Food, Risk Assessment and Pesticides

Chapter 13 Food Resources

Perennial Crops on the Kansas Prairie

- Planting a mixture of plants for crops using perennial grasses vs. monoculture
- Benefits by reducing soil erosion, less pesticides (more resistant); less irrigation (deeper roots)

13-1 How’s Food Produced?

What three systems provide us with food? Some good and bad news:

- Technological advances- increases global food production
- Environmental degradation due to many factors- food production; can we feed 9 billion by 2050?

What plants and animals feed the world?

- 15 plants, 8 terrestrial animals; wheat, rice, corn, beef, pork, chicken

What are the major types of food production?

- High input, uses large amounts of fossil fuels, commercialized fertilizer, large amounts of water to produce single crops/livestock;
- Agric/industrialized but in tropical locations, growing cash crops;
- Agric/polyculture, produce enough to feed farm family;
- Family + highered help makes some $ after feeding family

13-2 Producing Food by Green Revolution and Traditional Techniques

How have green revolutions increased food production? High-input monocultures in action

- Increased crop yields by using monoculture fertilizer, pesticides; dependant on fertile soil, plenty of water, lots of fossil fuel- produces 8% of world output

Case Study: food production in the U.S.

- 2% of U.S. population (650,000) produce all of the food, 9% in extended business (supermarket, restaurants); largest industry by far in the US 18% of GNP; Average US citizen spends ~10% of income on food, developing countries: 40-70% of income

What growing techniques are used in traditional agriculture? Low input agrodiversity in action

- Grow several crops on same plot; cultivation- a plot is planted with variety of some crop;
- 2 or more grown on same plot; Agroforestry (alleycropping)- crops and trees planted together;
- More complete form of intercropping, better timing of maturity for different crops

13-3 Food Production, Nutrition and Environmental Effects

How much has food production increased?

- Good news- grain production up, prices down, meat production up
- Bad news- population growth is outstripping food production, sources of meat/fish are reaching the limits

What is undernutrition and malnutrition?

- Not starving but get >90% of minimum requirements;
- Deficiencies of proteins and other nutrients

How serious are undernutrition and malnutrition?

- Developing world 1/6 underfed, developed 1/7 - both result in lower life expectancy-disease, illness and quality of life
- Children affected worse- stunted growth, mental retardation, marasmus (low calories/protein) anemia (low iron)

How serious are micronutrient deficiencies?

- Some 2 billion people are suffering from micronutrient deficiencies (vitamin A, iron, iodine) in developing countries leaving them less resistant to

How serious is overnutrition?

- Too much food, too little - #2 cause of death after smoking, due to meat based diet;
- Vegetarian- most healthy;
- $19 billion- would eliminate under/mal nourished annual; comparison $36 billion spent annual in diet industry; solution- tax unhealthy foods?
De we produce enough food to feed the world’s people?
-U.S. produces enough grain for entire world if everyone was _______________; why not working-
poverty!

What are the environmental effects of producing food?
- Erosion, desertification, salinization, droughts, loss of wildlife, global warming

Saving Children
- UNICEF- $5/10/year saves a child in a developing country from nutrition related deaths

13-4 Increasing World Crop Production
How can crossbreeding be used to develop genetically improved crop strains?
- Takes 15 years to make a new variety, pest resistance for 5-10 year, plants have to be close genetically=
artificial selection

Is genetic engineering the answer?
- ____________- put alien genes into a valuable plant- Genetically Modified Organism (GMO), takes
½ time of crossbreeding, cheaper, don’t have to be genetically close; 2/3 of supermarket food is GMO
- Controversies, patents, developing countries cannot afford it

Can we continue expanding the green revolution?
- Require lots of fertilizer, pesticides and water, expensive- traditional subsidence farmer cannot afford;
environmental effects; pest resistance as increased

Will people try new foods?
- __________, protein rich legume in New Guinea/Asia- supermarket on a stick
- Microlivestock- __________- more protein than typical livestock!

Can China’s population be fed?
- By 2030, will need to rely on rest of world due to unsustainalbe farming techniques

Is irrigating more land the answer?
- Droughts due to ________________, soil salinization, global warming, need increase efficiency; crops
that need less water, slower withdraw of aquifers

Is cultivating more land the answer?
- Land not great for farming: tropical forests, arid environments; unless mass irrigation- dams and large
amounts of fossil fuels
- Releases more CO2, deforestation and habitat fragmentation

Shrinking the world’s genetic plant library
- Many plant species go extinct, attempts are being made to save and store seeds

Can we grow more food in urban areas?
- Lots of potential in empty lots and __________

13-5 Producing More Meat
What are rangeland and pasture?
- 40% of ice-free land- rangeland for grazers and browsers; 29% of U.S. land- rangeland; pastures-
managed grasslands and meadows

What is the ecology of rangeland plants?
- Hearty plants can withstand various abiotic factors; metabolic reserve- grass survives when ½ is eaten
from top

How is meat produced, and what are it environmental consequences?
- Income increases- meat consumption increases, most raised on rangeland in developed countries

How can we raise meat production by recycling crop residues?
- Feed livestock ________________ residue such as wheat straw, rice straw, corn stalks instead of
consuming grain

