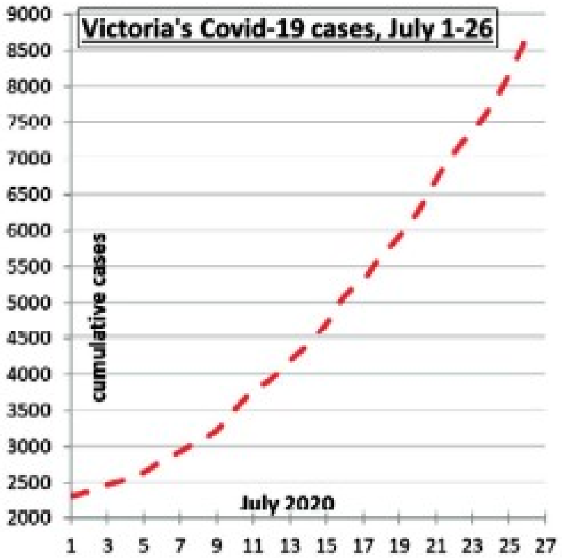
Growing at a fast rate

Continuing ideas for exploring the environment during the Covid-19 pandemic by Jeanie Clark

As I write this article, Melbourne and Mitchell Shire are back in lockdown, and the 'flattened' Covid-19 curve has gone up on a bigger swing and a faster growth rate than it had in autumn – a second wave (see graph below). So the focus for this article will be on exploring the fast



speed at which some populations can grow and their management. It will follow up on the previous article in autumn's Otherways ('Threats too tiny to see', Issue 164, May 2020, pages 44-48), that looked at tiny things, including Covid-19.

Different things grow at different rates. Numbers and statistics document the growth. Diagrams and graphs can summarise the statistics and reveal patterns of growth. When a pattern is revealed, future growth can be predicted. If there are known effects of a population size, and the concerns of any effects, then predicted growth can help planning to avoid any undesirable effects, or enhance good effects. This article will involve numeracy skills of adding, multiplying, drawing diagrams and graphs, and growth terms. See the Maths box (next page) to decide if you need to go through an introduction to this, or not.

Mould

Have you ever noticed how quickly mould takes over a food?

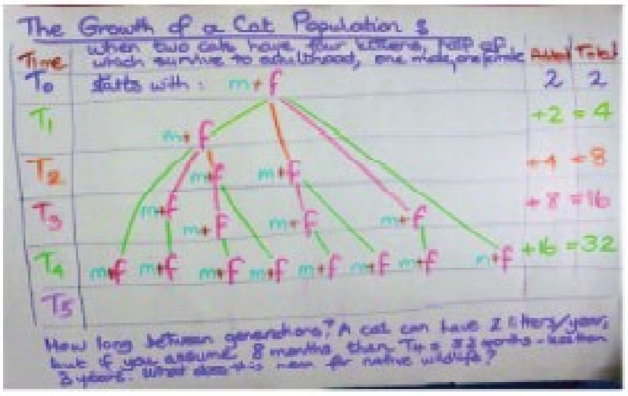
In the last article in this series, mould was identified as being a collection of tiny fungi. How quickly does such a collection increase? You might like to try an experiment to show the difference between mould growing on bread stored on the shelf, in a fridge and in a freezer. Shuttleworth's 'Mold Bread Experiment' has clear instructions about how to safely conduct such an experiment, record the fungi/mould growth and then graph the results.

A follow-up could be to observe how quickly mould grows on a piece of fruit? Could the bread instructions above be modified to investigate this? Does how much mould is on the fruit, affect what we do with it?

Cats

Why do we neuter cats? Consider how their populations can grow: a breeding pair can produce, twice yearly, between four and eight kittens, of which half are female and half may live to breeding age, which can last ten years.

How many cats can this initial two produce and how big might this population grow in their lifetime? The following diagram shows a minimum rate of growth: two kittens survive, one a breeding female, for four litter seasons. Can you continue the table to ten seasons (T_{10})?



