

Non-native host plant availability and habitat preference promote butterfly expansion across urbanized environments

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Fig. S1 Female of *P. mannii* ovipositing on *I. sempervirens*. The blue dot on the forewing represents the individual marking used for the MRR study.



Fig. S2 Settlement perimeters effectively considered for MRR fieldwork at the locations 1-3. The perimeters for the locations 4-7 are shown in Fig.5.

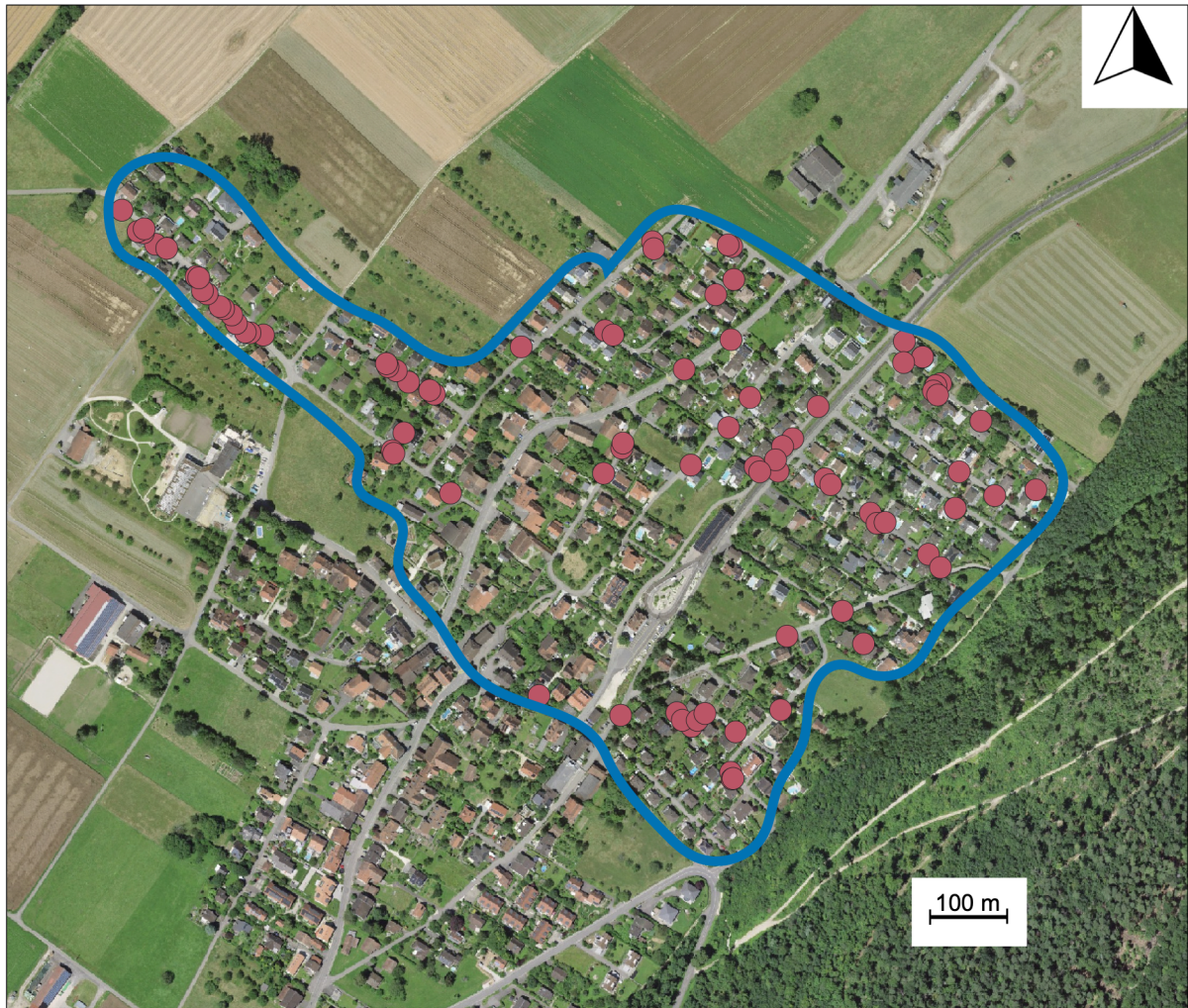


Fig. S3 *I. sempervirens* occurrences at location 1.



Fig. S4 Mapped *I. sempervirens* occurrences at location 2.

