Population Analysis & Breeding and Transfer Plan

Eastern Black Rhinoceros (*Diceros bicornis michaeli*)
AZA Species Survival Plan®
Yellow Program

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PMC Population Management Center
LINCOLN PARK ZOO. ASSOCIATION OF ZOOS & AQUARIUMS

Disney's ANIMALS, SCIENCE and ENVIRONMENT

Executive Summary
Species Survival Plan® for Eastern Black Rhinoceros (*Diceros bicornis michaeli*)

The current SSP population of Eastern black rhinoceros is N = 55 animals (30 males; 25 females; 0 unknown sex) at 24 AZA institutions. This Population Analysis and Breeding and Transfer Plan was prepared July 2021 at Disney's Animal Kingdom®. The last Breeding and Transfer Plan for this species was finalized 15 February 2018. Analyses were based on the AZA Regional Eastern Black Rhino Studbook (current to 15 March 2021) and were performed using ZIMS for Studbooks and PMx 1.6.20190628. The target population size designated by the Rhino Taxon Advisory Group's DRAFT RCP is 77. This population currently qualifies as a Yellow SSP.

Genetic diversity in this population is currently 95.50%. When gene diversity falls below 90% of that in the founding population, it is expected that reproduction will be increasingly compromised by, among other factors, lower birth weights and greater infant mortality. Gene diversity in 100 years is projected to be 85.7% (assuming a target population of 77 and a positive lambda = 1.004). Equalizing the founder representation by breeding individuals from underrepresented lineages, increasing the effective size, and increasing the target population size could extend gene diversity retention. To retain 90% GD for 100 years, one new founder would need to be incorporated every 14 years, which may be attainable with imports from Europe for this population.

Demography	
Current size of population (N) – Total (Males.Females.Unknown Sex)	55 (30.25.0)
Number of individuals excluded from the potentially-breeding population	3 (2.1)
Population size following exclusions	52 (28.24)
Target population size (Kt) from the Rhino TAG 2021 DRAFT RCP	77
Mean generation time (T; years)	15.7
Growth rate from life table (λ; 1960 – present) / 5-year from Poplink census / Projected growth rate from PMx stochastic 20-year projections	0.984/ 1.004/ 0.953 <> 0.977 <> 0.997

Genetics		
	Current	***Potential***
Founders	37	0
Founder genome equivalents (FGE)	11.11	16.29
Gene diversity (GD %)	95.50%	96.93%
Population mean kinship (MK)	0.0450	-----
Mean inbreeding (F)	0.0022	-----
N_e/N (Effective population size/census size ratio)	0.4487*	-----
% Pedigree Known prior to assumptions and exclusions	100%	-----
% Pedigree Known after assumptions and exclusions	100%	-----
Projections		
	[d]Historical λ = 0.984	[e]Projected λ = 1.004
Years to 90% GD	34	50
Years to 10% loss of GD	51	97
Gene Diversity at 100 Years (%)	68.0%	85.7%
Gene Diversity in 10 Generations (%)	33.4%	81.3%
Generation time (*T*) and Target population size used in projections	*T*=15.7 x 10 = 157 Target = 77	*T*=15.7 x 10 = 157 Target = 77

*Value includes founders.
[d]Historical λ is population growth rate from demographic window 1960 – 2020.
[e]Projected λ is population growth rate from the five-year census. Reproductive projections suggest it may take 84 years to grow to the target size at this rate with about 5 births per year.

Demographic analyses indicated that to increase the population size to 77, approximately five births are required per year (λ = 1.004). To remain at the current size (λ = 1.00), approximately 4 births are needed in the next year. As with most SSP populations, pairings are prioritized to maintain or increase gene diversity through considerations of mean kinship and avoidance of inbreeding.

Summary Actions: The SSP recommends 14 breeding males and 15 breeding females, as well as 10 transfers for this period. Approximately five births per year are required to grow this population to a size of 77. This plan adds a total of four new holding/breeding facilities to the program.

Table of Contents

Acknowledgments

A master planning session was held 17 March 2021 through video conferencing with the following attendees and others not noted. Please forgive us if we missed that you were on the call!

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Cover photo courtesy of Grahm Jones, Columbus Zoo

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This report, including analyses and specific recommendations, has been produced by the Adjunct PMC advisor listed on the title page.

Description of Population Status

Species Survival Plan® for Eastern Black Rhinoceros (*Diceros bicornis michaeli*)

Introduction: The Rhino Taxon Advisory Group Regional Collection Plan DRAFT (2021) designated the population to be managed as an SSP with a target size of 77 individuals. The current population qualifies as a Yellow SSP and consists of 55 individuals (30 males; 25 females; 0 unknown sex) distributed among 24 AZA institutions.

Comprehensive genetic and demographic analyses of the population were performed in July 2021 resulting in the current Breeding and Transfer Plan for the Eastern black rhino SSP population. The last Breeding and Transfer Recommendations for this species were published 15 February 2018. Recommendations contained in this report represent the results of these analyses. Demographic and genetic analyses were performed on the AZA Regional Studbook (current to 15 March 2021) using ZIMS for Studbooks and PMx 1.4.20190628. The goal of these recommendations is to help ensure the genetic and demographic health of this population. Recommendations contained in this plan supersede those made in earlier plans.

Status and Conservation: Eastern black rhinoceros are found in Eastern Africa in Kenya and Tanzania, and an introduced population in South Africa. They are currently listed as Critically Endangered by IUCN, with an approximate population of 740, making it the rarest of the three remaining black rhino subspecies. The biggest threat to the species continues to be poaching for horn.

Analytical Population: The current population size is 55 (TAG recommended size = 77). No pedigree assumptions are required for this population as the pedigree is 100% known. A total of 3 individuals (2.1) were excluded from the potentially-breeding population due to being potential carriers or having the genes for vitiligo (Appendix C). The population of potentially-breeding animals following all exclusions is 52 (28.24).

Demography: Eastern black rhinos were first seen in North American zoos starting in 1912, but have only consistently been exhibited in AZA institutions since 1930. The population remained at less than 10 animals throughout the 1930s and 1940s, but began to exhibit steady growth beginning in the 1950s due to a combination of continuing imports and successful zoo reproduction (average λ from census 1950 – 2020 = 1.024). From the demographic window when zoo births became more common (1960), the census growth rate was slightly lower (average λ from census 1960 – 2020 = 1.011). However, over the last five years the population has been almost static, growing at just 0.4% (last 5 years census lambda = 1.004). In the last five years, number of births has varied from 1–3 each year with the average being two births per year.

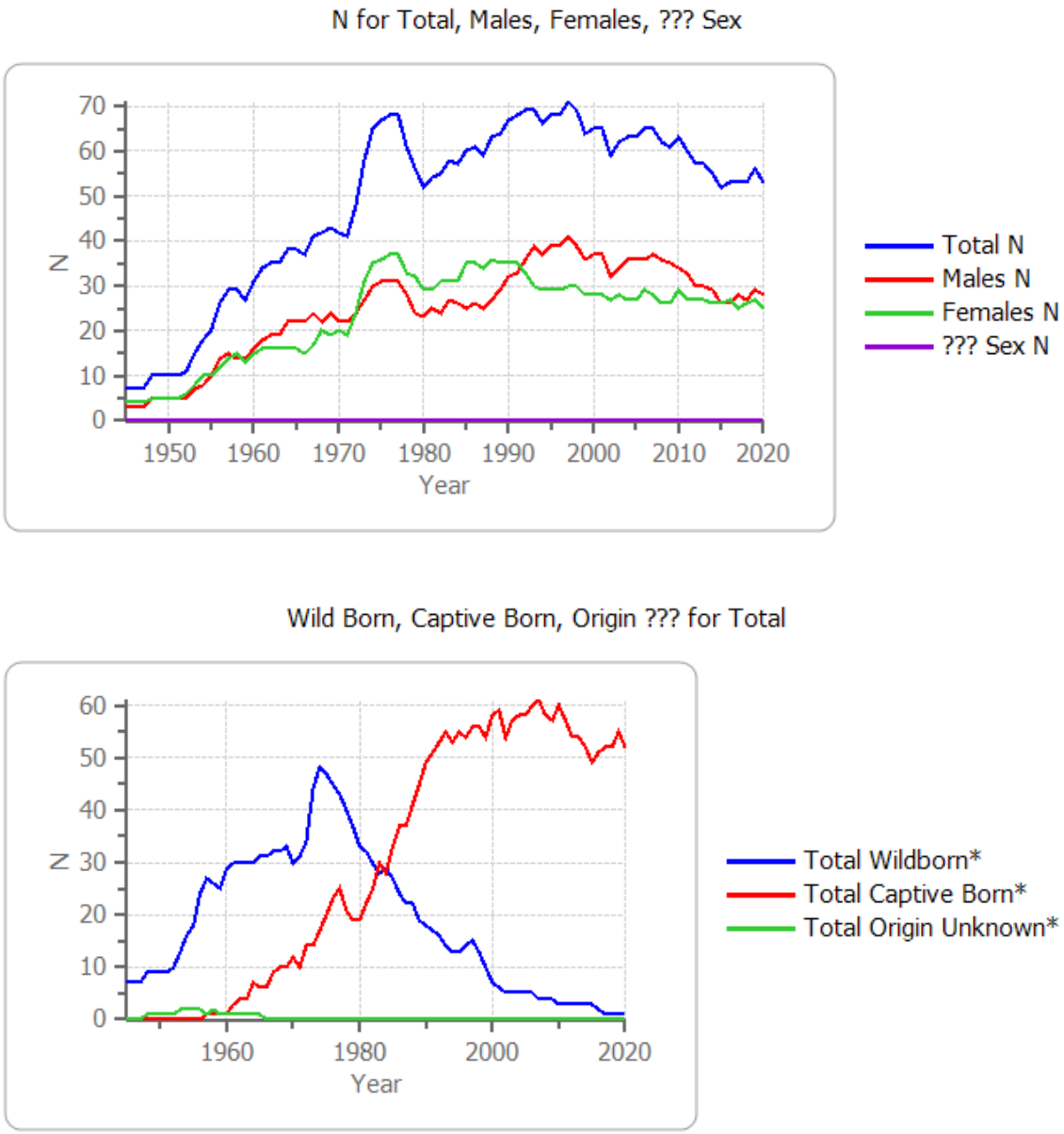

Figure 1. Census of Eastern black rhinoceros in the SSP from 1945 – 2020 by sex and by birth type.

The age structure of the Eastern black rhino population is generally columnar, which is common for a long-lived species (Figure 2). While most age classes through 35 are filled, there are typically only one or two individuals in each age class and an inconsistent filling of each age class with each sex, although with only 1–3 births occurring in most years, that is not unexpected. The sex ratio is just slightly male biased, which had historically been more of a concern than currently. However, a sex-ratio biased to males could have implications for future reproduction as the last six births in the population were males.