What are the effects of overgrazing and undergrazing?
- Overgrazing- exceeding carrying capacity- erosion; undergrazing- 5 year absence of grazing = lower
primary product

What is the condition of the world’s rangelands?
- 20% decrease of productivity due to __________________
Some environmental consequences of meat production
- 50% of cropland used to feed livestock; water pollution and massive runoff; methane - 15% cattle
produce 20 times more waste than humans

Endangered Riparian Zones
- Lush vegetation along - protect flooding; store water during droughts; 75% of wildlife
dependant on riparian zones

How can rangelands be managed sustainably to produce more meat?
- Control numbers, types, distribution of livestock and duration; defer grazing - fence areas off a few year
for recovery

13-6 Catching and Raising More Fish
How are fish and shellfish harvested?
- 6 groups of fish- sardines, hering, anchovies, salmon, cod, mackareal and tuna- ; flat fish-
flounder; invertebrate- clams
- scoop up bycatch 8 times higher than intended catch (other unsustainable methods:
pure-sence, longline drift net, etc.)

Can we harvest more fish and shellfish?
- No; all fish populations are in decline- 2040 will be depleted to levels that close to extinction

Connections: How are overfishing and habitat degradation affecting fish harvests?
- Overfishing- leads to commercial extinction- no longer ; 85% of fish stocks in decline

Commercial fishing and the tragedy of the commons
- Global fleet- $125 billion to catch estimated $70 billion worth of fish-

Is aquaculture the answer?
- 25% of commercial fish harvest comes from fish farming- controlled environment; fish salmon raised in captivity, released then harvested in spawning grounds

13-7 Governmental Agriculture Policy
How do government agricultural policies affect food production?
- Keep food prices low- good for consumers; gives farmers subsidies; free market

13-8 Solutions: Sustainable Agriculture
What is sustainable agriculture?
- Rangelands and oceanic fisheries- at limit; Reduce population growth main concern
- Organic farming- 95% organic ingredients, no GMO’s, no irradiation, soil cannot be from soil sludge,
organic- no antibiotics, fed organic feed, free range

Can we make the transition to more sustainable agriculture?
- Opposition- form , higher prices, only .2% of Dept. of Agriculture goes to researching
organic cultivation methods

Chapter 11 Risk, Toxicology and Human Health
The Big Killer
- Kill 4 million worldwide annually; 431,000 US; second hand smoke- 30,000-60,000 premature deaths;
nicotine is highly addictive; cost of treating >$100 billion;
- Suggestions- tax cigarettes, no , eliminate subsidies

11-1 Risk, Probability and Hazards
What is risk?
- Probability of harm in mathematical terms

How are risks assessed and managed?
- Risk assessment- identify hazards, determine probability and impact; risk mgmt- experts make decision
on how to deal with risk

What are the major types of hazards?
- Cultural hazards- working conditions, diet, drugs, alcohol, smoking, driving, poverty
- hazards- air, water, soil pollution; physical hazards- radiation, earthquakes, weather,
vvolcanoes, asteroids; biological- pathogens, allergies, poisonous insects, snakes, etc.

11-2 Toxicology
What determines whether a chemical is harmful? Dose and Response
- ____________ - measure of how harmful something is depends on dosage over time, how often, who is exposed, genetic info, solubility, persistence, bioaccumulation, biomagnifications, chemical interactions (synergistic)
- Regulation should be set to most sensitive persons
- Asbestos removers - chance of getting lung cancer- 20-fold
- Smokers - lung cancer- 400-fold

Should we be concerned about trace elements of toxic chemicals in the environment and in our bodies?
- Depends on chemical and concentration; body has natural defenses- liver dilutes, excretes, cell can repair themselves but too fast = __________

What is poison?
- Lethal Dose - ______ of test population killed by chemical being tested

How are case reports and epidemiological studies used to estimate toxicity?
- Case reports - people exposed to chemical (not reliable); lab investigations - usually on test animals to determine toxicity, residence time, and how body affected; ____________ - populations of humans exposed to certain chemicals and how some become sick, others do not

How are laboratory experiments used to estimate toxicity?
- Exposing live animals (mice, rats); animal welfare groups - push to test instead on bacteria, tissue cultures, etc.
- Use control group (identical in age and genetic makeup), and test group - exposed to high dosages - collect data, construct mathematical models; criticism - animals = not people

How valid are estimates of toxicity?
- Must recognize there are always uncertainties in epidemiology studies; but best we have, should estimate on conservative levels 1/1000 harmful levels

11-3 Chemical Hazards
What are toxic and hazardous chemicals?
- 50% fatal in test animals, flammable, skin, lung damage

What are mutagens?
- Cause random mutation in _____ molecules by chemicals and radiation

What are teratogens?
- Chemicals/radiation that cause birth defects during ________________

What are carcinogens?
- Chemicals/radiation or viruses that cause malignant tumors; can spread by metastasis - tumor cells break off and travel in body - lag time of ___________ years

How can chemicals harm the immune, nervous, and endocrine systems?
- HIV weakens immune system, more susceptible to damage to nervous system - DDT, PCBs, dioxins

