Lecture 10

Reproduction

WILD3810 (Spring 2019)

Readings

> Mills 70-71

Life tables

Last week, we learned *why* and *how* to estimate age-specific patterns of survival and mortality

TABLE 1

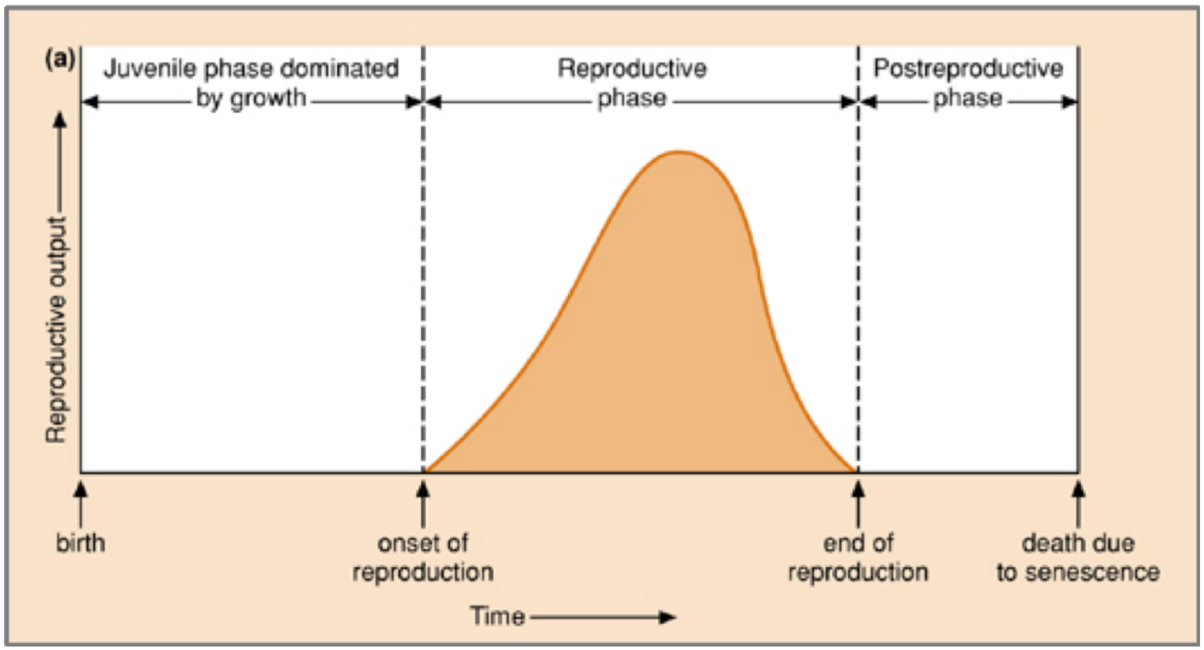
LIFE TABLE FOR *Phlox drummondii* AT NIXON, TEXAS

Age Interval (days) $x - x'$	Length of Interval (days) D_x	No. Surviving to Day x N_x	Survivorship l_x	No. Dying During Interval d_x	Average Mortality Rate Per Day q_x	Mean Expectation of Life (days) E_x
0– 63	63	996	1.0000	328	.0052	122.87
63–124	61	668	.6707	373	.0092	104.73
124–184	60	295	.2962	105	.0059	137.59
184–215	31	190	.1908	14	.0024	137.05
215–231	16	176	.1767	2	.0007	115.72
231–247	16	174	.1747	1	.0004	100.96
247–264	17	173	.1737	1	.0003	85.49
264–271	7	172	.1727	2	.0017	68.94
271–278	7	170	.1707	3	.0025	62.71
278–285	7	167	.1677	2	.0017	56.78
285–292	7	165	.1657	6	.0052	50.42
292–299	7	159	.1596	1	.0009	45.19
299–306	7	158	.1586	4	.0036	38.46
306–313	7	154	.1546	3	.0028	32.36
313–320	7	151	.1516	4	.0038	25.94
320–327	7	147	.1476	11	.0107	19.55
327–334	7	136	.1365	31	.0325	13.85
334–341	7	105	.1054	31	.0422	9.90
341–348	7	74	.0743	52	.1004	5.58
348–355	7	22	.0221	22	.1428	3.50
355–362	7	0	.0000			

