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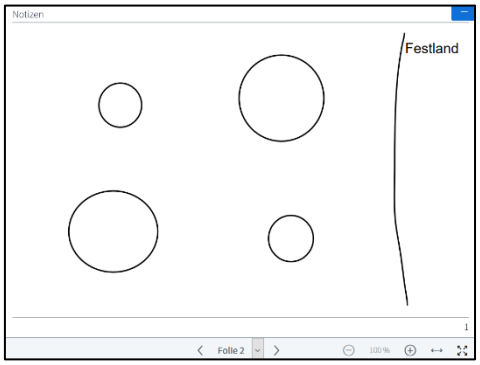
Simulation experiment island biogeography (online)

Aim: Simulate immigration from the mainland to an island and simulate extinction on the island to understand the dynamics and equilibrium of MacArthur & Wilson's island biogeography theory.

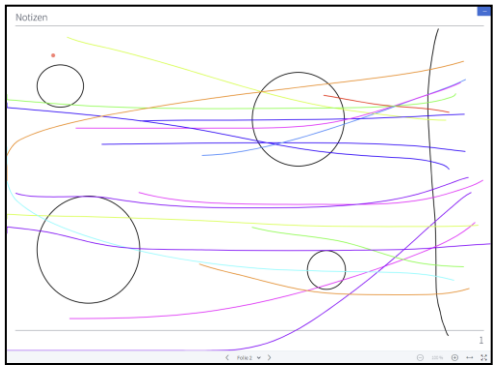
Material for each simulation experiment:
- whiteboard in multi-user mode with 10 colors (virtual, e.g. in BigBlueButton)
- timer or stop watch (cell phone)
- evaluation template (can be opened and edited in MS Excel)
- computer mouse (if available, not mandatory)

Preparation (before each time step):
Prepare whiteboard slide according to the sketch:
- indicate the border of the mainland with a black line
- draw two large islands (more or less circular, about the same size, one near, one far from the mainland)
- draw two small islands (more or less circular, about the same size, one near, one far from the mainland)
- for new time step prepare a new slide with approximately the same size and position of the islands



Phase 1: Immigration phase
Person A (with timer or stop watch) ...
- gives start and stop signal for each time step: one time step takes 1 minute

Person B (or more persons at the same time when using the multi-user mode of the whiteboard) ...
- selects freehand tool (to draw free lines, curves etc.)
- takes mouse in the left hand if right-handed, otherwise in the right hand (or puts the corresponding hand on the touchpad or similar)
- makes as many immigration attempts as possible between the start and stop signal, like this:
  1. randomly select a color at the whiteboard edge
     -> all 10 colors except black and white are possible
     -> the color corresponds to the species identity of the individual moving away from the mainland and attempting immigration
  2. draw a line from the mainland to the left
     -> start and end point are freely selectable, as long as they are respectively left or right of the mainland border
     -> the line corresponds to the path of immigration (e.g. of a plant seed that is blown away from the coast by the wind)
  3. repeat steps 1 and 2 as often as possible (lines may cross, same colors may and should be selected several times (as randomly as possible), do not aim at the islands on purpose)
- The result could look like the second sketch:



Phase 2: Documentation (after each time step = each immigration phase)

Aim: To evaluate the immigration and extinction for each island. The evaluation template contains separate tables for each island with one row for each time step. Individuals that live on the island are represented by x-symbols. If time is limited evaluate only one island for several time steps (instead of many islands for few time steps).

Person B ...
- ... announces the color of **each** line that intersects the selected island to person C
- (if time permits:) ... repeats this for the other three islands

Person C (with the evaluation template opened) ...
1. ... selects the table for the respective island in the evaluation template (e.g. large, far away for the bottom left island)
2. ... chooses a new row in the evaluation template and enters an "x"-symbol for each color announced by person B (also, e.g., three x-symbols in the 'red' column if three red lines cross the island)
3. ... compares the sum of the individuals *N* (number of x-symbols) with the capacity of the island N_{max} **in terms of individuals**: If there are too many individuals on the island, extinctions happen (see next step). Small islands have a capacity of 4 individuals, large islands have a capacity of 8 individuals.
4. ... deletes the *i*-th x-symbol in the row if the capacity of the island is exceeded. *i* is a random number between 1 and *N* (drawn automatically in the column '*Random number for extinction'*). By deleting something, a new random number *i* is drawn automatically. If the capacity is still exceeded, then again delete the *i*th x-symbol and so on until the capacity is no longer exceeded. For example, if *i* = 5, then the fifth x from the left in the row should be deleted (no matter if it is alone or with other x-symbols in a cell).
5. ... counts the number of the new resident species (R) and enters the value into the respective column of the **current** time step (e.g. cell M13 of the template). **Attention!: Species** are to be counted here, which are the **colors with at least one x-symbol**, but not the number of x-symbols in total (that would be the number of individuals).
6. ... counts the newly immigrated **species** (I) and the extinct species (E) and enters the corresponding numbers in the "I" and "E" columns of the table of the **previous** time step (e.g. cell N12 and O12).
7. ... checks if everything is entered correctly: Rt+1 = Rt + It – Et should be true.
8. ... transfers the remaining x-symbols into the **next row** (as the individuals remain on the islands until the next time step).

If time permits: ... repeats this for the three other islands

Phase 3: Evaluation (after 10 to 15 time steps)

- The following steps are performed automatically by the template:
  1. plot immigration (I) and extinction (E) against the number of resident species
  2. draw trend lines in the plot

- Compare the curves with the expected curves from island biogeography theory