Are hormonally active agents a health threat?
- Can disrupt endocrine and reproductive systems - glands and hormones that control body functions;

How do we know so little about the harmful effects of chemicals?
- 10% of 75,000 chemical have been tested for toxicity; 2% for carcinogens, not enough $, personnel, facilities and new chemical come out each year

What is the precautionary approach?
- Those proposing a new chemical/technology would bear the burden of establishing its safety

11-4 Biological Hazards: Disease in Developed and Developing Countries
What are nontransmissible diseases?
- Not contagious, heart disease, cancer, malnutrition, usually develop over time

What are transmissible diseases?
- Caused by living organisms (pathogens) spread by air, water, food body fluids, and vectors (mosquitos)
- i.e.: Pneumonia, flu (acute respiratory infection), AIDS, Diarrheal diseases, TB, Malaria, Measles, Hepatitis B

How rapidly are viral diseases spreading?
-Influenza- 1918-1919- epidemic killed ~25 million worldwide; STD’s 33% of sexually active will have one by age 24; AIDS- by 2015- killed more than all ________________
- Antibiotics almost useless due to genetic resistance of bacteria

Are we losing ground in our war against infectious bacteria?
- The evolutionary ability of bacteria to change genetically to withstand antibiotics has outpaced development

How are viral diseases treated?
- Only a few antiviral drugs exist but even using leads to more genetic resistance; best solution- ___________ that stimulate the body’s immune system to ward off viral infections (worked for polio, smallpox, measles)

The global tuberculosis epidemic
- 2 million die per year/vs Ebola- ___________; silent global epidemic in developing world- no media attention; can control TB would cost $360 million

Connections: what factors can affect the spread of transmissible diseases?
- Increased international air travel, migration to urban areas, deforestation, invasive vectors, frequent hurricanes, global warming; developed countries- migration to suburbs (lyme disease)

Producing and edible Hepatitis B vaccine
- Kills one million a year, current vaccine= $100/person (3 shots over 6 months, must refrigerate), extract vaccine in grow in potatoes- mice have shown immunity= $5/per dose

Case Study: Malaria, a protozoal disease
- ~400 million infected (45% of world population lives in tropics and subtropics) kills 1.5 million/year; caused by protozoa transferred in blood by mosquitoes

Improving health care in developing countries
- Better nutrition, prenatal care, clean drinking water would save millions of lives

How can we reduce the incidence of infectious diseases?
- Spend more on research; only $15 billion worldwide vs. over $1 trillion for weapons (150 million die from TB, malaria and AIDS vs. 23 million in wars)

11-5 Risk Analysis
How can we estimate risks?
- Comparative risk analysis- need to educate ‘citizens’ on perspective of certain risks; using cost-benefit analysis

What are the greatest risks people face?
- #1 Poverty, #2 Smoking, #3 Excess Sun, #4 Alcohol, #5 Diet/lack of exercise
- Other risks, you have no choice, gender based, genes we inherit, born into _____________

How can we estimate for technological systems?
- Even if tech is 100% reliable, human will never be (Chernobyl, Challenger disasters)

What are the limitations of risk analysis?
- How much risk is acceptable, is there a certain level of mortality for technology/toxin to be used?
- More a political question than science?

How should risks be managed?
- A compromise between political, economic, health and environmental risks

So how well do we perceive risks?
- Most shrug off high-risk chances of death- Motorcycle use- 1/50 death rate/ Smoking- 1/300 by age 65/ Driving 1/2500 w/o seatbelts, 1/5000 with seatbelts/
- Most people fear ‘exotic’ deaths- airplanes 1/4.6 million, snakebites 1/36 million, sharks 1/300 million due to media portrayal
- Most people live every year

Chapter 20 Pesticides and Pest Control
Along came a spider
- More successful at killing insects than any ____________; public view of spiders is bad; could save more crops than pesticides
20-1 Pesticides: Types and Uses

How does nature keep pest populations under control?
- Pest competes w/ us for food, invade lawns/gardens; spreads diseases; damages wood
- Artificial ____________ - upset natural predators- need pesticides

What are pesticides?
- Chemicals use to control insect, weed and rodent populations

What was the first generation of pesticides and repellants?
- 500 BC- ________; up till 1920 use of very toxic pesticides
- Pyrethium and Rotenone- 1st generation natural pesticides

What is the second generation of pesticides?
- 1939 ________; Paul Muller- 1948 won nobel prize for development of; since 1950 pesticide use has increased 50-fold; use of both broad and narrow spectrum agents

20-2 The Case for Pesticides
- Save human lives- prevented premature death of insect-transmitted diseases; increase food supply @ lower costs; work fast; health risks are insignificant when used properly

20-3 The Case Against Pesticides
- Cause genetic resistance- insects reproduce rapidly, can develop immunity with 5-10 years through natural selection, weeds develop immunity more slowly
- Broad spectrum insecticides- kill natural predators but make room for secondary pests
- Wildlife- Fish eating bird populations plummeted 1950-1960s due to DDT egg shells thinned= no offspring; fish and honeybee populations directly affected
- Human health- farm workers in developing countries-180,000 deaths/year; 165 ingredients in pesticides are carcinogens

How effective have synthetic pesticides been in reducing crop losses?
- Only 2% of pesticides reach target; 5% for herbicides; most ends up in waterways and air
- ____________________ = more frequent applications, larger doses, switch to new chemicals; evidence has shown that cutting pesticide use has not decreased harvest

20-4 Pesticide Regulation in the U.S.

