A chance to work with Dr. Gilg’s data

(Connect to Figure 1)

In figure A below, the functional response of the long-tailed skua was drawn based on both empirical data and modelisation. Students can use the raw data provided by Dr. Gilg and the differential equations to recreate the figure.

The functional response of the long-tailed skua is expressed as the Daily Consumption Rate (DCR) of lemmings by skuas (y-axis) according to the lemming density (x-axis). The function is a sigmoid function, which equation is:

\[
y(\text{DCR}) = \frac{wN}{(D + N)^{\frac{e}{2}}}
\]

where :

- \(N\): Current lemming density, meaning lemmings per ha.
- \(w\): Maximum predation rate for the skua, meaning maximum number of lemmings eaten per day by the skua.
- \(D\): Lemming density at which the slopes of the curves inflect.
- \(e\): Steepness of the function (typically 2 for a type III functional response and 1 for a type II)
Questions for the students

1. Change the values of each of the three parameters highlighted in yellow on the Excel file. How does the plotted functional response changes in function of the variations of each of the parameters values? (red curve, Figure A)

![Figure A](image)

2. Try to find the set of parameter values that best fit the empirical data (black curve, Figure A).

3. Why do we need to use a log scale to display the x-axis on Figure A? You can change for a standard scale by double clicking on the x-axis, and opening a setup panel.

4. What was changed on the figure below (Figure B) to display the predation pressure imposed by skuas on lemmings? The figure is based the same empirical data and parameters as used above.
5. What can you infer from the maximum value reached on the y-axis (1,16)?

6. What characterizes the functional response of skua compared to arctic fox and snowy owl? See Figure 1 of the research paper, upper panel.

**Answers**

1. When w increases, y values increase for large x values. When D increases, y values decrease for small x values. When e increases, the slope of the curve increases.

2. The exact values used to produce the published response can be found in Table S1 (online material):
   - w=4.4
   - D=2.2
   - e=4

3. We need a log scale because the skua, like most other lemming predators, is adjusting its lemming diet at very low lemming density. Thus, using a standard scale would give the wrong impression that data can fit a type II functional response. For example, if D, the lemming density at which the slopes of the curves inflect, was equal to 20, we would not have to use a log scale.
4. The y-axis (DCR/N) displays the daily consumption rate of lemmings by skuas divided by the lemming density, meaning the percentage of the lemming population eaten by skuas per day.

5. In order to interpret Figure B, we first need to change the values of w, D and e on the Excel file, as found in question 2. Thus, the red curve fits the black points. The maximum 1,16 is the maximum predation pressure imposed by skuas on lemmings: skuas eat 1,16% of the lemming population at the maximum per day. It cannot last for long, and this is reflected by the sharp slopes of this function, because lemming don’t reproduce enough to compensate.

6. The 3 predators eat about the same number of lemmings per day at maximum lemming densities. The arctic fox and the snowy owl shift to a diet dominated by lemmings at lower lemming density than the skua does. The slope of the snowy owl response is not so steep compared to the slope of the arctic fox and the skua.