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Flight Restriction:
PVA as a quantitative approach to examine implications for population sustainability

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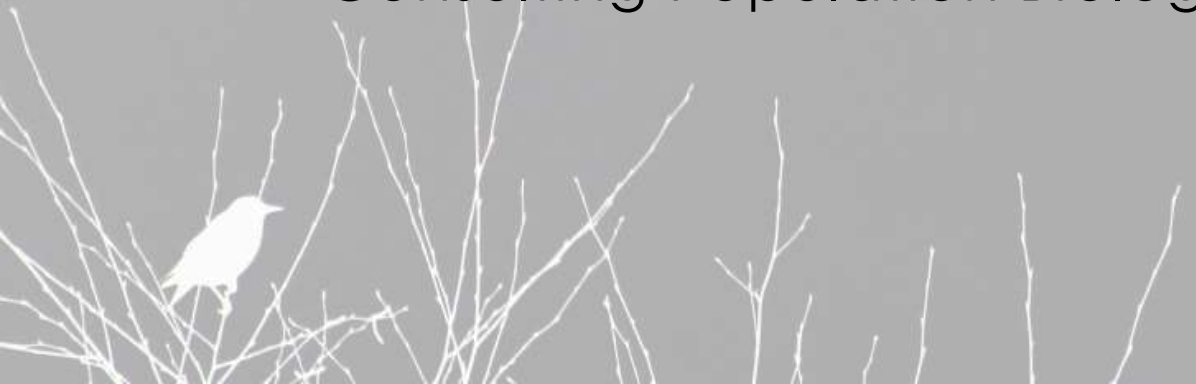
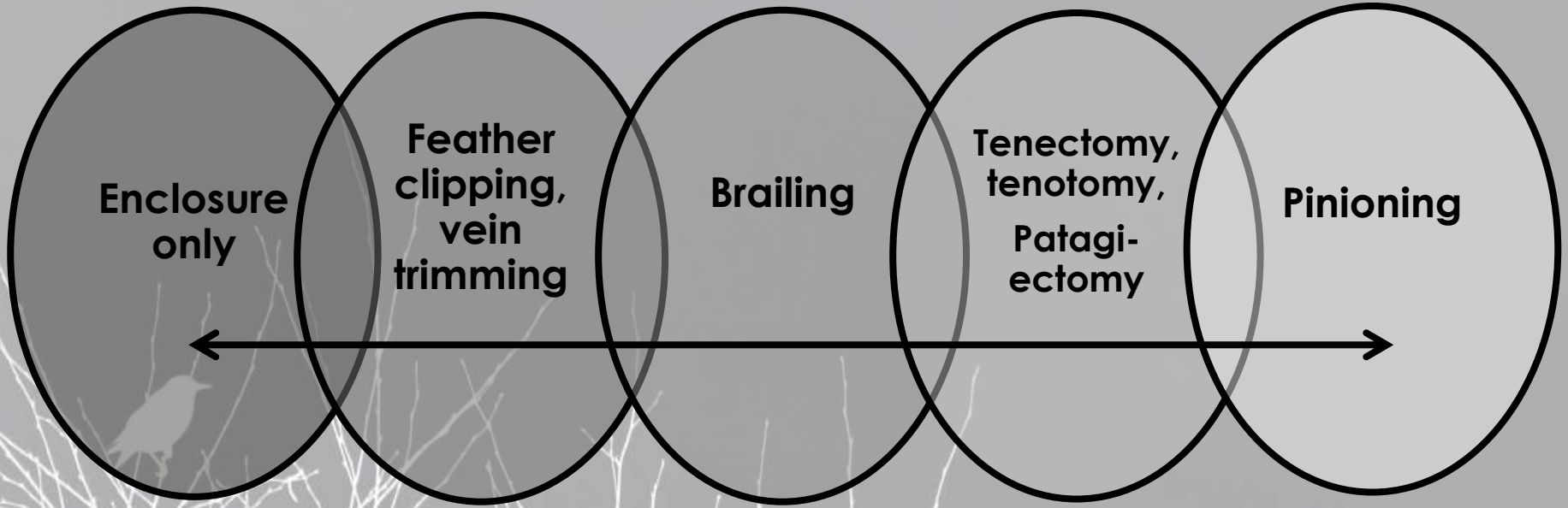


RIVERBANKS ZOO AND GARDEN

Flight restriction methods present a continuum…

- Reversibility
- Effort
- Maintenance
- Opinions



Collection Planning

- Can I pinion this species?
  - Non-reversible/permanent
- Can I manage feather clipping this species?
  - Reversible/temporary
- Can I provide enclosed housing for this species?

If I can't answer YES to at least one of these questions, I probably cannot participate in the management of this species

Collection Planning

- How is the population impacted if my zoo cannot participate in its management?

- **The carrying capacity, or target size, will be reduced…**

  the population will be smaller.

The question of flight restriction…

- Discussions of flight restriction are often QUALITATIVE, based on "gut feeling", personal experience, or emotion

- Discussions of flight restriction are **not** often QUANTITATIVE, based on data

- My Goal
  - IS NOT to discuss the ethics of various flight restriction practices
  - IS to introduce quantitative methods to the discussion

Adding data to the discussion

- Data that should be considered
  - Behavioral
  - Psychological
  - Veterinary
  - Logistical
  - Legal
  - Population biology
    - Vital rates – fecundity & mortality
    - Target population size

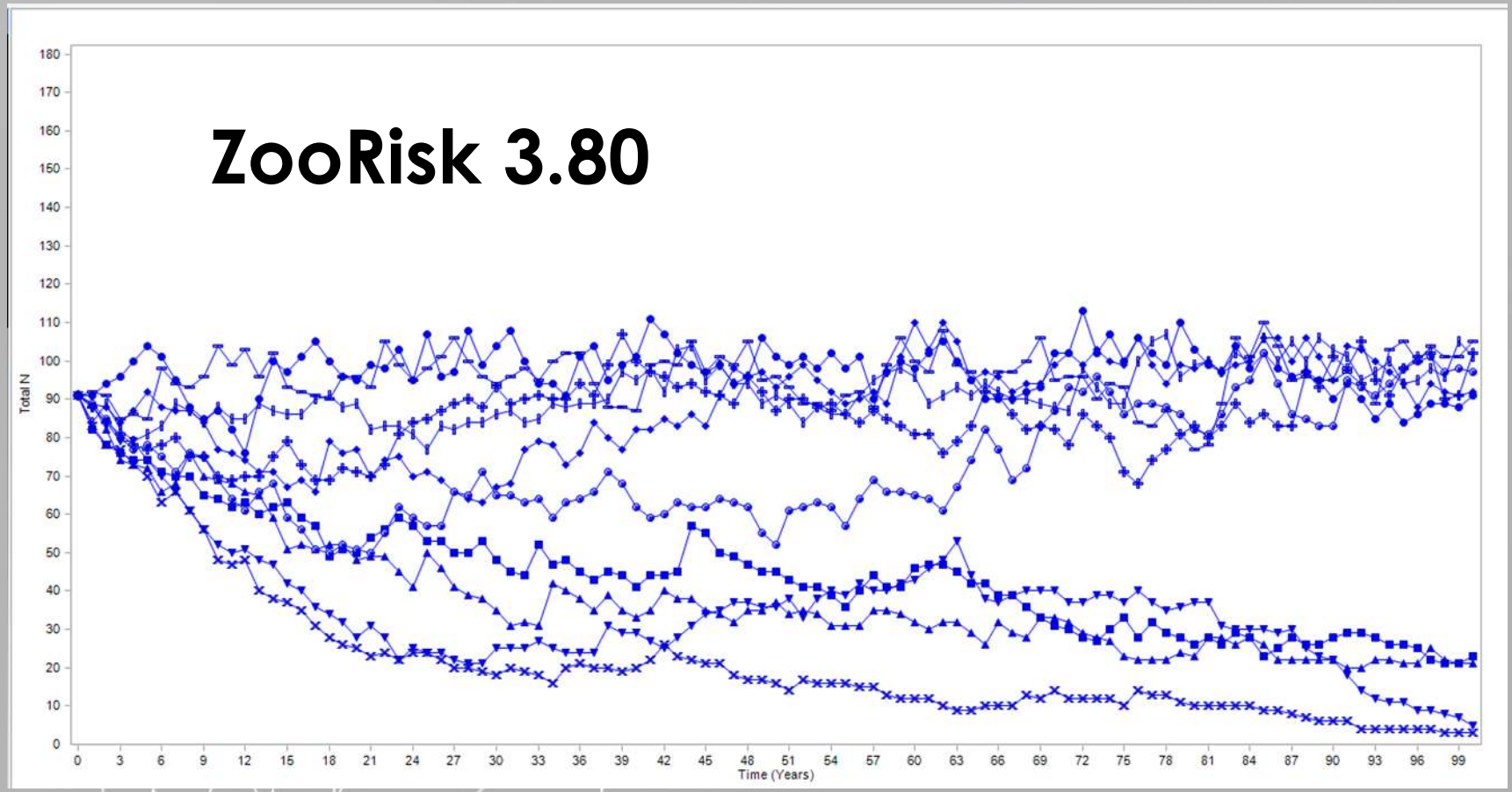
Adding data to the discussion

- Data that should be considered
  - Behavioral
  - Psychological
  - Veterinary
  - Logistical
  - Legal
  - Population biology
    - Vital rates – fecundity & mortality
    - **Target population size**

