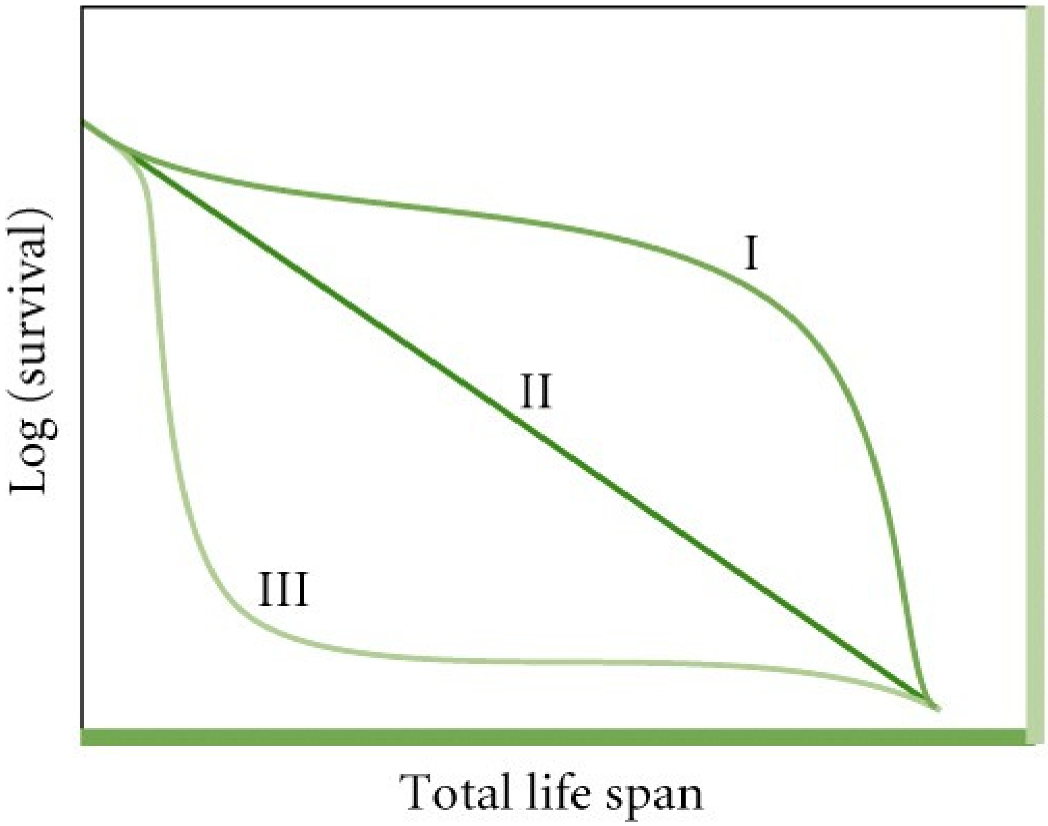
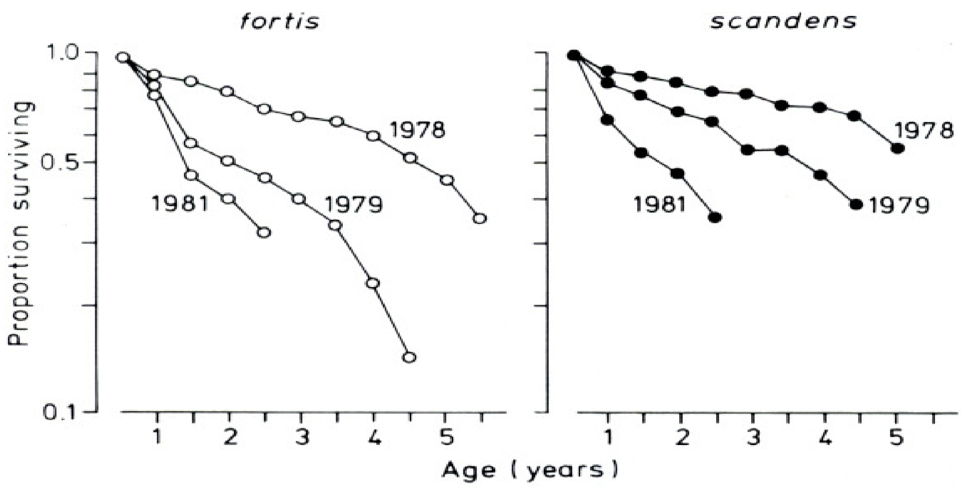
Survivorship Curves (Ricklefs & Miller, 1999)



