Some Abalone Data and an Intro To Parameter Estimation

Gorka Bidegain[1]
Tal Ben-Horin[2]

[1] Gulf Coast Research Lab, University of Southern Mississippi
[2] Haskins Shellfish Research Lab, Rutgers University

RCN Marine Disease Modeling and Transmission Workshop, 11-15 May 2015
Center for Coastal Physical Oceanography
Old Dominion University, Norfolk, Virginia 23529

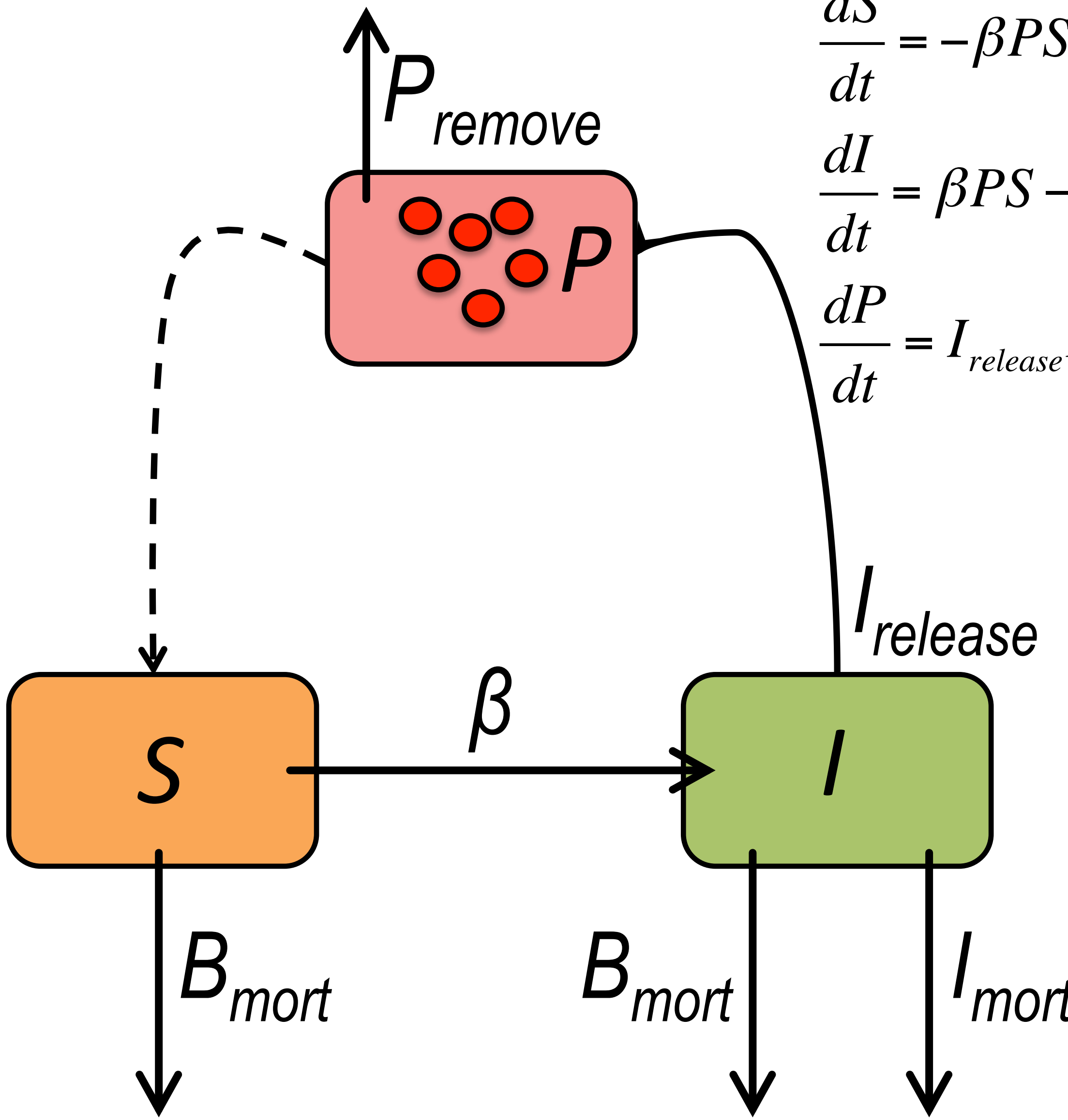
THE UNIVERSITY OF SOUTHERN MISSISSIPPI
GULF COAST RESEARCH LABORATORY

RUTGERS
THE STATE UNIVERSITY OF NEW JERSEY
