

Not Your Standard First Population Modeling Project

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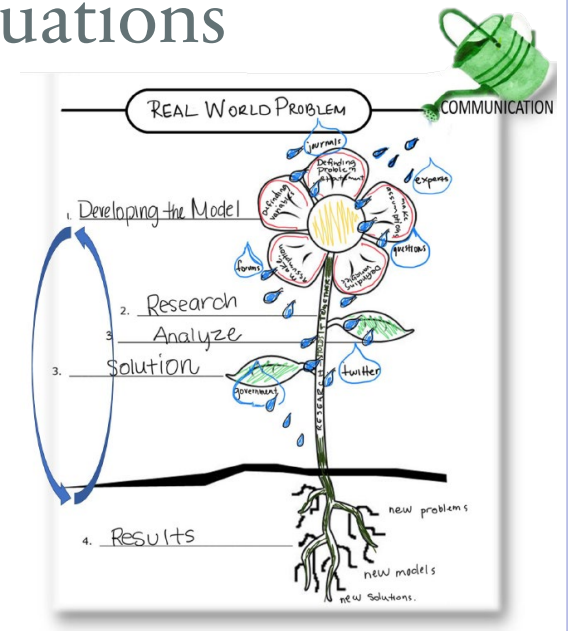
Saint Martin's University

- Private Benedictine Liberal Arts Institution
- 1300 Undergraduate & 250 Graduate
- 19 Nationalities
- 20+ Faiths
- 12:1 Student to Faculty Ratio
- 59% Identify as Ethnically Diverse
- 35% First Generation College Students



MTH 381 – Mathematical Modeling

- “Official” Prerequisite: Statistics & Computer Programming
 - Waived Liberally
- “Actual” Prerequisites: Statistics OR Differential Equations
- 8 (+1) Students by Major:
 - Mathematics Education ($\times 3 + 1$)
 - Biology ($\times 2$)
 - Computer Science & Mathematics Double Major ($\times 2$)
 - Mechanical Engineering



Timing & Preparation

- Semester Week 5 of 16
- First Individual Project
- Modeling Preparation
 - Process Introduction
 - Team Project
- Mathematics Preparation
 - Recursion, Regression, & Proportions