Population Viability Analysis

- Iterative stochastic individual-based computer model that predicts the likely future status of a population
- includes demographic, genetic and management processes that affect captive populations
- based on a population's history (studbook data) and the science of small population management

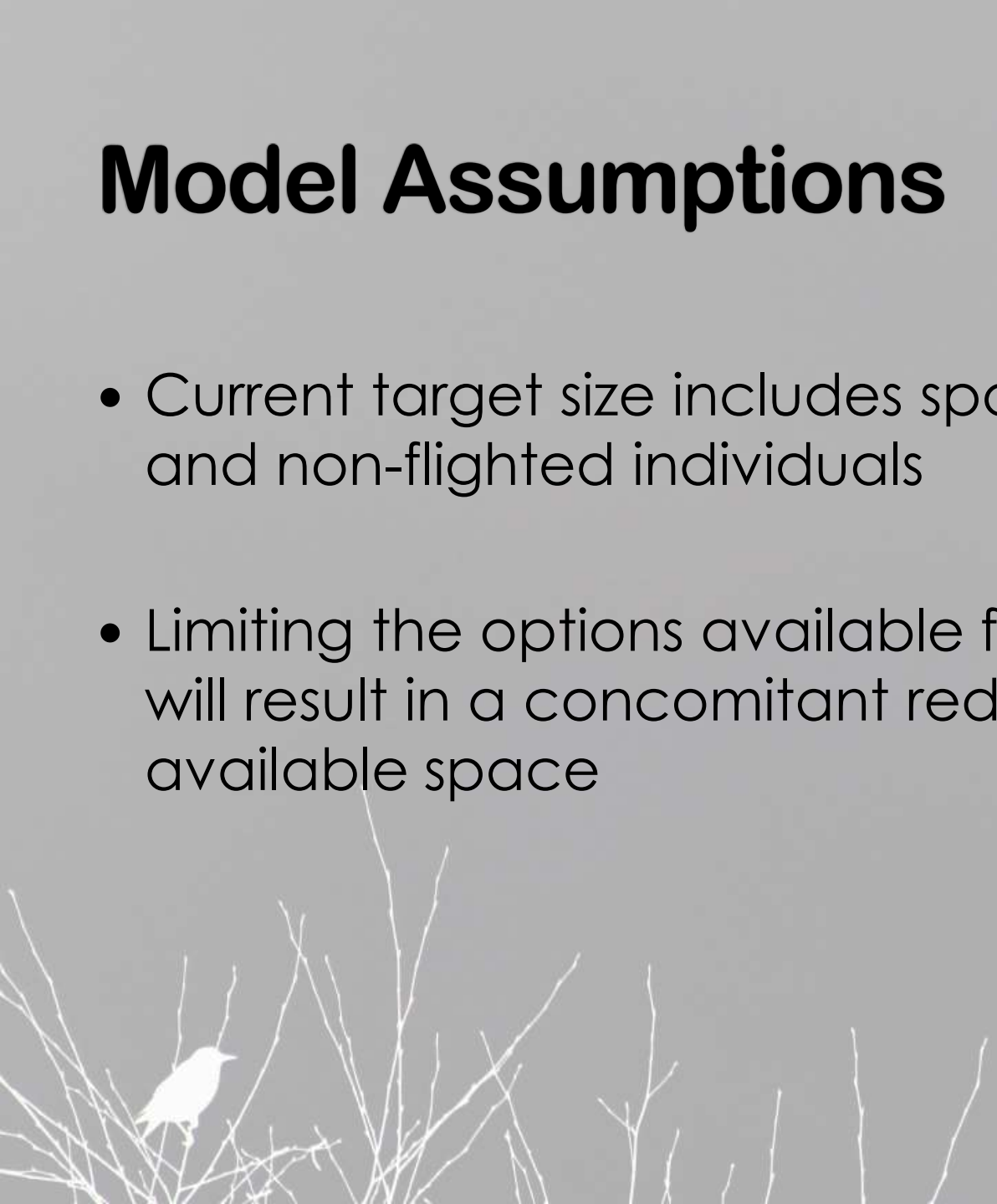
Population Viability Analysis



Model Assumptions

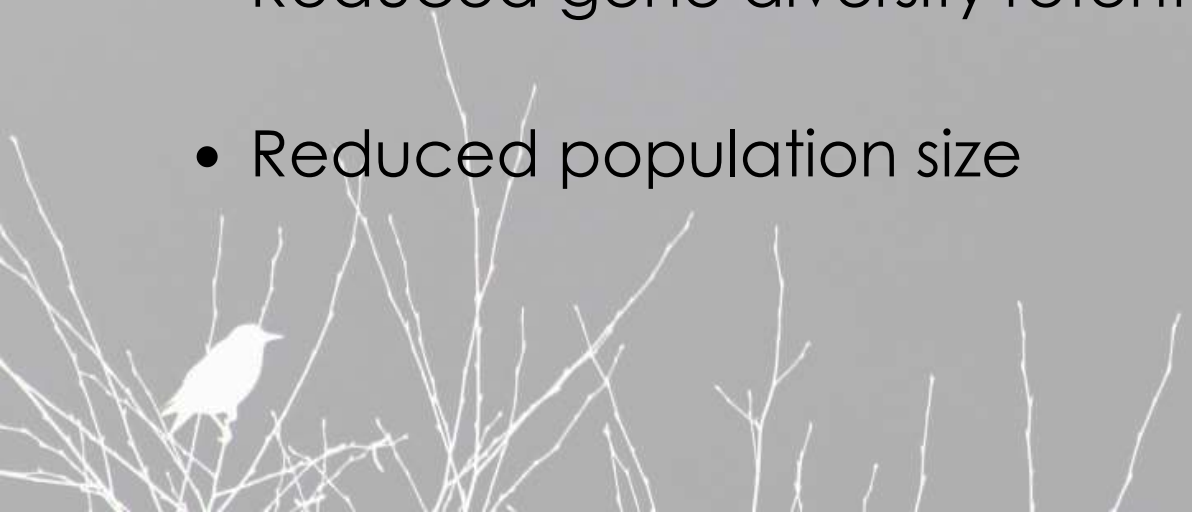
- Current target size includes spaces for flighted and non-flighted individuals

- Limiting the options available for flight restriction will result in a concomitant reduction in available space



Model Hypothesis

- Populations having a lower target size may exhibit reduced sustainability via
  - Increased extinction risk
  - Reduced gene diversity retention
  - Reduced population size



Model Structure

- Species to be modeled
  - Crane
  - Flamingo
  - Goose
  - Duck

Baseline Model Structure

- **Baseline Model** predicts population future under **current management conditions**
  - Input
    - Genetic structure of living population
    - Demographic rates derived from studbook
  - Output
    - Extinction Risk at 100 years from present
    - GD retained at 100 years from present
    - Population size at 100 years from present

Scenario Model Structure

- **Scenario Model** predicts population future under **varying management conditions**
  - Input
    - Genetic structure of living population
    - Demographic rates derived from studbook
    - **Reduced target size**
      - **90%, 80%, 60%**
  - Output
    - Extinction Risk at 100 years from present
    - GD retained at 100 years from present
    - Population size at 100 years from present

Misc. Model Rules

- Unknown pedigree
  - No pairing of animals having Pedigree < 50% known

- Inbreeding
  - No pairing of animals with F $\geq$ 25%

Model Details

- For the 5 of you who care…

Species Biology

	Variable	Value
	Number of Males per Breeding Group	1
	Number of Females per Breeding Group	1
▶	Number of Years between Pairing	1

Model Settings

	Variable	Value
	Number of Years	100
	Number of Iterations	1000
	Extinction Threshold	0
✎	GD Threshold	0

