

Exploratory population modeling exercise of Hawaiian Hoary Bat



Pictured is a photo by David Liittschwager and Susan Middleton

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Endangered Species Recovery Committee

Presenting on behalf of bat task force
March 6, 2020

Population Viability Analysis

Vortex 10

A stochastic simulation of the extinction process

Version 10.2.17.0



- Pigs
- Kauai Mongoose
- Maui Parrotbills
- Hawaiian Hoary Bats

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Bat Task Force

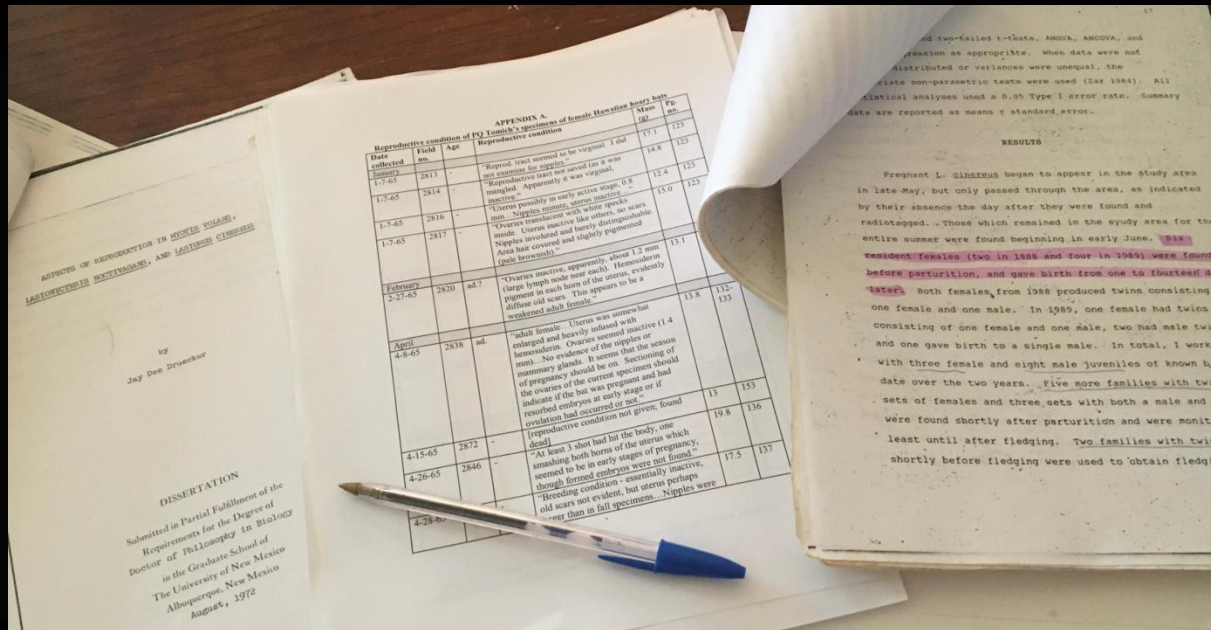
1. Specific population dynamics parameters needed to conduct an acceptable PVA
2. Particularly impactful parameters that should be prioritized for research
3. General trends or results that might inform conservation decisions or provide management sideboards for wind projects



Some Bat Task Force participants (2019)

What we did

- Started with gathering available data on reproduction





What we did


- Acquired mortality guesses from an “expert elicitation”
...led to a population decline

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Fatalities at wind turbines may threaten population viability of a migratory bat 

W.F. Frick^{a,b,*}, E.F. Baerwald^{c,d}, J.F. Pollock^b, R.M.R. Barclay^c, J.A. Szymanski^e, T.J. Weller^f, A.L. Russell^g, S.C. Loeb^h, R.A. Medellinⁱ, L.P. McGuire^j

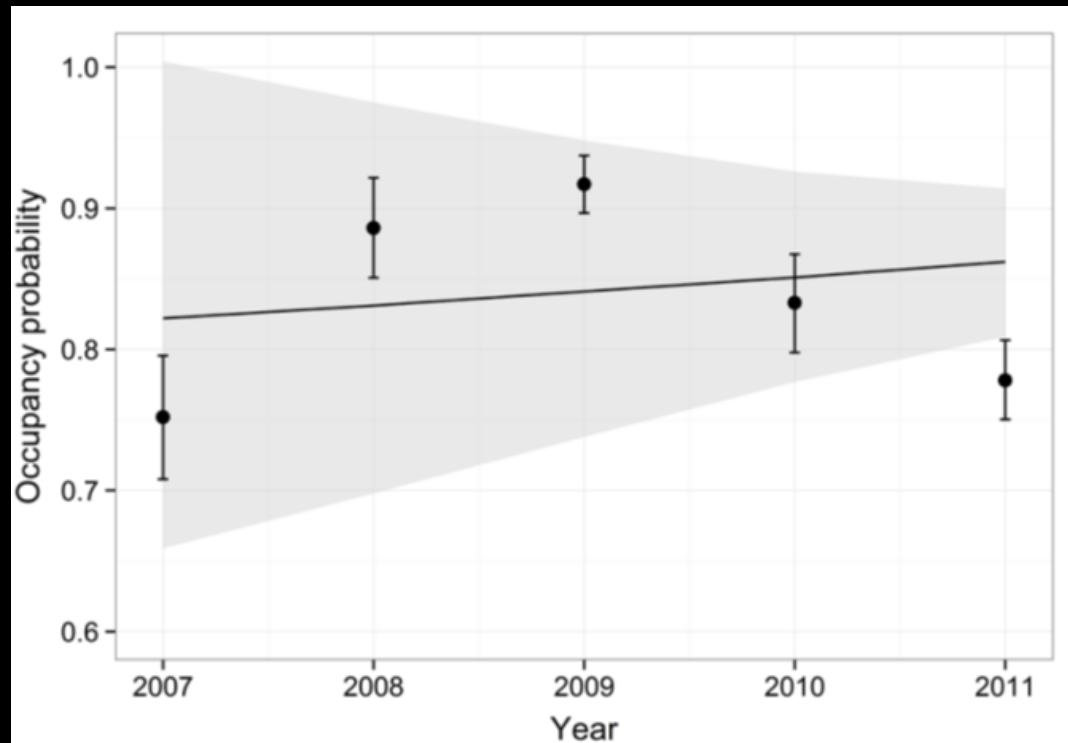
2. Materials and methods

2.1. Expert elicitation

We used a structured elicitation method to obtain specific judgments or values from experts. Co-author JAS and colleagues served as eliciting facilitators and identified the conservation problem (“Does mortality from wind turbines pose a threat to population viability of hoary bats in North America?”), selected the experts, and designed the elicitation process. Nine experts (see Supporting Information) were identified based on literature review and discussions with the bat ecol-