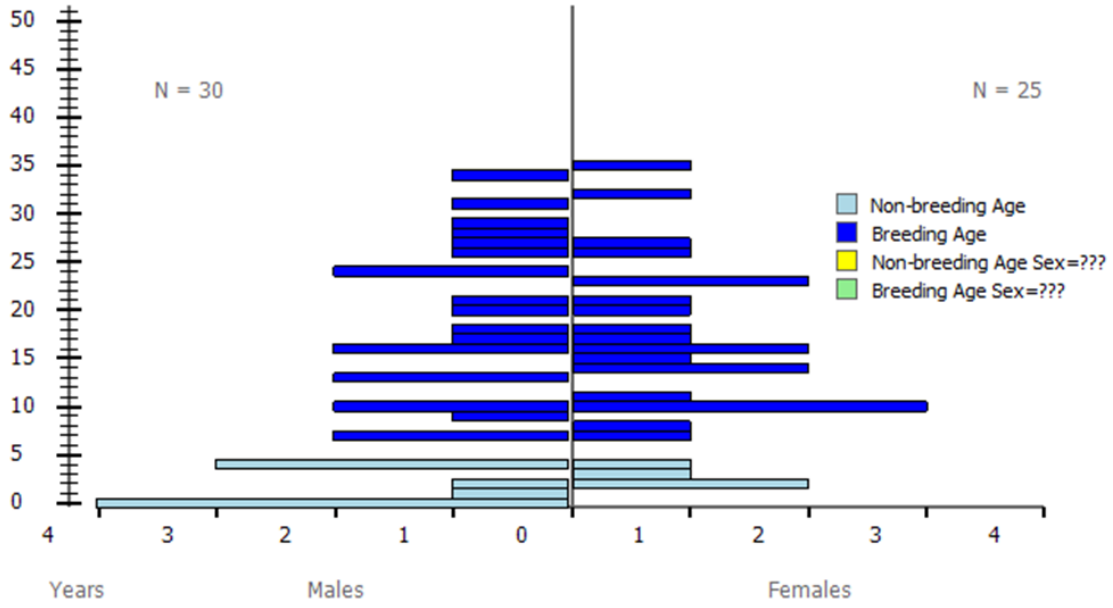

Figure 2. Age structure of the Eastern black rhinoceros population in the SSP showing age classes 0–35 as of July 2021.

According to studbook records from 1960 – 2020, first year mortality in the SSP is 26% for males and 27% for females. Males become sexually mature at age five and females become sexually mature at age four and can give birth at age five. It appears that fecundity is fairly consistent in both sexes from ages five to 15, and then begins to decrease throughout their lifetimes. Both males and females become senescent at approximately 37 years. The oldest male Eastern black rhino in the SSP was wild caught and lived to be almost 50, and the oldest female was also wild caught and lived to be approximately 48. However, if an Eastern black rhinoceros survives its first birthday, its median life expectancy is 18.8 years (Appendix F). Rhinos give birth to one infant and there is no birth seasonality in this species evident in SSP studbook records at this time, although more births seem to be spread in the latter half of the year (July through December).

Genetics: The Eastern black rhino SSP population is descended from 37 founders and no potential founders remain. Given current population parameters, gene diversity is estimated to be approximately 95.50%. This is equivalent to approximately 11 unrelated individuals (FGE = 11.11). Population mean kinship (MK) is 0.0450, and mean inbreeding (F) is 0.0022. These values are likely to remain low in this population for the near future due to slow reproduction rates and management practices/pairing of unrelated individuals. The ratio of N_e/N in this population including founders (0.4487) is above average for monogamous species, and reflects the fact that many of the individuals in the population have produced at least one calf.

Based on current statistics, at 100 years from present with a slightly negative rate (historical $\lambda = 0.9835$) and a target population size of 77, gene diversity is estimated to be 68.0%, and the population would decline to about 10 animals. In 10 generations, or 157 years, gene diversity is estimated at 33.4% and the population would decline to approximately five individuals. If the population continues to grow slightly (0.4%, the five-year census lambda), gene diversity is projected to be 85.7% and would grow to target in less than 85 years. When gene diversity falls below 90% of that in the founding population, it is expected that reproduction will be increasingly compromised by, among other factors, lower birth weights and greater infant mortality. To retain gene diversity for a longer period of time, pairings should

be made in order to maintain or minimize population mean kinship and mean inbreeding values and to equalize the founder representation (Figure 3). Increasing the growth rate so population growth is positive and maintaining the high ratio of N_e/N will yield greater gene retention.

The current population cannot be maintained above 90% GD for 100 years, though this can be accomplished by increasing the population growth rate and recruiting additional founders. By growing at a 0.4% growth rate (λ = 1.004, the five-year census lambda), and incorporating one new founder every 14 years, 90.1% GD can be maintained for 101 years. This goal may certainly be attainable given the ability to import founders from Europe and potentially from the wild.

Genetics					
	2011	***2014***	***2018***	***2021***	***Potential***
Founders	40	40	37	37	0
Founder genome equivalents (FGE)	13.60	12.57	11.69	11.11	16.29
Gene diversity (GD %)	96.32%	96.02%	95.72%	95.50%	96.93%
Population mean kinship (MK)	0.0368	0.0398	0.0428	0.0450	-----
Mean inbreeding (F)	0.0013	0.0015	0.0018	0.0022	-----
N_e/N (Effective population size/census size ratio)	0.46	0.4318*	0.4403*	0.4487*	-----
% Pedigree Known prior to assumptions and exclusions	100%	100%	100%	100%	-----
% Pedigree Known after assumptions and exclusions	100%	100%	100%	100%	-----
Projections					
	[a]Projected λ = 1.01	[b]Historical λ = 0.985	[c]Historical λ = 0.984	[d]Historical λ = 0.984	[e]Projected λ = 1.004
Years to 90% GD	74	39	36	34	50
Years to 10% loss of GD	>100	56	53	51	97
Gene Diversity at 100 Years (%)	88.00%	72.6%	69.7%	68.0%	85.7%
Gene Diversity in 10 Generations (%)	-----	43.1%	37.0%	33.4%	81.3%
Generation time (*T*) and Target population size used in projections	*T*=15.8 x 10 = 158 Target = 77	*T*=15.8 x 10 = 158 Target = 77	*T*=15.7 x 10 = 157 Target = 77	*T*=15.7 x 10 = 157 Target = 77	*T*=15.7 x 10 = 157 Target = 77

*Value includes founders.
[a]Projections based on the analytical population growing at a rate of λ = 1.01 to a target size of 77 animals.
[b]Historical λ is population growth rate from demographic window 1968 – 2013.
[c]Historical λ is population growth rate from demographic window 1968 – 2016.
[d]Historical λ is population growth rate from demographic window 1960 – 2020.
[e]Projected λ is population growth rate from the five-year census. Reproductive projections suggest it may take 84 years to grow to the target size at this rate with about 5 births per year.

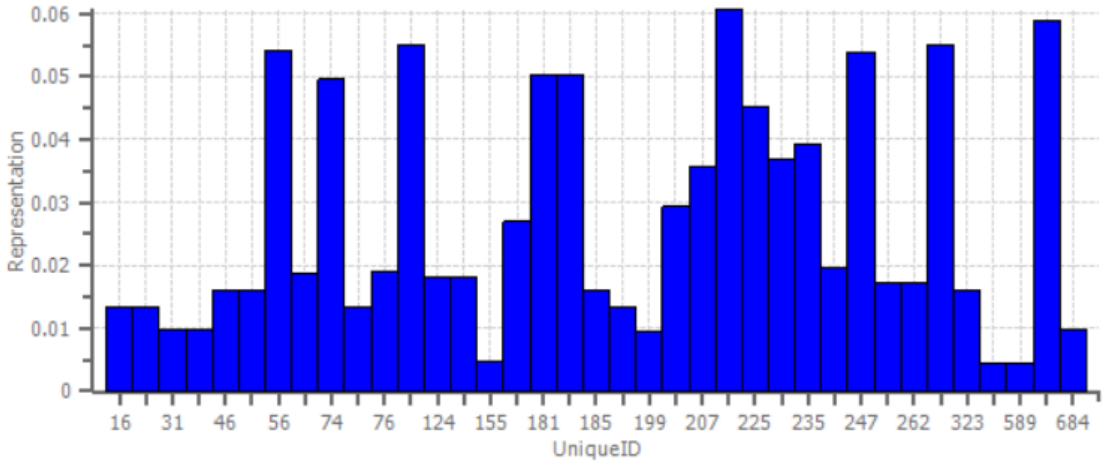

Figure 3. Founder representation graph illustrating the unequal distribution of founder lines in the Eastern black rhino SSP population as of July 2021.

Management Strategy: The current total population is 55 with a TAG recommended target of 77. According to demographic projections, to grow the population to the target size of 77 will take approximately 84 years at a growth rate of 0.4% (lambda = 1.004), and will require approximately five births each year. To simply maintain the population at its current size (λ = 1.00), approximately four births are required in the next year.

Historic reproduction and future population goals.

Current Reproductive Goals Summary		
	Number of Births Needed per Year over the next 5 Years	**Target Population Size**
To maintain current population size (λ = 1.00)	4	55
To grow to the TAG's target population size in 84 years (Kt = 77; λ = 1.004)	5	77
Reproductive Goals Summary from the Last BTP		
Number of pairs recommended to breed	15	
Number of births since then	5	
Average Number of Births/Hatches in the SSP Population		
Average number of births per year, from the past five years	2 (1–3 per year)	

This is a 2-year plan (2021 – 2023). Another full set of recommendations will be produced in 2023, but interim recommendations will be made as needed. Please promptly report births and deaths to the SSP Coordinator so that interim recommendations can be made as soon as possible.

To meet population goals, the SSP:

1) Recommends 14 males and 15 females for breeding.
    - All institutions are expected to hold offspring for at least 3 years.
    - This is an aggressive number of pairings for this population at this time, and while reproductive success has been high in recent years, the number of calves produced each year has not been enough to meet goals related to increasing population size and growth rates. This high number of pairings takes into account the long gestation, low likelihood of success in some pairs, and the length of time it may take to transfer an individual to create a new pairing.

2) Recommends 10 transfers for this plan to set up new breeding pairs and fulfill institutional requests.
    - Because of the imperative need to increase breeding in this population and reverse the decline that has occurred in recent years, more breeding pairs and transfers are recommended than in the previous plan. This will help to get genetically valuable animals moved into optimal breeding situations, and will fill the new space that has become available in recent years. The SSP thanks the four new institutions who are joining the SSP and the one institution temporarily closing their exhibit to do an expansion and giving space to this species.
    - Transfers were based on institution requests to send/receive animals for breeding purposes, and those institutions that are not actively breeding were recommended to receive an animal to fill exhibit space as well as to plan for future exhibit and breeding space that may be occurring in the next 3–5 years.

