Amur Leopard

Canada Lynx

Caracal

Cheetah

Clouded Leopard

Fishing Cat

Lion

Ocelot

Puma

Sand Cat

Serval

Snow Leopard

Felid TAG

AZA Animal Programs Population Viability Analysis Summary Reports

August 2013

Population Biologists
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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

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ACKNOWLEDGEMENTS

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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.

Funding provided by Institute of Museum and Library Services (IMLS) LG-25-11-0185

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.

FELID TAG SPECIES ANALYZED

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

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

AZA Animal Program	**PVA Status**
Amur Leopard (*Panthera pardus orientalis*)	PVA Completed
Amur Tiger (*Panthera tigris altaica*)	*Did not analyze*
Bobcat (*Lynx rufus*)	*Did not analyze*
Black-footed Cat (*Felis nigripes)*	*Did not analyze*
Canada Lynx (*Lynx canadensis)*	PVA Completed
Caracal (*Caracal caracal)*	PVA Completed
Cheetah (*Acinonyx jubatus)*	PVA Completed
Clouded Leopard (*Neofelis nebulosa)*	PVA Completed
Fishing Cat (*Prionailurus viverrinus)*	PVA Completed
Jaguar (*Panthera onca)*	*Did not analyze*
Lion (*Panthera leo)*	PVA Completed
Malayan Tiger (*Panthera tigris jacksoni*)	*Did not analyze*
Ocelot (*Leopardus pardalis)*	PVA Completed
Pallas' Cat (*Otocolobus manul)*	*Did not analyze*
Puma (*Puma concolor)*	PVA completed with no breeding
Sand Cat (*Felis margarita)*	PVA Completed
Serval (*Leptailurus serval)*	PVA Completed
Snow Leopard (*Uncia uncia)*	PVA Completed
Sumatran Tiger (*Panthera tigris sumatrae*)	*Did not analyze*

Amur Leopard *(Panthera pardus orientalis)*

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Population Viability Analyses (PVAs) for AZA Animal Programs

Photo by Joel Sartore

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:

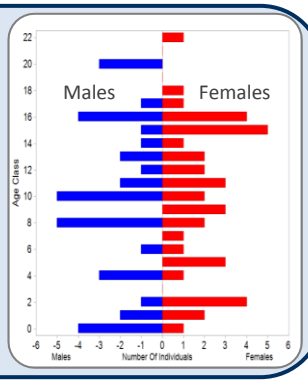
Low Risk | **Vulnerable** | Endangered | Critical

Status as of 2012

- 76 (36.40) Amur leopards at 36 AZA institutions
- 48 (25.23) potentially breeding AZA population
- Population trend over last 10 years: 2% increase (λ = 1.02)
- Gene diversity (GD) = 84.97%
- Target Population Size (TPS) from RCP = 100
- IUCN status = Critically Endangered

AZA Animal Program Challenges:

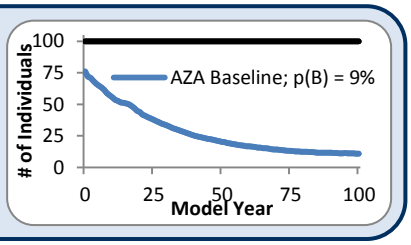
- Low reproduction = ~4 births/year in past 10 yrs
- Loss of gene diversity, difficulty with importations, aging population, and small potentially breeding population



Projected Status WITHOUT Potential Changes

CRITICAL in AZA Institutions

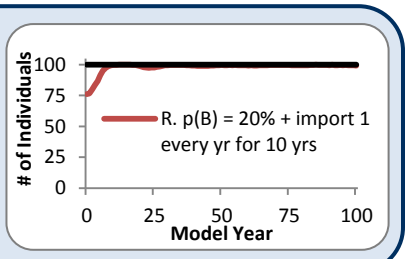
- Baseline scenario = ~4 births/year
- 78% chance of decreasing to extinction in 100 yrs
- 1% chance of increasing to TPS in 100 yrs
- 11 ± 10 (SD) average Amur leopards in 100 yrs
- 48% ± 18% (SD) projected GD in 100 yrs



Projected Status WITH Potential Changes

VULNERABLE in AZA Institutions

- Scenario R increases reproduction to p(B)= 20%, import 1 every yr for 10 yrs (~9 births/year)
- 0% chance of decreasing to extinction in 100 yrs
- 100% chance of increasing to 100 cats in 100 yrs
- 99 ± 4 (SD) average Amur leopards in 100 yrs
- 87% ± 1% (SD) projected GD in 100 yrs



Essential Actions

- Increase reproduction to 8 – 13 births per year
- Recruit new institutions and allocate additional space
- If possible, import young, reproductive-aged animals, ideally unrelated to the existing population, 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 cats are available

EXECUTIVE SUMMARY

Amur Leopard AZA Animal Program Population Viability Analysis

Population Viability Analysis (PVA) model scenarios were developed with members of the Association of Zoos and Aquariums (AZA) Felid Taxon Advisory Group (TAG) and Amur Leopard Animal Program in a meeting in September 2012. The PVA is being conducted under the support of a two-year grant to Lincoln Park Zoo researchers 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 assess the impact of changes such as increasing reproduction, importation strategies, increasing potential space, and not utilizing genetic management (alternative scenarios). The current Amur leopard AZA total population size is 76 (36 males, 40 females) individuals at 36 institutions.

MODEL RESULTS

Model results indicate that if conditions remain the same, the AZA Amur leopard population faces an **annual 3% decline over the next 25 years.** This decline is due to the small initial potentially breeding population (25 males and 23 females), low reproductive rates (population has been producing 4 births per year), and a projected increase in deaths over the next decade as the population ages. Under current conditions, the declining population has a 78% chance of reaching extinction and a 1% probability of reaching its number of potential spaces of 100 individuals. Given the level of GD retained in 100 years (48% ± 18%) and the projected mean final inbreeding coefficient (0.41) higher than full sibling relatedness, it is likely that these projections are optimistic, as they do not incorporate any effects of inbreeding depression (e.g., lowered fecundity, increased mortality). Currently there are 36 holding institutions in the program; under the baseline scenario, the population would have **one Amur leopard per holding institution (36 individuals) in approximately 26 years.**

The most sustainable model scenarios require an increase in the population's reproduction rate. An increase from the current average of 4 births per year to 8 births per year (Scenario C. p(B) = 15%), would allow the population to increase toward 100 individuals over the next 20 years. If the population can reach an average of 10 births per year, the population can reach the number of potential spaces in approximately 7 to 10 years with 100% of model iterations meeting the space goal. Furthermore, if the population can increase reproduction to an average of 10 births per year, the population is able to retain 78% to 81% gene diversity at the end of 100 years.
If appropriate, young, reproductively-viable leopards could be imported from outside the AZA population in accordance with federal and international regulations. These individuals may be able to benefit the population demographically and genetically. Model scenarios with both improved reproduction and importations illustrate that these management changes could help retain 82% to 88% gene diversity at the end of 100 years, and reduce inbreeding.

MANAGEMENT ACTIONS

The AZA Amur Leopard Animal Program should apply several management strategies in combination with one another to counteract the projected demographic decline, increase to meet the number of potential spaces, and retain long-term genetic health:

- **Increase reproduction:** The program should focus on breeding all reproductively viable females to increase the number of offspring produced per year. Any number of births in excess of the current average (4 births per year) will assist the population in growing towards 100 individuals and retaining gene diversity. To increase to the 100 individuals in the next 10 – 20 years the population must have 8 – 10 births per year. All breeding recommendations are important to the long-term future of this population; institutions should work to get recommended pairs into appropriate breeding situations quickly and work on husbandry to improve breeding success.

- **Import young, reproductively viable, unrelated individuals:** Importation (in accordance with federal and international regulations) could help 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 limited by the aging population. Imports must be coupled with increased reproduction to successfully grow the population in the long-term and maintain gene diversity. If imports are feasible, the young individuals can help to reverse the decline by offsetting the loss of older individuals.

- **Maintain high-quality husbandry, care, and continue research initiatives:** Collaborate with local and international partners to improve and ensure high-quality husbandry for Amur leopards in our care, especially focusing on reproduction.

- **Recruit new institutions and allocate additional spaces:** If reproduction and/or importation is successful in improving the population's trajectory, it may be hampered by its small number of potential spaces. As a long-term goal, an increased number of potential spaces for the population will allow for a healthier age structure, a more stable population size, and better long-term genetic health.

Canada Lynx (*Lynx canadensis*)

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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

Photo Credit: ZooBorns, Minnesota 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:

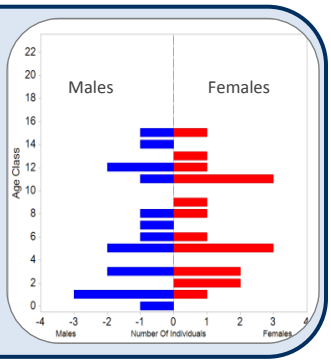
Low Risk | **Vulnerable** | Endangered | Critical

Status as of 2012

- 33 (16.17) Canada lynx at 21 AZA institutions
- 22 (11.11) potentially breeding AZA population
- Population trend over last 10 years: 1.5% annual decrease ($\lambda = 0.985$)
- Gene diversity (GD) = 93.34% (AZA)
- Potential Space= 51 (AZA), 65-75 (AZA + non-AZA institutions)
- IUCN status = Least Concern

AZA Animal Program Challenges:

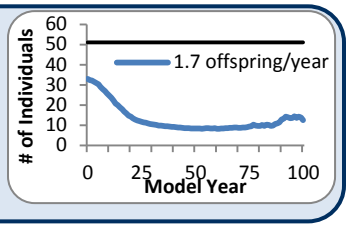
- Extremely small population size (N)
- Low reproduction = 2 average births/year in past 10 yrs



Projected Status WITHOUT Potential Changes

CRITICAL in AZA Institutions

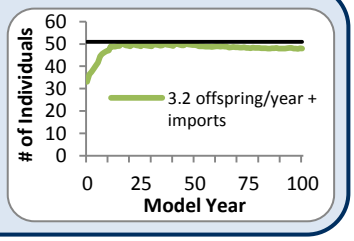
- Baseline scenario = ~2 births/year:
- 99% chance of decreasing to extinction in 100 yrs
- 2% chance of increasing to potential space in 100 yrs
- 13 ± 11 (SD) average Canada lynx in 100 yrs
- 52% ± 29% (SD) projected gene diversity in 100 yrs



Projected Status WITH Potential Changes

VULNERABLE in AZA Institutions

- With increased reproduction at p(B)= 15% (3.2 births/year) and import 1.1 every 5 yrs until yr 50 (Scenario I):
- 0% chance of decreasing to extinction in 100 yrs
- 100% chance of increasing to potential space in 100 yrs
- 48 ± 8 (SD) average Canada lynx in 100 yrs
- 81% ± 4% (SD) projected gene diversity in 100 yrs



Essential Actions

- Increase reproduction to 3 -6 births per year
- Integrate new institutions and closely manage genetics of this population
- 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 cats are available

EXECUTIVE SUMMARY

Canada Lynx AZA Animal Program Population Viability Analysis

Population Viability Analysis (PVA) model scenarios were developed with members of the Association of Zoos and Aquariums (AZA) Felid Taxon Advisory Group (TAG) and Canada Lynx Animal Program in a meeting in July 2012. This PVA is being conducted under the support of a two-year grant to Lincoln Park Zoo researchers 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 assess the impact of changes such as increasing reproduction, importation strategies, and increasing potential space (alternative scenarios). The current AZA Canada lynx total population size is 33 (16 males and 17 females) at 21 AZA institutions.

