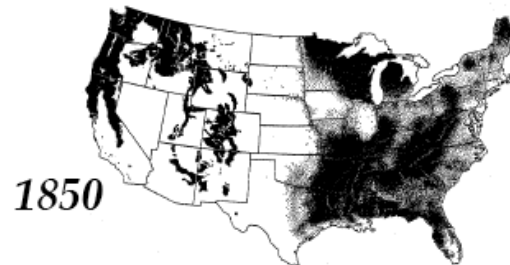
FORESTRY

- ◉ land where at least 10% has been or is currently covered by trees and is not build up or used for agriculture
- ◉ cover 1/3 of US
- ◉ include both commercial & non-commercial forests
 - commercial (timber for construction, fuel & paper)
 - non-commercial (parks, wildlife refuges & wilderness areas)



OLD-GROWTH FOREST VS. SECONDARY-GROWTH FOREST

- ◉ old-growth forest
 - Has NOT been modified by human activities or natural disasters in 200 years or more
- ◉ secondary-growth forest
 - Formed from secondary succession



IMPORTANCE OF FORESTS

- ◉ provide habitat for 2/3 of earth's terrestrial species
- ◉ tropical rainforest are home to more than 50% of world's species
- ◉ high area of biodiversity
- ◉ provide crucial ecosystem services
 - releasing oxygen
 - storing CO₂
 - reducing soil erosion
 - promoting nutrient recycling
 - influencing regional & local climate
- ◉ **Economic Benefits**
 - recreational activities (ecotourism)
 - medicines
 - fuelwood
 - jobs in lumber & paper industries



FOREST FIRES

◉ Surface fires

- Burn only in forests' underbrush
- Little damage to mature trees
- Protect the forest from more harmful fires by removing underbrush & dead materials

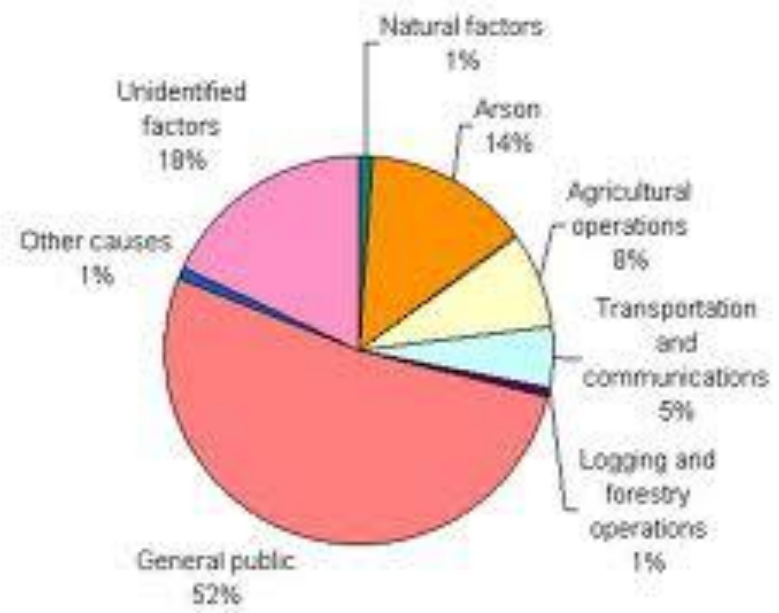
◉ Crown fires

- May start on ground or in canopies of forests that have not experienced surface fires
- Spread quickly
- High temperatures are huge threat to wildlife, human life & property

◉ Ground fires

- Smoldering fires that take place in swamps or bogs
- Can burn underground for days or weeks
- Originated from surface fires & are difficult to detect & extinguish

