

Appendix B

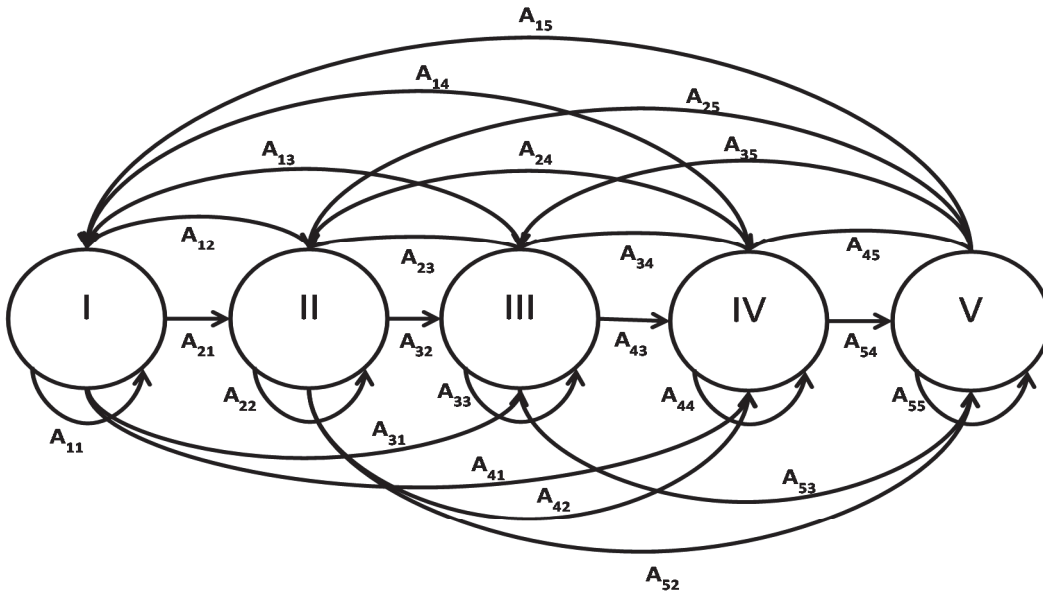


FIG. B1. Life cycle graph of *Opuntia macrorhiza* (Cactaceae). Circles correspond to plant stages (I: plants with 1 cladode; II: plants with 2-3 cladodes; III: plants with 4-7 cladodes; IV: plants with 8-15 cladodes; V: plants with > 15 cladodes). Arrows indicate potential transition between stages; A_{ij} denotes transition rate from stage j to stage i .

TABLE B1: Demographic matrices (for years 1999–2005) of *Opuntia macrorhiza* (Cactaceae) at five plots (52, 57, 28, 61 and 102) in Boulder, Boulder County, Colorado. Plants are classified into five stages: plants with one cladode (stage I), 2–3 cladodes (stage II), 4–7 cladodes (stage III), 8–15 cladodes (stage IV) and > 15 cladodes (stage V). Average (across years) sample size (**N**) of plants monitored, average (across years) number of plants (**N₁**) with unknown parents and percentage (**P**) of plants with missing information of the number of cladodes (i.e., their stages) are also shown. Matrix elements represent transition rates between stages (see Fig. 1 of Appendix A) in a single year. See Materials and Methods for details about estimation of transition rates.

Plot 52 (N = 74; N₁ = 16; P = 2%) :

1999–2000

Stages	I	II	III	IV	V
I	0	0.0513	0	0	0
II	1.0	0.6923	0.25	1.50	0
III	0	0.1538	0.50	0	0
IV	0	0.0256	0.25	1.0	0
V	0	0	0	0	0

2000–2001

Stages	I	II	III	IV	V
I	0	0.0286	0	0	0
II	0.50	0.5429	0.25	0.6667	0
III	0	0.3429	0.333	0.6667	0
IV	0	0.0286	0.50	0.6667	0
V	0	0	0	0	0

2001–2002

Stages	I	II	III	IV	V
I	0	0	0.05	0.0909	0
II	1.0	0.3704	0.05	0.2727	0
III	0	0.3333	0.25	0.4545	0
IV	0	0.1111	0.35	0.4545	0
V	0	0.0370	0	0.1818	0

2002–2003

Stages	I	II	III	IV	V
I	0	0	0.0526	0.0667	0
II	0.5	1.0	0.2105	0.6667	0.3333
III	0.5	0.6	0.7368	0.7333	0.6667
IV	0	0	0.2632	0.4667	0
V	0	0	0	0.20	0.3333

2003–2004

Stages	I	II	III	IV	V
I	0	0.1613	0.0811	0.3333	0
II	0	0.4516	0.2162	0.5833	0
III	0	0.2581	0.4865	0.3333	0.5
IV	0	0.0323	0.1892	0.2500	0.5
V	0	0	0.0270	0.2500	0.25

2004–2005

Stages	I	II	III	IV	V
I	0.1765	0.0690	0.1875	0	0.40
II	0.3529	0.6897	0.3125	0.3846	0.20
III	0.1176	0.1724	0.3125	0.6154	0.40
IV	0	0	0.0313	0.2308	0.40
V	0	0	0	0	0.20

