

# Population trends of the Karner Blue (*Plebejus melissa samuelis*) in the Albany Pine Bush Recovery Unit, 2007–2018



Photo by Amanda Dillon

A short report to the Albany Pine Bush Preserve Commission, New York State Department of Environmental Conservation, and New York Field Office of the United States Fish and Wildlife Service

**Prepared by:**

Steven P. Campbell, Conservation Biologist  
Amanda M. Dillon, Field Ecologist and Entomologist  
Neil A. Gifford, Conservation Director

Albany Pine Bush Preserve Commission  
195 New Karner Road  
Albany, NY 12205



The Karner blue (*Plebejus melissa samuelis*) inhabits oak savanna and pine barrens ecosystems that support sufficient populations of wild lupine (*Lupinus perennis*), which is the only known food source for the larvae. Loss, fragmentation, and degradation of these ecosystems have led to a 99% decline in abundance of Karner blues across their range. Consequently, United States Fish and Wildlife Service (USFWS) listed the species as endangered in 1992. To maintain an adequate number of populations, USFWS established 13 recovery units in six states, one of which is the Glacial Lake Albany recovery unit in eastern NY. Within the Glacial Lake Albany federal recovery unit, New York State Department of Environmental Conservation (NYSDEC) established four state recovery units: Saratoga Sandplains, Saratoga West, Queensbury, and Albany Pine Bush.

The Albany Pine Bush recovery unit protects remnants of a northeastern interior pine barrens ecosystem that once encompassed more than 10,000 ha in the Albany area. Most notably, the recovery unit contains a globally rare, inland pitch pine-scrub oak (*Pinus rigida* – *Quercus sp.*) barrens ecological community. Given the loss and ecological deterioration of the barrens, recovery of the Karner blue in the Albany Pine Bush depends largely upon the successful restoration of the barrens and the reintroduction of the ecological processes that maintain the ecosystem. To this end, the Albany Pine Bush Preserve Commission (APBPC) has been working with members of state and federal recovery teams to implement ecosystem management strategies to restore and maintain the barrens (e.g., removing invasive species and prescribed burning). To further improve the species' recovery potential, APBPC has also adopted species-specific management strategies (e.g., captive rearing and release and planting lupine) to increase the size and extent of the Karner blue population (Fig. 1).

To measure recovery progress of Karner blues, APBPC has been monitoring adult population size using distance sampling at an increasing number of sites since 2007 (Table 1). For each year of monitoring, we estimated first and second brood sizes for all sites combined as well as other brood characteristics (Table 2). Brood sizes (i.e., the cumulative number of butterflies that emerge within a brood) are measures of population size that can be directly compared to federal and state recovery criteria. In years when there were enough observations, we also estimated brood sizes of subpopulations (i.e., groups of survey sites that are within 200 m of each other; Figs. 1 and 2).

Brood sizes for all sites combined have generally exhibited an increasing trend between 2007 and 2018 (Fig. 3). From 2007 to 2015, the first brood increased from 700 to 14600 adults whereas the second brood increased from 850 to 18700. Both brood sizes decreased in 2016 but appear to have stabilized since then at around 6600 adults for the first brood and 13200 for the second brood. Despite the recent decrease, the most recent survey year marks the sixth year that the population exceeded the recovery threshold established by USFWS and NYSDEC (i.e., 3000 adults in either the first or second brood), and the fifth time it exceeded the population target set by APBPC (7640 adults). Brood size trends for subpopulations were mixed, but it appears that population trends are being driven primarily by two (Kings Road Barrens and Pine Bush Southwest) of the eight subpopulations (Figs 4 and 5). It is also important to note that brood size estimates for any given year are likely to be conservative because they only apply to the area that we surveyed and not all areas likely to contain butterflies. For example, in 2018 we surveyed only 19% of the area that was likely to contain butterflies (Fig. 2).

The primarily increasing trend from 2007 to 2018 is a result of at least three factors. First, the increase of potential habitat through restoration from 5 ha in 1997 to 290 ha in 2018 followed by the release of 8000 captive-reared butterflies between 2008 and 2015 into 27 patches of newly restored habitat likely expedited establishment and growth of new populations. The subsequent inclusion of these patches within our survey efforts contributed to the observed increase in population size. Second, habitat quality of existing patches has likely improved during this time due to management (e.g., mowing and/or burning) which has yielded positive responses of densities at these patches (Fig. 6). Third, favorable weather conditions also likely contributed to the increase in numbers through decreased mortality, especially between 2012 to 2015.

We recommend sustaining monitoring efforts for Karner blues in the Albany Pine Bush recovery unit so that we can continue to evaluate how their population size compares to federal and state recovery criteria. Continued monitoring will also provide opportunities to investigate factors that affect population dynamics. In the near term, we can relate changes in population size to changes in habitat (e.g., management and succession) and weather. Understanding the influence of these factors can help us to adjust our management strategies to better ensure the recovery of the species and to refine population size targets so that even with fluctuations, population size remains above recovery thresholds. In the long-term, as the length of the time series increases, we can also begin to examine the effects of climate change on important aspects of the species' phenology (e.g., start date of eclosion).

Table 1. Summary of monitoring efforts for Karner blue butterflies in the Albany Pine Bush recovery unit, 2007–2018. Number of transects, total transect length, and area are represented by a range in some cases because of year-to-year variation in number and lengths of transects.

Subpopulation	Survey site	Site code	Years surveyed	No. transects	Tot. transect length (m)	Area (ha)
Baron House	Barons Field	BAFI	2010–2018	7	921–1210	2.66–3.59
	Trustco	TRUS	2011–2018	7	587–612	1.51
Karner Barrens East	DC Field	DCFI	2007–2018	8	1107–1218	2.46
	Firebrand	FIRE	2016–2018	6	1300	4.59
	Landfill	LAND	2015–2018	7	997–1474	2.74
	Witches Hat	WIHA	2014–2015 <sup>a</sup>	7	1598	3.19
Karner Barrens West	Bivy	BIVY	2015–2018	11	1421	4.02
Kings Road Barrens	Alley Cat	ALCA	2011–2018	7	639–646	1.27
	Amphibian	AMPH	2013–2018	10	988	1.97
	Andromeda	ANDR	2011–2018	7–8	717–862	1.90–2.44
	Antelope A	ANTA	2010–2018	8	549–597	1.08
	Antelope B	ANTB	2010–2018	6	251–309	0.51
	Apollo North	APNO	2007–2018	8	224–234	0.47
	Apollo Restoration	APRE	2007–2018	7	620–635	1.24
	Apollo South	APSO	2007–2010	14	893–917	1.75
	Asphalt	ASPH	2011–2018	7	555–599	1.07–1.20
	New Hope	NEHO	2010–2018	7–9	314–384	0.64–0.75
	Pine Bush Northwest	Dergositz	DERG	2011, 2013–2018 <sup>b</sup>	6	845–888
Pine Bush Southeast	Blueberry Hill	BLHI	2010–2018	10	1437–1474	4.05
	Crossgates PROW East	CPEA	2007–2018	12–17	403–596	0.85–1.22
	Crossgates PROW West	CPWE	2008–2018	5	110–122	0.23
	Crossgates Hill	CRHI	2007–2010	6	466–476	0.96
	Gopher/Grouper	GOGR	2013–2018	9	1367	2.74
Pine Bush Southwest	Cathedral	CATH	2013–2018	12	1179	2.36
	Chubb	CHUB	2011–2018	5	443–468	1.21
	Comet	COME	2014–2018	7	1106	3.15
	Draperies	DRAP	2013–2018	13	1530	3.00
Rapp Road Barrens	Rapp Road	RAPP	2018	8	1217	4.54

<sup>a</sup> Site was excluded in 2013 because there were an insufficient number of surveys.

