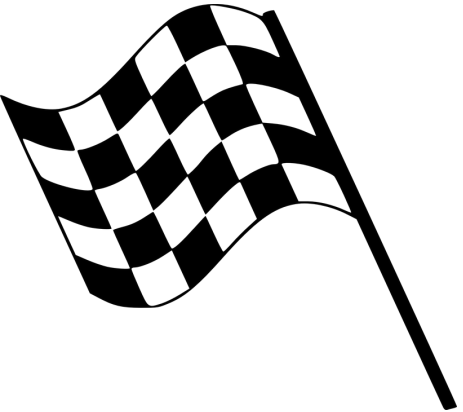
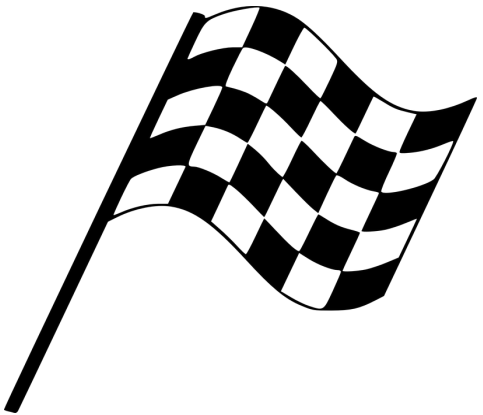
BIOL 121 Final Review Session





Hosted by:
Risa Ogushi and Ruby Burns

How are we feeling right now?

Yaaaaaaay finals! I'm having a great time :):)

we're 3 days in to finals and my brain is already mush

Finals?? I'm just ready for summer, before then whatever happens happens

Population Ecology

- Studying factors that influence a population (a group of individuals in a species that live in the same area at the same time)
  - Often this specifically looks at population size, N
- Size ≠ Density! A large but spread out population may have a lower density than a small but compact population (depending on the area you're surveying).
  - This influences the effect of density-dependent factors

vs

Populations

- What might cause a population to increase? decrease?
  - How can we group these factors together?
    - Births or immigration increase population size
    - Deaths or emigration decrease population size

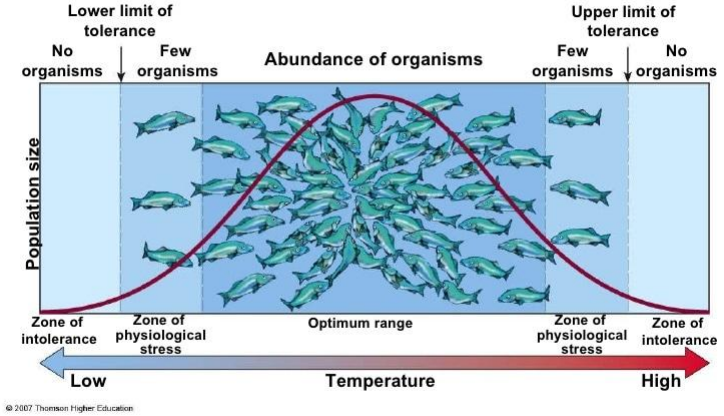


Fig. 3-11, p. 58

- How can we estimate population size?

Quadrat sampling

Lincoln-Petersen (Mark-recapture)

Lincoln-Peterson Mark-Recapture

$$\frac{M}{N} = \frac{m}{n}$$

Where:

M is the **total number of marked individuals** and **N** is the **total population size**

m is the number of **marked recaptured individuals** and **n** is the **total number of recaptured individuals**

This works because the proportion of all the marked individuals in the population should match the proportion of recaptured marked individuals… ***ASSUMING:***

The total **population size does not change** between when individuals are marked and when they are recaptured (no b, d, e, or i); All individuals have the **same probability of being caught**; **Marks stay on** all marked individuals

Your Turn! Mark Recapture Question:

A bird banding project at Iona Beach Regional Park captures and bands 20 song sparrows, then releases them.

