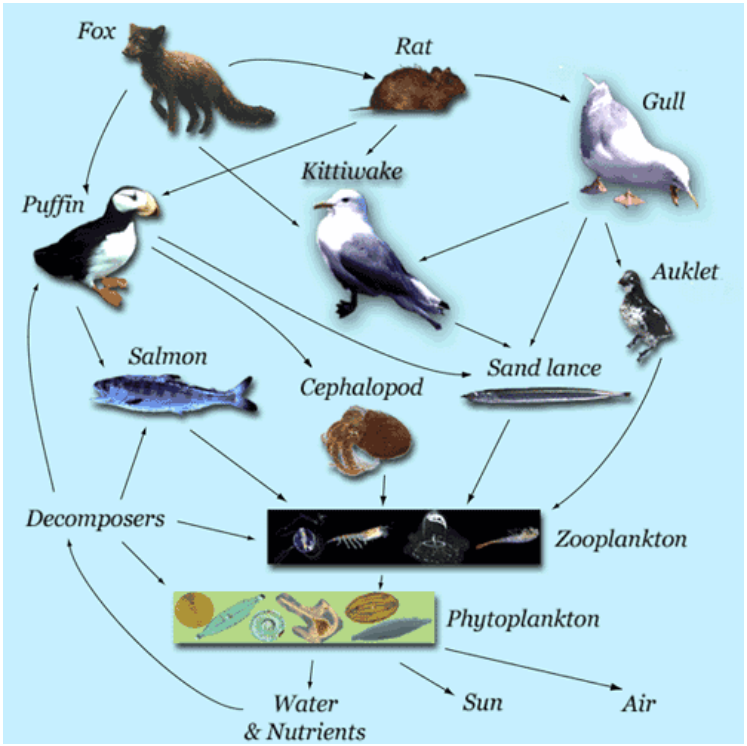
Unit V
Ecology

I. **Ecology**

1. Defined: The Interrelationships between organisms and their environment.
2. Ecosystem Structure- Trophic Levels
   - A. Autotrophic - **Producers**
   - B. Heterotrophic - Those that eat others
     - **Consumers**
       - Primary - plant eater
       - Secondary- eats the plant eater
       - Tertiary - feeds on other carnivores
     - **Decomposers** - bacteria and fungi
   - C. Abiotic
3. Energy Relationships
   - A. Food Chains - one organism eating another.



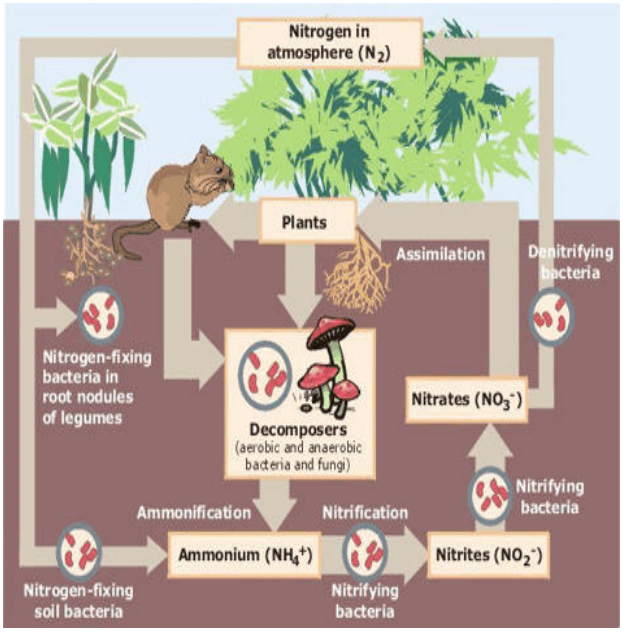
1 Food Chains and Food Webs

Predator - predator and prey
Parasitic - parasite and host
Saprophytic - organisms of decay - mold, soil bacteria

   - B. Food Webs - interrelated food chains

4. Concept of **Habitat** vs **Niche**
   Where it lives.
   What it does.

5. **Biogeochemical Cycles**
   Ex. Nitrogen Cycle



6. **Productivity**

   Measurements
      Standing Crop - cut down and weigh
      O_2 Method measure changes in Oxygen levels
      C^{14} Method most accurate- using radioactive CO2

II Limiting Factors

1. **Liebig**'s "Law of the Minimum" - It states that growth is controlled not by the total of resources available, but by the scarcest resource (limiting factor).