3) There is currently a single female (SB#913 KANSASCTY) who is excluded due to vitiligo, which prohibits her from being maintained long-term in an outside exhibit. If any institution exhibits black rhinos exclusively indoors, please consider bringing this individual to your institution. Contact the SSP if interested.

4) A Population Viability Analysis (PVA) was published in 2014 (Mechak L, Clausen N, Peachey H, Ferrie G, Shurter S, Rieches R. Eastern Black Rhinoceros (*Diceros bicornis michaeli*) AZA Animal Program Population Viability Analysis Report. Lincoln Park Zoo, Chicago, IL). The following management actions were recommended, and how they are being addressed in this plan are detailed below:

- Increase breeding to produce at least 4.6 births/year to maintain the current population size.
    - In the last five years, the average number of births per year was two. We are aiming to improve this number by increasing the number of pairings in this plan and ensuring valuable breeding females are placed in a breeding situation.
- Increase holding capacity to grow the population beyond its current size.
    - Four new holders have been identified to join the program within this plan, although one will be lost due to an upcoming construction project.

Recommendation Outcomes: The website PMCTrack calculates the outcomes for SSP recommendations by comparing Breeding and Transfer Plan recommendations to births and deaths recorded in the studbook. Of the recommendations proposed in the 2018 Eastern Black Rhino Breeding and Transfer Plan, 47% of the BREED WITH recommendations were fulfilled, and 75% of SEND TO recommendations were fulfilled as requested by March 2021. There are many reasons that recommendations might not be fulfilled, including interim recommendations issued by the SSP Coordinator; these reasons can be captured using PMCTrack Outcomes Surveys. SSP participants are always encouraged to attempt to fulfill recommendations and to communicate successes and failures to the SSP Coordinator.

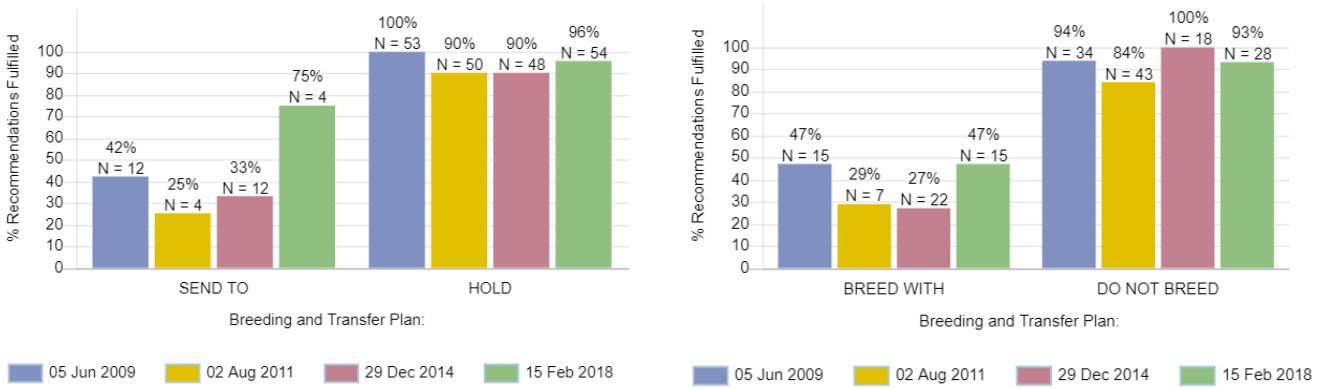

Figure 4. Recommendation outcome graphs by transfer (left) and breeding (right) for the past Eastern Black Rhino SSP Breeding and Transfer Plans. *N* represents the number of recommendations scored for each recommendation type, per plan, and the number represents the percentage recommendations fulfilled. Please visit PMCTrack.org or contact pmctrack@lpzoo.org for more information or with any questions.

Summary of Breeding and Transfer Recommendations

Sorted by Studbook ID

ID	Location	Sex	Age	Disposition	Location	Breeding	With	Notes
359	CALDWELL	F	35	HOLD	CALDWELL	DO NOT BREED		Genetically valuable but nearing senescence
372	HONOLULU	M	34	HOLD	HONOLULU	BREED WITH	560	Genetically valuable but unlikely pairing due to age of male
418	BUSCH TAM	F	32	HOLD	BUSCH TAM	BREED WITH	475	Genetically valuable pairing
427	CHICAGOBR	M	31	HOLD	CHICAGOBR	SEE NOTES		Genetically valuable
459	KANSASCTY	M	29	HOLD	KANSASCTY	DO NOT BREED		Excluded, potential carrier of vitiligo
475	BUSCH TAM	M	28	HOLD	BUSCH TAM	BREED WITH	418	Genetically valuable pairing
490	DENVER	M	27	HOLD	DENVER	DO NOT BREED		Excluded, carrier of vitiligo
542	LITTLEROC	M	26	HOLD	LITTLEROC	BREED WITH	944	Mis-matched pair, male genetically valuable, female over-represented, breed for demographics
560	HONOLULU	F	26	HOLD	HONOLULU	BREED WITH	372	Genetically valuable but unlikely pairing due to age of male
624	CINCINNAT	M	0	HOLD	CINCINNAT	DO NOT BREED		
625	GARDENCTY	M	0	HOLD	GARDENCTY	DO NOT BREED		
626	METROZOO	M	0	HOLD	METROZOO	DO NOT BREED		
627	SEDGWICK	M	0	HOLD	SEDGWICK	DO NOT BREED		Genetically valuable
636	SIOUX FAL	M	24	HOLD	SIOUX FAL	DO NOT BREED		
664	CHICAGOLP	M	24	HOLD	CHICAGOLP	BREED WITH	935	Mis-matched pairing, male valuable, female over-represented breed for demographics
677	SIOUX FAL	F	23	HOLD	SIOUX FAL	DO NOT BREED		
683	CLEVELAND	F	27	HOLD	CLEVELAND	BREED WITH	786	Genetically valuable pairing
711	SEDGWICK	F	23	HOLD	SEDGWICK	BREED WITH	745	Genetically valuable pairing
745	METROZOO	M	21	SEND TO	SEDGWICK	BREED WITH	711	Genetically valuable pairing
761	METROZOO	F	21	HOLD	METROZOO	DO NOT BREED		
786	CLEVELAND	M	20	HOLD	CLEVELAND	BREED WITH	683, 904	Genetically valuable pairing
859	RACINE	F	20	HOLD	RACINE	BREED WITH	907	Genetically valuable pairing
899	COLO SPRG	M	18	HOLD	COLO SPRG	DO NOT BREED		
904	CLEVELAND	F	18	HOLD	CLEVELAND	BREED WITH	786	Genetically valuable pairing
907	RACINE	M	17	HOLD	RACINE	BREED WITH	859	Genetically valuable pairing
913	KANSASCTY	F	17	HOLD	KANSASCTY	DO NOT BREED		Excluded, has vitiligo, available to transfer to an indoor exhibit
922	CINCINNAT	M	16	HOLD	CINCINNAT	BREED WITH	950	Mis-matched pairing, male valuable, female over-represented breed for demographics
923	ST LOUIS	M	16	HOLD	ST LOUIS	DO NOT BREED		
925	ST LOUIS	F	16	HOLD	ST LOUIS	DO NOT BREED		
935	CHICAGOLP	F	16	HOLD	CHICAGOLP	BREED WITH	664	Mis-matched pairing, male valuable, female over-represented breed for demographics
944	LITTLEROC	F	15	HOLD	LITTLEROC	BREED WITH	542	Mis-matched pair, male genetically valuable, female over-represented, breed for demographics
946	LANSING	M	13	HOLD	LANSING	BREED WITH	947	Mis-matched pair, female genetically valuable, male over-represented, breed for demographics

ID	Location	Sex	Age	Disposition	Location	Breeding	With	Notes
947	LANSING	F	14	HOLD	LANSING	BREED WITH	946	Mis-matched pair, female genetically valuable, male over-represented, breed for demographics
948	KANSASCTY	F	14	HOLD	KANSASCTY	BREED WITH	959	Mis-matched pair, female genetically valuable, male over-represented, breed for demographics
949	SAN FRAN	M	13	HOLD	SAN FRAN	DO NOT BREED		
950	CINCINNAT	F	11	HOLD	CINCINNAT	BREED WITH	922	Mis-matched pairing, male valuable, female over-represented breed for demographics
951	CHICAGOBR	F	10	HOLD	CHICAGOBR	SEE NOTES		Genetically valuable
952	GARDENCTY	F	10	HOLD	GARDENCTY	BREED WITH	962	Mis-matched pair, female genetically valuable, male over-represented, breed for demographics
954	DES MOINE	F	10	HOLD	DES MOINE	DO NOT BREED		
955	DES MOINE	M	10	HOLD	DES MOINE	DO NOT BREED		
957	PUEBLA	M	9	HOLD	PUEBLA	DO NOT BREED		
958	MILWAUKEE	F	8	SEND TO	PORTLAND	BREED WITH	961	Mis-matched pairing, female valuable, male over-represented breed for demographics
959	KANSASCTY	M	10	HOLD	KANSASCTY	BREED WITH	948	Mis-matched pair, female genetically valuable, male over-represented, breed for demographics
960	SD-WAP	F	7	HOLD	SD-WAP	BREED WITH	967	Over-represented pair, breed for demographics when male is mature
961	CHICAGOBR	M	7	SEND TO	PORTLAND	BREED WITH	958	Mis-matched pairing, female valuable, male over-represented breed for demographics, transfer occurred in comment period
962	GARDENCTY	M	7	HOLD	GARDENCTY	BREED WITH	952	Mis-matched pair, female genetically valuable, male over-represented, breed for demographics
964	SIOUX FAL	M	4	SEND TO	DISNEY AK	DO NOT BREED		
965	DES MOINE	F	4	~~SEND TO~~ HOLD	~~B BRYAN~~ DES MOINE	DO NOT BREED		
966	ST LOUIS	M	4	SEND TO	BIRMINGHM	BREED WITH	968	Mis-matched pairing, female valuable, male over-represented breed for demographics
967	SD-WAP	M	4	HOLD	SD-WAP	BREED WITH	960	Over-represented pair, breed for demographics when male is mature
968		F	4	RECEIVE FROM	SEE NOTES	BREED WITH	966	This individual is currently outside the SSP. Discuss with SSP Coordinator.
969	BUFFALO	F	3	SEND TO	CHICAGOLP	DO NOT BREED		Genetically valuable
970	CLEVELAND	F	2	SEND TO	PALM DES	DO NOT BREED		Genetically valuable, recommendation completed during comment period
971	DES MOINE	F	2	SEND TO	PUEBLA	DO NOT BREED		
972	CHICAGOLP	M	2	SEND TO	METROZOO	DO NOT BREED		
989	LANSING	M	1	SEND TO	PALM DES	DO NOT BREED		Recommendation completed during comment period

Breeding and Transfer Recommendations by Institution

B BRYAN

B. Bryan Preserve

Point Arena, CA

Note: ~~This is a new institution to the SSP. Thanks for joining!~~ Organization reported that they cannot receive at this time. Please reach out to SSP when you are interested in receiving a rhino in the future.