Type I: 3 phases, most mortality post-breeding

Type II: "Constant" proportional survival

Type III: Most mortality pre-breeding



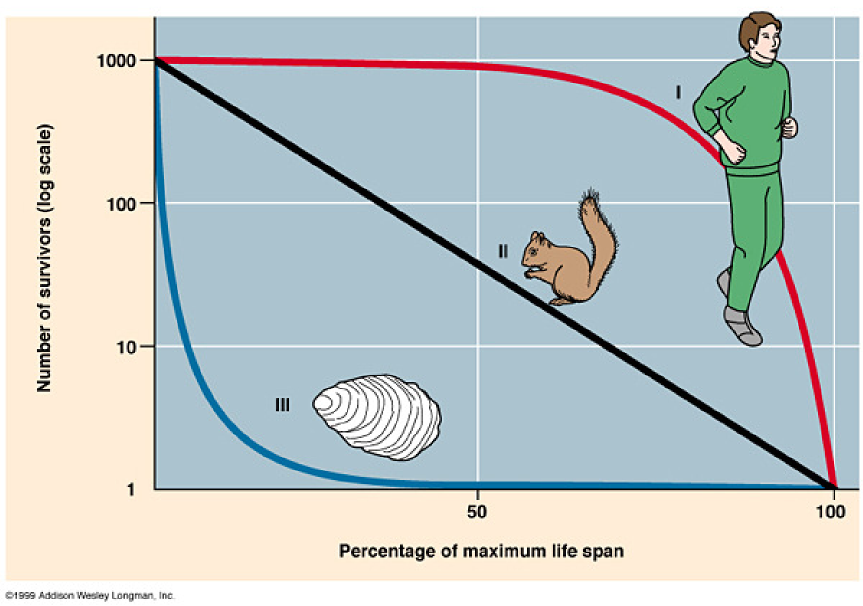
Geospiza sp (Gibbs & Grant, 1987)

Survivorship curves & type organism

Type I: large mammals (and *Drosophila*)

Type II: birds, small mammals, amphibians, reptiles

Type III: fish, invertebrates, plants



Life History: Survival and Fecundity

Survival Can Depend on Individual's Age *x*

Age-Specific Fecundity:

Mean Daughters/Female at Age x, rhesus

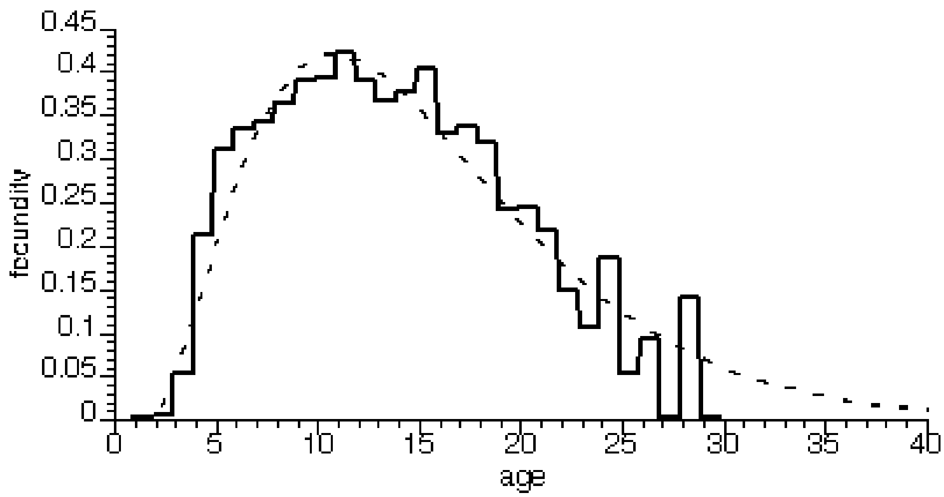


Figure 3a. presents the Gamma distribution (dashed line) fit to the observed Rhesus fecundity distribution (solid line).