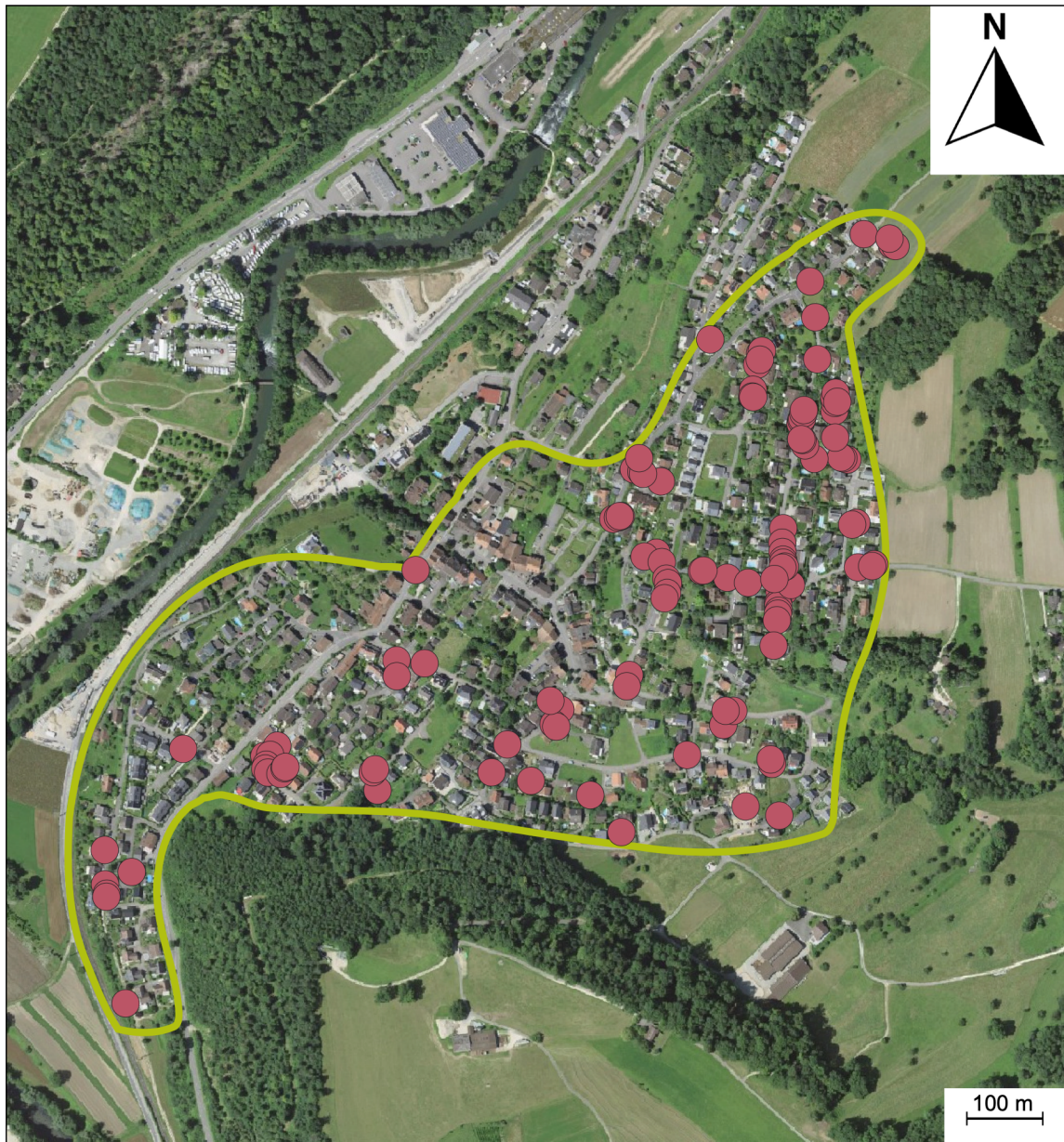


Fig. S5 Mapped *I. sempervirens* occurrences at location 3.