Model Options

Calculate Genetics	ON
Calculate Age Pyramids	OFF
Calculate Standard Deviations	ON
Impose Target Population Size	ON
Simulate Genetic Management	ON
Simulate Import/Export Events	OFF
Simulate Catastrophe Events	OFF
Impose Inbreeding Depression	OFF

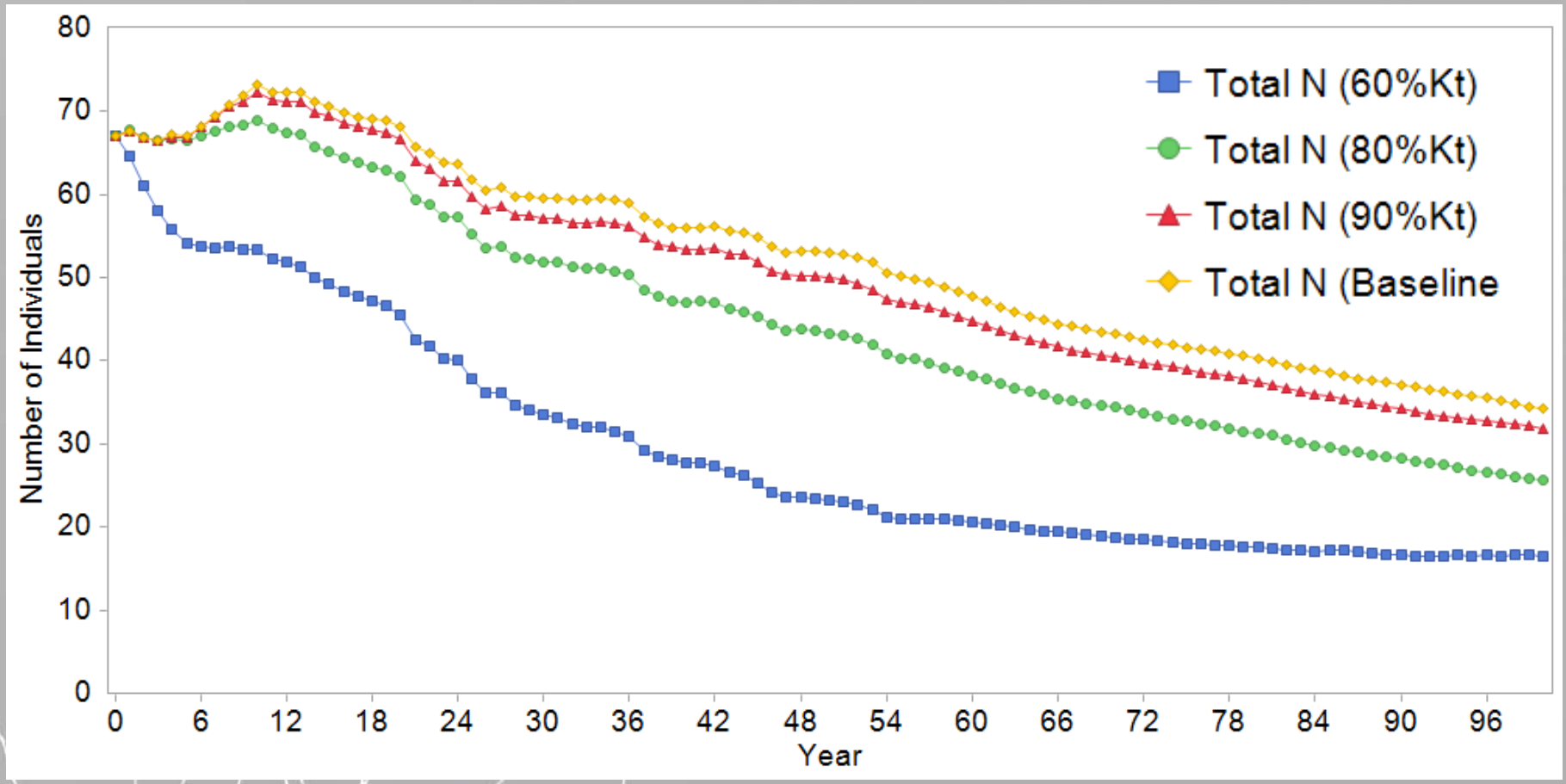
Model Results -

- Populations are not negatively impacted by REMOVING flight restriction IF Baseline = Scenario output
  - Acceptable risk of extinction
    - $\leq$ 10% extinction risk
  - Gene Diversity at 100 Years
    - $\geq$ 90% GD
  - Population Size at 100 years
    - N = Kt

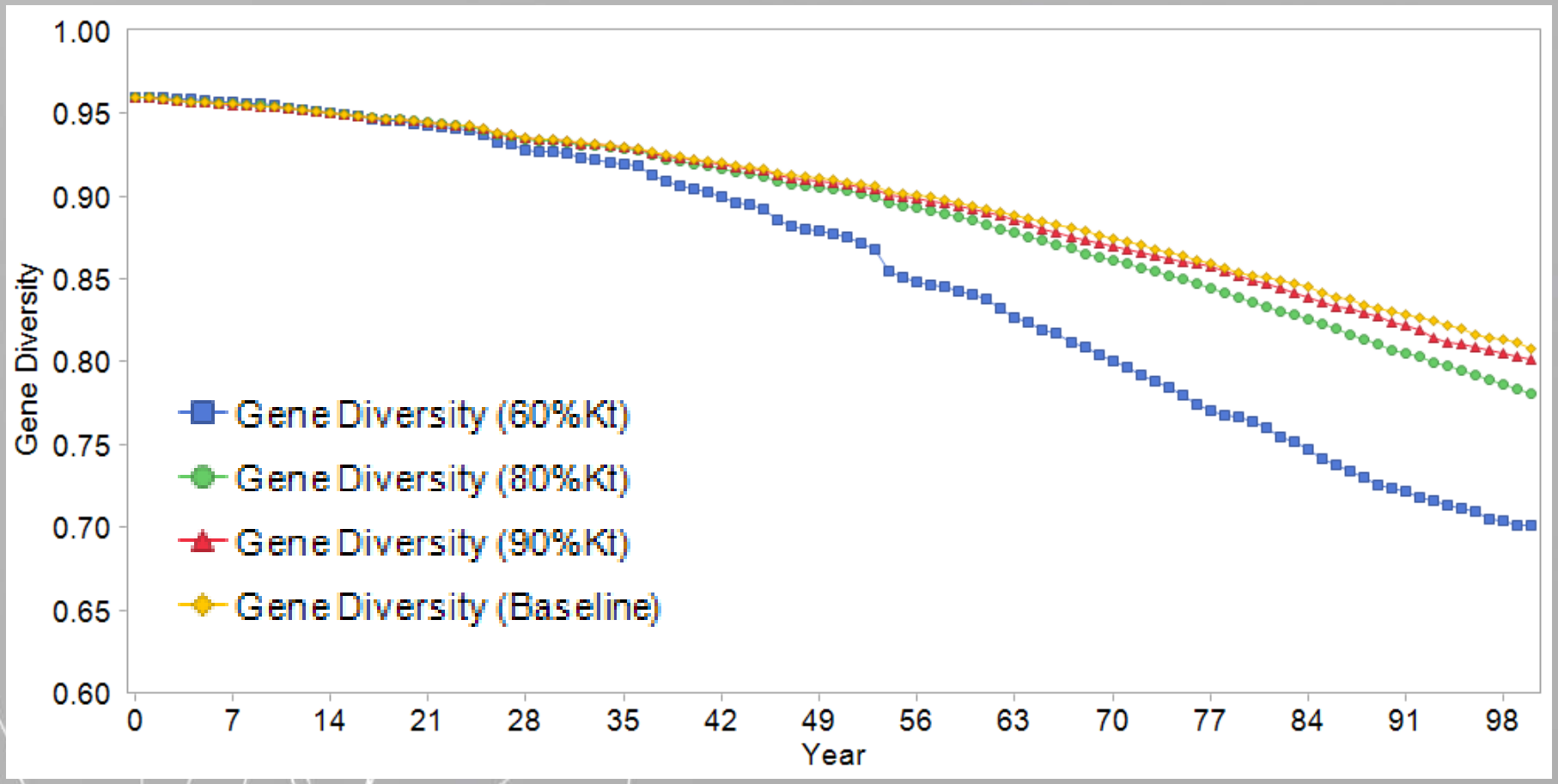
Crane background

- Population is currently
  - Below TAG recommended target size 67/90
  - Current GD = 96%
  - Projected lambda = 0.98

Crane Results – N (Kt = 90)