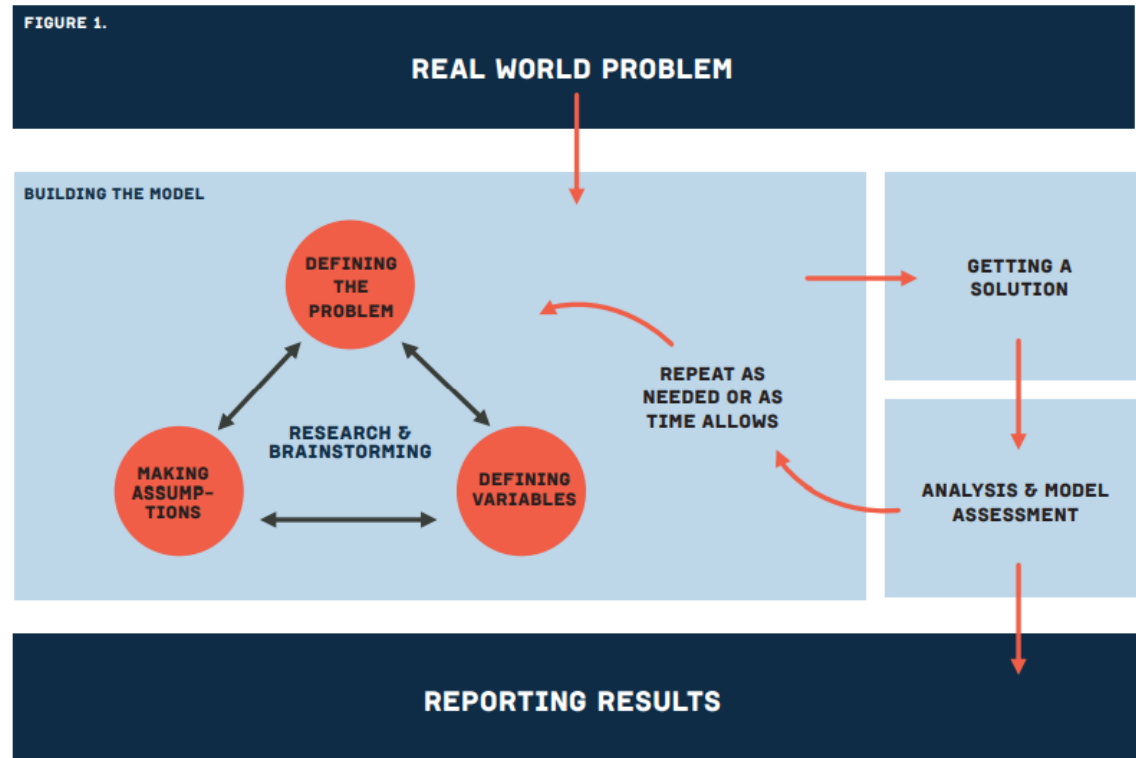
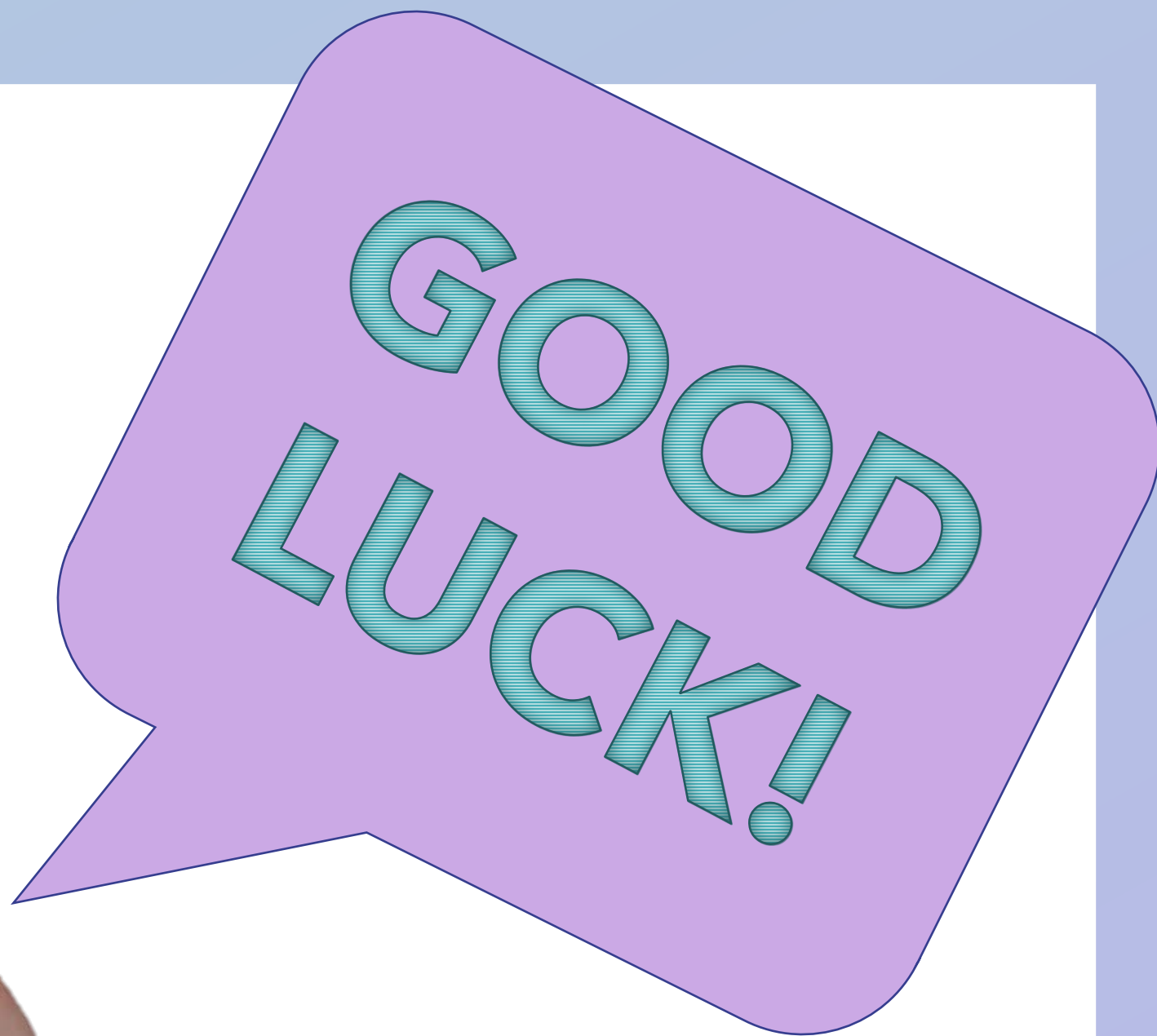
