APES CHAPTER 6 NOTES (MRS. BAUCK): POPULATION AND COMMUNITY ECOLOGY

MODULE 18: The Abundance and Distribution of Populations

I. Levels of complexity in Nature
   A. INDIVIDUAL → POPULATION → COMMUNITY → ECOSYSTEM → BIOSPHERE
   B. relevant terms
      1) **population**—*a group of organisms in the same species, living in the same area*
      2) **community**—*groups of different, interacting species in the same area*| (**association**—*a plant community with the same habitat)*
      3) **ecosystem**—*biotic factors interacting in a specific area with each other and with the environment*
      4) **population ecology**—*study of factors causing populations to increase or decrease*

II. Population characteristics
   A. **population size (N)** = *total number of individuals within a specific area at a given time*
   B. **population density**
      1) *total number of individuals per unit area at a given time*
      2) population density is directly proportional to **environmental resistance**, which is all biotic and abiotic factors that can limit population growth
   C. **population distribution**
      1) *how individuals are dispersed with respect to each other*
      2) can be random, uniform, or clumped
   D. **population sex ratio—***male to female proportion*
   E. **population age structure** (more in MODULE 22) – an analysis by age categories

III. Density dependence and population size
   A. **limiting resource**—*a material or immaterial supply that the population needs to survive and which limits population growth due it its scarcity*
   B. **limiting factors**—*biotic and abiotic factors which limit population growth*
      1) *density-dependent* factors
         a) limiting factors *affected by population size*
         b) generally associated with an S-curve
         c) food shortage, infectious disease…
      2) *density-independent* factors
         a) *not affected by population size*
         b) generally associated with a J-curve
         c) natural disasters, habitat damage…
   C. **critical number**—*the minimum number of individuals in a population needed to prevent extinction*

MODULE 19: Population Growth Models

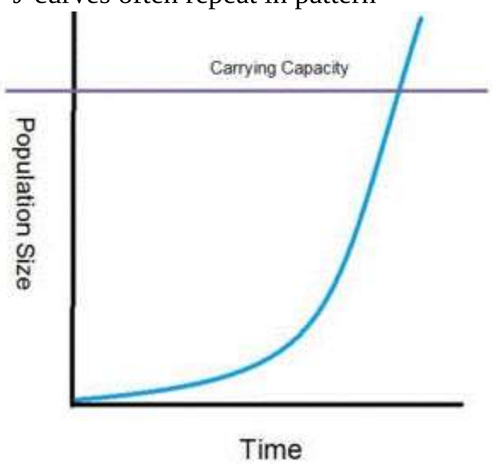
A. Relevant terms
   1) equilibrium = balance
   2) **population equilibrium**—*balance* between births and deaths
   3) **population growth rate**— (births - deaths)
   4) **intrinsic growth rate (r)**—*maximum growth potential*

B. Exponential growth
   1) **exponential growth model**

$$N_t = N_0 e^{rt}$$

N_t = future pop. size	N_0 = current pop. size	
e = natural log	r = intrinsic growth rate	t = time

   2) *J-curve*
      a) **exponential increase =** a *geometric* progression
      b) **population explosion**—exponential growth in a population
      c) growth is eventually limited and will not increase forever
      d) J-curve is *nonsustainable*
      e) J-curves often repeat in pattern



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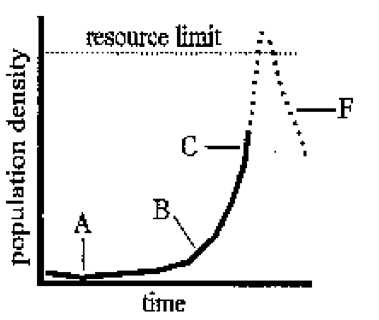
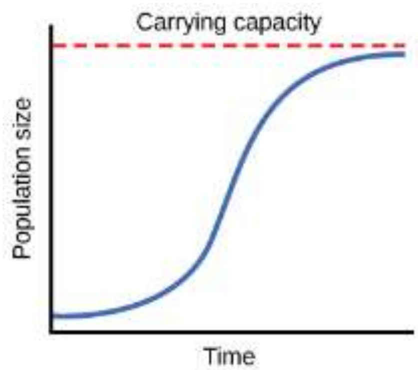
   3) *** Two options for what can happen to exponential population growth:
      a) population *levels off*: S-curve results
      b) population *crashes* (**die-off**): "*boom-and-bust"* (recovery can be observed over time)