How are pesticides regulated in the U.S.?
- EPA needs to approve pesticide and set tolerance level, has banned some chemicals
- Exposure to pesticides residue- 10,000 cancer deaths/year
- EPA is not fully utilized

What goes around can come around
- Many U.S. companies export banned pesticides to developing countries, some food imported into US has shown up with banned pesticide residue

How can pesticide regulation be improved?
- Make human health a priority, better testing procedures, new standards for testing levels

20-5 Other Ways to Control Pests

What should be the primary goal of pest control?
- Wipe out a pest to a level where economically tolerable; way to reduce pesticide use- pest loss insurance

What are other ways to control pests?
- __________; plant surrounding trees and bushes to house insect predators; shift from monoculture to polyculture
- ______________ - success over 10-20 years; Genetic engineering- faster but GMO’s controversial
- Insect birth control- males are sterilized in labs by radiation, mate many times; females only once (eliminated screwworm fly); drawbacks- costs; need background in insect reproduction
- Sex attractants and hormones- releasing pheromones from females to lure males into traps- will not cause genetic resistance
- ____________ - been successful on cotton, alfalfa and potato crops

Is integrated pest management the answer?
- A central program that includes a mix of cultivation, biological and chemical methods
- Reduces pesticide use, crop losses, genetic resistance
- If practice in US, health risks would drop 75%
- Drawbacks: slower acting; opposition from chemical companies; should tax pesticides
Part A: LD50 and MSDS

Background:

We handle many materials daily that are toxic. We are often unaware of the degree to which they are toxic. For a variety of reasons, different animals respond differently to the same toxin. Some animals may be very sensitive to a toxin, whereas others are relatively resistant to its effects. Because species of animals vary, it is important to understand that what is toxic to brine shrimp may not necessarily be toxic to other kinds of animals to the same extent.

Many household items that we deal with on a regular basis are toxic materials, but we don’t usually think of them as being toxic. It can be instructive to examine several such materials to determine their toxicity.

The commonly used term to describe acute ingestion toxicity is LD\textsubscript{50}. LD means Lethal Dose (deadly amount) and the subscript 50 means that the dose was acutely lethal to 50% of the animals to whom the chemical was administered under controlled laboratory conditions. The test animals (usually mice or rats) are given specific amounts of the chemical in either one oral dose or by a single injection and are then observed for 14 days.

Since LD\textsubscript{50} values are measured from zero up, the lower the LD\textsubscript{50} the more acutely toxic the chemical. Therefore, a chemical with an oral LD\textsubscript{50} of 500 would be much less toxic than a chemical with an LD\textsubscript{50} of 5. LD\textsubscript{50} values are expressed as milligrams per kilogram (mg/kg) which means mg of chemical per kg of body weight of the animal. Mg/kg is the same as ppm. For example, if the oral LD\textsubscript{50} of the insecticide parathion is 4, a dose of 4 parts of parathion for every million parts of body weight would be lethal to at least half of the test animals.

An MSDS (Material Safety Data Sheet) is a document (for each chemical) with information on all the physical and chemical properties for that chemical, as well as information on reactions and safe disposal of the chemical waste. The following information can usually be found in a MSDS:

- Identity of the organization responsible for creating the sheet and the date of issue.
- The material's identity, including its chemical and common names.
- Hazardous ingredients.
- Exposure limits.
- Physical and chemical hazards and characteristics.
- Health hazards.
- Emergency and first aid procedures.
- Spill and disposal procedures.
- Precautions and safety equipment.

There are two parts to this activity:

1. Using your OWN MASS in kg, figure out how many total g would be required to kill 50% of perfect duplicates of yourself. Be careful about units! For your reference, a penny weighs around 3000 mg or 3 g. You don't need to show work for all of these problems, but write out ONE complete example of your conversion to LD\textsubscript{50}/person below the table so that I know how you did it. Remember, everyone’s answers will be slightly different.

2. Find a Material Safety Data Sheet (MSDS) for an ingredient in some household substance you have (e.g. toothpaste, shampoo, mouthwash, junk food additives, etc.) and give its LD\textsubscript{50} for the oral route for a person in g/person. Assume the LD\textsubscript{50} of a rat or mouse will be the same as a human. Don’t use any of the
ones already listed below. Search for MSDS’s on the web, and print out the MSDS for the substance you have chosen.

