Levels of Organization

• Populations-
• Communities-
• Ecosystems
• Biomes
• Check out definitions pg 464!

• Today focus on “Population Ecology”

Population Structure

• Size= total number of individuals
• Density= number per area
• Distribution
  – random
  – clumped
  – uniform
FIGURE 51–2
Patterns of dispersion within a population's geographical range. Individuals within a population frequently exhibit either clustering or random distribution patterns. In a clustered distribution, individuals within each clump also show a pattern of dispersion, as do the clumps themselves. In butterfly flies, for many flies, the more rounded distribution is rare. In populations with a random distribution, the individuals within each clump also show a pattern of dispersion, as do the clumps themselves. The uniform spacing of these long-keeled species on South Georgia Island reflects the conditions under which they are growing. In seedling populations of some species, trees of the same species are often separated by distances determined by random events. But the pattern of dispersion is rare in nature.

Figure 51–2 Example of uniform dispersion. The uniform dispersion of certain desert plants such as the creosote bush and the saltbush is probably due to allelopathy, the production of toxic substances that inhibit the growth of nearby plants. (William E. Ferguson)
Survivorship Curves

Population Growth

• Simplest model = biotic potential
  – how fast can population grow when it is not limited by environmental conditions (food, space, etc)
  – population grows at a constant rate (intrinsic growth rate)
  – Mathematically = exponential growth

\[
d\frac{N}{dt} = rN
\]
Bacteria in a flask grow exponentially for many hours

FIGURE 23.13
The consequences of exponential growth. All organisms have the potential to produce populations larger than those that actually occur in nature. The German cockroach (Blattella germanica), a major household pest, produces 80 young every six months. If every cockroach that hatched survived for three generations, kitchens might look like this theoretical culinary nightmare concocted by the Smithsonian Museum of Natural History.
Population Growth

• Real world… resources are limiting
  – Density-Dependent Factors- depend on population size
    • limited resources (food, space, breeding sites, etc)
    • stress syndromes (diseases, suppression of immune system, migrations, hormonal changes)
  – Density-Independent Factors- random disturbances
    • fire, floods, hurricanes, storms, etc

FIGURE 23.14
Density-dependent effects. Migratory locusts, *Locusta migratoria*, are a legendary plague of large areas of Africa and Eurasia. At high population densities, the locusts have different hormonal and physical characteristics and take off as a swarm. The most serious infestation of locusts in 38 years occurred in North Africa in 1988.
Population Growth

- Real world… resources are limiting
  - Carrying capacity \((K)\) = number of individuals an area can support
  - population initially grows at the intrinsic growth rate… but slows as it approaches the carrying capacity
  - Mathematically: logistic growth curve

\[
d\frac{N}{dt} = rN \left(\frac{K-N}{K}\right)
\]

\((K-N)/K\) = fraction of \(K\) that is available for population growth.

• Note- when \(K=N\), \(dN/dt=\) zero
The Carrying Capacity

Most natural populations exhibit logistic growth. These data present the history of a fur seal (Callorhinus ursinus) population on St. Paul Island, Alaska. Driven almost to extinction by hunting at the turn of the century, the fur seal made a comeback after hunting was banned in 1911. Today the number of breeding males with "harcons" oscillates around 10,000 individuals, presumably the carrying capacity of the island for fur seals.
Population Growth Strategies

- Two basic survival strategies (table 23.2)
  - *r*-selected -
    - live fast, die young, leave a good looking body
  - *K*-selected -
    - slow and steady, steady and slow, that’s the only way to go!
### Population Growth Strategies

<table>
<thead>
<tr>
<th>Factor</th>
<th><em>r</em>-selected</th>
<th><em>K</em>-selected</th>
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<tbody>
<tr>
<td>lifespan</td>
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<td>long</td>
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<tr>
<td>maturation time</td>
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<td>long</td>
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<tr>
<td>mortality</td>
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<td>low</td>
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<tr>
<td>clutch size</td>
<td>large</td>
<td>small</td>
</tr>
<tr>
<td># reprod. cycles</td>
<td>one/few</td>
<td>many</td>
</tr>
<tr>
<td>body size</td>
<td>usually small</td>
<td>often large</td>
</tr>
<tr>
<td>size offspring</td>
<td>small</td>
<td>large</td>
</tr>
<tr>
<td>parental care</td>
<td>little/none</td>
<td>often extensive</td>
</tr>
</tbody>
</table>

**Figure 31-9** The reproductive strategies, *r* selection and *K* selection. (a) Dandelions (*Taraxacum officinale*) are *r* strategists—annuals that mature early and produce many small seeds. A dandelion population fluctuates from year to year but rarely approaches the carrying capacity of its environment. (b) Tawny owls (*Strix aluco*) are *K* strategists and maintain a fairly constant population size or near the carrying capacity. They mature slowly, delay reproduction, and have a relatively large body size. (a, Maria Lobateau; b, Stephen Delany, Photo Researchers, Inc.)
Early reproduction is correlated with short life!

Trade-off between reproduction and survival!

Moral: kids will kill 'ya.
Semelparity = “big bang”… One large reproductive event

Iteroparity = repeated reproductive events

FIGURE 23.8
Reproductive events per lifetime. Increasing current reproductive effort (CRI) decreases residual reproductive value (RRV). Adding eggs to nests of collared flycatchers (which increases the reproductive efforts of the female rearing the young) decreases clutch size the following year; removing eggs from the nest increases the next year’s clutch size.

Max rate of population growth = max. sustainable yield

Overharvesting (> max. sustainable yield) damages population!

FIGURE 23.15
Catch history of the Porvoo anchovy fishery. Catches fell precipitously after the 1972 E-Nets lowered ocean productivity at the same time that fishing intensity increased. The result was overharvesting and a precipitous drop in fish populations.
Consumption is also important!

Figure 21-16 People and natural resources. (a) The rapidly increasing number of people in developing countries overwhelms their natural resources, even though individual resource requirements may be low. Shown is a typical Indian family, from Abesara Village, India, with all their possessions. (b) People in developed countries consume a disproportionate share of natural resources. Shown is a typical American family from Portland, Texas, with all their possessions.

(a) Peter Greh/Maternal World
“Christmas Tree” pop structure = rapid growth

“Bullet” pop structure = stable size

Figure 51–14 Age structure diagrams. These age structure diagrams for (a) Nigeria, (b) the United States, and (c) Germany indicate that less developed countries such as Nigeria have a greater percentage of young people than highly developed countries. As a result, less developed countries are projected to have greater population growth than highly developed countries.

FIGURE 23.19
Most of the worldwide increase in population since 1950 has occurred in developing countries. The age structures of developing countries indicate that this trend will increase in the near future. The stabilizing of the world’s population at about 10 billion is an optimistic World Bank/United Nations prediction that assumes significant worldwide reductions in growth rate. If the world’s population continues to increase at its 1996 rate, there will be over 20 billion humans by 2100!