Supplementary Figures: Eco-evolutionary dynamics and collective migration: implications for salmon metapopulation robustness

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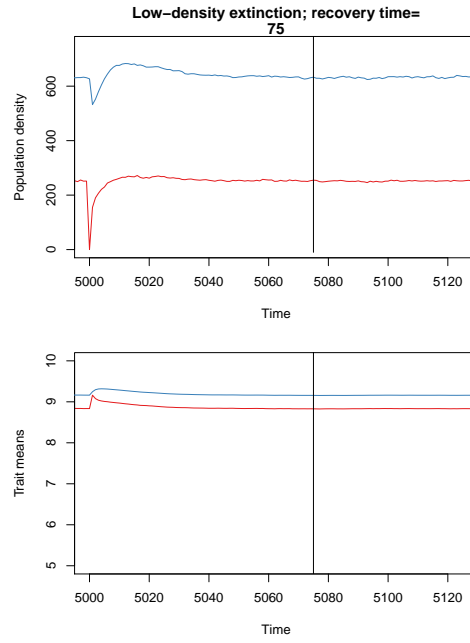[*]To whom correspondence should be addressed: jdyeakel@gmail.com

Figure S1: Extinction of low-density population with a high constant straying rate $m = 0.4$ and low trait heritability $h^2 = 0.2$ (see figure 4a). Black line marks the calculated point of recovery post-perturbation. Trait optima are $\theta_1 = 10$ (blue population trajectory) and $\theta_2 = 5$ (red population).
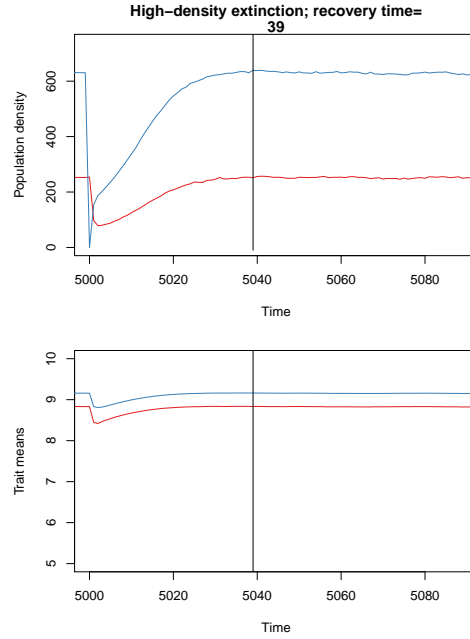

Figure S2: Extinction of high-density population with a high straying rate $m = 0.4$ and low trait heritability $h^2 = 0.2$ (see figure 4a). Black line marks the calculated point of recovery post-perturbation. Trait optima are $\theta_1 = 10$ (blue population trajectory) and $\theta_2 = 5$ (red population).
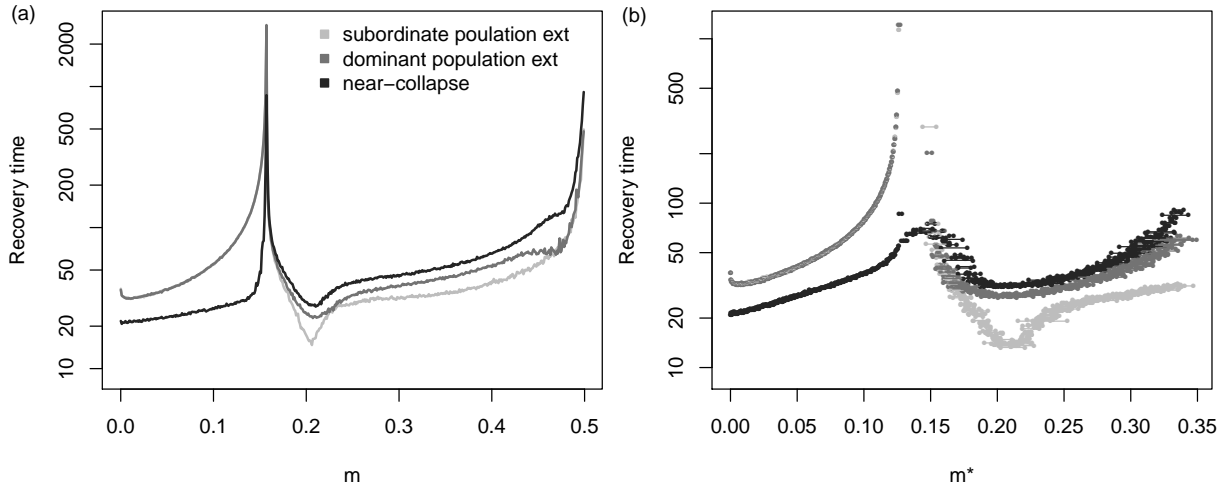
Figure S3: Recovery time of N_T following the extinction of either the low-density (light gray) or high-density (gray) population, or the near-collapse of both (dark gray) assuming (a) constant straying rates m and (b) density-dependent straying rates (evaluated at the steady state m^*) with trait heritability $h^2 = 0.8$. If m is density-dependent, in the alternative stable state regime there are two straying rates observed: one each for the low- and high-density populations, respectively, which are linked by a horizontal line.
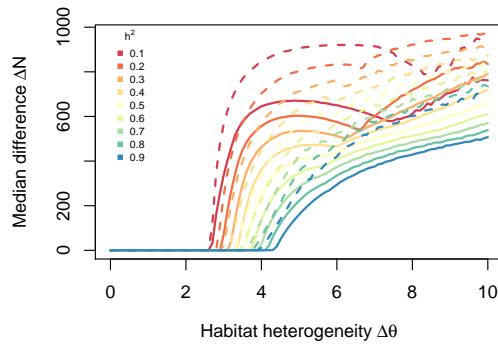