<table>
<thead>
<tr>
<th>Substance (source or product)</th>
<th>$\text{LD}_{50}$ (mouse or rat) mg/kg or g/kg</th>
<th>$\text{LD}_{50}$ for you (g/person)</th>
</tr>
</thead>
<tbody>
<tr>
<td>disodium EDTA (Secret)</td>
<td>2000. mg/kg</td>
<td></td>
</tr>
<tr>
<td>benzaldehyde (Cherry Flavor)*</td>
<td>4.8 mg/kg</td>
<td></td>
</tr>
<tr>
<td>Tetrahydrocannabinol (THC from marijuana)*</td>
<td>110 mg/kg</td>
<td></td>
</tr>
<tr>
<td>Ethyl acetate (Cherry Flavor)*</td>
<td>6100 mg/kg</td>
<td></td>
</tr>
<tr>
<td>propylene glycol (Cherry Flavor)</td>
<td>20 g/kg</td>
<td></td>
</tr>
<tr>
<td>Caffeine (Mountain Dew)*</td>
<td>0.13 g/kg</td>
<td></td>
</tr>
<tr>
<td>malic acid (sour candy)*</td>
<td>1.6 g/kg</td>
<td></td>
</tr>
<tr>
<td>Methanol (wood alcohol)*</td>
<td>5628 mg/kg</td>
<td></td>
</tr>
<tr>
<td>Nicotine (through mouth)*</td>
<td>190 mg/kg</td>
<td></td>
</tr>
<tr>
<td>Botulinum toxin (bacteria)*</td>
<td>$3 \times 10^{-8}$ mg/kg</td>
<td></td>
</tr>
<tr>
<td>potassium nitrate (fertilizer)</td>
<td>190 mg/kg</td>
<td></td>
</tr>
<tr>
<td>sodium fluoride (toothpaste)</td>
<td>52 mg/kg</td>
<td></td>
</tr>
<tr>
<td>parathion (pesticide)</td>
<td>6.0 mg/kg</td>
<td></td>
</tr>
<tr>
<td>Vx (nerve gas)</td>
<td>$2 \times 10^{-2}$ mg/kg</td>
<td></td>
</tr>
<tr>
<td>tetrodotoxin (poison from puffer fish)</td>
<td>$334 \times 10^{-6}$ g/kg</td>
<td></td>
</tr>
<tr>
<td>diazinon (ant killer dust)</td>
<td>0.076 g/kg</td>
<td></td>
</tr>
<tr>
<td>amphetamine sulfate</td>
<td>32 mg/kg</td>
<td></td>
</tr>
<tr>
<td>ephedrine</td>
<td>0.600 g/kg</td>
<td></td>
</tr>
<tr>
<td>gamma hydroxybutyrate (date rape drug)</td>
<td>2.0 g/kg</td>
<td></td>
</tr>
</tbody>
</table>

Showing your work for ONE problem:

* natural substances
Outbreak
Before viewing the film, read through all questions, they may not go in order

1. How is the discovery of the virus covered up in 1967?

2. What was the name of the virus?
3. How is it similar to a ‘real life’ virus in your textbook and in the news?

4. How is the virus transported to the U.S?

5. How does the virus reach Ceder Creek?

6. How does most of the town get infected with the virus?

7. Why are the CDC scientists search for the host animal?

8. What are two ways that the scientists become infected with the virus?

9. Movie Inaccuracy:
The host organism is not from Africa, what is the name of the species and where is it found?
An insect pest has attacked about 20 percent of the trees in a pure stand of white pine. In an effort to reduce the economic loss, the owner has the forest crop sprayed every spring with a relatively new pesticide. The species that the farmer is trying to eliminate is normally preyed upon by other insects, a parasite, and songbirds from nearby woods. To the south of the property is a bird sanctuary for rare species of waterfowl and the carnivorous osprey. The farmer has been assured that natural barriers and the wind direction will keep the pesticide out of the wildlife area. The three areas shown on the diagram (Figure 1) were carefully studied over a five-year period by researchers from a nearby university. Insect populations were estimated, fish and bird populations studied, soil samples collected, and pesticide concentrations measured in an effort to determine the overall environmental influence of this new pesticide. The results are recorded in Table 1.