FOREST FIRE CAUSES

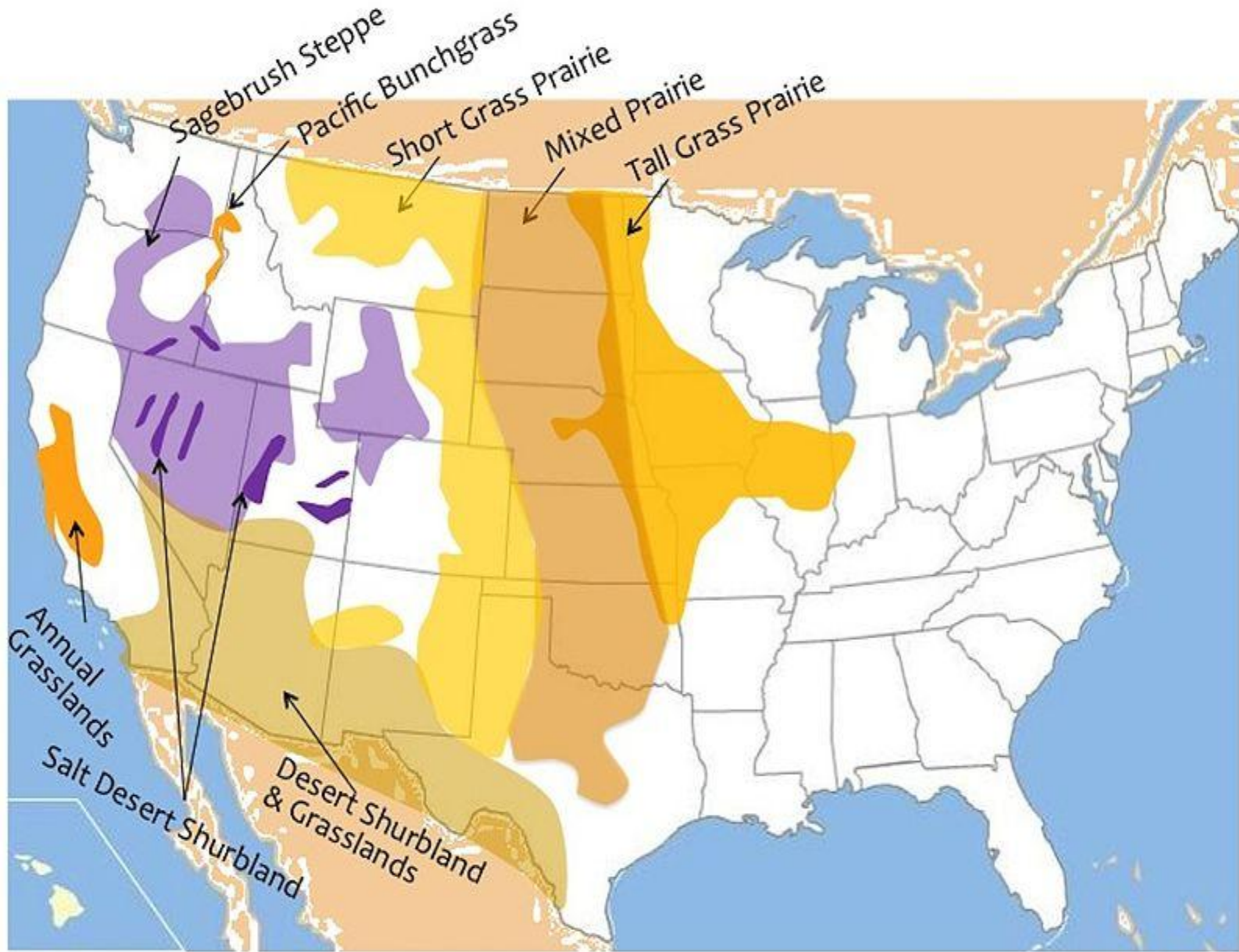


PRESCRIBED FIRE

- ◉ Reduce Hazardous Fuels
- ◉ Site Preparation
- ◉ Improve Wildlife Habitat
- ◉ Manage Competing Vegetation
- ◉ Control Disease
- ◉ Improve Forage for Grazing
- ◉ Enhance Appearance
- ◉ Improve Access
- ◉ Perpetuate Fire Adapted/Dependent Species
- ◉ Manage Endangered Species