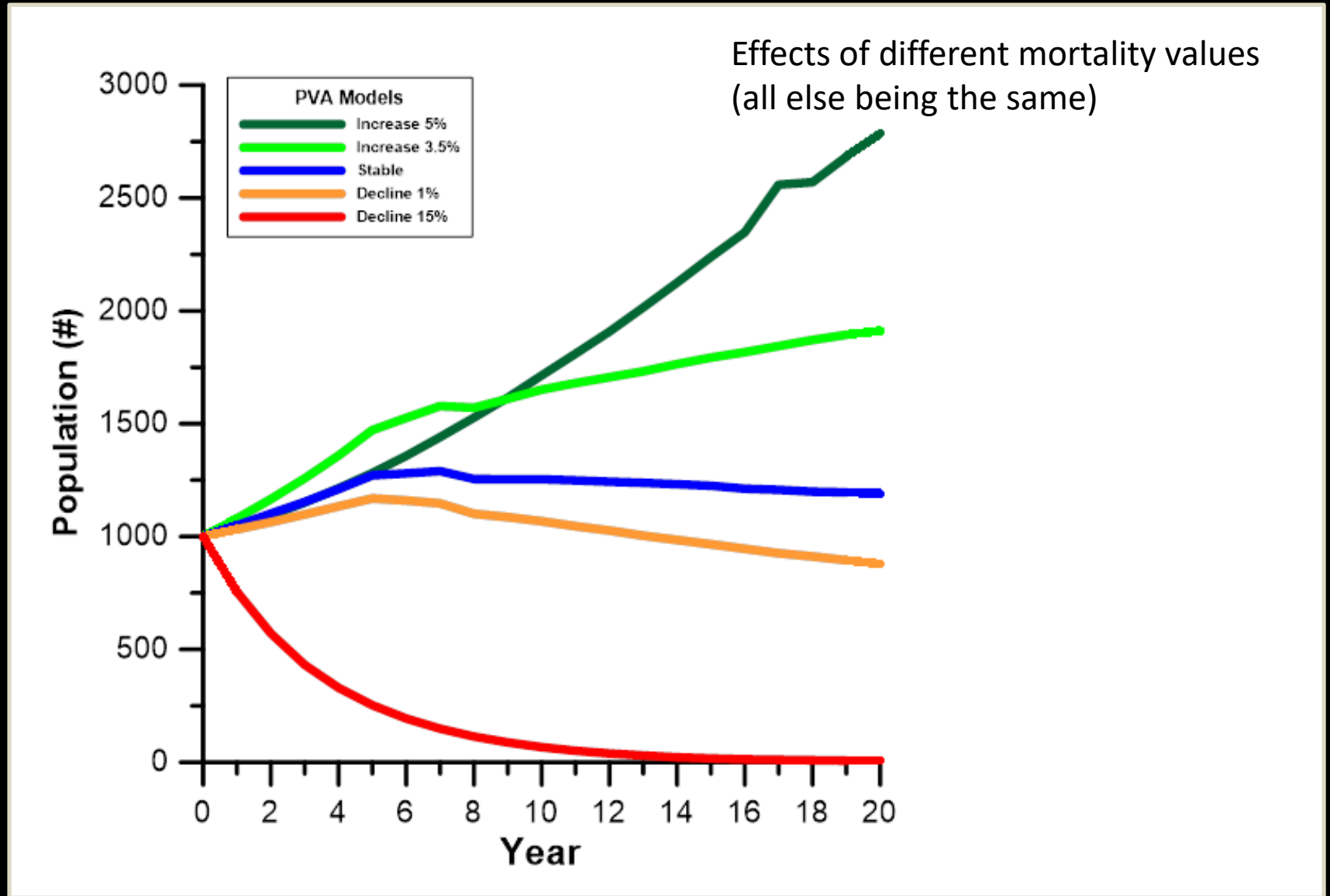
What we did

- Given a reported stable trend, we looked for mortality estimates that would give stability.

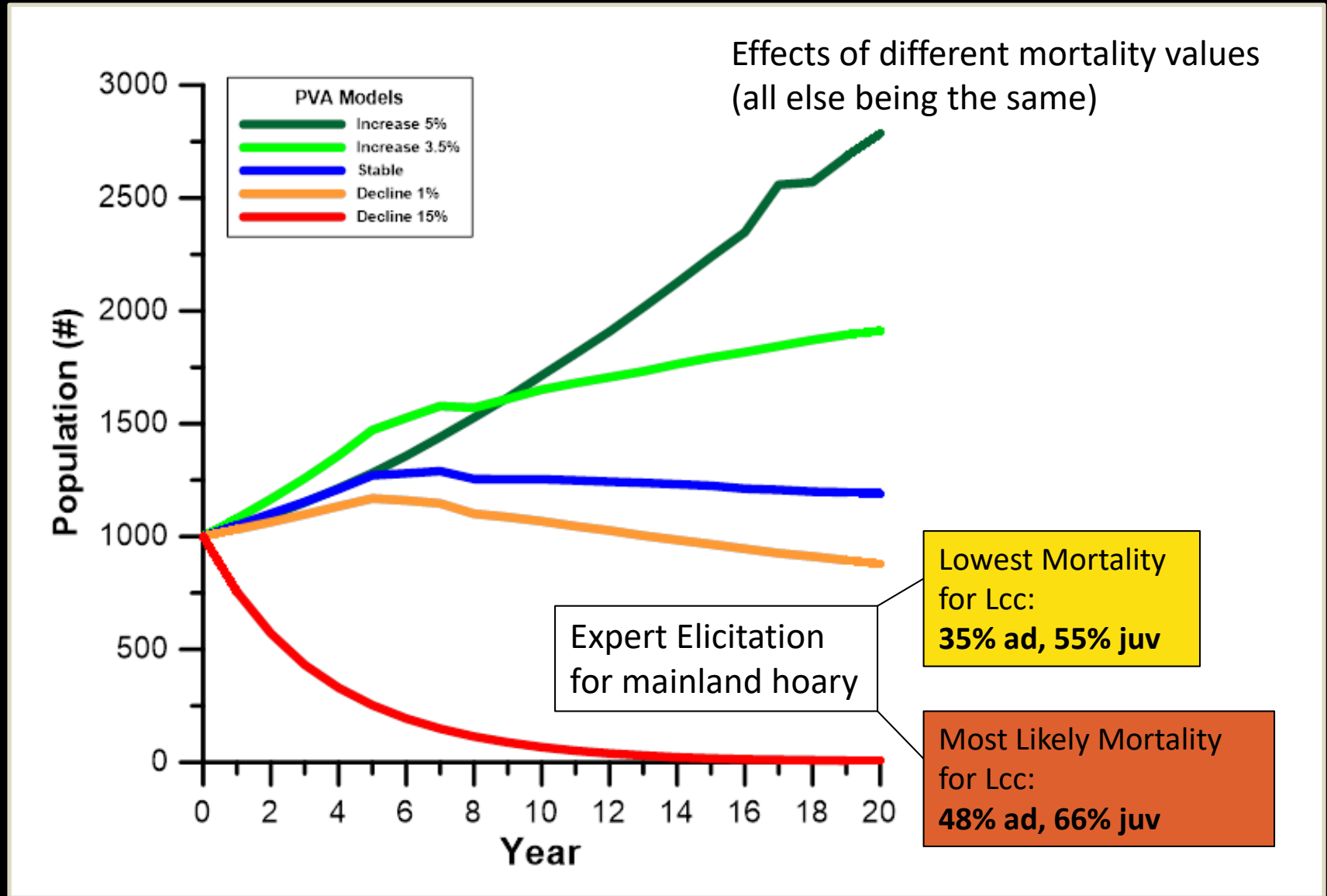


Trend in Hawaiian hoary bat occupancy on Hawaii Island from 2007 to 2011 during the period of relatively high detection probability (June to October). From Gorresen et al. (2013; p. 18).