Did you notice the total doubling? It is a geometric sequence. If you graph this, it has an **exponential** growth pattern. Assume that the time interval is eight months. Then T_4 is almost three years. What concern might there be for local wildlife with such a growing cat population? What can we do about it?

What happens if you change an assumption, e.g. keep this one going for up to twenty seasons; improve the survival rate; reduce the time interval to six months; start with two pairs!

Weblinks (in blue) p47 Shuttleworth's '*Mold Bread Experiment'* = <https://explorable.com/mold-bread-experiment>

Pest populations

Cats are not the only animal species to increase their populations exponentially. What do you know about cane toads, rabbits, foxes, goats, deer, horses, or camels? Note that they are all non-native animals and grew in number quickly here, partly due to a lack of predators.

What does Australia do about introduced animal populations which destroy so much native wildlife or environment? Labelling them as 'noxious animals' and 'pests' helps identify them as a problem, but this is because they are largely out of control. Control programs may use culling (e.g. feral pigs are shot; feral goats may be rounded up and sold for their meat; feral horses may be caught and sent to farms) or poisoning (e.g. baiting of foxes) or biologic controls (new predators or diseases imported from other parts of the world where they have reduced these populations).

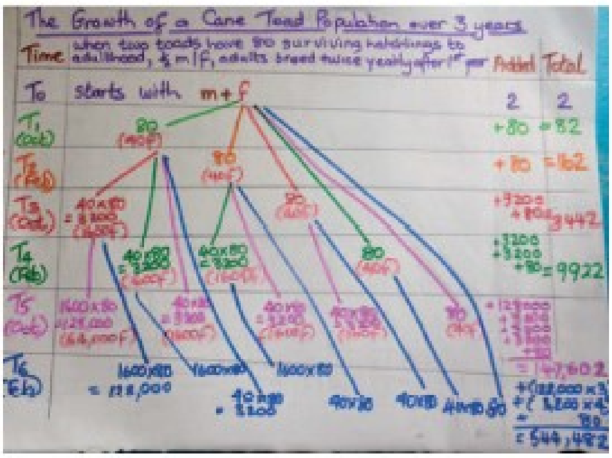
Cane Toads

Biologic controls do not always work as expected, e.g. cane toads. They were brought to Cairns-Innisfail sugar-cane farms to eat the Greyback and French's Cane Beetles that were eating too much of the sugar-cane crop. But they preferred to eat our wildlife. They had no predators, and many offspring, allowing them to spread across much of Australia.

A cane toad begins as one of 8000-35,000 eggs laid in water, between September and March. Hatching in a couple of days, they are tadpoles for four-eight weeks. The next year, they are ready to breed, but only a tenth have survived. Females lay their eggs twice a year for up to ten years. As food runs out, they move out.

How quickly might cane toads grow in a new area? That depends on the conditions, or assumptions of a model. The diagram below assumes a low growth rate, so is its T_6 total, after three years, surprising?

How will this look as a graph? Select an A4 log page with Y axis at 6 cycles on semi-log paper at Incompetech.

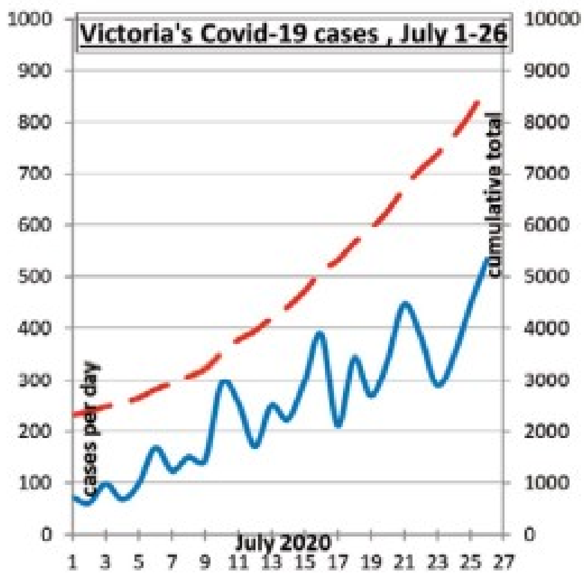


What could stop such growth? Sadly, we don't have anything to do that well enough yet.