ID	Local ID	Sex	Age	House Name	Disposition	Location	Breeding	With	Notes
~~965~~	~~2952~~	~~F~~	~~4~~	~~Tumani~~	~~RECEIVE FROM~~	~~DES MOINE~~	~~DO NOT BREED~~		

BIRMINGHM

Birmingham Zoo

Birmingham, AL

Note: This is a new institution to the SSP. Thanks for joining!

ID	Local ID	Sex	Age	House Name	Disposition	Location	Breeding	With	Notes
966	121079	M	4	Moyo	RECEIVE FROM	ST LOUIS	BREED WITH	968	Mis-matched pairing, female valuable, male over-represented breed for demographics
968		F	4	Kesi Akua	RECEIVE FROM	SEE NOTES	BREED WITH	966	This individual is currently outside the SSP. Discuss with SSP Coordinator.

BUFFALO

Buffalo Zoo

Buffalo, NY

Note: Transfer to occur in 2023 or 2024 and SB#969 will have breeding recommendation with SB#664 after transfer.

ID	Local ID	Sex	Age	House Name	Disposition	Location	Breeding	With	Notes
969	M20002	F	3	Lulu	SEND TO	CHICAGOLP	DO NOT BREED		Genetically valuable

BUSCH TAM

Busch Gardens Tampa Bay

Tampa, FL

ID	Local ID	Sex	Age	House Name	Disposition	Location	Breeding	With	Notes
418	52154	F	32	Jody	HOLD	BUSCH TAM	BREED WITH	475	Genetically valuable pairing
475		M	28	Tucker	HOLD	BUSCH TAM	BREED WITH	418	

CALDWELL

Caldwell Zoo

Tyler, TX

ID	Local ID	Sex	Age	House Name	Disposition	Location	Breeding	With	Notes
359	001111	F	35	Christa	HOLD	CALDWELL	DO NOT BREED		Genetically valuable but nearing senescence

CHICAGOBR

Chicago Zoological Society – Brookfield Zoo

Brookfield, IL

Note: Pair is genetically compatible for breeding and a valuable pairing. Female has health concerns that do not currently allow for pairing. Continue to attempt AI or breed when possible.

ID	Local ID	Sex	Age	House Name	Disposition	Location	Breeding	With	Notes
427	940123	M	31	Nakili	HOLD	CHICAGOBR	SEE NOTES		Genetically valuable
951	4182	F	10	Layla	HOLD	CHICAGOBR	SEE NOTES		Genetically valuable
961	4912	M	7	King	SEND TO	PORTLAND	BREED WITH	958	Mis-matched pairing, female valuable, male over-represented breed for demographics, transfer occurred during comment period

CHICAGOLP

Lincoln Park Zoological Gardens

Chicago, IL

Note: Transfer of SB#969 to occur in 2023 or 2024, and SB#969 will have breeding recommendation with SB#664 after transfer.

ID	Local ID	Sex	Age	House Name	Disposition	Location	Breeding	With	Notes
664	22430	M	24	Ricko	HOLD	CHICAGOLP	BREED WITH	935	Mis-matched pairing, male valuable, female over-represented breed for demographics
935	22153	F	16	Kapuki	HOLD	CHICAGOLP	BREED WITH	664	
969	M20002	F	3	Lulu	RECEIVE FROM	BUFFALO	DO NOT BREED		Genetically valuable
972	24070	M	2	Romeo	SEND TO	METROZOO	DO NOT BREED		

CINCINNAT

Cincinnati Zoo & Botanical Garden

Cincinnati, OH

Note: Ok to wait and hold off on breeding based on construction timeline.

ID	Local ID	Sex	Age	House Name	Disposition	Location	Breeding	With	Notes
624	120023	M	0	Ajani Joe	HOLD	CINCINNAT	DO NOT BREED		
922	115046	M	16	Utenzi	HOLD	CINCINNAT	BREED WITH	950	Mis-matched pairing, male valuable, female over-represented breed for demographics
950	113076	F	11	Zuri	HOLD	CINCINNAT	BREED WITH	922	

CLEVELAND

Cleveland Metroparks Zoo

Cleveland, OH

ID	Local ID	Sex	Age	House Name	Disposition	Location	Breeding	With	Notes
683	970703	F	27	Inge	HOLD	CLEVELAND	BREED WITH	786	Genetically valuable pairing
786	160607	M	20	Forrest	HOLD	CLEVELAND	BREED WITH	683, 904	Genetically valuable pairing
904	M30801	F	18	Kibibi	HOLD	CLEVELAND	BREED WITH	786	Genetically valuable pairing
970	180806	F	2	Nia	SEND TO	PALM DES	DO NOT BREED		Genetically valuable, recommendation completed during comment period

COLO SPRG

Cheyenne Mtn Zoological Park

Colorado Springs, CO

ID	Local ID	Sex	Age	House Name	Disposition	Location	Breeding	With	Notes
899	12M051	M	18	Zuri	HOLD	COLO SPRG	DO NOT BREED		

DENVER

Denver Zoological Gardens

Denver, CO

ID	Local ID	Sex	Age	House Name	Disposition	Location	Breeding	With	Notes
490	A16019	M	27	Rudisha	HOLD	DENVER	DO NOT BREED		Excluded, carrier of vitiligo

DES MOINE

Blank Park Zoo of Des Moines

Des Moines, IA

Note: Pair will likely have breeding recommendation again in next plan in two years if both offspring are placed. Recommendation for SB#965 has changed during comment period. SSP is still in discussions with multiple locations to find a new transfer location. Please continue discussions with SSP as options may become available.

ID	Local ID	Sex	Age	House Name	Disposition	Location	Breeding	With	Notes
954	2508	F	10	Ayana	HOLD	DES MOINE	DO NOT BREED		
955	2509	M	10	Kiano	HOLD	DES MOINE	DO NOT BREED		
965	2952	F	4	Tumani	~~SEND TO~~ HOLD	~~B BRYAN~~ DES MOINE	DO NOT BREED		
971	3284	F	2	Kamara	SEND TO	PUEBLA	DO NOT BREED		

DISNEY AK

Disney's Animal Kingdom

Lake Buena Vista, FL

Note: This is a new institution to the SSP. Thanks for joining!

ID	Local ID	Sex	Age	House Name	Disposition	Location	Breeding	With	Notes
964	4824	M	4	Komati	RECEIVE FROM	SIOUX FAL	DO NOT BREED		

GARDENCTY

Lee Richardson Zoo

Garden City, KS

ID	Local ID	Sex	Age	House Name	Disposition	Location	Breeding	With	Notes
625	121001	M	0	Ayubu	HOLD	GARDENCTY	DO NOT BREED		
952	116007	F	10	Johari	HOLD	GARDENCTY	BREED WITH	962	Mis-matched pair, female genetically valuable, male over-represented, breed for demographics
962	116008	M	7	Jabari	HOLD	GARDENCTY	BREED WITH	952	

HONOLULU

Honolulu Zoo

Honolulu, HI

ID	Local ID	Sex	Age	House Name	Disposition	Location	Breeding	With	Notes
372	990042	M	34	Corky	HOLD	HONOLULU	BREED WITH	560	Genetically valuable but unlikely pairing due to age of male
560	990050	F	26	Satsuki	HOLD	HONOLULU	BREED WITH	372	

KANSASCTY

Kansas City Zoo

Kansas City, MO

ID	Local ID	Sex	Age	House Name	Disposition	Location	Breeding	With	Notes
459	M12022	M	29	Werikhe	HOLD	KANSASCTY	DO NOT BREED		Excluded, potential carrier of vitiligo
913	M04003	F	17	Imara	HOLD	KANSASCTY	DO NOT BREED		Excluded, has vitiligo, available to transfer to an indoor exhibit
948	M18009	F	14	Zuri	HOLD	KANSASCTY	BREED WITH	959	Mis-matched pair, female genetically valuable, male over-represented, breed for demographics
959	M18017	M	10	Ruka	HOLD	KANSASCTY	BREED WITH	948	

LANSING

Potter Park Zoological Gardens

Lansing, MI

ID	Local ID	Sex	Age	House Name	Disposition	Location	Breeding	With	Notes
946	4285	M	13	Phineus	HOLD	LANSING	BREED WITH	947	Mis-matched pair, female genetically valuable, male over-represented, breed for demographics
947	3047	F	14	Doppsee	HOLD	LANSING	BREED WITH	946	
989	4509	M	1	Jaali	SEND TO	PALM DES	DO NOT BREED		Recommendation completed during comment period

LITTLEROC

Little Rock Zoological Gardens

Little Rock, AR

Note: ~~Female reported pregnant during planning.~~ Calf born during comment period and will soon be assigned studbook number.

ID	Local ID	Sex	Age	House Name	Disposition	Location	Breeding	With	Notes
542	5161	M	26	Johari	HOLD	LITTLEROC	BREED WITH	944	Mis-matched pair, male genetically valuable, female over-represented, breed for demographics
944	7644	F	15	Andazi	HOLD	LITTLEROC	BREED WITH	542	

METROZOO

Zoo Miami

Miami, FL

Note: SB#972 and SB#761 will have a breeding recommendation in future plan when male is old enough to breed.

ID	Local ID	Sex	Age	House Name	Disposition	Location	Breeding	With	Notes
626	21M010	M	0		HOLD	METROZOO	DO NOT BREED		
745	M60020	M	21	Eddie	SEND TO	SEDGWICK	BREED WITH	711	Genetically valuable pairing
761	M60021	F	21	Circe	HOLD	METROZOO	DO NOT BREED		
972	24070	M	2	Romeo	RECEIVE FROM	CHICAGOLP	DO NOT BREED		

MILWAUKEE

Milwaukee County Zoological Gardens

Milwaukee, WI

Note: Institution requested to place female for upcoming construction. Please contact SSP when you would like to receive rhinos again in the future.

ID	Local ID	Sex	Age	House Name	Disposition	Location	Breeding	With	Notes
958	5974	F	8	Janine	SEND TO	PORTLAND	BREED WITH	961	Mis-matched pairing, female valuable, male over-represented breed for demographics

PALM DES

The Living Desert

Palm Desert, CA

Note: This is a new institution to the SSP. Thanks for joining! Pair will have breeding recommendation in future plan and when old enough to breed. Both transfer recommendations were fulfilled during comment period.

