|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Lake** | | | |
| **Predictor variables vs. parasite Ne:** | **Pearson's r** | **t** | **df** | **p value** |
| host length vs. parasite Ne | 0.233 | 0.634 | 7 | 0.546 |
| sum parasites across hosts vs. parasite Ne | 0.739 | 2.88 | 7 | 0.024 |
| lake surface area vs. parasite Ne | -0.328 | -0.919 | 7 | 0.389 |
| Host heterozygosity vs. parasite Ne | 0.325 | 0.842 | 6 | 0.432 |
|  |  |  |  |  |
| **Predictor variables vs. host Ne:** |  |  |  |  |
| host length vs. host Ne | -0.019 | -0.0374 | 4 | 0.972 |
| sum parasites across hosts vs. host Ne | -0.095 | -0.191 | 4 | 0.858 |
| lake surface area vs. host Ne | 0.529 | 1.25 | 4 | 0.280 |
| Host heterozygosity vs. host Ne | 0.194 | 0.396 | 4 | 0.712 |
|  |  |  |  |  |
| host Ne vs parasite Ne | 0.225 | 0.463 | 4 | 0.668 |
|  |  |  |  |  |
| **Among predictor variables:** |  |  |  |  |
| host length vs. sum parasites across hosts | 0.109 | 0.291 | 7 | 0.772 |
| lake surface area vs. sum parasites across hosts | -0.391 | -1.125 | 7 | 0.298 |
| lake surface area vs. host length | -0.285 | -0.786 | 7 | 0.457 |
| lake surface area vs. host heterozygosity | -0.098 | -0.242 | 6 | 0.817 |
| host length vs. host heterozygosity | 0.051 | 0.124 | 6 | 0.905 |
| sum parasites across hosts vs. host heterozygosity | 0.793 | 3.194 | 6 | 0.019 |
|  |  |  |  |  |
| **Among collinear predictor variables:** |  |  |  |  |
| average parasites per host vs. sum parasites per host | 0.837 | 4.05 | 7 | 0.005 |
| host allelic richness vs. host heterozygosity | 0.517 | 1.48 | 6 | 0.189 |
| host heterozygosity vs. host Shannon index | 0.942 | 6.90 | 6 | 0.005 |
| host allelic richness vs. host Shannon index | 0.628 | 1.98 | 6 | 0.095 |
| lake volume vs. lake surface area | 0.653 | 2.11 | 6 | 0.079 |
|  | **Lake-year** | | | |
| **Predictor variables vs. parasite Ne:** | **Pearson's r** | **t** | **df** | **p value** |
| host length vs. parasite Ne | 0.241 | 1.29 | 27 | 0.208 |
| sum parasites across hosts vs. parasite Ne | 0.363 | 2.10 | 29 | 0.045 |
| host heterozygosity vs. parasite Ne | 0.283 | 1.10 | 14 | 0.289 |
|  |  |  |  |  |
| **Predictor variables vs. host Ne:** |  |  |  |  |
| host length vs. host Ne | 0.785 | 1.79 | 2 | 0.215 |
| sum parasites across hosts vs. host Ne | -0.514 | -0.848 | 2 | 0.486 |
| lake surface area vs. host Ne | 0.993 | 12.1 | 2 | 0.006 |
| Host heterozygosity vs. host Ne | -0.856 | -2.34 | 2 | 0.144 |
|  |  |  |  |  |
| host Ne vs parasite Ne | -0.296 | -0.439 | 2 | 0.704 |
|  |  |  |  |  |
| **Among predictor variables:** |  |  |  |  |
| host length vs. sum parasites across hosts | -0.137 | -0.721 | 27 | 0.477 |
| host length vs. host heterozygosity | -0.428 | -1.77 | 14 | 0.098 |
| sum parasites across hosts vs. host heterozygosity | 0.176 | 0.668 | 14 | 0.515 |
|  |  |  |  |  |
