I. **Ecosystem Stability**

   **A. Dynamic Equilibrium**
   1. Various aspects of the ecosystem change from day to day, season to season, and year to year
   2. Changes are within limits and are usually small
   3. Only mature ecosystems are stable and in dynamic equilibrium
   4. Mature ecosystems have resilience and inertia
      - **Resilience** – ability of an ecosystem to return to normal after a disturbance
      - **Inertia** – resistance of an ecosystem to change

   **B. What keeps an ecosystem stable?**
   1. **Species Diversity**
      - Definition – the measure of the number of different species represented in an ecosystem
      - Highest in a mature ecosystems over an immature ecosystems
      - Highest in complex ecosystems over simple ecosystems
      - Simple ecosystems have very low species diversity
         - (1) **Vulnerable** to disruption or destruction
         - (2) Lowest in **monocultures** (wheat field)
      - **HIGH SPECIES DIVERSITY** is the name of the game
         - (1) High species diversity ecosystems are **stable** and **complex**
         - (2) High species diversity ecosystems have many paths through the **food web**
         - (3) Low species diversity ecosystems have few paths through the food web
      - **Simplifying ecosystems**
         - (1) Occurs when species become **extinct**
         - (2) Occurs when humans remove species from the ecosystem
         - (3) Results:
            - (a) Can cause cause minor damage to irreparable damage to the ecosystem
            - (b) Minor damage can be repaired
            - (c) Irreparable damage will produce a new and different ecosystem
2. Dynamics of the ecosystem
   a. The **dynamic balance** of ecosystems is between **population growth** and **population reduction** factors
      (1) **Growth Factors** – factors that cause the population to increase in number
      (2) **Reduction Factors** – factors that cause the population to decrease in number
   b. **Biotic** and **abiotic factors** enhancing growth of the population
      (1) Ability to produce offspring
      (2) Ability to **adapt** to new environments
      (3) Ability to **migrate** to new territories
      (4) Ability to compete with other species for food and space to live
      (5) Ability to blend into the environment so as not to be eaten
      (6) Ability to find food
      (7) Ability to defend itself from enemies
      (8) Favorable light
      (9) Favorable temperature
      (10) Sufficient rainfall
   c. Biotic and abiotic factors reducing growth
      (1) **Predators**
      (2) Disease
      (3) **Parasites**
      (4) Competition for space and food
      (5) Unfavorable weather
      (6) Lack of food
      (7) Lack of water
   d. When all populations within an ecosystem are in balance, the entire ecosystem is in balance
   e. **Stability** of the ecosystem
      (1) The higher the **species diversity** the greater the **inertia** and **resilience** of the ecosystem is
      (2) When the species diversity is high within an ecosystem, a population within the ecosystem can be out of control because of an imbalance between **growth** and **reduction factors**, with the ecosystem at the same time can still remaining stable
C. Correcting Imbalance in Ecosystems
   1. Imbalance occurs when growth and reduction factors are out of balance
   2. Small scale changes
a. Natural and are the sum and substance of dynamic balance

b. Example 1: Mouse–coyote interactions
   (1) Increase in rainfall in the grasslands of Texas
   (2) Increase ground cover and food supply for mice
   (3) Increased mouse population
   (4) Increased coyote population
   (5) Decrease in coyote population as mouse population decreases
   (6) All populations back to "normal"

c. Example 2: Sewage accidentally dumped into a stream
   (1) Decreases the oxygen available as the detritus food chain breaks down the sewage
   (2) Some fish die at the pollution site and down stream
   (3) Sewage is broken down and washes out to sea and is finally broken down in the ocean
   (4) Oxygen levels return to normal
   (5) Fish populations that were deleted are restored as fish above the spill reproduce and the young occupy the real estate formerly occupied by the dead fish
   (6) Populations all return to "normal"

d. Small shifts are fairly common. The ecosystems can respond and return to normal.