MODEL RESULTS

Model results indicate that if conditions remain the same, the AZA Canada lynx (*Lynx canadensis*) population faces an **annual 4% decline over the next 25 years.** This decline causes a demographic and genetic bottleneck due to a small initial population size of 33 (16 males and 17 females) and low reproductive rates (currently producing an average of less than one birth per year).

The most demographically sustainable model scenarios require an increase in reproduction to 5 to 6 births per year over the next decade. To increase to 51 individuals in the next 10 years, there would need to be approximately 6 births per year over the next decade combined with the current average level of imports of 3 per year from outside the AZA population. It may be challenging to increase reproduction to these levels as they are higher than recently observed birth rates and, at this time, there is not high institutional interest in the species. Currently there are 21 holding institutions in the program; under the declining baseline scenario, the population would have one Canada lynx per holding institution (21 total individuals) in approximately 9 years.

Model scenarios with increased reproductive rates and importations could help meet the AZA Canada Lynx Animal Program's demographic goals. However, the population will only be capable of retaining low levels of gene diversity (lower than current levels) and high inbreeding levels under most realistic scenarios. The explicit effects of inbreeding were not included in the model scenarios explored, thus, if this population is susceptible to inbreeding depression, the predictions presented are likely optimistic. To reach the potential spaces and maintain maximum gene diversity, the population would need to increase reproduction to at least 20% (6 offspring per year), import at least 20 unrelated individuals, and increase the number of partnering institutions. In the best case scenario, P, (p(B) = 20% and import 1.1 every 5 years until year 50 and increase potential spaces to 75 individuals), the population can retain 89% gene diversity for 100 years.

MANAGEMENT ACTIONS

The AZA Canada Lynx Animal Program should apply several management strategies to avoid a strong demographic decline and high inbreeding levels in the future**. If conditions remain the same, the population will face a demographic and genetic bottleneck in the near future.** If significant actions are not taken to avoid this bottleneck the population will not be sustainable and cats may not be available to institutions in the near future. Even if the management actions listed below are taken, the population will still likely face low levels of gene diversity in the long-term. Given these results, the Animal Program must focus on whether to continue managing this population and, if it is continued, what management strategies will be employed to produce a robust population, meet the goals of the Animal Program, and meet institutional requests. **The management actions listed below will be most effective when applied in combination.**

- **Increase reproduction:** The Animal Program should focus on breeding reproductively viable females to increase the number of offspring produced, with goal of increasing from the current level (average of 2 births per year) to 4 to 6 births per year to maintain the current size and begin to increase towards the potential space. 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.
- **Importation of young, reproductively viable, unrelated individuals:** In some cases, importation (in accordance with federal agencies and international regulations) could offset the decline the population is facing in the next several years and increase the long-term gene diversity (if the imported individuals are founders). Imports must be coupled with increased reproduction to successfully grow the population in the long-term and increase gene diversity. Even though modeled levels of imports assisted the population demographically, ultimately this population, under all model scenarios, is predicted to retain very low levels of gene diversity over the next 100 years. To provide the biggest genetic impact, imported individuals should be unrelated to the AZA population.
- **Recruit new institutions and allocate additional spaces:** If reproduction and or/importation is successful in improving the population's trajectory, it may be hampered by its small number of potential spaces. An increased number of potential spaces for the population will allow for increased reproduction, a healthier age structure, a more stable population size, and somewhat improved long-term genetic health.

Caracal *(Caracal caracal)*

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AZA Felid TAG Co-Chair: Cheryl Morris, cherylm@omahazoo.ocm

Population Viability Analyses (PVAs) for AZA Animal Programs

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:

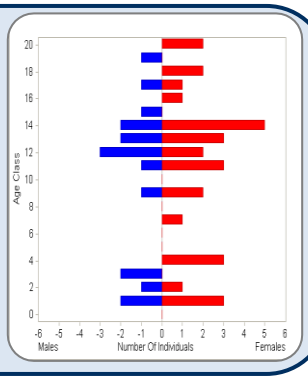
Low Risk | Vulnerable | **Endangered** | Critical

Status as of 2012

- 46 (17.29) caracals at 19 AZA institutions
- 21 (12.9) potentially breeding in AZA population
- Population trend over last 10 years: declining (λ = 0.964)
- Gene diversity (GD) = 93.88%
- Potential Spaces in model = 56
- IUCN status = Least Concern

AZA Animal Program Challenges:

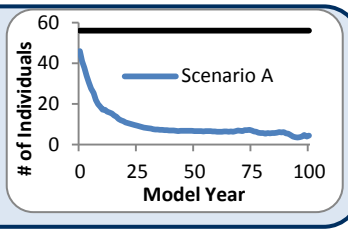
- Low reproduction = 1.5 births/year in past 10 yrs
- Higher mortality rate (~4 deaths/year) than birth rate
- Older cats make up a large portion of the population



Projected Status WITHOUT Potential Changes

CRITICAL in AZA Institutions

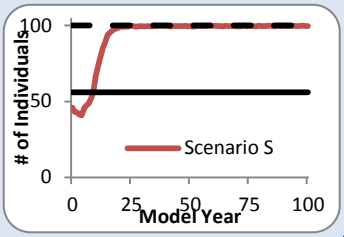
- Baseline Scenario = 1.5 births/year
- 99% chance of decreasing to extinction in 100 yrs
- 0% chance of increasing to N = 56 in 100 yrs
- 4 ± 3 (SD) average caracals in 100 yrs
- 52% ± 35% (SD) projected GD in 100 yrs



Projected Status WITH Potential Changes

ENDANGERED in AZA Institutions

- Scenario S with increased reproduction at p(B)= 33% (9 births/year), import 16 individuals, and increased space = 100
- 0% chance of decreasing to extinction in 100 yrs
- 100% chance of increasing to N = 100 in 100 yrs
- 100 ± 4 (SD) average caracals in 100 yrs
- 89% ± 1% (SD) projected GD in 100 yrs



Essential Actions

- Increase reproduction to 9 births per year
- If possible, import young, reproductive-aged animals in accordance with federal agencies and international regulations
- Recruit new institutions and allocate additional spaces

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 cats are available

EXECUTIVE SUMMARY

Caracal AZA Animal Program Population Viability Analysis

Population Viability Analysis (PVA) model scenarios were developed with members of the Association of Zoos and Aquariums (AZA) Felid Taxon Advisory Group (TAG) and AZA Caracal Animal Program in a meeting in July 2012. The PVA is being conducted under the auspices of a two-year grant to Lincoln Park Zoo researchers 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 assess the impact of changes such as increasing reproduction, importation strategies, increasing potential space, and not utilizing genetic management (alternative scenarios). The current AZA caracal total population size is 46 (17 males and 29 females).

MODEL RESULTS

Model results indicate that if conditions remain the same, the AZA caracal (*Caracal caracal*) population faces an **annual 6% decline over the next 25 years.** This decline causes a demographic and genetic bottleneck due to a small initial breeding population size of 21 animals (12 males, 9 females), low reproductive rates (currently producing 1.5 births/year), and high mortality rates (currently at ~4 deaths/year).

The most demographically sustainable model scenarios require an increase in reproduction to more than 6 births per year over the next decade to maintain or begin increasing the population towards its potential space of 56 individuals. Model scenarios with increased reproductive rates and importations could help meet the caracal program's demographic goals. If feasible, importing young, reproductively-viable cats 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. The AZA Caracal Animal Program should consider increasing potential space to increase the long-term demographic health of this population as smaller population sizes have detrimental impacts on retention of gene diversity and demographic stability.

MANAGEMENT ACTIONS

The AZA Caracal Animal Program should apply several management strategies to avoid a strong demographic decline and high inbreeding levels in the future. **If conditions remain the same, the population will face a demographic and genetic crisis in the near future.** If significant actions are not taken to avoid this crisis, the population will not be sustainable and genetically fit cats may not be available to institutions in the near future. Even if the management actions listed below are taken, the population will still likely face high levels of inbreeding in the long-term. Currently, the AZA population is managed as sub-populations. Only the *Caracal caracal* sub-species is recommended to breed at AZA institutions. Given these results, the Animal Program must focus on whether to continue managing this population and, if it is continued, how best to manage this population to produce a healthy population, meet the goals of the Animal Program and institutional requests. **The management actions listed below will be most effective when applied in combination with one another.**

- **Prepare for demographic and genetic bottleneck:** Most of the scenarios experience a population decline and a severe reduction in the population's gene retention over the next 5 – 15 years. Institutions holding this species must be aware of this pending demographic and genetic bottleneck unless management changes are made.
- **Increase reproduction:** The Animal Program should focus on breeding reproductively viable females to increase the number of offspring produced, with goals of increasing from the current level (1.5 births per year) to 6 - 8 births per year to roughly maintain the current size and begin to increase towards the potential space.
    - 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.
- **Subspecies Management:** The *C. caracal* population and the all subspecies populations do not have a significant difference in their future demographic or genetic trajectories in 25 or 100 model years. Therefore, the populations will be in similar places in 100 years whether all caracals are bred together or whether *C. caracal* is maintained separately.
- **Importation of young, reproductively viable, unrelated individuals:** In some cases importation of individuals from outside the AZA population (in accordance with federal agencies and international regulations) could offset the decline the population is facing in the next several years and increase the long-term gene diversity (if imported individuals are founders). Imports must be coupled with increased reproduction to successfully grow the population in the long-term and increase gene diversity. For the most effective impact, these individuals should be unrelated to the AZA population.
- **Recruit new institutions and allocate additional spaces:** Space and institutional interest are a main concern for this species. The current AZA population of 46 is below the potential spaces of 56 individuals. With the addition of the eight non-AZA institutions, the population is larger, has a higher rate of reproduction, and if these trends continue it is projected to avoid a strong bottleneck effect and reach the potential spaces at a much faster rate. If additional spaces are not actually available it will complicate the placement of offspring or imported individuals. If reproduction and or/importation is successful in improving the population's trajectory, it will quickly be hampered by its small number of potential spaces. In the long-term, additional institutions are vital to the population's growth and health, but these spaces may need to be added slowly until the population's demographics can improve.

Cheetah *(Acinonyx jubatus)*

Population Biologists: Nicole Clausen, nclausen@lpzoo.org
Katelyn Marti, kmarti@lpzoo.org
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AZA Advisor: Ed Spevak, spevak@stlzoo.org
AZA Felid TAG Chair: Don Goff, dgoff@beardsleyzoo.org

Population Viability Analyses (PVAs) for AZA Animal Programs

Photo by: Ray Meibaum

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:

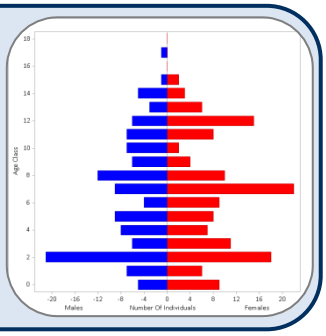
Low Risk | Vulnerable | Endangered | Critical

Status as of 2013

- 257 (117.140) cheetahs at 51 AZA institutions
- 196 (93.103) potentially breeding in AZA population
- Population trend over last 10 years: increasing (λ = 1.041)
- Gene diversity (GD) = 97.62%
- Potential Spaces in model = 300
- IUCN status = Vulnerable

AZA Animal Program Challenges:

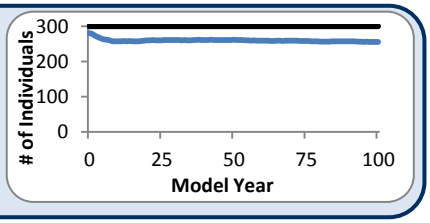
- High death rate = 25 deaths/year in past 10 yrs
- Exportation of education animals from breeding population



