Electronic Appendix A. Details of demographic models used in simulations. Solid boxes are shaded to indicate life history stages on the two hosts: white for the native host, *Astragalus canadensis* (*Ac*), and gray for the novel host, *Medicago sativa* (*Ms*). Between life history stages are calculations associated with each transition. Boxes surrounded by broken lines describe calculations associated with the distribution of eggs at the start of each generation and the fecundity of adults at the end of each generation.

Italicized words are either defined here or in Table 1. Note that *AF* and *MF* correspond to the fraction of native and novel hosts (respectively) flowering in each generation (these parameters are not described directly in Table 1; rather, Table 1 presents *AF*min and *MF*min, which are the lower bounds for the distributions from which *AF* and *MF* are drawn; maximum values were always set at 1 for these distributions).

Some parameters involve a range of values (e.g. *ELSurvival*). For these parameters, a specific value is drawn from a beta distribution (α = 2, β = 3) for each generation. These are unimodal, right-skewed distributions that we use as biologically relevant for life history parameters as extreme values are less commonly sampled.

The initial pool of eggs is given by *StartPropK* *EggK* (i.e., the starting proportion of eggs relative to carrying capacity multiplied by the egg carrying capacity); the pool of eggs in subsequent generations is determined by summing all eggs laid (see bottom of the flow chart).

The distribution of eggs across host-plants is given by *PropMedicago* (the proportion of eggs laid on *Ms*) and 1 - *PropMedicago* (the proportion on *Ac*). *PropMed* is calculated as *FreqMedicago* *PrefMedicago*.

*FreqMedicago* is constant across generations, while *PrefMedicago* (the preference for *Ms*) varies as a function of *AF*: *PrefMedicago* = B1 * AF + B0, where B1 and B0 are the slope and intercept from the following regression model:

\[ y \left( \frac{1}{AstragalusFlowerFactor}, 1 \right) = B1 \times x \left( 0, 1 \right) + B0, \]

y is a vector with two values (1/AstragalusFlowerFactor, 1) and x is a vector with two values (0,1).

Thus we estimate a slope and intercept as we go from x = 0 and y = 1/AstragalusFlowerFactor (i.e., no *As* flowering and *PrefMedicago* = B0 = 1/AstragalusFlowerFactor = 1/3) to x=0 and y=1 (i.e., all astragalus flowering and *PrefMedicago* = B0 + B1). B0 and B1 can then be used to estimate *PrefMedicago* for any value of *AF*. 
The fecundity of adults that developed on *A.c.* is related to the number of adult pairs that survived on *A.c.*:

\[
\text{Eggs from } A_c = A_{Ac} \times \frac{1}{2} \times \text{beta}(\alpha = 2, \beta = 3, \text{EggsAdult min.}, \text{EggsAdult max.})
\]

The fecundity of adults developing on *Ms* is calculated separately for the proportion that develop on flowering *Ms* and non-flowering *Ms*. For those developing on flowering, the total number of eggs is given by:

\[
\text{eggs from } M_s \text{ with flower} = A_{Ms} \times MF \times \frac{1}{2} \times \text{beta}(\alpha = 2, \beta = 3, \text{EggsAdult min.}, \text{EggsAdult max.} \times \text{MedicagoFecFactorWF})
\]

Without flowers, the number of eggs is given as:

\[
\text{eggs from } M_s \text{ without flowers} = A_{Ms} \times MF \times \frac{1}{2} \times \text{beta}(\alpha = 2, \beta = 3, \text{EggsAdult min.}, \text{EggsAdult max.} \times \text{MedicagoFecFactorNF})
\]
Electronic Appendix B. Details on parameterization of demographic models. Parameter values used in simulations are shown in table 1, and discussed in detail below.

Values for parameters 1 – 4 were taken from studies of the closely related Karner blue butterfly, *L. m. samuelis* (Lane & Andow 2003; Pickens & Root 2008; Nice *et al.* 2009). For the probability of surviving from egg to larva (parameter 1, *ELSurvival*), we used values associated with the second generation of *L. m. samuelis* (our focal population has three and possibly four generations per year, *L. m. samuelis* has two). Estimates of the number of eggs laid per individual for *L. m. samuelis* range from 0 to 180 (Nice *et al.* 2009). The maximum value accords well with our own observations of eggs laid by wild-caught *L. melissa* females from Beckwourth Pass (M.L.F unpubl. data). We have increased the minimum value to 10 for our simulations (parameter 4, table 1); this increased the stability of our baseline condition, which was useful for our comparative purposes. The use of parameter values derived from *L. m. samuelis* is discussed further in the main text. In particular, we note that the specific values used for these parameters are not as important as the fact that they create stable, baseline populations on our native host. Our primary interest is in asking how stable populations on the native host are affected by variation in other parameters (such as the presence of ants and the presence of the novel host).

