
FoxTrot
by Bill Amend
"A MATH TEACHER OFFERS TO ASSIGN ONE SECOND OF HOMEWORK THE FIRST WEEK OF SCHOOL, TWO SECONDS THE SECOND WEEK, FOUR SECONDS THE THIRD, AND SO ON."
A
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"IF THE AMOUNT OF HOMEWORK DOUBLES EVERY WEEK, IS THIS SOMETHING YOU WOULD AGREE TO FOR THE DURATION OF THE 36-WEEK SCHOOL YEAR?"
9-10
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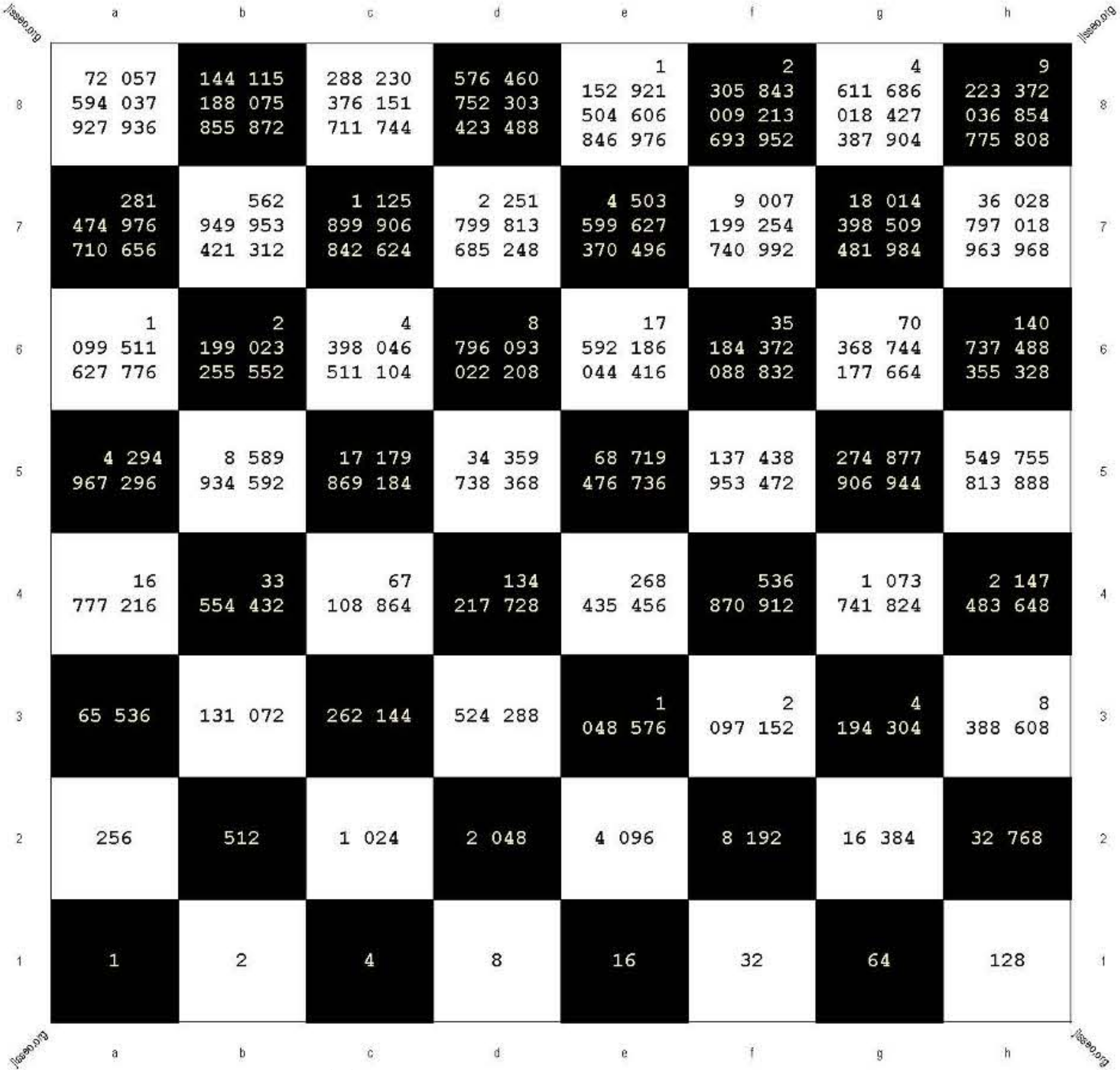
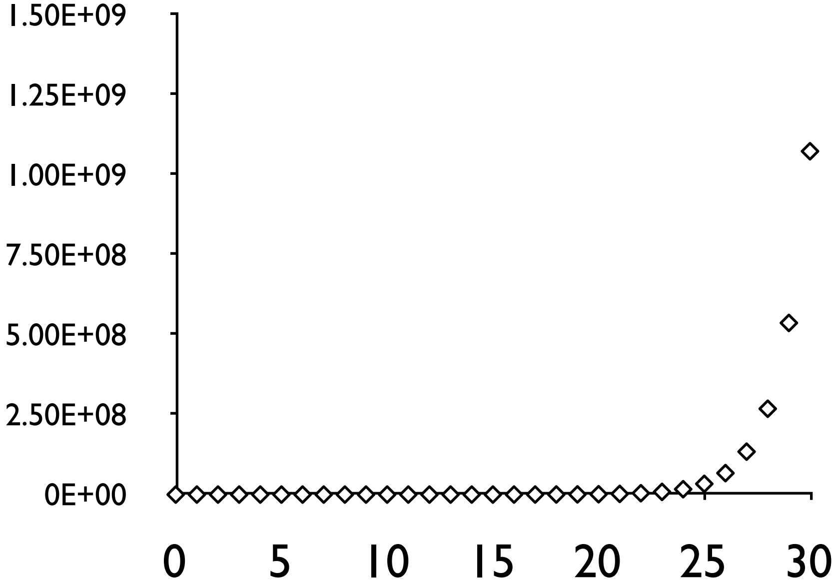
I'M A LITTLE WORRIED ABOUT ANSWERING THIS ONE WRONG.
IS THAT MR. THOMPSON? HE'S EVIL.
A
AMEND