**Table 1**

<table>
<thead>
<tr>
<th>Year</th>
<th>Area</th>
<th>Insect Population</th>
<th>Species of Insect Predators</th>
<th>Percentage of Pests with Parasites</th>
<th>Percentage of Fish Mortality (adults)</th>
<th>Pesticide Concentration in Fish (ppm)</th>
<th>Carnivorous Birds Percentage Nesting Success</th>
<th>Insecticide in Eggs (ppm)</th>
<th>Number of Soil Species</th>
</tr>
</thead>
<tbody>
<tr>
<td>1975</td>
<td>A</td>
<td>200,000</td>
<td>4</td>
<td>50</td>
<td>10</td>
<td>50</td>
<td>80</td>
<td>70</td>
<td>42</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>50,000</td>
<td>7</td>
<td>30</td>
<td>10</td>
<td>50</td>
<td></td>
<td>60</td>
<td>74</td>
</tr>
<tr>
<td></td>
<td>C</td>
<td>50,000</td>
<td>8</td>
<td>30</td>
<td>8</td>
<td>30</td>
<td></td>
<td>80</td>
<td></td>
</tr>
<tr>
<td>1976</td>
<td>A</td>
<td>4000</td>
<td>2</td>
<td>10</td>
<td>10</td>
<td>150</td>
<td></td>
<td>30</td>
<td></td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>2000</td>
<td>3</td>
<td>20</td>
<td>10</td>
<td>120</td>
<td></td>
<td>55</td>
<td></td>
</tr>
<tr>
<td></td>
<td>C</td>
<td>40,000</td>
<td>8</td>
<td>30</td>
<td>8</td>
<td>100</td>
<td></td>
<td>70</td>
<td></td>
</tr>
<tr>
<td>1977</td>
<td>A</td>
<td>200</td>
<td>0</td>
<td>4</td>
<td>10</td>
<td>50</td>
<td>250</td>
<td>24</td>
<td></td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>1000</td>
<td>1</td>
<td>10</td>
<td>10</td>
<td>200</td>
<td></td>
<td>50</td>
<td></td>
</tr>
<tr>
<td></td>
<td>C</td>
<td>40,000</td>
<td>8</td>
<td>25</td>
<td>10</td>
<td>150</td>
<td></td>
<td>68</td>
<td></td>
</tr>
<tr>
<td>1978</td>
<td>A</td>
<td>800,000</td>
<td>0</td>
<td>2</td>
<td>80</td>
<td>400</td>
<td></td>
<td>20</td>
<td></td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>80,000</td>
<td>1</td>
<td>5</td>
<td>70</td>
<td>350</td>
<td></td>
<td>46</td>
<td></td>
</tr>
<tr>
<td></td>
<td>C</td>
<td>50,000</td>
<td>7</td>
<td>25</td>
<td>50</td>
<td>250</td>
<td></td>
<td>60</td>
<td></td>
</tr>
<tr>
<td>1979</td>
<td>A</td>
<td>1,400,000</td>
<td>0</td>
<td>0</td>
<td>90</td>
<td>500</td>
<td></td>
<td>7</td>
<td></td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>100,000</td>
<td>0</td>
<td>0</td>
<td>90</td>
<td>450</td>
<td></td>
<td>25</td>
<td></td>
</tr>
<tr>
<td></td>
<td>C</td>
<td>50,000</td>
<td>7</td>
<td>30</td>
<td>70</td>
<td>300</td>
<td></td>
<td>40</td>
<td>56</td>
</tr>
</tbody>
</table>
**Analysis**

1. What are two ways to explain why the pest population increased in 1978 when in 1977 it appeared that it had been eliminated in area A?

2. What indication is there that Area C was not directly affected by aerial spraying of the pesticide?

3. a. What effect did the spraying have on the insect predator populations?

   b. How will this eventually influence the size of the pest populations?

4. a. Thoroughly explain how the birds and fish in the sanctuary could be affected by the spraying in the pine forest.

   b. A well known insecticide, now banned in the United States, had this effect on some bird species. What is the insecticide and what are two species of birds so affected? What does this tell one about their diet?

5. What is the LD$_{50}$ for the fish and insecticide involved? ________________

6. Biodiversity is a good measure of ecosystem stability. What has happened to the stability of these three ecosystems studied? Back up your statements with specifics!
RISK ASSESSMENT ACTIVITY

Environmental decisions involve an analysis of risks that affect humans and other living organisms. In a democracy, citizens participate in the decision-making process. Therefore, the ways in which people perceive risks, and the differences in perception among nonexperts, experts and lawmakers, are critical to effective communication, decision-making and management related to the environment. Risk assessment, however, is always based on a degree of uncertainty, and how to manage risk is based on values and opinions, as well as scientific observations. Interpretation of data and recommendations on courses of action are often controversial. When information is incomplete, the usual procedure in science would be to seek more information. In risk management, however, decisions often need to be made before more information can be obtained. To wait for complete information is, itself, a risky procedure.

In this activity, you will compare your perceptions of risks with those of experts and analyze the differences.

ACTIVITY:

1) Study the list of potential risks on the next page and rank them from 1 to 12, with 1 being the greatest risk and 12 being the least risk.

2) Rate each risk on two scales: the observable-not observable scale and the controllable-uncontrollable scale. For each scale, use the number 1 to 5 to rate each risk, with 1 being the most observable or controllable. Use the explanations of these terms that follow to decide how to rate each risk.

**Observable risks** are those that are known to you, have an immediate effect that you can observe, are old (i.e. familiar) risks, are known to science. **Not observable risks** are those that you are unaware of, have a delayed effect that you cannot observe immediately, are new risks, and are relatively unknown to science.

Controllable risks are those that you feel you have some control over, do not give you a feeling of ‘dread,’ are not global catastrophes, do not have fatal consequences, are fairly distributed among groups of people, pose a low risk to future generations, have an element of risk that is easily reduced or is currently decreasing, and are incurred voluntarily. **Uncontrollable risks** are those that cause you to feel dread, are global catastrophes, are often fatal, are not fairly distributed, pose a high risk to future generations, have an element of risk that is not easily reduced or is increasing, and are incurred involuntarily.
Potential Risk Factors

<table>
<thead>
<tr>
<th>Observable---------Not observable</th>
<th>Risk Estimate</th>
<th>Risk Factor</th>
<th>Controllable --------Uncontrollable</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
<td>Motorcycles</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
<td>Pesticides</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
<td>Commercial aviation</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
<td>Handguns</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
<td>Oral contraceptives</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
<td>X-rays</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
<td>Nuclear power</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
<td>Alcoholic beverages</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
<td>Antibiotics</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
<td>Motor vehicles</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
<td>Smoking</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>1 2 3 4 5</td>
<td>1 2 3 4 5</td>
<td>Electric power (nonnuclear)</td>
<td>1 2 3 4 5</td>
</tr>
</tbody>
</table>

Follow-Up

1) Compare your ranking of the 12 risks with those of experts (see Mr. Walsh). What differences are there? Can you explain the differences by studying the ways you rated the risks on the two scales?

