Parrot TAG

AZA Animal Programs Population Viability Analysis Summary Reports

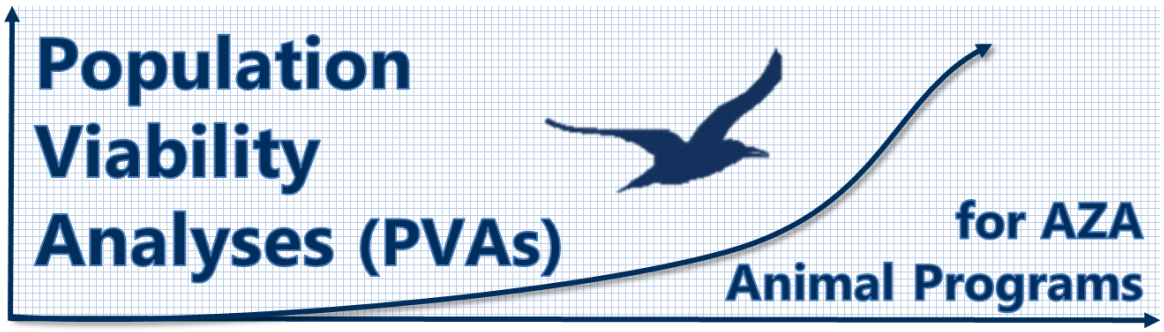
Blue-throated Macaw

Hyacinth Macaw

Kea

November 2012

Population Biologists
Melissa Theis and Katelyn Marti



Lincoln Park Zoo · PMC Population Management Center · Association of Zoos & Aquariums · Institute of Museum and Library Services

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ACKNOWLEDGEMENTS

Throughout the spring of 2012, meetings were help with the AZA Parrot TAG Program Leaders and Studbook Keepers to discuss the Parrot TAG Program's Population Viability Analyses. The following people contributed to the reports:

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Analyses in this report utilized the North American Regional Studbook for each species and were performed using PopLink 2.3 and ZooRisk 3.8.

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For further results and the full Population Viability Analyses for each species please see the appropriate Animal Program/TAG page on the AZA website.

The contents of this report including opinions and interpretation of results are based on discussions between the project team and do not necessarily reflect the opinion or position of Lincoln Park Zoo, Association of Zoos and Aquariums, and other collaborating institutions. The population model and results are based on the project team's best understanding of the current biology and management of this population. They should not be regarded as absolute predictions of the population's future, as many factors may impact its future status.

PVA PROJECT SUMMARY

A Population Viability Analysis (PVA) is a computer model that projects the likely future status of a population. PVAs are used for evaluating long-term sustainability, setting population goals, and comparing alternative management strategies. PVAs are tools that can be used to determine the extinction risk of a population, forecast the population's future trajectory, and identify key factors impacting the population's future.

ZooRisk is a PVA software package that can be used to model the dynamics of an individual population (Earnhardt et al., 2008). Full documentation on ZooRisk can be found in the software's manual (Faust et al., 2008). In this analysis, we use it to integrate the complex factors impacting a population – its age and sex structure, demographic rates, stochasticity (random chance due to variation in mortality, fecundity, and sex ratios among individuals), genetic management, and potential management actions. ZooRisk is an individual-based, stochastic model.

The most powerful use of PVAs is to compare a baseline scenario, reflecting the population's future trajectory if no management changes are made, to alternate scenarios reflecting potential changes. These comparisons can help evaluate the relative costs and benefits of possible management changes. Note that for easy comparison, model results across all scenarios are included in Appendix D.

The future can be uncertain and difficult to predict. Model results are most appropriately used to compare between scenarios (e.g. relative to each other) rather than as absolute predictions of what will happen.

PARROT TAG SPECIES ANALYZED

For the Parrot TAG analyses, we discussed the species to analyze with the Parrot TAG Chair. See Table 1 for a complete list.

Table 1. Parrot species in AZA institutions and analysis status.