Figure S4: Median difference in population densities taken over the straying rate as a function of habitat heterogeneity $\Delta\theta$. Solid lines are for constant m; dashed lines are for density-dependent m
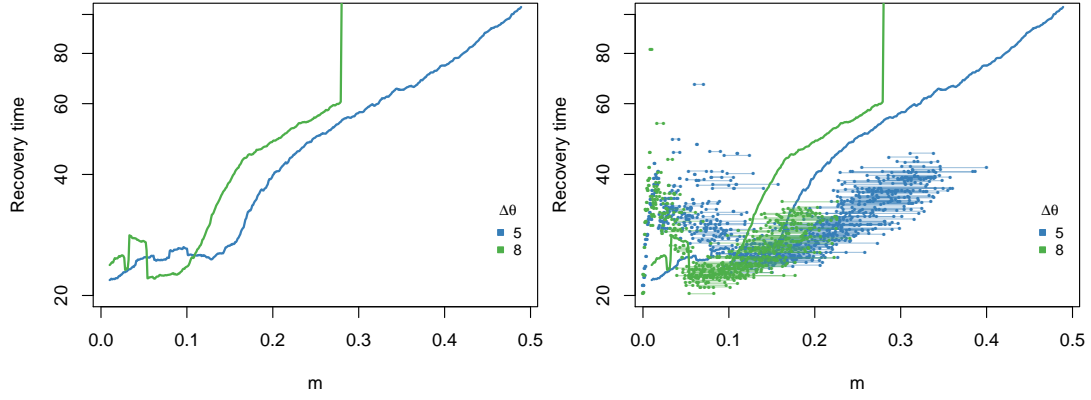
Figure S5: (a) Recovery time after near collapse of both populations as a function of straying rate m and habitat heterogeneity $\Delta\theta$. (b) The same as (a) but including recovery times when straying is density-dependent, shown by linked pairs of points. Recovery times for systems with density-dependent straying are longer at low straying rates and shorter at higher straying rates, mirroring the change in portfolio effects shown in figure 3.
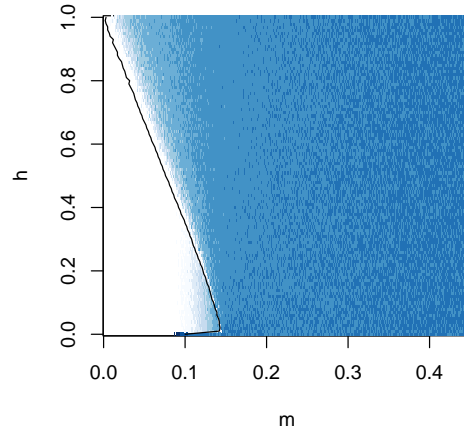