RANGELANDS

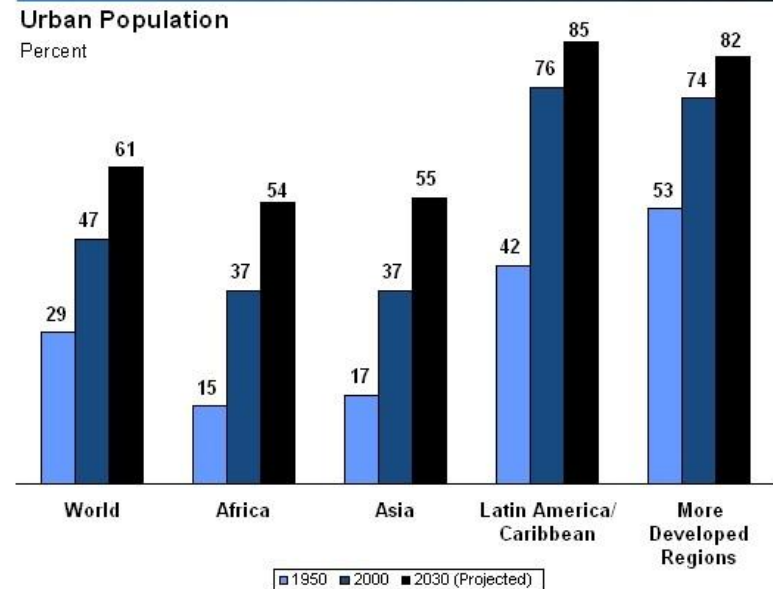
- areas of land that supply forage or vegetation for grazing and browsing animals but are NOT managed
- Examples: prairies, desert scrub, grasslands, chaparral, open woodlands, riparian areas, tundras (areas with low to moderate rainfall - arid or semi-arid)
- 40% worldwide devoted to livestock
- 25% USA (mostly privately-owned)
- major environmental problem is overgrazing



URBAN LAND DEVELOPMENT

- human population increase in industrialized , MDCs and LDCs, people tend to migrate toward cities and urban areas
- environmental costs of urbanization
 - consumption & waste production
 - lack of vegetation
 - microclimates
 - water runoff
 - solid waste & pollution
 - noise
 - land conversion

Trends in Urbanization, by Region



Source: United Nations, *World Urbanization Prospects: The 2003 Revision (medium scenario)*, 2004.