Values for parameters 5 – 10 were derived from our own data on the performance of *L. melissa* caterpillars and the behavior of adults. Of these, parameters 5 – 8 were taken directly from Forister *et al.* (2009). For example, *AstragalusFlowerFactor*, the ratio of the number of eggs laid on *A. canadensis* without flowers to the number laid on *A. canadensis* with flowers, was calculated as: 32.06 / 16.44 = 1.95 (Forister *et al.* 2009). These values are based on no-choice experiments, in which it was found that *L. melissa* females confined to *A. canadensis* plants with and without flowers laid fewer eggs in the cages with flowers, possibly because of a lack of oviposition cues in flower tissues (Forister *et al.* 2009).

Parameter 9 (*MedicagoQualFactor*), the multiplier for survival on *M. sativa* in the absence of flowers and ants (relative to base larval survival on the native host, *LPSurvival*) was derived from a combination of experimental results, in the lab and the field, as follows. We start with the effect (from a lab experiment) of *M. sativa* consumption on survival, relative to survival on *A. canadensis*. From Forister *et al.* (2009), average survival on *A. canadensis* (with or without flowers) is 0.52; average survival on *M. sativa* without flowers is 0.073; thus the relative
reduction in survival for larvae consuming \textit{M. sativa} without flowers is expressed as the fraction $0.073 / 0.52 = 0.14$. Second, we account for the effect of predation in the field by calculating a reduction in survival on \textit{M. sativa} without ants relative to survival on \textit{A. canadensis}. The latter value, survival on \textit{A. canadensis}, is based on average survival (0.74) across both \textit{A. canadensis} treatments, as shown in figure 1. For the effect of ant presence on the survival of larvae consuming \textit{M. sativa}, we draw then from figure 2 as our best estimate of that effect: 0.28 is the average survival across replicates without ants in figure 2. Thus the reduction in survival in the field in the absence of ants is $0.28 / 0.74 = 0.38$. These two proportional reductions are combined to give a multiplier for survival on \textit{M. sativa} in the absence of flowers and ants, relative to \textit{A. canadensis}: $0.14 \times 0.38 = 0.053$.

For simplicity in the calculation of \textit{MedicagoQualFactor}, we have used one value for survival on \textit{A. canadensis} with or without ants (0.74), from figure 1. This simplification stems from our specific interest in the effect of the mutualistic ant interaction on \textit{M. sativa}. Further experimentation with ants and caterpillars on the native host could lead to a better estimate of the effect of ants on that host. However, this information would be unlikely to change our primary conclusions, as the range of survival values with and without ants on \textit{A. canadensis} is similar, which is not true of the survival with and without ants on \textit{M. sativa} (figure 1).

Parameters 11 – 14, are our focal parameters of interest, for which simulations were used to explore population persistence under different ecological scenarios involving ant presence, amount of \textit{M. sativa}, and different levels of flowering for both hosts. The final parameters, 15 and 16, set carrying capacity and the fraction of carrying capacity at which simulations were started. We empirically settled on a carrying capacity that tended to result in population sizes that generally agreed with our observations of our focal population (hundreds to thousands of adults per generation).
Electronic Appendix C. Results of sensitivity analyses exploring a range of values for three parameters associated with juvenile survival. The parameters investigated here are those for which the values we used in our primary analyses (see table 1 and figure 3) were taken from the literature associated with the Karner blue butterfly, *Lycaeides melissa samuelis*. As in Fig. 3, results are shown here from demographic simulations under different combinations of ant presence and the minimum fraction of available hosts that are the novel host, *M. sativa*. Differing from Fig. 3, these simulations were done using the following minimum and maximum values for juvenile survival: (a) larva to pupa survival (*LPSurvival*): 0.1 and 0.7; (b) larva to pupa survival: 0.1 and 0.9; (c) egg to larva survival (*ELSurvival*): 0.15 and 0.9; (d) pupa to adult survival (*PASurvival*): 0.35 and 0.9.