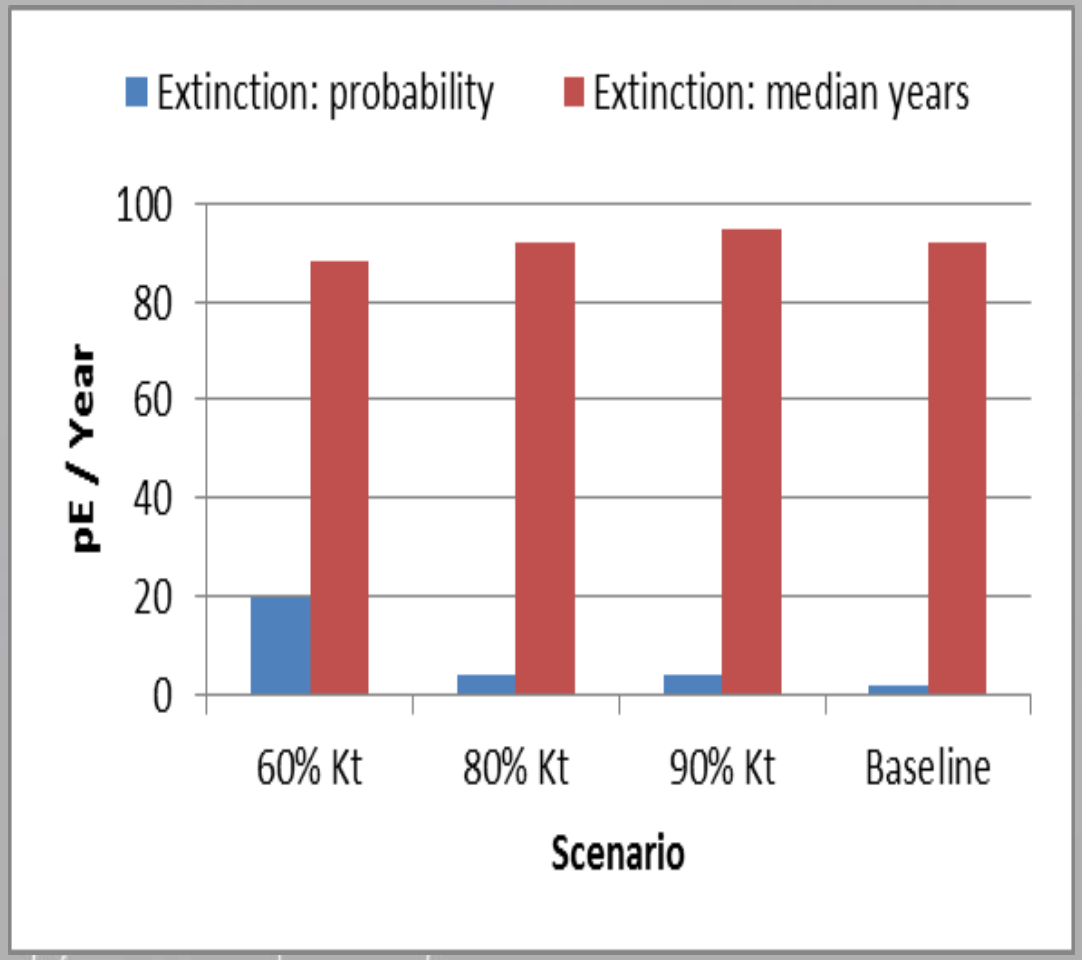


Crane Results - GD



Crane Results - Extinction Risk

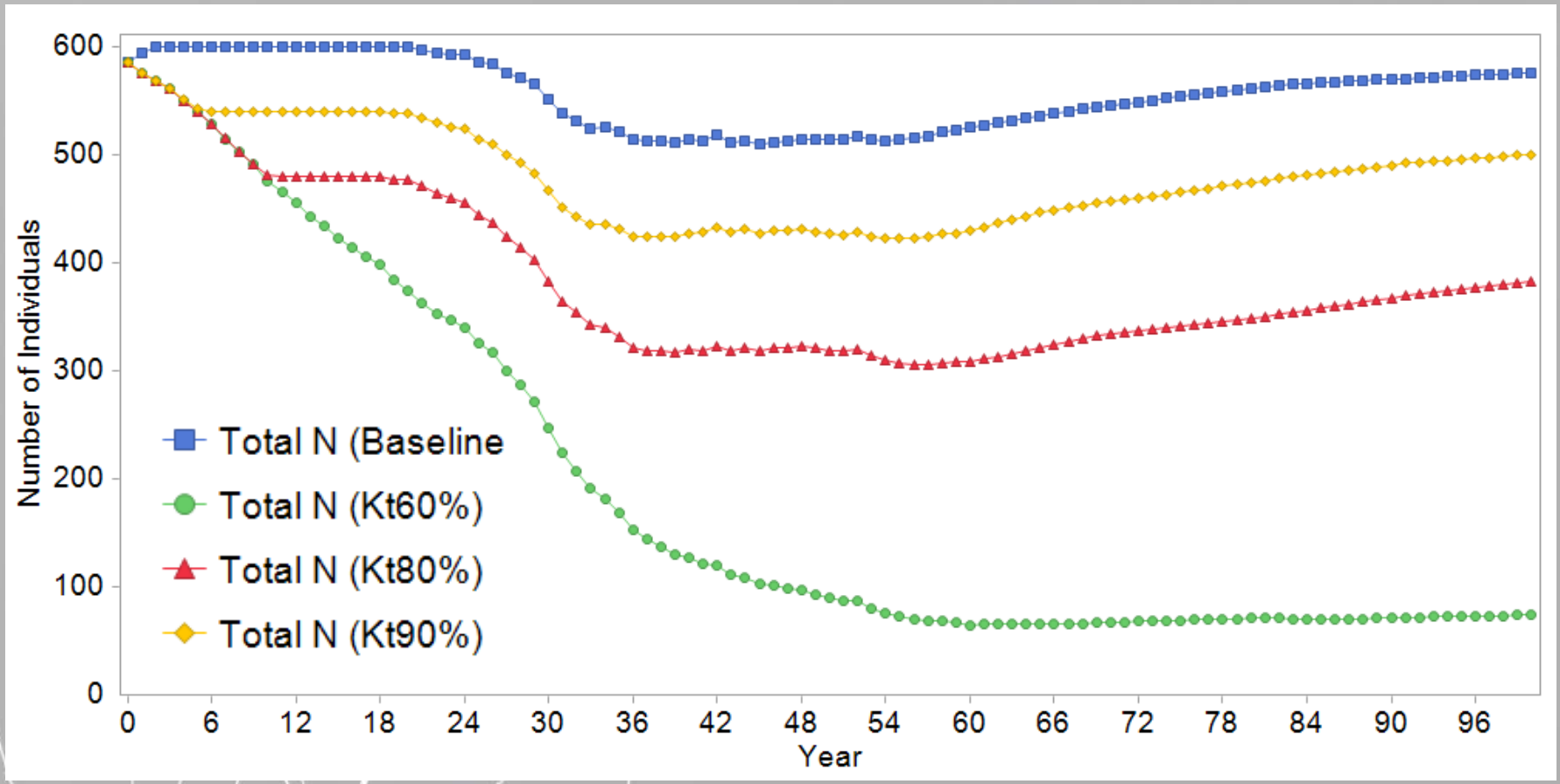
- Risk
  - High at 60%Kt
  - Acceptable in other scenarios
- Time
  - 80+ years