Projected Status WITHOUT Potential Changes

VULNERABLE in AZA Institutions

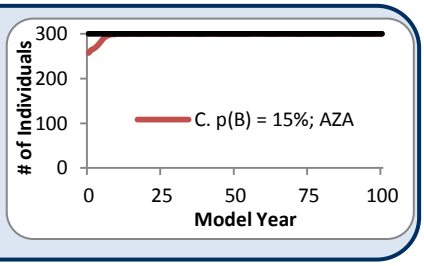
- Baseline Scenario = 28 births/year
- 1% chance of decreasing to extinction in 100 yrs
- 84% chance of increasing to N = 300 in 100 yrs
- 251 ± 59 (SD) average cheetahs in 100 yrs
- 89% ± 3% (SD) projected GD in 100 yrs



Projected Status WITH Potential Changes

LOW RISK in AZA Institutions

- Scenario C with increased reproduction at p(B)= 15% (38 births/year)
- 0% chance of decreasing to extinction in 100 yrs
- 100% chance of increasing to N = 300 in 100 yrs
- 300 ± 10 (SD) average cheetahs in 100 yrs
- 93% ± 0.3% (SD) projected GD in 100 yrs



Essential Actions

- Increase reproduction to ~38 births per year to continue growth
- Carefully weigh whether importations are needed or warranted
- Strategically manage exports to education programs to better maintain current demographic and genetic health

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 cats are available

EXECUTIVE SUMMARY

Cheetah AZA Animal Program Population Viability Analysis

Population Viability Analysis (PVA) model scenarios were developed with members of the Association of Zoos and Aquariums (AZA) Felid Taxon Advisory Group (TAG) and Cheetah Animal Program in July 2012. The PVA is being conducted under the support of a two-year grant to Lincoln Park Zoo researchers 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 such as increasing reproduction, importation strategies, and determining reliability of breeding centers (alternative scenarios). The current AZA cheetah total population size is 257 (117 males, 140 females) individuals at 51 institutions. For some scenarios, two non-AZA institutions, Toronto and Rockton, are included in the analysis for the AZA + non AZA population. The AZA + non-AZA total population consists of 281 (130.151) animals.

MODEL RESULTS

The AZA cheetah population is very strong demographically and has a high likelihood of remaining steady over the next 100 years. Model results indicate that if the AZA cheetah population continues on its current trajectory it may face a very mild 0.19% decline over the next 25 years. The projected population decline occurs because the current breeding rate and importation rates are insufficient to meet demand for exhibits and education programs. Even with this decline, the population can increase to its potential spaces (300) in 29 years and maintain this level for 100 years. Increasing the population's reproduction rate allows the population to prevent the initial decline and maintain higher levels of gene diversity in 100 years.

The cheetah population is able to improve its genetic trajectory with reasonable improvements in reproduction. For instance, an increase from the current average of 28 births per year to 38 births per year (p(B) =15% scenario), would allow the population to roughly sustain higher levels of gene diversity of 93% as compared to the baseline of 89%, over the next 100 years. If the population continues current rates of reproduction and exporting animals out of the potentially breeding population at 10 animals over a 5 year period, gene diversity will decrease exponentially and there is only a 50% probability of reaching potential spaces. However, if the current rate of reproduction and exports continue over the next 25 year (a total of 50 exports) the population may reach extinction in 24 years. If exports to the education program continue at current rates and breeding is increased to 25%, the population can avoid extinction and maintain high gene diversity.

The eight AZA breeding centers are large institutions with high rates of reproduction and space making up over half of the population as compared to the other contributing 43 AZA institutions. These designated breeding centers benefit the AZA population and it is vital that they continue their current rates of reproduction while the other AZA institutions increase their reproductive rates.

MANAGEMENT ACTIONS

The AZA Cheetah Animal Program should apply several management strategies in combination with one another to counteract the projected genetic decline, accommodate institutional interest, and retain long-term genetic health. **These management actions will be most effective when applied in combination with one another.**

- **Maintain/Increase reproduction:** The AZA Cheetah Animal Program should focus on breeding more reproductively viable females to increase the number of offspring produced per year. Any number of births in excess of the current level (28 births per year) will assist the population in growing towards its goal of 300 individuals. The average level seen over the last decade has been the product of intensive management, with considerable variability from year to year (range 16-48). The program will need to continue to aggressively pursue these or higher levels of reproduction to maintain or increase its population. Small decreases in reproduction resulted in declining populations, indicating that this population has a real possibility of decline. 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.

- **Carefully weigh whether importations of cheetah outside the AZA population (from the wild or from other zoo populations) 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. For importation scenarios modeled, gene diversity at the end of 100 years was the very similar or the same as scenarios that depended on zoo reproduction alone. If deemed necessary, importation (in accordance with federal and international regulations) should be coupled with increased reproduction to successfully grow the population in the long-term and maintain gene diversity.

- **Increase breeding in correspondence with education program demand:** The number of animals that are transferred out of the breeding population and into education programs should be carefully managed. At the current rates of reproduction, removing 10 individuals a year (for 5 – 100 years depending on scenario) resulted in severe declines in the population trajectory. If animals will be regularly moved into education programs, the population will need to increase breeding to compensate. Managers should carefully plan how to meet this demand.

- **Continue reproduction at AZA breeding centers**: AZA breeding centers make up over half of the AZA cheetah population. When the AZA population's reproduction is limited to breeding centers, they can maintain the AZA population without an initial decline if reproduction is increased.

Clouded Leopard *(Neofelis nebulosa)*

Population Biologist: Katelyn Marti, kmarti@lpzoo.org
AZA SSP Coordinator & AZA Studbook Keeper: Bonnie Breitbiell, bonnieb@centralfloridazoo.org
AZA Felid Chair: Don Goff, dgoff@beardsleyzoo.org

Population Viability Analyses (PVAs) for AZA Animal Programs

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:

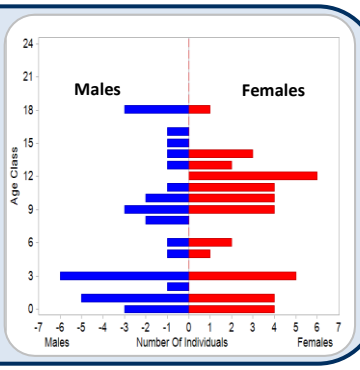
Low Risk | Vulnerable | **Endangered** | Critical

Status as of 2012

- 72 (32.40) total clouded leopards at 22 AZA institutions
  Population trend over last 10 years: slightly decreasing (λ = 0.962)
- Gene diversity (GD) = 87.77%
- Potential Space in model = 82
- IUCN status = Vulnerable

AZA Animal Program Challenges:

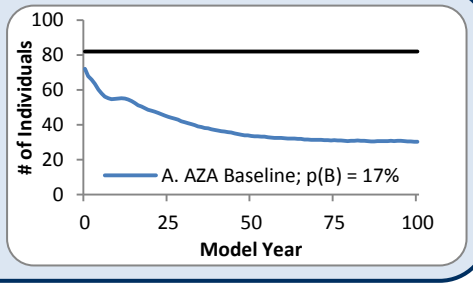
- Unique breeding system (pair young animals)
- Older, non-reproductive population
- High inbreeding levels



Projected Status WITHOUT Potential Changes

CRITICAL AZA institutions

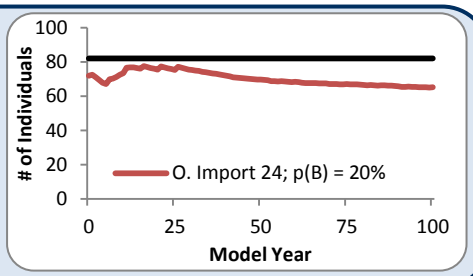
- Baseline Scenario = 6 births/year
- 57% chance of reaching extinction in 100 yrs
- Median time to extinction = 70 yrs
- 44 ± 20 (SD) average leopards in 25 yrs
- 30 ± 33 (SD) average leopards in 100 yrs
- 55% ± 14% (SD) projected GD in 100 yrs
- 0.38 ± 0.11 (SD) projected F in 100 yrs



Projected Status WITH Potential Changes

ENDANGERED in AZA institutions

- Increased female breeding at p(B)= 20% (~8 births/year) and potential space at 82
- 3% chance of reaching extinction in 100 yrs
- Median time to extinction = 83 yrs
- 65 ± 20 (SD) average leopards in 100 yrs
- 78% ± 7% (SD) projected GD in 100 yrs
- 0.20 ± 0.05 (SD) projected F in 100 yrs



Essential Actions

- Increase reproduction
- If possible, import young, unrelated animals in accordance with federal and international regulations

How to Help

- Pursue breeding recommendations given to your institution
- Research alternative paring options for current or future individuals
- Discuss husbandry challenges and successes with the SSP Coordinator
- Work with the SSP Coordinator and TAG to import young, unrelated animals

EXECUTIVE SUMMARY

Clouded Leopard AZA Animal Program Population Viability Analysis

Population Viability Analysis (PVA) model scenarios were developed with members of the Association of Zoos and Aquariums (AZA) Felid Taxon Advisory Group (TAG) and Clouded Leopard Animal Program in July 2012. The PVA is being conducted under the support of a two-year grant to Lincoln Park Zoo researchers 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 such as increasing reproduction, importation strategies, and not utilizing genetic management (alternative scenarios). The current AZA clouded leopard total population size is 72 (32 males, 40 females) individuals at 22 institutions.

MODEL RESULTS

Model results indicate that if conditions remain the same, the AZA clouded leopard population faces an **annual 2% decline over the next 25 years.** The projected population decline occurs because the number of deaths exceeds the number of births in the population. The baseline AZA model produces, on average, 6 births per year in comparison to an average of 8 projected deaths per year in the first 10 years of the model. The declining population has an only 27% probability of reaching its number of potential space of 82 individuals under current conditions.

The clouded leopard population is able to improve its trajectory with reasonable improvements in reproduction. For instance, an increase from the current average of 6 births per year to 8 births per year (p(B) = 20% scenario), would allow the population to roughly sustain its current size in the next 100 years. If the population can reach an average of 11 births per year, the population will reach the number of potential spaces in approximately 6 years with 100% of model iterations meeting the space goal.

If appropriate, young, reproductively-viable clouded leopards may be available from outside the AZA population and imported in accordance with federal and international regulations. These individuals would benefit the population demographically, but more importantly genetically as inbreeding levels are very high at the end of 100 years under the baseline scenarios (higher than sibling relationship). Model scenarios with both improved reproduction and importations improve the population's demographic and genetic outlook the most at the end of 100 years; however, genetics remain a concern as many of the animals in the current population are related to one another resulting in low gene diversity retention and higher inbreeding levels than desired.

MANAGEMENT ACTIONS

The AZA Clouded Leopard Animal Program should apply several management strategies in combination with one another to counteract the projected demographic decline, low gene diversity, and high inbreeding levels in the future, and to accommodate institutional interest.

- **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 births in excess of the current level (6 births per year) will assist the population in growing towards its potential space of 82 animals. 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.

- **Importation of young, reproductively viable individuals:** In some cases importation could offset the decline the population is facing in the next several years and increase the long-term gene diversity. However, importations will have less of a positive impact on genetics if the imported individuals are related to the current population or each other, which may be challenging for this population as the source of many of the imports is a population with some animals already related to the AZA population. In addition, it would increase the capacity of the population to produce offspring, which is limited currently by an aging population with many animals unable to breed for medical, behavioral, or age. Imports must be coupled with increased reproduction to successfully grow the population in the long-term and increase gene diversity. Even though modeled levels of imports assisted the population demographically, ultimately this population under most model scenarios had lower-than-desired levels of gene diversity in 100 years.

- **Recruit new institutions and allocate additional spaces:** Space and institutional interest are a main concern for this population if reproduction is increased. If additional spaces are not available it will complicate the placement of offspring or imported individuals. If reproduction and or/importation is successful in improving the population's trajectory, it will quickly be hampered by its small number of potential spaces. As a long-term goal, an increased number of potential spaces for the population will allow for a healthier age structure, a more stable population size, and better long-term genetic health.

