Answers to Exercise 33

Reserve Design

1. The optimal habitat proportion is 16% habitat 1 and 84% habitat 2, producing 20 individuals of species 1 and 18 individuals of species 2, for a total abundance of 38 individuals of both species. You can't reach your objective of 20 individuals of both species.

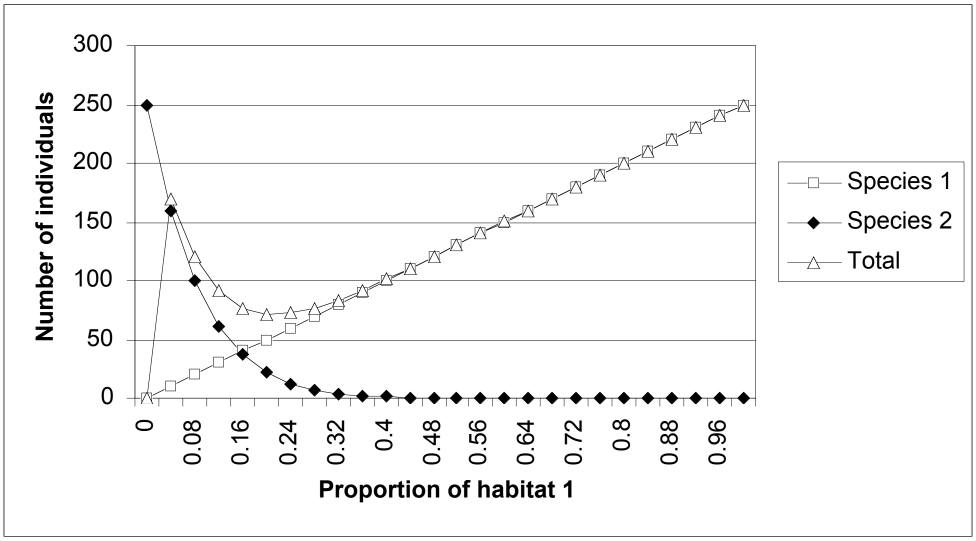
	L	M	N	O	P	Q
2		**Proportion of habitat**		**Number of individuals**		
3		Habitat 1	Habitat 2	Species 1	Species 2	Total
4	0	0	1	#NUM!	125	#NUM!
5	1	0.04	0.96	5	79.7799163	84.7799163
6	2	0.08	0.92	10	49.9546722	59.9546722
7	3	0.12	0.88	15	30.6351074	45.6351074
8	4	0.16	0.84	20	18.364629	38.364629
9	5	0.2	0.8	25	10.7374182	35.7374182
10	6	0.24	0.76	30	6.10744449	36.1074445
11	7	0.28	0.72	35	3.36951562	38.3695156
12	8	0.32	0.68	40	1.7968344	41.7968344
13	9	0.36	0.64	45	0.9223372	45.9223372
14	10	0.4	0.6	50	0.45349632	50.4534963
15	11	0.44	0.56	55	0.21231384	55.2123138
16	12	0.48	0.52	60	0.09396082	60.0939608
17	13	0.52	0.48	65	0.03895504	65.038955
18	14	0.56	0.44	70	0.01495855	70.0149585
19	15	0.6	0.4	75	0.00524288	75.0052429
20	16	0.64	0.36	80	0.00164527	80.0016453
21	17	0.68	0.32	85	0.00045036	85.0004504
22	18	0.72	0.28	90	0.00010367	90.0001037
23	19	0.76	0.24	95	1.9021E-05	95.000019
24	20	0.8	0.2	100	2.56E-06	100.000003
25	21	0.84	0.16	105	2.199E-07	105
26	22	0.88	0.12	110	9.2876E-09	110
27	23	0.92	0.08	115	1.0737E-10	115
28	24	0.96	0.04	120	5.2429E-14	120
29	25	1	0	125	0	125

2. The optimal habitat proportion is 4% habitat 1 and 96% habitat 2, producing 5 individuals of species 1 and 79 individuals of species 2, for a total abundance of 84 individuals of both species.