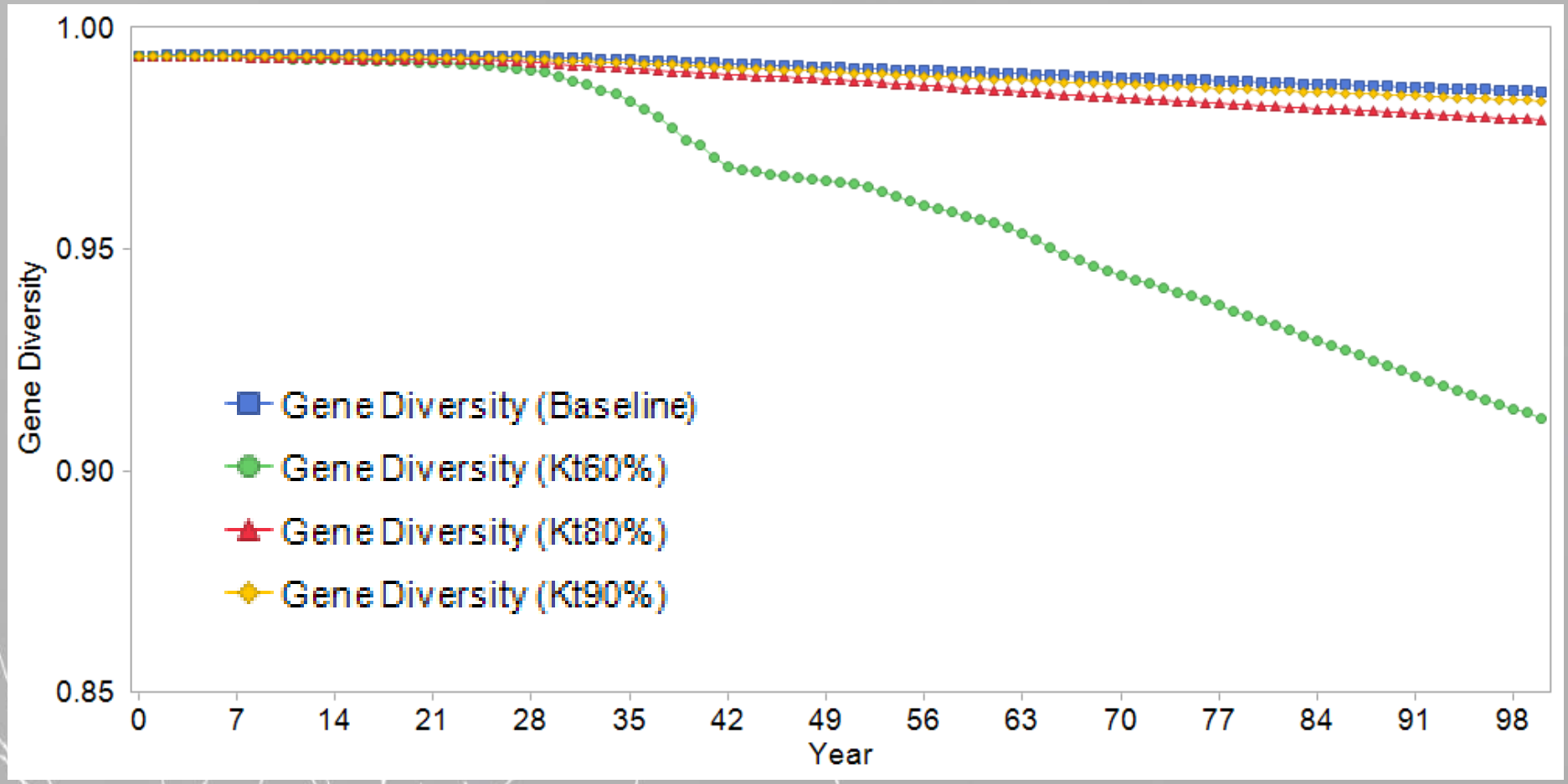
Flamingo background

- Population is currently
  - Below TAG recommended target size 585/600
  - Current GD = 99%
  - Projected lambda = 0.99

Flamingo Results – N (Kt = 600)

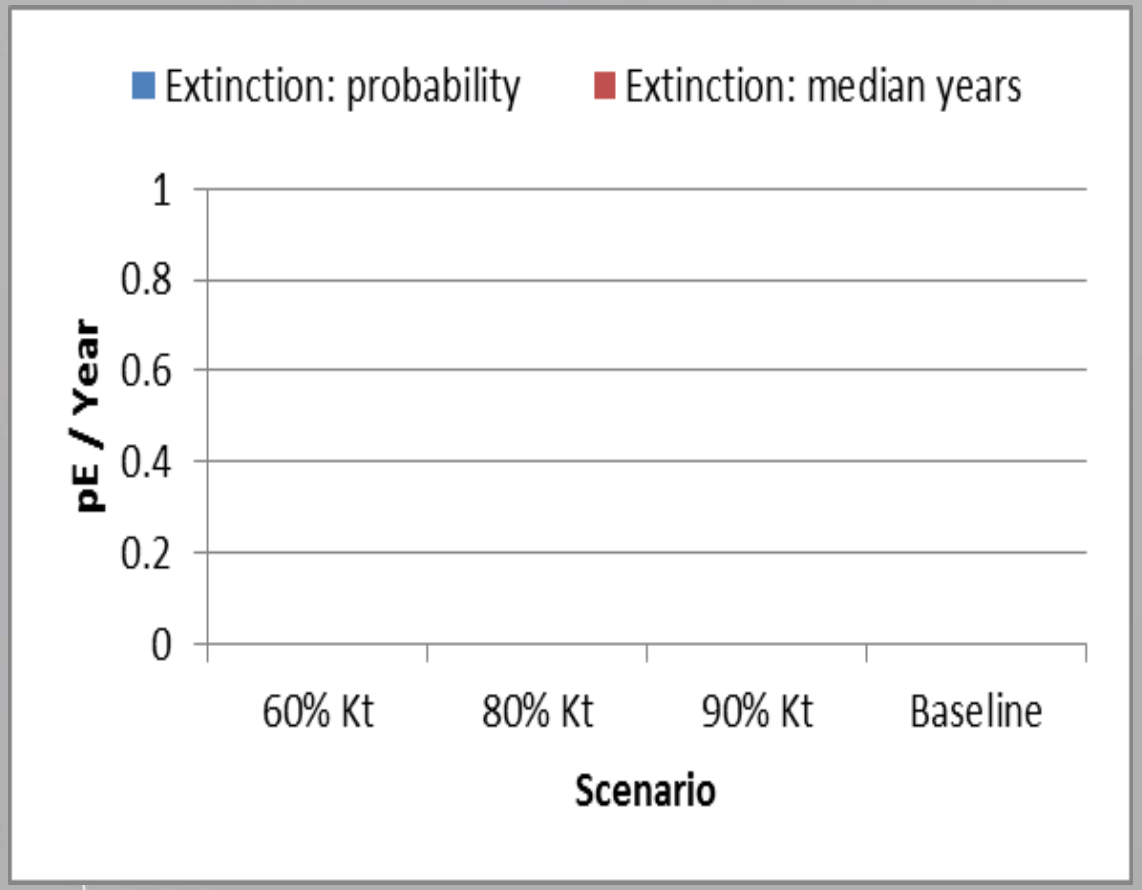


Flamingo Results - GD



Flam Results - Extinction Risk

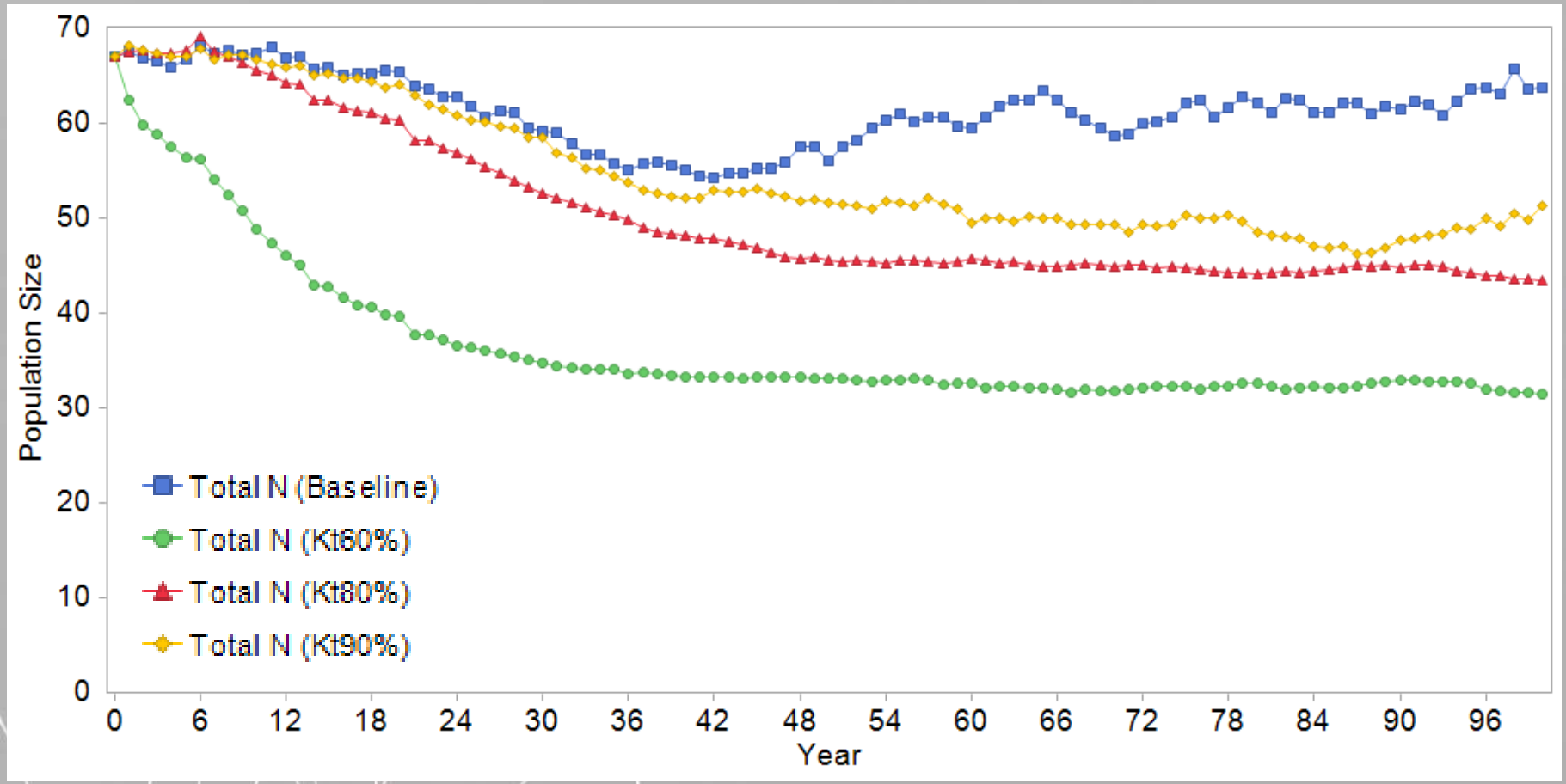
- Risk
  - Zero for all scenarios
- Time
  - n/a



