# Seasonal changes in biodiversity of native and non-native amphipod taxa under diverse environmental contexts

## - Supplementary Material -

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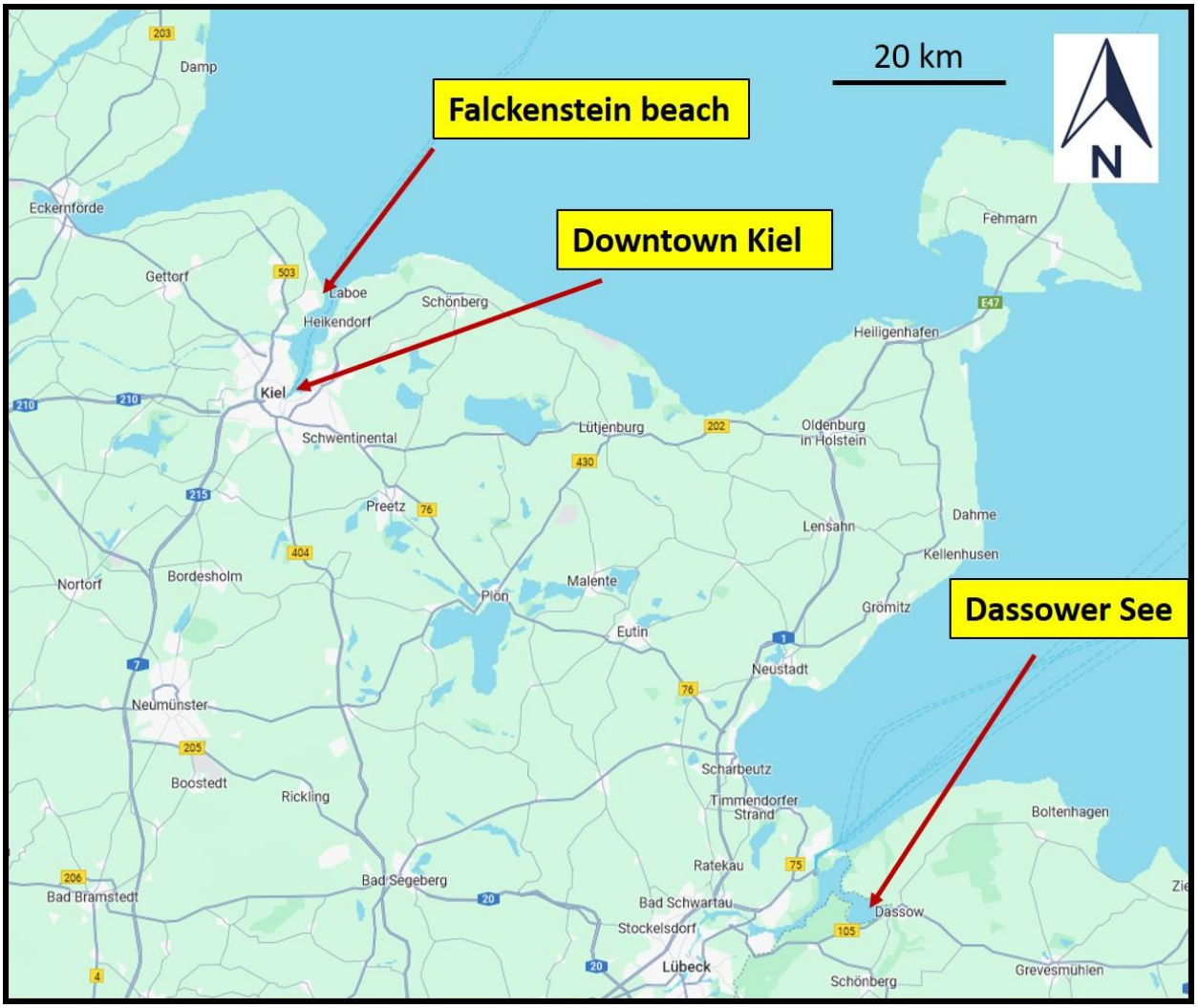


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26 **Supplementary Figure S1:** Sampling locations in Schleswig Holstein, Germany.