<sup>b</sup> Site was excluded in 2012 because there were an insufficient number of surveys.

Table 2. Characteristics of the first and second broods of the metapopulation (i.e., subpopulation All) and each subpopulation of Karner blues in the Albany Pine Bush recovery unit, 2007–2018.

Subpopulation	Year	Brood size		Density (#/ha)		Start date of eclosion		Date of peak daily abundance		Length of eclosion (days)	
		Brood 1	Brood 2	Brood 1	Brood 2	Brood 1	Brood 2	Brood 1	Brood 2	Brood 1	Brood 2
All	2007	717	849	88.5	104.8	20 May	26 Jun	1 Jun	17 Jul	19.1	34.3
	2008	262	125	31.5	15.0	18 May	18 Jun	1 Jun	10 Jul	21.8	34.8
	2009	211	311	25.3	37.3	11 May	3 Jul	3 Jun	20 Jul	37.4	26.3
	2010	622	515	34.2	28.3	12 May	22 Jun	26 May	9 Jul	21.1	27.2
	2011	684	991	27.2	39.4	20 May	2 Jul	2 Jun	17 Jul	19.5	23.5
	2012	1093	1974	48.5	87.6	3 May	16 Jun	23 May	4 Jul	31.0	29.8
	2013	2698	5390	77.9	155.7	13 May	30 Jun	1 Jun	12 Jul	30.2	18.4
	2014	8458	14190	203.8	341.8	10 May	27 Jun	31 May	14 Jul	34.5	28.1
	2015	14610	18720	293.0	375.5	16 May	23 Jun	27 May	12 Jul	16.3	31.6
	2016	6306	14930	127.9	302.7	14 May	24 Jun	30 May	14 Jul	26.0	32.1
	2017	6102	11550	123.7	234.2	13 May	29 Jun	3 Jun	18 Jul	34.6	31.0
	2018	7524	13260	139.7	246.2	21 May	28 Jun	2 Jun	16 Jul	18.8	28.8
	Mean	4107.3	6900.5	101.8	164.1	14 May	26 Jun	31 May	14 Jul	25.9	28.8
	SD	4533.9	7055.4	82.1	131.0	4.9	5.0	3.5	4.1	7.4	4.6
Baron House	2010 <sup>a</sup>										
	2011 <sup>a</sup>										
	2012	297	612	58.2	120.1	7 May	22 Jun	23 May	6 Jul	23.6	21.7
	2013	853	711	183.4	152.8	19 May	2 Jul	4 Jun	13 Jul	25.3	16.7
	2014	1175	2174	252.6	467.4	15 May	29 Jun	2 Jun	15 Jul	27.5	25.6
	2015	2554	1816	549.1	390.5	15 May	21 Jun	27 May	10 Jul	17.9	30.5
	2016	427	1240	102.4	297.2	20 May	24 Jun	29 May	13 Jul	12.7	32.0
	2017	558	1222	133.7	292.9	16 May	28 Jun	3 Jun	17 Jul	29.7	31.6
	2018	505 <sup>b</sup>	1230	121.1 <sup>b</sup>	294.8	26 May <sup>b</sup>	30 Jun	1 Jun <sup>b</sup>	15 Jul	9.0 <sup>b</sup>	23.2
		Mean	977.4	1286.4	213.3	288.0	16 May	27 Jun	30 May	13 Jul	22.8
	SD	834.5	557.4	177.7	122.0	4.3	4.1	4.4	3.6	6.4	5.8
Karner Barrens East	2007	223	111	90.5	45.2	19 May	28 Jun	31 May	14 Jul	17.9	24.5
	2008 <sup>a</sup>										
	2009 <sup>a</sup>										
	2010 <sup>a</sup>										
	2011 <sup>a</sup>										

	2012 <sup>a</sup>										
	2013 <sup>a</sup>										
	2014	535 <sup>b</sup>	628	94.6 <sup>b</sup>	111.1	1 May <sup>b</sup>	24 Jun	30 May <sup>b</sup>	15 Jul	49.2 <sup>b</sup>	33.4
	2015	747	443	75.8	45.0	15 May	23 Jun	27 May	11 Jul	18.2	30.1
	2016	223	1007	22.8	102.8	11 May	19 Jun	28 May	12 Jul	27.2	38.3
	2017	714	1313	72.9	134.1	10 May	25 Jun	29 May	17 Jul	29.8	35.7
	2018	984	1003	100.5	102.4	19 May	27 Jun	3 Jun	16 Jul	23.7	30.3
	Mean	578.3	751.0	72.5	90.1	15 May	25 Jun	30 May	14 Jul	23.4	32.1
	SD	340.7	439.1	30.0	36.7	4.1	2.8	2.9	1.9	5.3	4.9
Karner Barrens West	2015 <sup>a</sup>										
	2016 <sup>a</sup>										
	2017 <sup>a</sup>										
	2018	147 <sup>b</sup>	394	36.5 <sup>b</sup>	97.9	26 May <sup>b</sup>	5 Jul	23 May <sup>b</sup>	15 Jul	2.1 <sup>b</sup>	15.4
	Mean		394		97.9		5 Jul		15 Jul		15.4
	SD <sup>c</sup>										
Kings Road Barrens	2007	242	407	70.0	117.8	20 May	26 Jun	1 Jun	18 Jul	19.7	35.4
	2008	153	87 <sup>b</sup>	44.2	25.3 <sup>b</sup>	18 May	14 Jun <sup>b</sup>	1 Jun	8 Jul <sup>b</sup>	21.4	39.9 <sup>b</sup>
	2009	128	243	37.1	70.3	15 May	3 Jul	4 Jun	20 Jul	31.3	28.0
	2010	198	196	34.8	34.6	12 May	24 Jun	27 May	9 Jul	23.6	22.5
	2011	278	423	31.6	48.0	17 May	1 Jul	2 Jun	18 Jul	24.7	27.3
	2012	382	685	46.2	82.8	27 Apr	13 Jun	22 May	4 Jul	41.5	34.1
	2013	897	3297	87.6	321.9	15 May	30 Jun	29 May	12 Jul	21.3	17.8
	2014	4114	6511	381.6	603.9	11 May	27 Jun	30 May	14 Jul	31.6	26.6
	2015	3876	4339	355.2	397.6	12 May	21 Jun	26 May	10 Jul	20.5	32.2
	2016	1164	2929	106.7	268.4	10 May	23 Jun	30 May	14 Jul	31.9	34.6
	2017	1870	3690	171.4	338.2	13 May	28 Jun	3 Jun	17 Jul	34.1	29.9
	2018	2266	4672	207.7	428.2	21 May	25 Jun	2 Jun	15 Jul	18.06	175.6
	Mean	1297.3	2490.2	131.2	246.5	14 May	26 Jun	30 May	14 Jul	26.6	29.3
	SD	1443.0	2209.4	124.1	188.9	6.0	5.2	3.7	4.6	7.2	5.6
Pine Bush Northwest	2011 <sup>a</sup>										
	2012 <sup>a</sup>										
	2013 <sup>a</sup>										
	2014	324 <sup>b</sup>	218	131.1 <sup>b</sup>	88.2	4 May <sup>b</sup>	30 Jun	29 May <sup>b</sup>	17 Jul	42.1 <sup>b</sup>	26.1
	2015 <sup>a</sup>										
	2016 <sup>a</sup>										