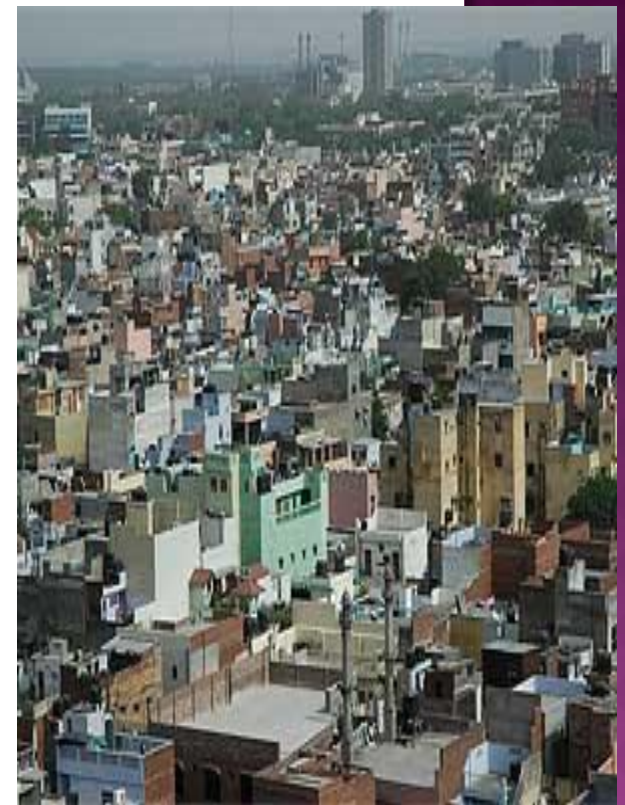
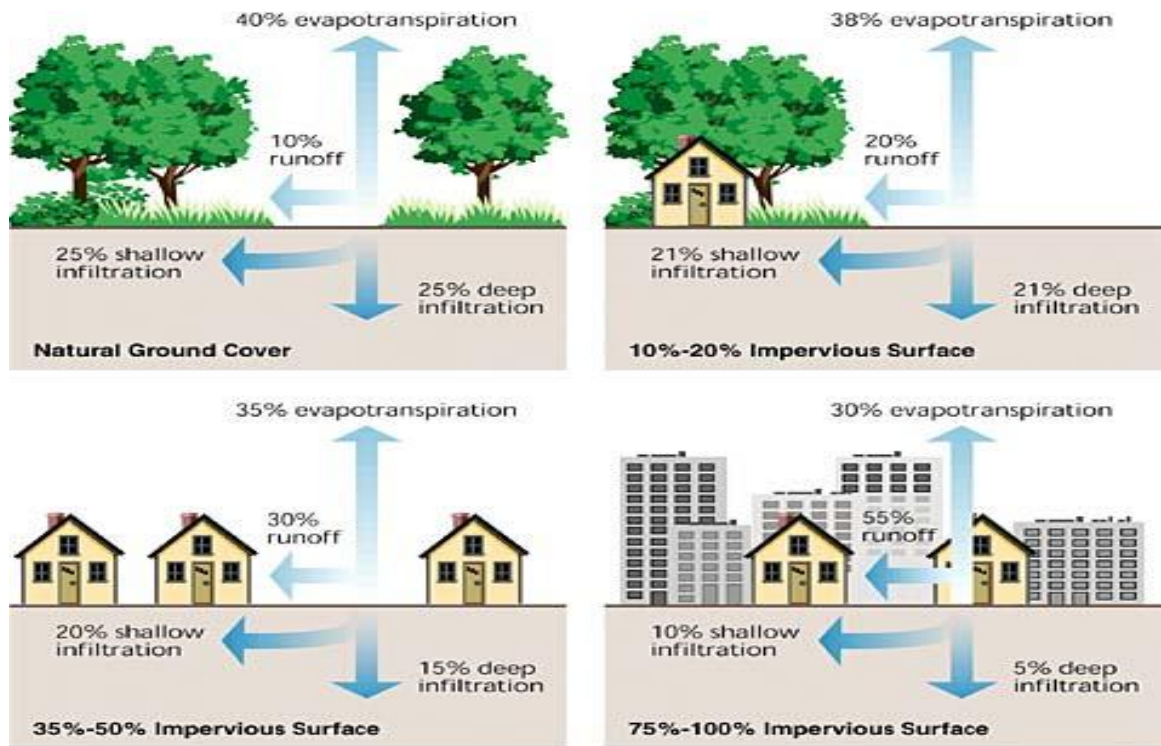