Haskin Shellfish Research Laboratory

CENTER FOR COASTAL PHYSICAL OCEANOGRAPHY
OLD DOMINION UNIVERSITY

NSF

Recap: a simplified particle contact model

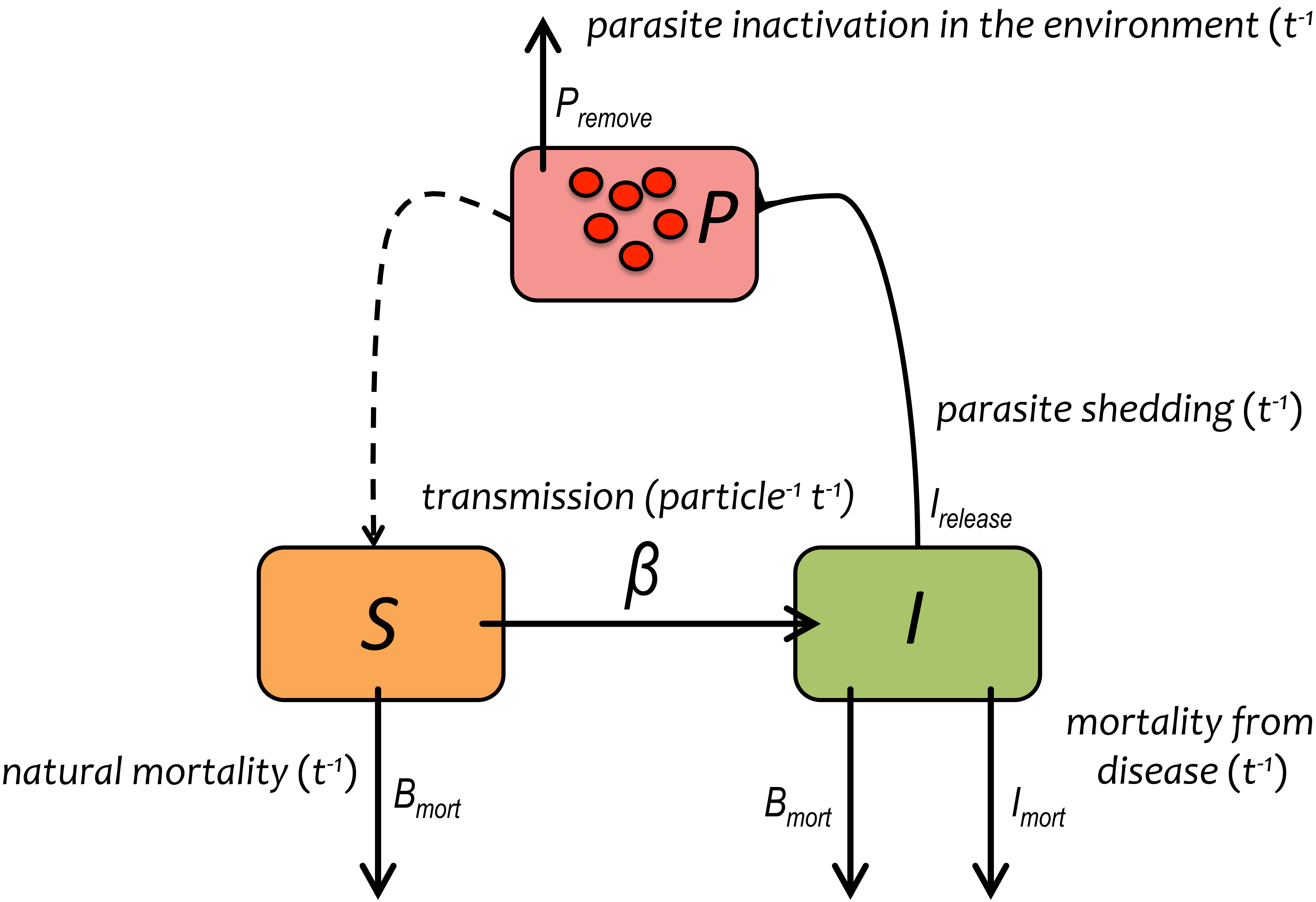


$$\frac{dS}{dt} = -\beta PS - B_{mort} S$$

$$\frac{dI}{dt} = \beta PS - (B_{mort} + I_{mort}) I$$

$$\frac{dP}{dt} = I_{release} I - P_{remove} P$$

Common ecological rate parameters



Transmission (β) and the force of infection (λ)

$$\lambda = \frac{\text{\# of new infections}}{\text{\# exposed * duration of exposure}}$$

