POPULATION GROWTH GRAPHS: THE “S” CURVE

LIMITING FACTORS

- Limiting factors control population growth
  - They are things that restrict biotic potential, or keep a population under control

    - Also known as: environmental resistance, selective pressures, environmental pressures.

- Can be anything that keeps a population from reproducing and growing too much.
    - Predation
    - Habitat loss
    - Competition for food, nest sites, water, mates, etc.
    - Illness, parasites
    - Pollution
    - Climate change

2 TYPES OF LIMITING FACTORS

Density Dependent

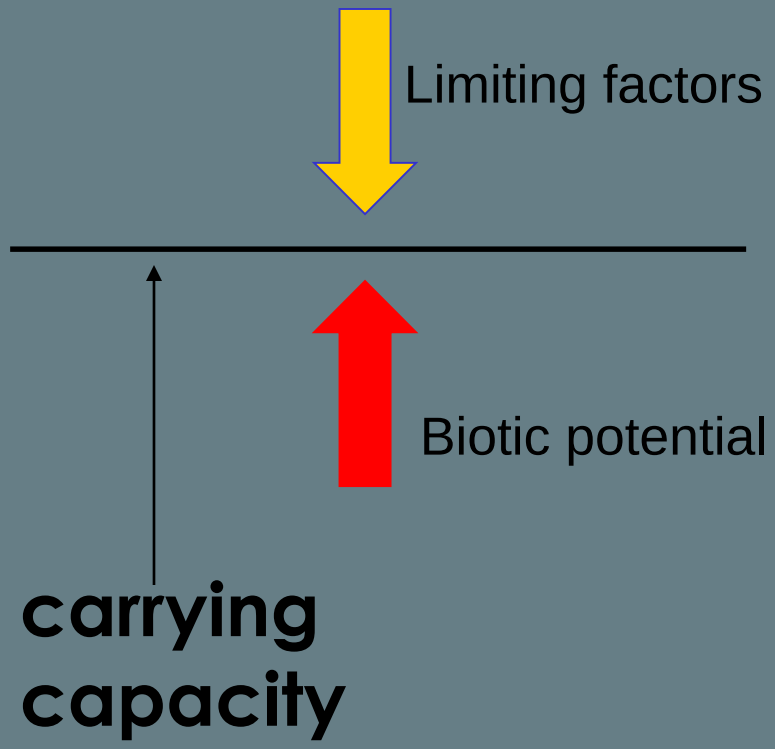
- Factors that impact the population depending on its size.
- Examples include:
  - When a population is too big: food shortage, passing of parasites, not enough shelter sites, competition within species
  - When a population is too small: can't find mates, inbreeding

Density Independent

- Factors that impact the population regardless of population size.
- Examples include:
  - Pollution
  - Habitat loss
  - Natural disasters
  - Climate change

CARRYING CAPACITY

- When the upward push of biotic potential meets the downward pressures of limiting factors, the end result is an ecosystem's carrying capacity.
- The carrying capacity is the maximum population size of a species that a habitat/environment can sustain.
- An ecosystem has a different carrying capacity for each species. (Remember the biomass pyramid? There are more herbivores than carnivores)



CARRYING CAPACITIES CAN CHANGE

- The Carrying capacity for each species is not set in stone; it fluctuates based on environmental conditions such as:
  - Food production
  - Cover availability
  - Water availability, etc.
- Generally speaking, a population that is below its carrying capacity will increase, while a population above its carrying capacity will decrease in size

S-CURVE

- When we account for limiting factors, we get a more realistic graph (compared to the J-curve, or exponential growth)
- This type of graph depicts an S-curve, or logistic growth
- The S-shape is a result of the biotic potential of the population and limiting factors (or environmental resistance) being in balance
- IT'S ALL ABOUT BALANCE!!!

S-CURVE GRAPH

- Notice the dashed line indicating the carrying capacity (K)
- The S-curve shows that a population's growth constantly changes due to limiting factors.