Life tables

Survival is not the only demographic process that varies with age

Reproductive output also varies with age



Reproduction

Reproduction

Terminology

Breeding Probability

> chance an adult will breed

Natality:

> average number of offspring born per individual that reproduces

- Clutch Size: birds, monotremes, oviparous herps, fish & insects
- Litter Size: mammals, viviparous herps & fish
- Progeny number: all others

Reproduction

Terminology

Fecundity (m_x)

> average number of offspring born per mature adult of age x

- typically measured as the number of *female* offspring produced per adult female (limiting sex)

$$m_x = \frac{Breeding\ Probability_x \times Natality_x}{2}$$

Reproduction

Estimation

Breeding Probability estimation

- Advanced multi-state CMR methods
- Hormone analysis (blood, hair/feather, or fecal samples)
- Flowering rates in mature plants

Reproduction

Estimation

Breeding Probability estimation

- Advanced multi-state CMR methods
- Hormone analysis (blood, hair/feather, or fecal samples)
- Flowering rates in mature plants

Natality estimation

- Direct observations in a sample of clutches, litters, or seed sets
- Number of corpora lutea scars in ovaries of hunted mammals
- Field ultrasounds on live captured individuals

Reproduction

Estimation using life tables

- F_x: Total offspring produced by each age class

x	N_x	l_x	F_x		
0	996	1.000	-		
7	159	0.160	53		
8	154	0.155	485		
9	147	0.148	802		
10	105	0.105	972		
11	22	0.022	95		
12	0	0.000	-		

Reproduction

- m_x: Number of offspring produced per living individual in age class x (fecundity)

x	N_x	l_x	F_x	m_x	
0	996	1.000	-	-	
7	159	0.160	53	0.33	
8	154	0.155	485	3.13	
9	147	0.148	802	5.42	
10	105	0.105	972	9.26	
11	22	0.022	95	4.31	
12	0	0.000	-	-	

Reproduction

- $l_x m_x$: Number of offspring produced per **original** individual

(x)	(N_x)	(l_x)	(F_x)	(m_x)	(l_xm_x)
0	996	1.000	-	-	-
7	159	0.160	53	0.33	0.0528
8	154	0.155	485	3.13	0.48515
9	147	0.148	802	5.42	0.80216
10	105	0.105	972	9.26	0.9723
11	22	0.022	95	4.31	0.09482
12	0	0.000	-	-	-