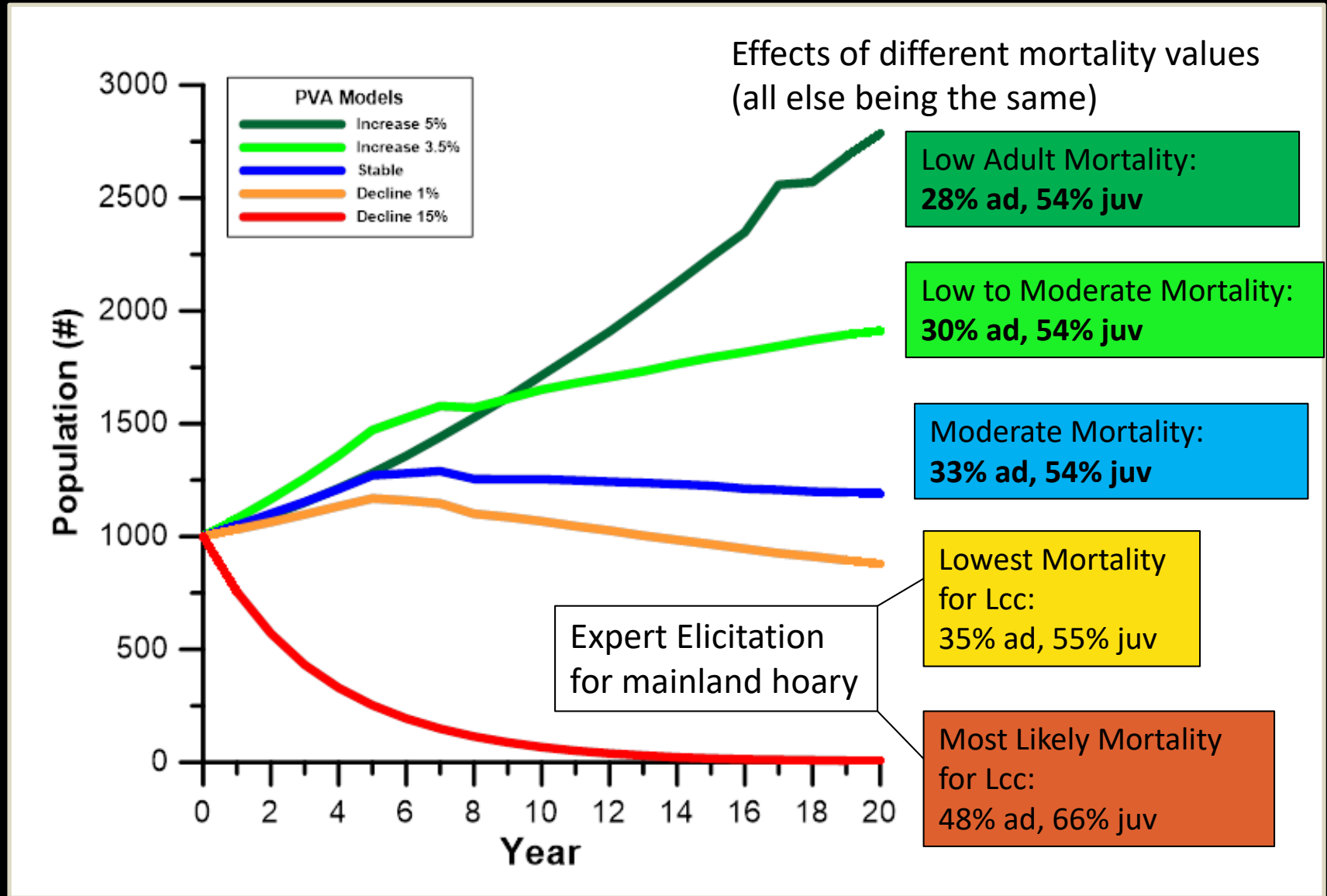
Population trends for an array of Hawaiian Hoary Bat PVA models without take



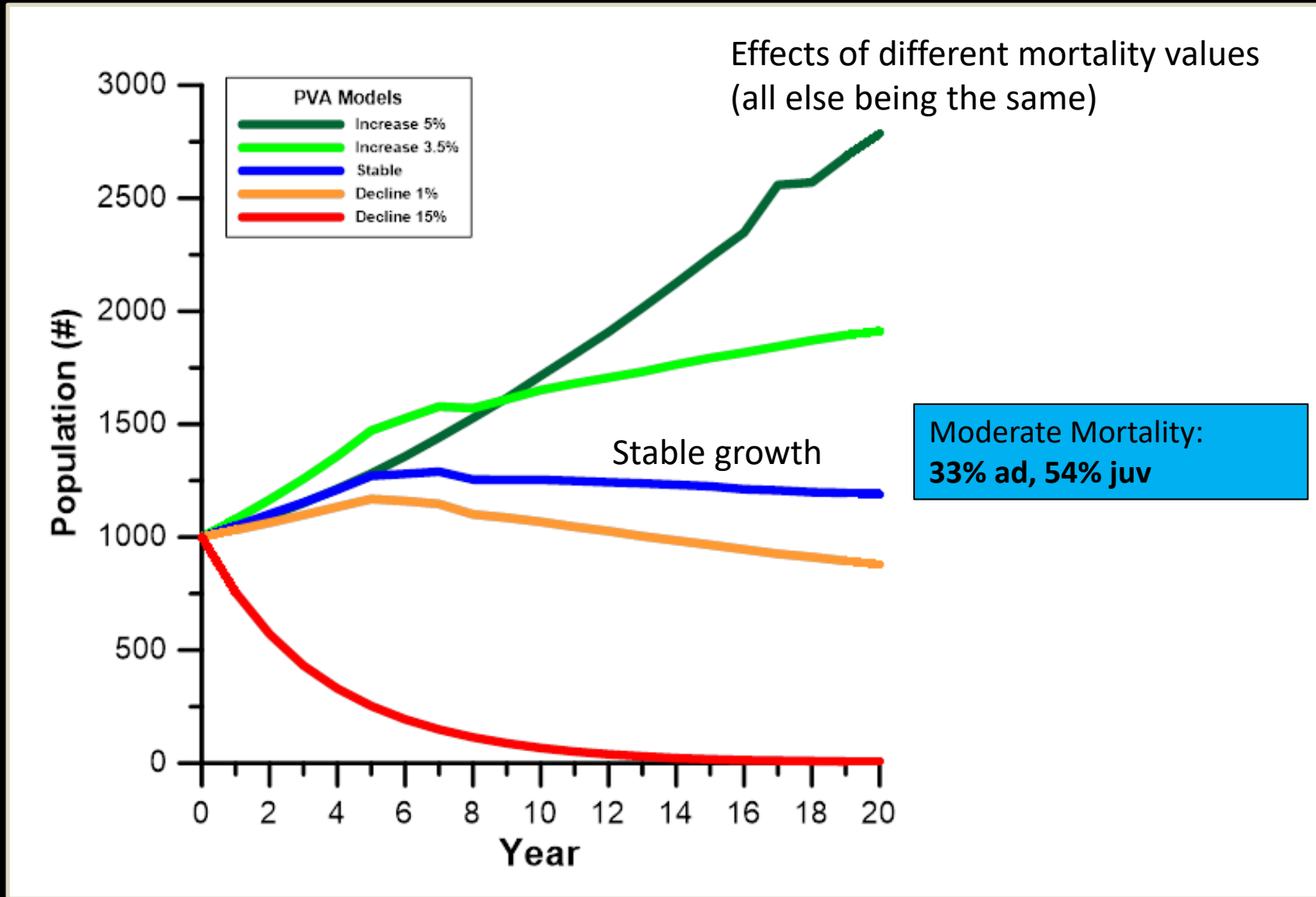
Population trends for an array of Hawaiian Hoary Bat PVA models without take



Population trends for an array of Hawaiian Hoary Bat PVA models without take



Population trends for an array of Hawaiian Hoary Bat PVA models without take



What we did

- We produced 3 models, then asked what level of “take” can a population of 1,000 support.

APPENDIX 2. A comparison of variables for model runs A, B, and C.

