Temperature and day length affecting growth rate in herring (Clupea herengus)

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Background

- Atlantic herring are divided into separated populations due to a reproductive barrier based on which time of the year they spawn.
- The survival of herring offspring will depend on vital factors such as the access to nutrition, which varies significantly with the different light regimes.
- At our latitudes, the seasonal variation of daylength suggests that different herring populations dispose of different genetic arrangement to be ideally adapted to seasonal variations.
- One can assume that these genetic variations altered by the seasonal fluctuations affect essential metabolic relationships, which is reflected by measurements such as growth-rate and relative condition.
- To minimize the influence of poorly controllable factors, the design of the project focuses on two major environmental factors affecting growth measures; light and temperature.
- Q: **How do temperature and light records affect relative condition and growth-rates among the different herring-populations?**

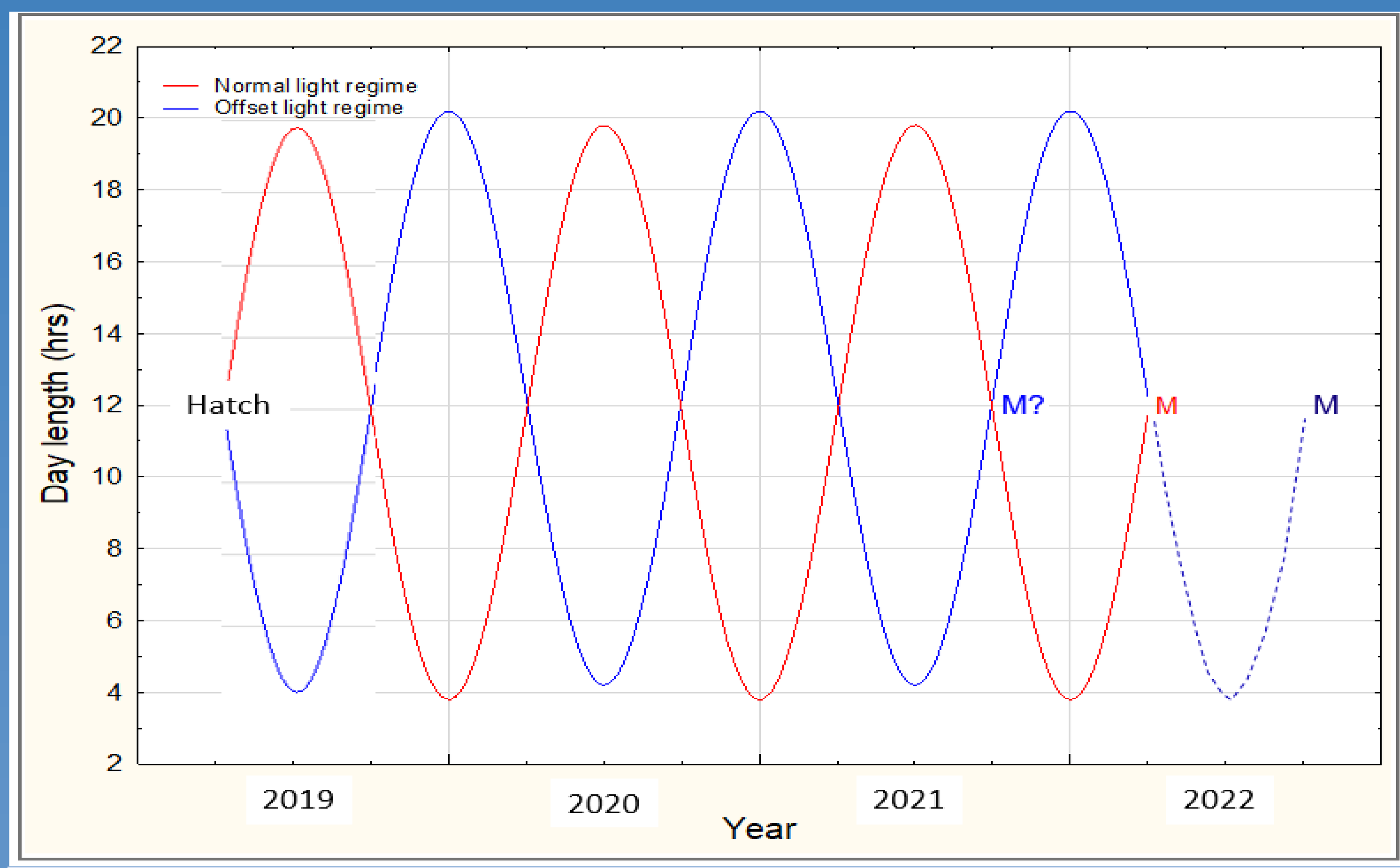

Figure 1: The figure illustrates the cycles of day length for the two light regimes, from the start of the project till it's estimated endex. Ref: Arild Folkvord.