| **Among collinear predictor variables:** |  |  |  |  |
| average parasites per host vs. sum parasites per host | 0.755 | 6.21 | 29 | <0.0001 |
| host allelic richness vs. host heterozygosity | 0.882 | 7.02 | 14 | <0.0001 |
| host heterozygosity vs. host Shannon index | 0.347 | 1.39 | 14 | 0.187 |
| host allelic richness vs. host Shannon index | 0.495 | 2.13 | 14 | 0.051 |

**Supplemental Table 1.** Univariate relationships among predictor variables and parasite Ne andPearson’s correlations among predictor variables used in RDA analyses.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **a)** |  |  |  |  |  |
| **Lake** | **# hosts** | **var/mean** | **residuals** | **% hosts crowded** | **% hosts highly crowded** |
| Aleknagik | 18 | 0.303 | -0.323 | 0 | 0 |
| Beaver | 22 | 2.520 | -0.013 | 0 | 0 |
| Cheney | 29 | 16.638 | 0.467 | 34.483 | 24.138 |
| Cornelius | 56 | 1.440 | 0.307 | 0 | 0 |
| Engineer | 10 | 4.325 | 0.008 | 20 | 10 |
| Falk | 10 | 2.808 | -0.610 | 90 | 70 |
| Iliamna | 11 | 0.950 | -0.089 | 0 | 0 |
| Loberg | 54 | 5.036 | 0.263 | 14.815 | 3.704 |
| Ohmer | 21 | 0.397 | 0.051 | 0 | 0 |
| Rocky | 10 | 0.311 | -0.683 | 0 | 0 |
| Scout | 46 | 0.153 | -0.274 | 0 | 0 |
| Seymour | 10 | 2.827 | -0.078 | 10 | 0 |
| Walby | 55 | 10.034 | 0.335 | 32.727 | 12.727 |
| Willow | 26 | 3.228 | 0.098 | 3.846 | 3.846 |
| Wolf | 25 | 2.665 | 0.540 | 0 | 0 |
|  |  |  |  |  |  |
|  |  |  |  |  |  |
| **b)** |  |  |  |  |  |
| **Lake-year** | **# hosts** | **var/mean** | **residuals** | **% hosts crowded** | **% hosts highly crowded** |
| Aleknagik\_2012 | 18 | 0.303 | -0.061 | 0 | 0 |
| Beaver\_2011 | 5 | 0.500 | -0.311 | 0 | 0 |
| Beaver\_2012 | 5 | 0.154 | -0.873 | 0 | 0 |
| Beaver\_2013 | 6 | 0.446 | 0.130 | 0 | 0 |
| Beaver\_2014 | 1 | NA | NA | 0 | 0 |
| Beaver\_2015 | 5 | 0.155 | -0.739 | 0 | 0 |
| Cheney\_2008 | 9 | 0.520 | -0.005 | 0 | 0 |
| Cheney\_2010 | 9 | 6.817 | 0.776 | 44.444 | 11.111 |
| Cheney\_2012 | 6 | 6.552 | 0.406 | 83.333 | 83.333 |
| Cheney\_2015 | 5 | 4.714 | 0.591 | 20 | 20 |
| Cornelius\_2009 | 29 | 0.900 | 0.522 | 0 | 0 |
| Cornelius\_2012 | 7 | 0.795 | 0.427 | 0 | 0 |
| Cornelius\_2013 | 10 | 0.289 | -0.102 | 0 | 0 |
| Cornelius\_2014 | 5 | 0.250 | -0.429 | 0 | 0 |
| Cornelius\_2015 | 5 | 0.034 | -1.279 | 0 | 0 |
| Engineer\_2012 | 10 | 4.325 | 0.585 | 20 | 10 |
| Falk\_2010 | 10 | 2.808 | 0.132 | 90 | 70 |
| Iliamna\_2012 | 11 | 0.950 | 0.273 | 0 | 0 |
| Loberg\_2009 | 29 | 2.735 | 0.682 | 3.448 | 0 |
| Loberg\_2012 | 10 | 1.914 | 0.114 | 60 | 20 |
| Loberg\_2013 | 5 | 1.246 | 0.064 | 20 | 0 |
| Loberg\_2014 | 5 | 0.544 | -0.129 | 0 | 0 |
| Loberg\_2015 | 5 | 0.620 | -0.164 | 0 | 0 |
| Ohmer\_2012 | 21 | 0.397 | 0.215 | 0 | 0 |
| Rocky\_2011 | 5 | 0.426 | -0.166 | 0 | 0 |
| Rocky\_2012 | 5 | 0.174 | -0.506 | 0 | 0 |
| Scout\_2009 | 30 | 0.206 | -0.036 | 0 | 0 |
| Scout\_2006 | 16 | 0 | NA | 0 | 0 |