C. Logistic growth

1) **logistic growth model**—*initial exponential growth which slows down*
2) *S-curve* (sigmoid shape)
   a) a leveling of growth; population held in balance
   b) S-curve signifies *dynamic equilibrium*
   c) S-curve is *sustainable* and stable
   d) **carrying capacity (K)—**the *maximum number* of organisms that can be supported by an ecosystem
      i. numbers of organisms decrease approaching K
      ii. K is the maximum upper limit of the S-curve
      iii. there are fluctuations
      iv. **overshoot**—*if the population temporarily exceeds K*



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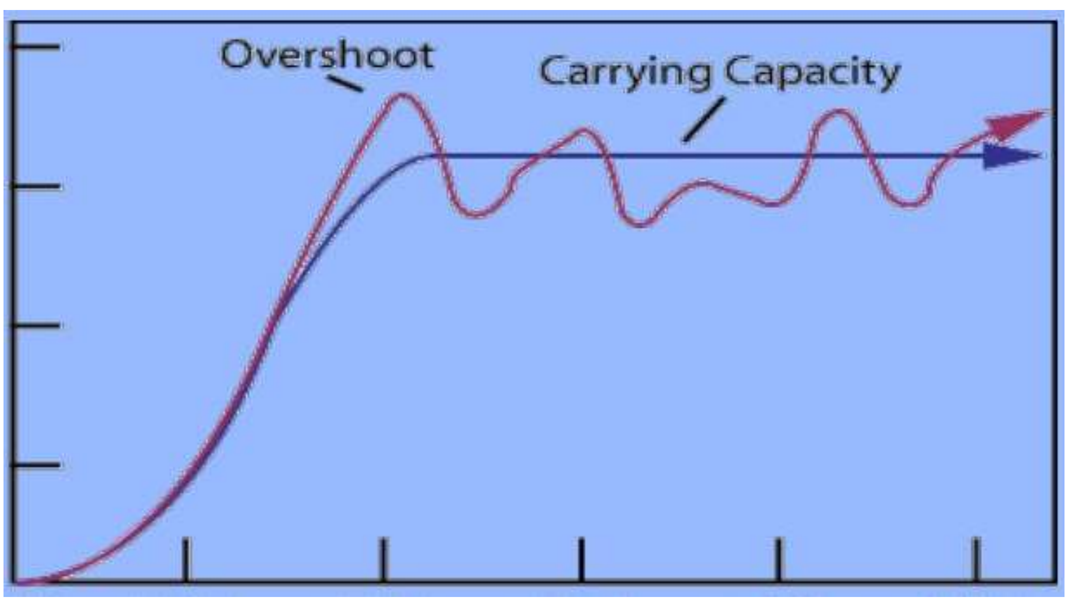

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3) the human population
   a) ours is still an exponential growth
   b) this cannot go on exponentially forever
   c) Earth can only support so many people
   d) scarce resources will eventually limit population size

D. Biotic Potential vs. Environmental Resistance

1) **biotic potential**
   a) the ability of populations to increase in number
   b) *number of possible offspring* produced under optimal conditions
2) **environmental resistance**—*all biotic and abiotic factors that can limit population growth*

The relationship between these two determines a population's status: growing, declining, or stable.

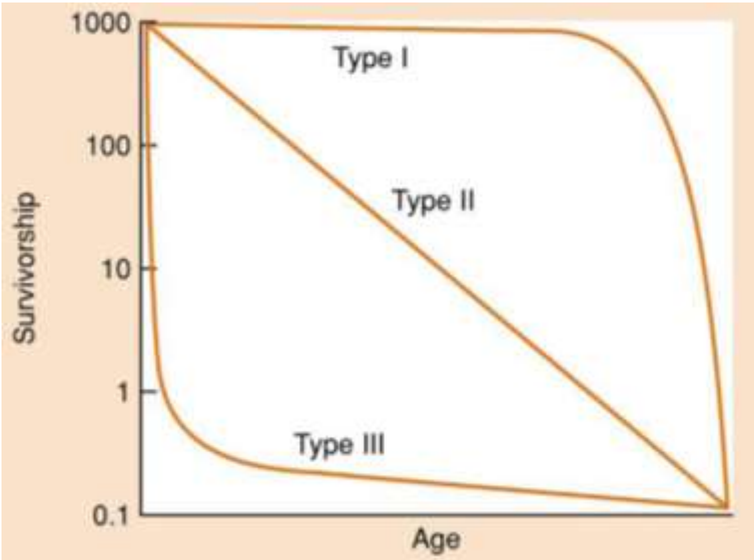
3) **recruitment**
   a) the *survival* of organisms to enter the *breeding* population
   b) this can be altered greatly
4) **replacement level**—*the rate at which organisms are "replaced" in the population after they die*
5) **dynamic balance**
   a) *birth rate and death rate are approximately equal*
   b) minor fluctuations are seen