Material and Methods

- The experiment started with one batch of artificially fertilized herring eggs from common parents. The juveniles were separated into different tanks by temperature (7°C and 10°C), and different rooms by light regime (Figure 1).
- Autumn spawning herring is simulated by an offset group, and spring-spawning herring is simulated by the normal group, each population living under different light regimes.
- To minimize the aspects of factors difficult to control, the different tanks are maintained with constant temperature and free access to food.
- To track growth patterns and relative condition, systematic samplings at the lab is done where the fish was killed, weighed and photographed.
- A computer program is used to find the precise length and height of the fishes (Figure 2).
- For this part of the study only data from the last two samplings are included; from 17.08.2019 and 02.09.2019.
- Formula 1: $\boldsymbol{K = \frac{Weight(g)}{\left[\frac{Length(mm)}{10}\right]^{3,395}} * 100}$

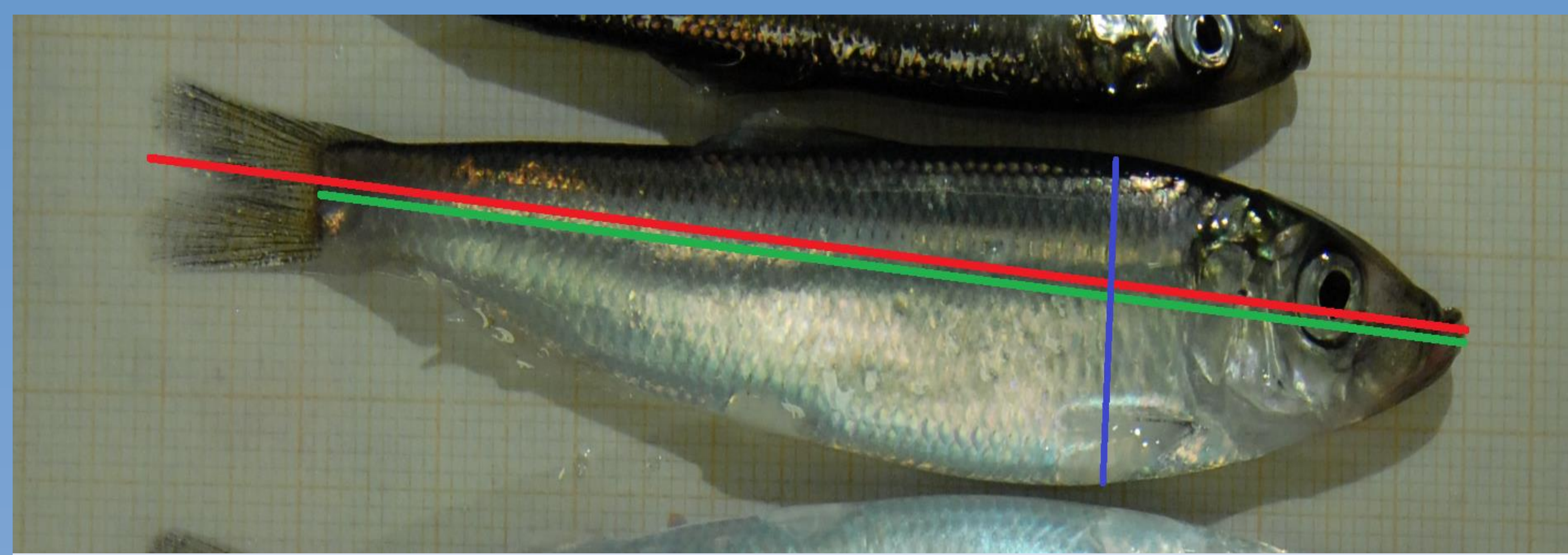

Figure 2: Illustration of how the lengths and hight of the herring were measures. The red line is the total length, the green line is the standard length and the blue line is height. The scale in the background is in centimeters.

Results

- The two graphs in the first figure in the results (Figure 3) combined illustrate a fairly strong linear relationship. Herring from the 2nd of September sample shows a stronger relationship between length and weight than the 17th of July sample.
- For the smaller values, the spread is bigger and diverges away from the regression line. This divergence from the values of (x,y) is bigger than (-1,3.8) shows a stronger relationship between the variables.
- Figure 4 shows a slightly higher mean condition factor in fish living in 10°C in water temperature, than those at 7°C.
- In both temperature groups, the herring with normal light regime has significantly better conditions than those from the offset tanks.
- The variation within the Offset/7 °C group is much higher than in the other groups.