AZA Animal Program	**PVA Status**
Blue-throated Macaw (*Ara glaucogularis)*	PVA Completed
Cuban Amazon (*Amazona leucocephala*)	*Did not analyze*
Golden Conure (*Aratinga gaurouba)*	*Did not analyze*
Hawk-headed Parrot *(Deroptyus accipitrinus)*	*Did not analyze*
Hyacinth Macaw (*Anodorhynchus hyacinthincus)*	PVA Completed
Kea (*Nestor notabilis)*	PVA Completed
Palm Cockatoo (*Probosciger aterrimus)*	*Did not analyze*
Red-fronted Macaw (*Ara rubrogenys)*	*Did not analyze*
Thick-billed Parrot *(Rhynchopsitta pachyrhyncha)*	*Did not analyze*

Blue-Throated Macaw

(Ara glaucogularis)

Population Biologist: Katelyn Marti, kmarti@lpzoo.org
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Population Viability Analyses (PVAs) for AZA Animal Programs

Lincoln Park Zoo | PMC Population Management Center | Association of Zoos & Aquariums | Institute of Museum and Library Services

Projected zoo & aquarium population status in 100 years WITHOUT potential changes:

Low Risk | **Vulnerable** | Endangered | Critical

Projected zoo & aquarium population status in 100 years WITH potential changes:

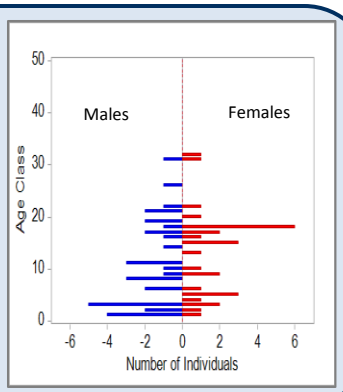
Low Risk | Vulnerable | Endangered | Critical

Status as of 2012

- 62 (32.27.3) blue-throated macaws at 10 AZA institutions
- Population trend over last 10 years: Increasing (λ = 1.116)
- Gene diversity (GD) = 94.4%
- Target Population Size (TPS) from RCP = 50
- Potential Space in model = 72
- IUCN status = Critically Endangered

AZA Animal Program Challenges

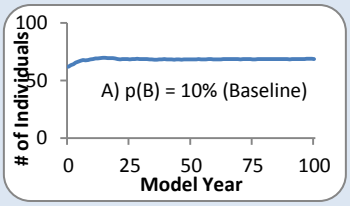
- Limited historical data due to longevity
- Few current AZA holding institutions



Projected Status WITHOUT Potential Changes

VULNERABLE in AZA institutions

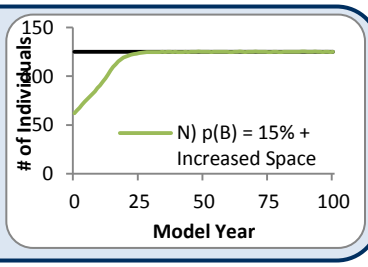
- Baseline Scenario A = ~3.5 hatches/year
- 100% chance of increasing to potential space in 100 yrs
- Will reach potential space (72) in approximately 9 yrs
- 68 ± 6 (SD) average blue-throated macaws in 100 yrs
- 89% ± 2% (SD) projected GD in 100 yrs



Projected Status WITH Potential Changes

LOW RISK in AZA institutions

- Scenario N: Increased female breeding to p(B)= 15% (~4 hatches/year) and potential space to 125
- 100% chance of increasing to potential space in 100 yrs
- Will reach potential space (125) in approximately 19 yrs
- 124 ± 7 (SD) average blue-throated macaws in 100 yrs
- 93% ± 1% (SD) projected GD in 100 yrs



Essential Actions

- Encourage new or previously unsuccessful pairs to breed
- Sustain current reproduction levels or increase reproduction if additional space is available
- Allocate additional space for this population in AZA zoos

How to Help

- Pursue breeding recommendations given to your institution and discuss husbandry challenges and successes with SSP Coordinator
- Discuss future institutional plans to house this species with SSP Coordinator to ensure birds are available

EXECUTIVE SUMMARY

Blue-Throated Macaw AZA Animal Program Population Viability Analysis

Population Viability Analysis (PVA) model scenarios were developed with members of the Blue-Throated Macaw Animal Program during a meeting at the 2012 AZA mid-year meeting in Palm Springs, CA. In 2011, Lincoln Park Zoo researchers received a two-year grant from the Institute of Museum and Library Services (IMLS) to analyze AZA population's long-term viability. The project team is using ZooRisk 3.80 (Earnhardt et al., 2008), a PVA modeling software, to examine what would happen to AZA populations if current conditions remained the same (the baseline scenario), and then assess the impact of changes of increasing reproduction, importation strategies, increasing breeding ages, and not utilizing genetic management (alternative scenarios). The current AZA blue-throated macaw total population size is 62 (32 males, 27 females, 3 unknown sex) individuals.