E. reproductive strategies (species can exhibit strategies somewhere in between)

1) **r strategy** (**r-selected species**)
   a) produce *many offspring* (high biotic potential) but many will die due to a variety of limiting factors
   b) high intrinsic growth rate
   c) overshoots, die-offs seen
   d) typically small organisms reaching sexual maturity young, reproducing often, having many offspring at once, giving little or no parental care
2) **K strategy** (**K-selected species**)
   a) produce *few offspring* (low biotic potential) and nurture them all
   b) low intrinsic growth rate
   c) typically large organisms reaching sexual maturity relatively late, having few, larger offspring at once, giving substantial parental care

F. survivorship curves

1) *Type I – high survival until a steep dropoff after middle age* (example: humans)
2) *Type II – constant decline throughout lifespan* (example: squirrels)
3) *Type III – low survivorship early in life* (example: mosquitoes)



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G. Interconnected populations
   1) **corridor**—*strips of habitat that connect populations; a belt of land linking two areas or following a river*
   2) **metapopulation**—*group of populations of the same species that are separated by space but have occasional interactions*
   3) **inbreeding depression**—*breeding of closely related individuals, resulting in populations of impaired individuals*

MODULE 20: Community Ecology

I. Species interactions
   A. **community ecology**—*the study of species interactions*
   B. competition
      1) **habitat**—*the area in which an organism is adapted to live*
      2) **ecological niche**—*the role or job an organism plays in its environment;* where it lives, what it eats, when it eats, where it eats, etc.
      3) **competition**—*the struggle of individuals to obtain a shared limiting resource*
      4) *two species cannot occupy the same niche*—competition will drive one out—but niche overlap is possible
      5) **competitive exclusion**—*species becoming extinct as a result of competition*
      6) **resource partitioning—***two species dividing a resource based on morphology or behavior, adopting a pattern of resource use that isn't competitive*
      7) competition between plant species
         a) **interspecific competition**—competition between *different species*
         b) HOW THIS CAN OCCUR:
            i. the *adaptation of a species to specific conditions* (microclimate) may enable that species to thrive and overcome competition in one location but not in another
            ii. a single species usually can't use all resources in a specific area, leaving resources for other species
            iii. *different root systems* (fibrous vs. tap)
            iv. *mutualism* (beneficial symbiosis)
            v. **epiphytes**—air plants live on other tree's limbs; they are not parasitic
      8) **territoriality**
         a) organisms *defending* an area against members of their *own species*, usually over resources for breeding and raising young
         2) **intraspecific competiton**—competition between members of the same species
   C. predation
      1) Population density depends on the relationship of a species with their *food* source and their natural enemies.
      2) **predation**—*the action of predators upon their prey, usually killing and consuming them*
      3) predation on animals

a) what happens to the prey population affects the predators and vice versa (cyclical nature)
b) the simpler the ecosystem, the simpler the predator-prey interactions
c) predation is a *density-dependent* action
d) other biotic and abiotic factors can affect the populations too (other predators, snowstorms, drought, disease)
e) *predators often can't attack mature, healthy members of their prey population*; *they prey upon the young and the weak*

4) **parasitoids**—*specialized predators that lays eggs that hatch inside their host*

D. parasities

1) highly diverse group:
   a) bacteria
   b) fungi
   c) viruses (can be classified as parasites even though not alive)
   d) protozoans
   e) worms (tapeworms, roundworms, hookworms…)
2) **parasitism**—*one organism living on or in its host*
3) parasitism is a *density-dependent* action
4) **pathogen**—*a parasite causing disease in its host*
5) *vector*—an agent carrying the parasite from one host to another

E. plant-herbivore dynamics

1) *herbivores* are natural enemies of *plants*
2) **herbivory**—*animal consumption of a producer* (example: grazing)
   a) **overgrazing—**herbivores' *depletion of plants* faster than they can grow back
      i. the depletion of some types of vegetation *may affect the entire ecosystem*
      ii. *human action* has contributed to this problem
      iii. in nature, herbivores rarely increase in population size so much as to overgraze
      iv. fluctuations in predator populations will affect plant-herbivore relationships

   b) **balanced herbivory**—*a balance among competing plant populations, kept in check by herbivores*
      i. **monoculture**—growth of a *single species* in an area; prone to attack by host-specific organisms; this is not stable in the natural world

The size of consumer populations in ecosystems is maintained such that overgrazing and other forms of overuse do not occur.