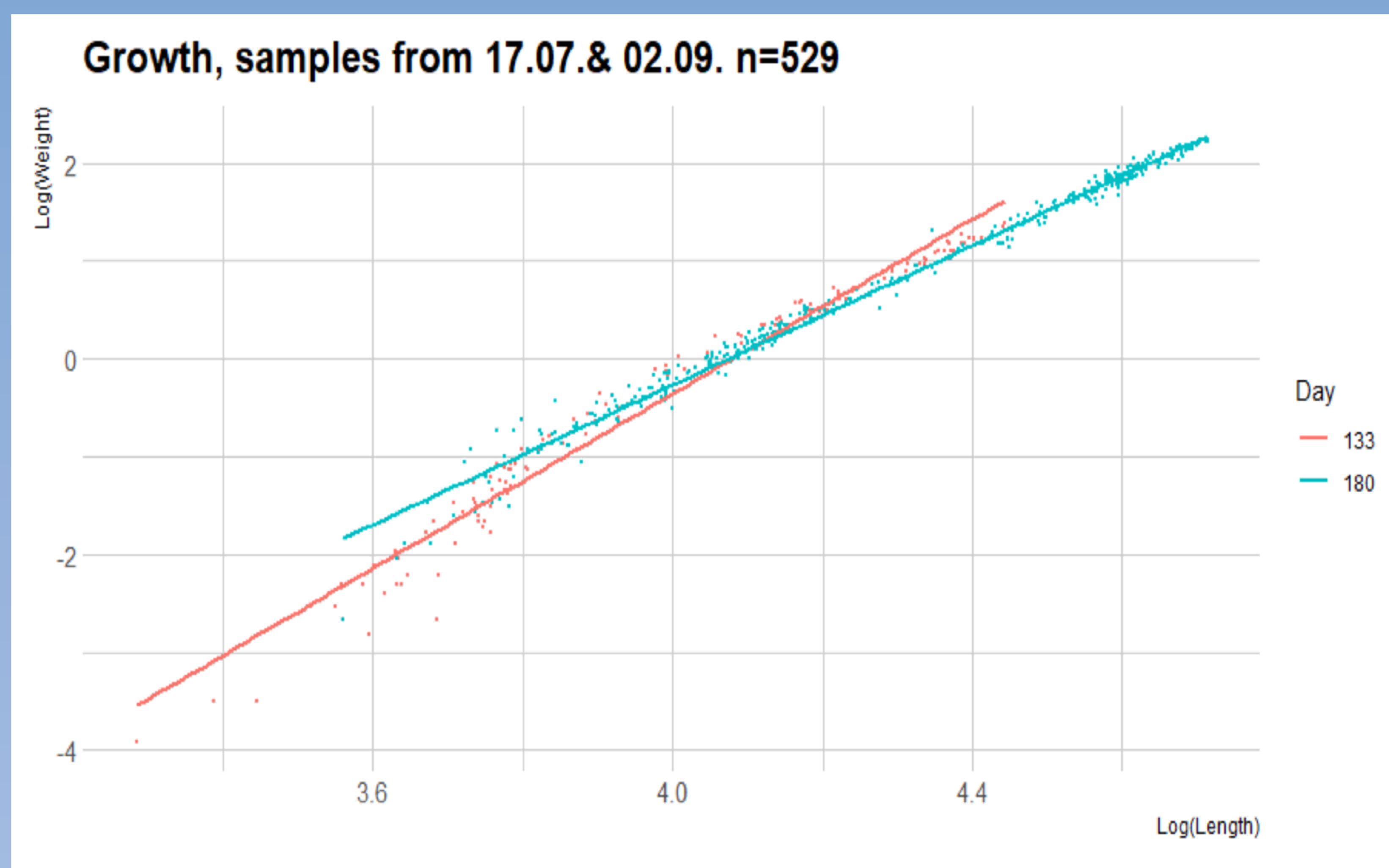

Figure 3: Illustration of the correlation between weight and length of the two samples. Logarithms of weight (y-axis) and length (x-axis) is used. Lengths in millimeters and weights in grams. The plot fits well to the regression line, except values of x smaller than 3.8.