MODEL RESULTS

Model results indicate that if the AZA blue-throated macaw population continues on its current trajectory it will be able to increase to its potential space under current breeding rates. Under the baseline scenario, the population will reach 72 individuals (the modeled potential spaces) in approximately 9 years, requiring only about 3.5 hatches per year, while retaining approximately 89% gene diversity in 100 years. If the population continues on this path, it will be capable of maintaining itself over 100 years. Increasing the population's reproduction rates and increasing the potential spaces to 125 allows the population to maintain higher levels of gene diversity and reach 125 individuals in approximately 19 years.

Though importations are available for this population, they are not needed to improve the demographics of the population and only have minimal impact on the amount of gene diversity retained in 100 years. Exportation scenarios were also explored for this population. Overall, the population would be capable of recovering from exportations, however the more individuals that are exported from the population, the longer it will take for the managed population to reach the potential spaces available to the population.

MANAGEMENT ACTIONS

The AZA Blue-Throated Macaw Animal Program is currently on a positive trajectory in AZA institutions. There are several management strategies which could be applied to the population that may help it maintain or increase its current demographic and genetic health. **These management actions will be most effective when applied in combination with one another.**

- **Sustain current reproduction rates/ increase reproduction:** The program should focus on breeding all reproductively viable females to increase the number of offspring produced per year. The population has the capability of slow growth to a larger size if it continues the current level of breeding (~3.5 hatches/year). If additional space is available (72 or 125 spaces were modeled here), improving reproductive rates will mean that it can reach those sizes more rapidly, resulting in better retention of genetic diversity and a more stable age structure.
    - All breeding recommendations received are important to the long-term future of this population; institutions should work hard to get recommended pairs into appropriate breeding situations quickly and work on husbandry to improve breeding success.
- **Allocate additional space, if available:** When making decisions about how much space to allocate to this population, the TAG should consider that long-term demographic viability of the population is improved and slightly more gene diversity may be retained at a population size of 125 individuals. If institutional interest exists to support this target size, it will improve the long-term security of this population.
- **Carefully weigh whether importations are needed or warranted:** As importations can be costly and time-consuming, it is important to carefully weigh whether they are justified for the AZA population. Blue-throated macaws are long-lived and the AZA population currently has high levels of gene diversity. With small improvements in management (increases available spaces and/or reproduction), the blue-throated macaw population can remain demographically and genetically healthy without importations.

Hyacinth Macaw

(Anodorhynchus hyacinthinus)

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AZA Parrot TAG Chair: Joe Barkowski, jbarkowski@tulsazoo.org

Population Viability Analyses (PVAs) for AZA Animal Programs

Photo Credit: Zoo New England Staff Member

Projected zoo & aquarium population status in 100 years WITHOUT potential changes:

Low Risk	**Vulnerable**	Endangered	Critical

Projected zoo & aquarium population status in 100 years WITH potential changes:

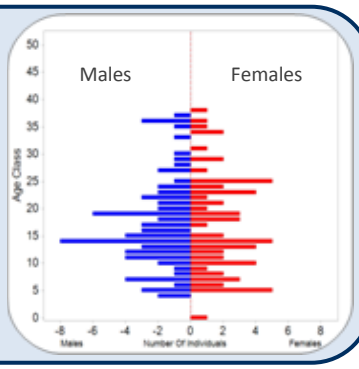
Low Risk	Vulnerable	Endangered	Critical

Status as of 2012

- 138 (73.63.2) hyacinth macaws at 50 AZA institutions
  - Only 86 individuals in breeding population
- Declining population over last 10 years: λ = 0.996
- Gene diversity (GD) = 97.82%
- Target Population Size (TPS) from RCP = 150
- IUCN status = Endangered

AZA Animal Program Challenges:

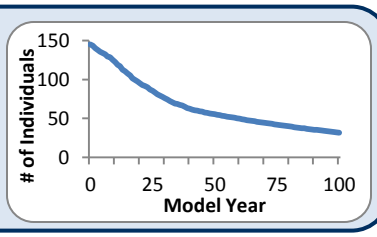
- Low reproduction = ~4 hatches/year in past 10 yrs
- Limited historical data due to longevity
- Higher death rate (6.5 deaths/year) than hatch rate



Projected Status WITHOUT Potential Changes

VULNERABLE in AZA institutions

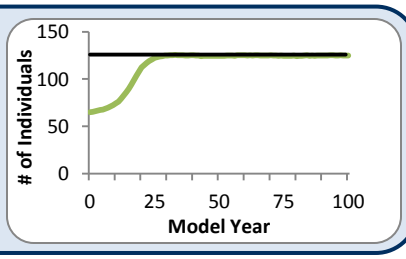
- Baseline Scenario = ~4 hatches/year
- 1% chance of decreasing to extinction in 100 yrs
- 0% chance of increasing to TPS in 100 yrs
- 31 ± 18 (SD) average hyacinth macaws in 100 yrs
- 87% ± 6% (SD) projected GD in 100 yrs



Projected Status WITH Potential Changes

LOW RISK in AZA + non-AZA institutions

- Scenario with increased female breeding at p(B)= 15% (~7 hatches/year)
- 0% chance of decreasing to extinction in 100 yrs
- 99% chance of increasing to TPS in 100 yrs
- 147 ± 9 (SD) average hyacinth macaws in 100 yrs
- 95% ± 1% (SD) projected GD in 100 yrs



Essential Actions

- Increase reproduction to 6 – 8 hatches per year
- Prioritize known pedigree birds for breeding in order to genetically manage the population

How to Help

- Pursue breeding recommendations given to your institution and discuss husbandry challenges and successes with SSP Coordinator.
- Investigate and resolve unknown pedigrees if possible. **Please do not accept unknown pedigree birds without first discussing with the SSP Coordinator.**
- Discuss future institutional plans with SSP Coordinator to make sure birds are available.

EXECUTIVE SUMMARY

Hyacinth Macaw AZA Animal Program Population Viability Analysis

Population Viability Analysis (PVA) model scenarios were developed with members of the Association of Zoos and Aquariums (AZA) Parrot Taxon Advisory Group (TAG) and Hyacinth Macaw Animal Program during a meeting in May 2012. In 2011 Lincoln Park Zoo researchers received a two-year grant from the Institute of Museum and Library Services (IMLS) to analyze AZA population's long-term viability. The project team is using ZooRisk 3.80 (Earnhardt et al., 2008), a PVA modeling software, to examine what would happen to the AZA population if current conditions remained the same (the baseline scenario), and then assessed the impact of changes of increasing reproduction, importation strategies, increasing breeding ages, and without genetic management (alternative scenarios).The current AZA Hyacinth Macaw population size is 138 individuals (73 males, 63 females, 2 unknown) at 50 AZA institutions and the Target Population Size (TPS) is 150 individuals.

MODEL RESULTS

Model results indicate that if conditions remain the same, the AZA Hyacinth Macaw population faces an annual 2% decline over the next 25 years. The projected population decline occurs because deaths exceed hatches. The baseline model produces, on average, 4 hatches per year in comparison to an average of 6 projected deaths per year in the first 10 years of the model. This scenario and these average levels of hatches and deaths can be anticipated by the AZA hyacinth macaw population if breeding does not increase from current levels or other changes are not made. The declining population is less than the target population size and if no management changes are made, institutions will continue to have difficulties filling exhibits. Currently there are 50 AZA holding institutions in the program; under the baseline scenario, the population would have one bird per holding institution (50 birds) in approximately 54 years.

Fortunately, the hyacinth macaw is able to improve its trajectory with reasonable improvements in reproduction. For instance, an increase from the current average of 4 hatches per year to 7 hatches per year (p(B) =15% scenario), would allow the population to roughly sustain its current size in the next 100 years. Around 98% of model iterations met the goal of 150 individuals over 100 years, and it is projected to take 26 years on average. Furthermore, the population is able to retain a projected 95 ± 1% gene diversity in the next 100 years. By doubling the number of hatches in the next decade to 8 hatches per year (p(B) = 20% scenario) the population is able to reach 150 individuals in approximately 4 years.