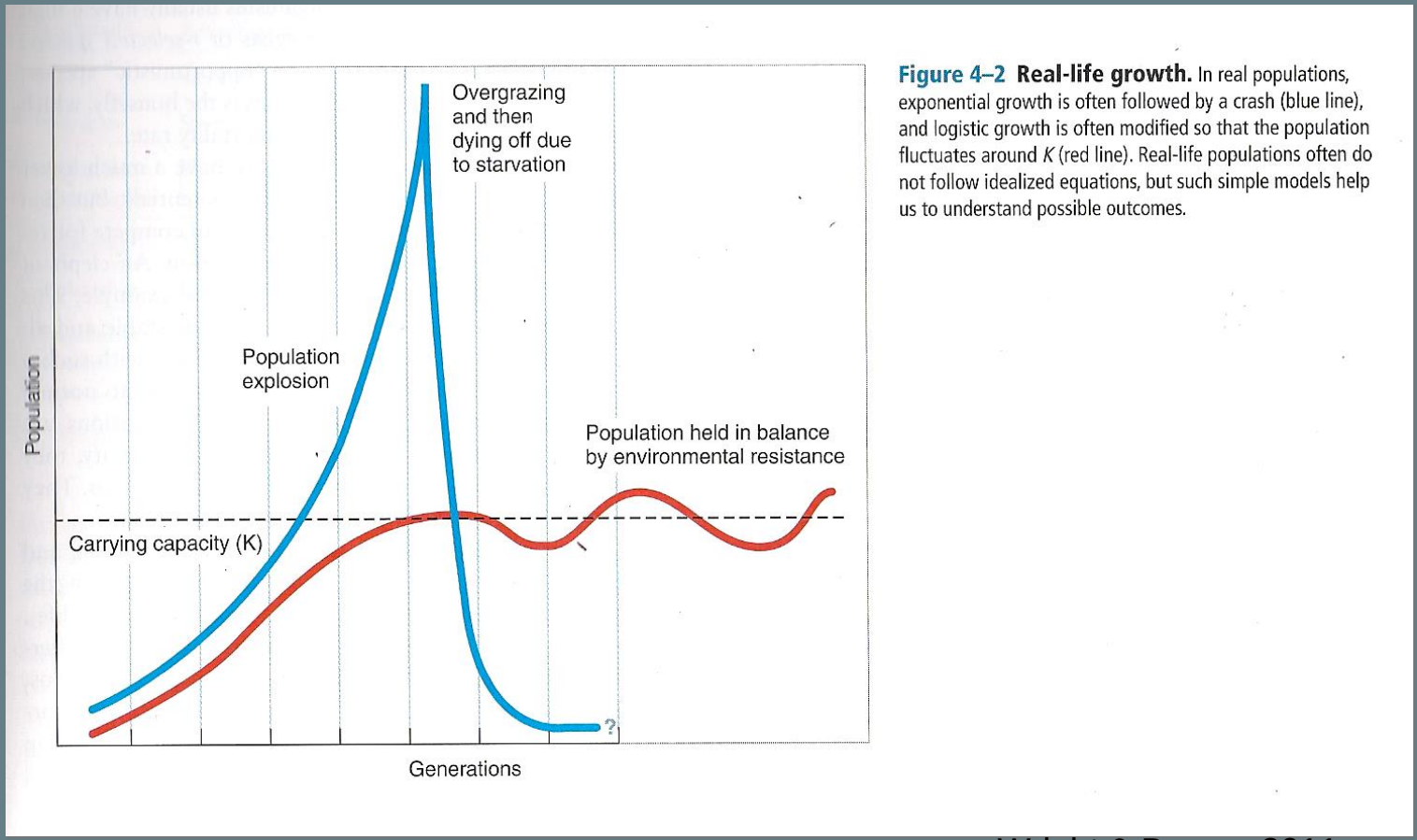