Input	Description	A	B	C
1	Populations: 1 island population	Same	Same	Same
2	Duration of 20 years to determine baseline trend (no take)	Same	Same	Same
3	Duration of 52 years to determine overall trends (take and no take)	Same	Same	Same
4	Take starts in year 2 and runs through year 52	Same	Same	Same
5	Extinction defined as no males or no females	Same	Same	Same
6	Reproductive system is polygyny, new mates each year	Same	Same	Same
7	Max age of survival is 8 years	Same	Same	Same
8	Beginning age of breeding is age 1	Same	Same	Same
9	Max age of breeding is age 5	Same	Same	Same
10	Sex ratio at birth is 50 - 50	Same	Same	Same
11	Reproduction is not density-dependent	Same	Same	Same
12	Correlation of environmental variation of 0.5 between repro and survival	Same	Same	Same
13	Percentage of adult females breeding each year	88%	80%	90%
14	Breeding environmental variation (SD) is 5%	Same	Same	Same
15	Percent of adult males breeding is 20%	Same	Same	Same
16	Percentage of broods with 1 pup	8%	0%	4%
17	Percentage of broods with 2 pups	92%	100%	96%
18	Annual juvenile mortality	54%	52%	55%
19	Juvenile mortality environmental variation (SD) is 5%	Same	Same	Same
20	Annual adult mortality	33%	33%	34%
21	Adult mortality environmental variation (SD) is 3%	Same	Same	Same
22	Initial population size is 1,000	Same	Same	Same
23	Carrying Capacity 10,000	Same	Same	Same
24	Harvest (e.g. take) ranges from 0 to 2%	Same	Same	Same
25	Model iterations: 5,000	Same	Same	Same

A Best Guess Scenario

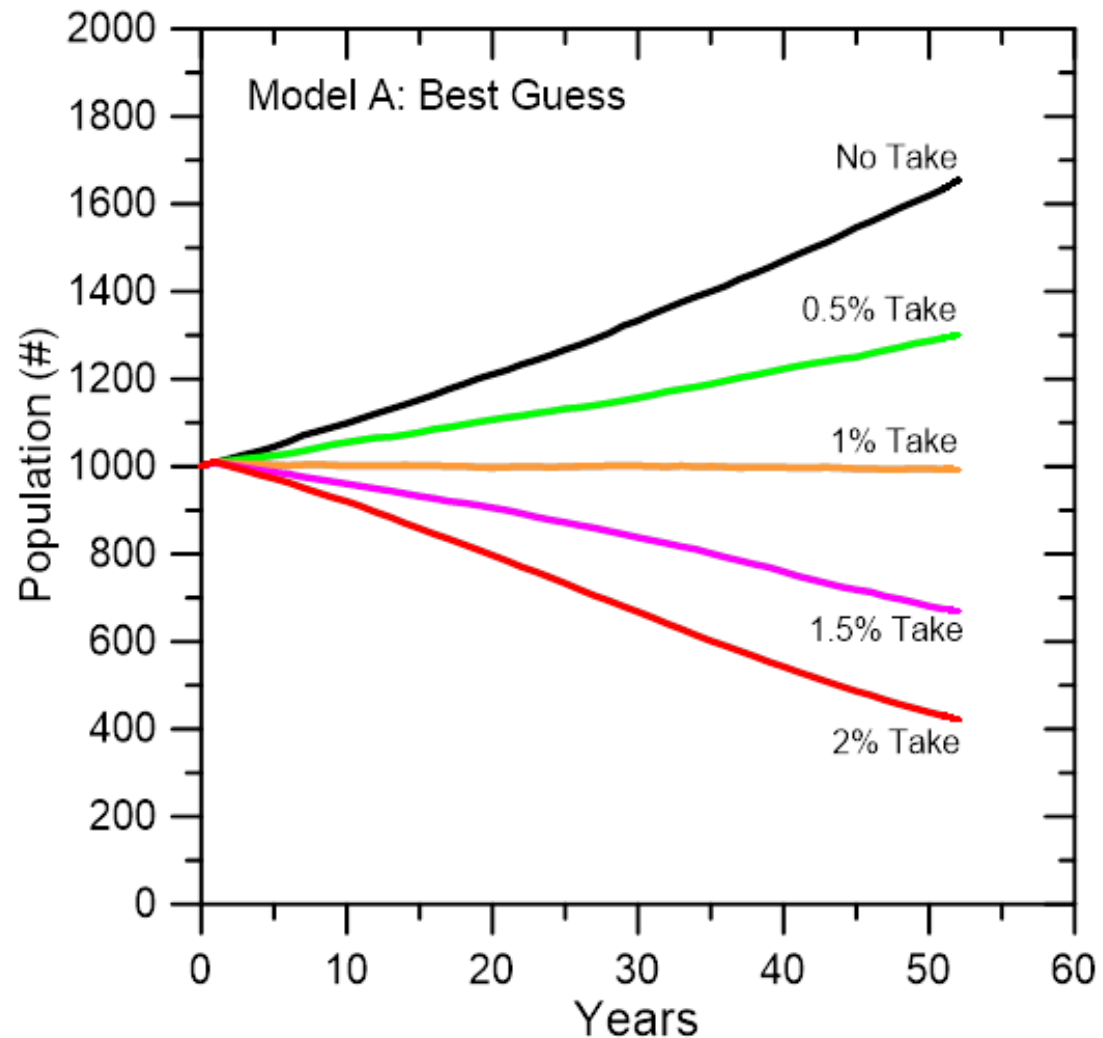
B Priority to HHB data

C Averaged data from all Hawaii and mainland HB data

Population Trend for Model A: Best Guess

(Take begins in year 2 and continues to year 52.)

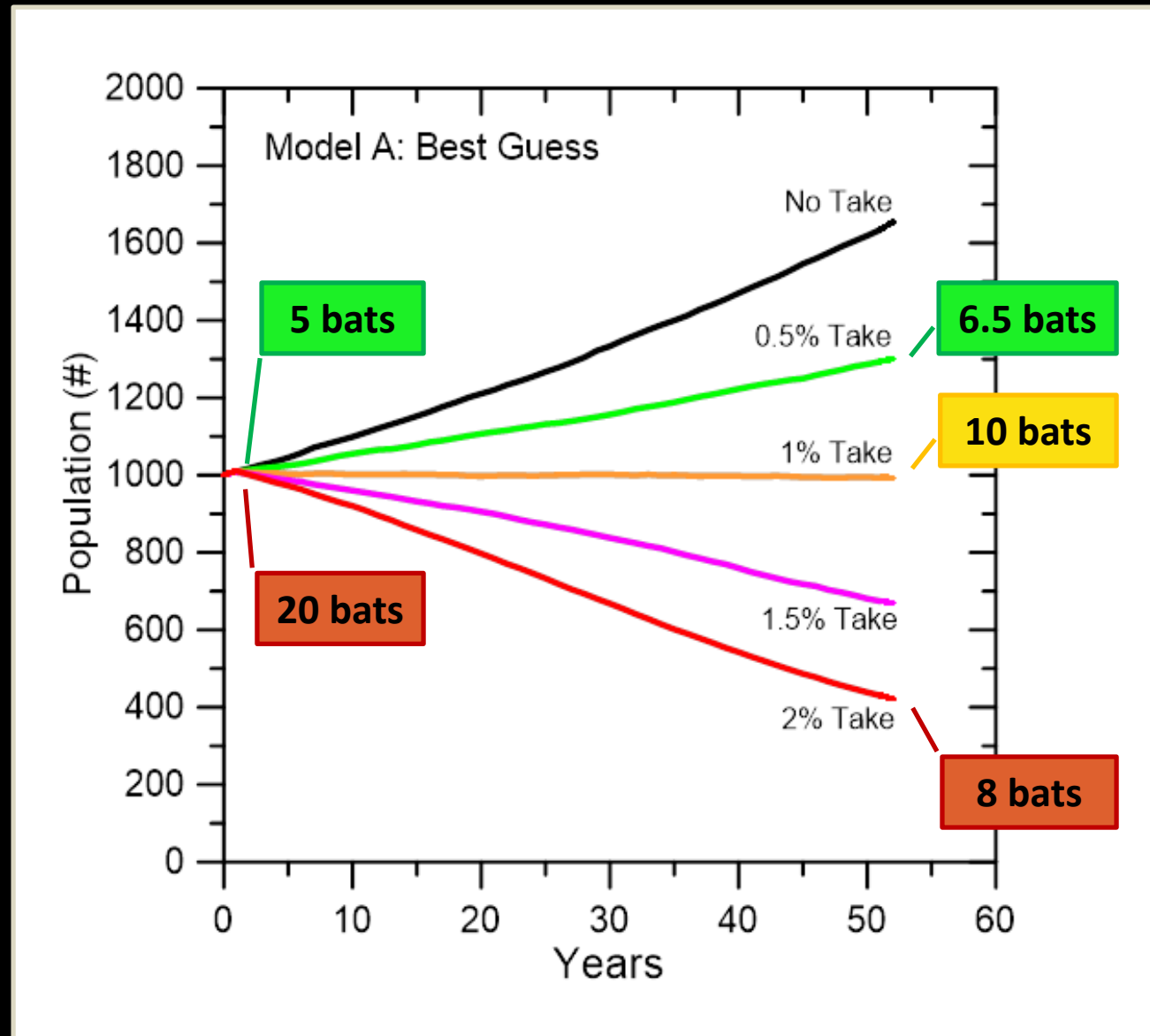
- No Take
 - Exponential rate of increase (r) = 0.0082
 - Annual rate of change (λ) = 1.0186
- Annual take of **up to 1%** of the population seems to maintain a stable population.
- Annual take greater than 1% results in a declining population.