Plot 57 (N = 139; N₁ = 23; P = 9%):

1999–2000

Stages	I	II	III	IV	V
I	0.0952	0.0357	0.0313	0	0
II	0.3333	0.6548	0.4688	0.8421	1.0
III	0.1429	0.0595	0.1563	0	0
IV	0	0.0119	0.0938	0.1579	0
V	0	0.0119	0	0	0.40

2000–2001

Stages	I	II	III	IV	V
I	0	0.0102	0	0	0
II	1.0	0.3367	0.1538	0.1429	1.0
III	0	0.2857	0.0769	0	0
IV	0	0.1429	0.4615	0.4286	0
V	0	0.1429	0.1538	0.5714	1.0

2001–2002

Stages	I	II	III	IV	V
I	0	0.0667	0.0690	0	0
II	1.0	0.6222	0.5172	0.5652	0.2174
III	0	0.2889	0.2759	0.3043	0.1304
IV	0	0.0222	0.0690	0.3478	0.3043
V	0	0	0.0345	0	0.2174

2002–2003

Stages	I	II	III	IV	V
I	0	0.0968	0.0323	0.3889	0.1667
II	0.80	0.6774	0.3548	0.8889	1.0
III	0	0.1774	0.4516	0.1111	0.3333
IV	0	0	0.0645	0.3333	0.1667
V	0	0.0161	0	0.1111	0.1667

2003–2004

Stages	I	II	III	IV	V
I	0	0.1772	0.1034	0.444	0
II	0.533	0.4684	0.3793	0.8889	0
III	0	0.0886	0.2069	0.222	0
IV	0	0.0127	0.0690	0.111	0.25
V	0	0	0.0345	0	0.25

2004–2005

Stages	I	II	III	IV	V
I	0.0952	0.2031	0.20	0.40	0
II	0.5714	0.4844	0.40	1.0	1.0
III	0.0952	0.125	0.4667	0.40	0
IV	0	0.0313	0.0667	0.40	0
V	0	0.0156	0	0	0.50

Plot 28 (N = 71; N₁ = 18; P = 24%):

2000–2001

Stages	I	II	III	IV	V
I	0.2727	0.3750	0	0	0
II	0.0909	0.3000	0	0	0
III	0.1429	0.1000	0	0	0
IV	0	0	0	1.0	0
V	0	0	0	0	0

2001–2002

Stages	I	II	III	IV	V
I	0.0556	0	0	0	0
II	1.0	0.6923	4.2500	0	0
III	0.3889	0.1538	0.2500	1.0	0
IV	0.0556	0	0	0	0
V	0	0	0	0	0

2002–2003

Stages	I	II	III	IV	V
I	3.0	0.0455	0	0	0
II	7.0	0.4773	0.7273	0	0
III	2.0	0.1591	0.6364	0	0
IV	0	0	0	1.0	0
V	0	0	0	0	0

2003–2004

Stages	I	II	III	IV	V
I	0	0.0278	0.0625	0	0
II	2.0000	0.7500	0.7500	0	0
III	0.2000	0.1389	0.3750	1.0	0
IV	0	0	0.0625	0	0
V	0	0	0	0	0

2004–2005

Stages	I	II	III	IV	V
I	1.0	0.0612	0	0	0
II	2.0	0.6327	0.6154	0	0
III	0.5	0.1224	0.3846	1.0	0
IV	0	0	0	0	0
V	0	0	0	0	0

Plot 61 (N= 42; N₁ = 9; P = 14%):

2000–2001

Stages	I	II	III	IV	V
I	0	0.0952	0	0.1250	0
II	0	0.4286	0	0.5000	4.0
III	0	0.1905	0.3750	0.2500	0
IV	0	0	0.5000	0.3750	0
V	0	0	0	0.3750	0

2001–2002

Stages	I	II	III	IV	V
I	0	0.1176	0.1111	0.2857	0
II	0.3333	0.4706	0.4444	0.2857	0
III	0	0.2353	0.3333	0	0
IV	0	0.0588	0.1111	0.7143	0
V	0	0	0.1111	0.1429	0

2002–2003

Stages	I	II	III	IV	V
I	0.2000	0	0.4286	0.4286	0
II	0.4000	0.3333	0.2857	1.1429	0
III	0.2000	0.5333	0.8571	0.4286	0
IV	0	0	0.1429	0.4286	0
V	0	0.0667	0	0.1429	0

2003–2004

Stages	I	II	III	IV	V
I	0	0.2353	0.0556	0	0
II	0.1429	0.3529	0.4444	1.0000	0
III	0	0.0588	0.1667	0.7500	0
IV	0	0	0	0	0
V	0	0	0	0	0

2004–2005

Stages	I	II	III	IV	V
I	0.4000	0.0526	0	0	0
II	0.2000	0.5789	0.1429	0	0
III	0	0	0.1429	0	0
IV	0	0	0.1429	0	0
V	0	0	0	0	0

Plot 102 (N = 20; N₁ = 3; P = 28%):