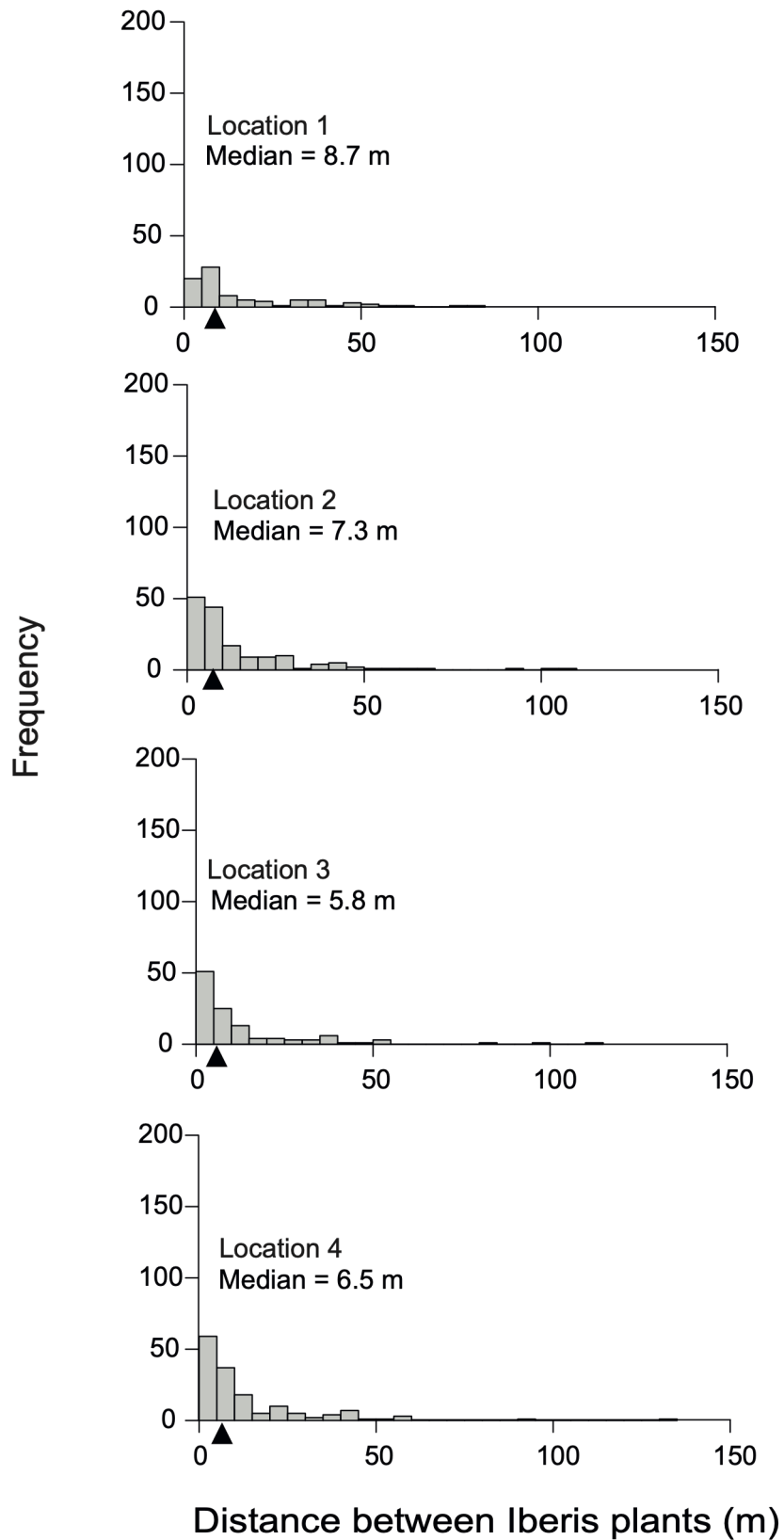


Fig. S6 Distribution of the distance between each *I. sempervirens* plant and its nearest neighbor for all study locations separately. Related to Fig. 2b.

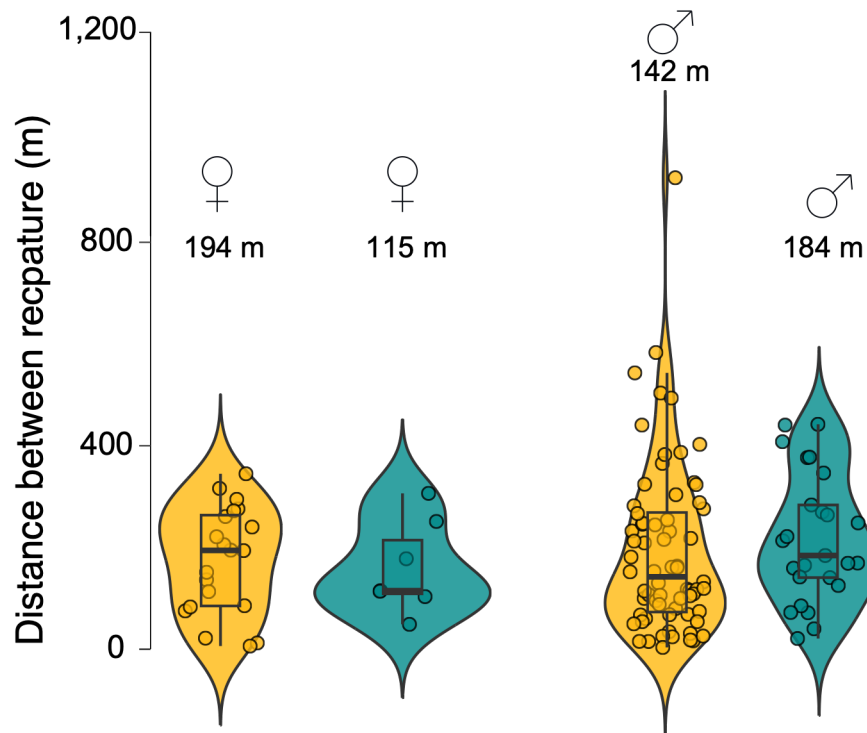


Fig. S7 Distribution of distances between consecutive (re)captures for female and male *P. mannii* (females: $n = 20$, males: $n = 68$) and *P. rapae* (females: $n = 6$, males: $n = 25$). This figure follows Fig. 4c with the difference that multiple data points per individual were averaged to a single one.