Population Trend for Model A: Best Guess

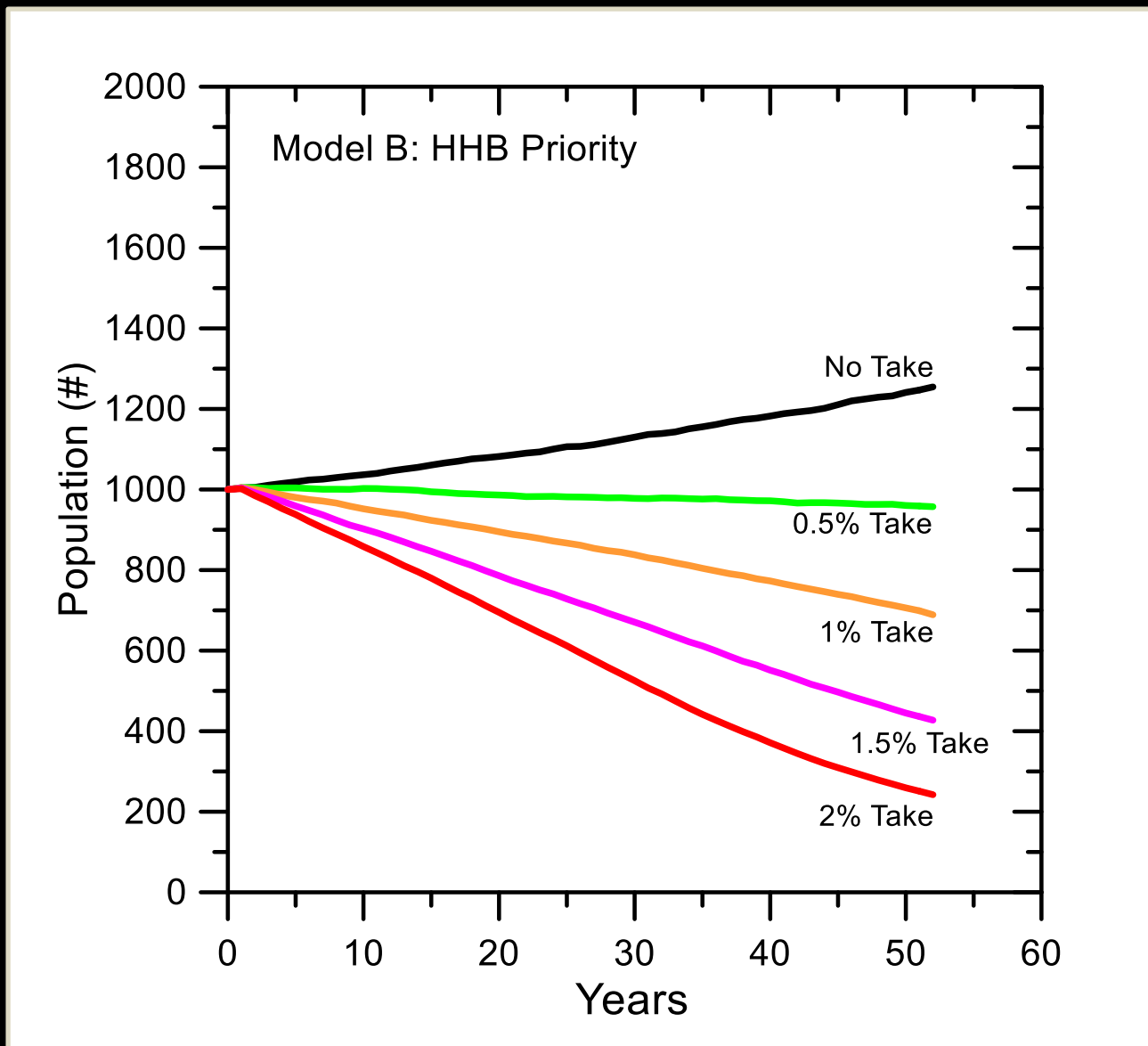
(Take begins in year 2 and continues to year 52.)

- No Take
 - Exponential rate of increase (r) = 0.0082
 - Annual rate of change (λ) = 1.0186
- Annual take of **up to 1%** of the population seems to maintain a stable population.
- Annual take greater than 1% results in a declining population.