R_0: Basic reproductive rate $= \sum l_x m_x = \frac{\sum F_x}{N_0} = 2.41$

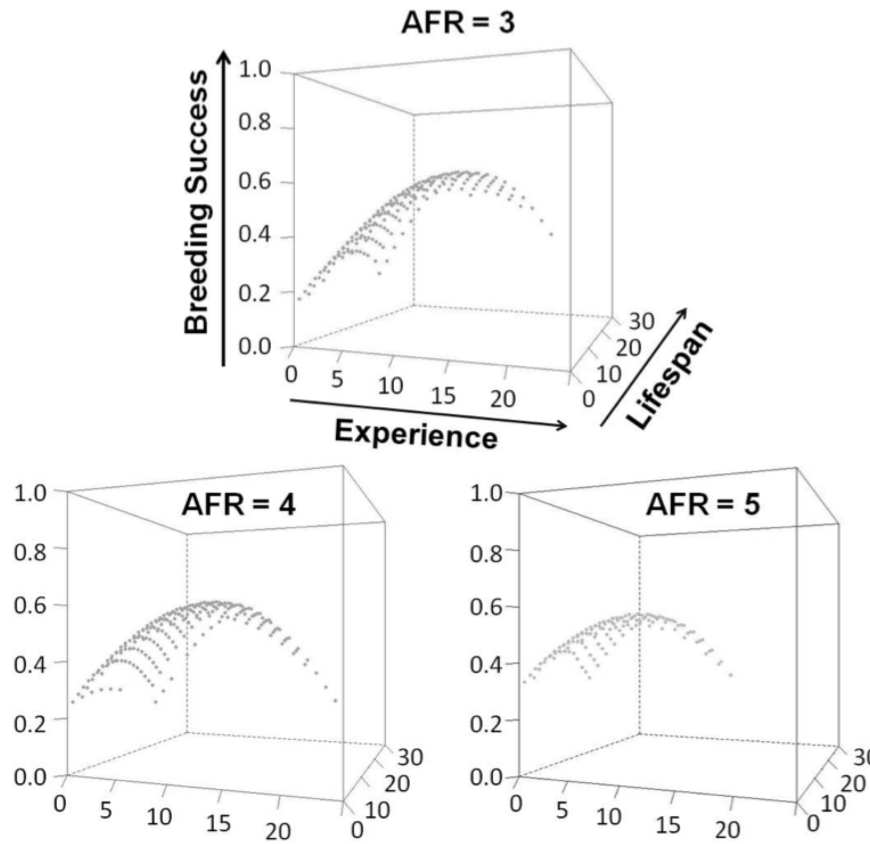
Reproduction

R_0: Basic reproductive rate

- includes the influence of both survival (l_x) and reproduction of survivors (m_x)
    - 15.5% of individuals survive to age 8
    - those survivors produce, on average, 3.13 offspring
    - the average number of offspring produced by 8yo individuals **per original individual** = 0.48
- defines the overall extent to which population changes
    - $R_0 = 1$ means the population exactly replaces itself per *generation*
- $r \approx \frac{ln(R_0)}{T}$
    - T = **average cohort lifespan** (average time from the birth of an individual to the birth of its offspring)
    - annual species: $T = 1, r = ln(R_0)$

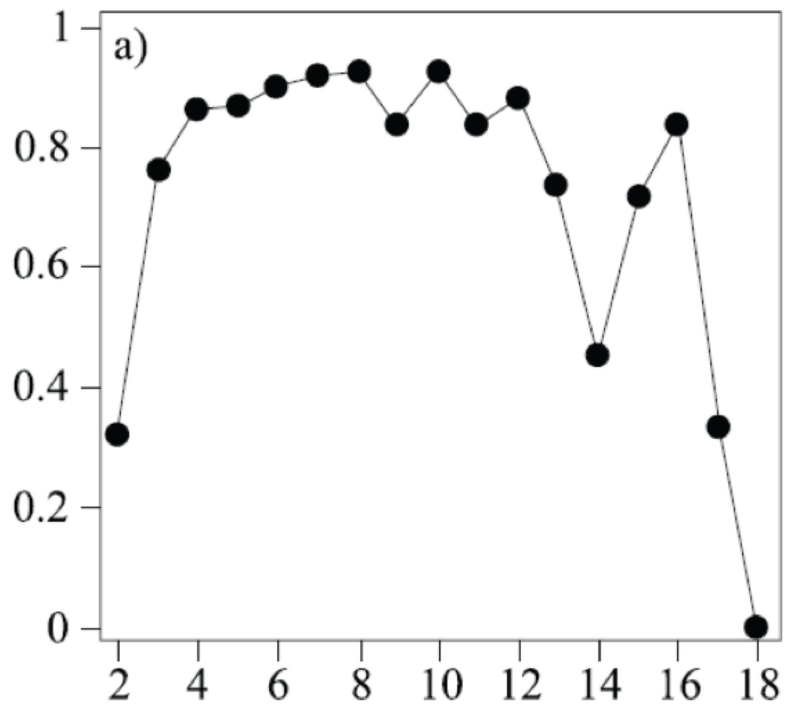
Fecundity schedules

Fecundity schedules



Fecundity schedules

Breeding probability vs. age



Fecundity schedules

Change in Canadian fecundity schedules over time

Births/1000 women