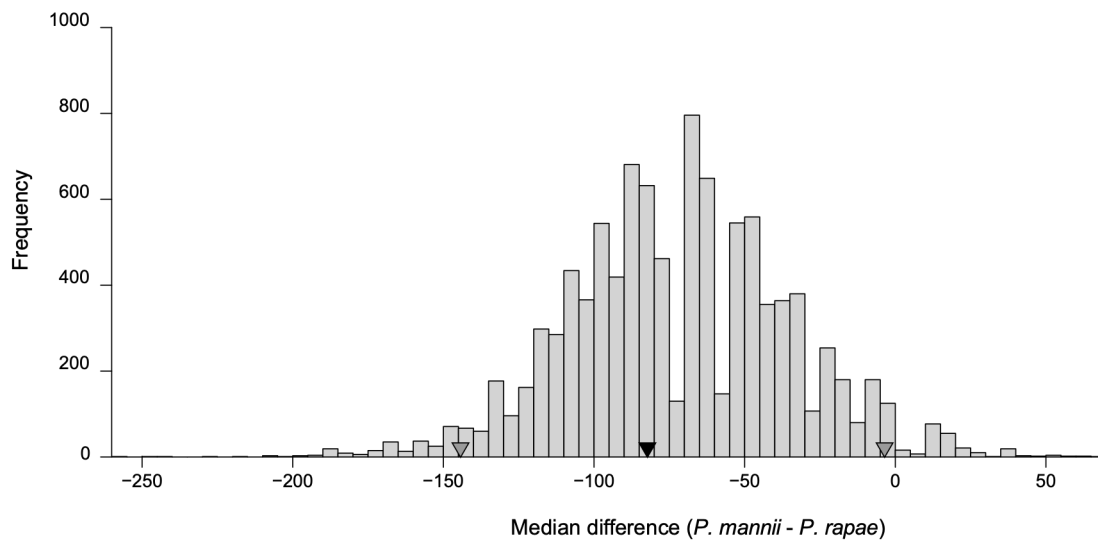


Fig. S8 Bootstrap distribution for the difference in median distance between consecutive recaptures for male butterflies (*P. mannii*: $n = 81$; *P. rapae*: $n = 29$; median distance *P. mannii* – median distance *P. rapae*), calculated from the data shown in Fig 4c. Black triangles indicate the observed median difference, and light grey triangles indicate the 95% compatibility interval.

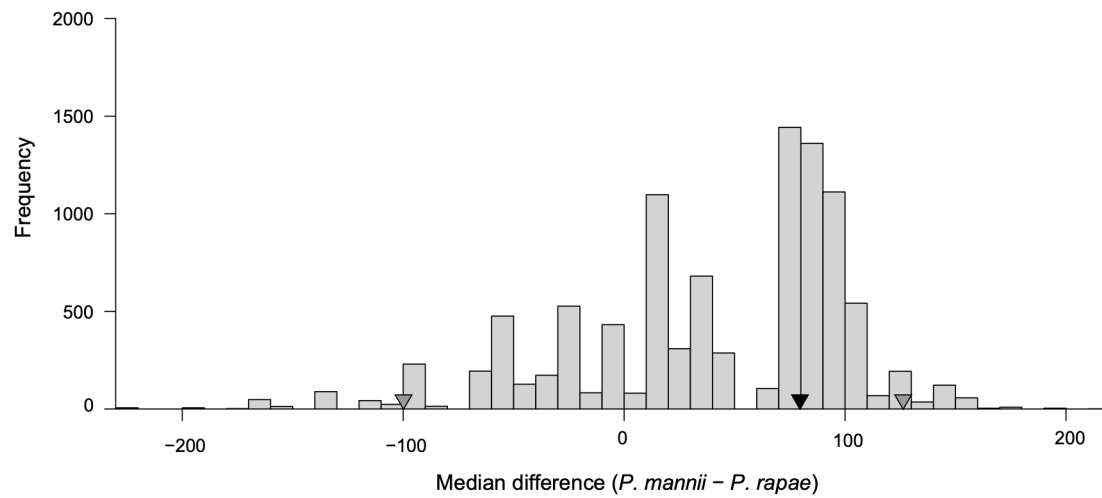


Fig. S9 Bootstrap distribution for the difference in median distance between consecutive recaptures for female butterflies (*P. mannii*: $n = 21$; *P. rapae*: $n = 7$; median distance *P. mannii* – median distance *P. rapae*), calculated from the data shown in Fig 4c. Black triangles indicate the observed median difference, and light grey triangles indicate the 95% compatibility interval.