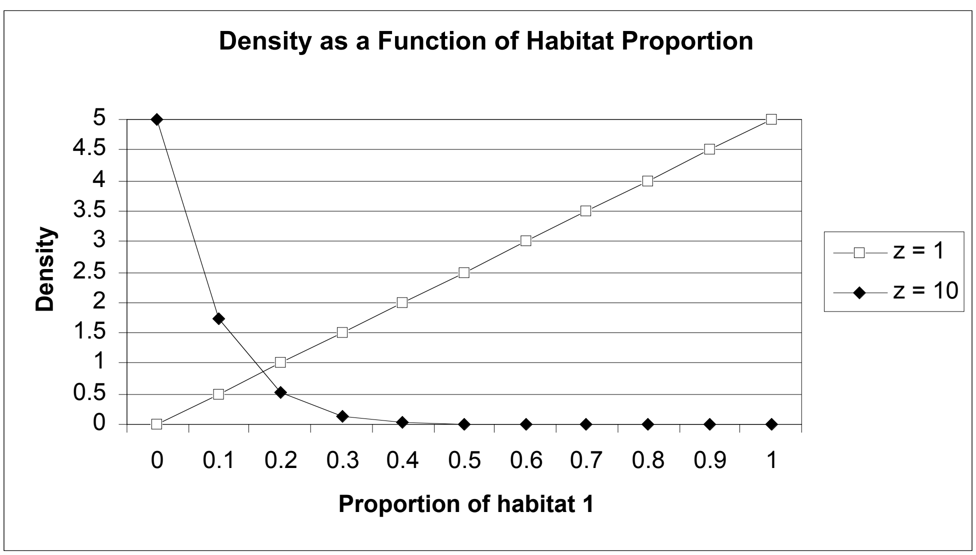
	L	M	N	O	P	Q
2		**Proportion of habitat**		**Number of individuals**		
3		Habitat 1	Habitat 2	Species 1	Species 2	Total
4	0	0	1	#NUM!	125	#NUM!
5	1	0.04	0.96	5	79.7799163	84.7799163
6	2	0.08	0.92	10	49.9546722	59.9546722
7	3	0.12	0.88	15	30.6351074	45.6351074
8	4	0.16	0.84	20	18.364629	38.364629
9	5	0.2	0.8	25	10.7374182	35.7374182
10	6	0.24	0.76	30	6.10744449	36.1074445
11	7	0.28	0.72	35	3.36951562	38.3695156
12	8	0.32	0.68	40	1.7968344	41.7968344
13	9	0.36	0.64	45	0.9223372	45.9223372
14	10	0.4	0.6	50	0.45349632	50.4534963
15	11	0.44	0.56	55	0.21231384	55.2123138
16	12	0.48	0.52	60	0.09396082	60.0939608
17	13	0.52	0.48	65	0.03895504	65.038955
18	14	0.56	0.44	70	0.01495855	70.0149585
19	15	0.6	0.4	75	0.00524288	75.0052429
20	16	0.64	0.36	80	0.00164527	80.0016453
21	17	0.68	0.32	85	0.00045036	85.0004504
22	18	0.72	0.28	90	0.00010367	90.0001037
23	19	0.76	0.24	95	1.9021E-05	95.000019
24	20	0.8	0.2	100	2.56E-06	100.000003
25	21	0.84	0.16	105	2.199E-07	105
26	22	0.88	0.12	110	9.2876E-09	110
27	23	0.92	0.08	115	1.0737E-10	115
28	24	0.96	0.04	120	5.2429E-14	120
29	25	1	0	125	0	125

This habitat is different than the optimal proportion found when the objective was 20 individuals per species. Specifically, the optimal proportion includes less of habitat 1 and fewer individuals of species 1, but a much larger total abundance across both species. The total abundance is much larger in this case because species 1 achieves the objective of 5 individuals with only 1 cell of habitat, at which time species 2 has many cells of habitat at close to the maximal density. species 2 does not reach the objective of 5 individuals until 80% of the habitat is habitat 2, allowing only 25 individuals of species 1 for a total abundance of 35 individuals. Thus, given these habitat associations and objectives, the optimal habitat proportion is mostly habitat 2.

3. As *d* increases, the carrying capacity of the habitat increases. As potential density increases, the range of abundance also increases for each species. Thus, fewer cells are necessary to achieve minimum abundances and higher abundances are possible. For example, here is a graph of abundances with d increased to 10.



As *z* increases, the critical threshold proportion increases for a species. In other words, a higher proportion of habitat is necessary for density to increase much above zero. For example, the graph below shows density as a function of proportion of habitat 1 with different values of *z*. Generally speaking, species with low value of *d* and high values of *z* are the limiting factors in reserve design considerations.



4. Habitat configuration B maximizes total abundance across the two species. This conclusion is reached by calculating the abundance of each species and total abundance for each habitat configuration. Configuration B provides the largest abundance of species 1 that was limited by patch sizes of at least 3 cells.

5. Habitat configuration B still maximizes total abundance across the two species. The abundance of species 1 is smaller with the larger minimum patch size requirement, causing the total abundances to be smaller as well. As the patch size requirements increase, the abundances are generally smaller because fewer cells meet the patch size requirement in any given configuration.