ID	Local ID	Sex	Age	House Name	Disposition	Location	Breeding	With	Notes
970	180806	F	2	Nia	RECEIVE FROM	CLEVELAND	DO NOT BREED		Genetically valuable, recommendation completed during comment period
989	4509	M	1	Jaali	RECEIVE FROM	LANSING	DO NOT BREED		Recommendation completed during comment period

PORTLAND

Oregon Zoo

Portland, OR

Note: This institution is returning to the SSP. Welcome back! Transfer of male occurred during comment period.

ID	Local ID	Sex	Age	House Name	Disposition	Location	Breeding	With	Notes
958	5974	F	8	Janine	RECEIVE FROM	MILWAUKEE	BREED WITH	961	Mis-matched pairing, female valuable, male over-represented breed for demographics
961	4912	M	7	King	RECEIVE FROM	CHICAGOBR	BREED WITH	958	

PUEBLA

Africam Safari

Puebla, Mexico

Note: Pair will be given a breeding recommendation in future plan when female is transferred and old enough to breed.

ID	Local ID	Sex	Age	House Name	Disposition	Location	Breeding	With	Notes
957	9514	M	9	Juba	HOLD	PUEBLA	DO NOT BREED		
971	3284	F	2	Kamara	RECEIVE FROM	DES MOINE	DO NOT BREED		

RACINE

Racine Zoological Gardens

Racine, WI

Note: Continue to discuss with SSP Coordinator and reproductive scientists to support pregnancy in female.

ID	Local ID	Sex	Age	House Name	Disposition	Location	Breeding	With	Notes
859	M0335	F	20	Timu Mbano	HOLD	RACINE	BREED WITH	907	Genetically valuable pairing
907	M0717	M	17	Kianga	HOLD	RACINE	BREED WITH	859	

SAN FRAN

San Francisco Zoological Gardens

San Francisco, CA

ID	Local ID	Sex	Age	House Name	Disposition	Location	Breeding	With	Notes
949	108039	M	13	Balozi/Boone	HOLD	SAN FRAN	DO NOT BREED		

SD-WAP

San Diego Zoo Safari Park

Escondido, CA

ID	Local ID	Sex	Age	House Name	Disposition	Location	Breeding	With	Notes
960	618382	F	7	Aria	HOLD	SD-WAP	BREED WITH	967	Over-represented pair, breed for demographics when male is mature
967	4001306	M	4	Kendi	HOLD	SD-WAP	BREED WITH	960	

SEDGWICK

Sedgwick County Zoo

Wichita, KS

ID	Local ID	Sex	Age	House Name	Disposition	Location	Breeding	With	Notes
627	16879	M	0	KJ	HOLD	SEDGWICK	DO NOT BREED		Genetically valuable
711	9888	F	23	Bibi	HOLD	SEDGWICK	BREED WITH	745	Genetically valuable pairing
745	M60020	M	21	Eddie	RECEIVE FROM	METROZOO	BREED WITH	711	

SIOUX FAL

Great Plains Zoo

Sioux Falls, SD

Note: Pair will likely have breeding recommendation again in next plan in two years.

ID	Local ID	Sex	Age	House Name	Disposition	Location	Breeding	With	Notes
636	2466	M	24	Jubba	HOLD	SIOUX FAL	DO NOT BREED		
677	2332	F	23	Imara	HOLD	SIOUX FAL	DO NOT BREED		
964	4824	M	4	Komati	SEND TO	DISNEY AK	DO NOT BREED		

ST LOUIS

Saint Louis Zoological Park

St. Louis, MO

Note: Pair will likely have breeding recommendation again in next plan in two years.

ID	Local ID	Sex	Age	House Name	Disposition	Location	Breeding	With	Notes
923	106094	M	16	Ajabu	HOLD	ST LOUIS	DO NOT BREED		
925	106135	F	16	Kati Rain	HOLD	ST LOUIS	DO NOT BREED		
966	121079	M	4	Moyo	SEND TO	BIRMINGHM	BREED WITH	968	Mis-matched pairing, female valuable, male over-represented breed for demographics

Appendix A
Pedigree Assumptions

No pedigree assumptions required as this population's pedigree is 100% known.

Appendix B
Summary of Data Exports

PMx Project: EBR 2 Aug 2021
Created: 2021-08-02 by PMx version 1.6.0.20190628
File: C:\PMxProjects\EBR 2 Aug 2021.pmxproj

Primary data file
Data File Name: zims.zims
Common Name: Black rhinoceros
Scientific Name: Diceros bicornis
Data Source: ZIMS for Studbooks
Studbook Name: Rhinoceros, Black (Diceros bicornis)
Exported On: 2021-08-02
Software version: ZIMS for Studbooks 3.0
Current Through: 2021-03-15
Compiled By: Gina M. Ferrie
Scope: AZA
Dates: 1960-01-01 to 2021-08-02
Location:
Association: AZA / Association of Zoos & Aquariums (AZA)
Other Filters: Status = Living
User: Gina M. Ferrie

Moves data file
Data File Name: demographic.csv
Common Name: Black rhinoceros
Scientific Name: Diceros bicornis
Data Source: ZIMS for Studbooks
Studbook Name: Rhinoceros, Black (Diceros bicornis)
Exported On: 2021-08-02
Software version: ZIMS for Studbooks 3.0
Current Through: 2021-03-15
Compiled By: Gina M. Ferrie
Scope: AZA
Dates: 1960-01-01 to 2021-08-02
Location:
Association: AZA / Association of Zoos & Aquariums (AZA)
Other Filters: Status = None
User: Gina M. Ferrie

Demographic input files
Census1 file: Exchcens.txt

Selected population was changed from the originally imported data.

Appendix C
Animals Excluded from the Genetic Analysis

Total exclusions: 3 (2.1)

SB#	Location	Sex	Age	Reason for Exclusion
459	KANSASCTY	M	29	Potential carrier of vitiligo
490	DENVER	M	27	Carrier of vitiligo
913	KANSASCTY	F	17	Has vitiligo

Appendix D
Life Tables

Males

Age (years)	Px	Mid Px	Qx	Risk Qx	Lx	Mx	Risk Mx	Ex	Vx
0	0.739	0.839	0.261	83.940	1.000	0.000	83.940	17.413	1.150
1	0.974	0.960	0.026	76.058	0.739	0.000	76.058	19.566	1.352
2	0.946	0.972	0.054	72.814	0.720	0.000	72.814	19.334	1.389
3	1.000	1.000	0.000	78.055	0.681	0.000	78.055	18.855	1.408
4	1.000	0.977	0.000	84.148	0.681	0.000	84.148	17.855	1.389
5	0.953	0.953	0.047	83.148	0.681	0.006	83.148	17.258	1.403
6	0.953	0.965	0.047	84.258	0.649	0.065	84.258	17.055	1.445
7	0.977	0.957	0.023	83.814	0.619	0.071	83.814	16.641	1.410
8	0.938	0.955	0.062	76.674	0.605	0.118	76.674	16.336	1.379
9	0.974	0.974	0.026	76.005	0.567	0.125	76.005	16.053	1.302
10	0.974	0.967	0.026	74.896	0.552	0.087	74.896	15.454	1.192
11	0.959	0.972	0.041	71.827	0.538	0.098	71.827	14.954	1.127
12	0.986	0.971	0.014	69.312	0.516	0.094	69.312	14.356	1.045
13	0.956	0.955	0.044	65.652	0.508	0.077	65.652	13.754	0.966
14	0.953	0.952	0.047	63.214	0.486	0.095	63.214	13.361	0.919
15	0.951	0.950	0.049	58.893	0.463	0.059	58.893	12.984	0.854
16	0.948	0.955	0.052	56.099	0.441	0.071	56.099	12.620	0.825
17	0.962	0.951	0.038	52.479	0.418	0.105	52.479	12.169	0.778
18	0.939	0.969	0.061	48.312	0.402	0.072	48.312	11.747	0.698
19	1.000	0.989	0.000	46.000	0.377	0.065	46.000	11.095	0.637
20	0.978	0.955	0.022	44.970	0.377	0.033	44.970	10.206	0.570
21	0.931	0.952	0.069	42.238	0.369	0.084	42.238	9.640	0.555
22	0.975	0.936	0.025	39.953	0.344	0.025	39.953	9.072	0.487
23	0.897	0.874	0.103	35.775	0.335	0.056	35.775	8.621	0.487
24	0.849	0.901	0.151	31.778	0.301	0.047	31.778	8.717	0.486
25	0.962	0.899	0.038	25.611	0.255	0.059	25.611	8.566	0.481
26	0.833	0.866	0.167	24.055	0.245	0.044	24.055	8.419	0.463
27	0.905	0.922	0.095	19.584	0.205	0.103	19.584	8.569	0.478
28	0.941	0.970	0.059	17.359	0.185	0.000	17.359	8.209	0.401
29	1.000	0.900	0.000	15.805	0.174	0.094	15.805	7.435	0.408
30	0.800	0.889	0.200	13.359	0.174	0.000	13.359	7.149	0.344
31	1.000	0.909	0.000	11.458	0.139	0.045	11.458	6.918	0.382
32	0.818	0.850	0.182	9.200	0.139	0.056	9.200	6.510	0.365
33	0.889	0.824	0.111	8.337	0.114	0.118	8.337	6.482	0.359
34	0.750	0.857	0.250	6.671	0.101	0.071	6.671	6.657	0.289
35	1.000	0.800	0.000	5.000	0.076	0.000	5.000	6.600	0.250
36	0.600	0.656	0.400	3.893	0.076	0.225	3.893	7.000	0.308
37	0.750	0.857	0.250	3.877	0.046	0.125	3.877	9.143	0.125
38	1.000	1.000	0.000	3.000	0.034	0.000	3.000	9.500	0.000
39	1.000	1.000	0.000	3.000	0.034	0.000	3.000	8.500	0.000
40	1.000	1.000	0.000	3.000	0.034	0.000	3.000	7.500	0.000
41	1.000	1.000	0.000	3.000	0.034	0.000	3.000	6.500	0.000
42	1.000	0.833	0.000	3.000	0.034	0.000	3.000	5.500	0.000
43	0.667	0.800	0.333	2.959	0.034	0.000	2.959	5.400	0.000
44	1.000	1.000	0.000	2.000	0.023	0.000	2.000	5.500	0.000
45	1.000	1.000	0.000	2.000	0.023	0.000	2.000	4.500	0.000
46	1.000	1.000	0.000	2.000	0.023	0.000	2.000	3.500	0.000

Males

Age (years)	Px	Mid Px	Qx	Risk Qx	Lx	Mx	Risk Mx	Ex	Vx
47	1.000	1.000	0.000	2.000	0.023	0.000	2.000	2.500	0.000
48	1.000	0.500	0.000	2.000	0.023	0.000	2.000	1.500	0.000
49	0.000	0.000	1.000	1.964	0.023	0.000	1.964	1.000	0.000
50	0.000	0.000	1.000	0.000	0.000	0.000	0.000	0.000	0.000