One week later, 25 song sparrows are caught. 3 have bands on them. **What is the size of the local song sparrow population?**

TRAIL INFORMATION				
Trail	Distance To Return	Time To Return	Terrain	Comments
Iona Jetty	8.0 km	2.5 Hours	Flat, exposed	Enjoy 360° views of sea, sky and mountains. Can be very windy!
North Arm Jetty	6.0 km	2.5 Hours	Sandy beach.	Walking on the North Arm Jetty is allowed only on the beach below the high tide line.
Bridle Path	2.0 km	20 minutes	Flat, dusty.	Walkers and horses share this trail.

Sparrow question Walkthrough

We know:

M = 20, m = 3, n = 25. M/N = m/n

We want to know:

N = ?

So we solve:

N = nM/m

N = 25*20 / 3

N = 166.666667

^ (Not sparrows)

∴ the population is about 167 song sparrows.

BONUS Sparrow Question

(For you to try at home!)

When the same park does a similar experiment again the next year, 8 sparrows are originally marked, then of 12 recaptured 2 are marked. Assume that the marks are distinguishable from the bands of last year, so there is no confusion between which marks were made this year. What is the population now?

What factors might have caused this result? Can we know for sure the population changed?

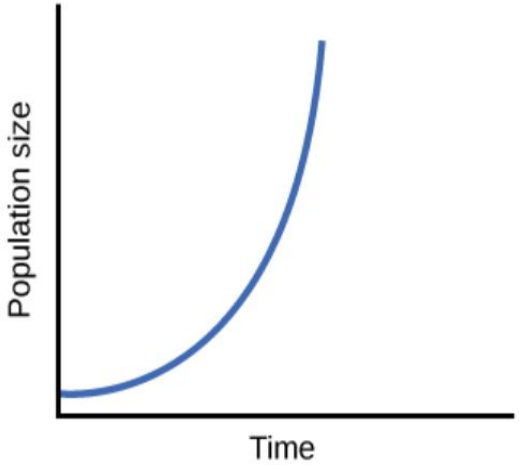
Population Growth

- **r** is the **per capita growth rate** of a population
  - Equivalent to the per capita birth rate - per capita death rate (r = b - d)
- r does not depend on population density for exponential growth
- r does depend on population density for logistic growth

b = number of births/population size
d = number of deaths/population size

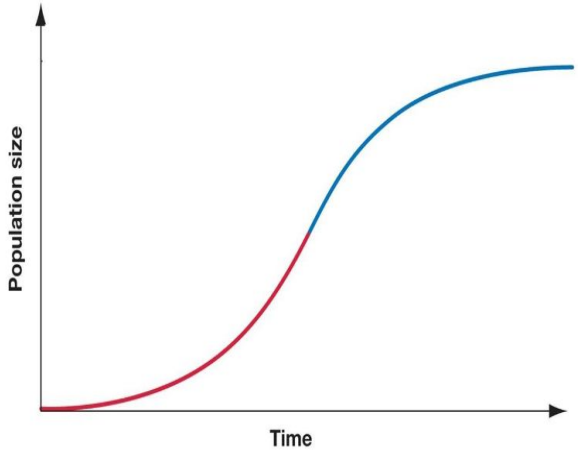
Applying r to estimate population size at future times:
$N_{t+1}=(1+r)N_t$

