

r and K

- r is the per capita rate of growth
 - r is determined both by genetics and environment
 - r can be measured (observed) rate of growth of an estimate of biotic potential (the maximum growth rate under ideal conditions)
- K is the carrying capacity
 - K is a measure of how many individuals the environment can support
 - K is determined both by genetics and environment

r-selected species

- Weedy species found in environments where disturbances are common
- Disturbance lowers population density
- Between disturbances the populations grow exponentially

K-Selected Species

- K-selected species live in stable environments.
- Population sizes remain stable.
- Selection favors traits that improve competitiveness.

r - Selection and K-selection

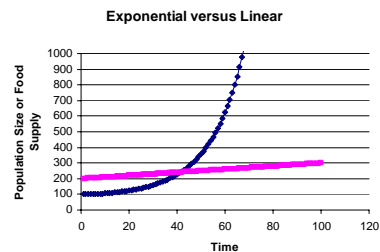
Trait	"r"	"K"
Litter size	Large	Small
Investment per offspring	Low	High
Parental Care	Little	Lots
Generation time	Short	Long
Longevity	Short	Long
Population Stability	Unstable	Stable

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Malthus

- Predicted populations could grow exponentially but food supplies could only grow linearly



Why Was Malthus Wrong?

- Food supplies increased exponentially.
 - Intensive versus non-intensive agriculture
 - More arable land used for intensive agriculture.
 - Fertilization
 - Haber – Bosch process and Nitrogen
 - Fossil fuel
 - Irrigation
 - Improved crops
 - Green revolution
 - Mechanization of agriculture
- Improved Distribution of Food supplies
 - It is now easier to transfer food from productive areas to non productive areas

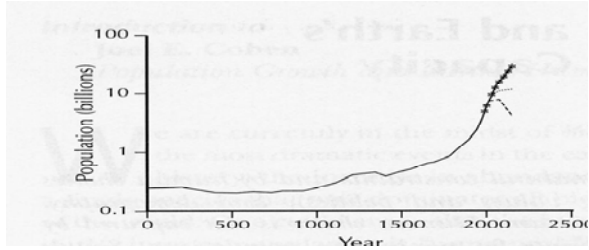
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Cohen, J. , 1995 **Population Growth and Earth's Human Carrying Capacity.** *Science* 169:341-348

Over the past 2000 years Human population have increased 50 fold.

Currently Human Population is about 6.6×10^9



Human Population Growth

Human r is currently about 1.17% ($1.17 \text{ new people} \cdot \text{person}^{-1} \cdot \text{year}^{-1}$).

Giving a doubling time of about 59 years

$$r = \frac{\ln(2)}{t_{\text{double}}}$$

$$t_{\text{double}} = \frac{\ln(2)}{r} = \frac{0.693}{0.0117} \approx 59 \text{ years}$$

Condorcet Hypothesis

Malthus assumed that each individual consumes food but does nothing to increase the amount of food being produced. If each individual helps contribute the production of food than logistic growth may not apply.

Mathematically there three possibilities

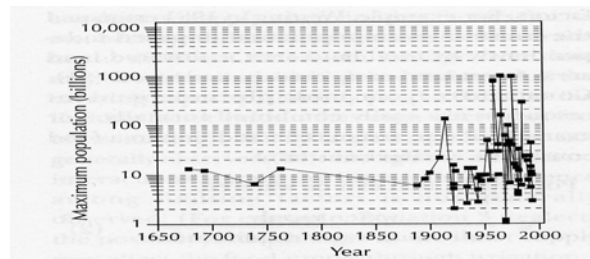
1. each individual consumes more additional resource than they produce
2. Each individual consumes exactly as much additional resource as they produce.
3. Each individual consumes less additional resources than they produce

#1 still results in logistic growth.

#2 in exponential growth

3 in hyperexponential growth

Meta-Analysis Predictions of Human Carrying Capacity over the past 400 years



How to calculate carrying capacity

1. Sum estimates of regional K.
2. Curve Fitting
3. Assume Single Resource Constraint
4. Reduce Multiple Requirements to one factor
5. Assume Multiple Independent Constraints
6. Multiple Factors and Dynamic Modeling
7. Guess and act like you know what your talking about

Historical development (much abbreviated)

Malthus
Condorcet
Paul Erlich