2. **Shelford**'s "Law of Tolerance"- A law stating that the abundance or distribution of an organism can be controlled by certain factors (e.g. the climatic, topographic, and biological requirements of plants and animals) where levels of these exceed the maximum or minimum limits of tolerance of that organism.

   Eury vs Steno

   Thermal - temperature Hydric - moisture
   Haline - salt levels Phagic - food preferences

3. Factors

   A. **Temperature**
   1) Low Temperature effects - ice crystals breaking cell membranes
   2) High Temperature effects - loss of cell water, coagulation of proteins.

3) **Animals**

a). **Poikilotherms** - “Cold blooded” animals
most aquatic animals - are the temperature of their surroundings
some terrestrial animals - maintain temperature by behavior.
b.) **Homotherms** - “Warm blooded” animals
keeping warm - “goose bumps”, shivering, increased metobolism
keeping cool - perspiration, behavior

4) **Plants** -transpiration - water loss by plants to cools cell tissues.

B. **Light**

1) **Wavelength** or color
ex: Seaweeds (red, green and brown), seed germination (visible red vs infrared).

2) **Intensity** or brightness photosynthesis loss due to heat and radiation. Animals can be damaged by irradiation.

3) **Duration**- Photoperiod

a) Day length in plants- Long day, short day, day neutral
b) Day length in animals- Bird reproduction, Jet lag.

C. **Water**

1)Rainfall -Hydrological Cycle.

Rainfall Classification
0"-10" Desert
10"-30" Grassland, Dry Forest, Open woodland
30"-50" Dry Forest
over 50" Wet Forest

2) Humidity
Absolute - amount of moisture in the a given volume.
Relative - amount of moisture in the air compared to the maximum amount of moisture the air could hold.

3) Available Surface Water Supply
Level of Water Table - affects the availability of surface water
Type of Soil
Sandy soils - capillary water
Clay soils - soil bound or hygroscopic water.
Aggregated soils - well formed aerated soils that forms capillary water tubes that are held in place by clay-like particles.

D. **Gases**- Oxygen and Carbon Dioxide -(Biological Gases)

1) On terrestrial environment - generally not limiting with the following exceptions: high mountain tops, deep caves, around volcanic vents.

2) In Aquatic environment
Solubility of the gas with changes in temperature and salinity.

3)How gases get into water
Atmosphere - diffusion
Plants - Respiration
Animals - Respiration
Decomposers - Decay (respiration)
Rocks - Breakdown of carbonates that release CO_2

E. **Currents and Pressures**

1) Currents
atmospheric- winds - along sea cliffs
water currents - distribute gases, affect distribution of organisms

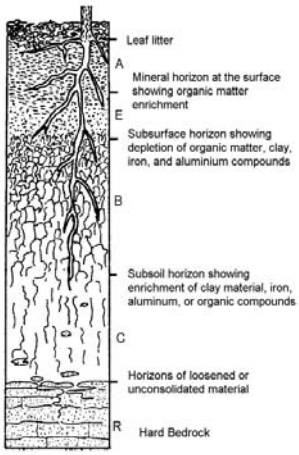
2) Pressures
Barometric - atmospheric pressure (15 lbs/sq. inc)
Hydrostatic -water weight pressure increases one atmosphere per 10 meters of depth.

F. **Soils**- Stratification

1) Soil profile

"O" horizon organic layer, dying and dead organisms
"A" horizon "humification" breakdown of organisms from above
"B" horizon "mineralization"
"C" horizon "transported materials"
"R" horizon "bedrock"

Soil Profile



2) Soil Comparisons
Coniferous Forest - poor soils, needle drop
Deciduous Forest - better soils, leaf drop
Grassland - best soils, entire plant dies.

3) Edaphic vs Climatic Soils

Edaphic - local conditions create a different soil type

Climatic - regional temperature and moisture form a soil type.