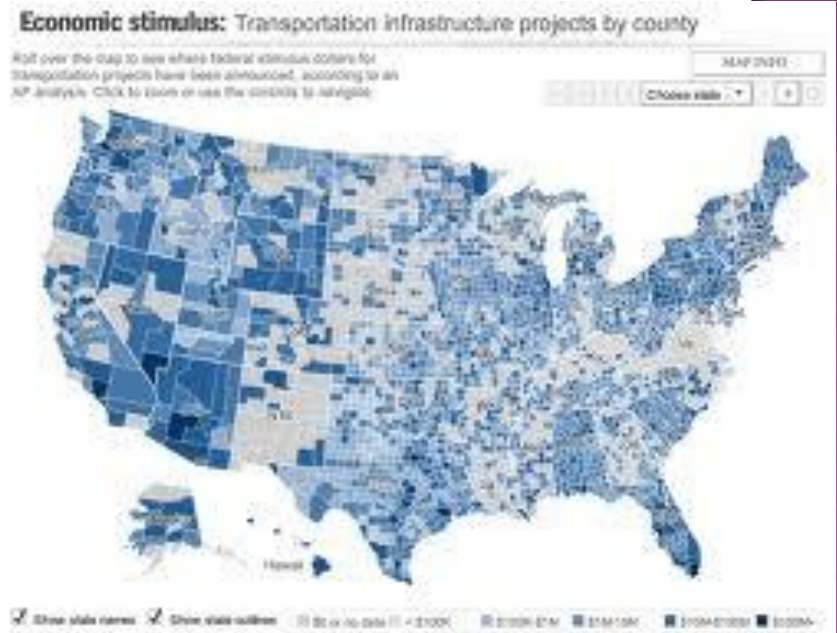