| Seymour\_2011 | 10 | 2.827 | 0.461 | 10 | 0 |
| Walby\_2009 | 30 | 13.770 | 1.212 | 13.333 | 10 |
| Walby\_2011 | 5 | 0.306 | -0.673 | 80 | 0 |
| Walby\_2012 | 5 | 2.720 | 0.141 | 100 | 60 |
| Walby\_2013 | 5 | 0.198 | -0.729 | 0 | 0 |
| Walby\_2014 | 5 | 0.964 | -0.098 | 20 | 0 |
| Walby\_2015 | 5 | 5.482 | 0.447 | 80 | 20 |
| Willow\_2011 | 5 | 0.097 | -0.894 | 0 | 0 |
| Willow\_2012 | 5 | 8.377 | 0.882 | 20 | 20 |
| Willow\_2013 | 5 | 0.056 | -1.050 | 0 | 0 |
| Willow\_2014 | 6 | 2.545 | 0.518 | 0 | 0 |
| Willow\_2015 | 5 | 0.512 | -0.219 | 0 | 0 |
| Wolf\_2010 | 3 | 1.500 | 0.681 | 0 | 0 |
| Wolf\_2011 | 7 | 0.118 | -0.795 | 0 | 0 |
| Wolf\_2006 | 15 | 0 | NA | 0 | 0 |

**Supplementary Table 2.** Aggregation and crowding indices for a) lakes and b) lake-years. Var/mean: ratio of variance intensity to mean intensity. Residuals: residuals of the regression of log transformed variance against log mean intensity. Crowded = average infection intensity greater than one standard deviation above the mean; highly crowded = average infection intensity greater than two standard deviations above the mean.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Response Variable | R2adj | | F | Model parameter | | | Coefficient | | | Variance partitioned (%) | | | | | | |
| lake-year parasite Ne | 0.15 | | 1.88 | | | host length | | 0.55 | | | 20.52\* | | | |
| (df=3,12) |  | |  | | | host heterozygosity | | 0.50 | | | 22.23\* | | | |
|  |  | |  | | | average number of parasites per host | | -0.16 | | | 1.03 | | | |
|  |  | |  | | |  | |  | | |  | | | |
|  |  | |  | | |  | |  | | |  | | | |
|  |  | |  | | |  | |  | | |  | | | |
| lake parasite Ne | -0.17 | | 0.66 | | | host length | | 0.57 | | | 21.40 | | |
| (df=3,4) |  | |  | | | host heterozygosity | | 0.59 | | | 11.92 | | |
|  |  | |  | | | average number of parasites per host | | 0.35 | | | 19.06 | | |
|  |  | |  | | |  | |  | | |  | | | |
|  |  | |  | | |  | |  | | |  | | | |
|  |  | |  | | |  | |  | | |  | | | |
| lake parasite Ne | -0.44 | | 0.27 | | | lake surface area | | -0.69 | | | 6.02 | |
| (df=3,4) |  | |  | | | host heterozygosity | | 0.77 | | | 0.38 | |
|  |  | |  | | | average number of parasites per host | | 0.81 | | | 0.42 | |
|  |  | |  | | |  | |  | | |  | | | |
|  |  | |  | | |  | |  | | |  | | | |
|  |  | |  | | |  | |  | | |  | | | |
| lake parasite Ne | -0.06 | | 0.86 | | | surface area | | -0.56 | | | 1.76 | | | |
| (df=3,5) | |  | |  | host length | | | | 0.40 | | | 6.99 | | | |
|  | |  | |  | average number of parasites per host | | | | 0.79 | | | 21.17 | | | |

**Supplementary Table 3.** Redundancy analysis (RDA) models with average number of parasites per host substituted for the sum of parasites across hosts for lake-year and lake estimates of Ne. \**P* < 0.01, \*\**P* < 0.05

**Supplementary Figure 1** Map of study sites in Alaska.