27 **Supplementary Table S1:** Raw data providing location and time of sampling, environmental parameters at sampling location on
28 particular sampling date, and number of species collected.

| Sampling location | Sampling month | Environmental parameters | | | | Species | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | pH | Salinity (ppt) | Temperature (°C) | Dissolved oxygen (%) | *Gammarus salinus* | *Gammarus locusta* | *Gammarus oceanicus* | *Gammarus zaddachi* | *Monocorophium insidiosum* | *Calliopius laeviusculus* | *Microdeutopus* cf. *gryllotalpa* | *Grandidierella japonica* | *Gammarus tigrinus* | Unidentified |
| Falckenstein beach | April | 8.206 | 11.3 | 6.7 | 104.3 | 265 | 49 | 23 | | 6 | 2 | 3 | 2 | | 1 |
| | May | 8.101 | 11.1 | 12.3 | 108.2 | 251 | 1 | 13 | 2 | | 17 | 1 | | | |
| | June | 8.263 | 14.9 | 14.4 | 112.6 | 92 | 4 | 10 | 6 | | 2 | 1 | | | |
| | July | 8.755 | 14.4 | 20.6 | 167.3 | 46 | 169 | 2 | | 1 | | 25 | 1 | | 4 |
| | August | 8.842 | 14.7 | 29.6 | 103.4 | 7 | 138 | 10 | | | | 20 | 3 | | 2 |
| | September | 8.501 | 14.5 | 19.9 | 123.9 | 35 | 123 | 1 | | | | 16 | 1 | | |
| | October | 8.931 | 14.6 | 16 | 136.8 | | 37 | 2 | | 1 | | 3 | | | 2 |
| | November | 8.488 | 20.8 | 12.5 | 119.8 | | 63 | 17 | | | 1 | 16 | | | 3 |
| | December | 8.068 | 20.9 | 6.1 | | | 71 | | | | | 1 | 2 | | |
| | January | 8.093 | 19.2 | 7.1 | 102.7 | 2 | 14 | | | | 5 | | | | |
| | February | 8.079 | 20.4 | 5.5 | 98.4 | | | | | | | | | | |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | March | 8.379 | 19.7 | 5.8 | 109.1 | 29 | 26 | | | | 35 | 4 | | | |
| Downtown Kiel | April | 8.227 | 12.1 | 6 | 102.9 | | | 1 | | | | | | | |
| | May | 7.999 | 12.1 | 11.9 | 107.2 | 11 | | 38 | | 1 | 2 | 13 | | | |
| | June | 7.835 | 15 | 12.4 | 84 | 4 | | 8 | | | | 13 | | | |
| | July | 8.051 | 14.2 | 17.6 | 93.3 | 7 | | 16 | | | 1 | 20 | | | |
| | August | 7.894 | 16.4 | 20.9 | 85.6 | 27 | | 80 | | | | 60 | | | |
| | September | 8.098 | 14.4 | 18.6 | 95.4 | 85 | | 31 | | | | 59 | | | 1 |
| | October | 7.803 | 15.6 | 15.5 | 83.8 | 4 | | 12 | | | | 19 | 1 | | 1 |
| | November | 7.662 | 21.7 | 13.5 | 91.6 | | | | | | | 21 | | | |
| | December | 7.91 | 20 | 8.3 | | 12 | | 7 | | | | 33 | | | 1 |
| | January | 7.87 | 19.2 | 7.3 | 88.3 | 1 | | 9 | | | | 22 | | | 3 |
| | February | 7.919 | 15.7 | 5 | 93.3 | 67 | | 6 | | | 1 | 1 | | | 2 |
| | March | 8.088 | 15.9 | 4.6 | 101.2 | 54 | | 83 | | | | | | | 6 |
| Dassower See | April | 8.488 | 6.2 | 5.5 | 109.9 | | | | | | | | | 22 | |
| | May | 9.138 | 7.8 | 18.9 | 155.8 | | | | | | | | | 32 | |
| | June | 8.051 | 7.3 | 16.4 | 108.8 | | 1 | | | | | | | 126 | 1 |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | July | 8.156 | 9.9 | 20.8 | 122.4 | | 1 | | | | | | | 241 | |
| | August | 8.251 | 10.2 | 22.7 | 113.9 | | 9 | | | | | | | 19 | |
| | September | 8.158 | 10.3 | 18.1 | 101.6 | | 1 | | | | | 21 | | 33 | |
| | October | 7.867 | 9.4 | 14.5 | 92.9 | | | | | | | | | 1 | |
| | November | 8.106 | 13.9 | 11.4 | 101.3 | | | | | | | 43 | | 4 | |
| | December | 7.928 | 15.1 | 4.2 | | | | | | | | 22 | | 4 | |
| | January | 7.985 | 13.8 | 6.9 | 93.1 | | 1 | | | | | 3 | | 39 | |
| | February | 8.165 | 10.7 | 4.2 | 97.8 | | | | | | | | | | |
| | March | 8.054 | 9.4 | 5.3 | 101.1 | | | | | | | | | 27 | |