Px = survival; Qx = mortality; Lx = cumulative survivorship; Mx = fecundity; Ex = life expectancy; Vx = expected future reproduction, At Risk (Qx and Mx) = number of animals corresponding values are estimated from.

r = -0.014
lambda = 0.984
T = 16.1
N = 30
N(at 20 yrs) = 17

Females

Age (years)	Px	Mid Px	Qx	Risk Qx	Lx	Mx	Risk Mx	Ex	Vx
0	0.733	0.819	0.267	65.808	1.000	0.000	65.808	15.964	1.154
1	0.936	0.911	0.064	59.995	0.733	0.000	59.995	18.278	1.383
2	0.884	0.923	0.116	57.041	0.686	0.000	57.041	18.970	1.489
3	0.967	0.969	0.033	58.707	0.606	0.000	58.707	19.466	1.582
4	0.972	0.972	0.028	69.786	0.587	0.000	69.786	19.047	1.601
5	0.973	0.986	0.027	72.619	0.570	0.034	72.619	18.561	1.615
6	1.000	0.987	0.000	75.123	0.554	0.105	75.123	17.807	1.572
7	0.974	0.981	0.026	76.786	0.554	0.091	76.786	17.027	1.458
8	0.987	0.967	0.013	76.027	0.540	0.086	76.027	16.345	1.367
9	0.947	0.960	0.053	74.058	0.533	0.088	74.058	15.866	1.299
10	0.973	0.979	0.027	73.167	0.505	0.110	73.167	15.493	1.238
11	0.986	0.964	0.014	68.668	0.491	0.080	68.668	14.803	1.130
12	0.942	0.955	0.058	65.803	0.484	0.092	65.803	14.319	1.068
13	0.969	0.953	0.031	64.458	0.456	0.109	64.458	13.944	1.003
14	0.935	0.950	0.065	60.627	0.442	0.091	60.627	13.588	0.920
15	0.965	0.955	0.035	56.490	0.413	0.053	56.490	13.252	0.856
16	0.944	0.952	0.056	52.329	0.399	0.114	52.329	12.832	0.825
17	0.960	0.969	0.040	48.551	0.377	0.020	48.551	12.433	0.733
18	0.978	0.967	0.022	45.521	0.362	0.143	45.521	11.802	0.721
19	0.956	0.943	0.044	43.310	0.354	0.046	43.310	11.170	0.586
20	0.930	0.964	0.070	40.688	0.338	0.075	40.688	10.786	0.562
21	1.000	0.961	0.000	38.518	0.314	0.052	38.518	10.157	0.495
22	0.921	0.933	0.079	35.759	0.314	0.071	35.759	9.533	0.453
23	0.946	0.928	0.054	35.252	0.289	0.042	35.252	9.146	0.402
24	0.909	0.921	0.091	31.482	0.274	0.095	31.482	8.778	0.381
25	0.933	0.948	0.067	28.515	0.249	0.018	28.515	8.448	0.304
26	0.963	0.962	0.037	26.951	0.232	0.056	26.951	7.860	0.296
27	0.960	0.882	0.040	25.436	0.224	0.058	25.436	7.134	0.245
28	0.800	0.889	0.200	22.863	0.215	0.025	22.863	6.958	0.207
29	1.000	0.925	0.000	20.000	0.172	0.025	20.000	6.703	0.201
30	0.850	0.838	0.150	19.104	0.172	0.054	19.104	6.165	0.187
31	0.824	0.764	0.176	15.164	0.146	0.036	15.164	6.165	0.155
32	0.692	0.818	0.308	11.932	0.120	0.000	11.932	6.758	0.153
33	1.000	1.000	0.000	9.000	0.083	0.000	9.000	7.037	0.184
34	1.000	0.889	0.000	9.000	0.083	0.056	9.000	6.037	0.180
35	0.778	0.875	0.222	7.175	0.083	0.000	7.175	5.667	0.137
36	1.000	0.833	0.000	6.000	0.065	0.083	6.000	5.333	0.154

Females

Age (years)	Px	Mid Px	Qx	Risk Qx	Lx	Mx	Risk Mx	Ex	Vx
37	0.667	0.700	0.333	4.847	0.065	0.083	4.847	5.200	0.083
38	0.750	0.714	0.250	3.195	0.043	0.000	3.195	6.000	0.000
39	0.667	0.800	0.333	2.652	0.032	0.000	2.652	7.000	0.000
40	1.000	1.000	0.000	2.000	0.022	0.000	2.000	7.500	0.000
41	1.000	1.000	0.000	2.000	0.022	0.000	2.000	6.500	0.000
42	1.000	1.000	0.000	2.000	0.022	0.000	2.000	5.500	0.000
43	1.000	1.000	0.000	2.000	0.022	0.000	2.000	4.500	0.000
44	1.000	1.000	0.000	2.000	0.022	0.000	2.000	3.500	0.000
45	1.000	0.750	0.000	2.000	0.022	0.000	2.000	2.500	0.000
46	0.500	0.667	0.500	1.370	0.022	0.000	1.370	2.000	0.000
47	1.000	0.500	0.000	1.000	0.011	0.000	1.000	1.500	0.000
48	0.000	0.000	1.000	0.247	0.011	0.000	0.247	1.000	0.000
49	0.000	0.000	1.000	0.000	0.000	0.000	0.000	0.000	0.000

Px = survival; Qx = mortality; Lx = cumulative survivorship; Mx = fecundity; Ex = life expectancy; Vx = expected future reproduction, At Risk (Qx and Mx) = number of animals corresponding values are estimated from.

r = -0.019
lambda = 0.981
T = 15.7
N = 25
N(at 20 yrs) = 17

Appendix E

Ordered Mean Kinship

Note: This list is current to August 2021. Values are subject to change with any birth, death, import, export, inclusion, or exclusion.

Average Population MK = 0.0450

Males

SB#	MK	%Known	Age	Location
372	0.025	100%	34	HONOLULU
542	0.031	100%	26	LITTLEROC
475	0.033	100%	28	BUSCH TAM
664	0.035	100%	24	CHICAGOLP
786	0.037	100%	20	CLEVELAND
627	0.038	100%	0	SEDGWICK
745	0.039	100%	21	METROZOO
907	0.039	100%	17	RACINE
922	0.043	100%	16	CINCINNAT
427	0.044	100%	31	CHICAGOBR
949	0.045	100%	13	SAN FRAN
899	0.046	100%	18	COLO SPRG
957	0.048	100%	9	PUEBLA
946	0.048	100%	13	LANSING
626	0.050	100%	0	METROZOO
624	0.050	100%	0	CINCINNAT
923	0.050	100%	16	ST LOUIS
967	0.050	100%	4	SD-WAP
989	0.051	100%	1	LANSING
961	0.051	100%	7	CHICAGOBR
972	0.051	100%	2	CHICAGOLP
959	0.053	100%	10	KANSASCTY
966	0.053	100%	4	ST LOUIS
636	0.053	100%	24	SIOUX FAL
964	0.054	100%	4	SIOUX FAL
625	0.055	100%	0	GARDENCTY
962	0.055	100%	7	GARDENCTY
955	0.059	100%	10	DES MOINE

Females

SB#	MK	%Known	Age	Location
951	0.024	100%	10	CHICAGOBR
359	0.027	100%	35	CALDWELL
683	0.029	100%	27	CLEVELAND
560	0.030	100%	26	HONOLULU
859	0.034	100%	20	RACINE
418	0.035	100%	32	BUSCH TAM
970	0.038	100%	2	CLEVELAND
904	0.040	100%	18	CLEVELAND
711	0.040	100%	23	SEDGWICK
958	0.041	100%	8	MILWAUKEE
948	0.042	100%	14	KANSASCTY
947	0.043	100%	14	LANSING
969	0.043	100%	3	BUFFALO
952	0.045	100%	10	GARDENCTY
677	0.045	100%	23	SIOUX FAL
925	0.046	100%	16	ST LOUIS
950	0.048	100%	11	CINCINNAT
960	0.050	100%	7	SD-WAP
761	0.050	100%	21	METROZOO
944	0.053	100%	15	LITTLEROC
954	0.054	100%	10	DES MOINE
935	0.059	100%	16	CHICAGOLP
965	0.061	100%	4	DES MOINE
971	0.061	100%	2	DES MOINE

Appendix F
Descriptive Survival Statistics Report

Black rhinoceros Studbook
Diceros bicornis
Studbook

Studbook data current as of 3/15/2021 12:00:00 AM

Compiled by

PopLink Studbook filename: EBR_4Aug21
PopLink User Who Exported Report: Gina Ferrie
Date of Export: 8/4/2021 12:00:00 AM
Data Filtered by: Association = AZA.FED AND StartDate = 1/1/1960 AND EndDate = 8/4/2021
PopLink Version: 2.5.2

REPORT OVERVIEW:

Based on this analysis, if a Black rhinoceros survives to its first birthday, its median life expectancy is 18.8 years. Please see the body of the report for more details.

BACKGROUND ON ANALYSES:

These analyses were conducted using animals that lived during the period 1 January 1960 to 4 August 2021 at institutions within AZA. The analyses mainly focus on survival statistics from 1 year (e.g. excluding any individuals that did not survive past their first birthday). These statistics most accurately reflect typical survival for animals which can be seen on exhibit in zoos and aquariums.

This report summarizes survival records of individuals housed at zoological facilities for a specific geographic range and time period; these records trace an individual's history from birth or entry into the population to death, exit out of the population, or the end of the time period. As such, this history only reflects standard practices - including management, husbandry, and acquisition/disposition practices - for the specified time period and geographic range. Thus, the report contents should be viewed with some caution as they may not fully reflect current and newly emerging zoo and aquarium management techniques or practices. For example, if the population has not been maintained in zoos and aquariums long enough to have many adults living into old age, median life expectancy will likely be an underestimate until more data accrue in older age classes. Thus, users of these reports should recognize that the results produced will likely vary over time or depending on the subset of data selected.

Although for many species, including humans, survival statistics often differ for males and females, for these analyses male and female statistics were not statistically different[1]; these results therefore include pooled data from males, females, and unknown sex individuals.

SUMMARY OF ANALYSES:

SURVIVAL STATISTICS

The dataset used for analysis includes partial or full lifespans of 239 individuals, 167 (69.9%) of which had died by 4 August 2021.

If a Black rhinoceros survives to its first birthday, its **median life expectancy**[2] is **18.8 years of age**. Given the quality of the data - how many animals are in the database and how many have died - there is a 95% chance that the true median falls between 16.2 and 22.6 years of age (i.e., these are the 95% confidence limits). Only 25% of Black rhinoceros can be expected to survive to be 28.7 years or older.