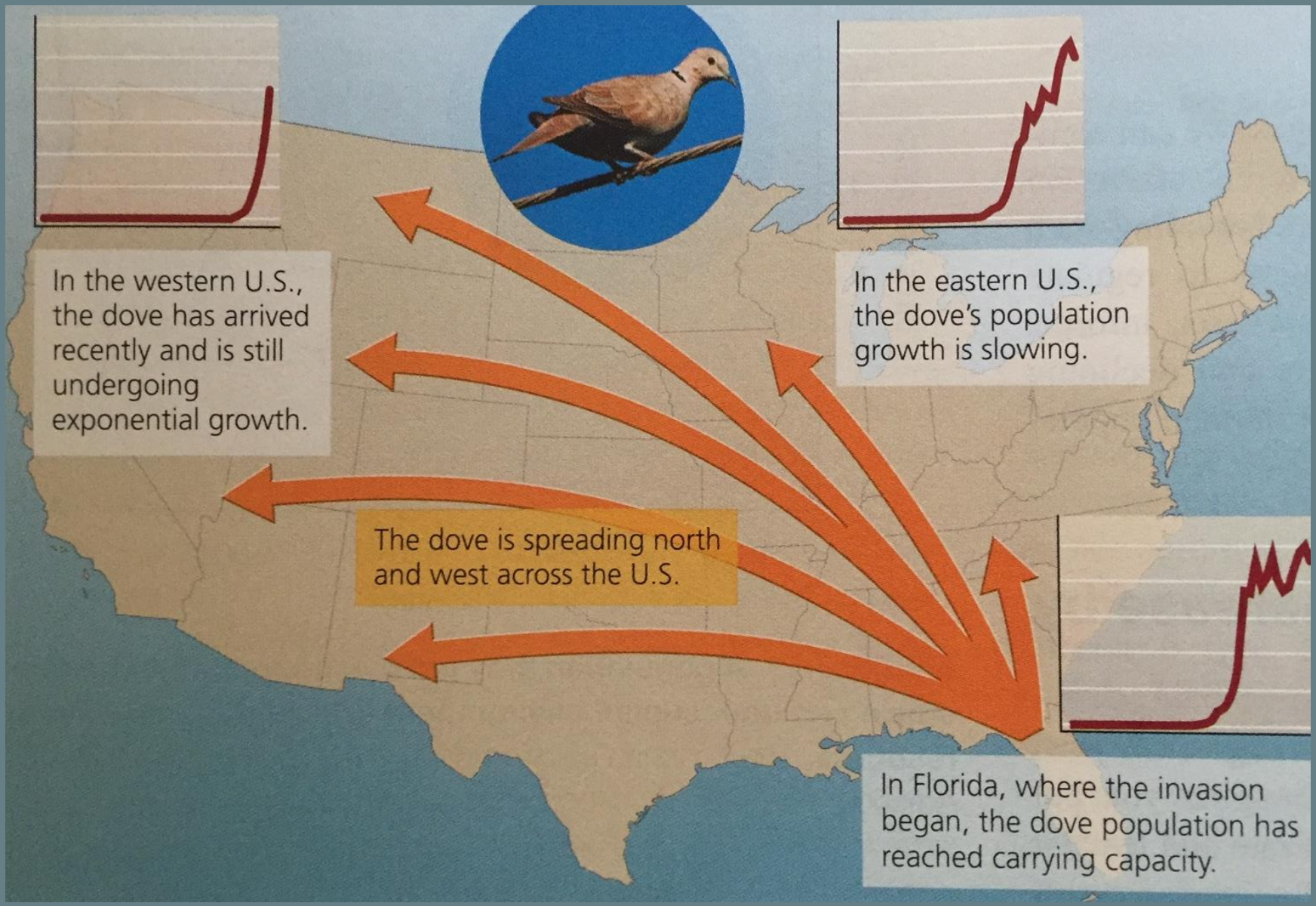