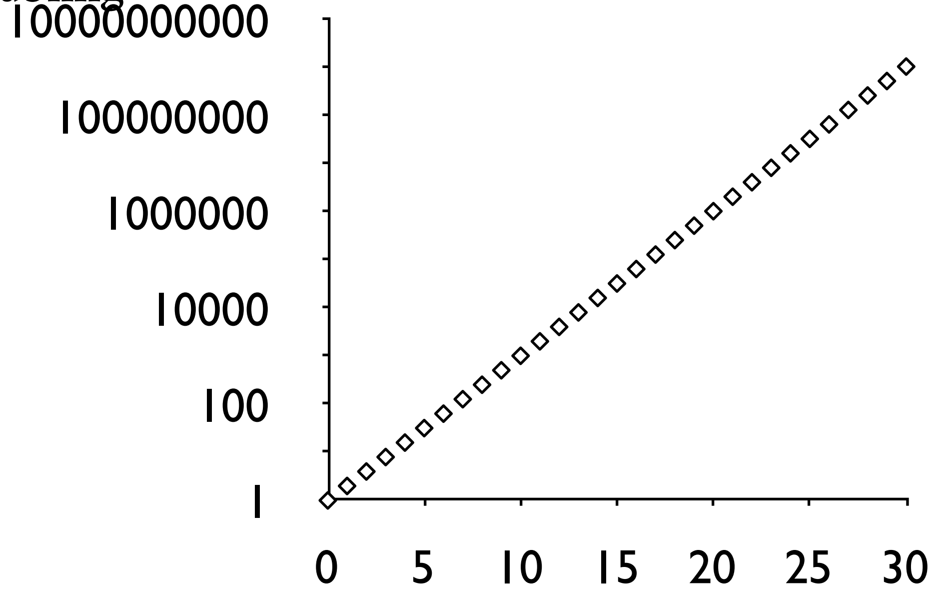


	a	b	c	d	e	f	g	h	
8	72 057 594 037 927 936	144 115 188 075 855 872	288 230 376 151 711 744	576 460 752 303 423 488	1 152 921 504 606 846 976	2 305 843 009 213 693 952	4 611 686 018 427 387 904	9 223 372 036 854 775 808	8
7	281 474 976 710 656	562 949 953 421 312	1 125 899 906 842 624	2 251 799 813 685 248	4 503 599 627 370 496	9 007 199 254 740 992	18 014 398 509 481 984	36 028 797 018 963 968	7
6	1 099 511 627 776	2 199 023 255 552	4 398 046 511 104	8 796 093 022 208	17 592 186 044 416	35 184 372 088 832	70 368 744 177 664	140 737 488 355 328	6
5	4 294 967 296	8 589 934 592	17 179 869 184	34 359 738 368	68 719 476 736	137 438 953 472	274 877 906 944	549 755 813 888	5
4	16 777 216	33 554 432	67 108 864	134 217 728	268 435 456	536 870 912	1 073 741 824	2 147 483 648	4
3	65 536	131 072	262 144	524 288	1 048 576	2 097 152	4 194 304	8 388 608	3
2	256	512	1 024	2 048	4 096	8 192	16 384	32 768	2
1	1	2	4	8	16	32	64	128	1
	a	b	c	d	e	f	g	h	