- **Research pairing options**: Institutions should work to form alternate pairing situations to provide more flexibility in breeding opportunities, thus increasing the number of females breeding. Forming trios (1.2.0) at early ages could allow for the rotation of males between familiar females and may provide additional breeding opportunities for the AZA population. This management strategy could also provide more genetic variation and reduce the issue of long-term bonded pairs that are unable to be managed with other individuals.

Fishing Cat *(Prionailurus viverrinus)*

Population Biologist: Melissa Theis, mtheis@lpzoo.org
AZA Studbook Keeper: Jessica Kinzer, JKinzer@riverbanks.org
AZA Felid TAG Chair: Don Goff, dgoff@beardsleyzoo.org

Population Viability Analyses (PVAs) for AZA Animal Programs


Photo by Richard Roakes

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:

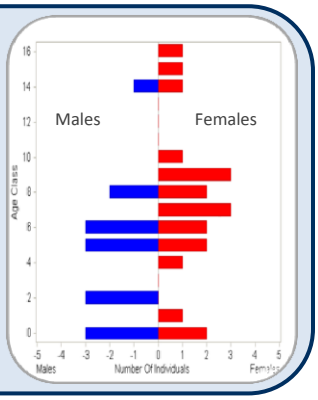
Low Risk	**Vulnerable**	Endangered	Critical

Status as of 2012

- 35 (15.20) fishing cats at 9 AZA institutions
  - 52 (19.33) cats at 9 AZA and 2 non-AZA institutions
- 30 (15.15) potentially breeding AZA population
  - 47 (19.28) potentially breeding AZA + non-AZA population
- Population trend over last 10 years: 3% decrease (λ = 0.972)
- Gene diversity (GD) = 88.22% (AZA), 90.56% (AZA + non-AZA)
- Potential Space= 50 (AZA), 62 (AZA + non-AZA)
- IUCN status = Endangered

AZA Animal Program Challenges:

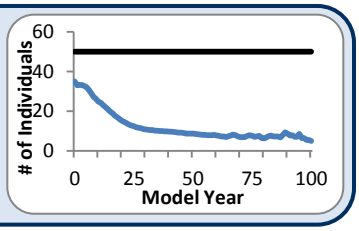
- Extremely small population size (N)
- Low reproduction = ~4 births/year in past 10 yrs



Projected Status WITHOUT Potential Changes

CRITICAL in AZA Institutions

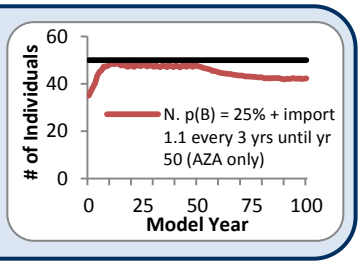
- Baseline scenario = ~4 births/year:
- 100% chance of decreasing to extinction in 100 yrs
- 4% chance of increasing to potential space in 100 yrs
- 5 ± 2 (SD) average fishing cats in 100 yrs
- 27% ± 14% (SD) projected GD in 100 yrs



Projected Status WITH Potential Changes

VULNERABLE in AZA Institutions

- With increased reproduction at p(B)= 25% and import 1.1 every 3 yrs until yr 50 (Scenario N):
- 0.03% chance of decreasing to extinction in 100 yrs
- 100% chance of increasing to potential space in 100 yrs
- 48 ± 5 (SD) average fishing cats in 100 yrs
- 77% ± 12% (SD) projected GD in 100 yrs



Essential Actions

- Increase reproduction to 6 - 9 births per year
- Integrate new institutions, allocate additional space and closely monitor genetics of this population
- 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 cats are available

EXECUTIVE SUMMARY

Fishing Cat AZA Animal Program Population Viability Analysis

Population Viability Analysis (PVA) model scenarios were developed with members of the Association of Zoos and Aquariums (AZA) Felid Taxon Advisory Group (TAG) and Fishing Cat Animal Program in a meeting in July 2012. This PVA is being conducted under the support of a two-year grant to Lincoln Park Zoo researchers 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 assess the impact of changes such as increasing reproduction, importation strategies, increasing potential space, and not utilizing genetic management (alternative scenarios). The current AZA fishing cat total population size is 35 (15 males and 20 females).

MODEL RESULTS

Model results indicate that if conditions remain the same, the AZA fishing cat (*Prionailurus viverrinus*) population faces an **annual 4% decline over the next 25 years.** This decline causes a demographic and genetic decline due to a small initial population size of 35 animals (15 males, 20 females), low reproductive rates (currently producing ~4 births/year), and low gene diversity (88%).

The most demographically sustainable model scenarios require an increase in reproduction to 7 births per year over the next decade. To increase to 50 individuals in the next 10 years, there would need to be approximately **8 births per year over the next decade**. It may be challenging to increase reproduction to these levels as they are higher than recently observed birth rates and, at this time, there is not high institutional interest in the species.

Model scenarios with increased reproductive rates and importations could help meet the Fishing Cat Animal Program's demographic goals. However, the population will only be capable of retaining low levels of gene diversity (lower than current levels) and high inbreeding levels under most realistic scenarios. Although explicit effects of inbreeding depression were not included in model scenarios, if this population is susceptible to inbreeding depression, it would mean that the model scenarios presented are likely optimistic (i.e., if inbreeding depression was included, the model's demographic projections over time would be worse). To reach the potential spaces and maintain maximum gene diversity, the population would need to increase reproduction to at least 25% (8 offspring per year), import at least 17 unrelated individuals, and increase the number of partnering institutions. In scenario O (p(B) = 25% and import 1.1 every 3 years until year 50), the population can retain 81% gene diversity for 100 years.

MANAGEMENT ACTIONS

The AZA Fishing Cat Animal Program should apply several management strategies to avoid a strong demographic decline and high inbreeding levels in the future**. If conditions remain the same, the population will face a demographic and genetic bottleneck in the near future.** If significant actions are not taken to avoid this bottleneck the population will not be sustainable and healthy cats may not be available to institutions in the near future. Even if the management actions listed below are taken, the population will still likely face low levels of gene diversity in the long-term. Given these results, the Animal Program must focus on whether to continue managing this population and, if it is continued, what management strategies will be employed to produce a healthy population, meet the goals of the Animal Program, and meet institutional requests. **The management actions listed below will be most effective when applied in combination with one another.**

- **Prepare for demographic and genetic bottleneck:** Most of the scenarios experience a population size decline and a severe reduction in the population's genetic diversity over the next 15 – 20 years. Institutions holding this species must be aware of this pending demographic and genetic bottleneck effect if management changes are not made.
- **Increase reproduction:** The Animal Program should focus on breeding reproductively viable females to increase the number of offspring produced, with goal of increasing from the current level (4 births per year) to 5-8 births per year to maintain the current size and begin to increase towards the potential space. 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.
- **Importation of young, reproductively viable, unrelated individuals:** In some cases importation (in accordance with federal agencies and internal regulations) could offset the decline the population is facing in the next several years and increase the long-term gene diversity (if the imported individuals are founders). Imports must be coupled with increased reproduction to successfully grow the population in the long-term and increase gene diversity. Even though modeled levels of imports assisted the population demographically, ultimately this population, under all model scenarios, had retained very low levels of gene diversity in 100 years. For biggest impact, these individuals should be unrelated to the AZA population.
- **Allocate additional spaces:** If reproduction and or/importation is successful in improving the population's trajectory, it may be hampered by its small number of potential spaces. An increased number of potential spaces for the population will allow for increased reproduction, a healthier age structure, a more stable population size, and somewhat improved long-term genetic health

Lion *(Panthera leo)*

Population Biologist: Katelyn Marti, kmarti@lpzoo.org
AZA SSP Coordinator: Hollie Calahan, hcolahan@denverzoo.org
AZA Studbook Keeper: Sue Pfaff, suepfaff@riverbankszoo.org
AZA Felid TAG Chair: Don Goff, dgoff@beardsleyzoo.org

Population Viability Analyses (PVAs) for AZA Animal Programs

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

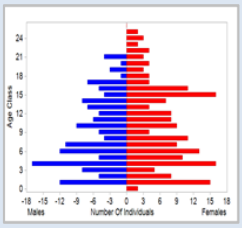
Status as of 2012

- 324 (139.185) total lions at 99 AZA institutions
- 177 (83.94) in potentially breeding population
- Population trend over last 10 years: Increasing (λ = 1.006)
- Gene diversity (GD) = 97.5%
- Target Population Size (TPS) from RCP = 320
- Potential Space in model = 356
- IUCN status = Vulnerable

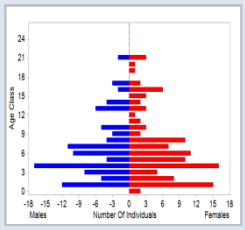
AZA Animal Program Challenges:

- Limited space
- Questions about effects of contraception

Total Population



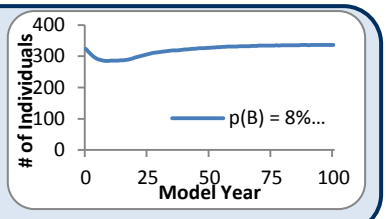
Potentially Breeding Population



Projected Status WITHOUT Potential Changes

Low Risk in AZA institutions

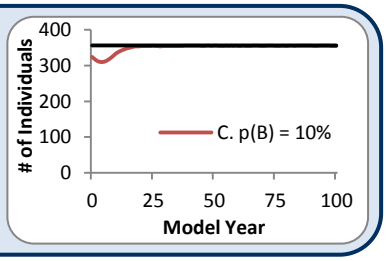
- Baseline Scenario = 23 births/year
- 97% chance of increasing to potential space in 100 yrs
- Will reach potential space (356) in approximately 32 yrs
- 356 ± 34 (SD) average lions in 100 yrs
- 93% ± 1% (SD) projected GD in 100 yrs



Projected Status WITH Potential Changes

Low Risk in AZA institutions

- Scenario C: Increased female breeding at p(B)= 10% (~29 births/year) and potential space at 356
- 100% chance of increasing to potential space in 100 yrs
- Will reach potential space (356) in approximately 12 yrs
- 354 ± 9 (SD) average lions in 100 yrs
- 95% ± 0.2% (SD) projected GD in 100 yrs



Essential Actions

- Sustain current reproduction levels or increase reproduction as space becomes available
- Continue only breeding pedigreed lions and manage unpedigreed (generic lions to attrition)

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 lions are available
- Dedicate current generic lion spaces to pedigreed lion spaces in the future
- Discuss the use of contraceptives on females with the SSP Coordinator

EXECUTIVE SUMMARY

Lion AZA Animal Program Population Viability Analysis

Population Viability Analysis (PVA) model scenarios were developed with members of the Lion Animal Program during a meeting at the 2012 Felid TAG meeting in Salt Lake City, UT. 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, managing the generic population to attrition, removing contracepted females, and not utilizing genetic management (alternative scenarios). The current AZA lion population size is **324 animals (139 males, 185 females) at 99 AZA institutions**

MODEL RESULTS

Model results indicate that if the AZA lion population continues on its current trajectory it will experience a small demographic decline in the next 15 to 20 years as the generic population is managed to attrition. Even with this decline, the population is able to increase to its potential spaces (356) in 32 years and maintain this level for 100 years. Increasing the population's reproduction rates allows the population to decrease or prevent the initial decline in the population and maintain slightly higher levels of gene diversity in 100 years.

Currently, the AZA Felid TAG does not recommend unpedigreed lions (generics) breed or be imported to the population. If there were no additional breeding or importations in the generic population, the Animal Program could expect generic lions to be managed to attrition in approximately 17 years. Currently, there are many female lions on contraceptives due to space limitations. If the females that are currently or have previously been on contraceptive do not breed in the future (removed from the breeding population), the population would face a much steeper demographic decline. With the removal of these females, the population will only have a 71% chance of reaching its potential spaces and will retain less gene diversity over 100 years.