Exponential Growth



- Close to unlimited amount of resources
- Small population size

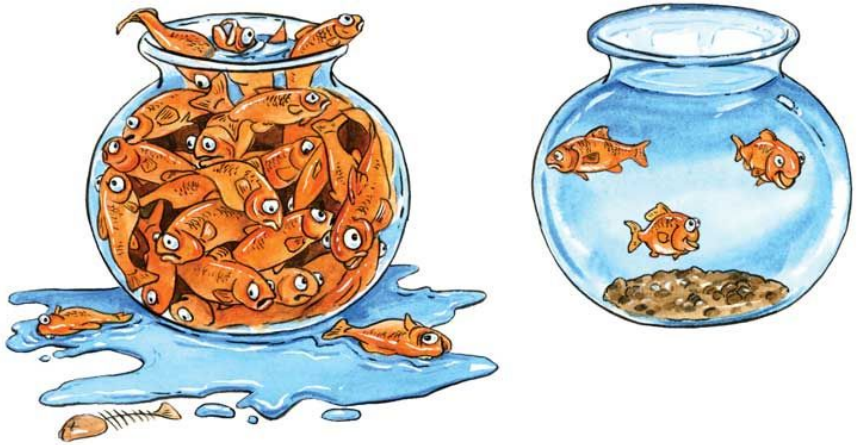
Logistic Growth



- Resources become limiting as the population grows
- r decreases and eventually reaches 0 at the carrying capacity (K)

Carrying Capacity (K)

- K can change over time with changes in the environment
  - Changes to the environment can change its ability to support a given population
- K can differ between different species
  - Different requirements to survive and reproduce
- Most populations fluctuate around K due to various random factors



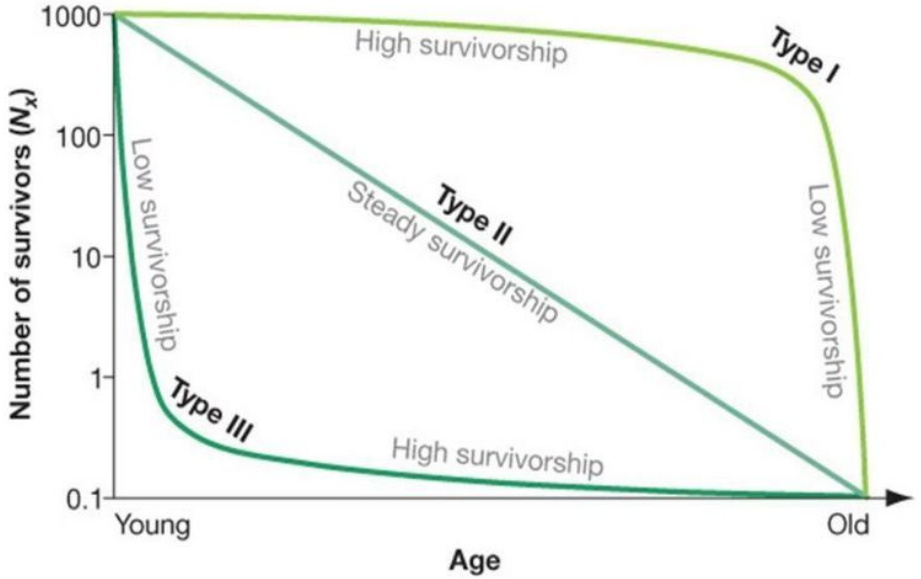
Factors Affecting Population Growth

- **Density-dependent**
  - Effects on r depends on population size
  - Often are biotic factors

- **Density-independent**
  - Effects on r do not depend on population size
  - Often are abiotic factors

Survivorship Curves

- Show probability of survival with age
- **Type I:** Most individuals survive until old age
- **Type II:** Individuals steadily die with age
- **Type III:** Most individuals die young, few live to old age



Life History Trade-offs

r-selected species	**K-selected species**
● Fast development time ● High fecundity ● Reproduce early in life ● Low quality offspring ● Low parental investment for reproduction associated with type III survivorship	● Slow development time ● Low fecundity ● Reproduce late in life ● High quality offspring ● High parental investment for reproduction associated with type I survivorship

Tip!: Put this in your cheatsheet!