Figure 4–2 Real-life growth. In real populations, exponential growth is often followed by a crash (blue line), and logistic growth is often modified so that the population fluctuates around *K* (red line). Real-life populations often do not follow idealized equations, but such simple models help us to understand possible outcomes.

Wright & Boorse 2011


In the western U.S., the dove has arrived recently and is still undergoing exponential growth.
In the eastern U.S., the dove's population growth is slowing.
The dove is spreading north and west across the U.S.
In Florida, where the invasion began, the dove population has reached carrying capacity.

OPTIMAL LEVEL

- A species can exceed the carrying capacity for its environment - when it does this, it is essentially living on borrowed time/living above the means of the ecosystem.

- Eventually, there will be a die off/population crash and the population will experience a negative growth rate

- **The optimal level for a population is defined as 50% of the carrying capacity.** Why?
  - This gives a buffer for boom years
  - Also, the carrying capacity can fluctuate up and down, so the optimal level provides a buffer for lower carrying capacity years.

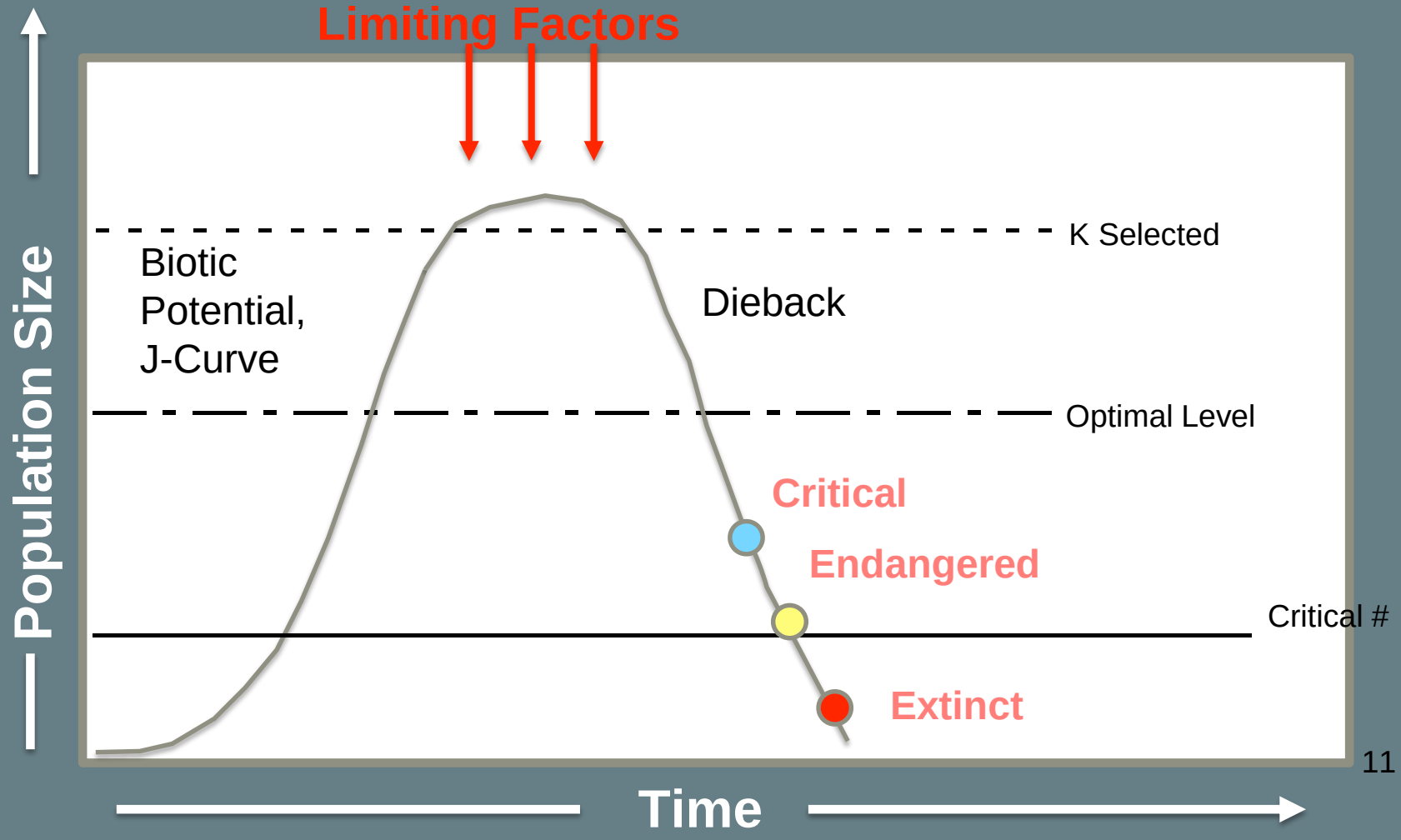
- When wildlife managers are making decisions about how to manage a population of wildlife, they must keep both the optimal level and the carrying capacity in mind.

CRITICAL NUMBER

- The critical number for a population is the number of individuals needed to keep a species surviving and producing viable offspring
  - This number is usually based on genetics and having enough genetic variety to produce healthy/viable offspring
- When the species population size reaches, or gets very close to, its critical number, they are designated as “endangered”
- Once the population size falls below the critical number, they are considered “extinct”

General Example

When the limiting factors/environmental resistance outweigh the biotic potential you get the graph below.



REPRODUCTIVE STRATEGIES

REPRODUCTIVE STRATEGIES

- There are 2 general types of reproductive strategies:
  - r-selected species
  - K-selected species
- These strategies are part of organisms' niches

r-SELECTED SPECIES

- r-selected species have the following characteristics:
  - Produce many offspring
  - Little/no parental care of offspring
  - Early reproductive age
  - Short lived
  - Most die before reproductively able
  - Small adults
  - Highly adaptable
  - High population growth rate
  - Population sizes fluctuate
  - Generalist niche
  - Tend to be low trophic level species

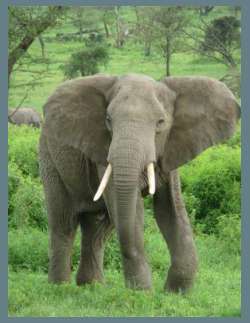
K-SELECTED SPECIES

- K-selected species have the following characteristics
  - Produce fewer, large offspring
  - High parental care and protection
  - Late reproductive age
  - Long lived
  - Most survive to reproductive age
  - Larger adults
  - Low population growth
  - Population sizes remain stable
  - Specialist niche
  - Tend to be high trophic level species

REPRODUCTIVE STRATEGIES

r-SELECTED SPECIES

K-SELECTED SPECIES



The reproductive strategies can be seen as a gradient, and species fall somewhere along this gradient. Most species have characteristics of both strategies, but usually have more K or more r-selected strategies.

Cockroaches, for example, would fall toward the extreme end of r-selected.
Lions would fall toward the other end, under K-selected.
Elephants are more K-selected although they are in a lower trophic level. So they fall along the gradient rather than at one end or the other.