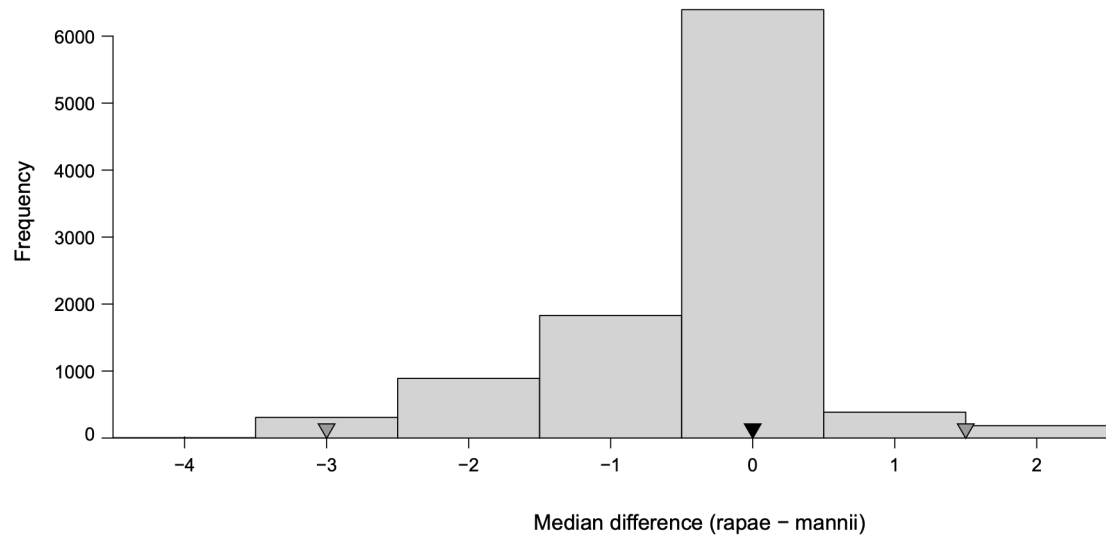


Fig. S10 Bootstrap distribution for the difference in median residence time between *P. mannii* and *P. rapae* (median residence time of *P. mannii* – median residence time of *P. rapae*) calculated from the data shown in Fig. 4d. Black triangles indicate the observed median difference, and light grey triangles indicate the 95% compatibility interval.

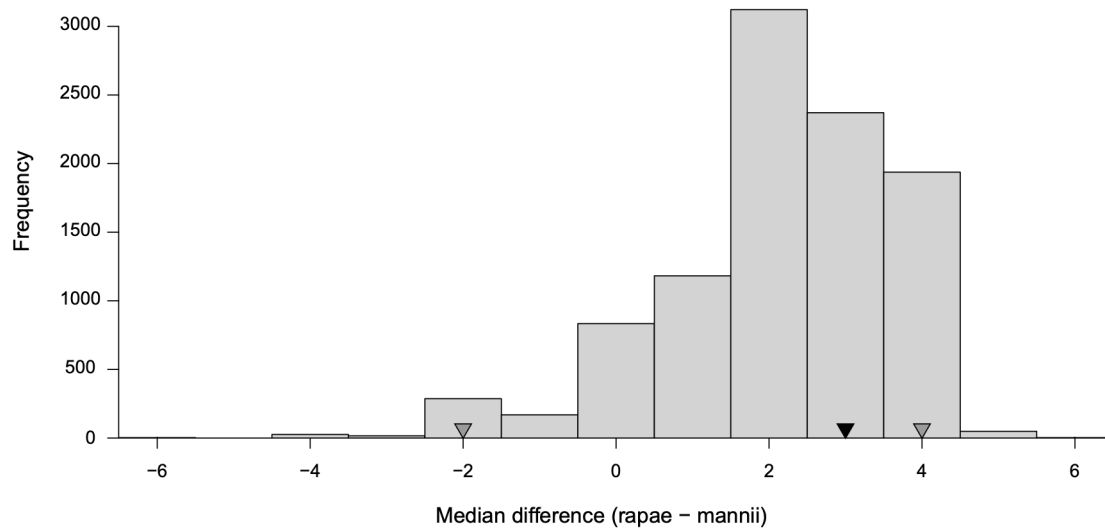


Fig. S11 Bootstrap distribution for the difference in median residence time for female butterflies (median residence time of *P. mannii* – median residence time of *P. rapae*) calculated from the data shown in Fig. 4d. Black triangles indicate the observed median difference, and light grey triangles indicate the 95% compatibility interval.

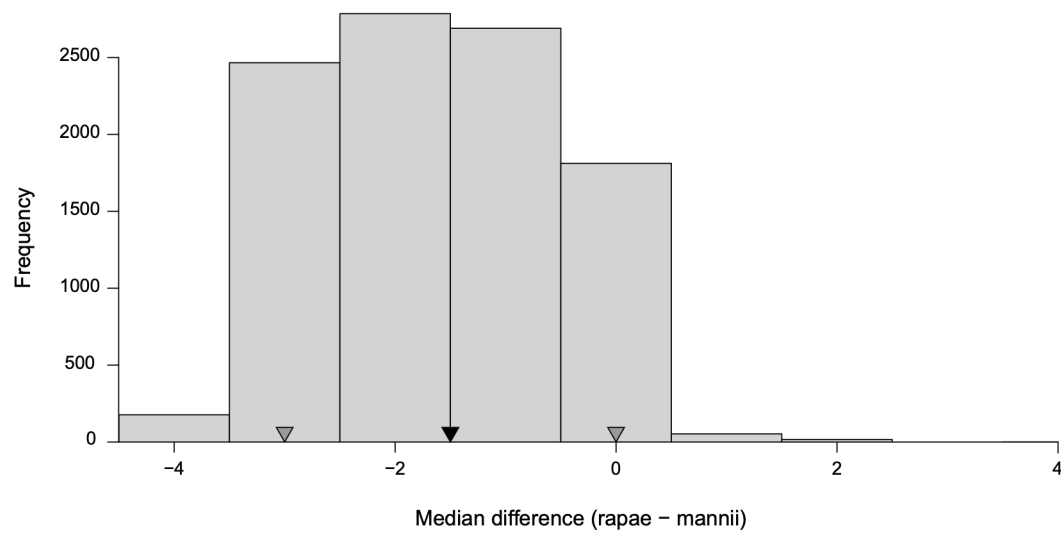


Fig. S12 Bootstrap distribution for the difference in median residence time for male butterflies (median residence time of *P. mannii* – median residence time of *P. rapae*) calculated from the data shown in Fig. 4d. The black triangle indicates the observed median difference, the grey triangle indicates the 95% bootstrap compatibility interval, and the red triangle indicates the median difference obtained from bootstrapping.