Transmission (β) and the force of infection (λ)

$$\lambda = \frac{\text{\# of new infections}}{\text{\# exposed} * \sout{\text{duration of exposure}}}$$

If λ is a *per capita* instantaneous incidence of infection, under density dependent transmission $\lambda = \beta P$

$$\beta = \frac{\lambda}{P}$$

Observations of the abalone WS-RLO system

Parameter	Definition	Value	Reference
B_{mort}	Natural mortality rate	0.15 yr^{-1}	Tegner et al (1989)
I_{mort}	WS mortality rate	0.05 – 0.90 yr^{-1}	Moore et al (2011)
β	Coefficient of transmission	?	
$I_{release}$	Production of infectious stages	?	
P_{remove}	Parasite inactivation in the environment	52.14 – 365 yr^{-1}	C. Friedman *pers. comm.*

Parameter estimation – mortality

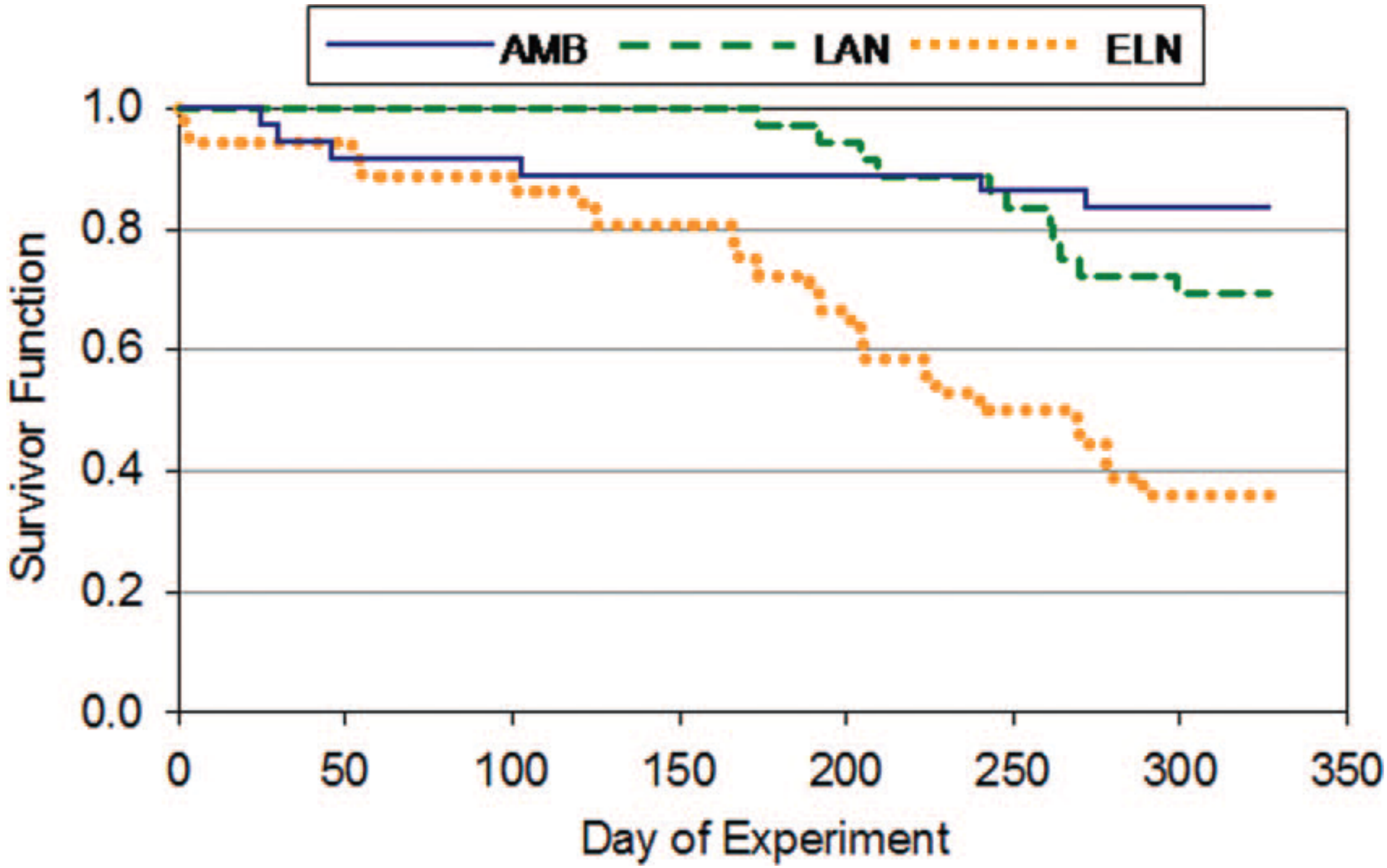
Estimating survival or mortality is a problem of estimating the proportion of individuals that survive or die from one time period to the next