http://mathsyear7.wikispaces.com/Compounds

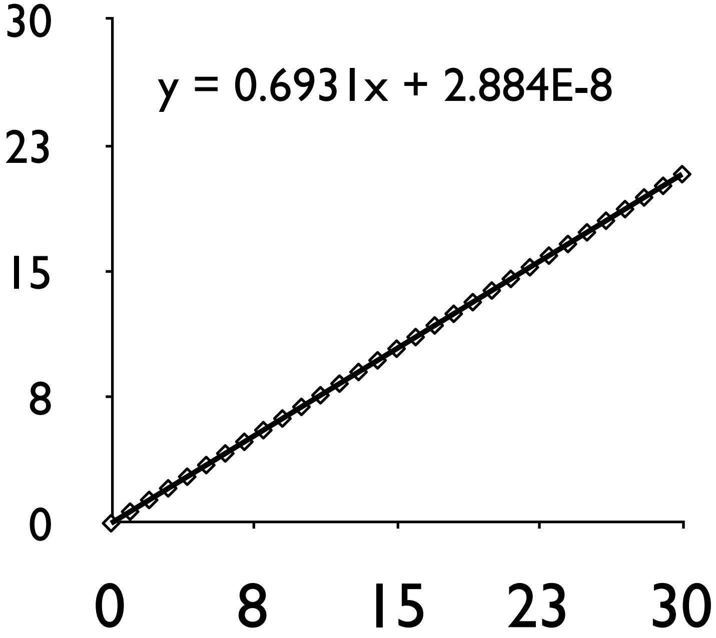
Doubling



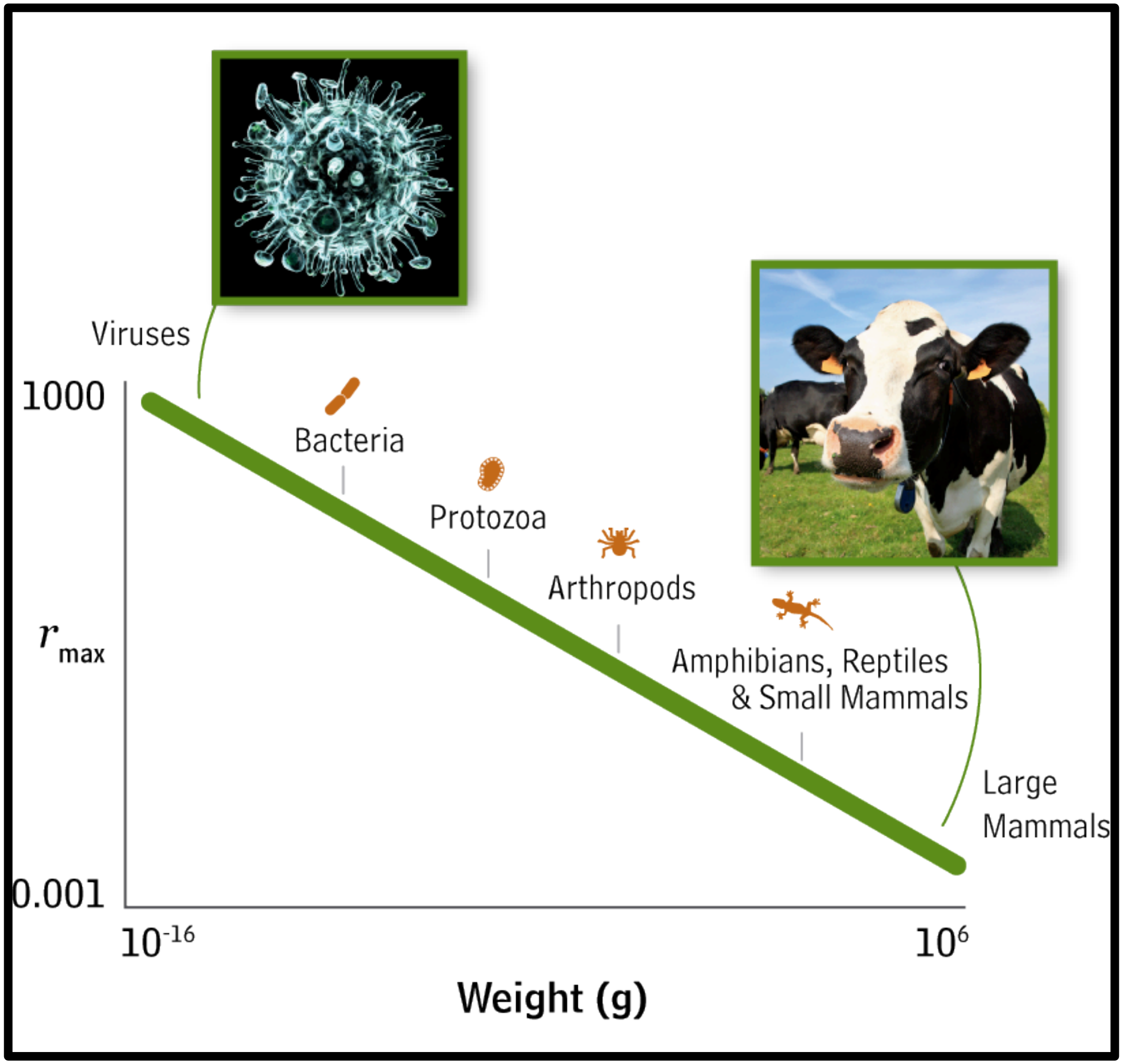


$$\lambda = \exp(r) = \exp(\text{slope})$$
$$= \exp(0.69314718) = 2$$

$$N_0 = \exp(\text{intercept})$$
$$= \exp(-0.0000288) \approx 1$$



Larger species tend to have lower r_{max} values:



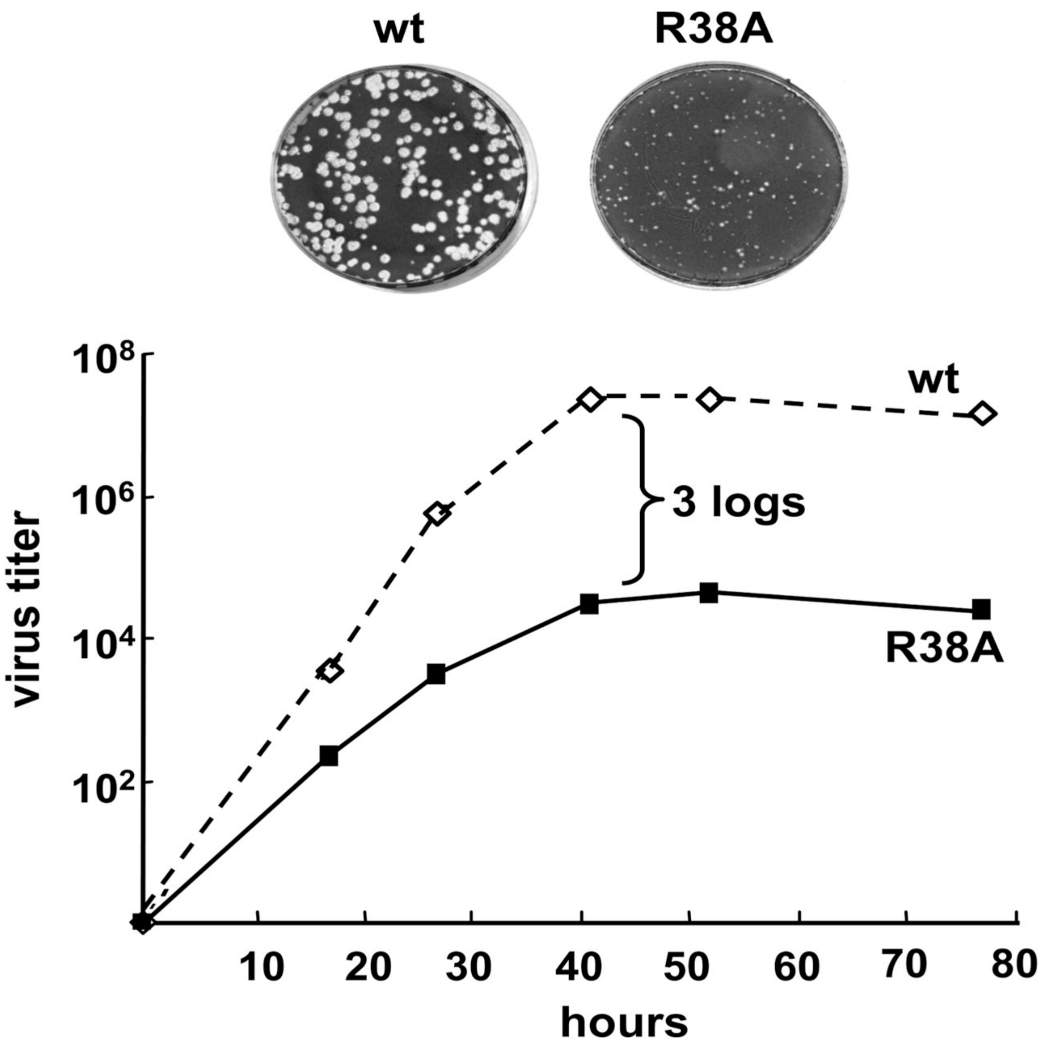
Why use models?

- Define most important parts/processes
- Clarify assumptions
- Express things simply and clearly
- Compare systems
- Make predictions (to test the model, to manage the process)
- Discover how complex behaviors merge from simple interactions
- When model does not fit, you're missing something important. Discovering why is interesting