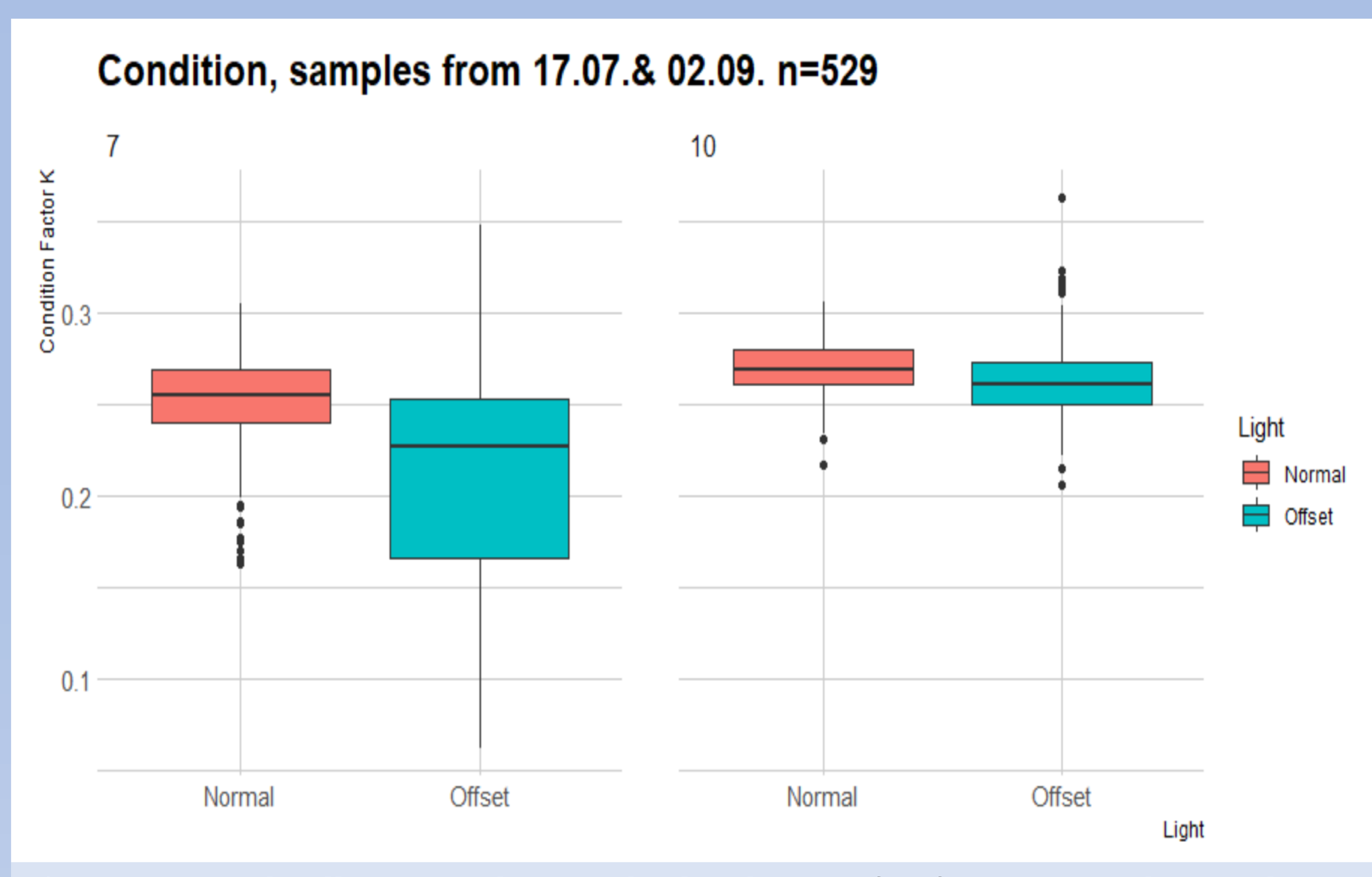

Figure 4: Box-plot illustration showing the distribution of K-factor among the sample, with groups of Normal/Offset and 7°C /10°C. The figure shows that both 10°C-groups have a mean K-factor higher than the corresponding 7°C-groups. The mean K-factor is higher in tanks of 10°C than at 7°C. The plot illustrates some weaknesses in case of greater spread within the Offset/ 7°C –group. Condition Factor K is calculated with formula 1.

Discussion and Conclusions

- Probably due to the smaller fishes in the sample, the regression model is not ideal for the whole analysis. Wider spread and divergence compared to the regression line, is mostly represented by the 17th/July sampling, and correspond with the variation observed in the Offset/7 °C groups.
- Smaller fish in the sample have a wider spread in the plot, indicating that these individuals most likely haven't completed the metamorphosis yet. By that fact, those herrings has significantly less K-factor and don't share the same growth pattern as the rest of the sample.

CONCLUSION:

- The study shows that temperature is the major environmental factor affecting the growth-rates of herring, but also day length plays a significant role.
- Individuals who have not gone through a complete metamorphosis will not share the same pattern of growth as those who have. Such data will affect the strength and fit of statistic analyses.