Horses

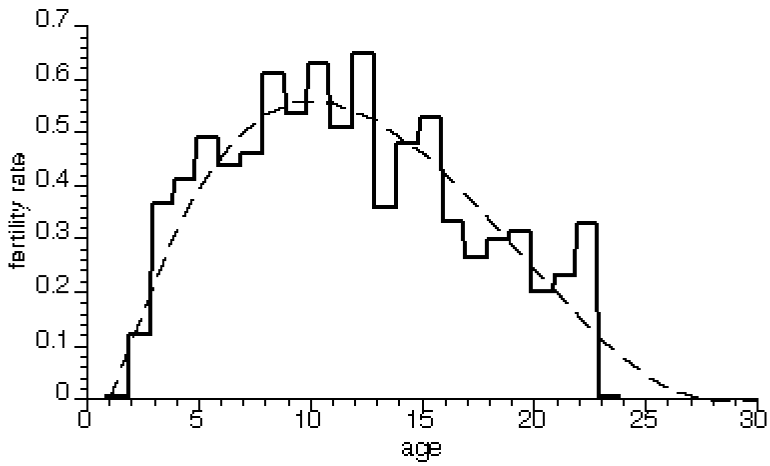
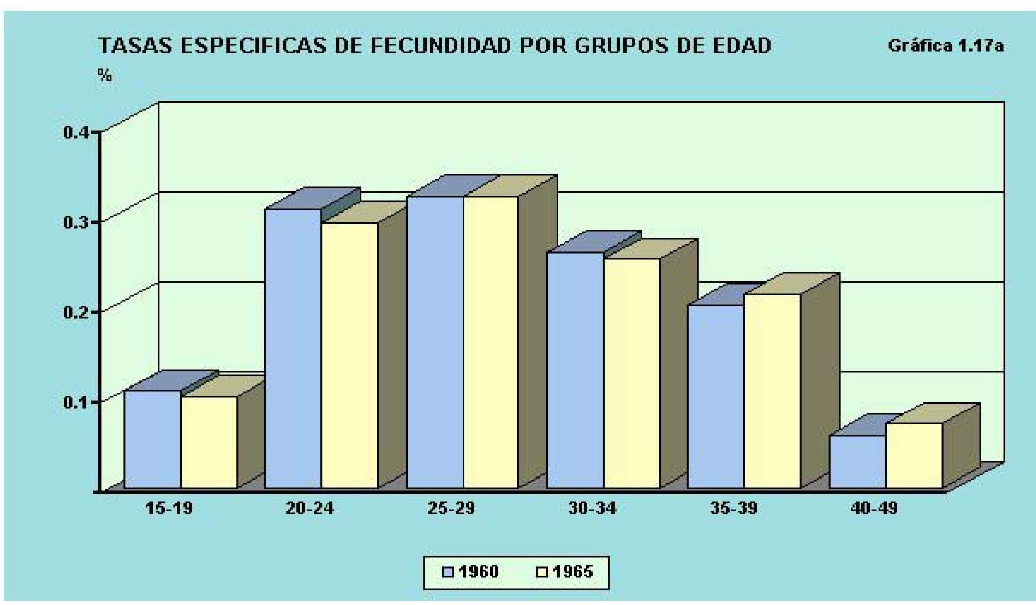


Figure 2c. presents the Brass polynomial (dashed line) fit to the observed Prizwalski's horse fecundity distribution (solid line).

