POPULATION and COMMUNITY ECOLOGY

Interactions of organisms with organisms

We will focus on

individual,
population,
community

} levels of organization.

Natural selection and *genetic mechanisms* operate at these levels to bring about evolutionary changes in species.

Understanding how populations grow and how species and individuals react to one another helps to understand *symbiosis between humans and the organisms*.

Population: A group of organisms of the same species found occupying a given space.

Density: Population size per unit of space.

Natality: Birth rate

Mortality: Death rate

Dispersal: ***The rate*** at which individuals are distributed in space.

Dispersion: ***The way*** in which individuals are distributed in space.

1. Random distribution: equal probability of occurrence in any spot.
2. Uniform distribution: individuals occur more regularly than at random (corn planted in cornfield).
3. Clumped distribution: individuals occur more irregularly then at random (flock of birds, people in cities).

Age distribution: The proportion of different ages in the population.

Genetic fitness or persistence: The probability of individuals' leaving descendants over long periods of time.

The population growth rate:

The net result of births, deaths and dispersals.

J shaped or exponential growth form and *S-shaped or sigmoid growth:*

When opportunity presents itself:

at the beginning of growing season

a few individuals enter or (introduced into) an unoccupied area

unused resources become available.

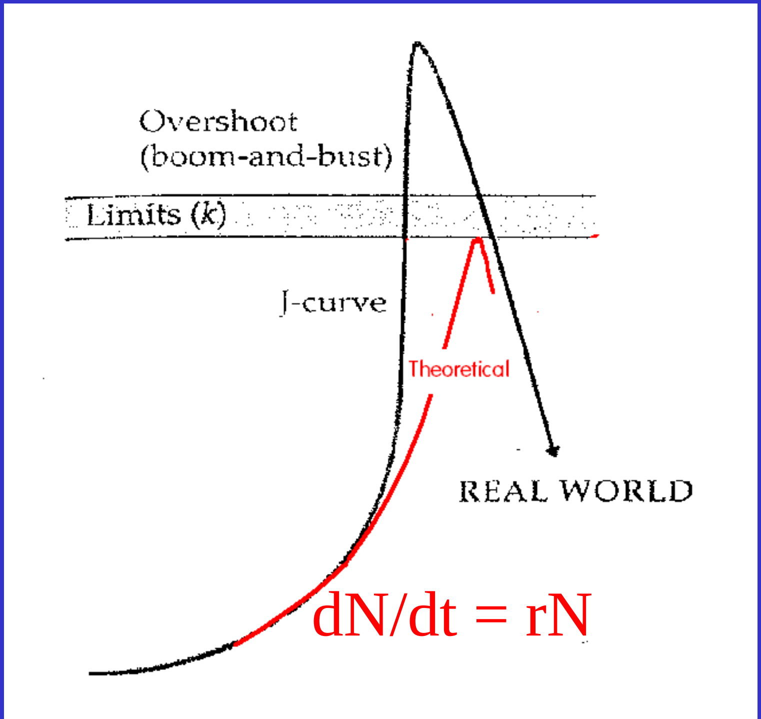
J CURVE

Theoretically:

density increases exponentially or geometrically: 2,4,8,16,32

until running out of resources or encountering other limitation.

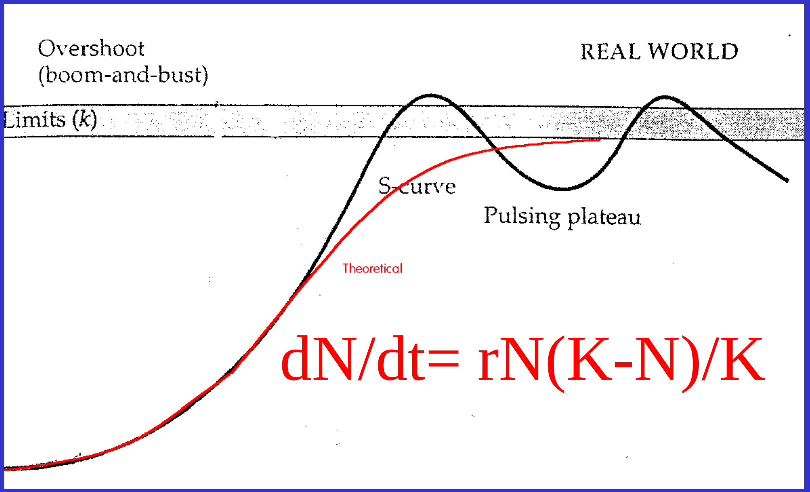
growth comes to an abrupt hold, density decreases until growth conditions restored.



In practice:

The momentum of growth is usually so great that limits are overshot, resulting in boom-and-bust cycles. Populations fluctuate greatly unless regulated by factors outside of the population.

S SHAPED CURVE



Limiting factors resulting from crowding provide negative feedback that reduces the rate of growth more and more as density increases.

Theoretically the curve will aproach an upper asymptote level, K, carrying capacity (theoretical maximum sustainable density).

In real world, density usually does not level off, but pulses above and below because the absence of set point controls above the organism level.