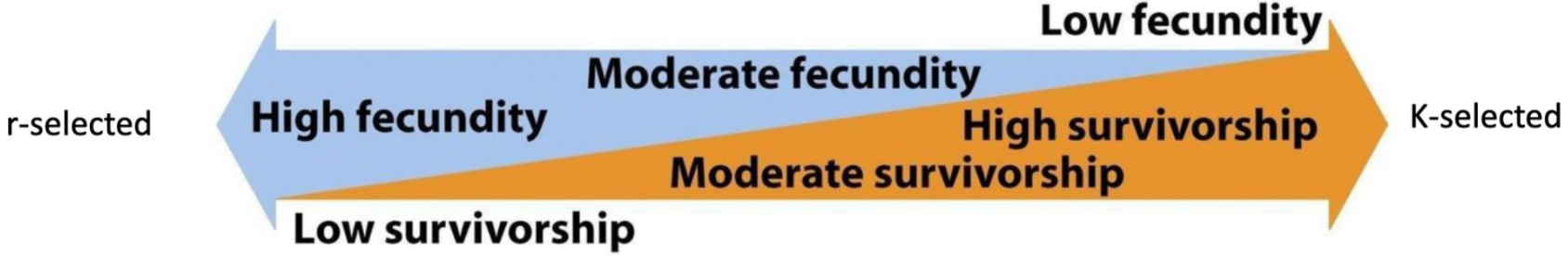


Figure 52-4 Biological Science, 2/e
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Population Growth Question

1. Dragons are known to be long-lived creatures that mate infrequently late in life. Dragons care for their offspring for several years. Krakens produce thousands of eggs, but many eggs do not hatch. Krakens have a shorter lifespan than dragons. Which species is likely maximizing “r”, and which is likely maximizing “K”? Explain your reasoning. How do the reproductive and survivorship strategies of dragons and krakens allow them to maximize their fitness?

2. Describe one density-dependent and one density-independent factor that could affect population growth for dragons.

Population Growth Question: Answer Guide

1.

Dragons:

- Low fecundity
- High-quality offspring (long-lived)
- K-selected

Krakens:

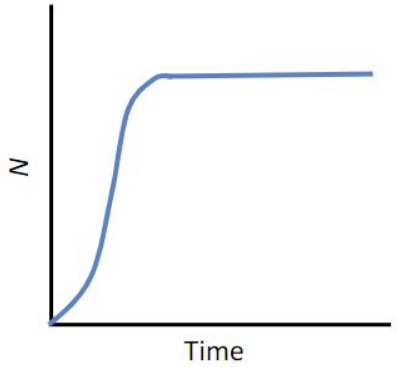
- High fecundity
- Low-quality offspring
- r-selected

Population Growth Question: Answer Guide

1.

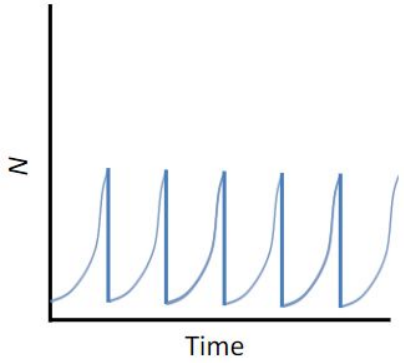
Dragons:

- Low mortality rates allow population to reach and remain at K
- Parents invest care into their offspring so they have high survival rates



Krakens:

- High mortality rates prevents population from reaching K
- Populations evolved traits that allowed them to produce many eggs since many won't hatch



Population Growth Question: Answer Guide

2.

- Density-dependent: e.g. competition for prey, disease
- Density-independent: e.g. flooding, landslides
- Justify why this factor is density-dependent or density-independent in your answer

Population Growth Question - Answer Guide Q2

We could say that a density-dependent factor that affects population growth for dragons is competition for prey because as the dragon population gets bigger, they will need more prey to sustain their population size. However, the amount of prey is limited, so competition for prey goes up and not all the dragons will be able to eat as much as they need to survive. This could lead to the per capita death rate increasing and the per capita birth rate decreasing, ultimately lowering the population growth rate.

A density-independent factor that affects the population growth for dragons could be flooding. This is because flooding would change their habitat significantly, and the habitat would no longer be suitable for dragon survival regardless of how small/big the population size is. This could increase the per capita death rate and decrease the per capita birth rate, lowering the per capita growth rate and affecting population growth.

Community Ecology

- Studying the **interactions between species** that form a **community** (the interacting species w/in a specified area)
  - Often looking at what those specific interactions are, how they impact fitness, and how they change over time
- **Five types** of interactions between two species
  - Amensalism (-/0)
  - Commensalism (+/0)
  - Mutualism (+/+)
  - Consumption (+/-)
  - Competition (-/-)
- The +'s and -'s relate specifically to the impact on **fitness**!