Keep in mind…

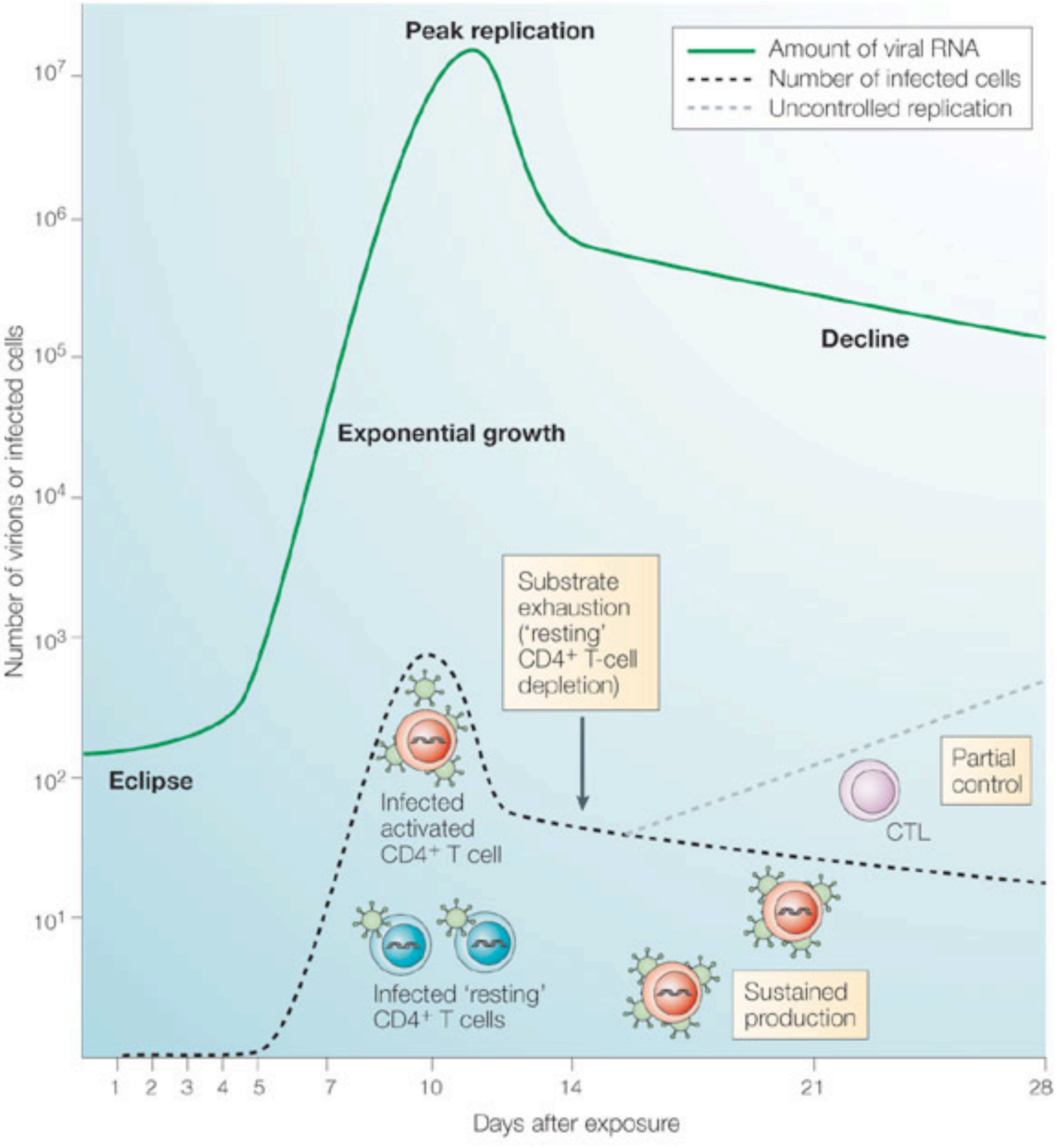
- “A model does nothing but expose the consequences of the assumptions upon which it is based.” - Eric Schauber & Rick Ostfeld *Ecological Applications,* 12(4), 2002, pp. 1142–1162
- “There's no sense in being precise when you don't even know what you're talking about.” - John von Neumann (1903-1957)
- “Essentially, all models are wrong, but some are useful.” In George E. P. Box and Norman R. Draper, *Empirical Model-Building and Response Surfaces (2007), 414.*
- “Make things as simple as possible, but no simpler.” –attributed to Albert Einstein

The R38A influenza A/Udorn/72 mutant virus is attenuated.



Min J , and Krug R M PNAS 2006;103:7100-7105

Virus replication in culture initially follows exponential growth curve



Nature Reviews | Immunology

Virus replication in host cells initially follows exponential growth curve

Bacterial growth in optimal, bioreactor conditions

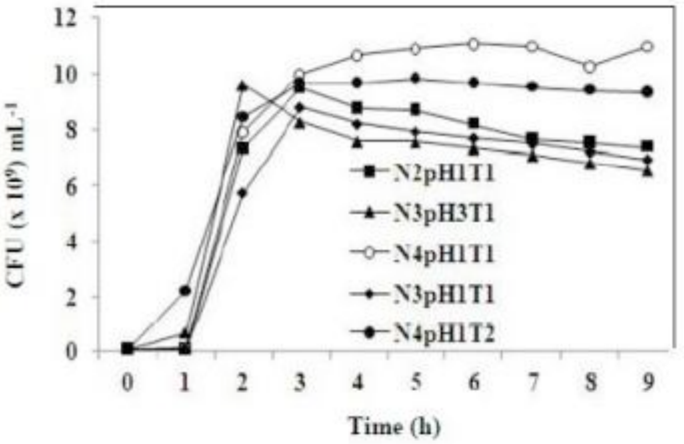


Figure 4. Growth of *Proteus* sp. on flask treatments (6.8 x 10^7 CFU mL^{-1}, to T=0 d).

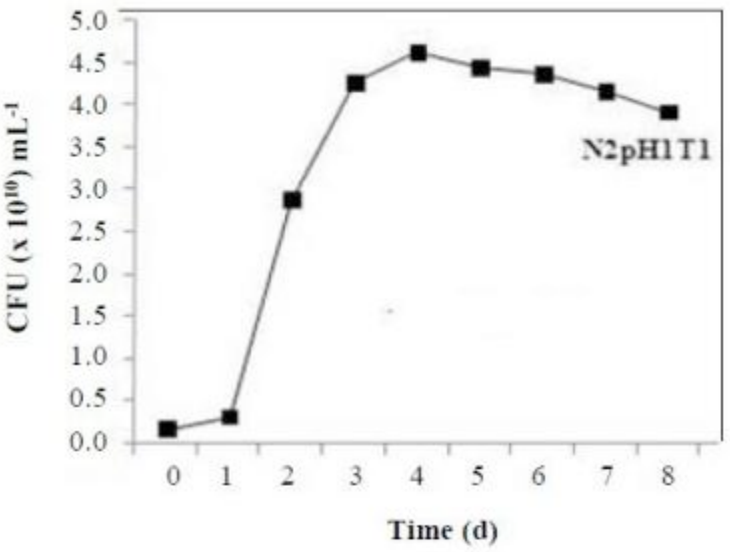


Figure 6. Growth of *Proteus* sp. on bioreactor treatment (4.3 x 10^8 CFU mL^{-1}, to T=0 d).