2) Compare your ranking of the 12 risks by the nonexperts and experts. To which ranking is your most similar? What can you conclude in general about the ways in which people assess risks?
Fishing Game --- Can you be a successful fisherman while preserving the common fishing grounds for everyone?

Background
In this game, you take on the role as the owner and captain of an independent fishing boat. You will fish for X rounds and see what is the most you can earn from your business. You will also be able to make decisions about taking out loans, investing in new equipment, and making agreements with other fishing captains about how many fish to catch. There are several sources of information to help you make these decisions, including market reports on your part of fishing industry, a business advisor, and news bulletins that inform you on how your business is doing and how the fish resources on which your business depends, are being affected.

Starting the Game
The first screen you see will allow you to name your captain. You can choose any name you want as long as it is 20 characters or less.

Choosing the Competition
In the Choose Captains screen you can decide how much competition you want from your rival captains. Select all rival captains as Independent.

How might independent captains differ from flexible and cooperative captains?

Visit the Boatyard
Describe how the following items will improve your ability to fish:
Navigational Charts
The Fish Finder
The Enhanced Fish Finder
The Improved Engine
Larger boats

Visit the Fisherman’s Association
The Fisherman’s Association Window is where you can attempt to make a deal with the other Captains. Set this to NO LIMITS!!

The Business Advisor
The Business Advisor Window is where you can get detailed information about your expenses and income, as well as the option getting or paying off a loan. In the very first round, you will not have any expenses, and no income either, unless you decide to get a loan right away.

Your expenses will be depend on several things, including the kind of boat you have (large boats are more expensive to maintain) how much fuel you use, and whether you have a loan or not. If you do not catch enough fish to cover your expenses, you may have a negative balance. Your creditors will not allow you to put to sea without paying all your bills, so you may have to stake out a loan or sell equipment, until you do not owe any more money. If you can’t pay all your bills, you will be forced to go out of business and the game will end.
Let’s go fishing!
Remember to double click to open your nets, and you can unload your catch when you are full at the dock to get a second fishing trip in, good luck!
After you are finished please answer the following reflection questions:

1. How did the following market trends change from round to round and why?
   Fish Catch
   ________________________________________________________________
   ________________________________________________________________
   Income
   ________________________________________________________________
   ________________________________________________________________
   Fish Pop.
   ________________________________________________________________
   ________________________________________________________________

2. How did the competing captains do in their fishing?
   ________________________________________________________________
   ________________________________________________________________
   ________________________________________________________________
   ________________________________________________________________

3. How does this activity reflect the tragedy of the commons from our activity earlier this year?
   ________________________________________________________________
   ________________________________________________________________
   ________________________________________________________________
   ________________________________________________________________

4. Fishing Game 2
   Change all captains to cooperative, how do your results from above differ from game 1?
   ________________________________________________________________
   ________________________________________________________________
   ________________________________________________________________
   ________________________________________________________________

5. Distinguish among trawling, purseine, longlining, and drift net methods for harvesting fish?
   ________________________________________________________________
   ________________________________________________________________
   ________________________________________________________________
   ________________________________________________________________

6. Describe trends in the world’s total fish catch and per capita fish catch since 1950, and explain why the per capita is expected to decline?
   ________________________________________________________________
   ________________________________________________________________
   ________________________________________________________________
   ________________________________________________________________

7. Distinguish between fish farming and fish ranching, what are the pros and cons of aquaculture?
   ________________________________________________________________
   ________________________________________________________________
   ________________________________________________________________
The Meatrix

Word Bank
1. This flash animation is a _________________ of the film "The Matrix".
2. It aims at making the _________________ aware of the danger and cruelty of___________.
3. Leo is a _________________ and Morpheus becomes Moopheus, a _________________.
4. Leo lives quite happily in a _________________ when Moopheus comes to tell him about the_______________, the world of the Meatrix where _________________ and come _________________ from.
5. In order to discover the Meatrix Leo has to choose between ___________ and a_______________.
6. If he swallows the red pill he will know the _________________ whereas if he swallows the blue one he will stay in the _________________.
   Questions:
   a. What food does factory farming produce?
   b. When was factory farming born?
   c. Who was it created by?
   d. Why was factory farming created?
   e. How are the animals treated in these farms?
   f. What do such conditions cause among animals?
7. To stop the chickens from fighting and hurting themselves the corporations turn to systematic mutilations such as ______________________
8. To fight diseases from spreading the machines add ______________________ to their feed
9. A consequence we breed some super strains of disease causing germs so every day we get close to an _________________
10. The excrement pollute ______________________ ________
11. What is the most surprising thing you learned from the Meatrix?
Bioassay Test for Toxicity

Up until as recently as 1986, canaries were used in coal mines to warn miners of the presence of harmful gases such as carbon monoxide or methane. Since the birds are more sensitive to these gases than humans, they are affected before the gases get to a level that is dangerous for humans. This use of a living organism to test for toxicity is called a bioassay. Though canaries have been replaced by electronic devices, bioassays with other biological organisms are used frequently in chemistry and environmental science. They are used to test for herbicide residue in soil, harmful chemicals in water, the effect of de-icing chemicals, and more.

