***Supporting Information Appendix***

**Larger but younger fish when growth compensates for higher mortality in heated ecosystem**

Max Lindmarka,b,1, Malin  Karlssona, Anna Gårdmarkc

a Swedish University of Agricultural Sciences, Department of Aquatic Resources, Institute of Coastal Research, Skolgatan 6, 742 42 Öregrund, Sweden

b Swedish University of Agricultural Sciences, Department of Aquatic Resources, Institute of Marine Research, Turistgatan 5, 453 30 Lysekil , Sweden

c Swedish University of Agricultural Sciences, Department of Aquatic Resources, Skolgatan 6, SE-742 42 Öregrund, Sweden

1 Author to whom correspondence should be addressed. Current address:

Max Lindmark, Swedish University of Agricultural Sciences, Department of Aquatic Resources, Institute of Marine Research, Turistgatan 5, 453 30 Lysekil , Sweden, Tel.: +46(0)104784137, email: max.lindmark@slu.se

Chart

Description automatically generated

Fig. S1. Prior predictive distribution for the von Bertalanffy growth equation (posterior draws from the prior only, ignoring the likelihood). The solid line is the median and the shaded area is the 95% credible intervals.

Table S1 Comparison of allometric growth model with different combinations of shared and area-specific parameters (ordered by difference in expected log pointwise density (elpd) from the best model) (note that in all models, and vary among cohorts).

|  |  |  |
| --- | --- | --- |
| Model Name | Model structure | elpd\_diff |
| M1 | Area-specific , and | 0 |
| M4 | Area-specific and , common | -9 |
| M2 | Area-specific , common and | -111 |
| M3 | Area-specific and , common | -150.5 |
| M7 | Area-specific , common and | -157.7 |
| M6 | Area-specific , common and | -173.9 |
| M5 | Area-specific , common and | -1337.5 |
| M8 | Common , and | -2153.8 |

Diagram

Description automatically generated

Fig. S2. von Bertalanffy growth equation: (A) traceplot to illustrate chain convergence for key (population-level) parameters, (B) residuals, (C) QQ-plot and (D) posterior predictive check (D).

A picture containing chart

Description automatically generated

Fig. S3. Cohort-specific predictions (i.e., with cohort-varying and ). Points correspond to data, solid lines correspond to the median of the posterior prediction from the model and the shaded area corresponds to the 95% credible interval.

Chart, scatter chart

Description automatically generated

Fig. S4. Posterior distributions of the cohort-varying parameter in the VBGE. Points correspond to the median and the horizontal lines correspond to the 95% credible interval. Note that the distributions of in the warm areas extend beyond the x-axis for cohorts 1995:1997 (also evident in Fig. S3). The range of the x-axis was set to be wide enough to include the posterior medians of the larger estimates but narrow enough to allow for comparison between the other cohorts and areas.

Chart

Description automatically generated

Fig. S5. Posterior distributions of the cohort-varying parameter in the VBGE. Points correspond to the median and the horizontal lines correspond to the 95% credible interval.

Diagram, schematic

Description automatically generated

Fig. S6. Prior vs posterior distributions for parameters (A), (B) and (C) in the von Bertalanffy growth equation.

Chart, histogram

Description automatically generated

Fig. S7. Prior predictive distribution for the allometric growth model (posterior draws from the prior only, ignoring the likelihood). The solid line is the median and the shaded area is the 95% credible intervals.

Table S2. Comparison of allometric growth models with common or unique -parameter (exponent in the allometric growth model) (ordered by difference in expected log pointwise density (elpd) from the best model).

|  |  |  |
| --- | --- | --- |
| Model Name | Model structure | elpd\_diff |
| M1 | Intercept () varying across individuals within cohorts, fixed, area-specific slope ( | 0 |
| M2 | Intercept () varying across individuals within cohorts, “fixed” common slope ( | -2.7 |

Chart

Description automatically generated

Fig. S8. Allometric growth model: (A) traceplot to illustrate chain convergence for key (population-level) parameters, (B) residuals, (C) QQ-plot and (D) posterior predictive check (D).

Chart, diagram

Description automatically generated

Fig. S9. Prior vs posterior distributions for parameters (A) and (B) in the allometric growth model (inset in panel (B) is a zoomed-in version to better visualize the priors in the range of the posteriors).

Table S3 Comparison of catch-curves models with “fixed” or random (i.e., varying by cohort) slopes (ordered by difference in expected log pointwise density (elpd) from the best model).

|  |  |  |
| --- | --- | --- |
| Model Name | Model structure | elpd\_diff |
| M1 | Area-specific and cohort varying , area-specific | 0 |
| M2 | Area-specific and cohort varying and | -1.2 |

Diagram

Description automatically generated with medium confidence

Fig. S10. Catch curve model: (A) traceplot to illustrate chain convergence for key (population-level) parameters, (B) residuals, (C) QQ-plot and (D) posterior predictive check (D).

Chart

Description automatically generated

Fig. S11. Posterior distributions of the cohort-varying slopes, where , the mortality rate, is the negative of the slope of natural log of catch per unit effort (CPUE) as a function of age). Points correspond to the median and the vertical lines correspond to the 95% credible interval.