Cheatsheet again!

Interaction	Description	Fitnesseffect
Amensalism	Occur when an organism inflicts harm to another without anyfitness cost/benefit to itself.	– / 0
Commensalism	Occurswhen one species benefits from the interaction, but the other species is unaffected	+ / 0
Mutualism	Occurswhen two species interact in awaythat confers fitness benefits to both	+ / +
Consumption - Predation - Herbivory - Parasitism	Occurs when one organism eats (or absorbs the nutrients) from another. There is a positive fitness effect for the consumer, and a negative fitness effect on the "prey".	+ / –
Competition - Intraspecific - Interspecific	Occurswhen individuals use the same limited resources. There are negative fitness consequences for both individuals.	- / -

* Pairwise = relating to a pair (in this context, 2 interacting organisms of different species)

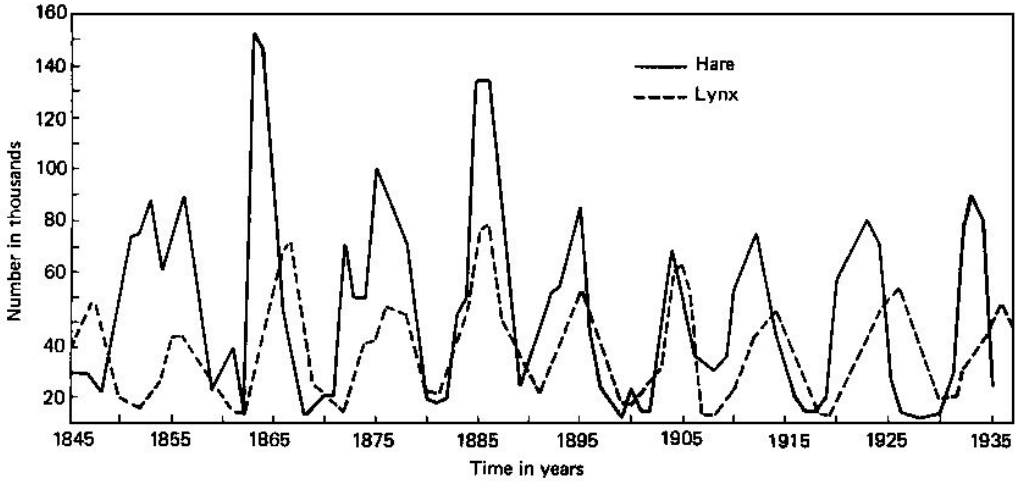
Community Ecology

The effects of species interactions are usually **density dependent** (ie. they will change depending on how dense the interacting populations are)

- Large amounts of predators will decrease prey population
- Large amounts of prey will increase predator population

^ and vice versa!

A classic example of the influence hare and lynx populations have on each other —-->



Community Ecology - Food Chains/Food Webs

Canadian Lynx

Snowshoe Hare

White Spruce

Some things to think about:

Can you label the trophic levels?

If one species were to decrease/increase how would the other species change (or not)?

What is each species relative biomass compared to the others?

How would you add a detritivore? the carbon cycle? the nitrogen cycle?