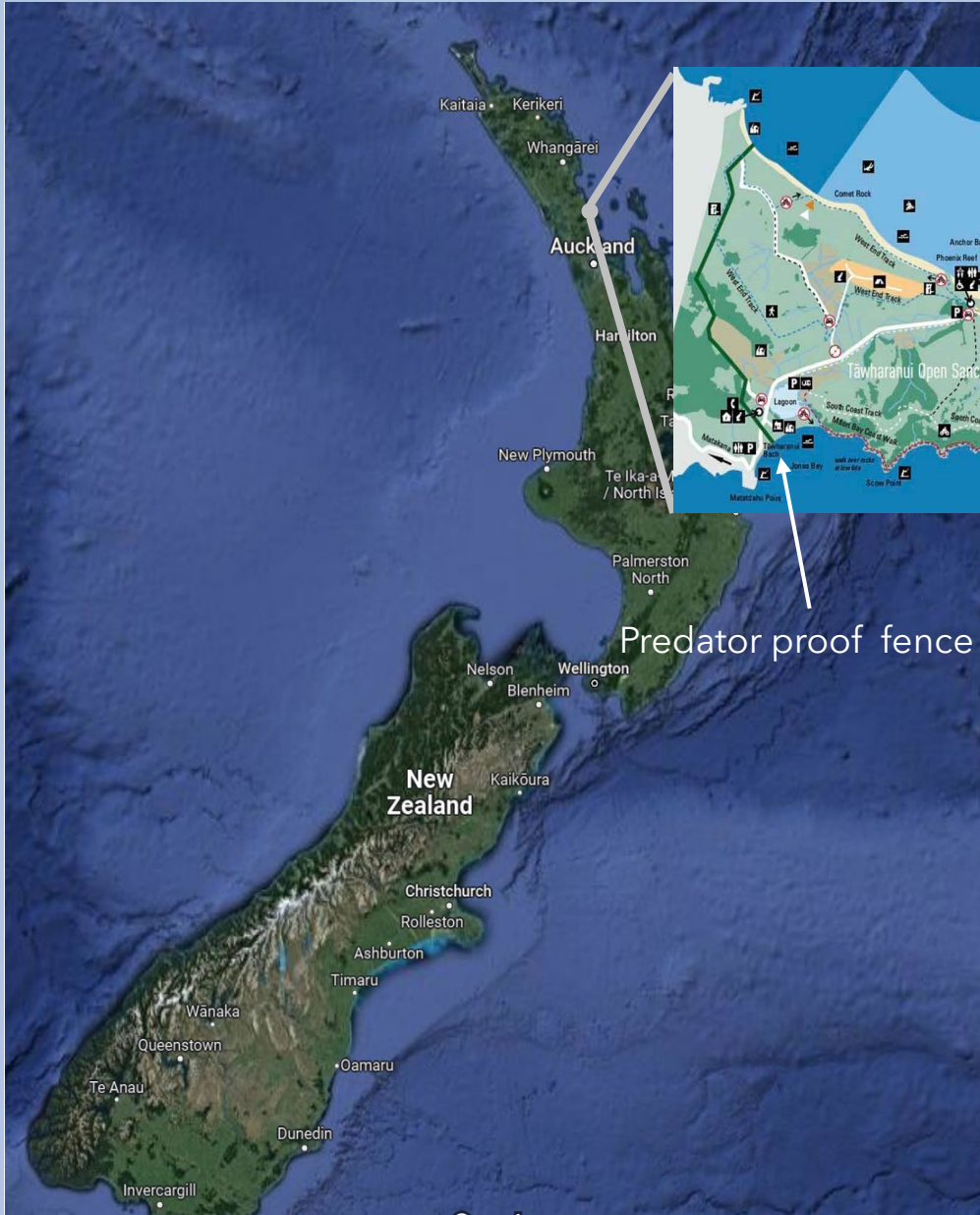