MANAGEMENT ACTIONS

The AZA Lion 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 reproductive rates/Increase reproduction:** The program should focus on breeding reproductively viable females to **maintain or begin increasing** the number of offspring produced per year. Under current breeding rates, the population could reach its potential spaces in 32 years, and will sustain a slight decline in population size in the short-term. If reproduction is increased (29 – 33 births/year) the population has the capability of slowing or preventing the slight demographic decline that will occur as the generic population ages out of the population.
    - 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.
- **Carefully weigh whether contraceptives are needed or warranted:** Currently, there is not enough information to determine the long-term effects of contraception on female lions. However, model results indicate that if the females currently on contraceptive do not breed again, the population will experience a much more severe decline than the baseline scenario. As the effects of contraceptives could be costly, it is important to carefully weigh whether contraception is justified for wide use across the lion population. Institutions should contact the SSP Coordinator prior to placing female lions on contraceptives.
- **Manage the generic population via attrition:** There are currently 115 (43.72) generic lions in the AZA population. The AZA Felid TAG does not recommend that lions with unknown pedigree (generics) breed or be imported to the AZA population. In the future, space occupied by generic lions will be converted to space for pedigreed lions. Institutions holding generic lions should discuss their plans for lions with the AZA Lion SSP Coordinator.

Ocelot (*Leopardus pardalis*)

** Analyses divided into two subpopulations- mitis subspecies & generic population*

Population Biologist: Melissa Theis, mtheis@lpzoo.org
AZA SSP Coordinator: Ken Kaemmerer, kkaemmerer@pittsburghzoo.org
AZA Studbook Keeper: Nanette Bragin, nbragin@denverzoo.org
AZA Felid TAG Chair: Don Goff, dgoff@beardsleyzoo.org

Population Viability Analyses (PVAs) for AZA Animal Programs

Photo by Joel Sartore

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:

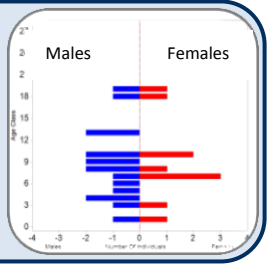
Low Risk | **Vulnerable** | **Endangered** | Critical

Mitis Subspecies

* AZA population: 27 (17.10)
* Gene diversity (GD) = 88.05%
* SSP prioritizes breeding this subspecies
* IUCN status = Least Concern

AZA Animal Program Challenges:

* Low reproduction
* Small population
* Only 7 reproductively-aged females

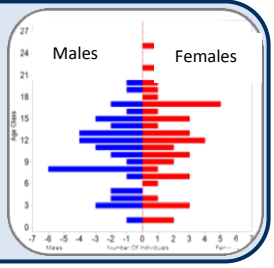


Generic Individuals

* AZA population: 64 (31.33)
* Gene diversity (GD) = 93.74%
* Animals bred for demographic needs
* IUCN status = Least Concern

AZA Animal Program Challenges:

* Low reproduction
* Small population
* Unknown subspecies

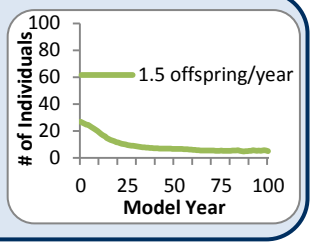


Projected Status in 100 years WITHOUT Potential Changes

CRITICAL in AZA Institutions

Baseline = 1.5 births/year

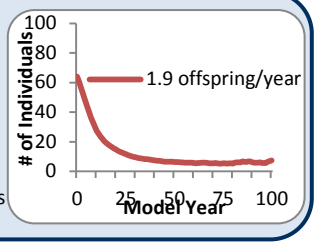
* 99% chance of decreasing to extinction in 100 years
* 0% chance of increasing to potential space (50 individuals)
* 5 ± 3 (SD) *mitis* ocelots in 100 yrs
* 37% ± 24% (SD) projected GD in 100 yrs



CRITICAL in AZA Institutions

Baseline = 1.9 births/year

* 99% chance of decreasing to extinction
* 0% chance of increasing to potential space (89 individuals)
* 7 ± 6 (SD) generic ocelots in 100 yrs
* 51% ± 31% (SD) projected GD in 100 yrs

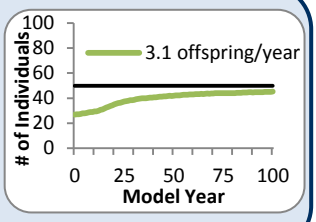


Projected Status in 100 years WITH Potential Changes

ENDANGERED in AZA Institutions

p(B) = 33%; 3.1 births/year

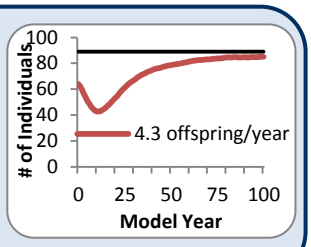
* 10% chance of decreasing to extinction in 100 years
* 88% chance of increasing to potential space
* 37 ± 14 (SD) *mitis* ocelots in 100 yrs
* 72% ± 6% (SD) projected GD in 100 yrs



VULNERABLE in AZA Institutions

p(B) = 33%; 4.3 births/year

* 2% chance of decreasing to extinction
* 96% chance of increasing to potential space
* 85 ± 10 (SD) generic ocelots in 100 yrs
* 80% ± 5% (SD) projected GD in 100 yrs



Essential Actions

- Increase reproduction from current 3 births/year (both subspecies) to 5 - 8 births 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 cats are available

EXECUTIVE SUMMARY

Ocelot AZA Animal Program Population Viability Analysis

Population Viability Analysis (PVA) model scenarios were developed with members of the Association of Zoos and Aquariums (AZA) Felid Taxon Advisory Group (TAG) and Ocelot Animal Program in July 2012. The PVA is being conducted under the support of a two-year grant to Lincoln Park Zoo researchers 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 such as increasing reproduction and/or utilizing importation strategies (alternative scenarios). In AZA institutions there are 91 (48 males, 43 females) individuals at 49 institutions. The population is divided into two subpopulation – *mitis* subspecies which consists of 27 individuals (17 males, 10 females) at 17 institutions and a generic population which consists of 64 (31 males, 33 females) at 34 institutions. In current management, the *mitis* subpopulation is prioritized for breeding and the generic subpopulation is allowed to breed to meet demographic institutional needs. For this modeling, we divided the results into three sections: *mitis* subspecies subpopulation, generic subpopulation, and total population (both *mitis* and generic individuals). This overview focuses on the total population results; see the full report for results for each subspecies.

MODEL RESULTS

Model results indicate that if conditions remain the same, the AZA ocelot total population faces an annual 6% decline over the next 25 years. The projected population decline occurs because the number of deaths exceeds the number of births. The baseline model produces, on average over the first 10 years of the model, 3 births per year in comparison to an average of 8 projected deaths per year. The declining population has a 94% probability of extinction under current conditions.

The ocelot AZA population is able to improve its trajectory with reasonable improvements in reproduction (in both subpopulations). For instance, an increase from the current average of 3 births per year to 5 births per year would allow the population to recover from the bottleneck and roughly stabilize in the next 100 years. If the AZA population can reach an average of 8 births per year, the population can approach the number of potential spaces in approximately 33 years with 100% of model iterations meeting the space goal. Furthermore, if the AZA ocelot population can increase reproduction to an average of 8 births per year, the population is able to reduce inbreeding and help retain gene diversity in the next 100 years.

If appropriate, young, reproductively-viable ocelots could be imported from outside the AZA population in accordance with federal and international regulations. These individuals may be able to benefit the population demographically and genetically. Model scenarios with both improved reproduction and importations illustrate that these management changes could help retain gene diversity at the end of 100 years and reduce inbreeding.

MANAGEMENT ACTIONS

The AZA Ocelot Animal Program should apply several management strategies in combination with one another to counteract the projected demographic decline, accommodate institutional interest, and retain long-term genetic health. These management actions will be most effective when applied in combination with one another.

- **Increase reproduction:** The Animal Program should focus on breeding reproductively viable females, with goals of increasing the number of offspring produced from the current level (3 births per year in the AZA population) to 5-8 births per year (one offspring per female every 3-4 years). 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, consider artificial reproductive technologies, and work on husbandry to improve breeding success.

- **Import young, reproductively viable individuals:** In some cases importation (in accordance with federal agencies and international regulations) could help prevent 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 limited currently and in the future by the aging population. Imports from outside the AZA population must be coupled with increased reproduction to successfully grow the population in the long-term and maintain gene diversity.

- **Prepare for demographic bottleneck:** All projected combination scenarios still experience a population decline in the next 15 to 20 years. Institutions holding this species must be aware of this pending demographic bottleneck.

- **Consider implications of maintaining subpopulations:** If the Animal Program attempts to maintain the mitis subpopulation separately, it will be challenging to sustain/increase the mitis portion of the population, especially to do so to a level that the generic individuals can eventually be phased out. With a small current size (27) and starting gene diversity of 88%, model projections illustrate how challenging it will be to maintain a genetically and demographically viable mitis population if that population is kept separate. The TAG and Animal Program should consider the implications of maintaining the sub-species distinctly.

Puma *(Puma concolor)*

Population Biologist: Katelyn Marti, kmarti@lpzoo.org
AZA SSP Coordinator &
AZA Studbook Keeper: Michelle Schireman, pumacoug@aol.com
AZA Felid Chair: Don Goff, dgoff@beardsleyzoo.org

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 under current conditions = STABLE

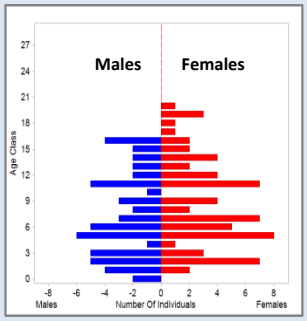
The AZA Felid TAG recommends the Puma population as a non-breeding population. This population is currently maintained by the importation of wild, rescue animals.

Status as of 2012

- 120 (54.66) total pumas at 59 AZA institutions
- Population trend over last 10 years = Stable: (λ = 0.999)
- Target Population Size (TPS) from RCP = 120
- Potential Space in model = 130
- IUCN status = Least Concern

AZA Animal Program Challenges:

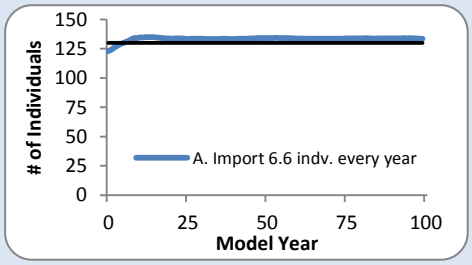
- Lack of available animals to meet high institutional interest



Projected Status WITHOUT Potential Changes

STABLE in AZA institutions

- Baseline Scenario = 12 (6.6) individuals imported per year
- 100% chance of reaching 130 individuals
- Median time to 130 individuals = 5 yrs
- 134 ± 7 (SD) average pumas in 25 yrs
- 134 ± 7 (SD) average pumas in 100 yrs



Essential Actions

- Sustain current levels of importations (at least 12 individuals/year)
- Continue restricting breeding in current individuals to allow space for rescue animals

How to Help

- Discuss future institutional plans for exhibiting this species with the SSP Coordinator
- Cultivate relationships with rescue and wildlife personnel to ensure rescue pumas are available in the future for AZA institutions

EXECUTIVE SUMMARY

Puma AZA Animal Program Population Viability Analysis

Population Viability Analysis (PVA) model scenarios were developed with members of the Association of Zoos and Aquariums (AZA) Felid Taxon Advisory Group (TAG) and Puma Animal Program in a meeting in October 2012. The PVA is being conducted under the support of a two-year grant to Lincoln Park Zoo researchers 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 assess the impact of changes in importation strategies (alternative scenarios). The current AZA puma total population size is 120 (54 males and 66 females) at 59 AZA institutions.