G. **Fire**

1) Types

Surface - light burns, grass fires

Crown - hot burns, often jumping from the ground into the crowns of trees

Fire Storms - fire generated winds, fire tornados.

2) Fire Communities

fire dependent - require a periodic burning to maintain

fire independent - will not come back to present community if burned

H. **Ecological Indicators** animals or plants used to indicate conditions.

Eury vs Steno indicators

Organisms which are steno in their tolerance limits are good indicators

III Organization of the Community

1. **Major vs Minor Communities**

Major - All trophic levels included - producer, consumer, decomposers

Minor - missing usually the producer level, dependent on adjacent communities

2. Naming of communities

Physical habitat - mud flats, sandy beaches

Dominant plants - yellow pine forest, low desert scrub, etc.

Dominant animals - elephant savana

3. **Ecological Succession**

A. Defined: The process of orderly community change

B. **Primary Succession**: begins in an area where no biological community existed before, such as barren rock.

C. **Secondary Succession**: community development from where a previous community had been removed. Usually the result of recovery after a fire or another catastrophic event.

D. **Serial Stage** - a step in succession

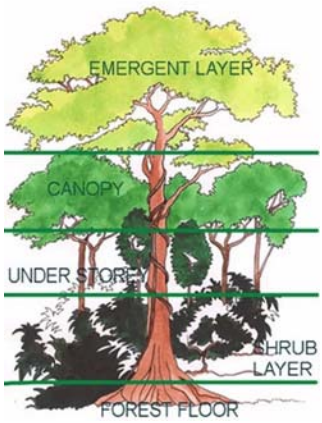
E. **Climax Stage** - the last step in succession.

Climatic - result of the climate for that region

Edaphic - result of localized conditions, such as a river valley or a flat pleatu.
Disclimax - the result of people's activity or their domestic animals, such as over grazing.

F. **Sere**- a successional story, ie. Grasslands turning into forests, a river turning into a lake, a lake turning into a pond turning into a grassland.

4. Community **Stratification** : formation of layers within the community. Horizontal layers such as grasses, shrubs, trees, tall trees all forming distinct horizontal layers in a community.



5. Community **Periodicity**

A. Daily Rhythms
1) Diurnal -Ex: photosynthesis
2) Nocturnal - night time animals
3) Crepuscular - twilight animals ie bats, mosquitos

B. Seasonal Rhythms
1) Hibernal - (sleep) - migration away, hibernation, dormancy.
2) Prevernal - (awaking) early spring, sap beginning to flow, flowers
3) Vernal - (reproduction) having offspring, mild limiting factors
4) Aestival - (growth) plants and animals putting on their growth
5) Serotinal - (maturation) increased competition
6) Autumnal - get ready for tough times ahead, migration, putting on fat, dropping leaves, becoming dormant.

C. Lunar Rhythms-tides - grunion life cycle

D. Inherent Rhythms - Biological Clocks Ex: Mice

6. Ecotone and Edge Effect
Ecotone - where two different communities come together.
Edge Effect The occurrence of greater species diversity and biological density in an ecotone than in any of the adjacent ecological communities.

7. Species-numbers Relationships

Moving from mild climates to harsh ones the variety is large and the numbers of each variety is small. As the climates becomes harsher, fewer species, but some become very abundant.

8. Paleoecology -Using fossils to interpret the ecological conditions of the past, based on their closest living members today.