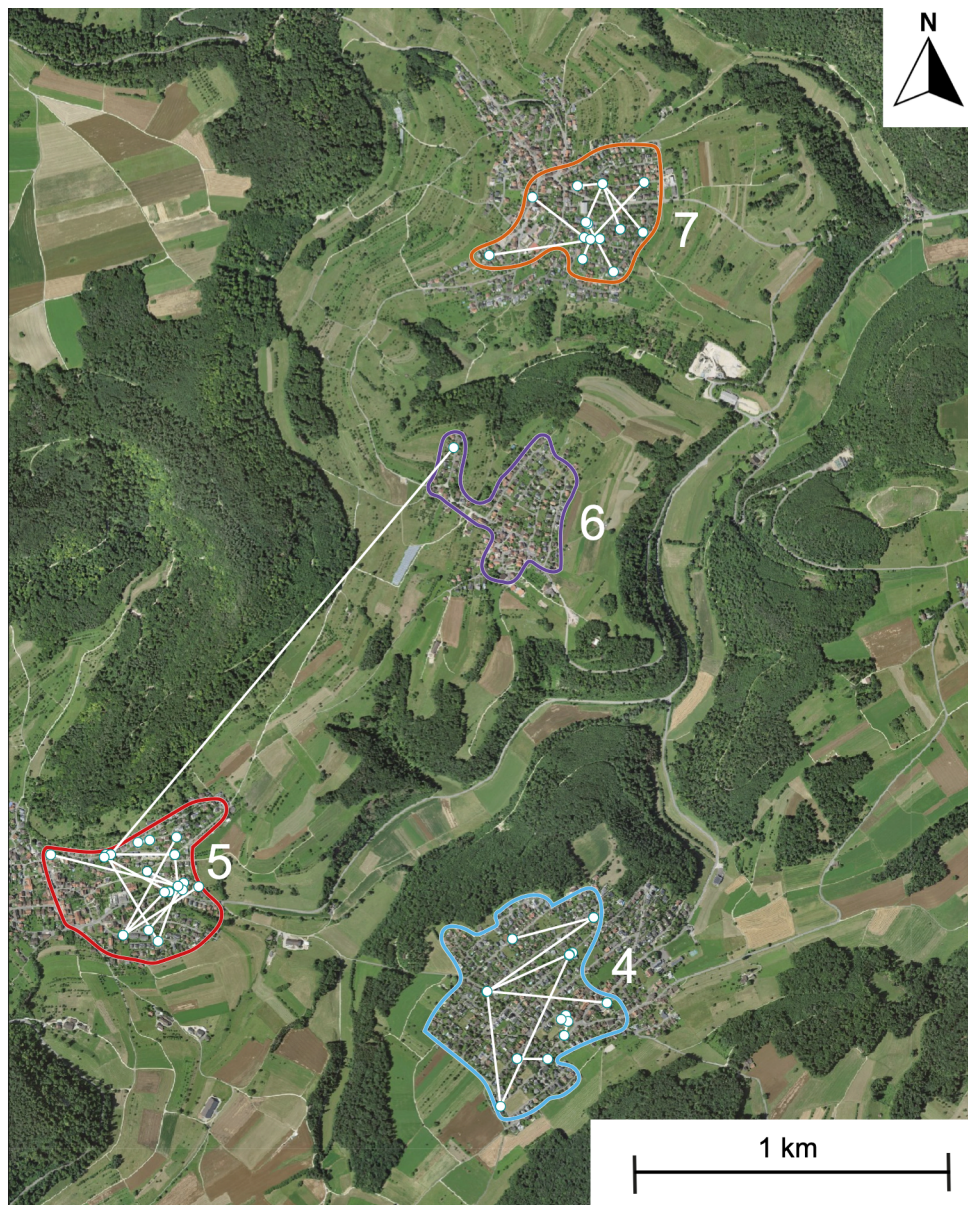


Fig. S13 Inter-village dispersal of *P. rapae* illustrated as white lines connecting consecutive captures (dots) of the same individual. In one case (female), inter-village dispersal was observed.