	2017 <sup>a</sup>	2018 <sup>a</sup>									
	Mean	218	88.2	30 Jun	17 Jul	26.1					
	SD <sup>c</sup>										
Pine Bush Southeast	2007	236	285	108.2	130.6	23 May	27 Jun	2 Jun	16 Jul	14.0	30.5
	2008 <sup>a</sup>										
	2009 <sup>a</sup>										
	2010 <sup>a</sup>										
	2011 <sup>a</sup>										
	2012 <sup>a</sup>										
	2013	386	631	46.9	76.5	12 May	30 Jun	30 May	13 Jul	28.8	19.3
	2014	902	1622	109.4	196.9	17 May	25 Jun	3 Jun	15 Jul	27.5	31.6
	2015	653	1407	79.3	170.8	19 May	19 Jun	28 May	13 Jul	12.8	40.8
	2016	378	1123	45.9	136.3	12 May	25 Jun	29 May	12 Jul	28.2	26.9
	2017	463	660	56.1	80.2	15 May	26 Jun	1 Jun	17 Jul	27.2	35.1
	2018	497	807	60.4	98.0	23 May	26 Jun	1 Jun	16 Jul	13.4	32.0
	Mean	546.5	1041.7	66.3	126.5	16 May	25 Jun	31 May	14 Jul	23.0	31.0
	SD	200.4	411.4	24.3	50.0	4.2	3.7	2.2	1.6	7.7	7.3
Pine Bush Southwest	2011 <sup>a</sup>										
	2012 <sup>a</sup>										
	2013	433 <sup>b</sup>	264	66.0 <sup>b</sup>	40.2	15 May <sup>b</sup>	2 Jul	3 Jun <sup>b</sup>	15 Jul	29.9 <sup>b</sup>	19.7
	2014	1441	3026	148.4	311.6	6 May	2 Jul	31 May	14 Jul	43.0	18.6
	2015	5812	9552	598.4	983.5	19 May	26 Jun	26 May	13 Jul	11.1	27.0
	2016	3444	6869	354.6	707.3	16 May	26 Jun	30 May	15 Jul	21.8	29.9
	2017	1947	3753	200.5	386.4	16 May	2 Jul	5 Jun	19 Jul	31.8	27.7
	2018	2473	3837	254.6	395.1	21 May	4 Jul	2 Jun	16 Jul	18.8	19.0
	Mean	3023.5	4550.2	311.3	470.7	16 May	1 Jul	1 Jun	16 Jul	25.3	23.6
	SD	1726.1	3232.1	177.7	329.4	6.0	3.1	3.5	2.1	12.4	5.1
Rapp Road Barrens	2018 <sup>a</sup>										

<sup>a</sup> There were not enough observations to reliably estimate a detection function and survey-specific abundances (see Table A6).

<sup>b</sup> Estimates were unreliable because model convergence and fit was poor (see Fig. A7), so they were not included in the subpopulation mean and standard deviation.

<sup>c</sup> Standard deviation could not be calculated because there were too few years for this subpopulation.

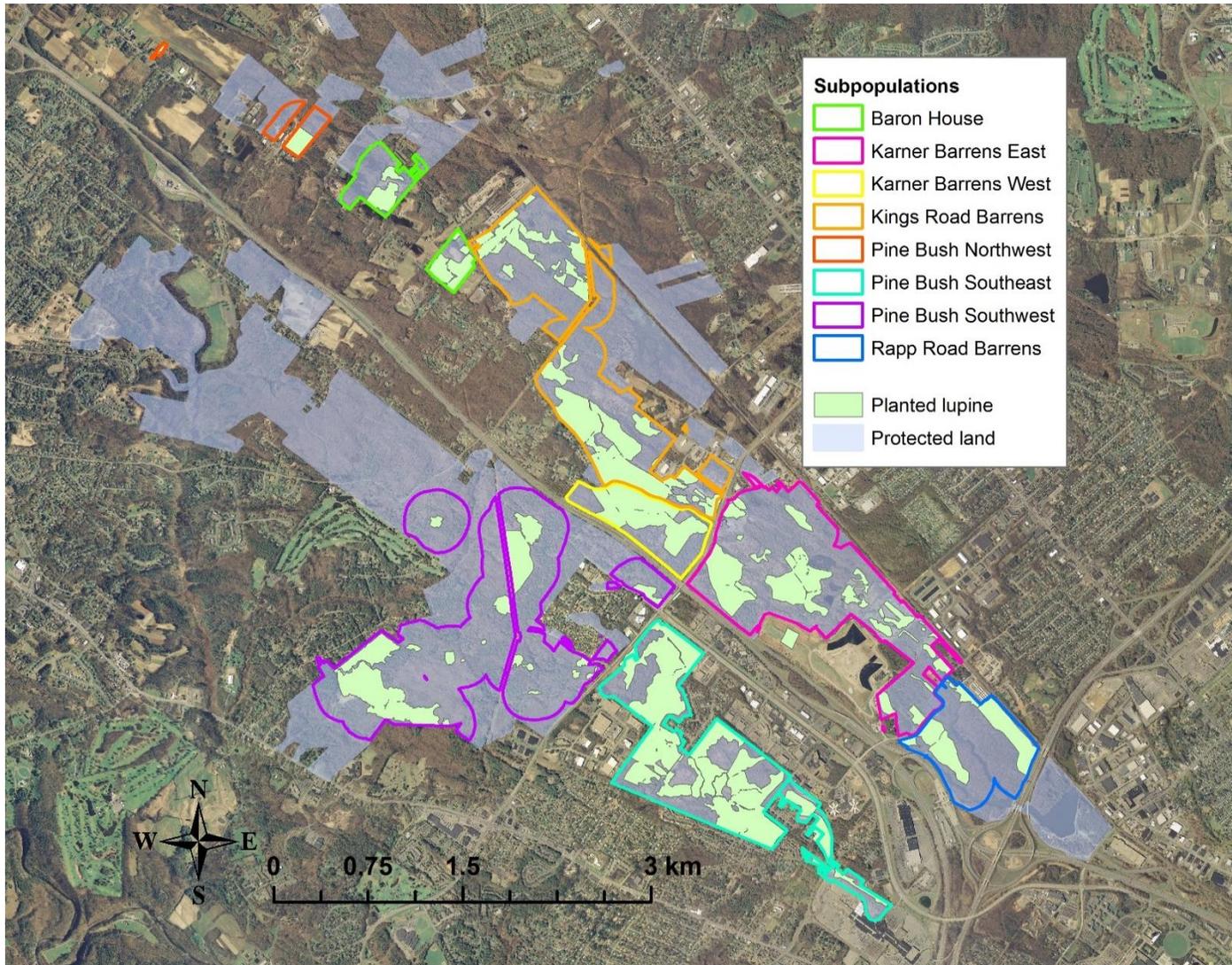


Figure 1. Distribution of sites that have been planted with lupine between 1995 and 2018 in the Albany Pine Bush recovery unit. Planted lupine sites are grouped into subpopulations based on their proximity (< 200 m) to other sites and their location relative to geographic barriers such as roads.