Parameter estimation – mortality

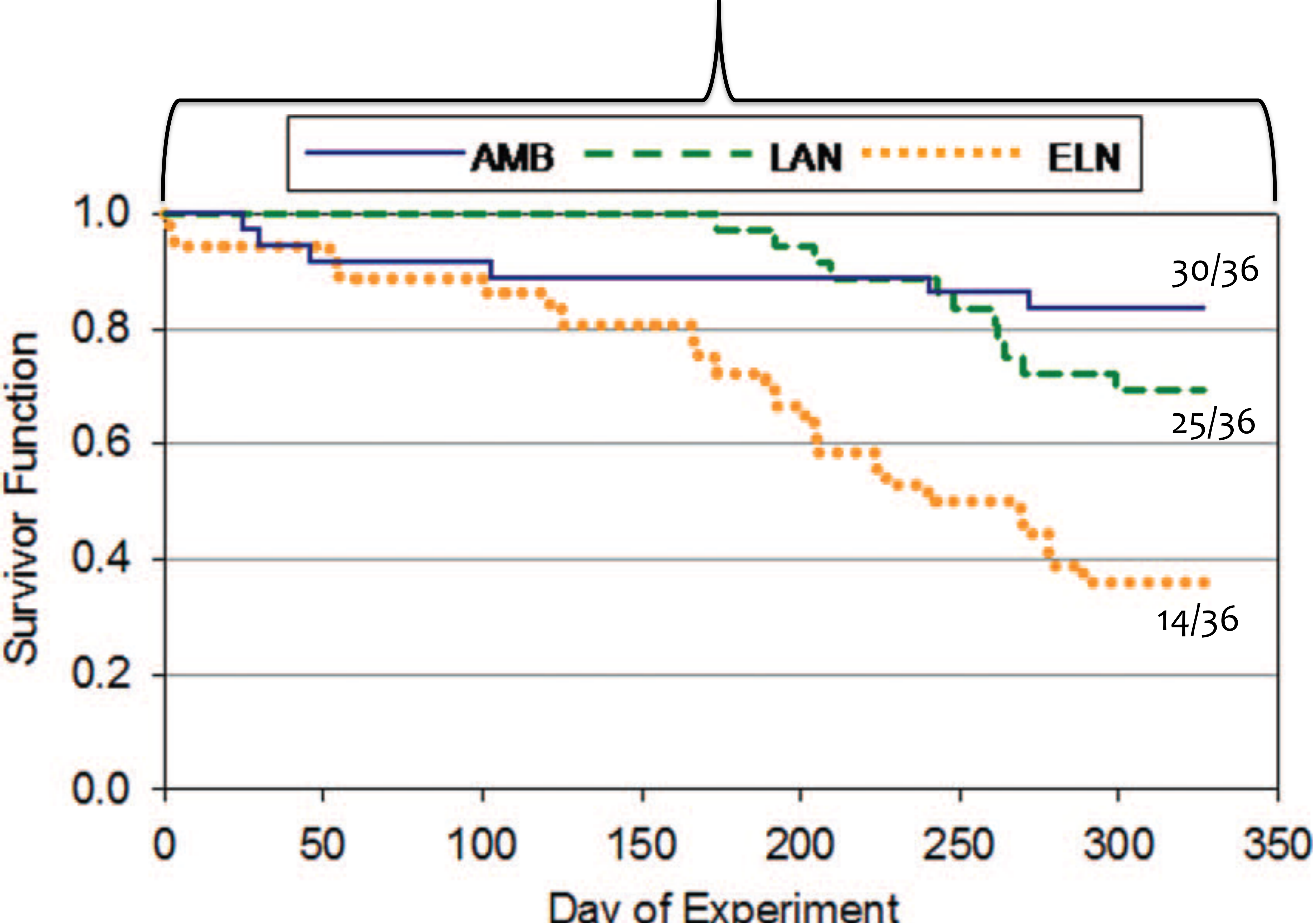
Estimating survival or mortality is a problem of estimating the proportion of individuals that survive or die from one time period to the next