Fig. 3.21 – Relationship between impervious cover and surface runoff. Impervious cover in a watershed results in increased surface runoff. As little as 10 percent impervious cover in a watershed can result in stream degradation.
 In *Stream Corridor Restoration: Principles, Processes, and Practices* (1998).
 By the Federal Interagency Stream Restoration Working Group (FISRWG) (15 Federal agencies of the U.S.)



TRANSPORTATION INFRASTRUCTURE

- ◉ federal highway system increased access to many areas in US; roads traverse diverse ecosystems
- ◉ construction degrades the environment
- ◉ leads to urbanization
- ◉ increase in pollution



PUBLIC & FEDERAL LANDS

- ◉ National Park System
- ◉ National Wildlife Refuge System
- ◉ National Forest System
- ◉ National Resource Lands

LAND CONSERVATION

◉ preservation

- prevent the land from being used
- methods for preserving land
 - purchasing
 - legal agreements
 - donations
 - debt for nature swaps

◉ remediation

- removal of pollutants from the disturbed land; including sediments in waterways

◉ mitigation

- describe projects or programs intended to offset known impacts to an existing historic or natural resource such as a stream, wetland, endangered species, archeological site or historic structure.
- to "mitigate" means to make less harsh or hostile

◉ restoration

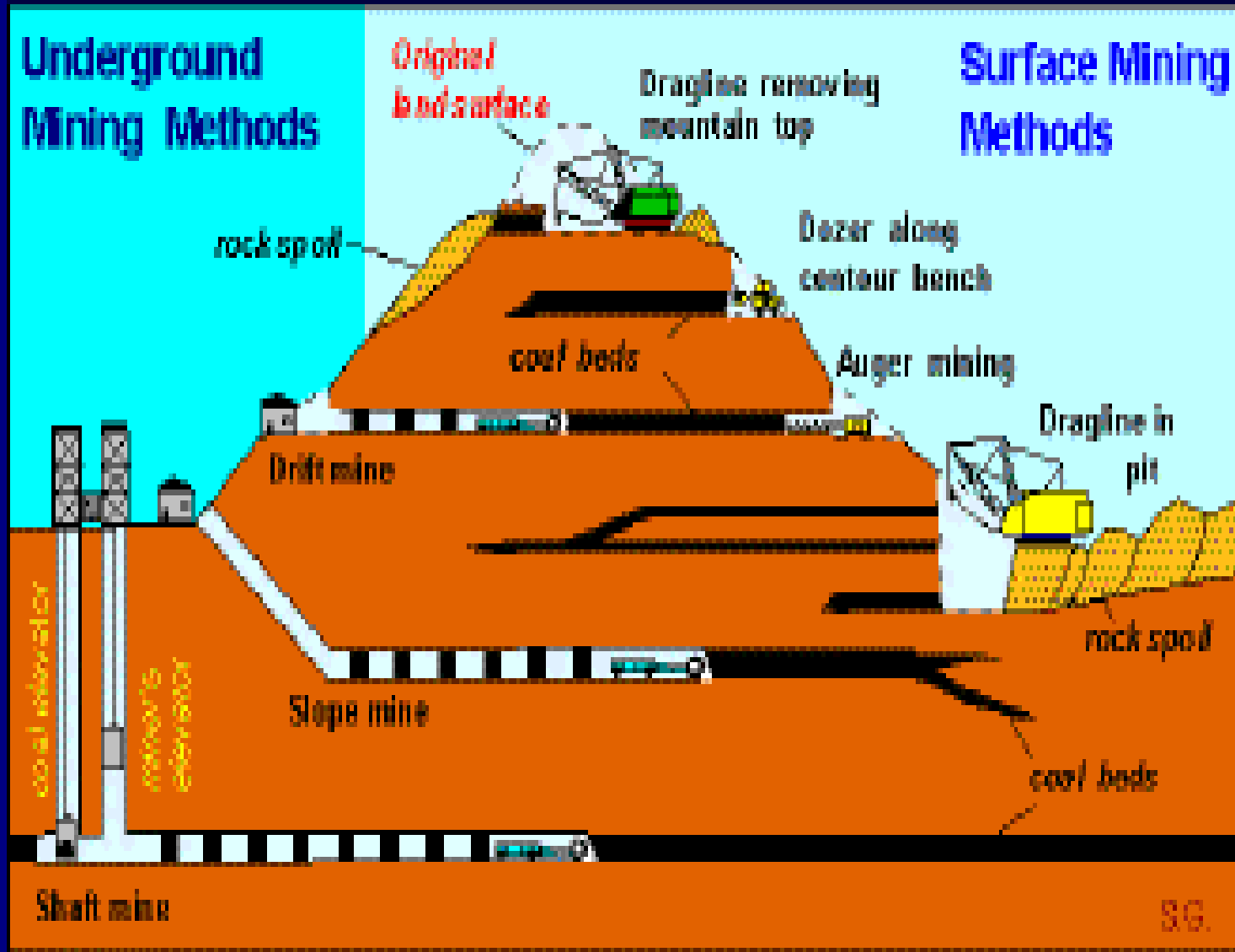
- land that has been altered is returned to pre-disturbance conditions

MINING

- Minerals: nonliving natural substances
- Extraction Method
 - Open Pit Surface Mining
 - miners dig large pit & remove exposed ore
 - used to extract copper, iron, sand stone, gravel, limestone, granite & marble
 - Area Strip Mining
 - used on flat or rolling hill terrains
 - dig series of parallel trenches to expose the ore
 - after 1st trench dug & ore is extracted, used to store debris & overburden from 2nd trench
 - at end land may be reclaimed or just left as a series of mounds of debris than then erode
 - Contour Strip Mining
 - Deep Mining
 - used for mineral deposits far below the surface

