

Community Ecology

Learning objective 8.5.A Describe the structure of a community according to its species composition and diversity, and 8.5.B explain how interactions within and among populations influence community structure.

Name:

Date:

Period:

Use the tool **Who Eats Whom, and What It Costs**. Parts 1 and 2 use **Counting is not enough**, Part 3 uses **Two signs**, Part 4 uses **The chase**, Part 5 uses **Down the chain**, and Parts 6 and 7 use **Sharing a resource**. A community is a set of populations whose numbers are wired to each other. This topic is about what happens to the rest of them when one changes, and in three places the honest answer is not the one that gets memorised — so work each of those out from the numbers rather than from what you already believe.

Part 1 • Two communities, five species each

Both communities below contain **one hundred individuals** of **five species**. Compute Simpson's Diversity Index for each: $1 - \Sigma(n/N)^2$. Do the squaring before the adding, and keep four decimal places — you will need the precision in Part 2.

Community	Counts	$\Sigma(n/N)^2$	Index = $1 - \Sigma(n/N)^2$
Even, five species	20, 20, 20, 20, 20		
Dominated, five species	96, 1, 1, 1, 1		

1. Define a community, and name the two things its structure is described in terms of.

2. Write Simpson's Diversity Index and define every symbol in it.

3. Both communities above contain exactly five species. Explain how they can have such different indices, and say what that tells you about counting species.

Part 2 · What the square is for

Take the dominated community — **96, 1, 1, 1, 1** — and fill in the table one species at a time. Then do the last column a second way, leaving the square off, and add that column up too.

Species	n	n/N	$(n/N)^2$	n/N without the square
Species A	96			
Species B	1			
Species C	1			
Species D	1			
Species E	1			

4. Add up your two right-hand columns. What is 1 minus each of those sums?

5. Explain what squaring each proportion does, and what the index would be for every community that has ever been measured if the square were left off.

6. A five-species community can never have an index above 0.8, and a ten-species community can never go above 0.9. Write the general rule for the highest index a community of S species can reach, and explain in one sentence why it has that form.

Part 3 · Every interaction is a pair of signs

For each interaction, mark what it does to each partner: + for benefit, – for harm, 0 for no effect. Then look down your last column and find the two rows you cannot tell apart.

Interaction	Effect on A	Effect on B	Signs	One example
Mutualism				
Commensalism				
Predation				
Parasitism				
Competition				
Amensalism				

7. Name the three symbioses and give the pair of effects for each.

8. Two of your rows have the same pair of signs. Name them, and give a difference between them that the signs cannot capture.

Part 4 · The chase, at two amplitudes

The tool runs the same predator-prey model twice, changing nothing but where the run starts. Record both. The predicted period is $2\pi/\sqrt{r \cdot m} = 16.22$, and the lag is usually quoted as a quarter of a cycle. Check both claims against both runs before you answer question 10.

Run	Measured period	Predicted period	Lag as a share of a cycle
Small oscillation		16.22	
Large oscillation		16.22	

9. Explain why predator and prey populations cycle rather than settling at fixed numbers.

10. The predator peak is often said to lag the prey peak by a quarter of a cycle. Using both of your rows, state the condition under which that is true and what happens to it when the condition fails.

11. The prey equilibrium here is 75 and the predator equilibrium is 25. One of these is made entirely of predator parameters and the other entirely of prey parameters. Work out which is which, and say what that means about whose number each one is.

Part 5 · Down the chain, twice

The tool removes the top predator from a four-level chain and from a three-level one, using **identical rules**. Record which way each level moves. Then look at the bottom row of each column and notice that they disagree.

Links below the removal	Four-level chain: level	Direction	Three-level chain: level	Direction
0 (removed)	Top predator	removed	Predator	removed
1	Mesopredator		Herbivore	
2	Herbivore		Plants	
3	Plants		—	—

12. Explain what a trophic cascade is, and why the directions alternate as you move down a chain.

13. Removing the top predator raises the plants in one of your chains and lowers them in the other, under exactly the same rules. Write the rule that predicts which happens, using nothing but the number of links.

Part 6 · Two advantages

Two species compete for one resource, which they use in **exactly the same way**. In the first run species A grows **2%** faster. In the second it tolerates **10%** more crowding. Predict each outcome before you run it, then record what actually happened.

Advantage held by A	Your prediction	Species A ends at	Species B ends at
Grows 2% faster			
Tolerates 10% more crowding			

14. State the competitive exclusion principle.

15. Only one of the two advantages above ended the competition. Say which, and explain why the other one — a real, permanent advantage — never excludes anybody.

Part 7 · Then separate the niches

The same pair, the same crowding advantage, run at four degrees of niche overlap. Overlap **1.0** means the two species are using the resource identically; **0.3** means they mostly are not competing at all. Fill in the last column by adding the two before it.

Niche overlap	Species A	Species B	Both persist?	A + B
1.0				
0.9				
0.6				
0.3				

16. Explain how niche partitioning permits two competitors to coexist.

17. Look at your last column. The partitioned communities support more individuals in total than the single winner does alone. Explain why.

18. A field ecologist watches two similar bird species share a woodland for thirty years and sees no sign that either is losing. Explain why this is not evidence against the competitive exclusion principle.

What the model simplifies

Simpson's Diversity Index is one of several diversity indices and it is the one the 2025 CED gives. It weights common species heavily and is comparatively insensitive to rare ones: a community's index barely moves when a species making up a thousandth of it disappears. Other indices weight rarity more.

All five communities contain exactly a hundred individuals, which makes the arithmetic legible and hides a real difficulty. In the field you do not know the true proportions — you have a sample, and rare species are systematically missed. The dominated community here would very likely be recorded as having one or two species rather than five.

The predator-prey model is the Lotka-Volterra pair integrated in small steps. It leaves out everything except birth, predation, conversion and death: no carrying capacity for the prey, no handling time for the predator, no other species, no environment. Its cycles are neutral, meaning the amplitude is fixed by where the run started and never grows or shrinks. Real cycles are damped or driven and do not behave that way.

The quarter-cycle lag is not a general result. Running the identical model near equilibrium and far from it gives lags of 24.3% and 14.5% of a cycle and periods of 16.23 and 18.02 against a predicted 16.22. The familiar figures are small-oscillation approximations, and this tool shows both runs rather than quietly showing the one that agrees with the textbook.

The trophic cascade model is a schematic in which each level is pushed toward an abundance set by its food supply and the pressure from above. It is not fitted to any real food web, and real food webs are webs rather than chains — most organisms eat at more than one level, which blurs the alternation. What is asserted is the structural claim, that the effects alternate, and its consequence, that the effect on the plants depends on the parity of the chain length.

The competition model is discrete Lotka-Volterra competition. The crowding advantage is given as a higher ceiling for species A, standing in for the real mechanism: being able to persist at a lower level of the remaining resource. The growth-rate advantage genuinely produces no exclusion in this model, which is a property of the model as much as of the world — but it is the right lesson, because the species that draws a resource down furthest is the one that wins, not the one that gets there first.

The 2025 CED's exclusion statements for this topic place the specific mechanisms of individual interactions beyond the scope of the exam. What is in scope is the classification by effect, the fact that interactions shape community structure, and the named examples: predator/prey, cooperation, trophic cascades, niche partitioning, competition, predation and the symbioses.