MODEL RESULTS

The AZA puma population is a non-breeding population and is solely supported by wild rescue animals which are imported to the population on a regular basis. These imported animals are brought into the AZA population due to their inability to be rereleased back into the wild due to age, health, or medical reasons. Over the past 10 years, there has been an average of 12 imports per year. Model results indicate that if conditions remain the same (12 (6.6) imports per year), the AZA puma (*Puma concolor*) population can increase to its potential spaces (130 individuals) in approximately 5 years**.**

If there were a decline in the number of animals available for importation, the population would face a steep decline as animals that pass out of the population are not being replaced**. If imports stopped, there would be fewer than 59 individuals (current number of AZA holding institutions) in approximately 8 years** and the population would be extinct by model year 26.

MANAGEMENT ACTIONS

The AZA Puma 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 health. **These management actions will be most effective when applied in combination with one another.**

- **Continue importation of young, rescue individuals:** The puma population is dependent on the importation of animals from the wild that are unable to be rereleased due to age, health, or medical reasons. If the population continues to bring in rescue animals at its current rate (12 individuals/year) the population should be able to quickly grow to its potential spaces.

- **Cultivate relationships with wildlife personnel:** In order to maintain rescue animals, the Animal Program is dependent on relationships with government wildlife personnel. Institutions interested in this species should reach out to cultivate relationships with these agents in their area to ensure cooperative management of this species in the wild and within zoos in the future.

- **Continue high-quality husbandry and care:** Collaborate with partners to improve and ensure high-quality husbandry for pumas in our care.

Sand Cat *(Felis margarita)*

Population Biologist: Katelyn Marti, kmarti@lpzoo.org
AZA Studbook Keeper: Stacey Konwiser, skonwiser@livingdesert.org
AZA Felid Chair: Don Goff, dgoff@beardsleyzoo.org

Population Viability Analyses (PVAs) for AZA Animal Programs

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:

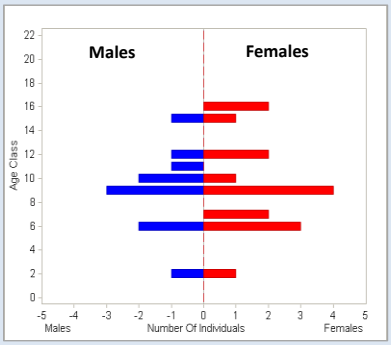
Low Risk | Vulnerable | Endangered | **Critical**

Status as of 2012

- 27 (11.16) total sand cats at 9 AZA institutions
  Population trend over last 10 years: slightly decreasing (λ = 0.996)
- Gene diversity (GD) = 80.7%
- Potential Space in model = 42
- IUCN status = Near Threatened

AZA Animal Program Challenges:

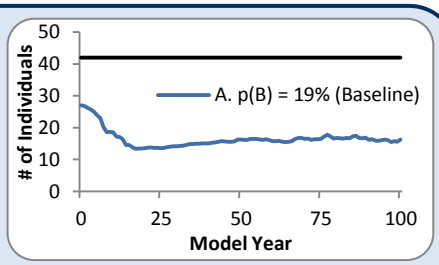
- Small population
- Current lack of institutional interest (space)
- Low gene diversity



Projected Status WITHOUT Potential Changes

CRITICAL AZA institutions

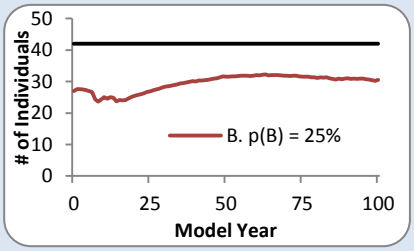
- Baseline Scenario = 2.9 births/year
- 96% chance of reaching extinction in 100 yrs
- Median time to extinction = 34 yrs
- 14 ± 12 (SD) average sand cats in 25 yrs
- 16 ± 13 (SD) average sand cats in 100 yrs
- 40% ± 31% (SD) projected GD in 100 yrs
- 0.56 ± 0.29 (SD) projected F in 100 yrs



Projected Status WITH Potential Changes

CRITICAL in AZA institutions

- Increased female breeding at p(B)= 25% (~5 births/year) and potential space at 42
- 53% chance of reaching extinction in 100 yrs
- Median time to extinction = 39 yrs
- 27 ± 15 (SD) average sand cats lions in 100 yrs
- 39% ± 17% (SD) projected GD in 100 yrs
- 0.59 ± 0.17 (SD) projected F in 100 yrs



Essential Actions

- Sustain current reproduction levels or increase reproduction as space becomes available
- Recruit new institutions and allocate additional space
- Prepare for demographic and genetic bottleneck

How to Help

- Pursue breeding recommendations given to your institution and discuss husbandry challenges and successes with the Studbook Keeper
- Discuss future institutional plans with Studbook Keeper

EXECUTIVE SUMMARY

Sand Cat AZA Animal Program Population Viability Analysis

Population Viability Analysis (PVA) model scenarios were developed with members of the Association of Zoos and Aquariums (AZA) Felid Taxon Advisory Group (TAG) and Sand Cat Animal Program in a meeting in July 2012. The PVA is being conducted under the support of a two-year grant to Lincoln Park Zoo researchers 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 assess the impact of changes such as increasing reproduction, importation strategies, increasing potential space, and not utilizing genetic management (alternative scenarios). The current AZA sand cat total population size is 27 (11 males and 16 females).

MODEL RESULTS

Model results indicate that if conditions remain the same, the AZA sand cat (*Felis margarita*) population faces an **annual 3% decline over the next 25 years.** This decline causes a demographic and genetic bottleneck due to a small initial population size of 27 animals (11 males, 16 females), low reproductive rates (currently producing ~3 births/year), and low starting genetic diversity (81%).

The most demographically sustainable model scenarios require an increase in reproduction to 5 births per year over the next decade to maintain or begin increasing the population towards its potential space of 42 individuals. To increase to 42 individuals in the next ten years, there would need to be approximately **7 births per year over the next decade**. It may be difficult to increase reproduction to these levels as they are higher than the recently observed birth rates and at this time this species is not in high demand.

Model scenarios with increased reproductive rates, importations, and increased space could help meet the AZA Sand Cat Animal Program's demographic goals. However, the population will only be capable of retaining low levels of gene diversity (37% - 75%, lower than current levels) and high inbreeding levels (0.24 - 0.59) under most feasible scenarios. In order to maintain the current gene diversity (81%) for 100 years, the population would need to increase reproduction to at least 33% (7 offspring/year), import at least 16 unrelated individuals, and increase the population's potential space even higher, to 100. These changes to the population are extremely optimistic and would require major management shifts, as institutional interest is lacking even to potentially fill 42 spaces or maintain the current size. In addition, many of the animals that would be available to the program as imports are related to our current population and would not be founders. The AZA Sand Cat Animal Program should consider how to best manage the population to meet the long-term needs of the Program within the Felid TAG.

MANAGEMENT ACTIONS

The AZA Sand Cat Animal Program should apply several management strategies to avoid a strong demographic decline and high inbreeding levels in the future. **If conditions remain the same, the population will face a demographic and genetic crisis in the near future.** If significant actions are not taken to avoid this crisis the population will not be sustainable and cats may not be available to institutions in the near future. Even if the management actions listed below are taken, the population will still likely face low levels of gene diversity in the long-term. Given these results the Animal Program must focus on whether to continue managing this population and if it is continued, how best to manage this population to produce a healthy population, meet the goals of the Animal Program and institutional requests. **The management actions listed below will be most effective when applied in combination with one another.**

- **Prepare for demographic and genetic bottleneck**: Most of the scenarios experience a population size decline and a severe reduction in the population's genetic diversity over the next 15 – 20 years. Institutions holding this species must be aware of this pending demographic and genetic bottleneck if management changes are not made.

- **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 births/year) to 5-7 births/year to maintain the current size and begin to increase towards the potential space. 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.

- **Importation of young, reproductively viable individuals:** In some cases importation could offset the decline the population is facing in the next several years and increase the long-term gene diversity (if the imported individuals are founders, which may be challenging for this population as the source of many of the imports is a population already related to the AZA population). In addition, it would increase the capacity of the population to produce offspring, which is limited currently and in the future by the aging population and lack of space. Imports must be coupled with increased reproduction to successfully grow the population in the long-term and increase gene diversity. Even though modeled levels of imports assisted the population demographically, ultimately this population under all model scenarios had lower-than-desired levels of gene diversity in 100 years.

- **Recruit new institutions and allocate additional spaces:** Space and institutional interest are a main concern for this species. The current population of 27 is below the potential spaces of 42 individuals, and well below the long-term target number of spaces for the population (50 individuals). If additional spaces are not actually available it will complicate the placement of offspring or imported individuals. If reproduction and or/importation is successful in improving the population's trajectory, it will quickly be hampered by its small number of potential spaces. In the long-term, additional institutions are vital to the population's growth and health, but these spaces may need to be added slowly until the population's demographics can improve. As a long-term goal, an increased number of potential spaces for the population will allow for a healthier age structure, a more stable population size, and better long-term genetic health.

Serval *(Leptailurus serval)*

Population Biologist: Katelyn Marti, kmarti@lpzoo.org
AZA Studbook Keeper: Dan Dembiec, dembiecd@jacksonvillezoo.org
AZA Felid TAG Chair: Don Goff, dgoff@beardsleyzoo.org

Population Viability Analyses (PVAs) for AZA Animal Programs

Photo by: Ray Thomas, Tautphaus Park 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:

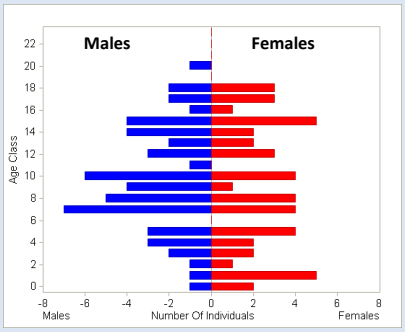
Low Risk | **Vulnerable** | Endangered | Critical

Status as of 2012

- 101 (53.48) total servals at 46 AZA institutions
- Population trend over last 10 years: slightly increasing (λ = 1.033)
- Gene diversity (GD) = 90.83% - 91.56%
- Potential Space in model = 97
- IUCN status = Least Concern

AZA Animal Program Challenges:

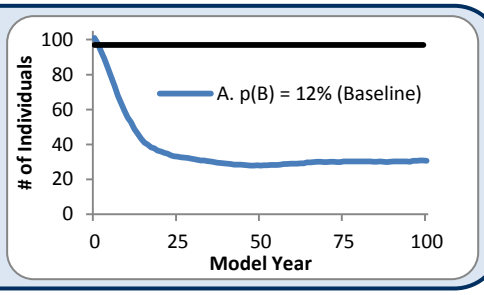
- Small breeding population
- Many animals excluded due to participation in education programs or unknown pedigree
- Dependent on non-AZA institutions for individuals



Projected Status WITHOUT Potential Changes

CRITICAL AZA institutions

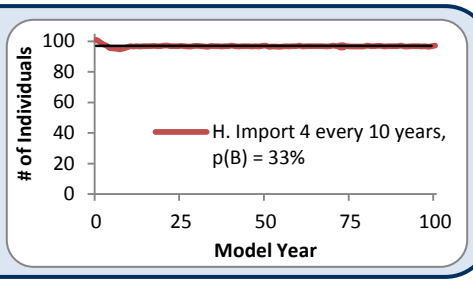
- Baseline Scenario = 4 births/year
- 58% chance of reaching extinction in 100 yrs
- Median time to extinction = 63 yrs
- 33 ± 19 (SD) average servals in 25 yrs
- 31 ± 26 (SD) average servals in 100 yrs
- 57% ± 16% (SD) projected GD in 100 yrs
- 0.37 ± 0.13 (SD) projected F in 100 yrs



Projected Status WITH Potential Changes

VULNERABLE in AZA institutions

- Increased female breeding at p(B)= 33% (~10 births/year) and 2.2 imports every 10 yrs
- 0% chance of reaching extinction in 100 yrs
- 97 ± 4 (SD) average servals in 100 yrs
- 95% ± 0.7% (SD) projected GD in 100 yrs
- 0.07 ± 0.02 (SD) projected F in 100 yrs



Essential Actions

- Increase reproduction
- Prepare for demographic decline if importations are halted
- If importations are necessary, assure that imported individuals have known pedigree

How to Help

- Pursue breeding recommendations given to your institution and discuss husbandry challenges and successes with the SSP Coordinator
- Discuss future program animals plans with the SSP Coordinator

EXECUTIVE SUMMARY

Serval AZA Animal Program Population Viability Analysis

Population Viability Analysis (PVA) model scenarios were developed with members of the Association of Zoos and Aquariums (AZA) Felid Taxon Advisory Group (TAG) and Serval Animal Program in a meeting in July 2012. This PVA is being conducted under the support of a two-year grant to Lincoln Park Zoo researchers 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 assess the impact of changes such as increasing reproduction, importation strategies, including or excluding education animals in the breeding population, and including or excluding animals with less than 25% known pedigree. The current AZA serval total population size is 101 (53 males and 48 females).