RECRUITMENT

- The term recruitment refers to the number of organisms that survive to adulthood and reproduce.

- This is different from a species' biotic potential (its ability/drive to produce offspring or reproduce)

Biotic Potential vs. Recruitment

r-Selected Species

- High biotic potential
  produce lots of offspring
- Low recruitment
  but few, or a low percentage, make it to adulthood.

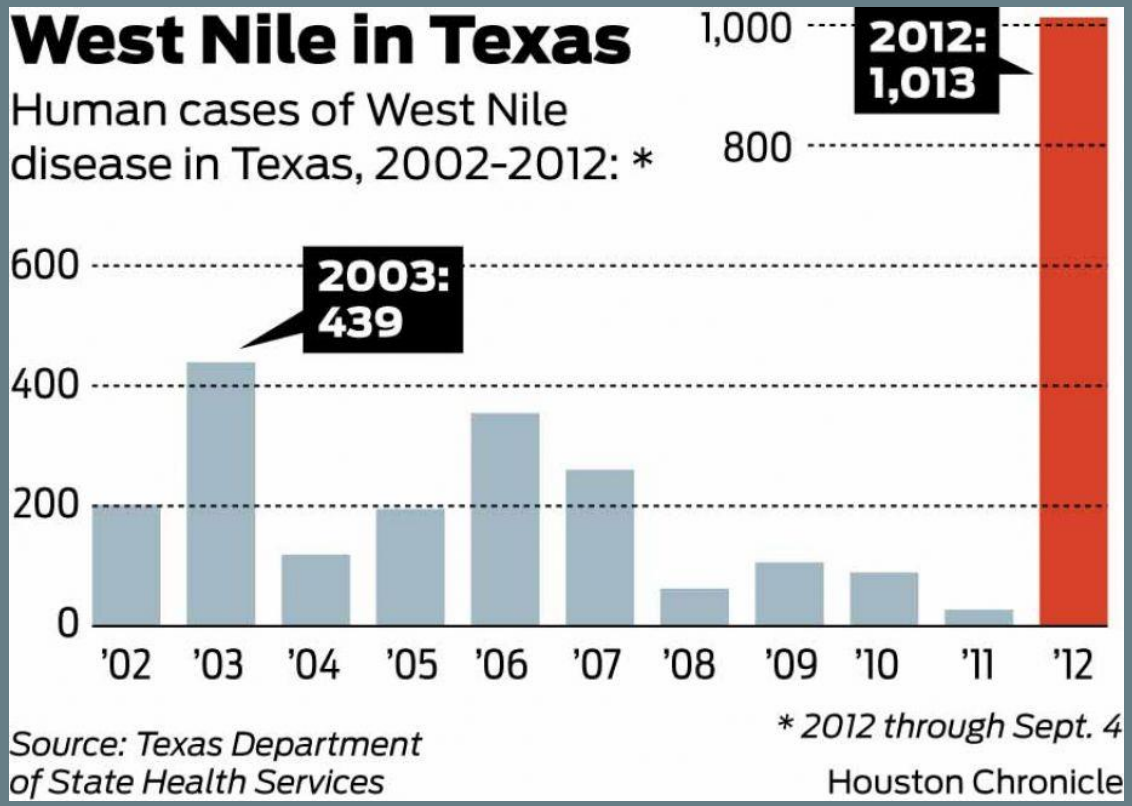
Sea Turtle hatchlings

K-Selected Species

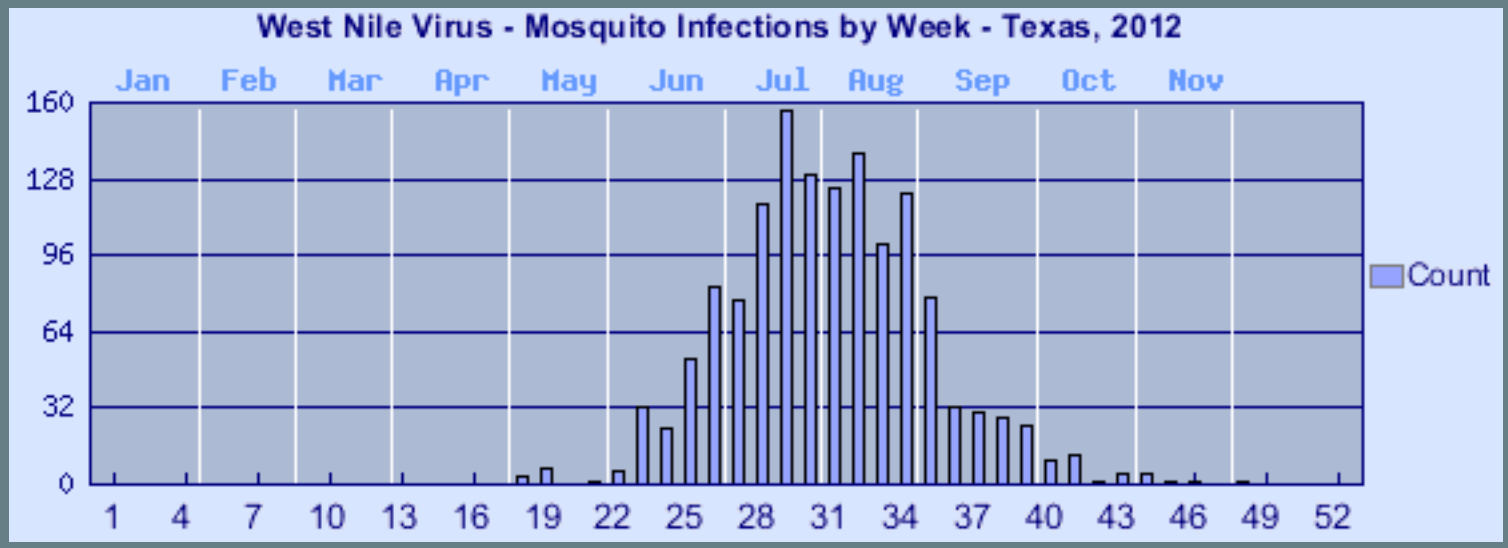
- Low biotic potential
  produce few offspring
- High recruitment
  but, a higher percentage of their offspring make it to adulthood
  due to more parenting!

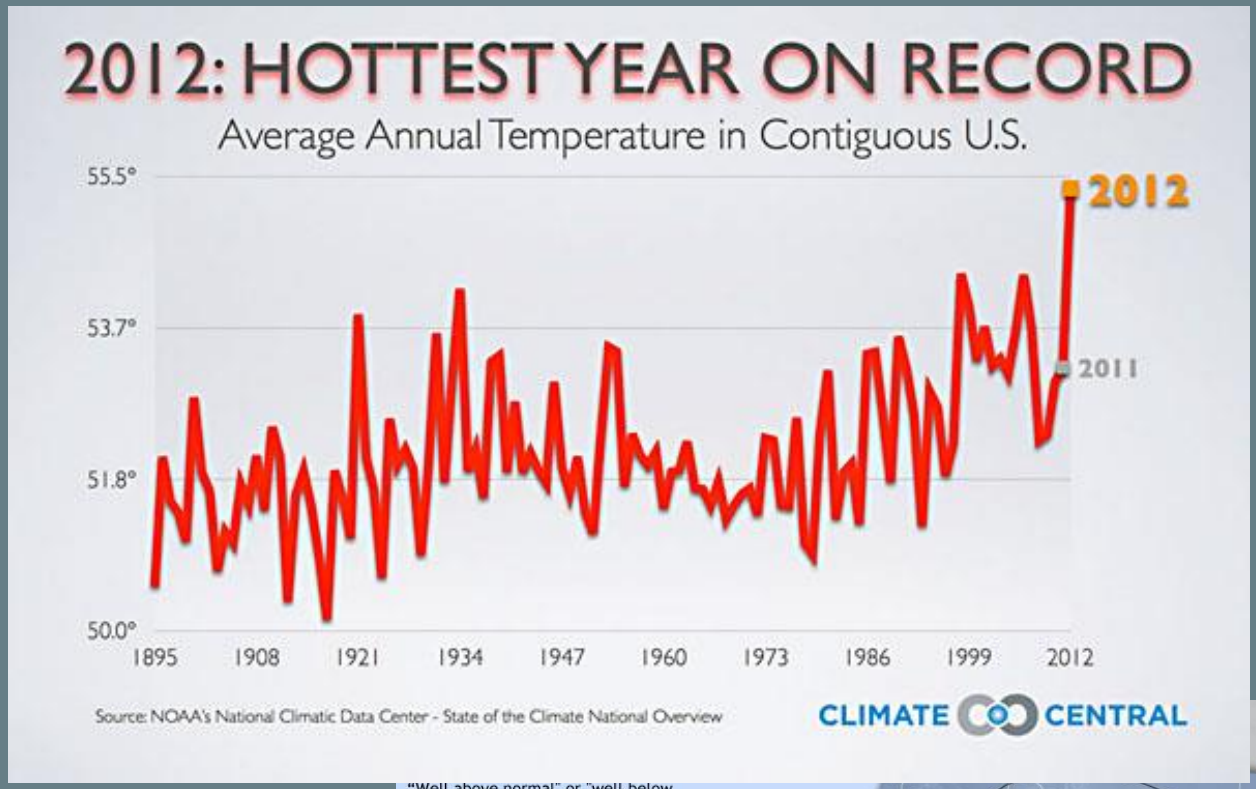
California Condors

The Texas Mosquito Example . . .

