|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Variables** | **Relationship** | **Estimate** | **Estimate SE** | **Z statistic** | **p-value** |
| Ice-on date |  |  |  |  |  |
| Fall mixed period (d) | Covariance | 0.84 | 0.26 | 3.16 | *0.002* |
| Under ice shallow (°C) |  |  |  |  |  |
| Ice-on date | Regression | -0.23 | 0.19 | -1.20 | 0.229 |
| Intercept | Regression | 0.09 | 0.19 | 0.47 | 0.637 |
| Under ice deep (°C) |  |  |  |  |  |
| Ice-on date | Regression | -0.43 | 0.17 | -2.52 | *0.012* |
| Intercept | Regression | 0.10 | 0.17 | 0.60 | 0.549 |
| Under ice deep (°C) |  |  |  |  |  |
| Under ice shallow (°C) | Covariance | 0.70 | 0.22 | 3.26 | *0.001* |
| Density Δ (kg m-3) |  |  |  |  |  |
| Under ice deep (°C) | Regression | -0.87 | 0.36 | -2.42 | *0.016* |
| Under ice shallow (°C) | Regression | 1.27 | 0.35 | 3.58 | *<0.001* |
| Intercept | Regression | 0.01 | 0.16 | 0.03 | 0.974 |
| Heat content (MJ) |  |  |  |  |  |
| Under ice deep (°C) | Regression | 0.43 | 0.03 | 14.52 | *<0.001* |
| Under ice shallow (°C) | Regression | 0.61 | 0.03 | 19.13 | *<0.001* |
| Density Δ (kg m-3) | Regression | -0.05 | 0.01 | -3.09 | *0.002* |
| Intercept | Regression | 0.01 | 0.01 | 0.59 | 0.557 |
| Ice-off date |  |  |  |  |  |
| Density Δ (kg m-3) | Regression | -0.12 | 0.23 | -0.50 | 0.614 |
| Under ice shallow (°C) | Regression | 0.00 | 1.68 | 0.00 | 0.999 |
| Under ice deep (°C) | Regression | 0.87 | 1.20 | 0.73 | 0.466 |
| Heat content (MJ) | Regression | -0.81 | 2.67 | -0.30 | 0.762 |
| Intercept | Regression | 0.01 | 0.19 | 0.06 | 0.955 |
| Ice-off date |  |  |  |  |  |
| Spring mixed period (d) | Covariance | -0.49 | 0.20 | -2.43 | *0.015* |

**Table S4**. Structural equation model fits. Relationship indicates the type of relationship (covariance or regression) for each variable with the variable (indented) below. For regression, variables indicate response variable (non-indented) and predictor variable or intercept (indented). For each relationship, an estimate of fit (Estimate), standard error of the estimate (Estimate SE), test-statistic (Z statistic) and p-value are included.