Figure 2a. Locations of transects and survey sites used for distance sampling of Karner blue butterflies in the Pine Bush Northwest and Baron House subpopulations of the Albany Pine Bush recovery unit, 2018.

Figure 2b. Locations of transects and survey sites used for distance sampling of Karner blue butterflies in the Kings Road Barrens and Karner Barrens West subpopulations of the Albany Pine Bush recovery unit, 2018.

Figure 2c. Locations of transects and survey sites used for distance sampling of Karner blue butterflies in the Pine Bush Southwest and Pine Bush Southeast subpopulations of the Albany Pine Bush recovery unit, 2018.

Figure 2d. Locations of transects and survey sites used for distance sampling of Karner blue butterflies in the Karner Barrens East and Rapp Road Barrens subpopulations of the Albany Pine Bush recovery unit, 2018.

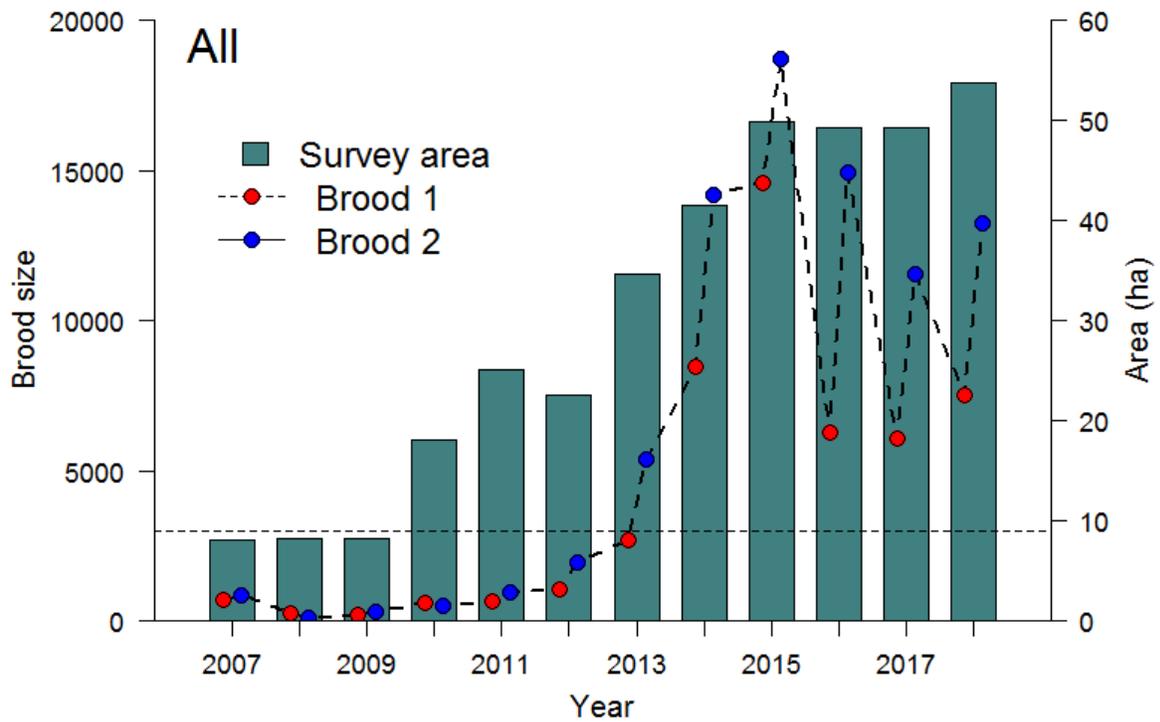


Figure 3. Brood size estimates of the Karner blue metapopulation (i.e., subpopulation All) in the Albany Pine Bush recovery unit obtained by distance sampling of the butterfly stage, 2007–2018. Dashed horizontal line represents the state and federal recovery criteria (i.e., 3000 butterflies in the first or second brood).