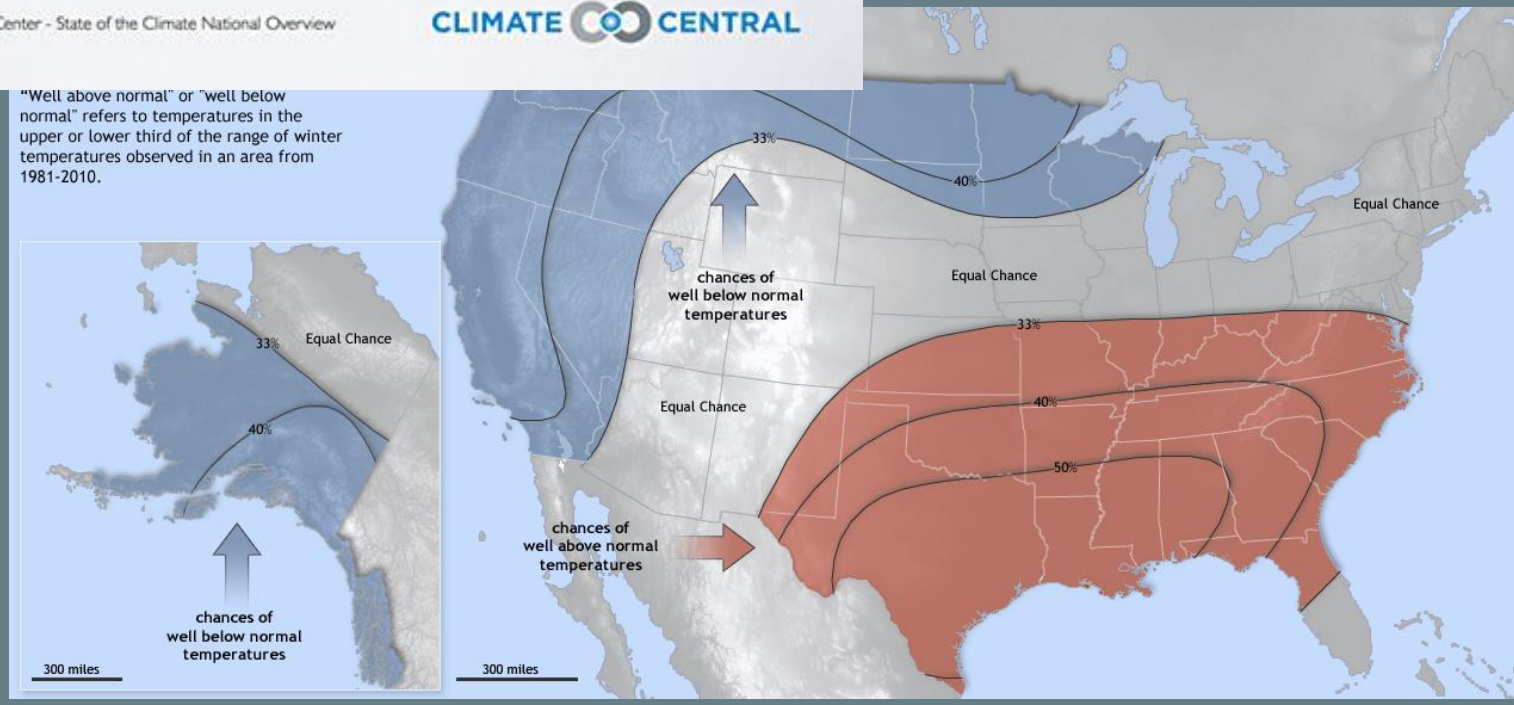


2012 West Nile Virus infections in Texas





2011 - 2012 Temps



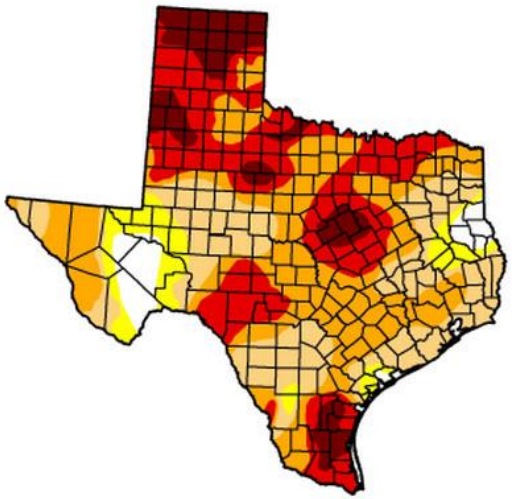
U.S. Drought Monitor

December 18, 2012
Valid 7 a.m. EST

Texas

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	4.54	95.46	88.31	64.13	33.95	9.89
Last Week (12/11/2012 map)	5.91	94.09	87.72	65.04	32.22	8.45
3 Months Ago (09/18/2012 map)	11.28	88.72	76.12	51.82	22.90	4.88
Start of Calendar Year (12/27/2011 map)	0.01	99.99	97.83	84.81	67.32	32.36
Start of Water Year (09/25/2012 map)	9.13	90.87	78.73	57.41	24.91	5.18
One Year Ago (12/13/2011 map)	0.00	100.00	99.83	90.20	76.41	41.29



Intensity:

- D0 Abnormally Dry
- D1 Drought - Moderate
- D2 Drought - Severe
- D3 Drought - Extreme
- D4 Drought - Exceptional

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

http://droughtmonitor.unl.edu

Released Thursday, December
Brian Fuchs, National Drought Mitigatio

95% of mosquitos tested carried the virus

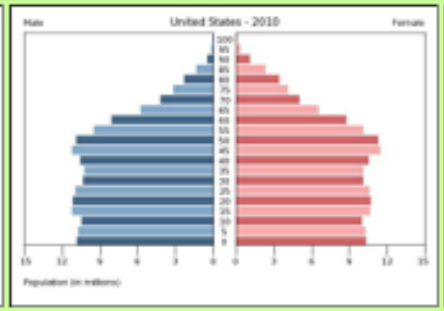
Environmental impact of human population growth

1. Famine
2. Political unrest (disparities)
3. Environmental degradation
4. Water pollution
5. Air pollution
6. Extinctions

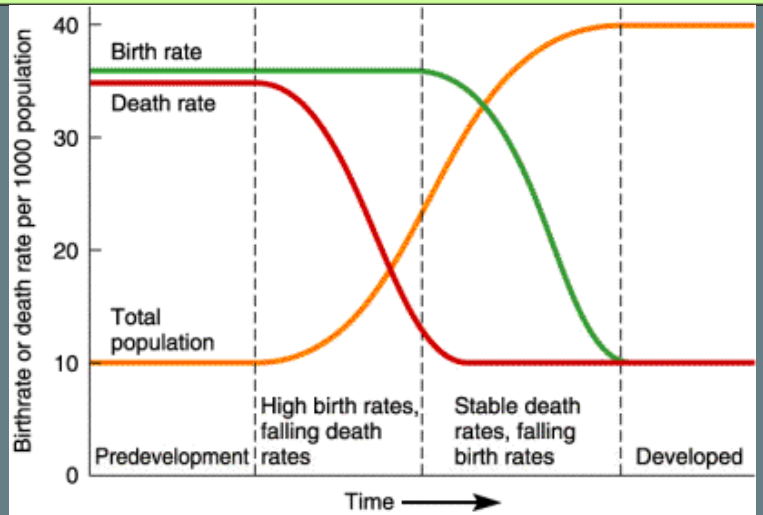
Ecological footprint

Measure of the land area required to provide the resources and absorb the wastes of a population.

Most of the more developed countries have a much larger ecological footprint.