MANAGEMENT ACTIONS

The AZA Hyacinth Macaw Animal Program should apply several management strategies in combination with one another to counteract the projected demographic decline, accommodate institutional requests, and retain long-term genetic health:

- **Increase reproduction:** The Animal Program should focus on breeding more reproductively viable females to increase the number of offspring produced per year. Any number of hatches in excess of the current level (4 hatches per year) will assist the population in growing towards its goal of 150 individuals. All breeding recommendations received are important to the long-term future of this population; institutions should work to get males and females into appropriate breeding situations quickly and work on husbandry to improve breeding success.

- **Consider long-term impacts of accepting unknown pedigreed birds:** Currently 34% of the AZA hyacinth macaw population has unknown pedigree. These birds are not recommended to breed due to unknown parentage. For such a long-lived species, accepting these birds into the population can have long-term implications as they fill space and do not contribute to future generations. **Please do not accept unknown pedigree birds without first discussing with the SSP Coordinator.**

- **Keep current Target Population Size:** This population did not benefit substantially from additional spaces – increasing the population to 175 or 200 individuals resulted in slight increases (1-2%) in gene diversity, but the population has the ability to stay demographically and genetically healthy at the current TPS of 150 over the next 100 years. If additional spaces were available, they may be more appropriately allocated to other small populations.

- **Carefully weigh whether importations are needed or warranted:** As importations can be costly and time-consuming, it is important to carefully weigh whether they are justified. Hyacinth macaws are long-lived and the population has currently has high levels of gene diversity. With small improvements in management (increases in breeding), the population can remain demographically and genetically healthy without importations of individuals. Exportations may be warranted if they assist other regional management programs.

Kea

(Nestor notabilis)

Population Biologist: Melissa Theis, mtheis@lpzoo.org
AZA Program Leader &
AZA Studbook Keeper: Jessica Meehan, JMeehan@denverzoo.org
AZA Parrot TAG Chair: Joe Barkowski, jbarkowski@tulsazoo.org

Population Viability Analyses (PVAs) for AZA Animal Programs

Photo by Dave Parsons, Denver Zoo

Projected zoo & aquarium population status in 100 years WITHOUT potential changes:

Low Risk | Vulnerable | Endangered | **Critical**

Projected zoo & aquarium population status in 100 years WITH potential changes:

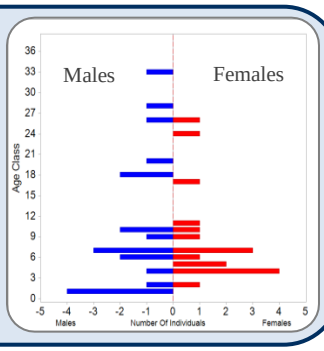
Low Risk | **Vulnerable** | Endangered | Critical

Status as of 2012

- 37 (20.17) keas at 10 AZA institutions
- Population trend over last 10 years: declining (λ = 0.962)
- Gene diversity (GD) = 83.03%
- Target Population Size (TPS) from RCP = 75
- IUCN status = Vulnerable

AZA Animal Program Challenges:

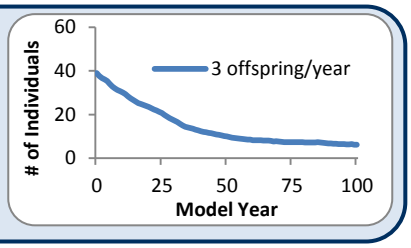
- Low reproduction = ~3 hatches/year in past 10 yrs
- Limited historical data due to longevity
- Higher death rate (6.3 deaths/year) than hatch rate



Projected Status WITHOUT Potential Changes

CRITICAL in AZA institutions

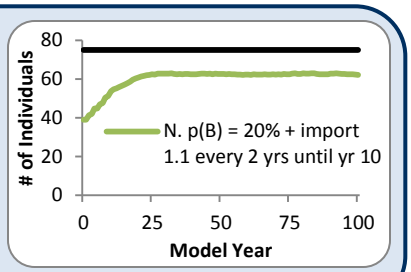
- Baseline Scenario = ~3 hatches/year
- 82.5% chance of decreasing to extinction in 100 yrs
- 0% chance of increasing to TPS in 100 yrs
- 6 ± 5 (SD) average keas in 100 yrs
- 49% ± 21% (SD) projected GD in 100 yrs