Image from [SIAM Modeling Handbooks](#)

The Project

- One Week to Complete
- We provided:
 - Background
 - A Question
 - Data









- Mark and recapture: banding caught individuals and checking for pre-banded birds ~1x per month during the breeding season for past 5+ years

The Question

- How has population changed over time since the addition of the acoustic attraction set-up and artificial nesting boxes?



Data – Table 1 of 2

Date	% Recaps	Recaptures	New Bands	Total	Days after Full Moon	Comments
11 June 2015	17%	6	29	35	8	
2 July 2015		0	0	0	0	Only 1 bird heard at 1902
23 July 2015	33%	1	2	3	21	
17 August 2015	13%	5	35	40	17	
3 September 2015	19%	11	47	58	4	
1 October 2015		0	0	0	3	1 wfsp came in
7 April 2016	40%	4	6	10	14	
7th May 2016	32%	13	27	40	15	Ended after 1.5 hrs out of bands
8 June 2016	45%	19	23	42	17	
3 July 2016	20%	2	8	10	13	
6 August 2016	39%	15	23	38	17	
14 April 2017	38%	17	28	45	3	
20 May 2017	43%	9	12	21	9	Ended after 50 mins due to rain
17 June 2017		0	0	0	7	No birds
25 July 2017	57%	4	3	7	16	
23 August 2017	44%	14	18	32	15	
17 September 2017		2	2	4	11	
15 April 2018	50%	13	13	26	14	

Student Work – Assumptions

- Each individual had no audible impairments. If an individual was not able to hear the sounds from the speakers, there is a possibility that the bird may not come back onshore which may result in reduced population data taken for the mark-recapture.
- The bands on each bird did not become damaged enough to fall off. If a band is not presently on the leg of the bird when recorded for, it will change in how the data is recorded; the bird will likely not count as a recovery but as a newly banded bird. That may result in a reduction of population data size.
- Each researcher successfully caught and banded every bird that they saw come onshore. If a bird escaped without being recorded as a recovery or a newly-banded, this may result in complications in the data that may affect the population category and size recorded.

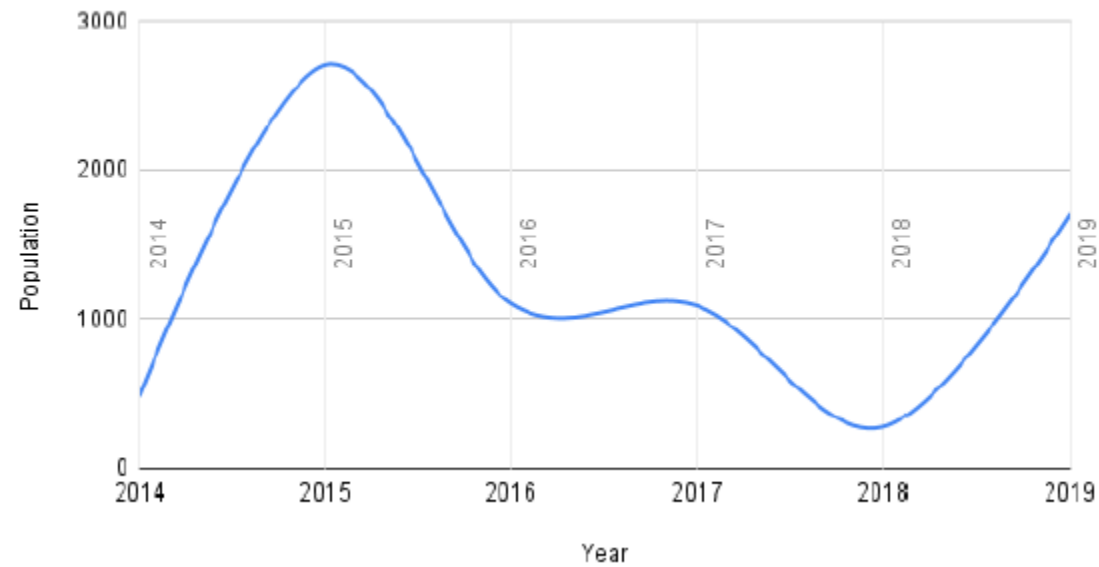
Student Work – Strengths & Weaknesses

The equation used for this model has its strengths and weaknesses in how it correlates to the data implications. There was a data point that was skipped, the 16 individual recoveries for the year of banding in 2011. This was a necessary step as 16 would essentially be disregarded in terms of the equation, which is not ideal. Instead of using a mark-recapture equation, there could have been an exponential population growth equation as that would calculate all of the data that was found. By skipping the 16 individual recoveries, that will affect the outcome for the estimate in population likely in a negative direction so that the estimate is potentially too low. However, the equation used is a foundational mark-recapture equation that also simplifies data in a way that the data can be calculated at a less complicated rate.