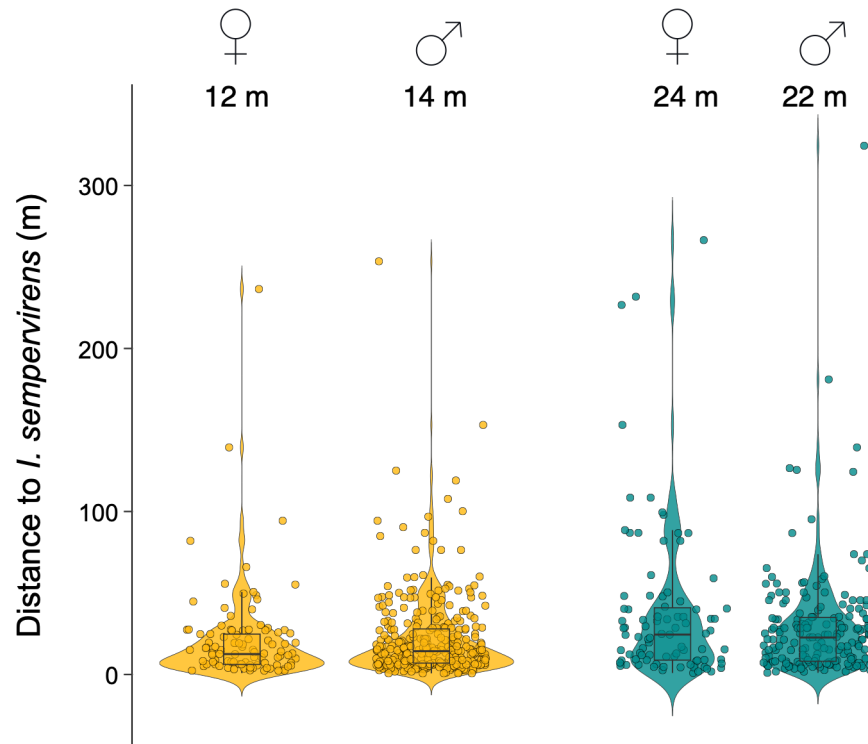


Fig. S14 Distribution of the minimum distance from each capture coordinate to the nearest *I. sempervirens* plant for male and female butterflies separately. Sample sizes for *P. mannii* (yellow) are females $n = 130$ and males $n = 332$, and for *P. rapae* (green) females $n = 91$ and males $n = 182$. Related to Fig. 5e.

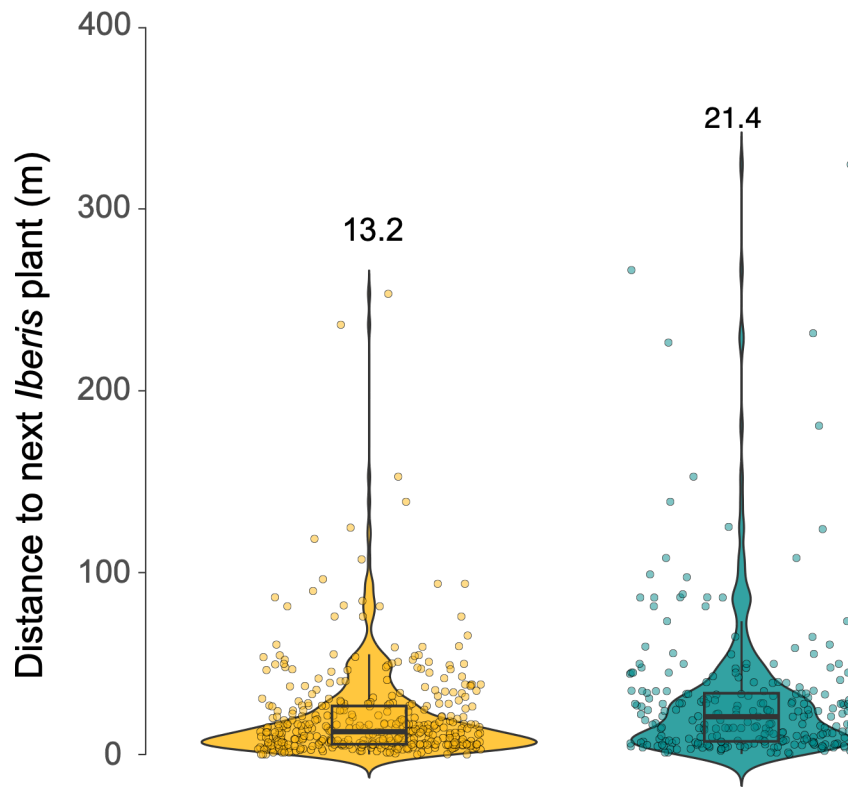


Fig. S15 Distribution of the minimum distance from each capture coordinate to the nearest *I. sempervirens* plant for *P. mannii* (yellow) and *P. rapae* (green), considering only MRR data from outside the host plant's flowering season. Related to Fig. 5e.

Table S2 Number of individuals captured for each species during the mark–release–recapture (MRR) survey. In parentheses the sex-specific counts for M / F.

Species	Summer 2024	Spring 2025	Summer 2025	Total
<i>P. mannii</i>	221 (156 / 64)	40 (30 / 10)	427 (249 / 187)	688
<i>P. rapae</i>	149 (94 / 52)	22 (21 / 1)	458 (265 / 190)	629

Table S3 Population size estimates and associated uncertainty. Median population size calculated across sampling days for each location.