Projected Status WITH Potential Changes

VULNERABLE in AZA institutions

- Scenario N with increased reproduction at p(B)= 20% and import 1.1 every 2 yrs until yr 10 (~7 hatches/year)
- 1% chance of decreasing to extinction in 100 yrs
- 89% chance of increasing to TPS in 100 yrs
- 62 ± 17 (SD) average keas in 100 yrs
- 82% ± 5% (SD) projected GD in 100 yrs



Essential Actions

- Increase reproduction to 4 – 8 hatches per year
- If possible, import young, reproductive-aged animals in accordance with federal agencies and international regulations

How to Help

- Pursue breeding recommendations given to your institution and discuss husbandry challenges and successes with Program Leader
- Discuss future institutional plans with Program Leader to make sure birds are available

EXECUTIVE SUMMARY

Kea AZA Animal Program Population Viability Analysis

Population Viability Analysis (PVA) model scenarios were developed with members of the Association of Zoos and Aquariums (AZA) Parrot Taxon Advisory Group (TAG) and Kea Animal Program during a meeting in March 2012. In 2011 Lincoln Park Zoo researchers received a two-year grant from the Institute of Museum and Library Services (IMLS) to analyze AZA population's long-term viability. The project team is using ZooRisk 3.80 (Earnhardt et al., 2008), a PVA modeling software, to examine what would happen to the AZA population if current conditions remained the same (the baseline scenario), and then assessed the impact of changes of increasing reproduction, importation strategies, increasing breeding ages, and without genetic management (alternative scenarios). The current AZA kea population size is **37 individuals (20 males, 17 females) at 10 AZA institutions** and the Target Population Size (TPS) is 75 individuals.

MODEL RESULTS

Model results indicate that if conditions remain the same, the AZA kea (*Nestor notabilis*) population faces an **annual 2% decline over the next 25 years.** This decline causes a demographic bottleneck due to the small initial population size, low reproductive rates (currently producing ~3 hatches per year), and deaths exceeding current hatch rates. The baseline model produces, on average, 3 hatches per year in comparison to an average of 4.0 projected deaths per year in the first 10 years of the model. Currently there are 10 holding institutions in the program; under the baseline scenario, the population would have one kea per holding institution (10 individuals) in approximately 60 years.

An increase from 3.4 hatches per year to 4 -6 hatches per year allows the population to increase its chances of reaching TPS in 100 years and retain more gene diversity. **To increase to the TPS of 75 individuals in the next 30 years, there would need to be approximately 8 hatches per year over the next decade.**

Model scenarios with both increased reproductive rates and importations could help meet the kea TPS over 100 years. If feasible, importing young, reproductively-viable birds from outside the AZA population (in accordance with federal agencies and international regulations) could demographically and genetically benefit the population, but only if the imported individuals produce offspring at a level higher than the population's current reproductive rates.

MANAGEMENT ACTIONS

The AZA Kea Animal Program should apply several management strategies to avoid a strong demographic decline, meet the target population size, accommodate institutional needs, and retain long-term genetic health. **These management actions will be most effective when applied in combination with one another.**

- **Increase reproduction:** The program should focus on breeding reproductively viable females to increase the number of offspring produced, with goals of increasing from the current level (3 hatches per year) to 4 to 6 hatches per year to reach the TPS. All breeding recommendations received are important to the long-term future of this population; institutions should work hard to get recommended pairs into appropriate breeding situations quickly and improve husbandry to improve breeding success.

- **Importation of young, reproductively viable individuals:** In some cases importation could offset the decline the population is facing in the next several years. In addition, it would increase the capacity of the population to produce offspring, which is will be limited in the future by the aging population. Imports must be coupled with increased reproduction to successfully grow the population in the long-term and maintain gene diversity.