Goose background

- Population is currently
  - Below TAG recommended target size 67/100
  - Current GD = unknown %
  - Projected lambda = 0.97

Goose Results – N (Kt = 100)

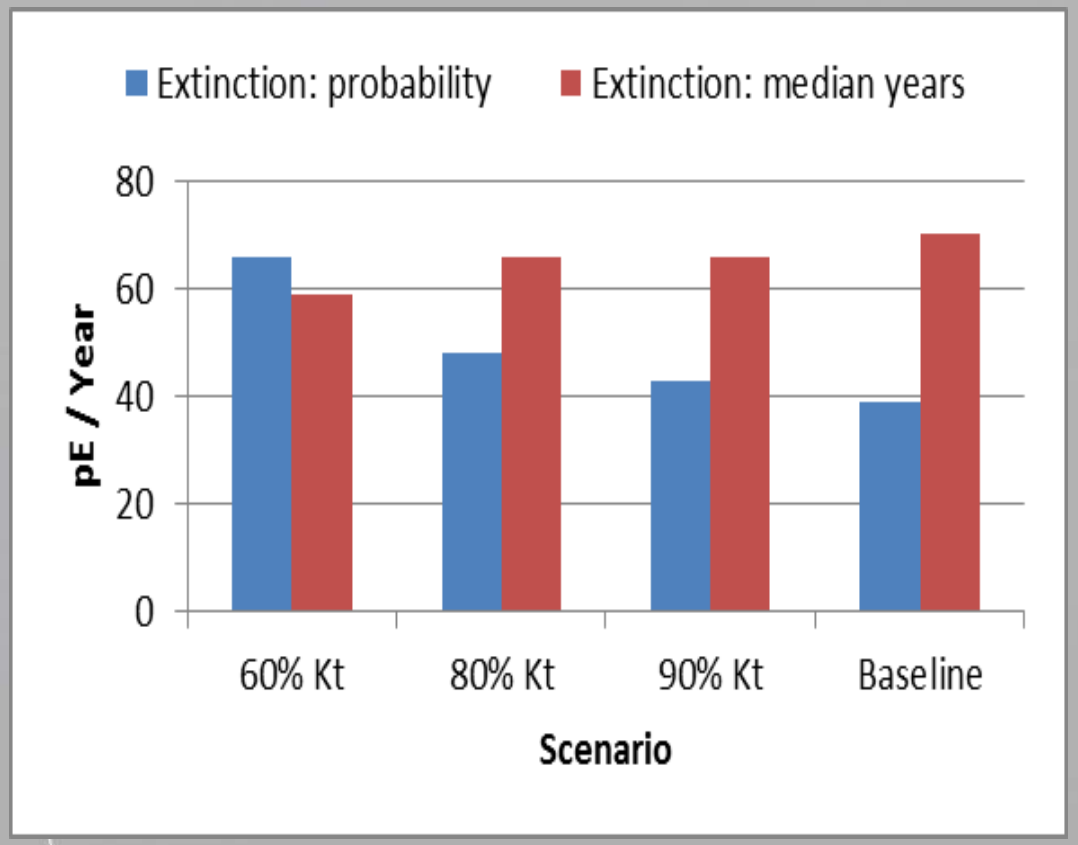


Goose results - GD

- Too much unknown pedigree to model…
  - Needs an analytical studbook with data conventions supported by ZooRisk

Goose Results - Extinction Risk

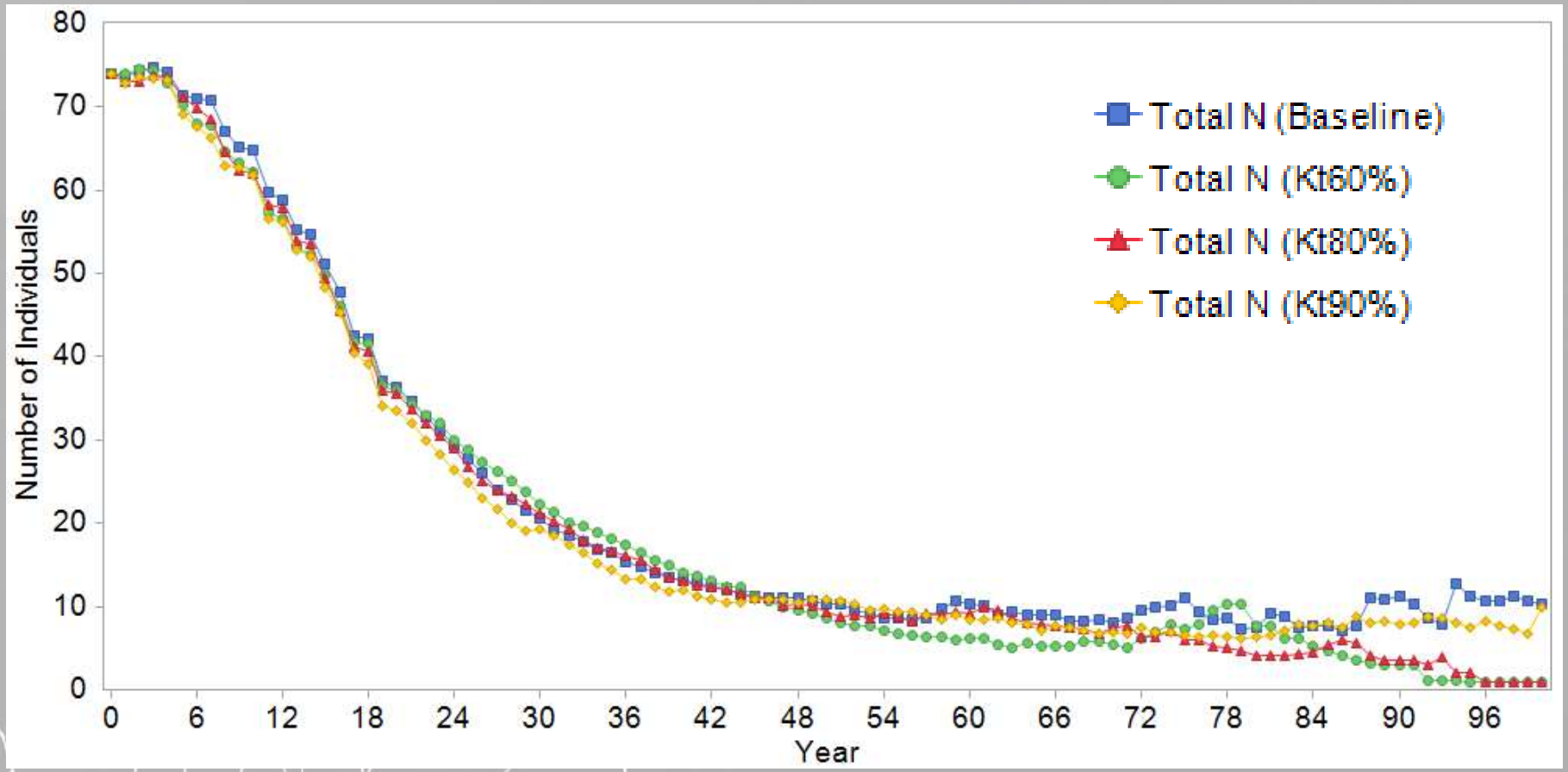
- Risk
  - High for all scenarios
- Time
  - 60-70 years