30 **Supplementary Table S3**. Results of the Generalized Additive Models (GAMs) for the response of the abundance of amphipods to
31 the exposure of environmental predictors at each location.

| Salinity | | | |
|---|---|---|---|
| **Falckenstein beach** | | | |
| | Estimate | Standard Error | P value |
| Intercept | 7.60 | 1.30 | 0.001 |
| Salinity | -0.17 | 0.07 | 0.02 |
| **Downtown Kiel** | | | |
| | Estimate | Standard Error | P value |
| Intercept | 5.16 | 1.62 | 0.001 |
| Salinity | -0.05 | 0.10 | 0.55 |
| **Dassower See** | | | |
| | Estimate | Standard Error | P value |
| Intercept | 4.70 | 1.53 | <0.01 |

| | | | |
|---|---|---|---|
| Salinity | -0.07 | 0.14 | 0.62 |
| Oxygen | | | |

| **Falckenstein beach** | | | |
|---|---|---|---|
| | Estimate | Standard Error | P value |
| Intercept | 4.34 | 2.21 | 0.05 |
| Oxygen | 0.005 | 0.01 | 0.77 |

| **Downtown Kiel** | | | |
|---|---|---|---|
| | Estimate | Standard Error | P value |
| Intercept | 3.55 | 3.90 | 0.36 |
| Oxygen | 0.07 | 0.04 | 0.85 |

| **Dassower See** | | | |
|---|---|---|---|
| | Estimate | Standard Error | P value |
| Intercept | 0.25 | 2.55 | 0.92 |
| Oxygen | 0.03 | 0.02 | 0.14 |

| Temperature | | | |
|---|---|---|---|
| **Falckenstein beach** | | | |
| | Estimate | Standard Error | P value |
| Intercept | 4.53 | 0.67 | <0.01 |
| Oxygen | 0.02 | 0.04 | 0.51 |
| **Downtown Kiel** | | | |
| | Estimate | Standard Error | P value |
| Intercept | 3.74 | 0.66 | <0.01 |
| Oxygen | 0.03 | 0.05 | 0.45 |
| **Dassower See** | | | |
| | Estimate | Standard Error | P value |
| Intercept | 2.57 | 0.70 | <0.01 |
| Oxygen | 0.09 | 0.04 | 0.04 |
| pH | | | |

| **Falckenstein beach** | | | |
|---|---|---|---|
| | Estimate | Standard Error | P value |
| Intercept | 3.27 | 9.25 | 0.72 |
| Oxygen | 0.19 | 1.10 | 0.85 |
| **Downtown Kiel** | | | |
| | Estimate | Standard Error | P value |
| Intercept | -14.10 | 14.88 | 0.34 |
| Oxygen | 2.30 | 1.87 | 0.22 |
| **Dassower See** | | | |
| | Estimate | Standard Error | P value |
| Intercept | 7.01 | 9.64 | 0.46 |
| Oxygen | -0.36 | 1.17 | 0.75 |

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**Supplementary Table S4.** Summary of Redundancy Analysis (RDA) results and permutation tests (n= 999) for environmental variables influencing species composition across all sites (i.e. Falckenstein beach, Downtown Kiel, and Dassower See).

| | Inertia | Proportion | Rank |
|---|---|---|---|
| Total | 8188.12 | | |
| Constrained | 973.48 | | 1 |
| Unconstrained | 7214.64 | | 1 |
| Eigenvalues for constrained axes: RDA1: 973.5 | | | |
| Eigenvalues for unconstrained axes: PC1: 7215 | | | |

Number of permutations: 999

| | | Variance | F | P value |
|---|---|---|---|---|
| Salinity | 1 | 0.4 | 0.001 | 0.97 |
| Oxygen | 1 | 358.3 | 1.29 | 0.23 |
| Temperature | 1 | 328.7 | 1.18 | 0.29 |
| pH | 1 | 105.3 | 0.37 | 0.54 |
| Residual | 26 | 7214.6 | | |