COMPARITIVE PARROT TAG BASELINE SCENARIOS

The baseline scenarios for the AZA Parrot TAG Animal Programs predict what might happen to each population if conditions remain the same, specifically if the population experiences the mortality patterns observed in the studbook and maintains a birth rate equivalent to that observed over the last decade (from 2002 – 2011).

If no changes are made over the next 25 years, two of the three cooperatively managed parrot populations in AZA are projected to decline and fall well below their corresponding Target Population Sizes (Figure 1). The Blue-throated Macaw Animal Program will be able to maintain its current population size under its current conditions.

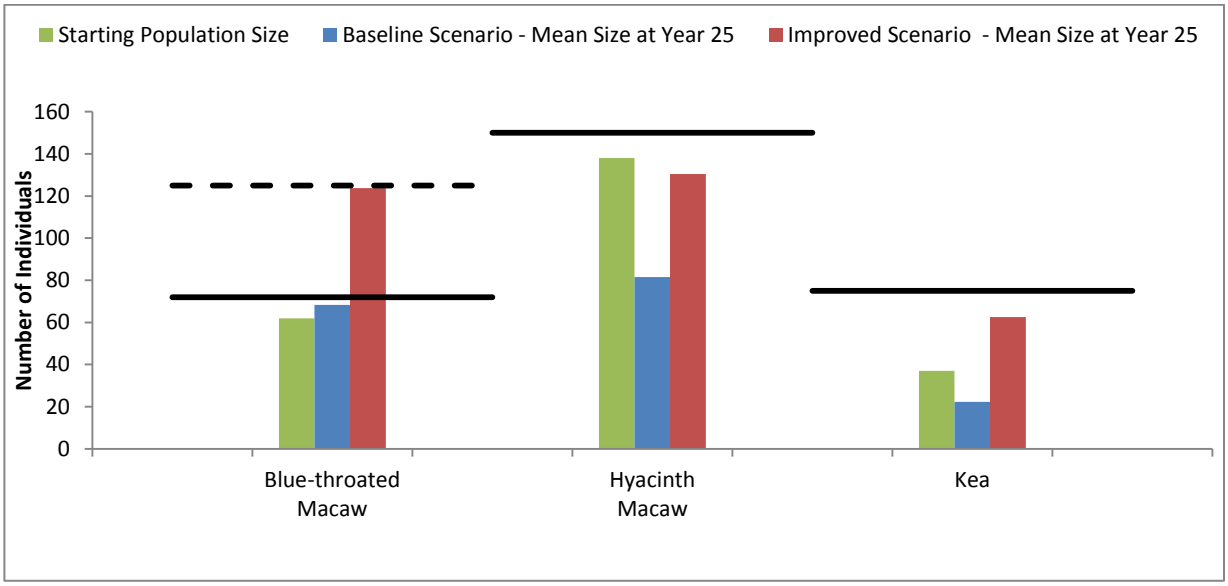


Figure 1. Mean population size in model year 25 for AZA Parrot TAG Animal Programs baseline scenarios. The back line represents the potential space in the population and the dotted black line represents increased space for the improved scenario.