IV. Organization at the Population Level

1. Population **Density**

A. Defined- number of organisms in an area

B. Crude Density - using broad areas to define the density.

C. Ecological Density using the ecological preferred habitat as the unit area.

D. Methods for estimating numbers

1) Direct Counts - large, diurnal social animals

2) Subsample counts

transect - long, linear areas, lines or belts

quadrants - rectangular areas, or plots

3) Mark Recapture Methods

$$\frac{P_?}{M_1} \quad \frac{P_2}{M_2}$$

$P_?$ = Unknown Population size

M_1 = Animals captured and Marked

P_2 = Caught Population Number

M_2 = Number caught that are marked

2. **Natality** Rates

A. Absolute Natality - how many offspring can possibly be produced

B. Ecological Natality - how many offspring are produced.

3. **Mortality** Rates

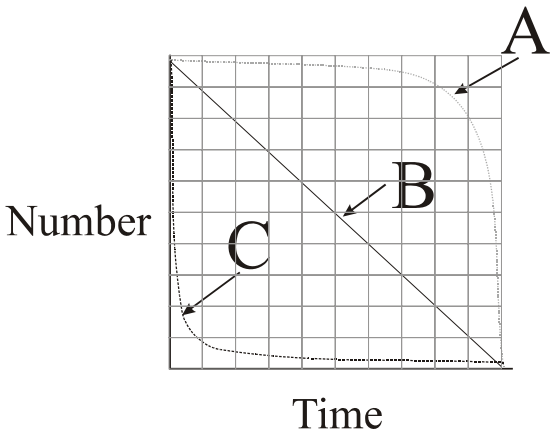
A. Minimum Mortality - least amount of deaths

B. Ecological Mortality - actual death rates

C. **Survivorship Curves**

<u>Convex Curve</u> - A All survive, live out physiological life span and then die

<u>Straight Line</u> - B Equal number die per time period until all are gone

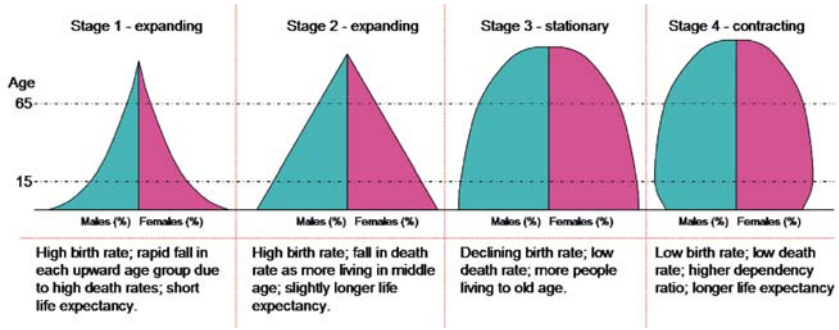


Concave Curve - C High juvenile mortality, those that survive have high probability of living out physiological life span

4. Population Age Distribution

A. **Age Pyramids**

1) Increasing Populations - large base for the top (stage 1)
2) Declining Populations - small base for the top (stage 4)
3) Stable Populations - line triangle (stage 3)



B. **Ecological Ages**

1) Prereproductive - longest time spent
2) Reproductive - short time spent
3) Postreproductive - little to no time spent

5. **Biotic Potential** and **Environment Resistance**

$r = PZ^n (R^{n-1})$ r = biotic potential

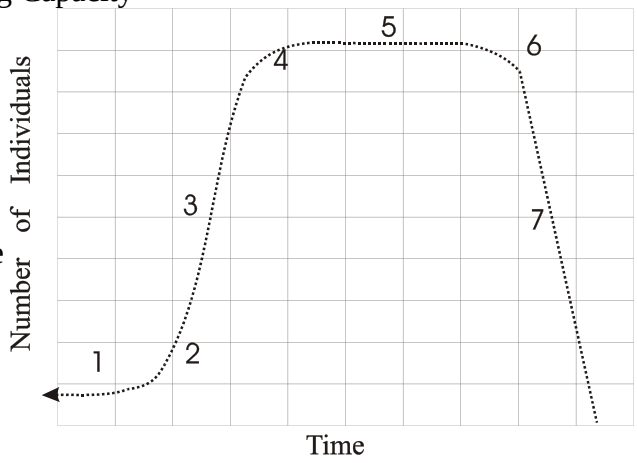
P = # of females in population
Z = # of young each female produces
n = # of generations per year
R = % of young which are female

Environmental Resistance is the sum total of the environmental limiting factors.