Figure S6: Distance dependent portfolio effects as a function of straying rate m and trait heritability h^2. When straying is distance dependent, m increases as $\Delta\theta$ decreases.
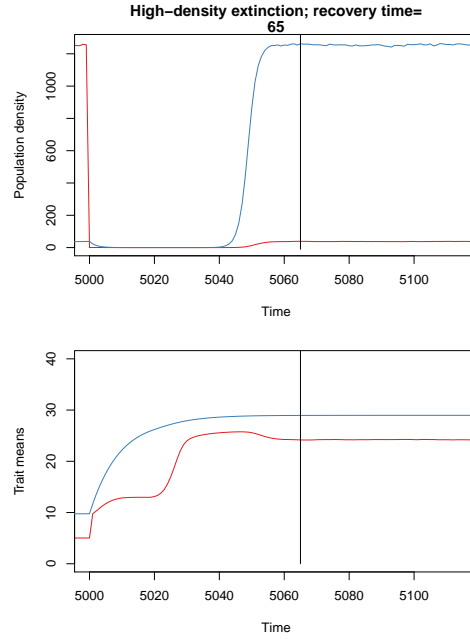
High–density extinction; recovery time= 65

Figure S7: Distance dependent straying, where increased differences in trait optima between sites $\Delta\theta$ corresponds to lower rates of straying m. At low rates of straying $m = 0.02$ ($\Delta\theta = 24$), extinction of the dominant population leads to slower-than-expected recovery times because the subordinate population is isolated enough to evolve towards its own trait optimum. In this case, m is less than $m = 0.034$ (denoted by the asterisk in figure 6), such that isolation allows the subdominant population to 'run away' from the influence of the dominant population, leading to a switch in states. If m is low but greater than 0.034, isolation permits the subdominant population to 'run away' from the influence of the dominant population, until it is overwhelmed by the recovering dominant population, and reverts back to its previous trait mean prior to the disturbance.
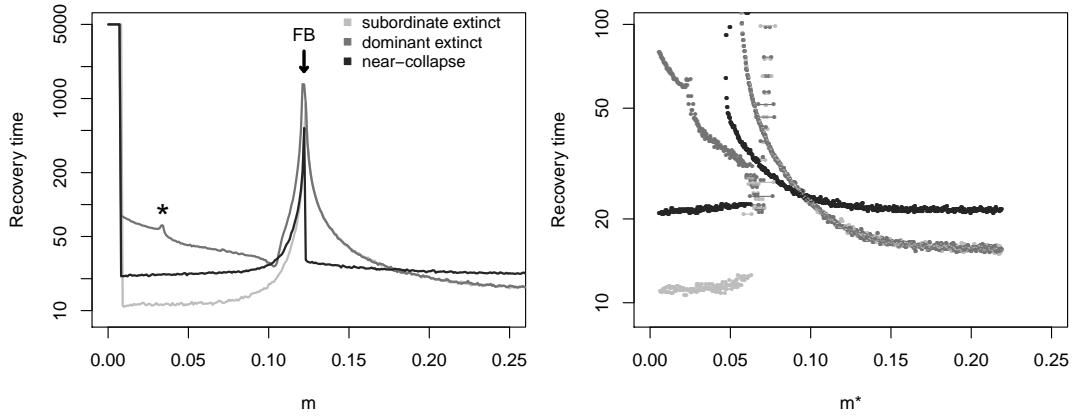
Figure S8: Distance dependent recovery times for three disturbance types. When straying is distance dependent, m increases as $\Delta\theta$ decreases for constant (a) and density-dependent (b) staying rates. The fold bifurcation is not as clear in (b) because $\Delta\theta$ is a function of the individual straying rate m_0, whereas the x-axis in (b) is the straying rate at the steady state m^*. Despite this difference, the general trends shown in (a) are also present in (b).
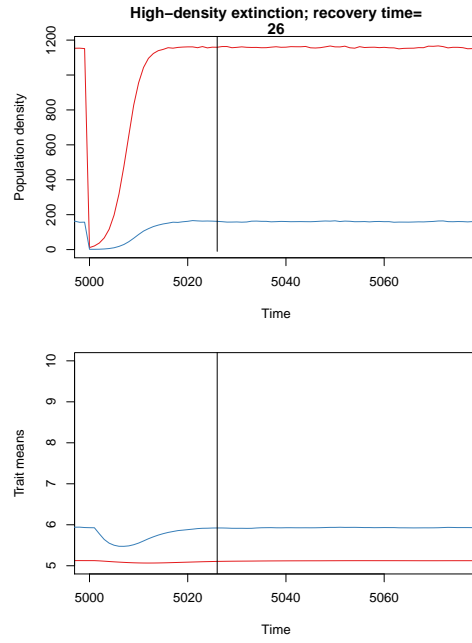
Figure S9: Near collapse of both populations with a low straying rate $m = 0.1$ and low trait heritability $h^2 = 0.2$ (see figure 4a). Black line marks the calculated point of recovery post-perturbation. Trait optima are $\theta_1 = 10$ (blue population trajectory) and $\theta_2 = 5$ (red population).