F. **symbiosis**—*a relationship or close association between members of different species*

1) **mutualism**—*mutually beneficial to both organisms* (lichens = algae and fungi)
2) **commensalism**—*one organism benefits, but the other is unchanged* (fish hiding in coral reefs)
3) **parasitism**—*one organism benefits, the other is harmed* (tapeworm infestation of a puppy)

II. Keystone species

A. **keystone species**

1) *species which are vital to maintaining diversity of life* and whose extinction would consequently lead to the extinction of other forms of life
2) common examples: grizzly bear, sea otter, prairie dog

B. examples of keystone roles
https://www.nationalgeographic.org/encyclopedia/keystone-species/

1) predators (ochre sea star)
2) mutualists, often rare pollinator species (rare hummingbirds)
3) *umbrella species* have large habitat needs; usually migratory, and the requirements of that habitat will impact many other species in the area (Siberian tiger)
4) *foundation species* play a major role in creating or maintaining a habitat (coral)
5) **ecosystem engineers** *modify, create, and maintain habitats* (prairie dog)

III. Other species classifications

A. **indicator species**—*an organism that is very sensitive to environmental changes in its ecosystem* (oysters and other filter feeders)
http://wwf.panda.org/our_work/wildlife/flagship_keystone_indicator_definition/

1) "chosen as an indicator of… the state of an ecosystem or of a certain process within that ecosystem
2) Examples include crayfish as indicators of freshwater quality; corals as indicators of marine processes such as siltation, seawater rise and sea temperature fluctuation; peregrine falcons as an indicator of pesticide loads; or native plants as indicators for the presence and impact of alien species."

B. **flagship species** serve as popular mascots for conservation issues (panda for WWF)

MODULE 21: Community Succession

Ecological (Natural) Succession—*the transition from one biotic community to another; groups of species replace other species*

I. **Primary succession**—*the first species colonization in a previously barren area*

A. examples: after volcanic eruptions or glacial retreats
B. *** *soil profile has been destroyed* *** *bare rock, no soil* ***
C. general sequence of events:

lichens → grasses → shrubs → coniferous trees → hardwood trees → climax stage

1) *lichen community*
   a) **lichen** ("like-un")—*mutualistic algae and fungi*
   b) lichen's *acids break down rock into soil*
2) **climax ecosystem**—a *stable, balanced ecosystem* not undergoing further succession
3) not all ecosystems achieve a "climax ecosystem" level

D. **Secondary succession**— *re-colonization of an area after disturbance*
   1) examples of disturbance: fire, flood, human interference
   2) secondary succession *must have a soil base* to build upon
   3) general sequence of events:

grasses → shrubs → coniferous trees → hardwood trees → climax stage

   4) not all ecosystems achieve a "climax ecosystem" level
   5) **pioneer species**—*a species that can colonize new areas quickly and grow well in full sun*

E. **Aquatic succession**
   1) lakes and ponds are gradually taken over and filled
   2) soil/detritus contributions
   3) general sequence of events:

shore water plants →
organic matter collects →
surface water plants →
marsh →
land plants →
meadow →
forest

F. **Island succession**
   1) *many possible niches* to fill
   2) water, wind, or other organisms bring new species to islands
   3) **theory of island biogeography**—*habitat size and distance are key factors in determining species richness*

"Two eminent ecologists, the late Robert MacArthur of Princeton University and E. 0. Wilson of Harvard, developed a theory of 'island biogeography' …They proposed that the number of species on any island reflects a balance between the rate at which new species colonize it and the rate at which populations of established species become extinct… Equally, the rate at which species might become extinct on the island would be related to the number that have become residents. When an island is nearly empty, the extinction rate is necessarily low because few species are available to become extinct. And since the resources of an island are limited, as the number of resident species increases, the smaller and more prone to extinction their individual populations are likely to become. The rate at which additional species will establish populations will be high when the island is relatively empty, and the rate at which resident populations go extinct will be high when the island is relatively full…"
https://web.stanford.edu/group/stanfordbirds/text/essays/Island_Biogeography.html

G. Influencing factors
   1) latitude: biodiversity decreases from equator to the poles
   2) time: older communities have more time for speciation to occur
   3) size of habitat (see F above)
   4) distance from other communities (see F above)