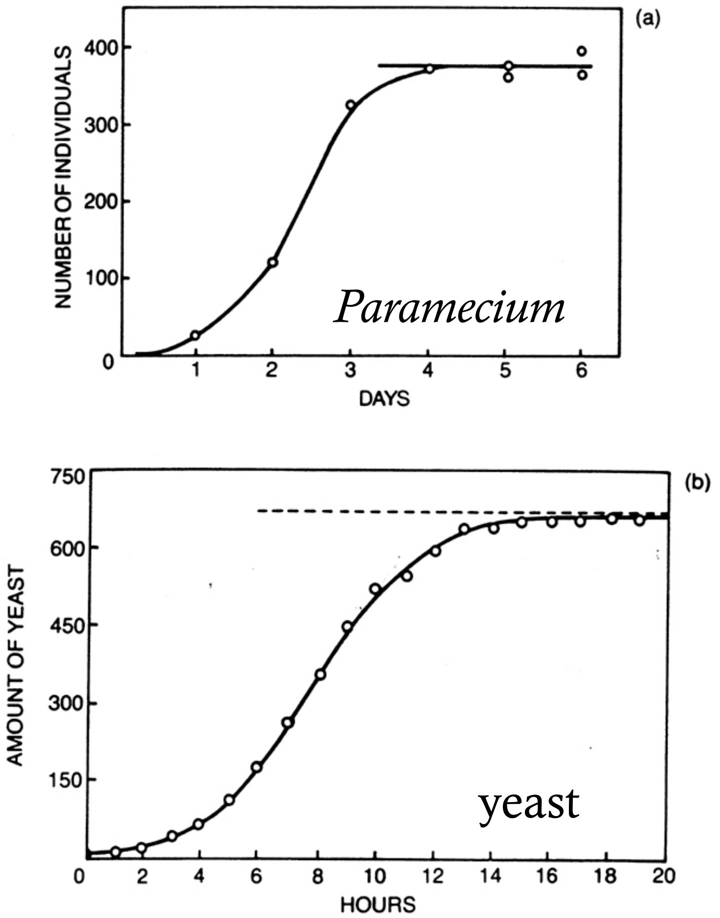
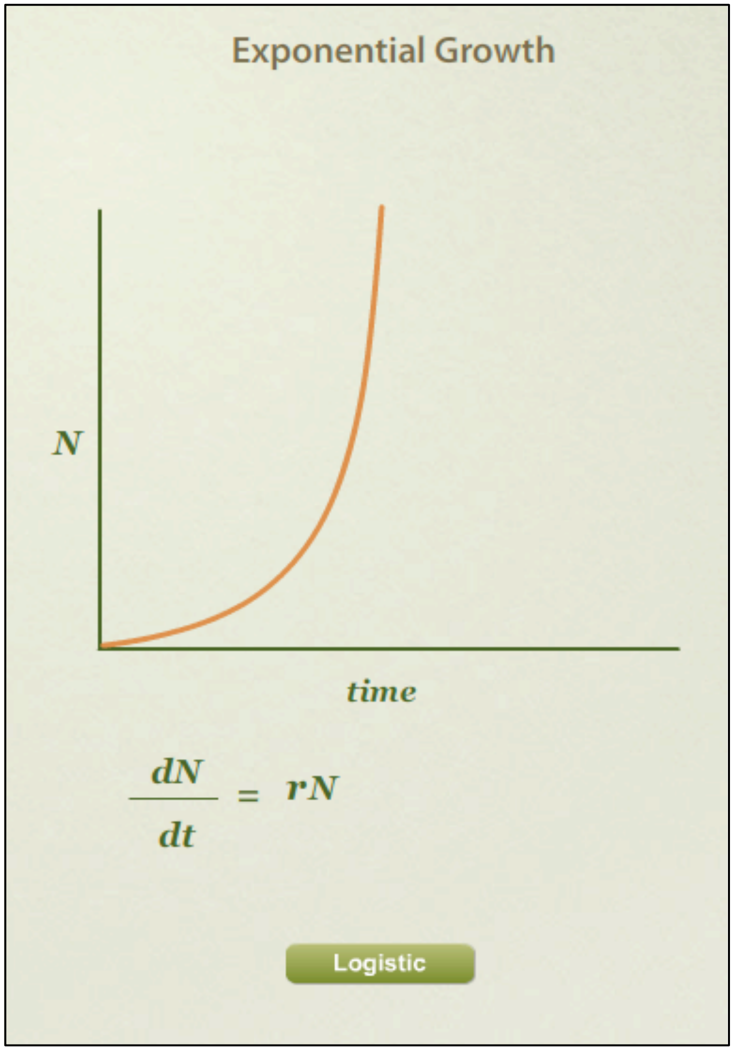


Fig. P2.1. (a) The growth of a laboratory population of *Paramecium caudatum* fitted to the logistic equation. Circles are observed counts; line is the fitted curve. (From Gause.) (b) The logistic growth of a laboratory population of yeast cells. (From Pearl.) (Reproduced, with permission, from *Principles of Animal Ecology*, W.C. Allee, A.E. Emerson, O. Park, T. Park and K.P. Schmidt, W.B. Saunders Co., Philalplina, 1949.

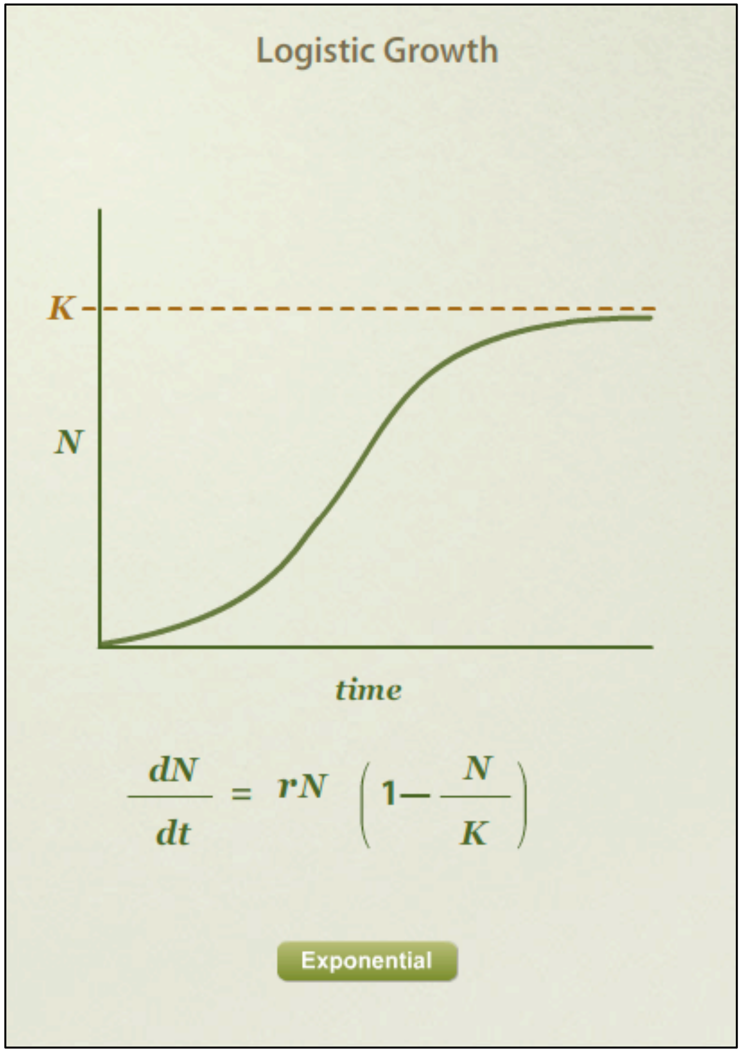
HERNANDEZ-RIVERA, M.A et al. OPTIMAL PARAMETERS FORT In Vitro DEVELOPMENT OF THE HYDROCARBONOCLASTIC MICROORGANISM Proteus sp. J. Soil Sci. Plant Nutr. [online]. 2011, vol.11, n.1, pp. 29-43. ISSN 0718-9516.