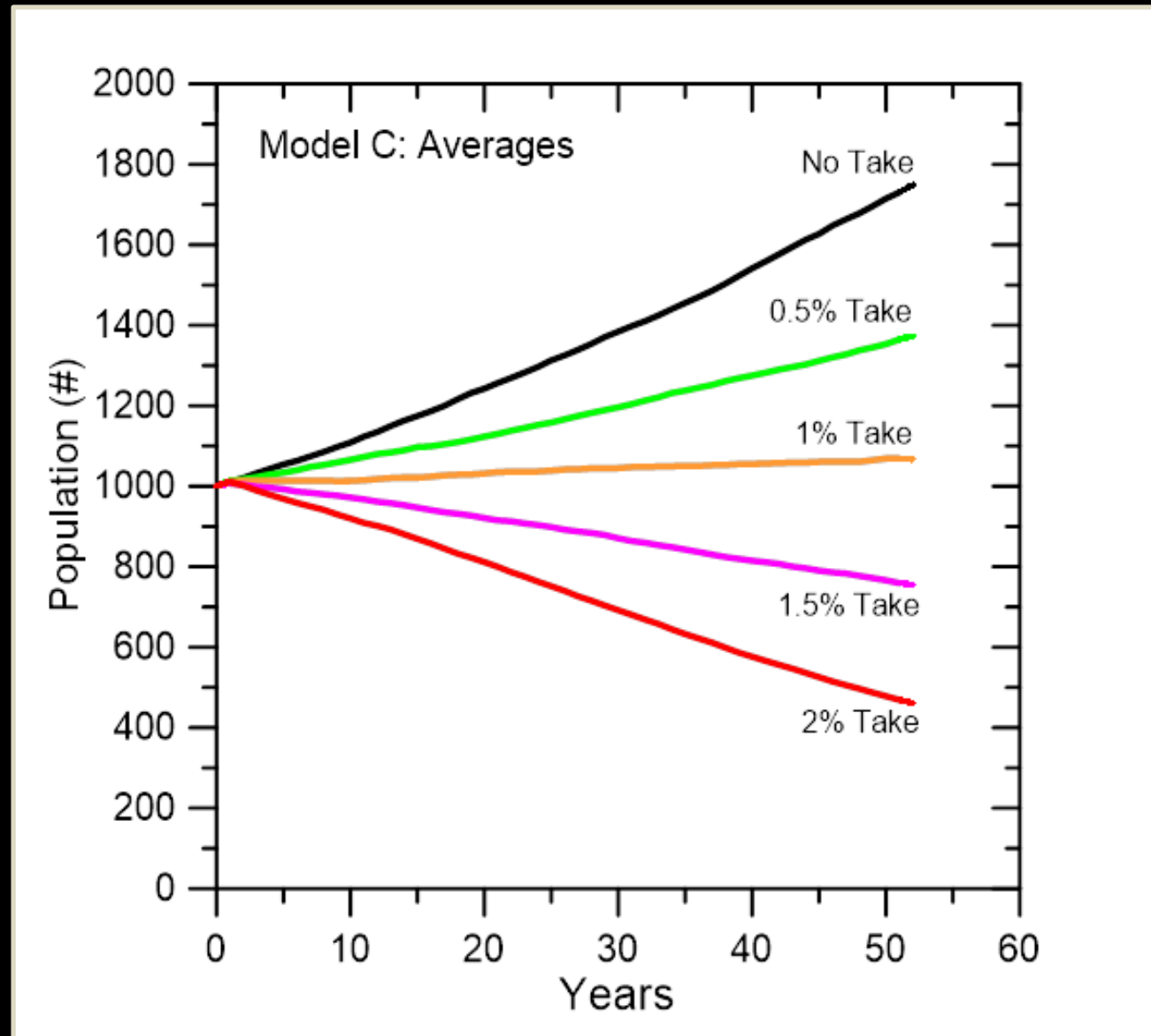
Population Trend for Model B: Hawaiian Hoary Bat Priority (Take begins in year 2 and continues to year 52.)

- No Take
 - Slightly increasing population trend with the exponential rate of increase (r) = 0.0029
 - Annual rate of change (λ) = 1.0029
- Annual take of **0.5%** of the population results in a slightly declining population.
- Annual take greater than 0.5% results in a declining population.



Population Trend for Model C: Averaged data (Take begins in year 2 and continues to year 52.)

- No Take
 - Slightly increasing population trend with the exponential rate of increase (r) = 0.0094
 - Annual rate of change (λ) = 1.0095
- Annual take of **up to 1%** of the population seems to maintain a stable population.
- Annual take of 1.5% or more results in a declining population.

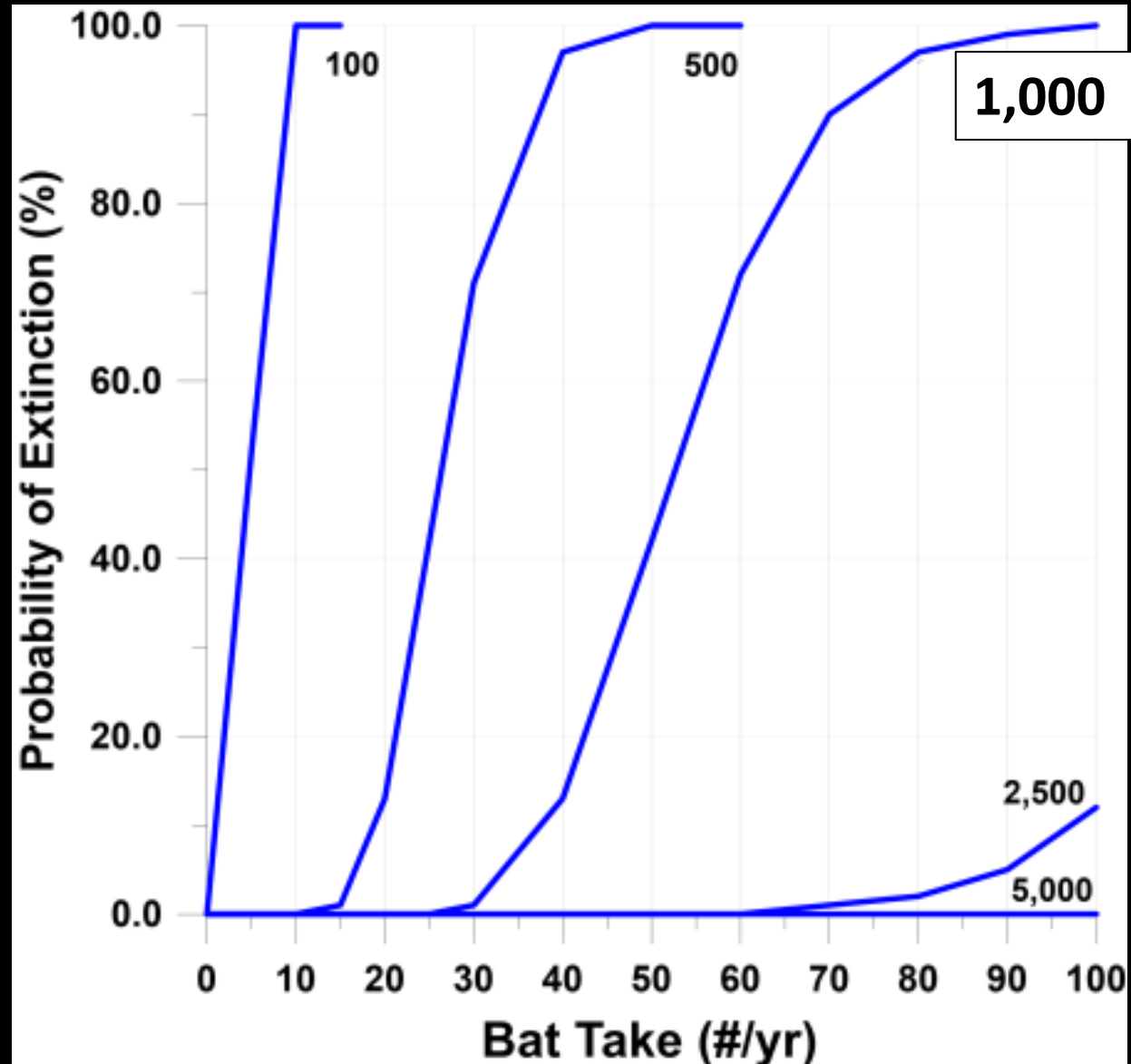


Summary

- All 3 models had “no take” scenarios that led to slightly increasing populations.
- Under all 3 models, the annual take of bats has a negative impact on population growth; even a 0.5% take reduced some populations.
- When modeled annual take exceeded the annual growth rate, modeled population numbers declined.