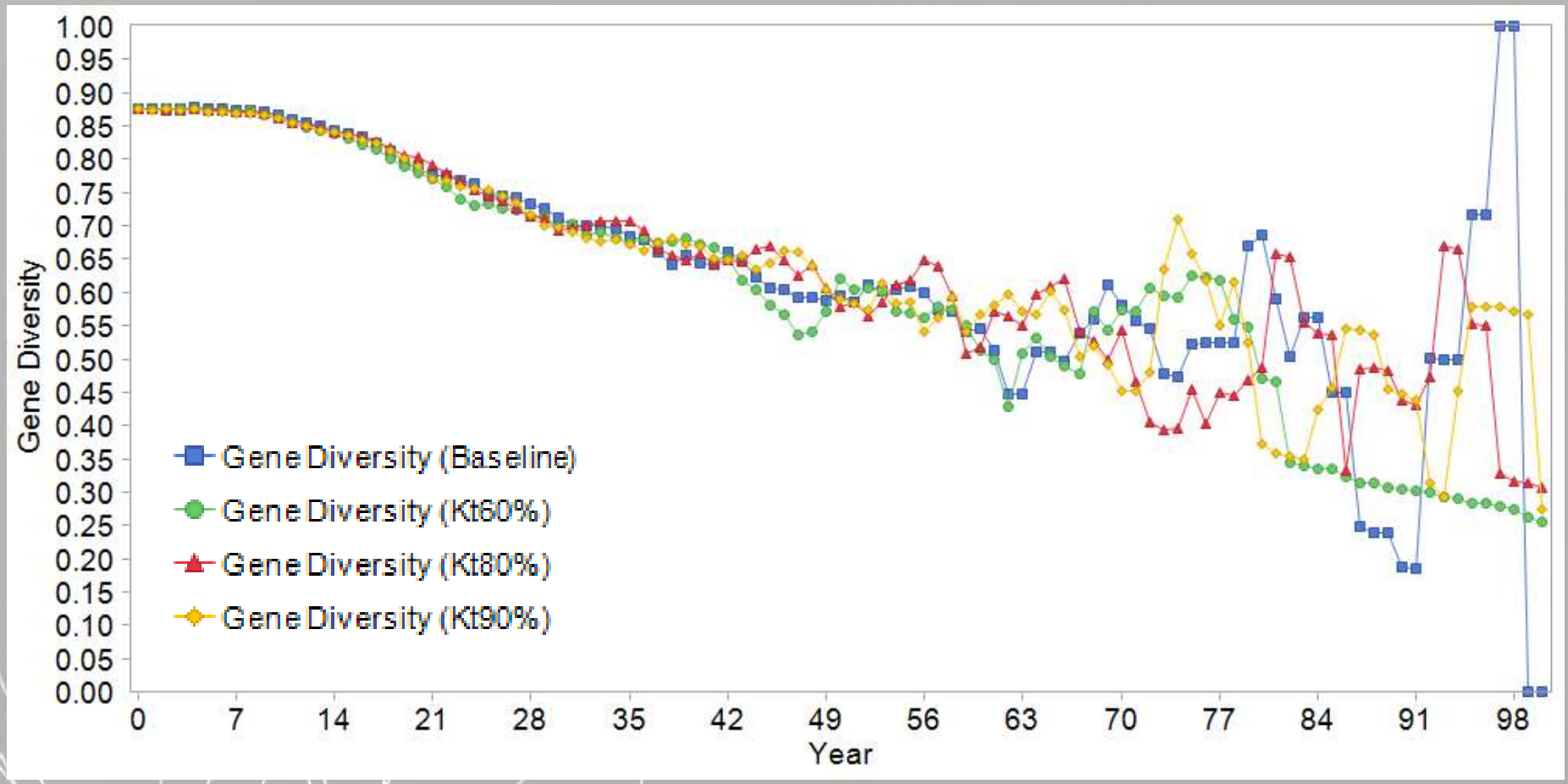
Duck background

- Population is currently
  - Below TAG recommended target size 73/150
  - Current GD = 87%
  - Projected lambda = 0.91

Duck Results – N (Kt = 150)

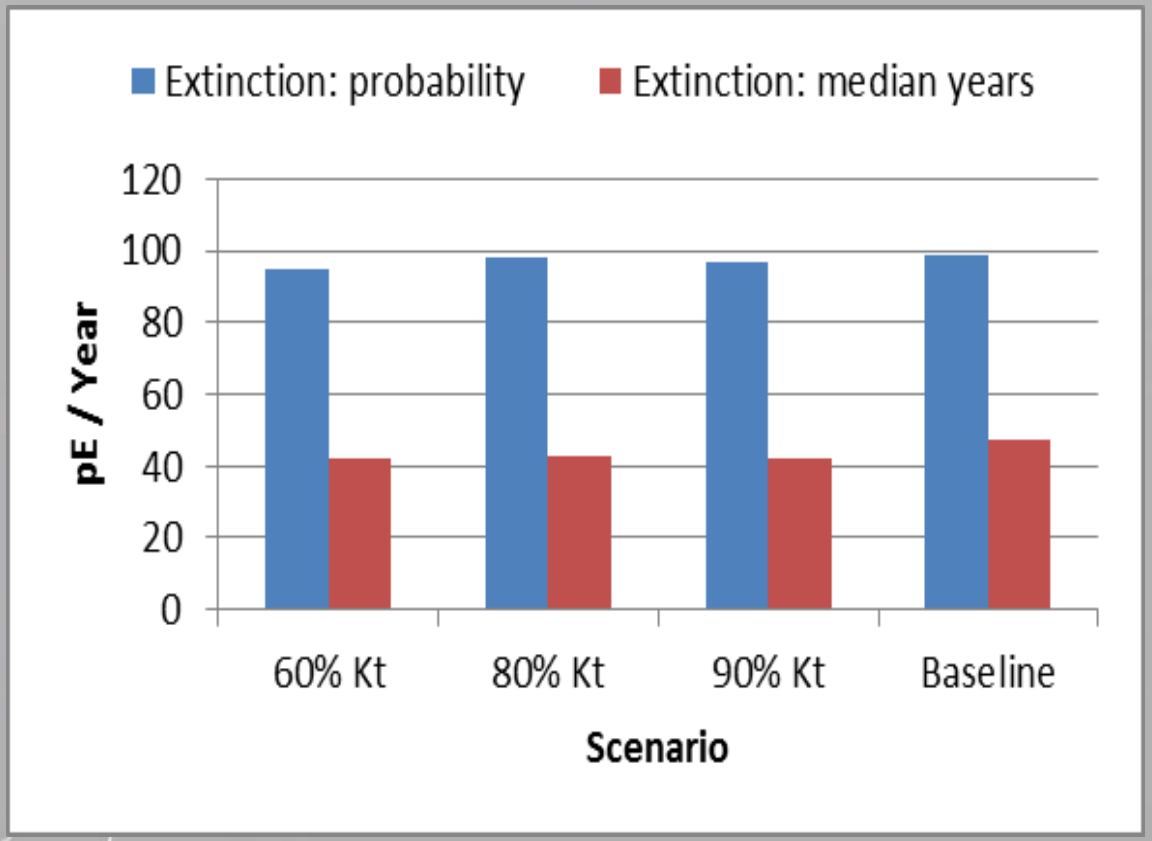


Duck Results - GD



Duck Results - Extinction Risk

- Risk
  - Extinction is almost certain in all scenarios
- Time
  - 40-50 years



Results - Patterns

- NS^2 - "no ---- sherlock"
  - Result trends are intuitive
  - But result values are actually measurable
  - Relative impacts of alternative management can be predicted

- Most of our populations are
  - Currently not achieving their TAG Recommended Target Size
  - Currently projected to decline rather than grow
  - Currently projected to not meet genetic goals (90%GD)
    - welfare issue may arise as inbreeding accumulates

- **Any actions that further reduce resources, including space, should be carefully considered**

Other questions to be modeled

- These models examined change in TARGET SIZE

- Other models could be built to incorporate examinations of potential changes in individual fitness
  - FECUNDITY
    - What if a flight restriction method reduces the likelihood of successful reproduction?
  - MORTALITY
    - What if a method of flight restriction directly or indirectly influences mortality?