The following procedure involves running a bioassay to determine what concentration of salt (NaCl) is toxic for seeds. Lettuce seeds work well because of their sensitivity, but other seeds (such as radish seeds) will work also. This project can be easily modified to test toxicity in your local environment. If you live in an area where there is lots of snow and ice, try testing different concentrations of a solution containing de-icing substances used in your city. If local refineries or factories release waste into a river, research what kinds of chemicals are in the waste and run a bioassay to determine what concentration of the chemical becomes toxic for local plant life. You can also research methods of performing bioassay tests on soil samples.

**Question:** At what concentration does salt (NaCl) become toxic to seeds? Is a certain amount of NaCl beneficial to seed germination/growth?

**Observe/Gather Data:** Research all you can about how large concentrations of salt (or whatever chemical you decide to test for) could get into local water or ground water, and find out the existing data about how salt affects plant germination and growth. The more detail you gather in your research, the more informed your hypothesis will be.

**Hypothesis:** Based on your research, write a detailed hypothesis predicting the answer to the question:

____________________________________________________________________________________

**Experiment:** To test your hypothesis, run a bioassay testing the effect of solutions with varying concentrations of NaCl.

**Materials**
- pipet
- NaCl (table salt)
- Water
- 6 petri dishes
- filter paper
- seeds
- 100 ml graduated cylinder

**Procedure**
The first part of the experiment involves making solutions with several different concentrations. The easiest way to do this is to make a high concentrate solution and then dilute it for your other solutions.

- Obtain six Petri dishes and label the dishes as follows: 10%, 1%, 0.1%, 0.01%, 0.001%, 0.0001%
- Put a piece of filter paper in each of six petri dishes.
- Make six serial dilutions of NaCl
  - First make a 10% solution by putting 10 mL of original NaCl in 90 mL of water (distilled)
  - Then take 10 mL of this solution and add it to 90 mL of water to make a 1% solution
  - Make further dilutions to prepare the 0.1%, 0.01%, 0.001%, 0.0001%
• Place each solution into the corresponding labeled Petri dish, use a pipet to add 5 ml of the appropriate solution to each petri dish
• Place eight seeds from the same packet in each dish, evenly spaced.
• Put the lids on the dishes and seal them with tape to help keep them moist.
• Put the dishes in a dark place and keep them at room temperature for 5 days.
• After 5 days, measure the radicle (embryonic root) length in mm of each seed that germinated. Look closely so you measure just the root, not the shoot as well.

Lettuce Seed Dose/Response Bioassay
Data Form

Name ____________________________
Date ____________________________

Chemical tested ____________________________
Length of experiment ______________________ days
Constants (such as temperature and light) ______________________________________________

Table 2a. Seed Germination Data

<table>
<thead>
<tr>
<th>Individual Group Results</th>
<th>Class Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concentration (%)</td>
<td>Concentration (%)</td>
</tr>
<tr>
<td># Seeds Germinated/Dish</td>
<td># Seeds Germinated/Dish</td>
</tr>
</tbody>
</table>

Table 2b. Radicle Length Data

<table>
<thead>
<tr>
<th>Concentration (%)</th>
<th>Radicle Length (???)</th>
<th>Average Length (???)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Make line graphs of the averages you calculated in Tables 2a and 2b:

Some questions to consider: (Please answer using full sentences.)
1. Did at least 80% of the seeds in the control dishes germinate? If not, what would you recommend doing differently next time to try to get a better germination rate?
2. Did lettuce seed germination respond in a predictable way to concentration? Describe any trends you observed.

3. Do any of your data not fit the trends you observed? If so, can you think of any reasons why these data might lie outside the range you would expect?

4. What is your estimate of the LD<sub>50</sub> based on your lettuce seed germination data?
   \[ \text{LD}_{50} = \] _____
   What is your estimate of the LD<sub>50</sub> based on your radicle length data?
   \[ \text{LD}_{50} = \]
   Which shows a greater response to the chemical you tested: germination rate or radicle length? Describe any similarities or differences that you noticed in trends between these two indicators of toxicity.

5. What can you conclude about the toxicity of the substance you tested? Is this what you expected? Was your hypothesis supported by the data?

6. If other students carried out a dose/response experiment using the same chemical, did their data follow the same trends as yours?

7. Based on this experiment, would you say that lettuce seed germination or root length would provide a useful bioassay for water samples from the environment? Why or why not?

8. If you were going to repeat this experiment, what would you do differently? How might you improve the experimental design to reduce the variability of your data or lead to more reliable results?