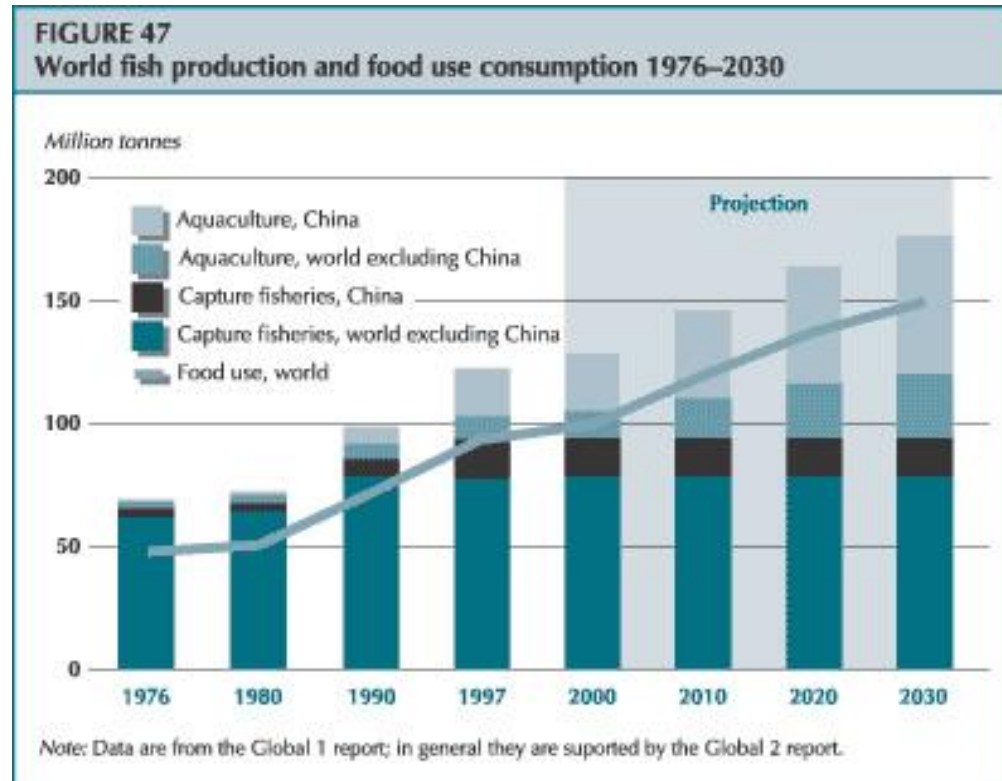
Underground Mining Methods

Surface Mining Methods



FISHING

- Worldwide people get 20% protein from fish & shellfish

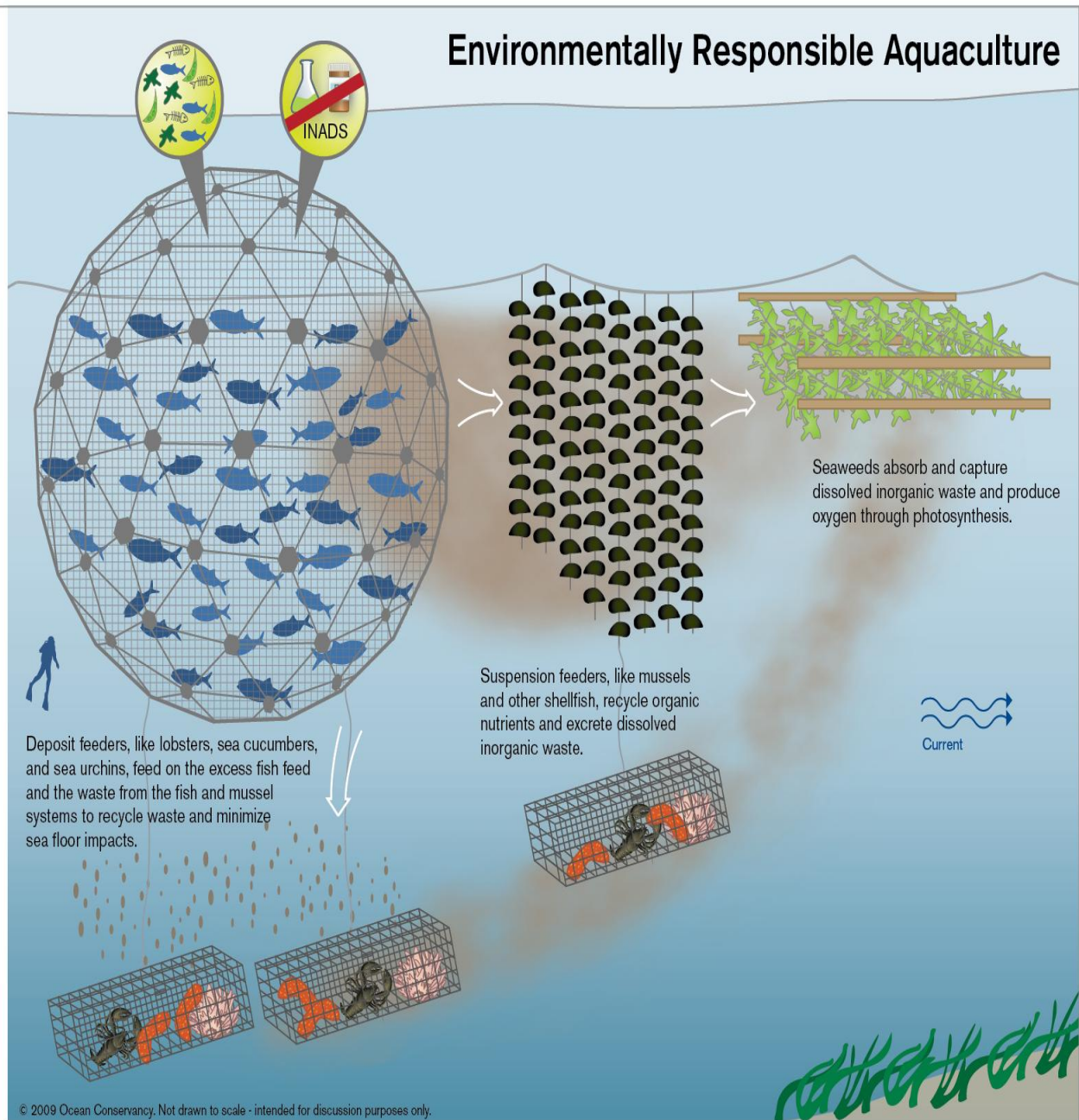


To minimize the negative impacts of nutrient pollution from open-ocean fish farming, Integrated Multi-Trophic Aquaculture (commonly referred to as 'IMTA') is a system in which seaweeds (kelps and other algae), suspension feeders (mussels, clams, and oysters), and deposit feeders (lobsters, sea cucumbers, and sea urchins) are cultured in the proximity of fish cages to recycle the waste byproducts of each segment. The dissolved nutrients from the fish and shellfish are used by the seaweeds, while the particulate wastes serve as food for the shellfish and other invertebrates. Such a system can help limit the impacts of nutrient loading on a farm's surrounding ecosystem, while also offering economic stability and supplemental income from the sale of multiple products raised on the farm.

Environmentally responsible aquaculture operations will:

- produce more fish than they consume by using alternatives to fish meal and fish oil in fish feed ingredients;
- maintain low stocking densities to minimize waste, maximize fish welfare, and reduce reliance on drugs and chemicals;
- raise species that are native to the region, never genetically modified (GMOs);