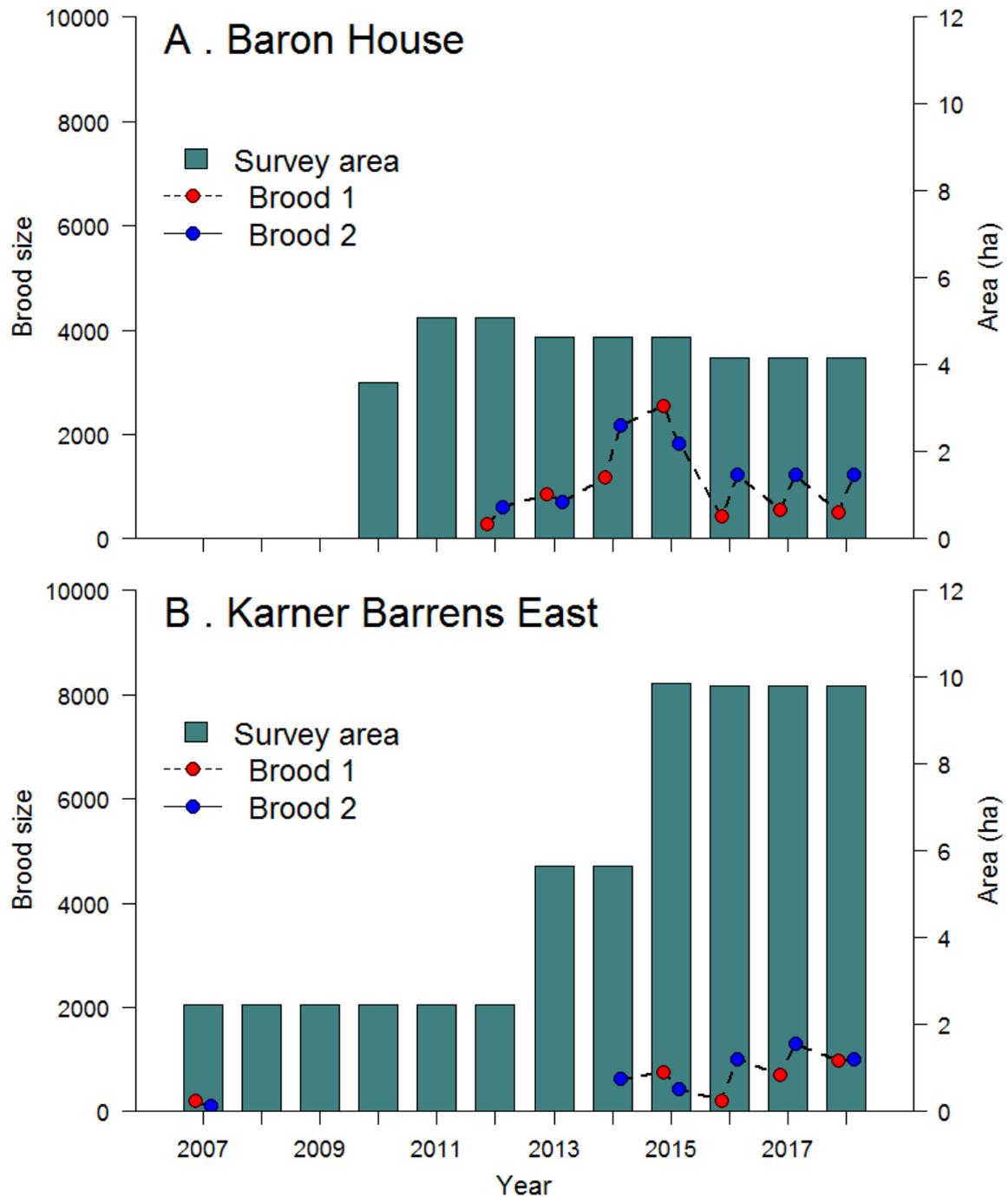


Figure 4. Brood size estimates of Karner blue subpopulations in the Albany Pine Bush recovery unit obtained by distance sampling of the butterfly stage, 2007–2018. Years without survey area indicate that restoration efforts had not yet created suitable survey sites in the subpopulation. Years with survey areas but without brood size estimates occurred when not enough individuals were observed in a subpopulation to reliably estimate brood sizes or when model convergence was poor.

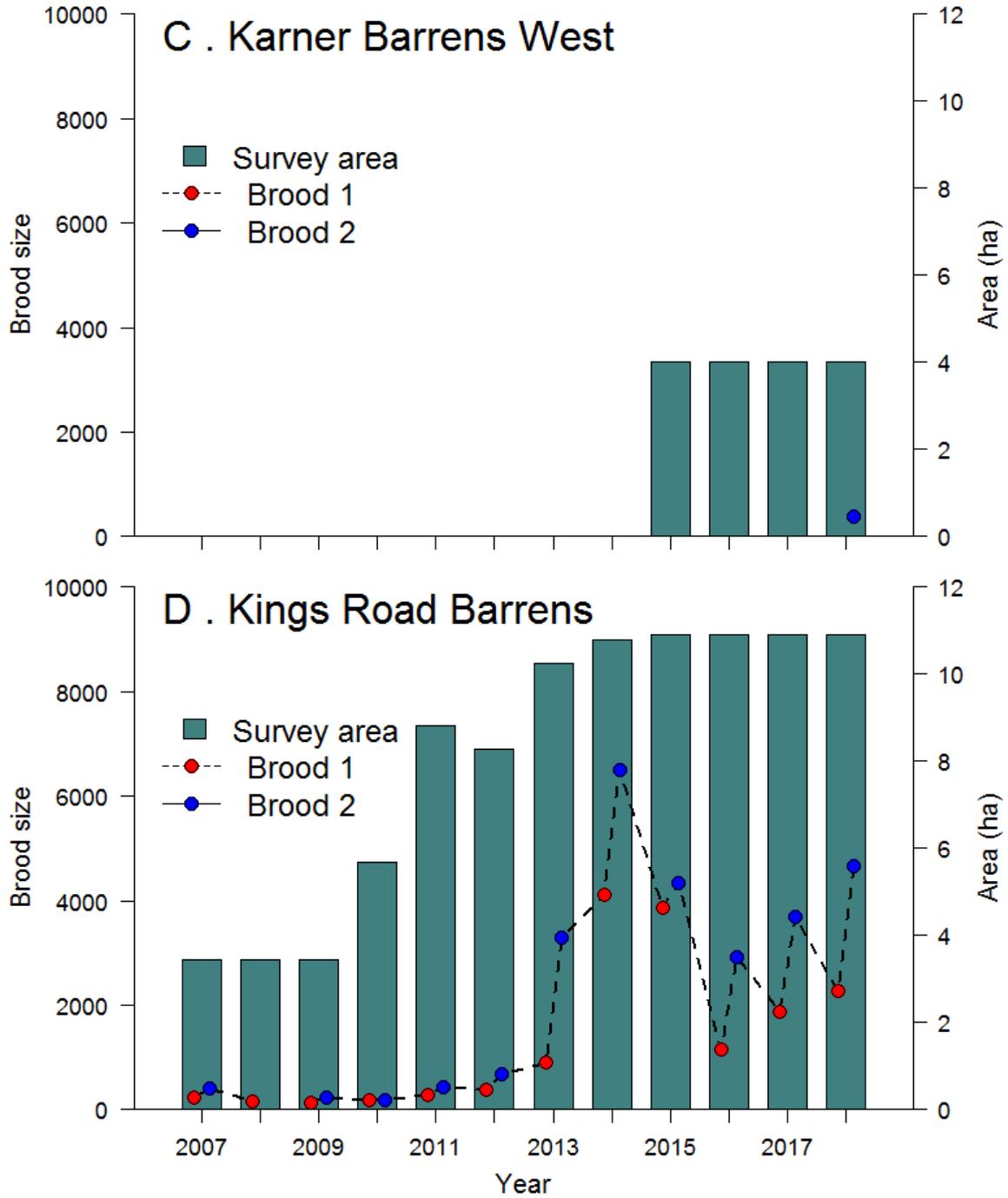


Figure 4 (continued).