3. Large-scale changes:
   a. Can be caused by either natural or human events
   b. Damage can be so bad that it takes years to decades to recover
   c. Succession – method by which an ecosystem forms or heals itself
      (1) **Primary Succession**
         (a) Succession where nothing has ever grown before
         (b) First inhabitants are called the pioneer community
         (c) Good example:
            i) Hawaiian Islands
            ii) Started off as bare volcanic rock
            iii) Now a tropical paradise
      (2) **Secondary Succession**
         (a) Succession after partial or complete destruction of the ecosystem
         (b) Complete soil development is generally unnecessary
         (c) Example: Forest succession on Howell Mountain
i) Mature forests were cut down and vineyards planted in the '20s

ii) Vineyards were abandoned in the '30s

iii) Shrubs and trees began to grow in the abandoned vineyards until there is now a mature forest again

(d) Each new species that invades the disturbed area helps to modify the environment until the climax species are reached

(e) Early communities in the successional process have a low species diversity

(f) Species diversity increases over the successional period

(3) Biomass flow in secondary succession

(a) Early communities

   i) Nutrient loss is high

   ii) Very open nutrient cycles

   iii) All because of grazers and erosion

(b) Late communities

   i) Nutrients are trapped and held and returned to the community through the detritus food chain

   ii) Nutrient cycles tend to become more closed

   iii) Because of the detritus food chain

(4) Summary

(a) Pioneer and intermediate communities are in imbalance because they are in a constant state of change

(b) When environmental resistance peaks a new stable climax community becomes established

II. Human Impact on Ecosystems

A. Altering biotic factors

1. Introducing foreign species

   a. Rabbits in Australia

      (1) 12 pairs introduced to Australia in 1859

      (2) 1 billion by 1953

      (3) 5 rabbits eat as much as one sheep

   b. Water Hyacinth introduced in Florida

      (1) Chokes water ways

      (2) Difficult to remove

2. Eliminating predators

   a. Man tends to eliminate bears, eagles, and wolves because they interfere with his livestock
b. **Bounty** on predators in Grand Canyon
   (1) 1900 Arizona put bounty on wolves, coyotes, and lions
   (2) Within 15 years there were no predators
   (3) In 1900 there were 4000 deer on the Kiabab Plateau
   (4) 1924 there were 100,000 deer
   (5) 60,000 deer starved in the following winters

3. Introducing predators
   a. **Mosquito fish** introduced into ponds or streams
   b. The mosquito fish eat mosquito larvae and zooplankton
   c. Without zooplankton the algae proliferates

4. Introducing disease organisms
   a. There are natural controls on most pathogens within most ecosystems
   b. Humans have knowingly or unknowingly have introduced pathogens
      (1) There are no controls in the new ecosystem
      (2) Pathogen proliferates rapidly
   c. Example: **Chestnut** blight
      (1) 1800s the fungus that infects Chinese chestnuts was introduced accidentally into the U.S.
      (2) Brought to New York Botanical Gardens on diseased Chinese chestnuts
      (3) Chinese chestnuts immune
      (4) American chestnuts virtually eliminated between 1910 and 1940

B. Tampering with abiotic factors
   1. Creating pollution
      a. Pollution kills
      b. Creates an unfavorable abiotic environment
   2. Deleting resources
      a. Depletes or destroys resources used by other species
      b. Example: Diversion of water from Mono Lake for Los Angeles
         (1) Mono lake a salt lake with no outlet
         (2) An important ecosystem for many wildlife species
         (3) Diverting water from the lake causes the lake level to drop by evaporation
         (4) This causes further concentration of salt in the lake
         (5) The lowered lake level causes islands with nesting sites to become accessible by predators because of land bridges
         (6) The ecology of the area changed dramatically
C. Simplifying Ecosystems

1. Tampers with abiotic and biotic factors
2. Results in reduced species diversity
3. May cause ecosystem imbalance or collapse
4. Best seen where natural ecosystems are converted into farmland
   a. Monocultures – crops of only one species
   b. Susceptible to damage from insects and disease
   c. Unlimited food source for insects and disease
   d. Little or no environmental resistance
   e. Chemical pesticides are used to resist these pests
   f. Peregrine falcon suffered from DDT