Stage 1	Stage 2	Stage 3	Stage 4
Expansive.	Expansive.	Stationary.	Contractive.
Concave sides.	Straight sides.	Convex sides.	Convex sides.
High birth rate.	Still high birth rate.	Declining birth rate.	Very low birth rate.
High death rate.	Falling death rate.	Low death rate.	Low death rate.
Short life expectancy.	Slightly longer life expectancy.	Long life expectancy.	Longer life expectancy.
Rapid fall in each upward age group due to high DR.	Fall in DR so more people living into middle age.	An increasing proportion of the population is in the 65+ age group.	Higher dependency ratio.
Niger	Haiti	Morocco	Australia



Government Incentives to reduce population growth:

- Free/more accessible family planning (clinical services like birth control, education)

- Economic rewards/penalties: payment for sterilization, eliminating income tax deductions for more than one child, free higher education for women/child of single-child family, couples pay a tax for each child over first, gov. subsidized housing for 1-child families

Prepare to debate

- You will be assigned a “Side” and a speaking position (1st speaker -> last)
- Read and annotate the Pro and con packet
- Read Chapter 7 (p. 155-171)
- research online
- **<u>You will be graded on:</u>**
  - your annotations and written points including notes during the debate
  - Your speech and participation during the debate
  - Your reflection and analysis of the outcome/decision