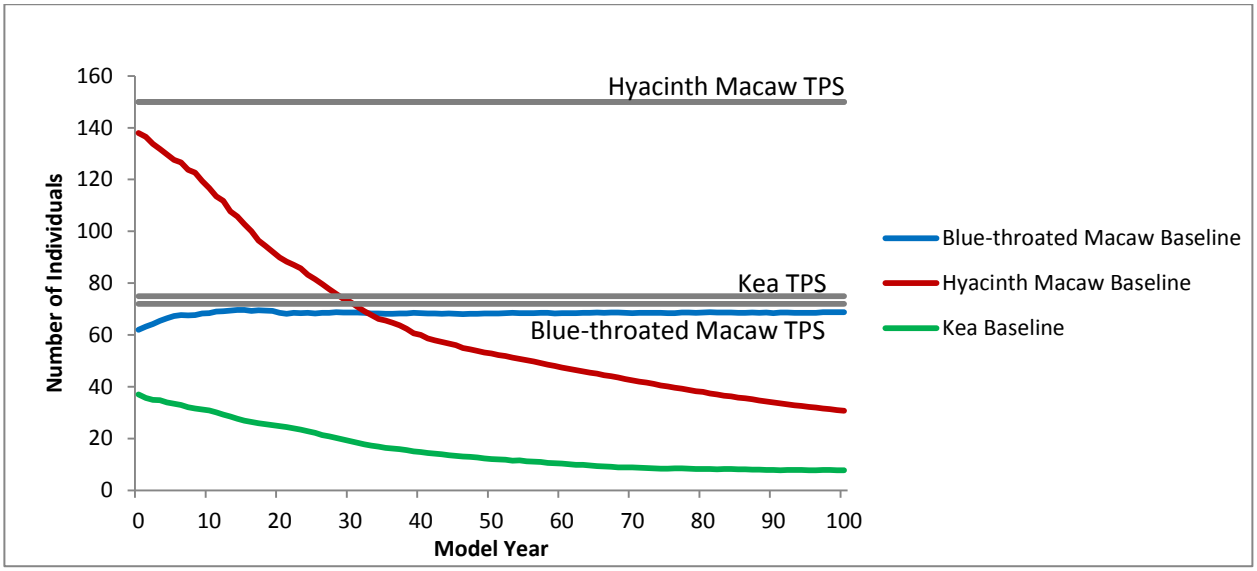


Figure 2. Mean population sizes for AZA Parrot TAG Animal Programs baseline scenarios. Results are averaged over 1000 iterations.

RISK RESULTS

ZooRisk uses five, standardized tests to determine a scenario's risk level. The ZooRisk development team and members of the AZA Small Population Management Advisory Group (SPMAG) worked to develop a risk test that evaluates:

- Probability of extinction (P(E)) in 100 years, based on ZooRisk model
- Distribution of breeding-aged, mixed-sex groups, based on current population
- Current number of breeding-aged animals (m.f), based on current population
- Reproduction in the last generation, based on historic studbook data
- Gene diversity of starting population or modeled population in 100 years, based on current population and ZooRisk model

Each scenario is given an overall risk score based on the above tests. For the Parrot TAG Animal Programs, we've shown the baseline scenario and an improved, realistic scenario in the below table:

Table 2. AZA Parrot Animal Program risk results for baseline scenarios and improved scenarios. See individual Animal Program summaries for details on baseline and improved scenarios illustrated in this table.

Blue-throated Macaw				
Baseline	Low Risk	**Vulnerable**	Endangered	Critical
Improved Scenario	**Low Risk**	Vulnerable	Endangered	Critical
Hyacinth Macaw				
Baseline	Low Risk	**Vulnerable**	Endangered	Critical
Improved Scenario	**Low Risk**	Vulnerable	Endangered	Critical
Kea				
Baseline	Low Risk	Vulnerable	Endangered	**Critical**
Improved Scenario	Low Risk	**Vulnerable**	Endangered	Critical

TAG OVERVIEW MANAGEMENT ACTIONS

Table 3. Management Actions outlined in PVA reports for Parrot TAG Animal Programs.

Animal Program	Prepare for decline	Increase Reproduction	Import Individuals	Increase Space
Blue-throated Macaw		?	?	?
Hyacinth Macaw	◆	◆	?	
Kea	◆	◆	◆	

All of the AZA Parrot Animal Programs face similar challenges; each would need to apply several management strategies to avoid a strong demographic decline, increase to meet the target population size, accommodate institutional needs, consider long-term impacts of accepting unknown pedigreed birds, and retain long-term genetic health. For more details on each management action, refer back to the species' Executive Summary. **These management actions will be most effective when applied in combination with one another.**

CONCLUSIONS

These models are a scientifically-sound comprehensive tool to be used by population managers for assessing future directions for the Parrot TAG Animal Programs. The PVA reports are provided to the AZA community and others to integrate into management of the important species within our care. The PVA model results are intended to provide the necessary data to make science-based decisions.

The model results for the AZA Parrot TAG Animal Programs shows that all the Programs will face challenges in the coming years if management actions are not implemented. The baseline scenarios for all the Parrot TAG Programs are declining in the near future and there are predicted to be very few parrots and macaws in zoos in 100 years. If potential management actions are applied, such as improving reproduction and strategically importing individuals several of the population's long-term demographic and genetic health could be improved. All efforts should be made to explore these possibilities as a way to set the bear populations on the path towards long-term sustainability within AZA institutions.

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