J shaped and S shaped growth forms represent the extreme fast and slow growth

In real world intermediate growth rates and combination of forms

For complex life histories; a stair-step form

Patterns of population growth:

Inversely density dependent

Density independent

(Insects and other pests: when controls in the ecosystem absent or break down)

Allee type

(Social animals and colonial plants

undercrowding and overcrowding are limiting factors

gulls, oysters

Patterns of population growth rate in relation to population density

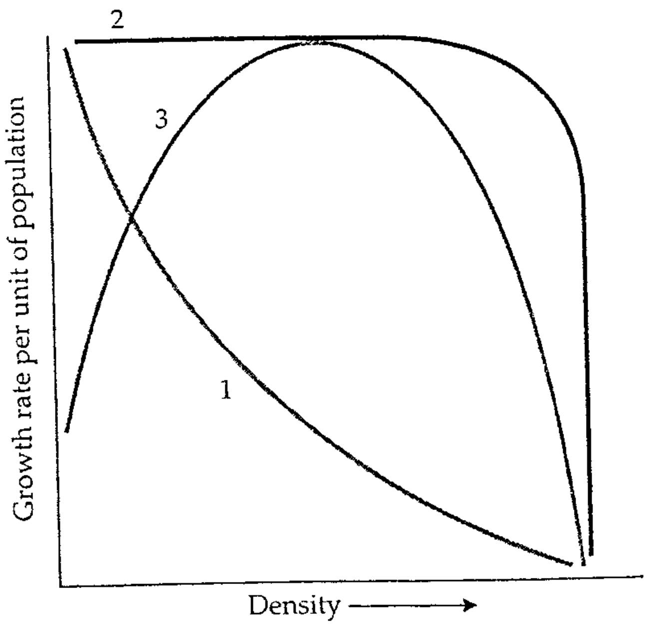


FIGURE 3
Three patterns of population growth rate in relation to population density. Curve 1, growth rate decreases as density increases (self-limiting or inverse density-dependent type); curve 2, growth rate remains high until density becomes high and factors outside of the population become limiting (density-independent type); curve 3, growth rate is highest at intermediate densities (Allee type).

Ecology, Eugene P. Odum, Sinauer Associates, Inc., Rev. Ed. of 2nd Ed. 1993

For some species

population irruptions or outbreaks:

boom and burst cycles of abundance
with regular periodicity

EPHEMEROPTERA

Mayflies

The name Ephemeroptera is derived from the Greek "*ephemera*" meaning short-lived, and "*ptera*" meaning wings. This is a reference to the short lifespan of most adult mayflies.

Life History & Ecology:

The immature stages of mayflies are aquatic. They generally live in unpolluted habitats with fresh, flowing water. Some species are active swimmers, others are flattened and cling to the underside of stones, a few are burrowers who dig U-shaped tunnels in the sand or mud. Most species are herbivorous. Their diet consists primarily of algae and other aquatic plant life scavenged from surrounding habitat.

r and K selection

Fig. 1 differential form — Fig. 2 integrated form

Growth rate= reproductive rate x number → $N = N_o \; e^{r t}$

$dN/dt = r N$

Growth rate = reproductive rate x number x self limiting factor

$dN/dt = r N (K-N)/K$ → $N = K / \{[1+(K-N_0)/N_0] \; e^{-r t}\}$

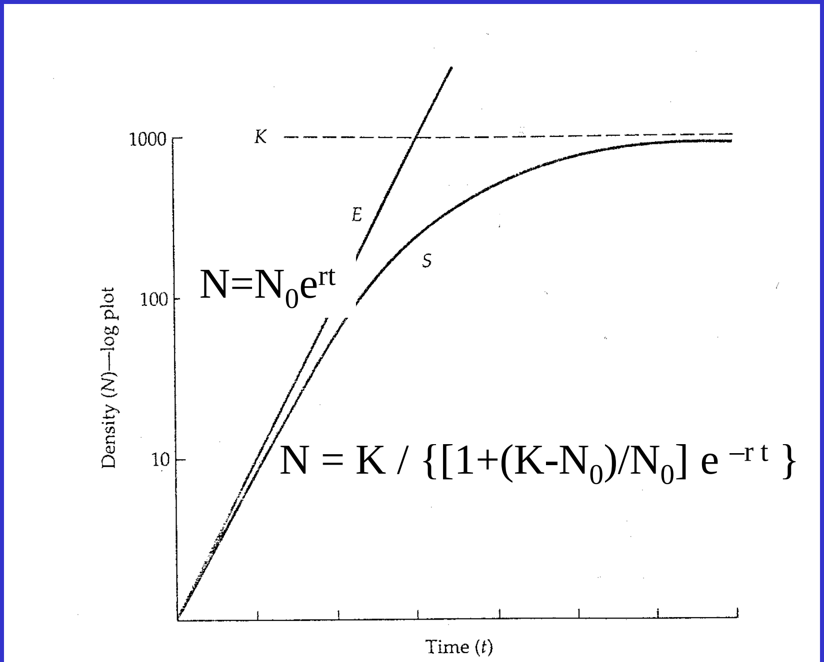
where

K upper carrying capacity level

r intrinsic rate of growth of the population when in an unlimited environment

Semilog plot

J curve becomes a straight line, its slope represents the growth rate constant.



The other curve becomes a convex curve, The slope of the tangent at any point represents the rate of growth at that point.

Optimizing energy use

Individual organisms and their populations can grow and reproduce only if they can acquire more energy than maintenance (called existance energy)

Additional or net energy is required for reproduction

For animals:
Energy in food / cost of getting it
Optimization:
Minimizing time or getting large amount of food

Use of space

Organisms sometimes aggragate for mutual benefit and sometimes isolate themselves for individual benefit

Sometimes highly mobile animals establish territorial ownership

Genetic diversity

Endangered species: If population size becomes small

Metapopulation dynamics:
Group of individuals will form and live in discrete patches,
The group will extinct in time , but the patch will be occupied by a neighboring patch.

Interactions between two species
Positive +, negative - , neutral 0

Competition (--): both populations inhibit or have some negative effect
Predition (+-): positive for the praditor, negative for the pray
Parasitism (-+): negative for the host, positive for the parasite
Cooperation or mutualism (++): both populations benefit
optional :cooperation
essential :mutualism
Commensalism (+,0): One gets benefit, the other no harm
no benefit