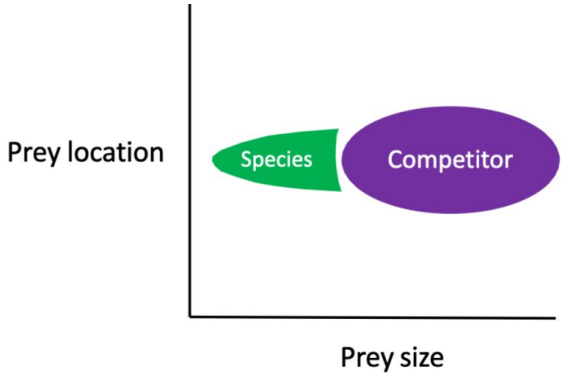
Competition

- Organisms have **overlapping niche** for some limiting resource
  - (eg. access to sunlight, nutrients, shelter… can you think of others?)
- Can be **intraspecific** (same species) or **interspecific** (between different species)
- The amount in which the competing populations' niches overlap, and how strong competitors they are, will determine whether they can **coexist** or whether one will be **eliminated** (competitive exclusion)
- **Niche: the resources used by a species**, and its role in the ecosystem
  - Fundamental niche: The full range of that resource the species could use if there was no competition / other conflicting biotic interactions
  - Realized niche: The observed range of a resource the species is using in the presence of a competitor

Bonus Activity: think of a forest ecosystem. What is one resource in limited supply for animals? For plants? Is there one strong competitor or many different species sharing the resource? Do you think a species has been excluded from this resource?

Fundamental vs. Realized Niches

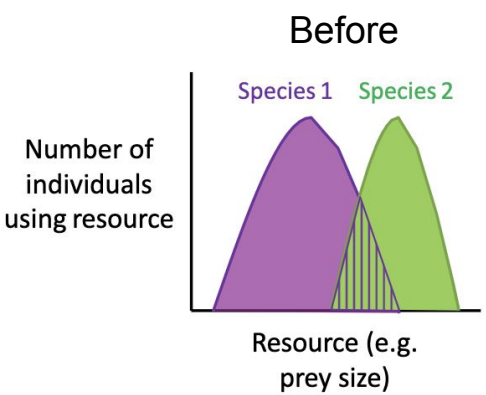
Fundamental niche
(no competitor present)

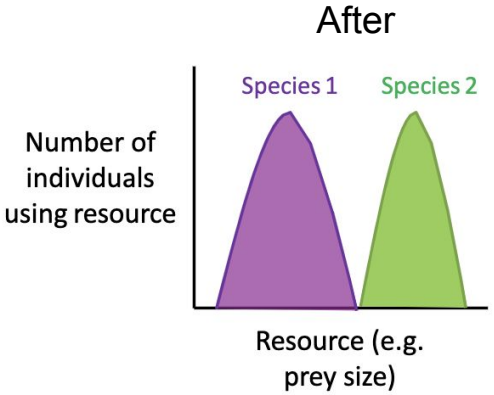


Realized niche
(competitor present)

Niches

Niche partitioning:

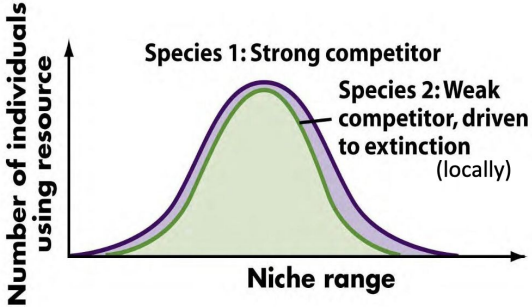




<- reduction in niche size for **both**

Competitive exclusion:

Note: niches don't have to fully overlap, but one species will fully exclude another from the niche it takes up