Logistic Growth



Exponential Growth

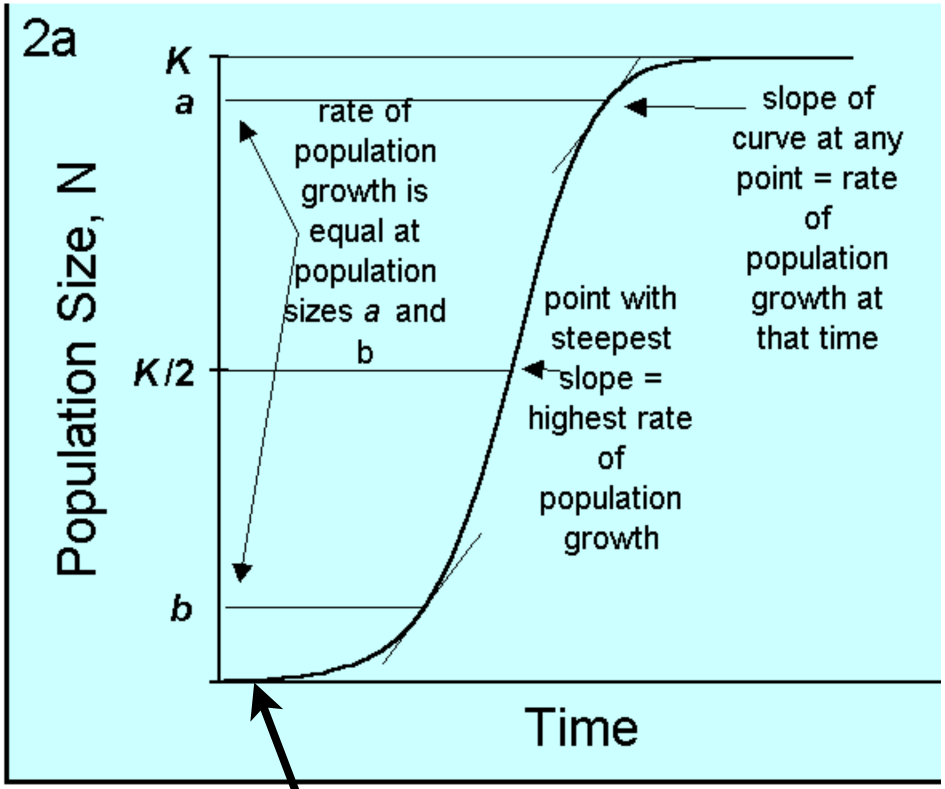
$$\frac{dN}{dt} = rN$$



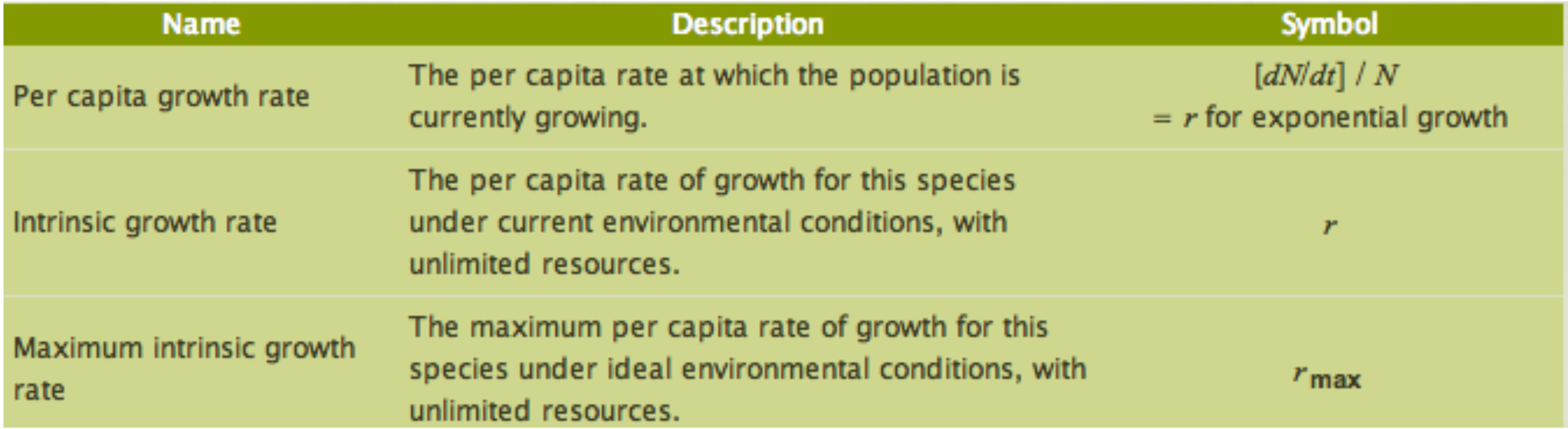
Logistic Growth

$$\frac{dN}{dt} = rN\left(1 - \frac{N}{K}\right)$$

$$\frac{dN}{dt} = rN\left(1 - \frac{N}{K}\right)$$

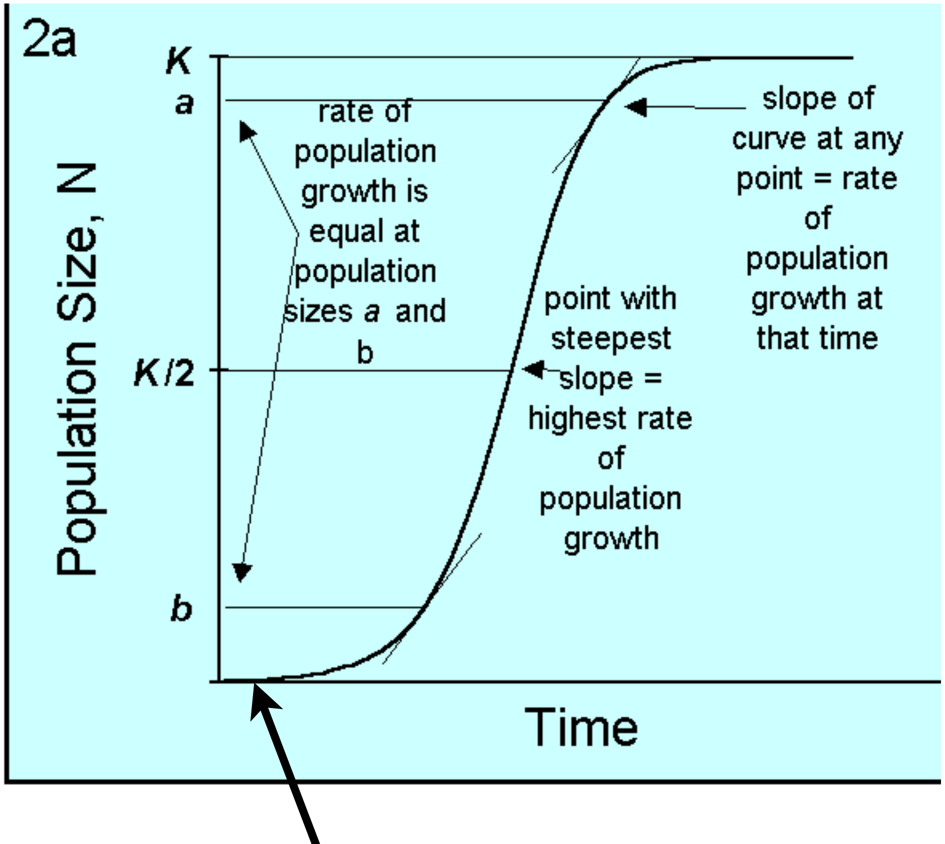


Point at which **[*dN*/*dt*]/*N***
is closest to ***r***



Name	Description	Symbol
Per capita growth rate	The per capita rate at which the population is currently growing.	$[dN/dt]\ /\ N$ $= r$ for exponential growth
Intrinsic growth rate	The per capita rate of growth for this species under current environmental conditions, with unlimited resources.	r
Maximum intrinsic growth rate	The maximum per capita rate of growth for this species under ideal environmental conditions, with unlimited resources.	$r_{\max}$