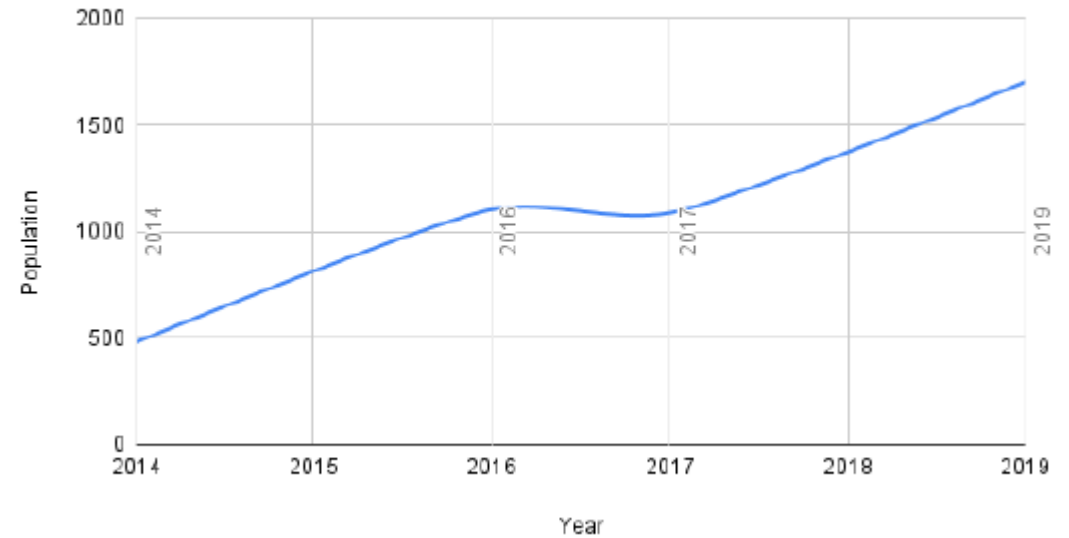
Student Work – Outliers?

$$\frac{\text{\# of individual birds with 2011 bands recaptured in 2014}}{\text{\# of birds caught in 2014}} = \frac{\text{\# of birds banded in 2011}}{\text{total population of birds in 2014}}$$

Population Prediction from 2011 Data

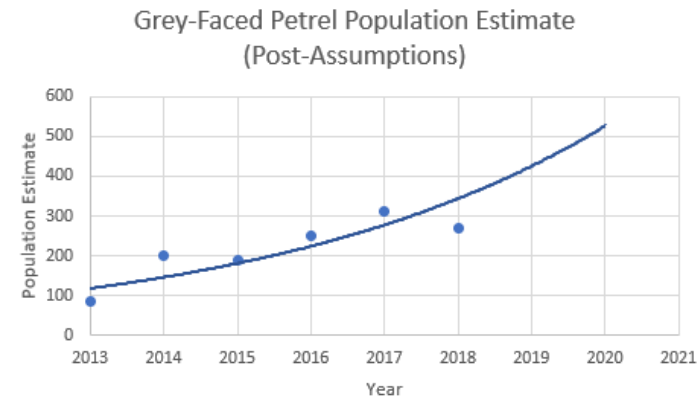
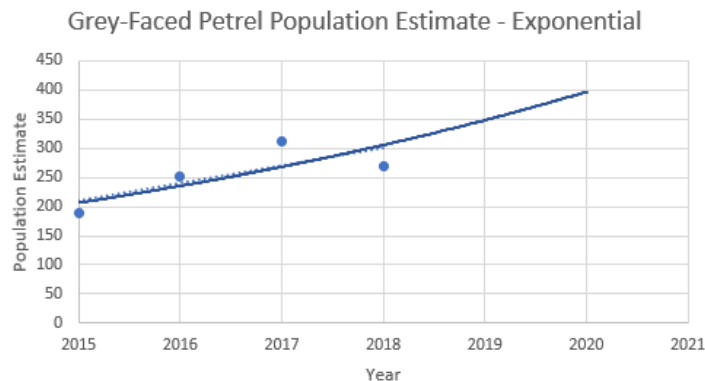


Population Prediction from 2011 Data



Student Work – What kind of model?

These two models really have no significant meaning other than to show the differences that one assumption can make, even in a linear model. This is because when describing population growth, an exponential model should be used, since, in an ideal scenario, a population should double or quadruple (depending on number of offspring) every birth cycle.



Thank You!

Questions?

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