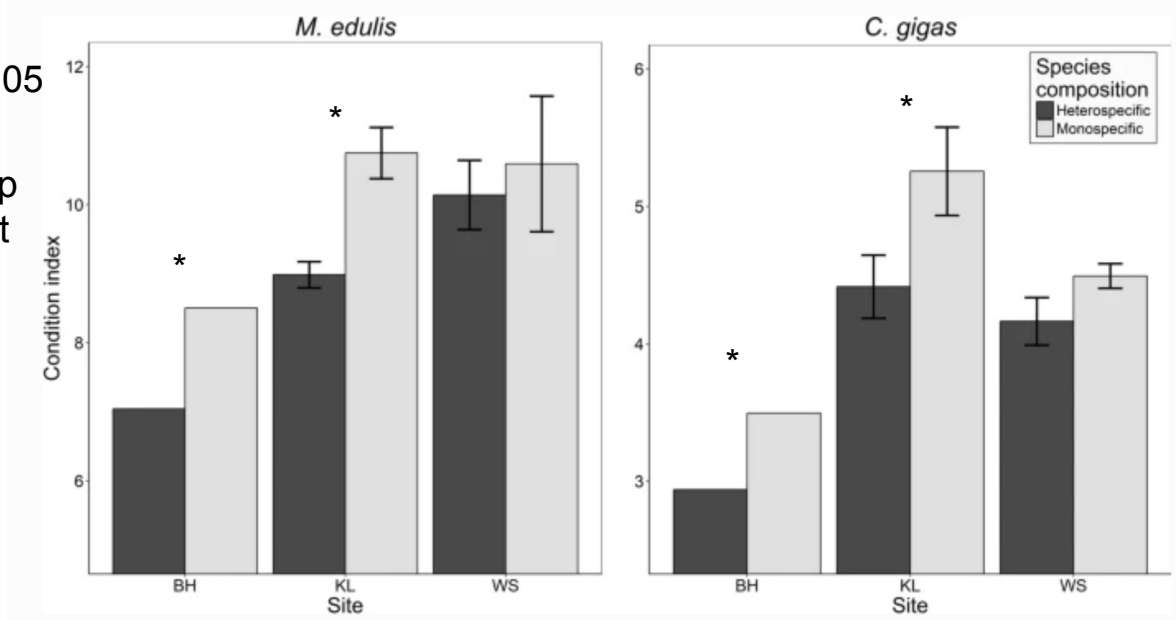
If niches **fully overlap**:
- Species cannot co-occur
- Weaker competitor is competitively excluded from entire niche

Community Ecology Question: Oysters and mussels

The Pacific Oyster (*Crassostrea gigas*) is invasive in many intertidal ecosystems in western North America and Europe, which are typically home to mussels (*Mytilus edulis*). Mussels and Pacific oysters now live in the same region of the intertidal zone. Joyce et al. (2021) wanted to know how sharing a habitat impacts mussels and oysters, so they set up enclosures at three separate sites (BH, KL, and WS) that either had 1) only mussels, 2) only oysters, or 3) both mussels and oysters. After one year, they collected the animals from the enclosures and measured their condition (a higher condition index means there is more muscle relative to shell - a good thing).

a) Interpret these results. * means $p<0.05$

b) How can we describe the relationship between mussels and oysters? What might cause this?



Notes: 'Heterospecific' means both species are present. 'Monospecific' means one species is present. Condition is not comparable between species.

Oysters and mussels: (sample) answer

a) Condition was significantly lower when both species lived together compared to living separately in all species and sites except WS. Condition also appears to be site-specific, with mussels and oysters at site BH having lower condition indexes than any other sites no matter the treatment. At site BH, mussels living with oysters had a condition index about 1 unit lower than when they lived alone, and oysters living with mussels had a condition index about 0.5 units lower than those living alone. At site KL, mussels living with oysters had a condition index about 2 units lower than those living alone, and oysters with mussels had a condition index about 1 unit lower than oysters alone. There was no significant difference in condition between treatments for mussels or oysters in at site WS.

Oyster and mussels: (sample) answer

b) The oysters and mussels are both negatively affected when they live together, as they have less muscle mass compared to shell mass when coexisting. Less muscle mass might mean the animal cannot feed or reproduce as efficiently, lowering its energy and overall its fitness. They interact competitively (-/-).

Both mussels and oysters are filter feeders, so when they live together they are eating from the same food source. The reduced condition when living together might be because food is a limiting factor, and the oysters and mussels compete for food, each overall getting less food than if they lived alone.

Alternatively, the reduced condition could be due to competition for space. Both mussels and oysters grow on the hard substrate, and over time might begin overlapping or pressing against each other. This could negatively impact feeding, muscle growth, reproduction (etc.) and result in a reduced condition.