Location ID	Location name	Year	Season	Median population size	Estimate	SE	lower CI	upper CI
1	Rodersdorf	2024	Summer	35.3	50.3	25.4	18.7	135.2
2	Ettingen	2024	Summer	88.6	218.8	111.5	80.6	593.8
2	Ettingen	2025	Spring	29.6	47.5	23.9	17.8	127.2
3	Duggingen	2024	Summer	45.1	51.2	22.4	21.7	120.6
4	Lupsingen	2025	Summer	254.4	420.4	135.8	223.2	791.9
4	Lupsingen	2024	Summer	57.8	101.6	50	38.7	266.8
5	Bueren	2025	Summer	74.7	103.9	59.8	33.6	321.3

Table S4 Population density of *P. mannii* at study locations visited in 2024, used for population size extrapolation across Switzerland.

Location ID	Location name	Year	Season	Median population size	Settlement area (km ²)	Density of <i>P. mannii</i>
1	Rodersdorf	2024	Summer	35.3	0.77	45.9
2	Ettingen	2024	Summer	88.6	1.10	80.5
3	Duggingen	2024	Summer	45.1	0.75	60.2
4	Lupsingen	2024	Summer	57.8	0.48	120.4

Table S5 Table S5 Recapture probability of female and male *P. mannii* and *P. rapae* at all locations during the summers 2024 and 2025. The total captures column indicates the number of individuals marked. Compatibility intervals for the recapture probability were generated by bootstrapping.

Location ID	Location name	Species	Sex	Total captures	Recap-tures	Year	Lower CI	Recapture probability	Upper CI
5	Bueren	mannii	F	59	3	2025	0.0000	0.0508	0.1186
5	Bueren	mannii	M	80	20	2025	0.1625	0.2500	0.3500
5	Bueren	rapae	F	55	3	2025	0.0000	0.0545	0.1273
5	Bueren	rapae	M	72	8	2025	0.0417	0.1111	0.1944
3	Duggingen	mannii	F	6	1	2024	0.0000	0.1667	0.5000
3	Duggingen	mannii	M	38	10	2024	0.1316	0.2632	0.3947
3	Duggingen	rapae	F	5	0	2024	0.0000	0.0000	0.0000
3	Duggingen	rapae	M	22	1	2024	0.0000	0.0455	0.1364
2	Ettingen	mannii	F	6	0	2024	0.0000	0.0000	0.0000
2	Ettingen	mannii	M	54	5	2024	0.0185	0.0926	0.1852
2	Ettingen	rapae	F	6	0	2024	0.0000	0.0000	0.0000
2	Ettingen	rapae	M	21	1	2024	0.0000	0.0476	0.1429
4	Lupsigen	mannii	F	30	1	2024	0.0000	0.0333	0.1000
4	Lupsigen	mannii	M	38	9	2024	0.1053	0.2368	0.3684
4	Lupsigen	rapae	F	15	2	2024	0.0000	0.1333	0.3333
4	Lupsigen	rapae	M	25	3	2024	0.0000	0.1200	0.2400
4	Lupsigen	mannii	F	51	5	2025	0.0196	0.0980	0.1961
4	Lupsigen	mannii	M	84	7	2025	0.0238	0.0833	0.1429
4	Lupsigen	rapae	F	36	0	2025	0.0000	0.0000	0.0000
4	Lupsigen	rapae	M	63	4	2025	0.0159	0.0635	0.1270
7	Nuglar	mannii	F	38	1	2025	0.0000	0.0263	0.0789
7	Nuglar	mannii	M	41	3	2025	0.0000	0.0732	0.1707
7	Nuglar	rapae	F	59	0	2025	0.0000	0.0000	0.0000
7	Nuglar	rapae	M	92	9	2025	0.0435	0.0978	0.1630
1	Rodersdorf	mannii	F	22	1	2024	0.0000	0.0455	0.1364
1	Rodersdorf	mannii	M	26	10	2024	0.1923	0.3846	0.5769
1	Rodersdorf	rapae	F	25	1	2024	0.0000	0.0400	0.1200
1	Rodersdorf	rapae	M	26	0	2024	0.0000	0.0000	0.0000
6	St.Pantaleon	mannii	F	39	6	2025	0.0513	0.1538	0.2821
6	St.Pantaleon	mannii	M	35	5	2025	0.0286	0.1429	0.2571
6	St.Pantaleon	rapae	F	40	0	2025	0.0000	0.0000	0.0000
6	St.Pantaleon	rapae	M	38	0	2025	0.0000	0.0000	0.0000

Analysis S1: Extrapolation of population size across suitable settlement areas in Switzerland.

The median estimated density of *P. mannii* across the four study locations was 70.35 individuals km⁻² (Table S3). Assuming this density applies across the total settlement area below 1200 m a.s.l. (3,045 km²), the estimated population size was calculated as:

$$70.35 \text{ individuals km}^{-2} \times 3,045 \text{ km}^2 = 214,216 \text{ individuals.}$$

Thus, the estimated population size within suitable settlement areas below 1200 m a.s.l. was approximately **214,000 individuals**.