MODEL RESULTS

Model results indicate that if breeding conditions remain the same and no animals are imported or exported, the AZA serval (Leptailurus serval) population faces an **annual 4% decline over the next 25 years.** This decline causes a demographic and genetic bottleneck due to a small initial breeding population size of 33 animals (16 males, 17 females), low reproductive rates (currently producing ~4 births/year), and low percent of the pedigree known (36%).

The most demographically sustainable model scenarios require an increase in reproduction to at least 8 births per year over the next decade to maintain or begin increasing the population towards its potential space of 97 individuals. It may be difficult to increase reproduction to these levels as there are currently many animals excluded from the breeding population due to age, unknown pedigree, and their participation in education programs.

Model scenarios with increased reproductive rates and importations could help meet the Serval Animal Program's demographic and genetic goals. The AZA serval population has received approximately 6 imports per year over the last 10 years. If appropriate, young, reproductively-viable servals could be imported from outside the AZA population in accordance with federal and international regulations. However, any imported individuals should have known pedigrees to prevent further increases in pedigree unknownness in the serval AZA population (which is already very high, with only 36% of the population having a known pedigree). Imported individuals with high pedigree knownness would benefit the population demographically and genetically, as many animals in the current population are unable to breed. Model scenarios with both increased reproduction and importations improve the population's demographic and genetic outlook over the next 100 years. However, the Program may want to explore alternative management strategies for the future of this population including breeding education and unknown pedigreed animals as this could increase the ability of the population to reach its potential space without maintaining the current high level of importation.

MANAGEMENT ACTIONS

The AZA Serval Animal Program should apply several management strategies to avoid a strong demographic decline, meet the potential spaces, accommodate institutional needs, and retain long-term generic health in the future. **The management actions listed below will be most effective when applied in combination with one another.**

- **Prepare for demographic and genetic bottleneck**: If the serval population was to depend only on its current population without sustaining its current high level of imports, the population is predicted to experience a decline in size and lose genetic diversity over the next 15 – 20 years. Institutions holding this species must be aware of this pending demographic and genetic bottleneck if current reproduction and importations are not maintained.
- **Increase reproduction:** It is a goal of the population to become less dependent on receiving animals from outside the managed population. In order to accomplish this, the Program should focus on breeding reproductively viable females to increase the number of offspring produced. Any additional births than the current average of 4 births per year will begin to increase the population towards its potential space available.
    - 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.
- **Importation of young, reproductively viable individuals:** If importation continues at its current rate, the population could offset the decline it is facing in the next several years and possibly increase the long-term gene diversity (if the imported individuals are founders, which may be challenging for this population as the source of many of the available imports have unknown pedigree). However, under this management strategy the AZA serval population would remain dependent on institutions outside of the managed program.
- **Research pedigree unknownness:** Currently only 36% of the serval population has known pedigree. To improve this and obtain a more accurate representation on the genetic diversity retained by the population, institutions should research the pedigree of their current individuals if possible. In the future, institutions should also work with the SSP Coordinator to import animals with known pedigrees. Animals with known pedigrees can also be prioritized for breeding but this may limit demographic goals.
- **Consider alternate management strategies**: If all animals regardless of pedigree knownness or participation in education programs were allowed to breed, the population is predicted have a greater chance of reaching its potential space (97 animals), especially if these strategies were coupled with increased breeding.

Snow Leopard *(Uncia uncia)*

Population Biologist: Melissa Theis, mtheis@lpzoo.org
AZA SSP Coordinator®: Jay Tetzloff, jtetzloff@cityblm.org
AZA Studbook Keeper: Lynn Tupa, LTupa@cabq.gov
AZA Felid TAG Chair: Don Goff, dgoff@beardsleyzoo.org

Population Viability Analyses (PVAs) for AZA Animal Programs


Photo by Joel Sartore

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:

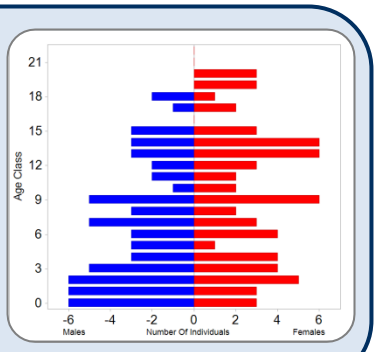
Low Risk | Vulnerable | Endangered | Critical

Status as of 2012

- 128 (62.66) snow leopards at 58 AZA institutions
- 111 (58.53) potentially breeding AZA population
- Population trend over last 10 years: declining (λ = 0.965)
- Gene diversity (GD) = 94.96%
- Potential Spaces in model = 159
- IUCN status = Endangered

AZA Animal Program Challenges:

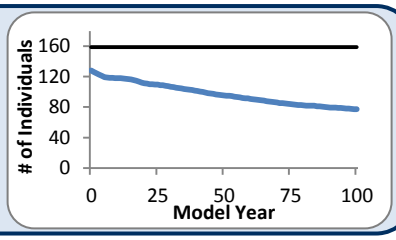
- Low reproduction = ~13 births/year in past 10 yrs
- Higher mortality rate (18 deaths/year) than birth rate
- Older cats make up large portion of the population



Projected Status WITHOUT Potential Changes

VULNERABLE in AZA Institutions

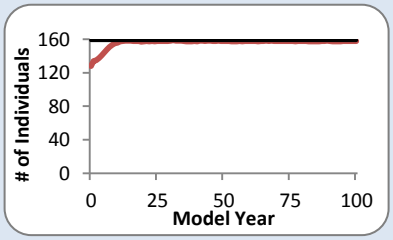
- Baseline Scenario = ~13 births/year
- 6% chance of decreasing to extinction in 100 yrs
- 35% chance of increasing to N = 159 in 100 yrs
- 77 ± 46 (SD) average snow leopards in 100 yrs
- 81% ± 9% (SD) projected GD in 100 yrs



Projected Status WITH Potential Changes

LOW RISK in AZA Institutions

- Scenario M with increased reproduction at p(B)= 20% (AZA) and import 2.2 every 10 yrs until yr 50 (~20 births/year)
- 0% chance of decreasing to extinction in 100 yrs
- 100% chance of increasing to N = 159 in 100 yrs
- 158 ± 6 (SD) average snow leopards in 100 yrs
- 93% ± 1% (SD) projected GD in 100 yrs



Essential Actions

- Increase reproduction to 15 to 20 births 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 cats are available

EXECUTIVE SUMMARY

Snow Leopard AZA Animal Program Population Viability Analysis

Population Viability Analysis (PVA) model scenarios were developed with members of the Association of Zoos and Aquariums (AZA) Felid Taxon Advisory Group (TAG) and Snow Leopard Animal Program in July 2012. The PVA is being conducted under the support of a two-year grant to Lincoln Park Zoo researchers 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 such as increasing reproduction, importation strategies, and not utilizing genetic management (alternative scenarios). The current AZA snow leopard total population size is 128 (62 males, 66 females) individuals at 58 institutions.

MODEL RESULTS

Model results indicate that if conditions remain the same, the AZA snow leopard population faces an **annual 0.6% decline over the next 25 years.** The projected population decline occurs because the number of deaths exceeds the number of births. The baseline model produces, on average, 13 births per year in comparison to an average of 14 projected deaths per year in the first 10 years of the model. The declining population has a 35% probability of reaching its number of potential space of 159 individuals under current conditions.

The snow leopard population is able to improve its trajectory with reasonable improvements in reproduction. For instance, an increase from the current average of 13 births per year to 15 births per year (p(B) =15% scenario), would allow the population to roughly sustain its current size in the next 100 years. If the population can reach an average of 20 births per year, the population will reach the number of potential spaces in approximately 6 to 10 years with 100% of model iterations meeting the space goal. Furthermore, if the population can increase reproduction to an average of 20 births per year, the population is able to retain a projected 90 ± 1% gene diversity in the next 100 years.

If appropriate, young, reproductively-viable snow leopards could be imported from outside the AZA population in accordance with federal and international regulations. These individuals may be able to benefit the population demographically and genetically. Model scenarios with both improved reproduction and importations illustrate that these management changes could help retain 92% - 93% gene diversity at the end of 100 years, and reduce inbreeding.

MANAGEMENT ACTIONS

The AZA Snow Leopard Animal Program should apply several management strategies in combination with one another to counteract the projected demographic decline, accommodate institutional interest, and retain long-term genetic health. **These management actions will be most effective when applied in combination with one another.**

- **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 births in excess of the current level (13 births per year) will assist the population in growing towards its goal of 159 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.

- **Importation of young, reproductively viable individuals:** If deemed appropriate, importation (in accordance with federal and international regulations) should be coupled with increased reproduction to successfully grow the population in the long-term and maintain gene diversity over the long-term.

COMPARATIVE FELID TAG BASELINE SCENARIOS

The baseline scenarios for the AZA Felid TAG Animal Programs predict what might happen to each population if conditions remain the same, specifically if the population 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, all cooperatively managed cat populations in AZA are projected to decline and fall well below their corresponding potential populations sizes (Figure 1).