Ecological Succession

- Directional, predictable change in the species composition of a community over time
- Primary succession
  - Follows a disturbance that removed all organisms and soil
- Secondary succession
  - Follows a disturbance that removed some/all organisms, but soil still remains

Primary vs. Secondary Succession Examples

Primary Succession

- e.g. succession following:
  - Volcanic eruption, Glacier retreat, Extreme landslide only leaving bare rock, surface mining

Secondary Succession

- e.g. succession following:
  - Forest fires, logging, construction, farming, moderate landslide, flooding, windstorms, may be biotic (e.g. mountain pine beetle)

Ecological Succession

Early succession

- Pioneer species appear first (lichens, moss, small invertebrates)
- Grasses and herbaceous plants appear once some soil is present

Mid succession

- Mid-successional community develops (shrubby plants and small trees)

Late succession

- Climax community develops (large, long-lived trees)

Ecological Succession Question

Surtsey is an island off the coast of Iceland that was created from volcanic eruptions. The island emerged from the ocean over the course of several years starting in 1963. Scientists inspecting Surtsey soon after the island's emergence found lichens and plants typically found in beaches growing on the island.

a) How did these plants reach Surtsey? Why were these plants able to grow under these conditions while others were unable to grow?
b) Describe the kinds of species you would expect to see growing on the island in 100 years and why you would expect to see them.

Ecological Succession Question: Answer Guide

a)

- Seeds were carried by wind or water to Surtsey from the mainland (Iceland)
- These plants normally grow in sand, meaning they don’t need soil to grow and were able to grow on the shore of Surtsey

Ecological Succession Question: Answer Guide

b)

- Expect to see more shade-tolerant species that are stronger competitors for resources than the early successional species
    - Can outcompete the species from earlier successional stages
    - Could argue mid- or late-successional species, no definite timescale for ecological succession

Species Concepts (Bonus Question)

There are two butterfly populations living in Neverland. Population 1 preferentially drinks nectar from roses while Population 2 preferentially drinks nectar from pansies. Both populations of butterflies are able to interbreed with each other and produce viable offspring. Population 1 are found in meadows while Population 2 are found in forests. The wingspan for Population 1 is 1 meter while the wingspan for Population 2 is 0.8 meters. Population 1 have orange wings while Population 2 have yellow wings.

It is hypothesized that Population 1 and Population 2 are the same species. Which species concept(s) support(s) this hypothesis and which do not support this hypothesis? Explain your answer.

Species Concepts Question: Answer Guide

Biological species concept:

- Are Population 1 and Population 2 able to interbreed?
  - Yes!
- Are the offspring fertile?
  - Yes!
- This means that according to the biological species concept, Population 1 and Population 2 are the same species

Species Concepts Question: Answer Guide

Morphological species concept:

- Population 1 and Population 2 have different wing colours and different wingspan lengths
  - The two populations have different morphologies
- This means that according to the morphological species concept, Population 1 and Population 2 are different species

Species Concepts Question: Answer Guide

Ecological species concept:

- Population 1 and Population 2 use different flowers as their nectar sources and live in different habitats
  - The two populations occupy different niches
- This means that according to the ecological species concept, Population 1 and Population 2 are different species

Species Concepts Question: Answer Guide

Phylogenetic species concept:

- We don’t have any information about the phylogeny of Population 1 and Population 2 given in the question
- Cannot make any conclusions about whether the two populations are considered as different species or the same species

Species Concepts Question: Answer Guide

- Biological species concept supports the hypothesis
- Morphological species concept does not support the hypothesis
- Ecological species concept does not support the hypothesis
- Insufficient information given to make a judgment using the phylogenetic species concept

Final Tips

- Check out our previous review sessions if you need a refresher on genetics or evolution (emphasis on pedigrees and stages of mitosis/meiosis)
- Check out exam tips session for more advice on studying and exam-taking
- Read the questions carefully!! After writing your answer, look at the question again to make sure you addressed what the question is asking
- When answering, use specific numbers and data given to prove your point
- Worry less about getting the ‘right’ answer and more about how to argue your case (for the more open-ended questions, at least)
- Refer to class concepts, but don’t just throw in every bit of terminology you know whether it is related to the question or not!

You’ve got this!