First-year (infant) survival[3] for Black rhinoceros is 73%. The year after birth/hatching is a period of relatively low survival for many species and life histories.

The **maximum longevity**[4] observed for Black rhinoceros is **50.0 years**; this longevity record is based on an individual which was DEAD as of the analysis end date (studbook number 68, sex = Male, origin = Wild Born, birth date estimate = Other).[5]

The correct interpretation of these statistics is that, if it survives the first year of life, the 'typical' Black rhinoceros will live 18.8 years; that half of all Black rhinoceros can be expected to die before they reach 18.8 and half will live longer than 18.8; that only 25% of all Black rhinoceros can be expected to live 28.7 years; and that it is rare but possible for Black rhinoceros to live 50.0 years.

The median life expectancy, confidence interval, first-year survival, and maximum longevity may change as more data are accumulated, the population's age structure changes, or management practices improve.

While both median life expectancy and maximum longevity are discussed in this report, it is more appropriate to rely on median life expectancy to place the age of any one individual in context. To put these statistics in perspective, median life expectancy from age one for people in the United States is 77.5 years and the maximum longevity (documented worldwide) is 122 years[6]. Therefore, if a person lived to be 85 years old, the appropriate context is that they lived well beyond the median life expectancy (77.5), not that they fell short of the maximum longevity (122).

DATA QUALITY

The PopLink Survival Tool uses five data quality measures to determine whether data are robust enough to make reliable estimates of key survival parameters. **This population passed all of the following data quality tests:**

1. Can the median life expectancy be calculated? **PASS**
2. Is the sample size (number of individuals at risk) greater than 20 individuals at the median? **PASS**
3. Is the 95% Confidence Interval (CI) bounded? **PASS**
4. Is the sample size in the first age class of analysis (e.g. the first day of analysis) greater than 30 individuals? **PASS**
5. Is the length of the 95% CI < 33% of the maximum longevity? **PASS**

PopLink data validation was last run on 8/4/2021. This validation found 443 errors, including 3 high priority errors, 15 medium priority errors, and 425 low priority errors. These errors may or may not directly affect the data in this analysis.

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[1] Statistical significance was determined by comparing 84% confidence intervals around median life expectancy for males and females, with 0 unknown sex individuals proportionally incorporated into the analysis. For this population, overlapping confidence intervals indicated that data could be pooled. See the PopLink manual for more details.

[2] The statistics analyzed for this report (median life expectancy, 95% confidence limits, and age to which 25% of individuals survive) exclude any individuals who did not survive to their first birthday; these individuals are excluded because this Report is focused on providing median survival estimates for the typical individual that survives the vulnerable infant stage. In other words, this report answers the question, 'how long is this species expected to live once it has reached its first birthday?' For this studbook, 53 individuals died before their first birthday and were excluded from these analyses.

For all animals that survive to their first birthday, 50% will die before the median life expectancy in this report and 50% die after. Note that the median life expectancy obtained from population management software (PM2000, PMx, ZooRisk) or from life tables in Breeding and Transfer Plans (e.g. where Lx = 0.5) will be lower because it includes these individuals that did not survive to their first birthday in order to project the correct number of births needed. See the PopLink manual for more details.

[3]For reference, first-year survival is provided. For this studbook and the selected demographic window, 53 individuals did not survive to their first birthday and were excluded from the estimates provided above (median life expectancy, 95% confidence limits, and age to which 25% of individuals survive).

[4] Maximum longevity is the age of the oldest known individual for this species, living or dead. It is not necessarily the biological maximum age, but only reflects the individuals included in the dataset.

[5] Censored individuals are individuals whose deaths have not been observed as of the end of the analysis window, including individuals who 1) are still alive as of the end date, 2) exited the geographic window before the end date (through transfer or release), or 3) were lost-to-follow up before the end date.

[6] Median life expectancy for people is estimated from: Xu, Jiaquan, Kochanek KD, Murphy SL, and Tejada-Vera B. 2007. Deaths: Final Data for 2007. National vital statistics reports; vol 58 no 19. Hyattsville, MD: National Center for Health Statistics. Jeanne Calment of France was the oldest documented and fully validated human and died at 122 years and 164 days; from: http://www.grg.org/Adams/Tables.htm. Accessed August 9, 2007.

Appendix G
Population Viability Analysis Summary Report

Eastern Black Rhinoceros (*Diceros bicornis michaeli*)

September 2014

Photo courtesy of Graham Jones / The Columbus Zoo

Population Biologists: Lauren Mechak, lmechak@lpzoo.org
Nicole Clausen
AZA Studbook Keeper: Gina Ferrie, gina.m.ferrie@disney.com
SSP Coordinator: Harry Peachey, harry.peachey@columbuszoo.org
AZA Rhinoceros TAG Chair: Stephen Shurter, sshurter@wogilman.com
AZA Rhinoceros TAG Vice-Chair: Randy Rieches, rrieches@sandiegozoo.org

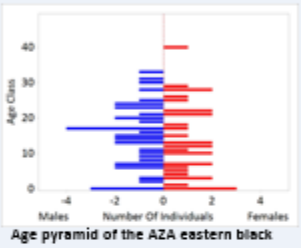
Population Viability Analyses (PVAs) for AZA Animal Programs

Projected zoo & aquarium population status in 100 years

	Low Risk	Vulnerable	Endangered	Critical
WITHOUT potential changes:		✓		
WITH potential changes:	✓			

Current Population

- 68 rhinos (37 males, 31 females) are housed at 25 AZA institutions
- The population has increased at 0.2% annual growth over the last decade, with an average of 2.9 births/year, 0.4 imports, and 0.4 exports per year
- 96% of the founding gene diversity (GD) has been retained
- The population's average inbreeding value (F) is 0.0013
- IUCN status: Critically Endangered



Age pyramid of the AZA eastern black rhinoceros population

Program Challenges

- Reproduction has been low in recent decades

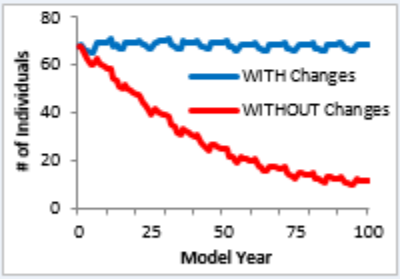
Model Results

Projected Status WITHOUT Potential Changes

- If the population continues breeding, importing, and exporting at current rates, it has a 0.2% chance of extinction in the next 100 years but is projected to be very small (11 ± 5 individuals) if it persists over that same time
- Status: **Vulnerable** in zoos in the 100 years due to its reduced gene diversity (GD: 81% ± 12%)
- For additional details, see page 7 in the main report

Projected Status WITH Potential Changes

- The population could maintain its current size if the breeding rate is increased to 4.6 births/year
- High gene diversity (95% ± 1%) and low inbreeding (F: 0.0389 ± 0.0127) would remain in 100 years
- Status: **Low Risk** in zoos in 100 years
- For additional details, see pages 8-9 (scenario C) in the main report



Projected size of the AZA eastern black rhino population

Essential Management Actions

- Increase breeding to produce at least 4.6 births/year to maintain the current population size
- Increase holding capacity to grow the population beyond its current size

How Institutions Can Help

- Pursue breeding recommendations given to your institution
- Report breeding challenges and successes to the Program Leader

EXECUTIVE SUMMARY

Population Viability Analyses (PVA) are being conducted by Lincoln Park Zoo and Population Management Center researchers through funding from the Institute of Museum and Library Services (IMLS). The project team uses ZooRisk 3.80 (Earnhardt et al. 2008), a PVA modeling software, to examine what would happen to AZA populations if current conditions remain the same (the baseline scenario), and then assess the impact of changes in reproductive rates, space availability, imports/exports, and other potential management actions (alternate scenarios). Model scenarios for this population were developed with members of the Association of Zoos and Aquarium (AZA) Rhinoceros Taxon Advisory Group (TAG) during spring of 2014.

POPULATION HISTORY/CURRENT STATUS

Eastern black rhinos (*Diceros bicornis michaeli*) have been consistently held in AZA institutions since 1930. The population grew initially through the importation of wild-born individuals until the 1960s when AZA institutions began to regularly breed eastern black rhinos. An importation of 11 individuals in 1973 followed by consistent breeding allowed the population to grow to a peak size of 71 individuals by 1977. By 1980 the population had fallen to 53 due to individuals being exported from the AZA population to international institutions, but has since grown to its current size of 68 individuals. Over the last decade the population has been stable with almost no growth, and has had an average of 2.9 births, 0.4 imports, and 0.4 exports each year. Recent imports and exports are exchanges between AZA institutions and private holders in North America. The population currently has high gene diversity (96.4%) and low inbreeding (average inbreeding coefficient of 0.0013).

PVA RESULTS

Model results indicate that the eastern black rhinoceros population will decline if current breeding rates are not improved (with or without imports and exports, average 2.9 births/year over the past 10 years). However, **increasing breeding is predicted to allow the AZA eastern black rhinoceros population to remain stable in the next 100 years**. If the population could produce 4.6 births per year, it could maintain its size (~68 individuals) over the next 100 years. Increased breeding would also allow the population to maintain gene diversity over 90%. If more space becomes available, the population is projected to grow to ~93 individuals in the next century with 4.7 births/year in the first 10 years and 5.6 births/year for the remainder of the projection.

MANAGEMENT ACTIONS

The AZA Eastern Black Rhinoceros Animal Program should consider the following changes to management:

- **Increase breeding:** In order for the population to sustain itself (with or without current rates of importation and exportation) the Animal Program will need to increase breeding rates from ~3 births/year to ~5 births/year. Under this management strategy, the population is predicted to remain demographically stable and maintain high gene diversity (90% to 95%) over the next century.

- **Increase Space:** In order for the population to grow (with current rates of importation and exportation) the Animal Program needs to acquire more space and increase breeding rates to ~5 births/year in the first 10 years and to ~6 births/year in the remaining 90 years of the projection. If this management strategy could be achieved, the population is predicted to grow to 93 individuals and maintain high gene diversity (96%) over the next century.

Appendix H
Definitions

Management Terms (as of January 2019)

Green Species Survival Plan® (Green SSP) Program – A Green SSP Program has a population size of 50 or more animals and is projected to retain 90% gene diversity for a minimum of 100 years or 10 generations. Green SSP Programs are subject to AZA's Full Participation and Sustainability Partner Policies.

Yellow Species Survival Plan® (Yellow SSP) Program – A Yellow SSP Program has a population size of 50 or more animals but cannot retain 90% gene diversity for 100 years or 10 generations. Yellow SSP participation by AZA facilities is voluntary. Yellow SSP Programs are subject to AZA's Sustainability Partner Policy.