- use drugs and chemicals only for emergency treatments and never use Investigational New Animal Drugs (INADs); and
- deploy cage technologies that prevent escapes and interactions with marine mammals and predators.

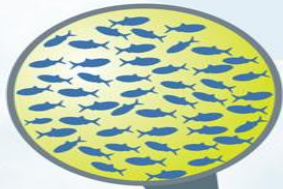
Environmentally Responsible Aquaculture



Environmental Impacts of Open-Ocean Aquaculture

Fish Meal & Fish Oil

Using wild-caught fish to feed farmed fish puts additional pressure on these populations and can impact other wildlife that depends on them for food.



Drugs & Chemicals

When used, antibiotics, parasiticides, and other chemicals flow out of pens and can affect wild fish as well as the broader marine ecosystem.



Escaped Fish

Escaped fish compete for food and habitat, transmit diseases, and prey on and breed with local fish, reducing the health of wild populations.



Diseases & Parasites

Disease, pathogens, and parasites can multiply in crowded pens and rapidly spread to wild fish.



Fish Waste

Fish waste flows out into the ocean, adding potentially harmful extra nutrients to the ecosystem. Uneaten food can also build up on the ocean floor underneath pens, altering the abundance and biodiversity of these communities.



Predators

Seals, sea lions, sharks, birds, and other marine wildlife can become entangled in fish pens. The use of deterrents like underwater loudspeakers can alter the natural behavior of predators.