If the rate of an event happening to any one individual is ***p***, and there are ***n*** independent individuals, the number of individuals ***y*** to which the event happens follows a **binomial** distribution

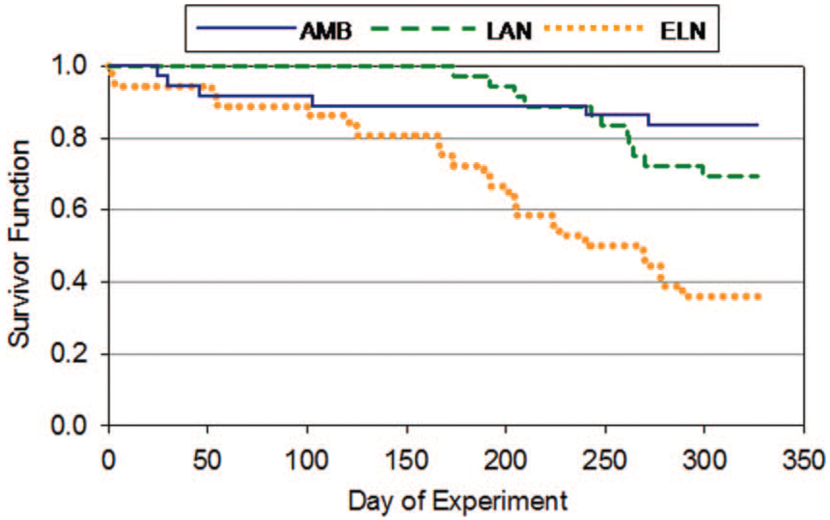
$$LogL(p \mid n, y) = y\log(p) + (n - y)\log(1 - p)$$



Moore et al (2011)

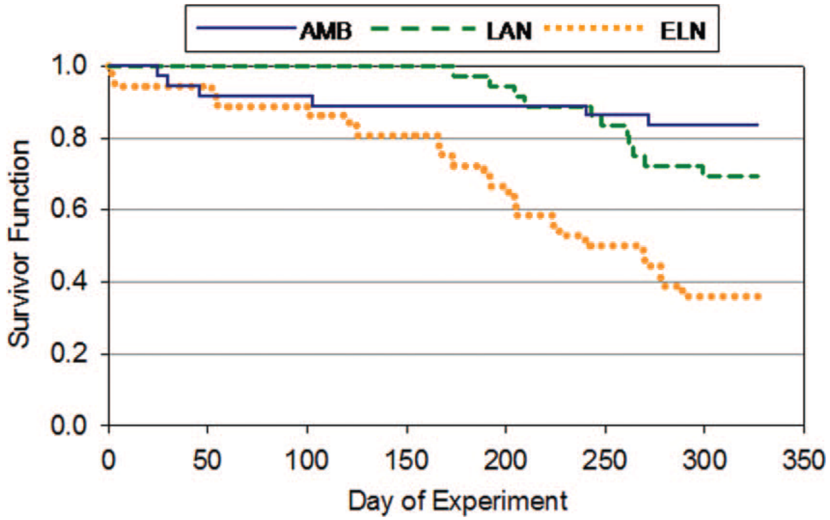


Moore et al (2011)



$$p = e^{(B_{mort} + I_{mort})t}$$

$$LogL(p \mid n, y) = y\log(p) + (n - y)\log(1 - p)$$



$$p = e^{(B_{mort} + I_{mort})t}$$

$$LogL(p \mid n, y) = y \log(p) + (n - y) \log(1 - p)$$

$$LogL(I_{mort} \mid n, y) = y(0.15 + I_{mort})t + (n - y) \log[1 - e^{(0.15 + I_{mort})t}]$$

Lets try it!