Population Viability Analysis

- The models presented are simple examples
  - But they demonstrate that results vary among species
- More accurate/complex models should be constructed in cooperation with species managers to ensure accurate and useful outcomes
  - Species were not identified (but actual studbooks were used)
  - Thanks studbook keepers for sharing your data!
- **PVA provides a quantitative method to be included in discussions of flight restriction**

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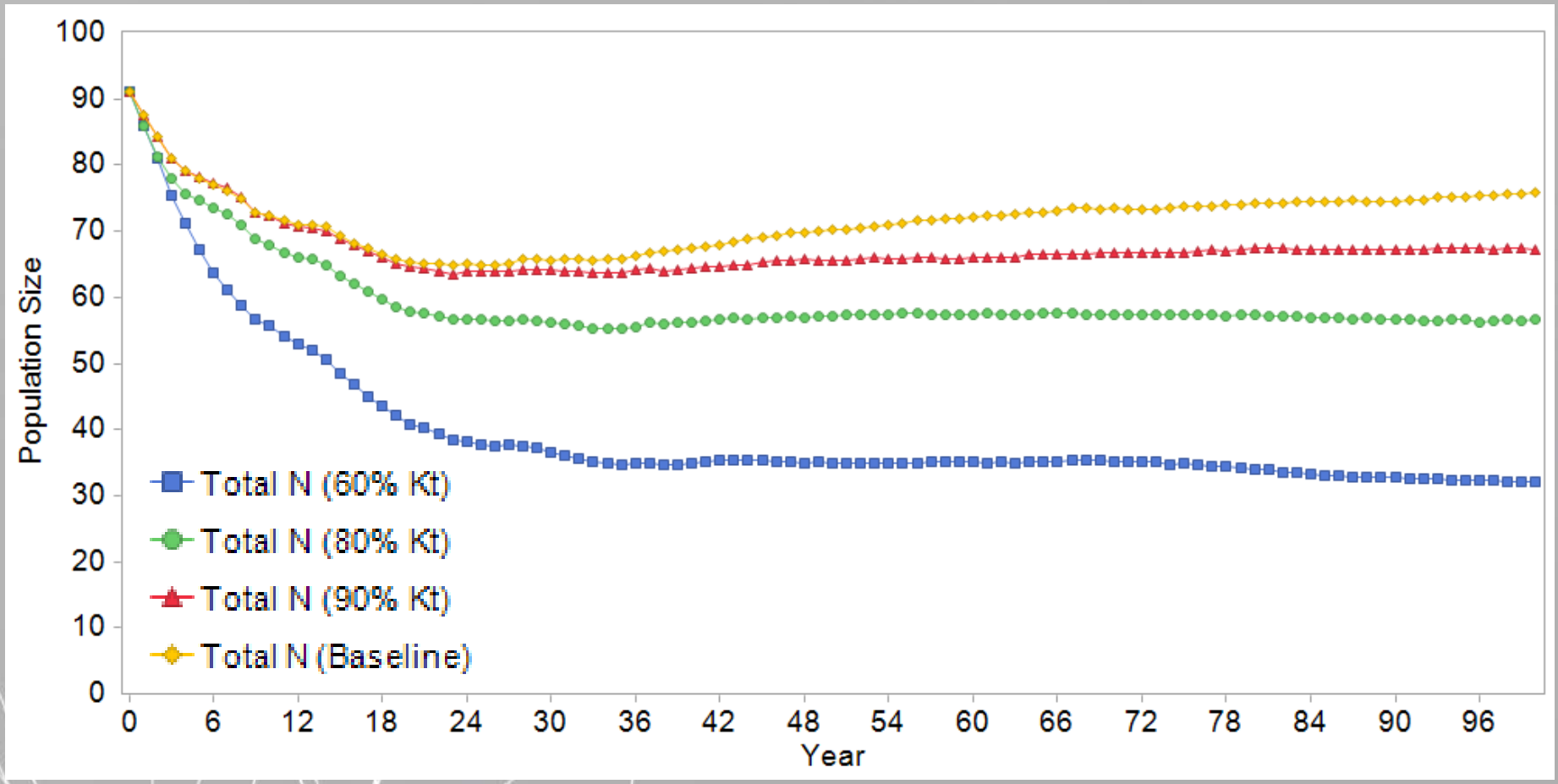
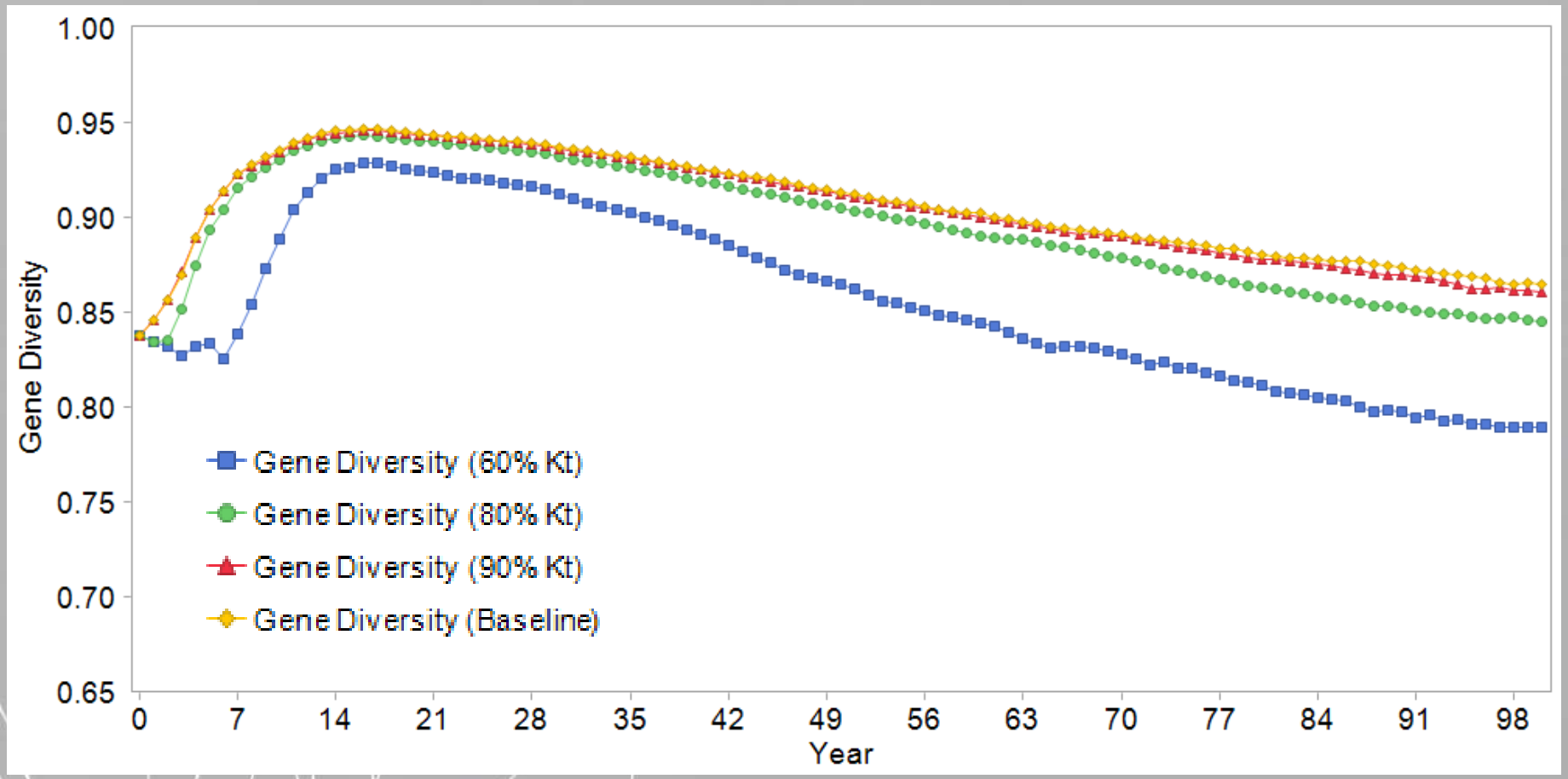
Stork background

- Population is currently
  - Below TAG recommended target size 91/100
  - Current GD = 87%
  - Projected lambda = 0.95

Stork results – N (Kt=100)



Stork Results - GD



Stork Results - Extinction Risk

- Risk
  - High at 60%Kt
  - Acceptable in other scenarios
- Time
  - 80+ years