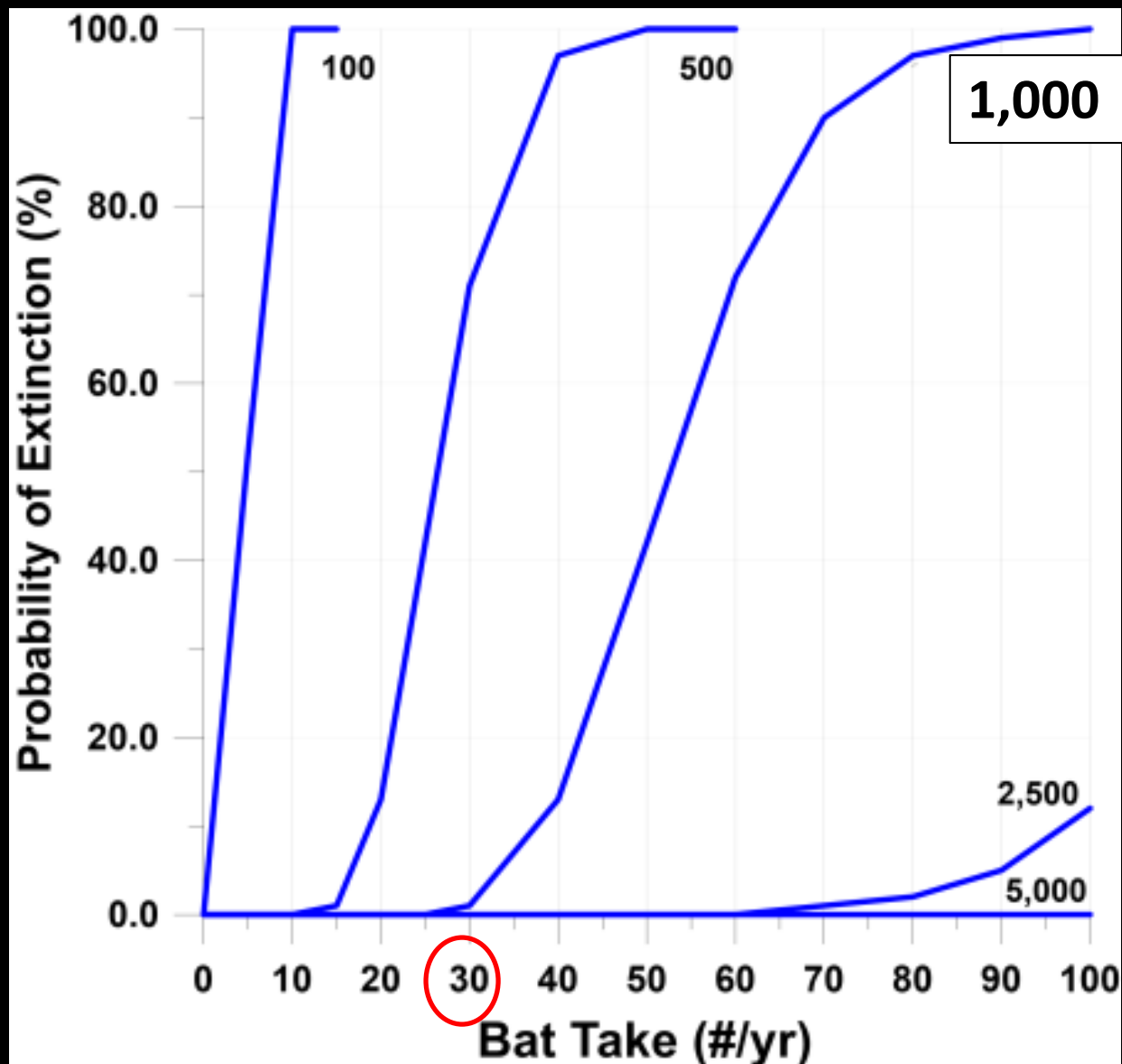
What we did

- We looked at how population size and total annual take might factor into population trends.