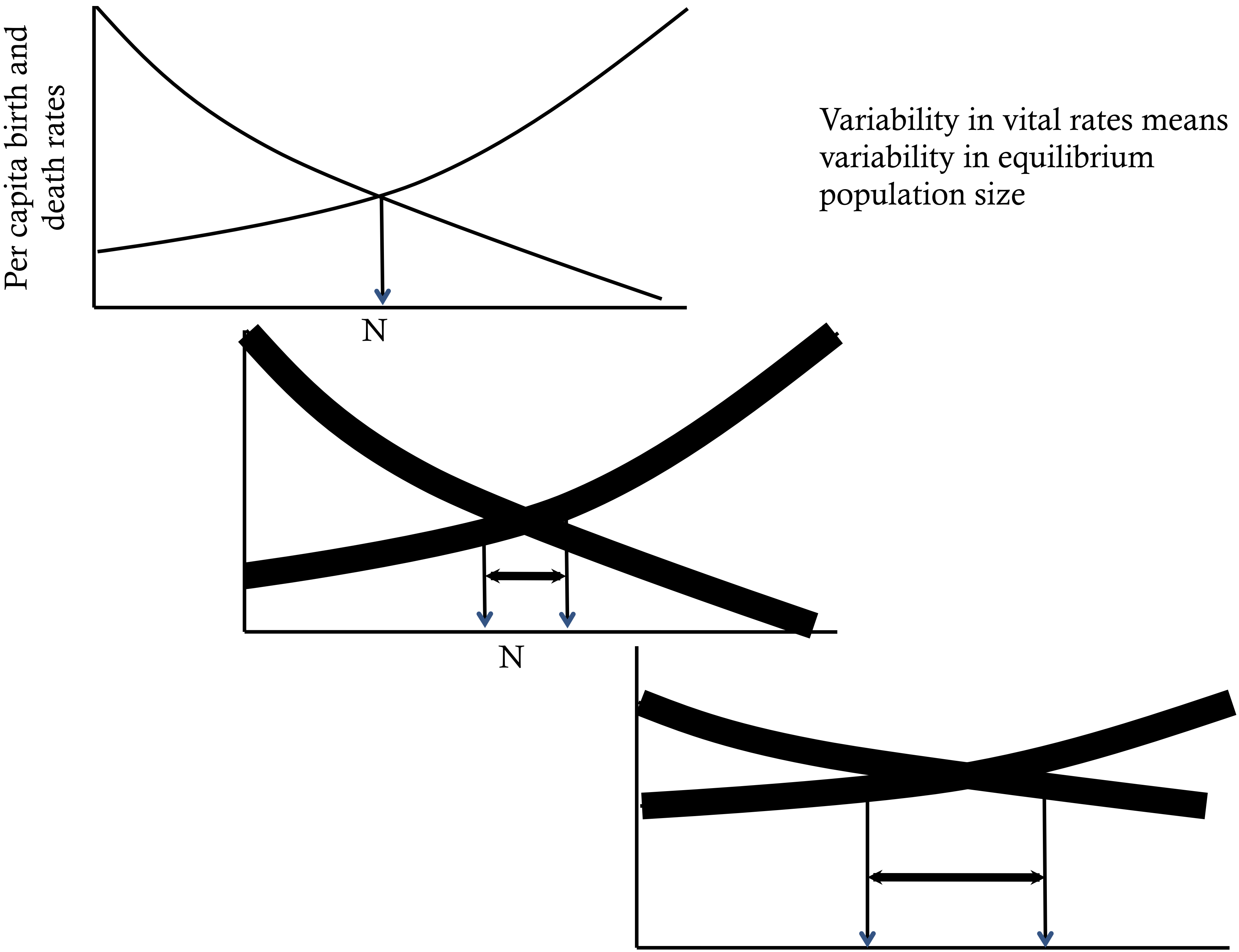
$$\frac{dN}{dt} = rN\left(1 - \frac{N}{K}\right)$$



Point at which **[*dN*/*dt*]/*N***
is closest to ***r***

$$N_t = \frac{KN_0e^{rt}}{K + N_0(e^{rt} - 1)}$$
$$= \frac{K}{1 + \frac{N_0}{K}\left(e^{rt} - 1\right)}$$

Variability in vital rates means variability in equilibrium population size



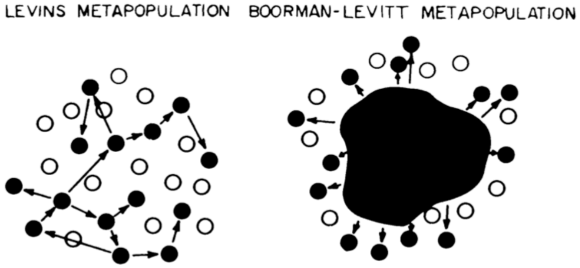


FIG. 11. Two models of metapopulations, 1 postulated by Levins (1970) and another proposed by Boorman and Levitt (1973). Closed circles are occupied patches and open circles are vacant ones. Reproduced with the kind permission of the authors and Academic Press.