6. Population Growth Form and Carrying Capacity

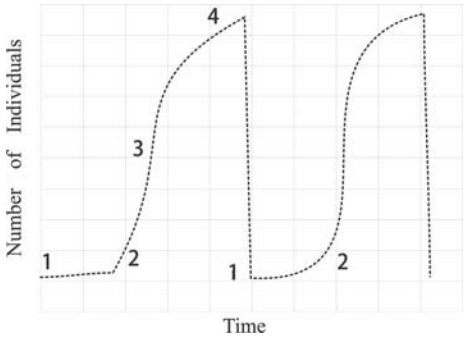
A. **Sigmoid** Growth Curve

1) Lag Phase
2) Positive Growth Phase
3) Log growth phase
4) Negative growth phase
5) Stationary Growth phase
6) Death phase
7) Log death phase



B. "**J" Shaped Growth Curve**

1) Lack the stationary phase
2) Extrinsic Factors: weather, food supply, habitat changes
3) Intrinsic Factors: biological clocks, disease, parasites, ex. lemmings



7. Population **Dispersal**

A. Defined: organisms tend to move away.

B. General effects on Populations

Small scale - little affects on population size, although the composition may change.

C. Causative Factors for dispersal

1) Climate-where the weather is severe
2) Light- birds (photoperiod)
3) Temperature - water begins to freeze over, vegetation dies.
4) Food - following the migration of food sources, ie Tunas
5) Reproduction - solely to reproduce, Gray Whales, Salmon.

D. Orientation of Migration - how do they find their way?

1) Smell- large terrestrial mammals, fishes
2) Sight- landmarks, flyways, shorelines, etc
3) Stellar- stars -birds that fly at night.
4) Solar- penguins
5) Magnetic fields

E. Dispersal Patterns (how the individuals are found in nature)

1) Random - unless the environment is uniform, not common
2) Uniform - directed antagonism by individuals (territories)
3) Clumped - most common type.

8. Population **Aggregation** (coming together)

A. **Allee's Principle**: Since the it is the degree of aggregation as well as the over all density which results in optimum population growth and survival; therefore under crowding may well be limiting as well as over crowding.

B. Reasons for Aggregation

1) Habitat differences - some spots better than others
2) Daily and seasonal weather changes - huddling together keeps them warm
3) Reproductive processes - the need to reproduce
4) Social attractions in higher social animals - mutual protection and the division of labor within the group.

C. Group Survival from Aggregation

1) Survival against the elements - Emperor Penguins
2) Against toxins - fish secretions
3) Against predators - Baboons against the lions
4) Increased efficiency of the group - some watch, others sleep or eat.

D. Social Aggregations

1) "Pecking" orders - social hierarchy (Alpha - Omega)
2) Flocks or schools - increased efficiency of their movement
3) Social Insects: the caste system - ultimate in the division of labor, workers, soldiers, queen.

9. Population **Isolation**

A. Isolation defined: Achieving the maximum distance from each other

B. Home Range - encompassing the entire activity and area of an animal

C. Territory - that portion of the home range which is defended

1) marking of territories (mammals - urine)
2) announcing of territories (vocalization - bird song)
3) defense of territories (a physical display)

V. Concepts of at the interspecies level - Symbiosis

1. **Competition**

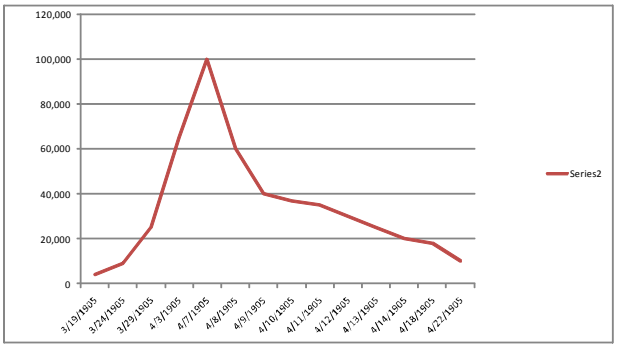
A. **Gause's principle**:"one species to a niche" theories are that two species have the same job in the same habitat will come into conflict.

B. Types of competition

1) perfect - eventually only one species will survive after a competitive struggle.

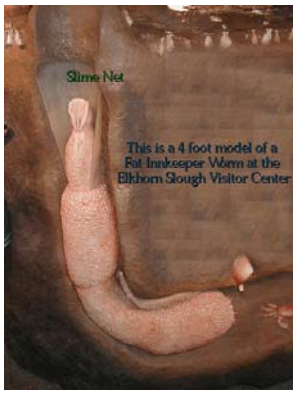
2) hyperperfect - no competition, the one species eliminates the other, ie the mold *Penicillium*.