2000–2001

Stages	I	II	III	IV	V
I	0	0.2000	1.0	0	0
II	2.0	0.5333	0	0	0
III	0	0.2000	1.0	0	0
IV	0	0	0	1.0	0
V	0	0	0	0	0

2001–2002

Stages	I	II	III	IV	V
I	0	0	0	0	0
II	1.20	0.5833	0.40	0	0
III	0	0.2500	0.40	0	0
IV	0	0	0	1.0	0
V	0	0	0	0	0

2002–2003

Stages	I	II	III	IV	V
I	0	0.3330	1.0000	0	0
II	0	0.6667	0.2000	0	0
III	0	0.1333	0.4000	0	0
IV	0	0	0.2000	0	0
V	0	0	0	1.0	0

2003–2004

Stages	I	II	III	IV	V
I	0	0	0	0	0
II	0.2857	0.0588	0.2000	1.0	1.0
III	0	0	0	0	0
IV	0	0	0	0	0
V	0	0	0	0	0

2004–2005

Stages	I	II	III	IV	V
I	0	0.1667	0	0	0
II	0	0.1667	0	0	0
III	0	0.1667	0	0	0
IV	0	0	0	0	0
V	0	0	0	0	0

TABLE B2: Soil type , topography, and grazing patterns of the five plots (52, 57, 28 , 61 and 102) of *Opuntia macrorhiza* (Cactaceae) from Boulder, Boulder County, Colorado.

Plot	Size(m ²)	Soil		Position			Grazing	
		Gravel	Grass	Flat	Hilltop	Slope(East)	Summer	Winter
28	100	X		X			X	
52	100	X			X			X
57	92	X		X				
61	100	X		X			X	
102	100		X			X		

TABLE B3: Mean vital rates and their coefficients of variation (CV: in parantheses) for the populations of cacti *Opuntia macrorhiza* in plots 52, 57, 28 , 61 and 102. Plants are classified into five stages: plants with one cladode (stage I), 2–3 cladodes (stage II), 4–7 cladodes (stage III), 8–15 cladodes (stage IV) and > 15 cladodes (stage V). Vital rate means are obtained across years, from 1998–99 to 2004–05. Vital rates whose CVs are > 1 are shown in shaded cells.

Plot 52

Stage	I	II	III	IV	V
I	0.029 (2.24)	0.052 (1.06)	0.062 (1.02)	0.082 (1.44)	0.275 (1.67)
II	0.558 (0.633)	0.625 (0.328)	0.215 (0.377)	0.679 (0.581)	0.089 (1.48)
III	0.103 (1.77)	0.310 (0.478)	0.436 (0.371)	0.467 (0.531)	0.261 (1.04)
IV	0	0.033 (1.13)	0.264 (0.543)	0.511 (0.514)	0.150 (1.43)
V	0	0.006 (2.23)	0.005 (2.23)	0.105 (1.02)	0.131 (1.04)

Plot 57

Stage	I	II	III	IV	V
I	0.032 (1.414)	0.098 (0.718)	0.073 (0.903)	0.206 (1.003)	0.028 (2.236)
II	0.706 (0.351)	0.541 (0.225)	0.379 (0.303)	0.721 (0.403)	0.703 (0.604)
III	0.039 (1.456)	0.171 (0.526)	0.272 (0.532)	0.173 (0.867)	0.077 (1.604)
IV	0	0.037 (1.314)	0.137 (1.057)	0.297 (0.403)	0.120 (1.054)
V	0	0.031 (1.62)	0.037 (1.466)	0.114 (1.834)	0.422 (0.668)

Plot 28

Stage	I	II	III	IV	V
I	0.8697 (1.3)	0.0528 (0.79)	0.0125 (2.0)	0.0118 (2.0)	0
II	2.6182 (0.88)	0.5678 (0.22)	1.2378 (1.23)	0.3776 (0.69)	0
III	0.5733 (1.28)	0.1462 (0.14)	0.3292 (0.63)	0.3077 (0.82)	0
IV	0.0515 (1.31)	0.0531 (1.52)	0.0432(1.25)	0.2824(1.39)	0
V	0	0	0	0	0

Plot 61

Stage	I	II	III	IV	V
I	0.1200(1.3)	0.1002 (0.78)	0.1190 (1.35)	0.1679 (0.99)	0
II	0.2152 (0.66)	0.4329 (0.20)	0.2635 (0.66)	0.5857 (0.73)	0.8000 (2.0)
III	0.0400 (2.0)	0.2036 (0.91)	0.3750 (0.69)	0.2857 (0.99)	0
IV	0	0.0118 (2.0)	0.1794 (0.94)	0.3036 (0.90)	0
V	0	0.0133 (2.0)	0.0222 (2.0)	0.1321 (1.04)	0

Plot 102

Stage	I	II	III	IV	V
I	0	0.1399 (0.91)	0.4000 (1.22)	0	0
II	0.6971 (1.13)	0.5018 (0.45)	0.1600 (0.94)	0.2000 (2.0)	0.2000 (2.0)
III	0.0400 (2.0)	0.1500 (0.56)	0.3600 (1.02)	0	0
IV	0	0	0.0400 (2.0)	0.4000 (1.22)	0
V	0	0	0	0.2000 (2.0)	0