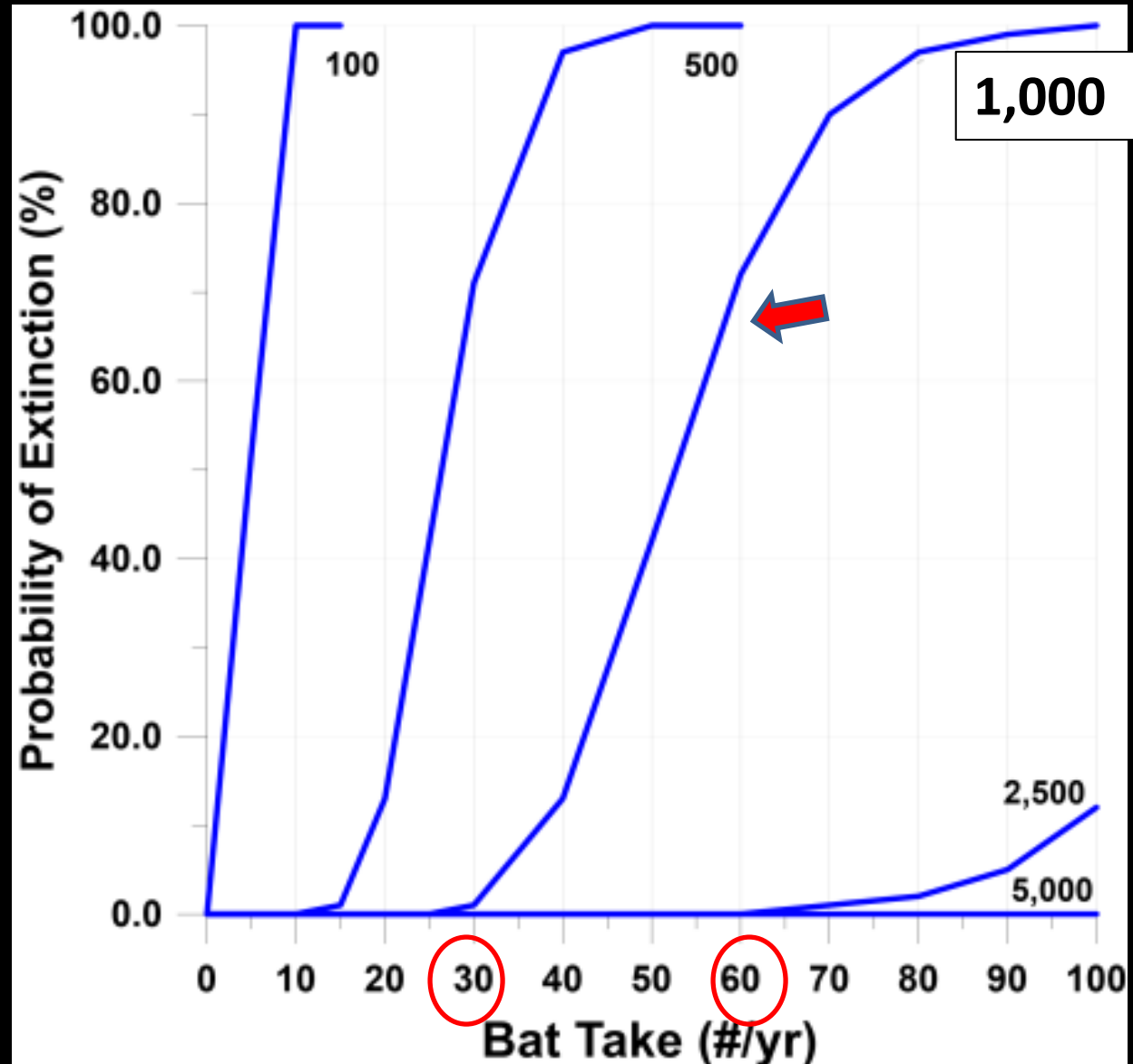
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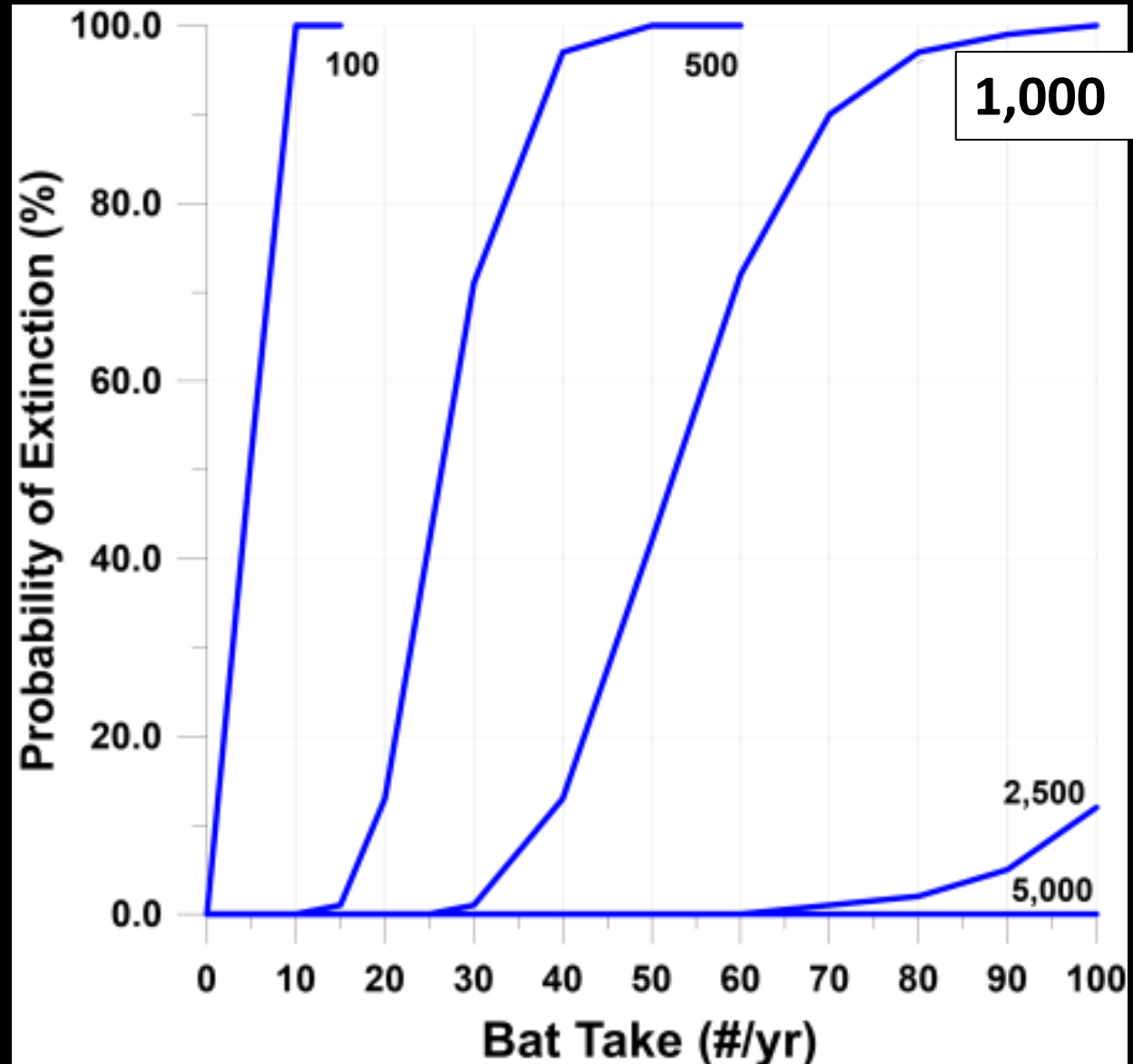
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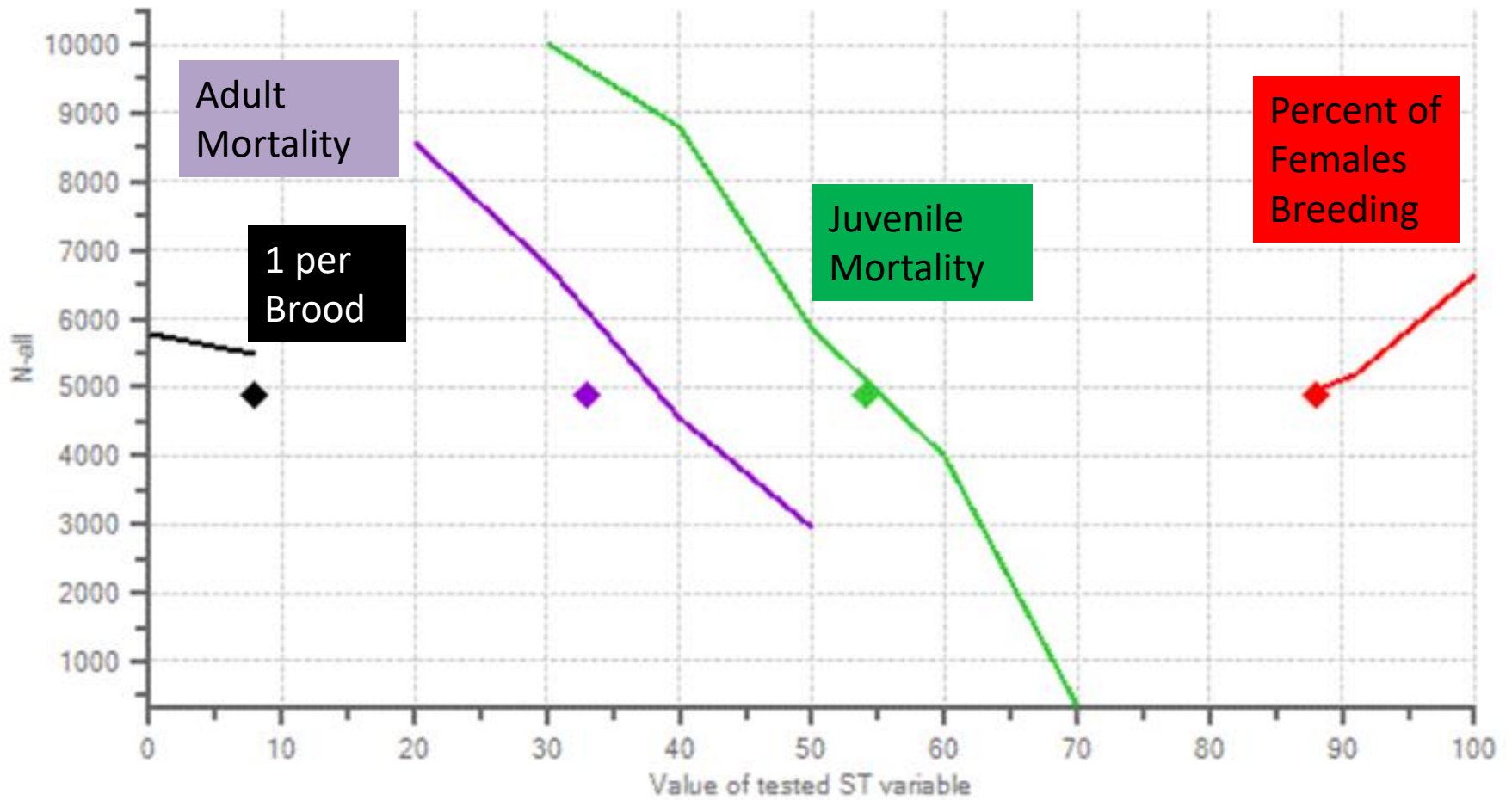
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The End*

*This is our first effort at modeling Hawaiian hoary bats; a much more sophisticated and intensive modeling effort is needed before relying heavily on this effort.

Sensitivity Analysis



Research Priorities

1. Determine the current bat population trend on Oahu.
2. Determine the current bat population trend on Maui.
3. Determine if past habitat restoration projects have increased bat populations.
4. Determine the size of bat populations on Oahu, Maui, and Hawaii.
5. Determine if bat populations are habitat limited.
6. Determine adult bat mortality.
7. Determine juvenile bat mortality.
8. Determine the maximum age of bat reproduction.