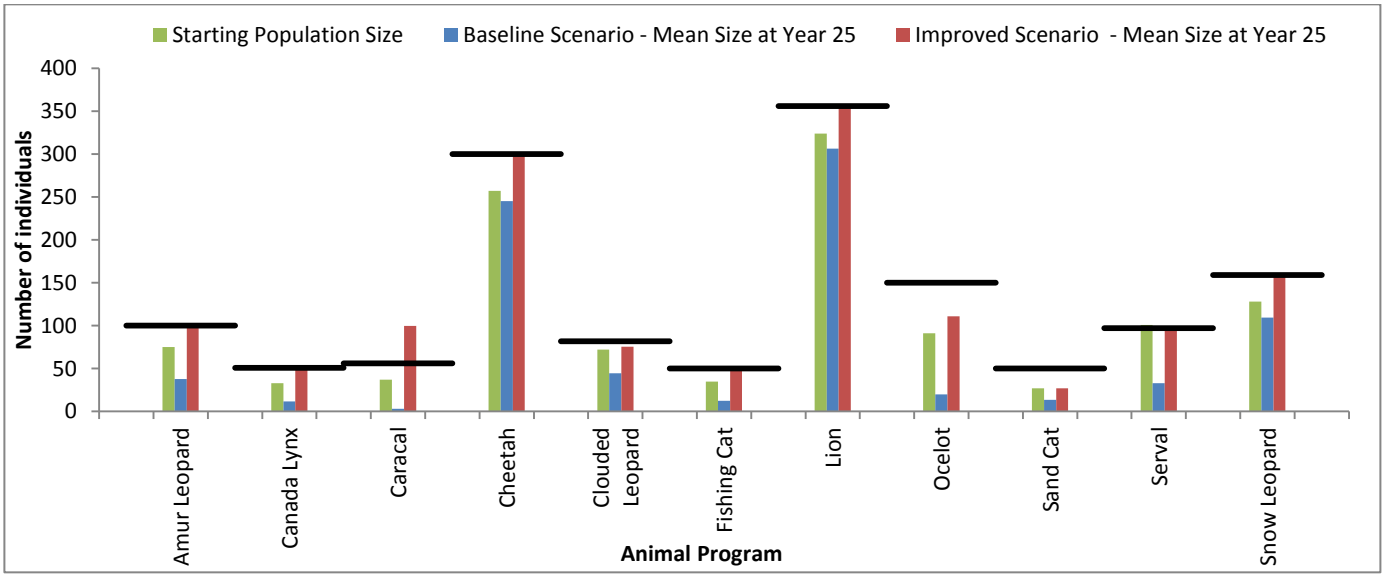
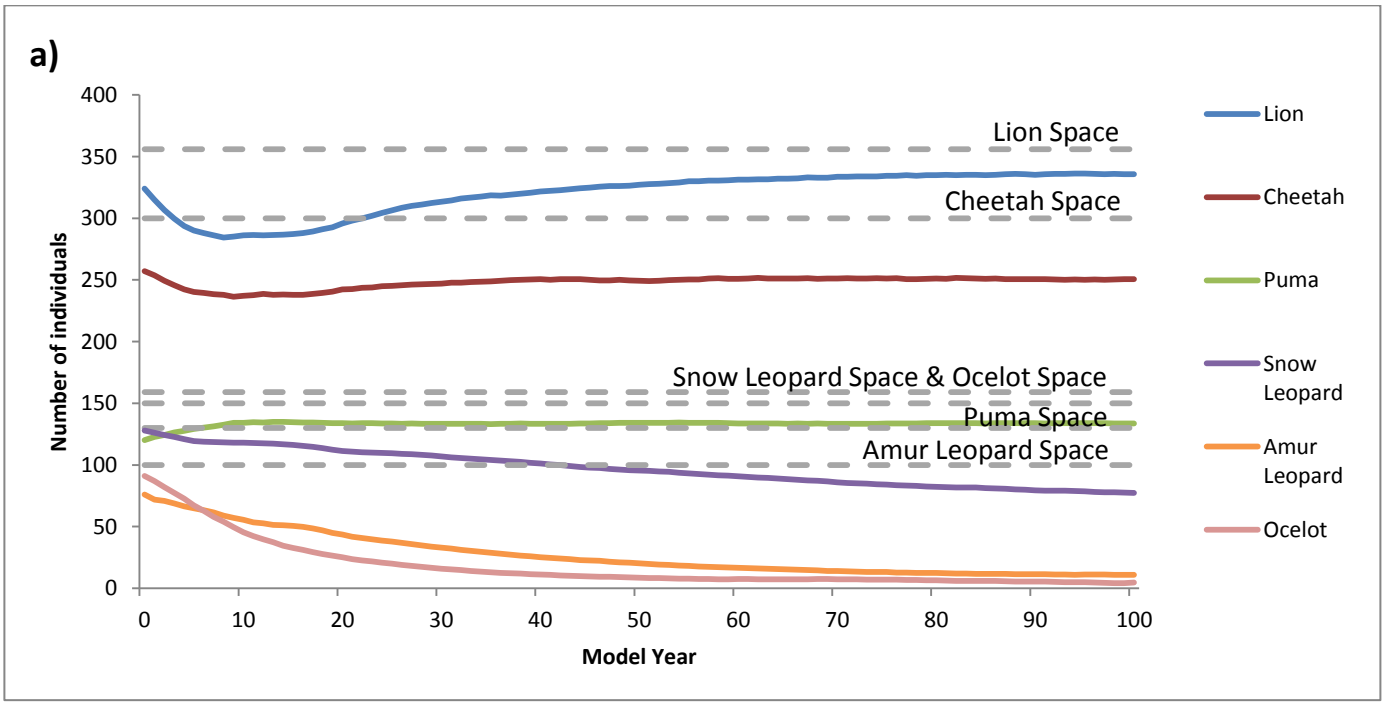


Figure 1. Mean population size in model year 25 for AZA Felid TAG Animal Programs baseline scenarios. The back line represents the potential space in the population.



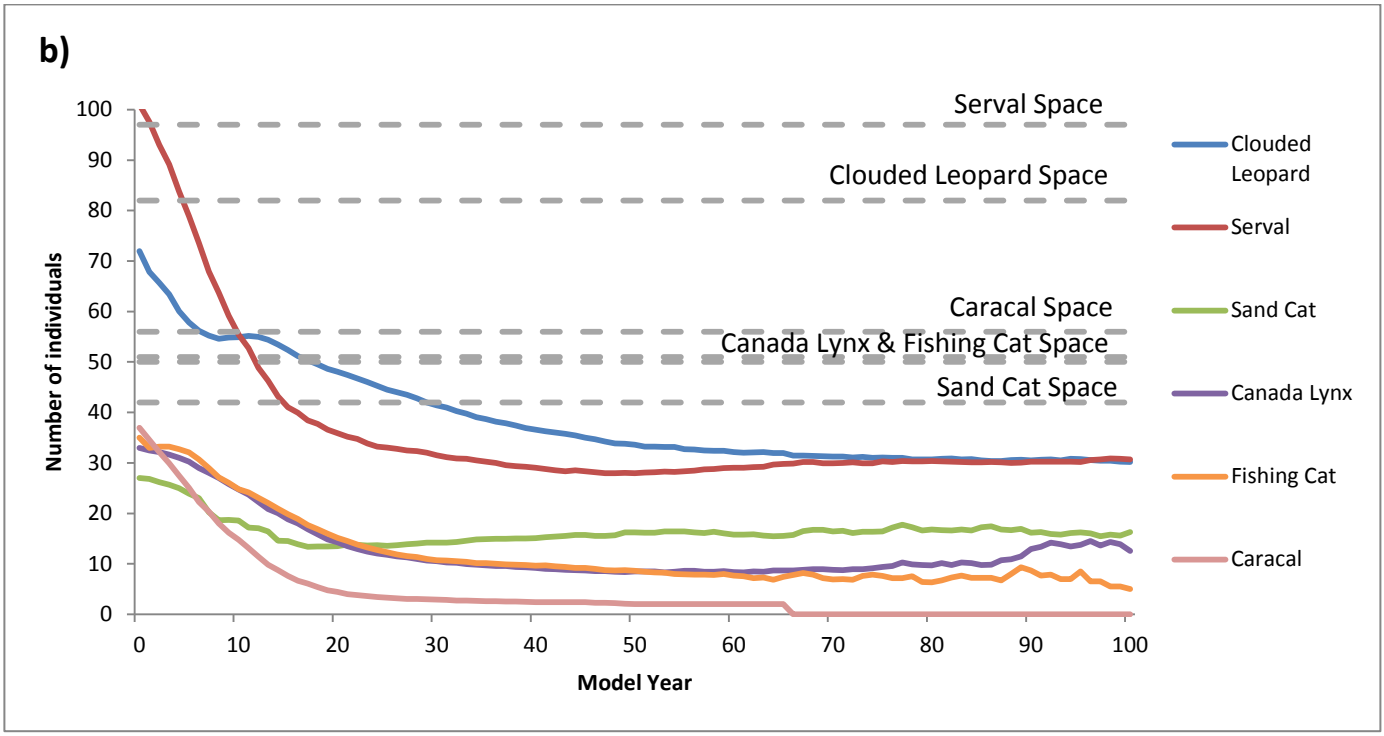


Figure 2 (a & b). Mean population sizes for AZA Felid TAG Animal Programs baseline scenarios. Results are averaged over 1,000 iterations.

The projected population declines mostly occur because deaths exceed births. These baseline scenario trajectories can be anticipated if breeding do not increase from current levels or other changes are not made. When the population sizes decrease to low levels, increasing reproduction and meeting institutional needs will be even more difficult in the future.

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 Felid TAG Animal Programs, we've shown the baseline scenario and an improved, realistic scenario in the below table:

Table 2. Felid 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.

Amur Leopard				
Baseline	LOW RISK	VULNERABLE	ENDANGERED	**CRITICAL**
Improved Scenario	LOW RISK	**VULNERABLE**	ENDANGERED	CRITICAL
Canada Lynx				
Baseline	LOW RISK	VULNERABLE	ENDANGERED	**CRITICAL**
Improved Scenario	LOW RISK	**VULNERABLE**	ENDANGERED	CRITICAL
Caracal				
Baseline	LOW RISK	VULNERABLE	ENDANGERED	**CRITICAL**
Improved Scenario	LOW RISK	VULNERABLE	**ENDANGERED**	CRITICAL
Cheetah				
Baseline	LOW RISK	**VULNERABLE**	ENDANGERED	CRITICAL
Improved Scenario	**LOW RISK**	VULNERABLE	ENDANGERED	CRITICAL
Clouded Leopard				
Baseline	LOW RISK	VULNERABLE	ENDANGERED	**CRITICAL**
Improved Scenario	LOW RISK	VULNERABLE	**ENDANGERED**	CRITICAL
Fishing Cat				
Baseline	LOW RISK	VULNERABLE	ENDANGERED	**CRITICAL**
Improved Scenario	LOW RISK	**VULNERABLE**	ENDANGERED	CRITICAL
Lion				
Baseline	**LOW RISK**	VULNERABLE	ENDANGERED	CRITICAL
Improved Scenario	**LOW RISK**	VULNERABLE	ENDANGERED	CRITICAL
Ocelot				
Baseline	LOW RISK	VULNERABLE	ENDANGERED	**CRITICAL**
Improved Scenario	LOW RISK	**VULNERABLE**	ENDANGERED	CRITICAL
Sand Cat				
Baseline	LOW RISK	VULNERABLE	ENDANGERED	**CRITICAL**
Improved Scenario	LOW RISK	VULNERABLE	ENDANGERED	**CRITICAL**
Serval				
Baseline	LOW RISK	VULNERABLE	ENDANGERED	**CRITICAL**
Improved Scenario	LOW RISK	**VULNERABLE**	ENDANGERED	CRITICAL
Snow Leopard				
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 Felid TAG Animal Programs

	Prepare for decline	Increase Reproduction	Import Individuals	Increase Space
Amur Leopard	◆	◆	◆	◆
Canada Lynx	◆	◆	◆	◆
Caracal	◆	◆	◆	◆
Cheetah		?	?	
Clouded Leopard	◆	◆	◆	◆
Fishing Cat	◆	◆	◆	◆
Lion		?		
Ocelot	◆	◆	◆	
Puma			◆	
Sand Cat	◆	◆	◆	◆
Serval	◆	◆	◆	
Snow Leopard	◆	◆	◆	

Many of the AZA Felid Animal Programs face similar challenges; most would need to apply several management strategies to avoid a strong demographic decline, increase to meet the target population size, accommodate institutional needs, 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 Felid 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 Felid TAG Animal Programs shows that all the Programs will face challenges in the coming years if management actions are not implemented. Nearly all the baseline scenarios for the Felid TAG Programs are declining in the near future and there are predicted to be very small cats 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 felid populations on the path towards long-term sustainability within AZA institutions.

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