A. MESOCOSM

A self-sustaining ecosystem

Seal:

- Makes this a **closed** system
- **Prevents entry** and **exit** of chemical substances

Air contains:

- **O_2** for **respiration**
- **CO_2** for **photosynthesis**

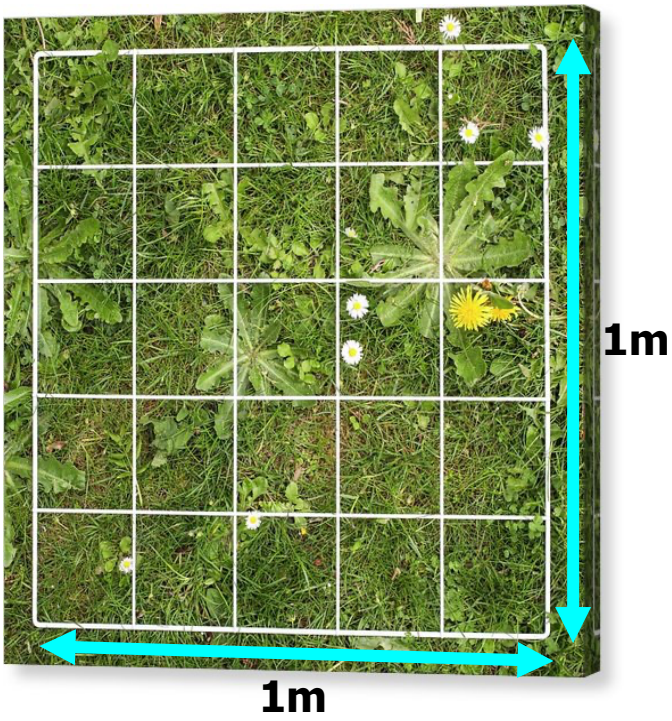
Pond water contains:

- **Autotrophs** to produce **glucose** and **oxygen** by **photosynthesis** that **themselves** and **other organisms** can use in **respiration**
- **Saprotrophs** to **decompose dead organic matter** and **recycle nutrients**
- **Consumers** and detritivores are **not essential** but are usually **included** as they are **part of normal ecosystems**

Advantages of using a mesocosm	Limitations of using a mesocosm
Can easily alter/control other variables	Difficult to mimic natural environmental conditions exactly
Closed system so no external processes affect the experiment	Natural environments change/are not static
Can carry out experiments with many samples/replicates	
Easy collection of continuous data	

B. QUADRATS

A square sampling area used in ecology



Random sampling:

- **Divide** a sample area up using **gridlines** and **coordinates**
- **Use a computer random number generator** to produce **random grid coordinates** e.g. A3, G10
- Place a **quadrat on the ground with its corner** at these coordinates
- **Count** the species of interest
- **Repeat** this with **many quadrats** so that data is **reliable**

Example calculation of how to estimate the total number of daisies in a field

- Imagine that you have calculated the **mean** number of daisies seen in fifty quadrats that were randomly placed in a field, as **22** daisies.

  22 daisies in **1 m^2** of the field

  The whole field measures **200 m^2**

  (So) estimated total number of daisies in the whole field is 22 x 200 = **4,400**

C. ASSOCIATION & THE CHI-SQUARED TEST

ASSOCIATION means that one species can interact with another species and influence where it is found

There are **two** possibilities here:

- If two species **are associated**, they interact but this can be positive or negative association.
  - **positively** associated means that they are **found** in the **same habitat**
  - **negatively** associated means that they are **not found** in the **same habitat**
- If two species show **no association**, they **do not interact** and their distribution is **random** and completely **independent** of one another

We are counting individuals here, not measuring, so the chi-squared test is used

Worked Example

The presence or absence of two species were recorded in fifty 1 m^2 quadrats on a rocky sea shore in the UK.

The results are shown in the table below.

Use the chi-squared test to determine if there is an association between these two species.

- The table must be set out **exactly** like this:
- The table shows the **presence** or **absence** of **each species** in **different quadrats**.

		Number of individuals of species **X**	
		Present	**Absent**
Number of individuals of species **Y**	**Present**	6	15
	Absent	20	9

- We first calculate the **expected numbers**, assuming **no association** between these two species

NULL HYPOTHESIS: There is no significant association between the two species (i.e. the location of species A has no effect on the location of species B)

- This is calculated by the equation:

  Expected number = $\frac{\text{row total x column total}}{\text{grand total of all numbers}}$

- This allows us to put the expected number, assuming **no association**, in **brackets**.

		Number of individuals of species **X**	
		Present	**Absent**
Number of individuals of species **Y**	**Present**	6 (10.9)	15 (10.1)
	Absent	20 (15.1)	9 (13.9)

- We now calculate the **chi-squared (χ2)** value using each of the four squares of the table:

Square	**Observed (O)**	**Expected (E)**	**(O - E)**	**$(O - E)^2$**	**$\frac{(O - E)^2}{E}$**
A	6	10.9	- 4.9	24.01	2.20
B	15	10.1	4.9	24.01	2.37
C	20	15.1	4.9	24.01	1.59
D	9	13.9	-4.9	24.01	1.72

- The **chi-squared (χ2)** is the **total** of the **last column** of this table, so **χ2 = 7.89**

- For this table, **degrees of freedom** =

  (m-1) x (n-1)

  where **m** = number of **rows** in results table;
  n = number of **columns** in results table.

  (So) **degrees of freedom** = (2-1) x (2-1) = **1** (it **always will be** for this grid!)

Degrees of freedom	Probability, p				
	0.2	0.1	**0.05**	0.02	0.01
1	1.64	2.71	**3.84**	5.41	6.64
2	3.22	4.61	5.99	7.82	9.21
3	4.64	6.25	7.82	9.84	11.35
4	5.99	7.78	9.49	11.67	13.28
5	7.29	9.24	11.07	13.39	15.09

The critical (book) value at 1 degree of freedom and a probability level of 0.05 is 3.84

- Our **χ2 value** of 7.89 is > than the **critical value** of 3.84
- (So) we **reject** the **null hypothesis**
- (So) there **is** a **significant association** between the two species
- There is a significant difference between observed and expected numbers at the **5% significance level**.
- Looking at the results table, they are **not usually found together** in the **same habitat**, so this is a **significant negative association**.
- The **probability** of these **two species not** being **negatively associated is <5%**
- The location of species **A does negatively affect/influence** the location of species **B**.