2. **Predation** Ex: Kaibab plateau in Northern Arizona- eliminating the upper trophic levels (wolves, coyotes, mountain lions) to benefit the deer population eventually destroyed not only the deer, but harmed the habitat.
Usually a ten to one relationship between the prey to predators, keeps both populations healthy.



3. **Parasitism** "good parasite does not destroy its host" natural parasites become adapted to their natural hosts and it is not a benefit to kill off the source of food. Accidental hosts are most often harmed when they become infected by unnatural parasites.

4. **Commensalism** - only one species is benefitted, Fat Innkeeper and its guests, cattle egret and cows.

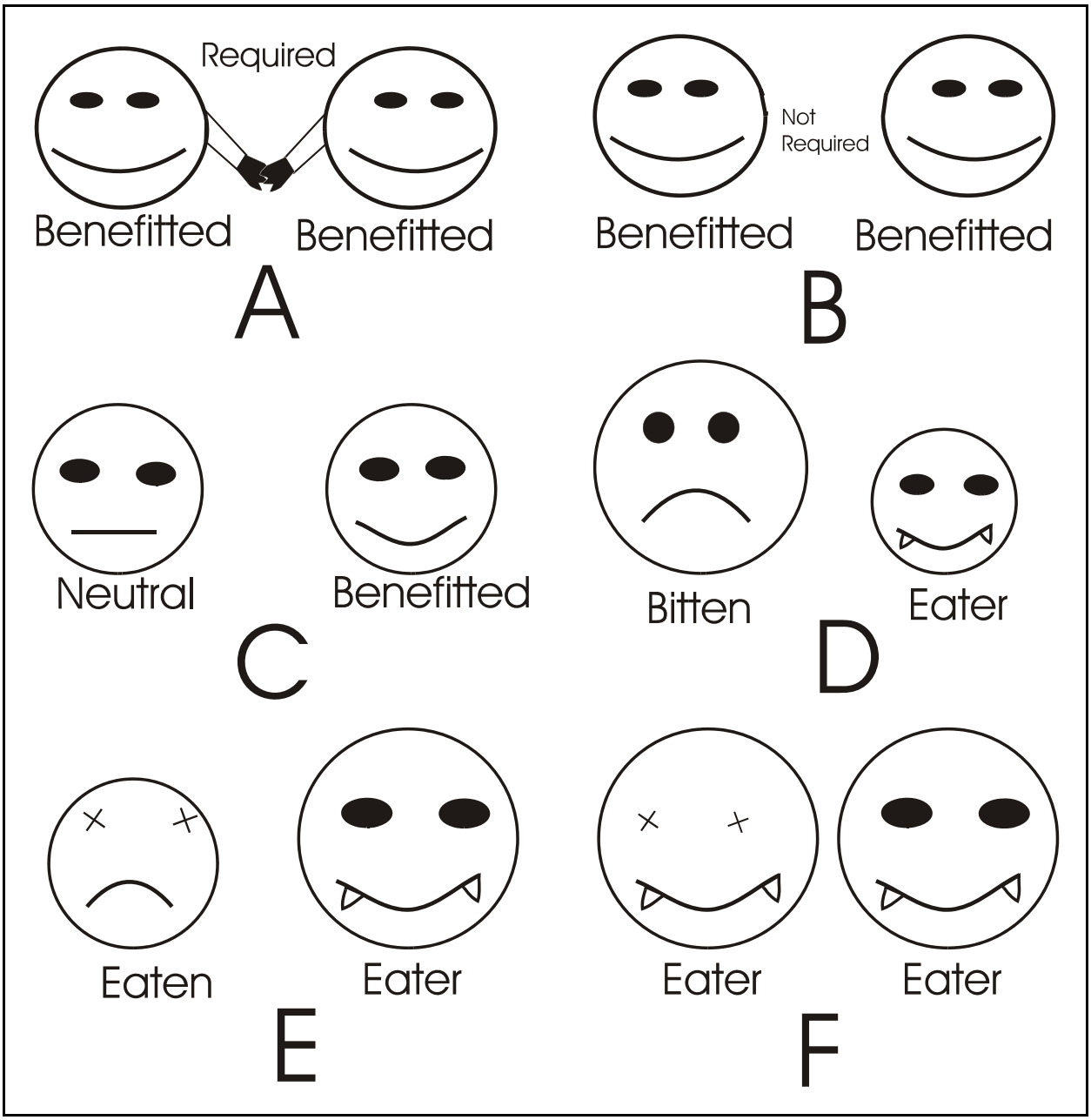


5. **Protocooperation** both are helped, but not necessary for survival. ie Ants and Aphids; Cleaner Shrimp and fish clients, Rainbox Wrasse clean parasites off other fishes.