Red Species Survival Plan® (Red SSP) Program – A Red SSP Program has a population size of twenty or more animals managed among three or more participating AZA facilities. If a population does not meet these minimum criteria, but has an IUCN designation of Critically Endangered, Endangered, or Extinct in the Wild, and the TAG has developed three goals to sustain this population, then the population will be considered a Red SSP Program. Red SSPs cannot retain 90% gene diversity for 100 years or 10 generations and participation by AZA facilities is voluntary. Red SSP Programs are subject to AZA's Sustainability Partner Policy.

Sustainability Partners – AZA Wildlife Conservation and Management Committee (WCMC) approved wildlife facilities that regularly exchange animals with AZA-accredited facilities and certified related facilities, typically as part of the Species Survival Plan® (SSP) Program Breeding and Transfer Plan or other SSP Program management process.

Full Participation – AZA policy stating that all AZA accredited facilities and certified related facilities having a Green SSP animal in their collection are required to participate in the collaborative SSP planning process (e.g., provide relevant animal data to the AZA Studbook Keeper, assign an Institutional Representative who will communicate facility wants and needs to the SSP Coordinator and comment on the draft plan during the 30-day review period, and abide by the recommendations agreed upon in the final plan).

All AZA member facilities and Animal Programs, regardless of management designation, must adhere to the AZA Policy on Responsible Population Management and the AZA Code of Professional Ethics. For more information on AZA policies, see https://www.aza.org/board-approved-policies-and-position-statements.

Demographic Terms

Age Distribution – A visual representation of the numbers or percentages of individuals in various age and sex classes.

Ex, Life Expectancy – The average years of further life for an animal in age class x.

Lambda (λ) or Population Growth Rate – The proportional change in population size from one year to the next. Lambda can be based on life-table calculations (the projected lambda) or from observed changes in population size from year to year. A lambda of 1.11 means an 11% per year increase; a lambda of 0.97 means a 3% decline in size per year. The three lambdas highlighted in this BTP are: 1) Life Table, from the PMx life tables, based on the demographic regional and date window exported from the studbook; 2) 5-year, from the studbook census; and 3) Projected, from the PMx stochastic 20 year projections.

lx, Age-Specific Survivorship – The probability that a new individual (e.g., age 0) is alive at the *beginning* of age *x*. Alternatively, the proportion of individuals which survive from birth to the beginning of a specific age class.

Mean Generation Time (T) – The average time elapsing from reproduction in one generation to the time the next generation reproduces. Also, the average age at which a female (or male) produces offspring. It is not the age of first reproduction. Males and females often have different generation times.

Median Life Expectancy (MLE) – The 'typical' age at which an average animal is expected to live, excluding those that were born and died on the same day. This is the age at which Lx = 0.5, meaning that 50% are expected to die before that age and 50% after that age. A Survival Statistics Library is maintained for most AZA Animal Programs on the AZA website: https://www.aza.org/species-survival-statistics

Maximum Longevity – The maximum age at which we have observed a species to live. If the oldest observed animal is currently living, we do not yet know the maximum longevity.

Mx, Fecundity – The average number of same-sexed offspring born to animals in that age class. Because studbooks typically have relatively small sample sizes, studbook software calculates Mx as 1/2 the average number of offspring born to animals in that age class. This provides a somewhat less "noisy" estimate of Mx, though it does not allow for unusual sex ratios. The fecundity rates provide information on the age of first, last, and maximum reproduction.

Px, Age-Specific Survival – The probability that an individual of age *x* survives an age class; is conditional on an individual being alive at the beginning of the age class. Alternatively, the proportion of individuals that survive from the beginning of one age class to the next.

Qx, Mortality – The probability that an individual of age *x* dies during an age class (Qx = 1-Px). Alternatively, the proportion of individuals that die during an age class. It is calculated from the number of animals that die during an age class divided by the number of animals that were alive at the beginning of the age class (i.e., "at risk").

Risk (Qx or Mx) – The number of individuals that have lived during an age class. The number "at risk" is used to calculate Mx and Qx by dividing the number of births and deaths that occurred during an age class by the number of animals at risk of dying and reproducing during that age class.

Target Population Size (TPS) – The desired number of SSP animals to be held across AZA and approved partner facilities over a specific, stated timeframe. This number is determined with consideration for program roles and goals (genetic, demographic, and others), logistical constraints, spatial competition with other TAG-managed species, and other population-specific concerns. Target Population Size is determined by the Taxon Advisory Group (TAG) and published in their Regional Collection Plan (RCP).

Vx, **Reproductive Value –** The expected number of offspring produced this year and in future years by an animal of age *x*.

Genetic Terms

Allele – Alternate forms of DNA at a particular position in a genome (genetic locus). Alleles represent the most basic form of genetic diversity.

Gene Diversity (GD) – The probability that two alleles randomly sampled from the same genetic locus across a population are not identical by descent. Gene diversity is calculated relative to a population's founders, which are assumed to be unrelated and not inbred, and is the proportional diversity retained by the current, descendant population.

Effective Population Size (Inbreeding N_e) – The size of a randomly mating population of constant size with equal sex ratio and a Poisson distribution of family sizes that would (a) result in the same mean rate of inbreeding as that observed in the population, or (b) would result in the same rate of random change in allele frequencies (genetic drift) as observed in the population. These two definitions are identical only if the population is demographically stable (because the rate of inbreeding depends on the distribution of alleles in the parental generation, whereas the rate of allele frequency drift is measured in the current generation).

Founder – An individual obtained from a source population (often the wild) that has no known relationship to any individuals in the derived population (except for its own descendants).

Founder Genome Equivalents (FGE) – The number of wild-caught individuals (founders) that represent the same amount of gene diversity as does the population under study. The gene diversity of a population is 1 - 1 / (2 * FGE).

Founder Representation – The proportion of the alleles in the living, descendant population that are derived from that founder.

Inbreeding Coefficient (F) – The probability that the two alleles present at an individual's genetic locus are identical by descent (i.e., both alleles originated from an ancestor common to both the individual's parents).

Mean Kinship (MK) – The mean (or average) kinship coefficient between an animal and all animals (including itself) in the living, captive-born population. An individual's mean kinship is a measure of how well its alleles are represented within a population. Animals with low mean kinships have few relatives, are from under-represented founder lineages, and have transmitted few of their alleles to the next generation; these individual should be prioritized for breeding to slow a population's gene diversity loss.

Percent Known – The percentage of an animal's genome that is traceable to known founders. Thus, if an animal has an UNK sire, its % Known = 50. If it has an UNK grandparent, its % Known = 75.

Percent Certain – The percentage of the living individuals' pedigree that can be completely identified as *certain:* (exact identity of both parents is known) and traceable back to known founders. Individuals that are 100% *certain* do not have any MULTs or UNKs in their pedigree. *Certainty* represents a higher degree of knowledge than *Known* and therefore is always less than or equal to *Known*.

Appendix I
Directory of Institutional Representatives

Facility Mnemonic	Facility	Institutional Representative	IR Email
ABILENE	Abilene Zoological Gardens	Denise Ibarra	denise.ibarra@abilenetx.gov
PUEBLA	Africam Safari Park	Frank Camacho	fcamacho@africamsafari.com
AKRON	Akron Zoological Park	Shane Good	S.Good@akronzoo.org
BIRMINGHM	Birmingham Zoo	Amy Toman	atoman@birminghamzoo.com
DES MOINE	Blank Park Zoo	Kayla Freeman	krfreeman@blankparkzoo.net
BUFFALO	Buffalo Zoo	Lisa Smith	lsmith@buffalozoo.org
BUSCH TAM	Busch Gardens Tampa Bay	Jason Green	Jason.Green@BuschGardens.com
CALDWELL	Caldwell Zoo	Scotty Stainback	sstainback@caldwellzoo.org
COLO SPRG	Cheyenne Mountain Zoo	Jason Bredahl	jbredahl@cmzoo.org
CHICAGOBR	Chicago Zoological Society - Brookfield Zoo	Dana Vinci	dana.vinci@czs.org
CINCINNAT	Cincinnati Zoo & Botanical Garden	Randal Pairan	randal.pairan@cincinnatizoo.org
CLEVELAND	Cleveland Metroparks Zoo	Travis Vineyard	tgv@clevelandmetroparks.com
COLUMBUS	Columbus Zoo and Aquarium	Adam Felts	Adam.Felts@columbuszoo.org
DENVER	Denver Zoo	Dale Leeds	dleeds@denverzoo.org
DISNEY AK	Disney's Animal Kingdom	Ike Leonard	ike.a.leonard@disney.com
FOSSILRIM	Fossil Rim Wildlife Center	Adam Eyres	adame@fossilrim.org
SIOUX FAL	Great Plains Zoo & Delbridge Museum of Natural History	Mollye Nardi	mnardi@gpzoo.org
HONOLULU	Honolulu Zoo	Tyris A. K. Perreira	tperreira@honolulu.gov
KANSASCTY	Kansas City Zoo	Joni Hartman	JoniHartman@fotzkc.org
GARDENCTY	Lee Richardson Zoo	Joe Knobbe	joe.knobbe@gardencityks.us
CHICAGOLP	Lincoln Park Zoo	Michael Murray	mmurray@lpzoo.org
LITTLEROC	Little Rock Zoo	Carrie Day	cdday@littlerock.gov
PALM DES	The Living Desert Zoo and Gardens	RoxAnna Breitigan	rbreitigan@livingdesert.org
METROZOO	Zoo Miami	Joseph Svoke	joseph.svoke@miamidade.gov
MILWAUKEE	Milwaukee County Zoological Gardens	Tim Wild	timothy.wild@milwaukeecountywi.gov
PORTLAND	Oregon Zoo	Amy Cutting	amy.cutting@oregonzoo.org
LEON	Patronato del Parque Zoologico de Leon	Pavlova Sheffield	curador@zooleon.org.mx
LANSING	Potter Park Zoological Gardens	Patrick Fountain	pfountain@ingham.org
RACINE	Racine Zoological Gardens	Aszya Summers	asummers@racinezoo.org
SACRAMNTO	Sacramento Zoo	Matthew McKim	MMcKim@saczoo.org
ST LOUIS	Saint Louis Zoo	Katie Pilgram-Kloppe	pilgram@stlzoo.org
SD-WAP	San Diego Zoo Safari Park	Steve Metzler	smetzler@sdzwa.org
SAN FRAN	San Francisco Zoological Gardens	Ron Whitfield	RonW@sfzoo.org
SEDGWICK	Sedgwick County Zoo	Michael Quick	Michael.Quick@scz.org
MANHATTAN	Sunset Zoological Park	Kirk Nemechek	nemechek@cityofmhk.com
TOLEDO	Toledo Zoo & Aquarium	Michael Frushour	Michael.Frushour@Toledozoo.org
B BRYAN	B Bryan Preserve	Judy Bryan Mello	bryanmello@yahoo.com