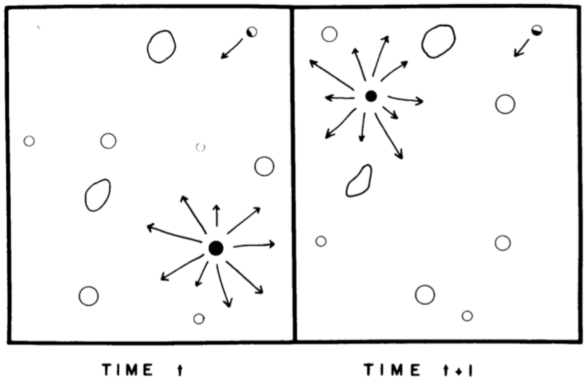
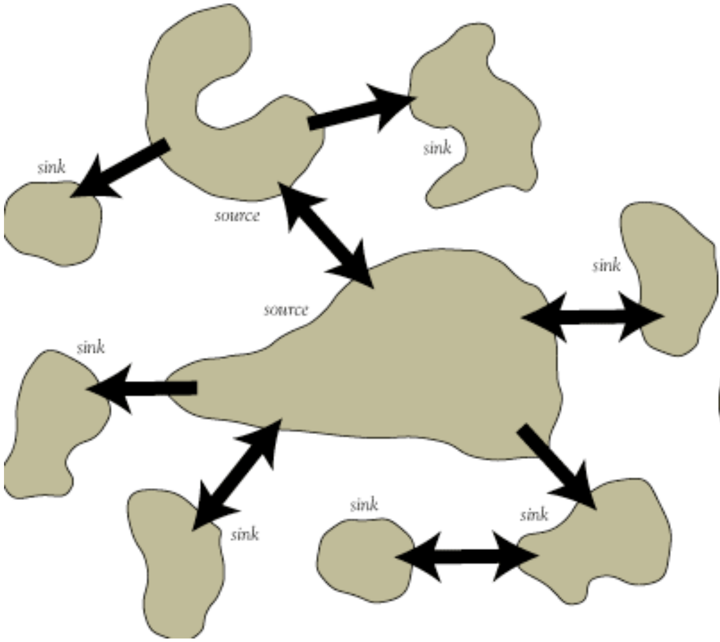
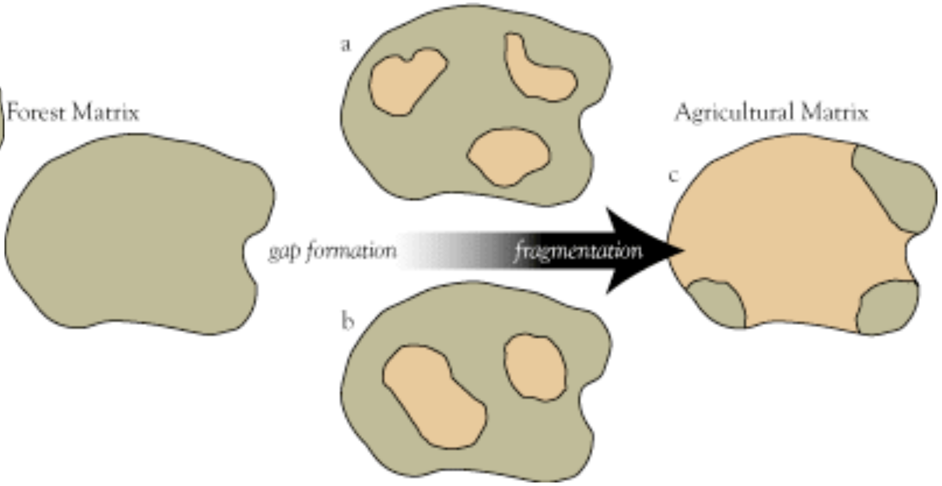
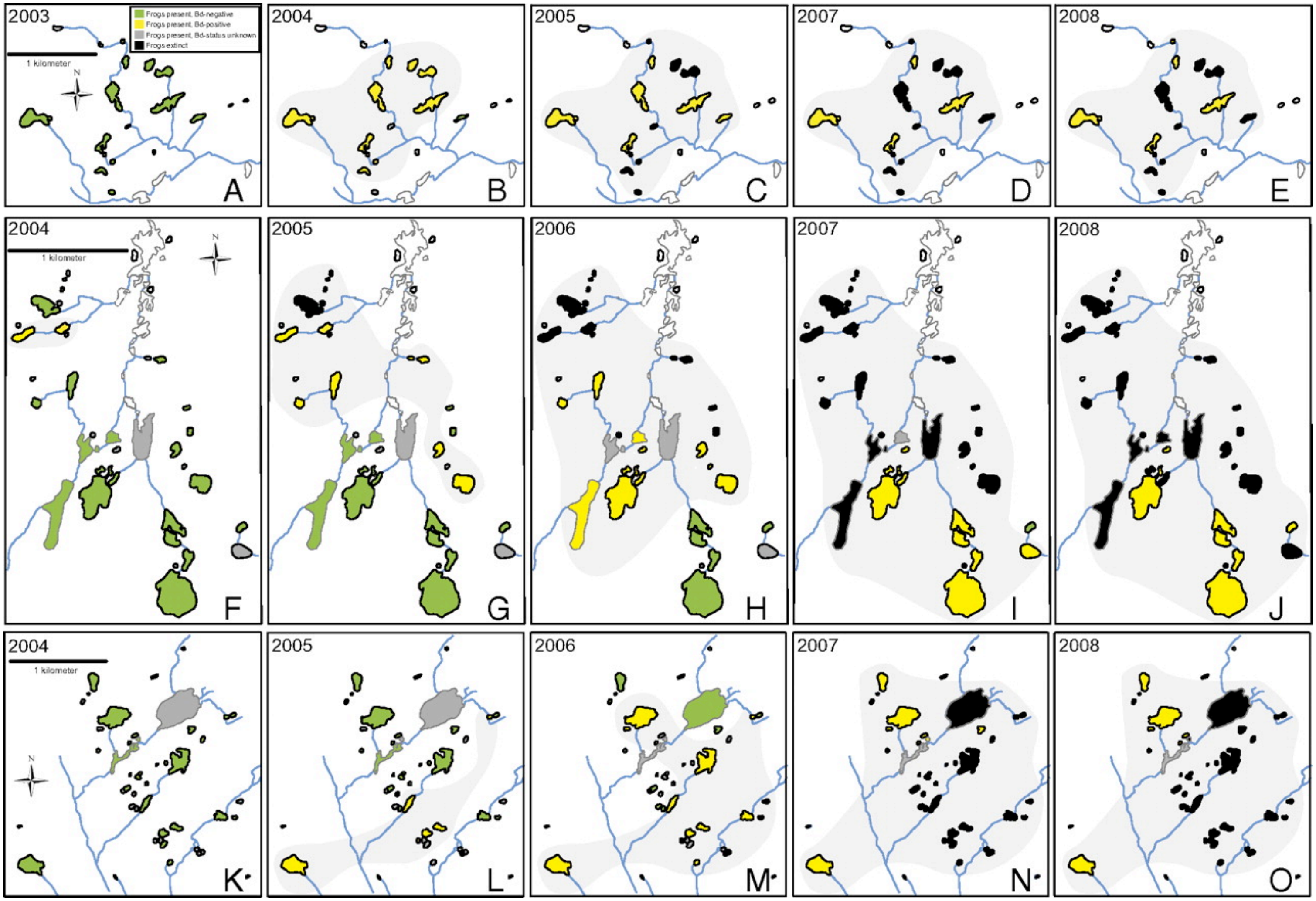


FIG. 10. New model of the dynamics of newt metapopulation. All patches are occupied by breeding populations, but only a small minority (filled circles) are reproductively successful. The identity of the hotspot pond changes with time.





Maps of the three study metapopulations showing the spread of Bd and frog population status (adults only) during a 4-year period following the initial detection of Bd. Depicted are Milestone Basin (A–E), Sixty Lake Basin (F–J), and Barrett Lakes Basin (K–O).



Vredenburg V T et al. PNAS 2010;107:9689-9694

PNAS