Aphids and Ants

6. **Mutualism** - examples of co-evolution, lichen, termites, and pronuba moth and Yucca.

Yucca Flower



A - Mutualism, B - Protocooperation, C - Commensalism, D- Parasitism, E - Predation, F- Competition.

Review Questions.

1. What is the maximum number of steps in a food chain?

2. What advantage is it to have a short food chain?

3. What is a niche?

4. Nitrogen fixing bacteria are associated with what plants?

5. What do you call a group of similar organisms from the same locality?

6. Name a source for atmospheric nitrogen.

7. What is the most abundant gas in the atmosphere?

8. What do you call the place where an organism lives?

9. What is a pyramid of numbers?

10. What is weathering?

11. Name the trophic levels and give an example of each.

12. What is a food chain?

13. What is a food web?

14. What is the relationship between a legume and its nitrogen fiixing bacteria?

1 5. What is the relationship between a termite and its cellulose eating protozoa?

16. What is the relationship between a host and a natural parasite?

17. What was the big mistake made at Kaibab?

i8. Be able to identify the different age pyramids: stable, declining and expanding population.

19. What is the formula for biotic potential?

20. What keeps a population from over reproducing?

21. Name the seven stages of a sigmoid growth curve.

22. What is the difference between a sigmoid growth curve and a "j" shaped growth curve?

23. Name the three survivorship curves and what they represent.

24. Name the six biological seasons and what happens in each.

25. What kind of biological cycle is shown by grunion?

26. Give an example of an inherent rhythm.

27. What is the difference between primary and secondary succession?

28. Be able to identify the symbiotic relationships and know examples of each.

29. What is a sere?

30. What is a serial stage?

31. What is a Disclimax?

32. Can succession be controlled?

33. What is an Ecotone?

34. What is the "edge effect?"

35. What is the species - numbers relationship?

36. What are some of the ways that a community can become more stable?

37 Name the useful kind of fire?

38. How are redwoods affected by fire?

39. Hygroscopic water is associated with what type of soils?

40. What is an ecological indicator?

41. Name some of the benefits of fire.

42. What is Liebig's Law of the Minimum?

43. What is Shelford's Law of Tolerance?

44. How can a terrestrial poikilotherrn regulate its body temperature?

45. What are the sources of oxygen in water?

46. What are the sources of carbon dioxide in water?

47. In which soil horizon does mineralization take place?

48. In which soil horizon is the bulk of organic life found?

49. Which horizon indicates the productivity of that environment?

50. Name the habitat with the thickest "A" horizon.

5 I. Which habitat should not be used for agriculture do to its fragile nature?

52. What are the qualities of light that make it a Limiting factor?

53. What are some of the benefits gained from the light duration studies?

54. What are the properties of water and their associated gas absorption values?

55. What is the difference between an extrinsic and an intrinsic factor?

56. Name an animal which migrates just to reproduce.

57. What is the social structure in a "pecking order?"

58. What is the Alpha individual and an Omega individual?

59. How does territory influence the behavior of animals?

60 What is the symbiotic relationship between the pronuba moth and the yucca plant?

61. Give the correct sequence for nitrogen build up in the soil starting with ammonia.

62. Name the kind of decomposers one would find in the soil.

63. What is known as Gause's principle?

64. Name the three kinds of successional climaxes.

65. Why are high temperature more damaging than low temperature to organisms?

66. Light sensitive seeds show the greatest germination in what wavelenght of light?

67. What group of plants/algae have shown the effect of wavelength on their distribution?

68. What is the relationship between temperature of the air and the amount of moisture it can hold?