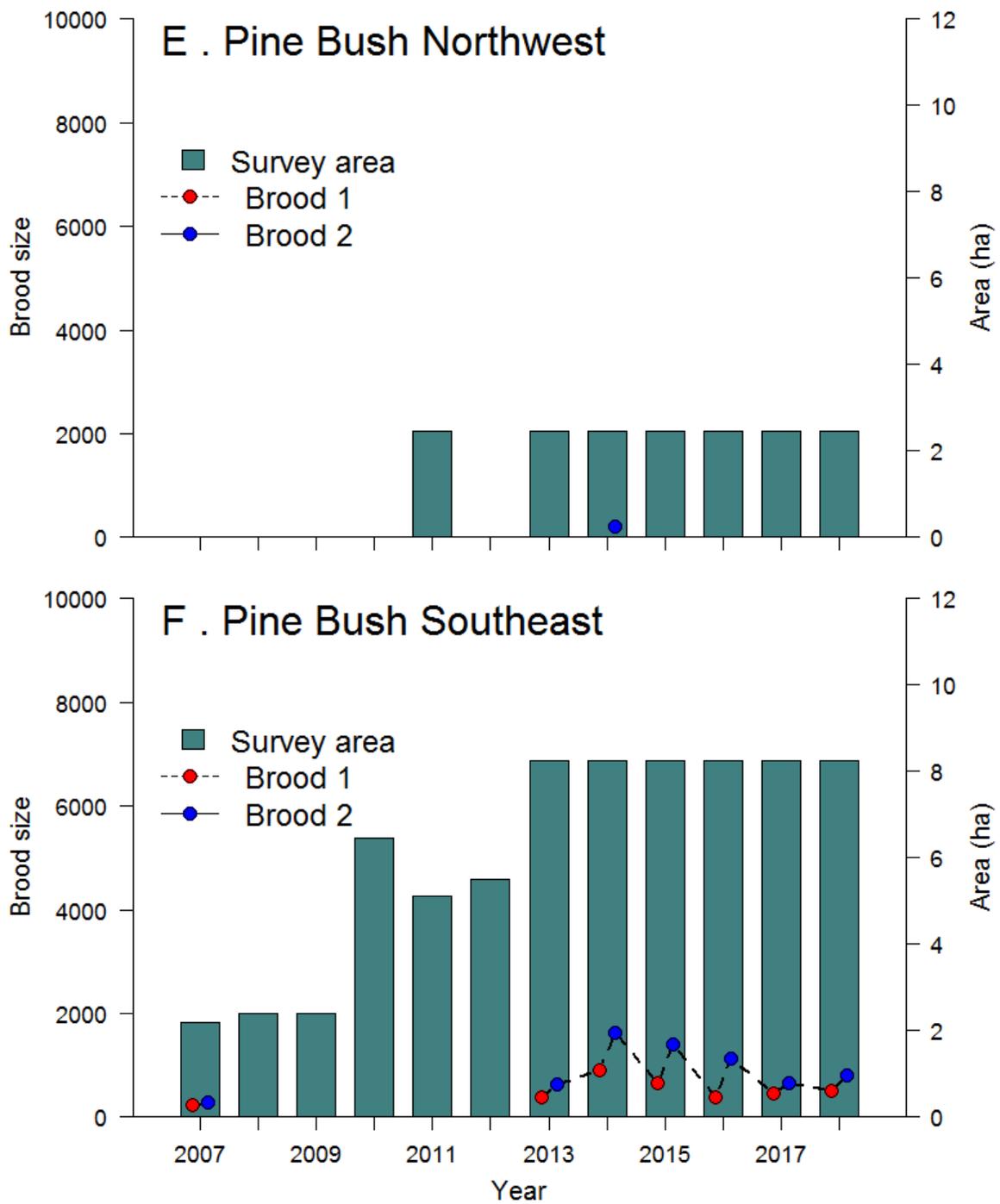


Figure 4 (continued).

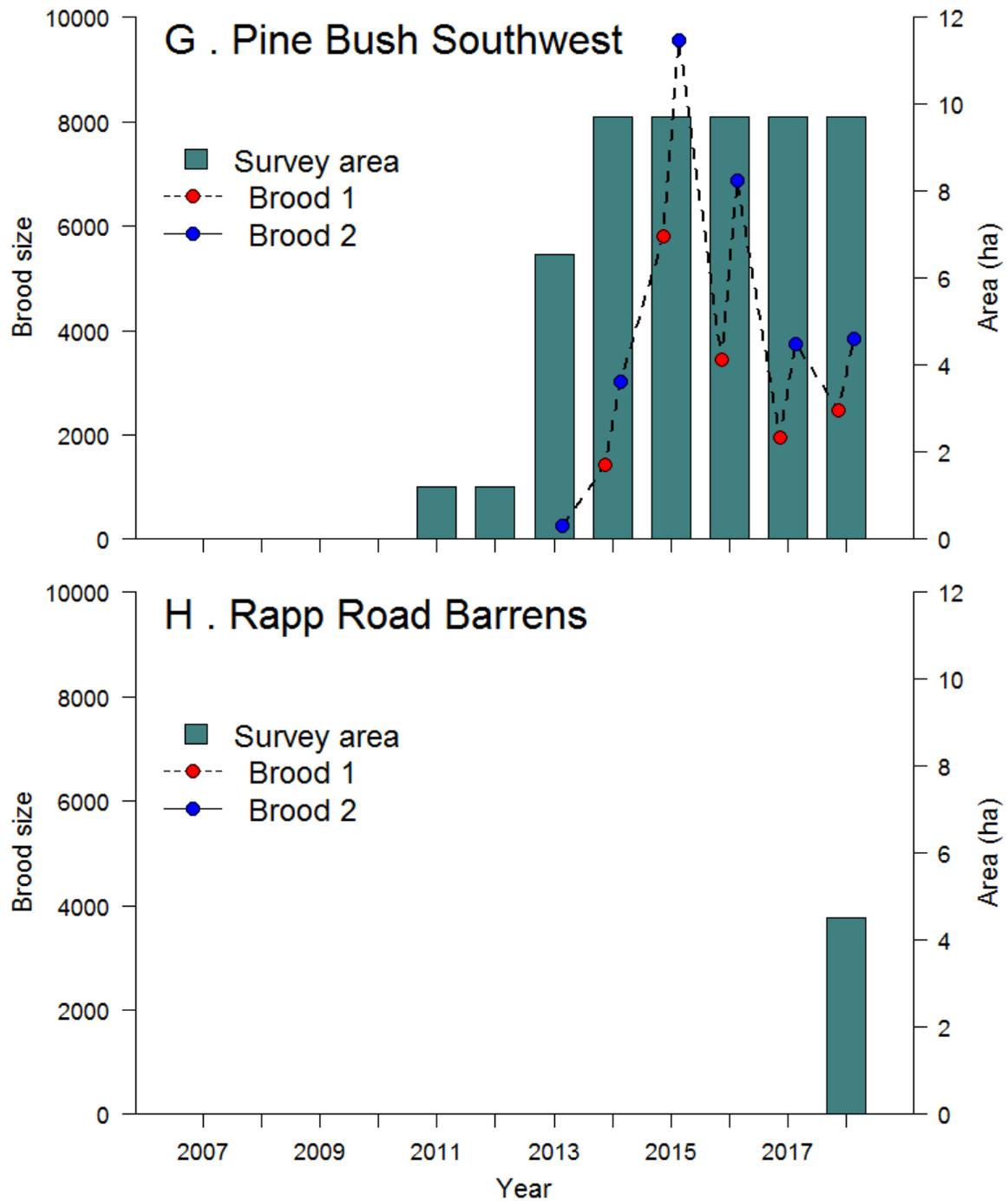


Figure 4 (continued).