Covid-19

How are these examples like the growth of Covid-19? Firstly, imagine an infected person, who, on each of four incubation* days, infects two other people, and then half of those people do likewise. The increase in those infected would grow like the above cat population diagram. Secondly, imagine a worker in a busy place like a supermarket, who has a two-day incubation*, and on each day infects forty people. The increase in those infected would grow like the above cane toad population diagram to row T_2.

Covid-19 is a new disease to humans - like a new creature invading a habitat. Without immunity, unchecked growth in either of the above human examples will overwhelm our health systems and result in deaths, like some mouldy food! Hence the focus is to slow any exponential growth, i.e. 'flatten the curve', using social distancing, hand cleaning, masks, contact tracing and a fortnight's isolation. If growth doesn't slow fast enough, 'lockdowns' for multiples of a fortnight are needed, to stop the spread. All these measures are like culling, neutering and poisoning pest populations that have grown too much, too quickly.



Fast growth patterns are a fact of nature. What we do about them when they get out of control depends on their threat to different species in the environment. With Covid-19, the species threatened is us!

Weblinks (in blue)
P47
Incompetech [for semi-log paper] = https://incompetech.com/graphpaper/logarithmic/

Maths for Growing Populations

Let's find out how quickly things can grow by adding or multiplying each time to the number before. Draw up two tables with eleven rows and three columns each – an example is below. In the ADDING table, add a constant amount to the previous total, e.g. +2. In the MULTIPLYING table, multiply the previous total by a constant amount, e.g. X2. How much do they differ by at the end of ten times (T_{10})?

ADDING		
Time	ADD 2 =	Total
T_1	1	1
T_2	1+2 =	3
T_3	3+2 =	5
T_4	5+2 =	7
T_5	7+2 =	
T_6		
T_7		
T_8		
T_7		
T_{10}		

MULTIPLYING		
Time	TIMES 2 =	Total
T_1	1	1
T_2	1x2 =	2
T_3	2x2 =	4
T_4	4x2 =	8
T_5	8x2 =	
T_6		
T_7		
T_8		
T_7		
T_{10}		

*Now graph this data. How different are the graphs? ADDING by a constant amount makes '**linear**' growth - a **straight line**. MUTLIPLYING by a constant amount makes '**geometric**' growth – a **curved line**. 'Join the dots' examples of these graphs are at Math Bits Notebook - Arithmatic and Math Bits Notebook - Geometric.*

*A specific type of geometric growth is '**exponential**' - growth by a power, e.g. the power of 2 or 'squaring' i.e. 2^x. You might draw up an EXPONENTIAL table for this, e.g. beginning with T_1 2^1 =2; T_2 2^2=4; T_3 2^3=8; T_4 2^4=16 etc. RSU.Ed shows line with exponential graphs.*

*On normal graph paper, the axis scales increase at a constant linear rate, e.g. 0, 5, 10, 15, 20. For graphing with very large number increases, there is another sort of graph paper - '**logarithmic**' (log) - where the numbers increase in powers, e.g. 1, 10, 100, 1000 etc. When only the vertical scale increases in this way it is a 'semi-log' graph; a full log one has both scales like this.*

Log graph paper can be downloaded from the web, e.g. Sample Templates.com. It can be used to graph the results of the MULTIPLYING and/or EXPONENTIAL tables and see how they differ to those done as normal graphs.

Weblinks

P48

Math Bits Notebook – Arithmetic = http://mathbitsnotebook.com/Algebra2/Sequences/SSArithmetic.html
Math Bits Notebook – Geometric = http://mathbitsnotebook.com/Algebra2/Sequences/SSGeometric.html

RSU.Ed [line with exponential graphs] = https://faculty.rsu.edu/users/f/felwell/www/Theorists/Essays/Malthus%20files/MalthusGrowthCurves.JPG

Sample Templates.com [for 1-cycle log paper] = https://images.sampletemplates.com/wp-content/uploads/2016/03/04065354/Semi-Log-Graph-Paper-to.jpeg