CSDA, UAlbany (2000)



INEGI (2000)

Demography, Age-specific survival & fecundity

Note: To produce *b(x)* daughters at age *x*, female must

survive to *x*-yr old reproductive status

Life Table

1. *Age x* (age class $x + 1$); **Age begins at 0**

2. *Survival*
   From age 0 (newborn) ordinarily

3. *Fecundity* at age *x*

Life Table *to* **Individual's Net Reproductive Rate**

Age Structure → **Population Growth**, Estimate *r*

x: Age 0, 1, …*k* (*k* is maximal age)

$\mathbf{N}_x$: Number of cohort alive at age x ($N_0 = 1000$, ♀♀)

$\boldsymbol{b_x}$: Births per *x*-year old ♀

Age x	No. Surviving N_x	Births b_x
0	1000	0
1	400	1.5
2	240	2
3	0	-

Analyze Life Table

1. $N_x \rightarrow \boldsymbol{g_x}$: Proportion age x survive to age (x + 1)

2. $g_x \rightarrow \boldsymbol{l_x}$: Proportion newborns survive to age (x)

$$l_x = \prod_{i=0}^{x-1} g_i$$

$$\boldsymbol{g_x = l_{x+1} / l_x}$$

3. Calculate Net Reproductive Rate $\boldsymbol{R_0}$

$$R_0 = \sum_{x=0}^{k} l(x) b(x) \quad = \quad \sum_{x=\alpha}^{\omega} l(x) b(x)$$

Age first reproduction or 0; Age last reproduction or *k*

Net Reproductive Rate: Mean Number of Female Offspring Produced by a Female over *Her Lifetime*

$\boldsymbol{R_0}$ Units: Offspring/**Generation**
Not Offspring per Year(s)

$\boldsymbol{R_0} < 1$, Population declines

$\boldsymbol{R_0} > 1$, Population grows

How fast in absolute (real) time?

To compare populations/species

Female lifetime can differ

Estimate r

Life Table

Age x	No. Surviving N_x	Births b_x
0	1000	0
1	400	1.5
2	240	2
3	0	-

$g_0 = N_1/N_0 = 400/1000 = 0.4$

$g_1 = N_2/N_1 = 240/400 = 0.6$

$g_2 = 0$

$l_0 = 1$ (*definition*)

$l_1 = g_0 = 0.4$

$l_2 = (g_0)\ g_1 = (0.4)\ 0.6 = 0.24$

$l_3 = 0$

$$R_0 = \sum_{x=\alpha}^{\omega} l_x b_x = l_1 b_1 + l_2 b_2 = (0.4)(1.5) + (0.24)(2) = 0.6 + 0.48 = 1.08$$

$R_0 > 1$ Population size increases (eventually, at least)

Generation Time *G*

Average age of parents,
across all offspring produced by a single cohort

$$G = \frac{\sum_{x=0}^{k} L(x)\, b(x)\, x}{\sum_{x=0}^{k} L(x)\, b(x)}$$

G years (units of time)

G = [0 + 0.4 (1.5) 1 + 0.24 (2) 2] / [0 + 0.4 (1.5) + 0.24 (2)]

G = [0.6 + 0.96] / [0.6 + 0.48] = 1.56 / 1.08 = 1.44

Estimate *r*

Assume exponential growth of *entire* population

Sum over all ages x

Growth for one generation length G; N_0 initial size

$$N_G = N_0 \, e^{rG}$$

Divide by (arbitrary) initial population size

$$N_G / N_0 = e^{rG}$$

N_G / N_0 All daughters /all female parents, *One Generation*

$$N_G / N_0 \approx R_0$$

Substitute

$$R_0 \approx e^{rG}$$

Logs, and

$$r \approx \ln(R_0) / G$$

Intrinsic rate of increase for growing population

Greater as R_0 increases

Smaller as generation time increases

$r = \ln(1.08) / 1.44 = 0.077 / 1.44 = 0.053 > 0$