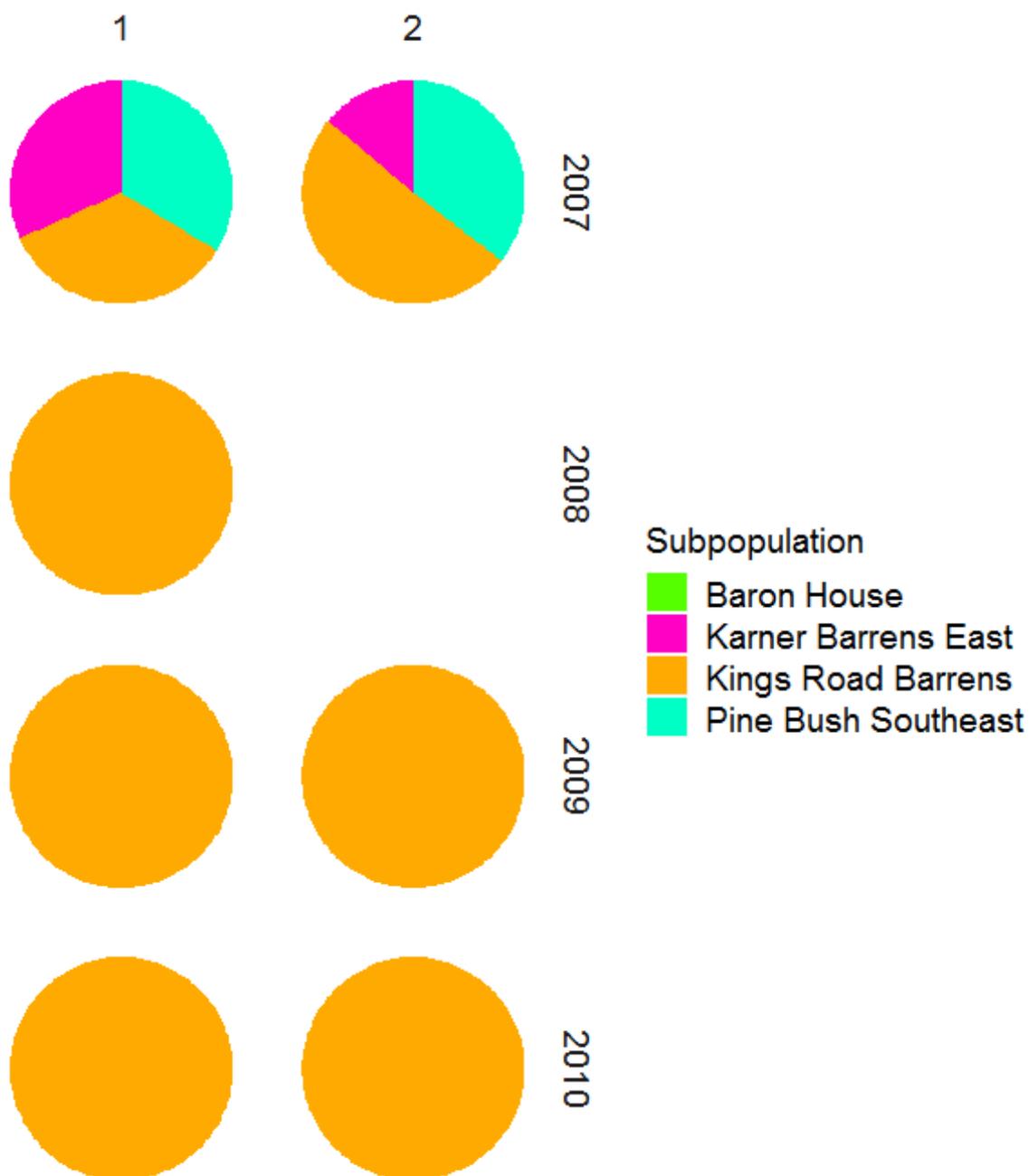


Figure 5. Relative contributions of subpopulations to sizes of broods 1 and 2 of the Karner blue butterfly in the Albany Pine Bush recovery unit, 2007-2018. The absence of a subpopulation in a specific chart indicates that too few butterflies were observed in a subpopulation to reliably estimate brood sizes or that convergence of the estimating model was poor.

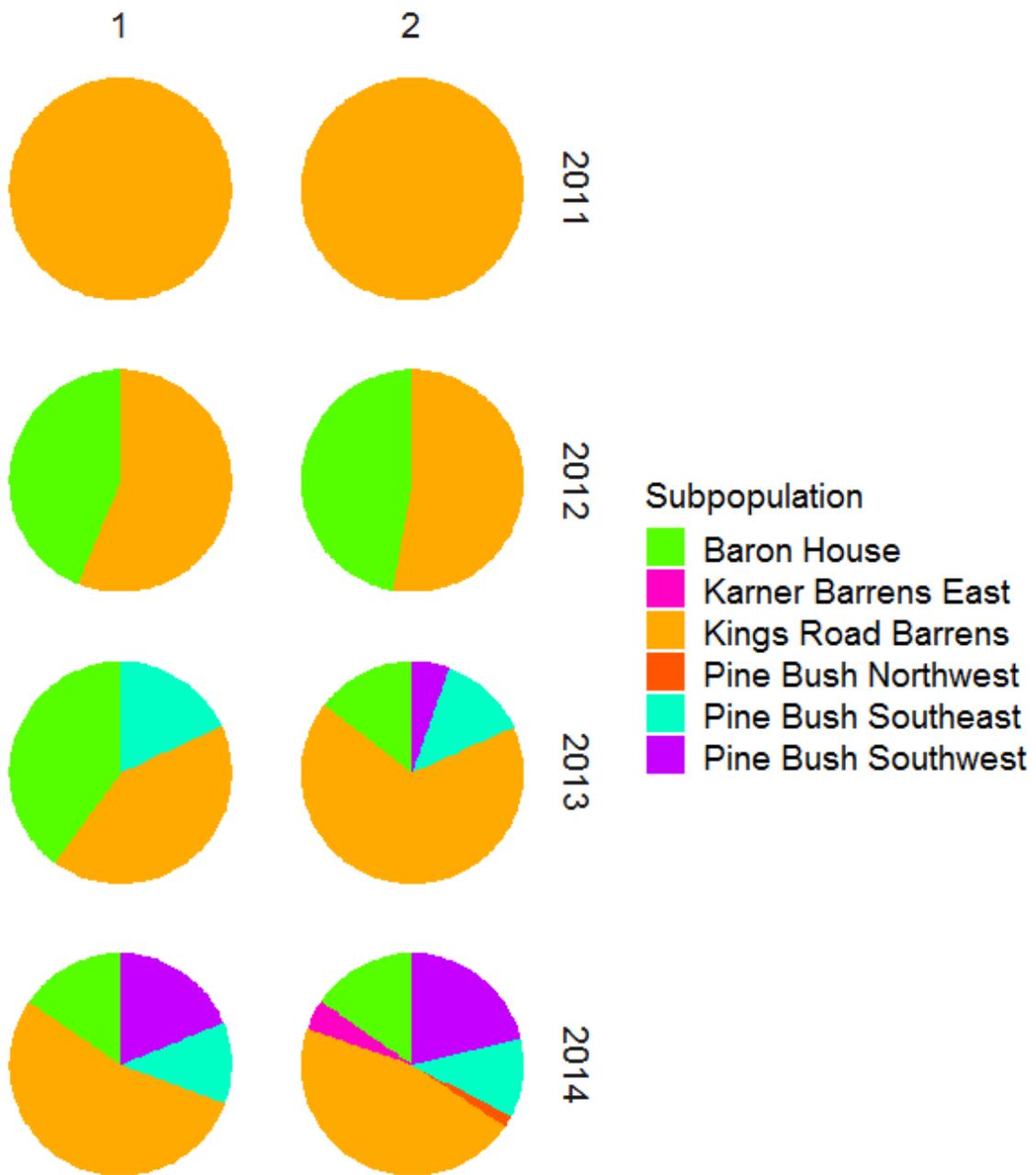


Figure 5 (continued).