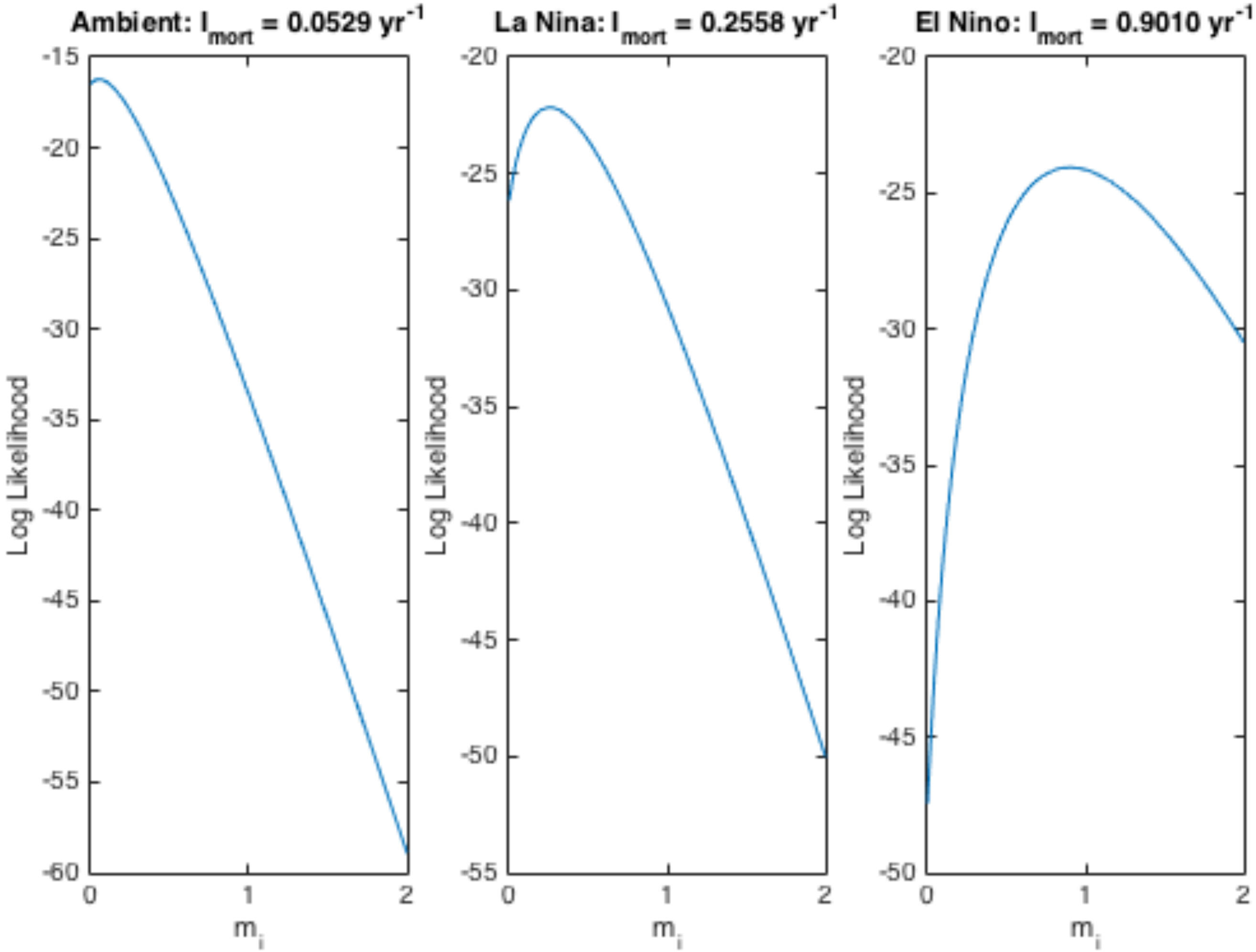
$$LogL(I_{mort} \mid n, y) = y(0.15 + I_{mort})t + (n - y)\log[1 - e^{(0.15+I_{mort})t}]$$

Function files

- binoLogLike.m
- binoNLogLike.m

Scripts

- fit_mortality.m



Ambient: l_{mort} = 0.0529 yr^{-1}
La Nina: l_{mort} = 0.2558 yr^{-1}
El Nino: l_{mort} = 0.9010 yr^{-1}
Log Likelihood
m_i