Appendix 1. Equilibria for the two-patch resource-consumer-predator model when the consumer disperses between patches

In the presence of consumer dispersal ($\beta_C > 0$), it is not possible to obtain analytical solutions for the equilibria for the tri-trophic interaction (Eq. 1). I therefore numerically calculated equilibria for the three relevant cases: 1) predator is absent from both patches, 2) predator can colonize one patch, and 3) predator can colonize both patches. Figure 1 depicts these equilibria as a function of the consumer’s dispersal rate. The key point to note is that when the predator can colonize both patches, equilibrium abundances of resource, consumer and predator are all independent of the magnitude of the consumer’s dispersal rate. This is because when the predator is present, the consumer’s equilibrium abundance is independent of resource productivity and hence there is no spatial variation in consumer fitness despite spatial variation in resource productivity across patches. Note also that the resource population in the less productive patch is viable over a wider range of consumer dispersal rates when the predator is present in both patches.

Appendix 2. Effects of dispersal costs on dispersal evolution

Figure A2.1 and A2.2 depict, respectively, the pairwise invisibility plots under different levels of dispersal mortality when the predator can invade both patches vs. when it can invade only one patch. Figure A2.3 depicts the evolutionary dynamics for the latter case. As can be seen, dispersal costs reduce the magnitude of the evolutionarily stable dispersal rate when the predator can invade both patches and the evolutionary outcome is a dispersal monomorphism. When the predator can invade both patches, interaction types 3 and 4 exhibit a dispersal polymorphism in the absence of dispersal mortality. Dispersal mortality has the effect of reducing the magnitude of the dispersal rate of the mobile phenotype. This
effect is stronger for interaction type 4, where increasing dispersal mortality reduces the
dispersal rate of the mobile phenotype to the extent that eventually it converges on the
lowest possible dispersal rate, effectively reducing the polymorphism to a monomorphism
involving the sedentary phenotype.

Figure captions

**Figure 1.1.** Equilibria for the two-patch model of resource-consumer-predator interaction as
a function of the consumer’s dispersal rate ($\beta_C$). The top row depicts equilibria when the
predator is absent from both patches ($r_1 = 0.01, r_2 = 0.2$), the middle row, when the predator
can colonize one patch ($r_1 = 0.1, r_2 = 0.2$), and the bottom row, when the predator can colonize
both patches ($r_1 = 0.1, r_2 = 0.2$). Parameter values used are: $K = 1, a_C = 2, a_P = 4, e_C = e_P =
1, d_C = d_P = 0.1$ and $r_1 = 0.01$.

**Figure A2.1.** Pairwise invasibility plots for the four types of tri-trophic interactions when the
predator can colonize both patches and dispersing individuals experience mortality in
transit ($m$ is the fraction of dispersers surviving dispersal mortality). Parameter values are
as in Fig. 2.

**Figure A2.2.** Pairwise invasibility plots for the four types of tri-trophic interactions when the
predator can colonize only one patch and dispersing individuals experience mortality in
transit ($m$ is the fraction of dispersers surviving dispersal mortality). Parameter values are
as in Fig. 2.

**Figure A2.3.** Evolutionary trajectories for the four types of tri-trophic interactions when the
predator can colonize only one patch and dispersing individuals experience mortality in
transit ($m$ is the fraction of dispersers surviving dispersal mortality). Parameter values are
as in Fig. 2.
Consumer's dispersal rate ($\beta_C$)

Equilibrium abundance

(a) (b)

(c) (d)

(e) (f)

Patch 1

Patch 2

Predator absent from both patches

Predator present in one patch

Predator present in both patches

Resource

Predator

Consumer

Consumer's dispersal rate ($\beta_C$)
Resident dispersal phenotype
Mutant dispersal phenotype
Type 1 Type 2 Type 3 Type 4
m=1.0
m=0.98
m=0.95
m=0.93
m=0.90

Resident dispersal phenotype
<table>
<thead>
<tr>
<th>Type 1</th>
<th>Type 2</th>
<th>Type 3</th>
<th>Type 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>m=1.0</td>
<td>m=0.98</td>
<td>m=0.95</td>
<td>m=0.93</td>
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<tr>
<td>m=0.90</td>
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</tbody>
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Dispersal rate vs Time for different types and dispersal rates.