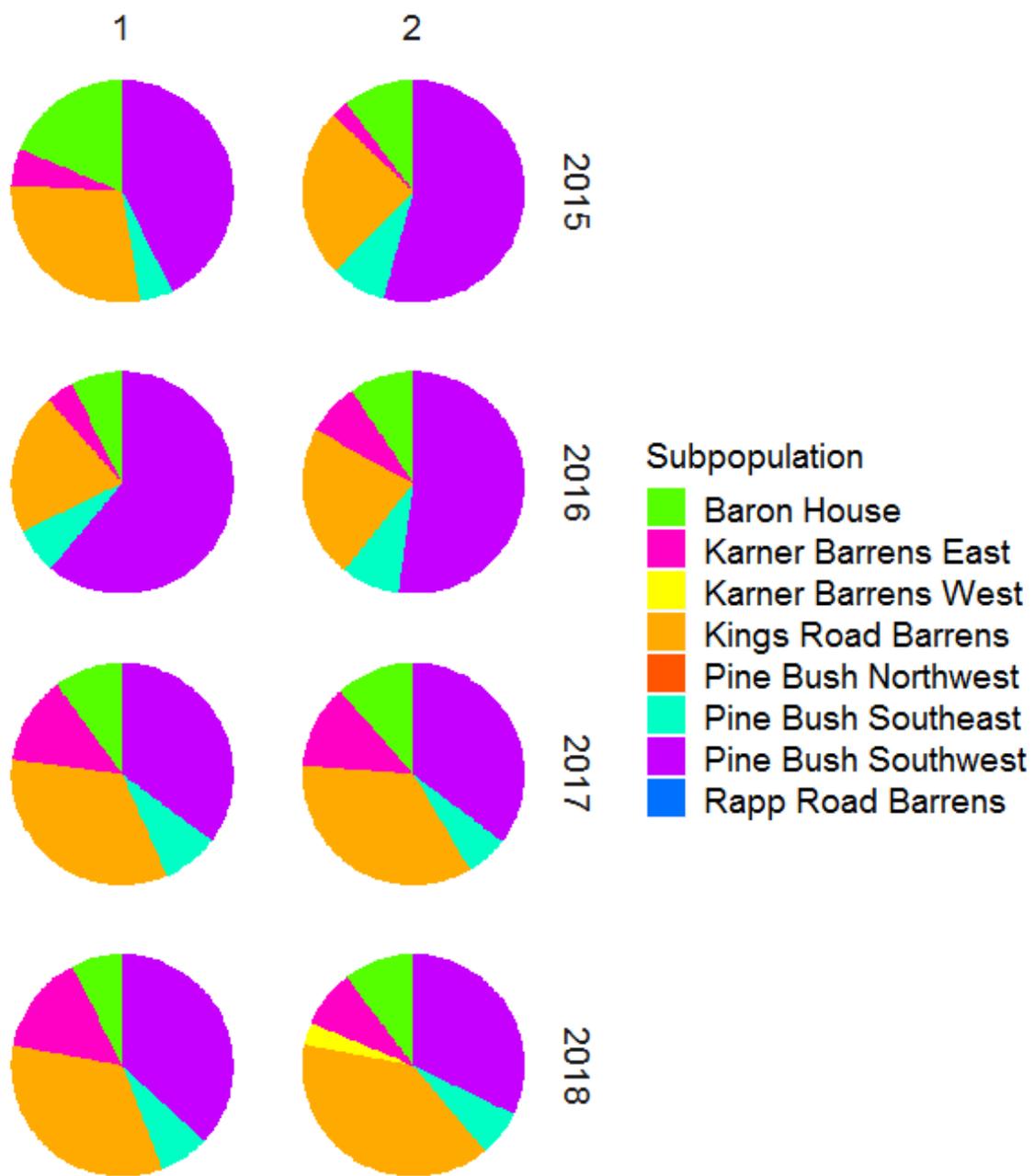


Figure 5 (continued).

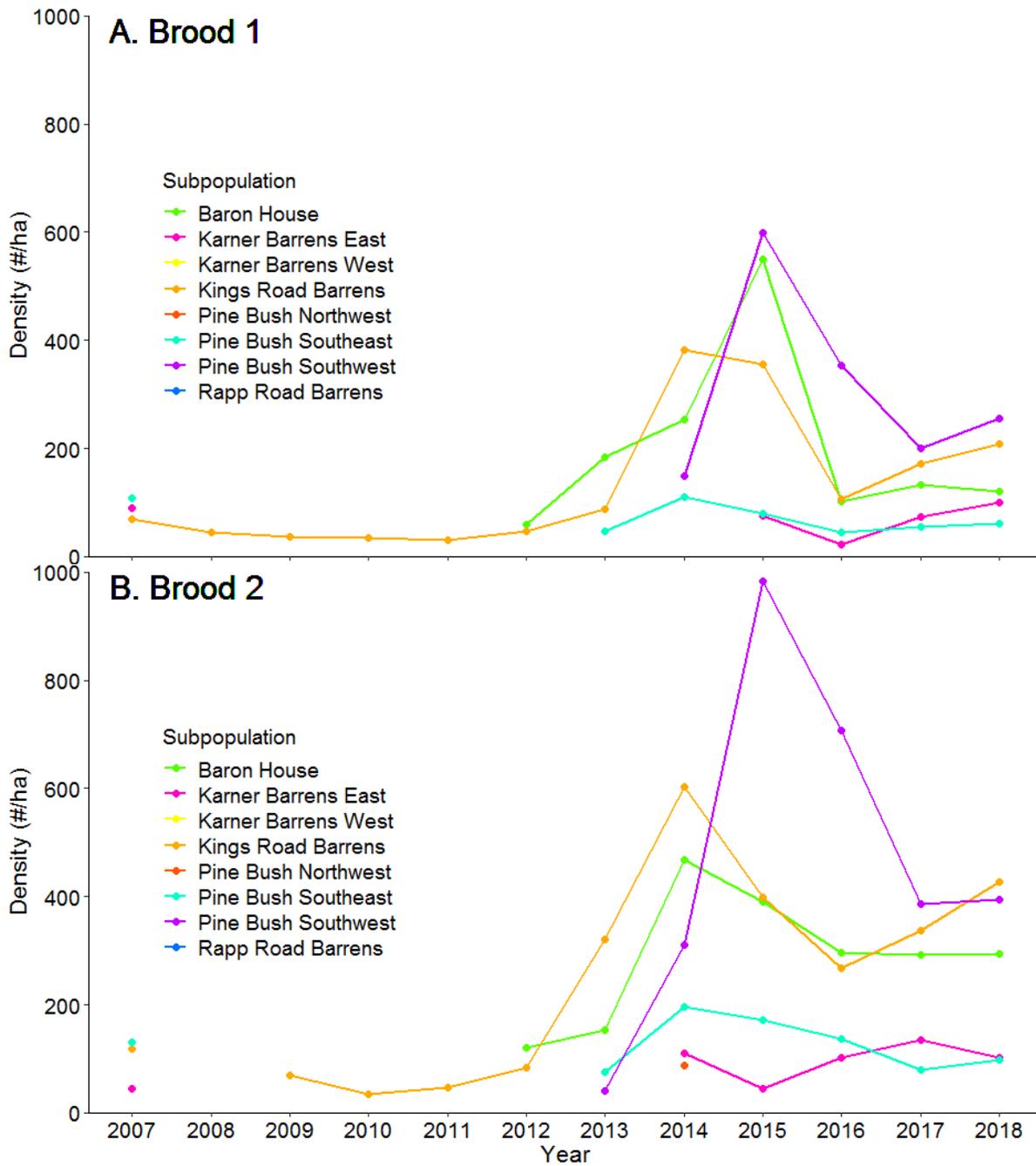


Figure 6. Densities of each brood of Karner blue butterflies in subpopulation of the Albany Pine Bush recovery unit, 2007-2018.