Population Analysis & Breeding and Transfer Plan

African White-backed Vulture (*Gyps africanus*)
AZA Species Survival Plan®
Red Program

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PMC Population Management Center

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DALLAS ZOO

Executive Summary

Species Survival Plan® for African White-backed Vulture (*Gyps africanus*)

The current, managed African White-backed Vulture SSP population includes 11 birds (6 males, 5 females, 0 unknown) held by 4 AZA institutions. The Raptor Taxon Advisory Group set a target size of 50 individuals for this population (RCP 2015). At present, the African White-backed Vulture SSP population qualifies as a Red Program because of its IUCN Red List status as Critically Endangered. This is a two-year breeding and transfer plan.

Genetic and demographic analyses of the North American Regional African White-backed Vulture Studbook (current to 26 January 2017) were performed using PopLink 2.4 and PMx 1.2, resulting in the current breeding and transfer plan for this species. The current gene diversity in the population is 84.38% of that present in the founding population. Gene diversity at 100 years from present is projected to be 33% if the population maintains its population size of 11 individuals. If the population can slowly grow (2% per year) to reach the RCP target size of 50 individuals, gene diversity is projected to be 56.2%. Increased reproduction, however, will be necessary to attain a 2% growth rate, as the population on average has experienced a population decline over the past 10 years. **Without an increase in reproduction this SSP population is projected to go extinct within 25 years.** A decrease in gene diversity below 90% of that in the founding population has been associated with reproduction increasingly compromised by, among other factors, lower hatch weights and greater neonatal mortality. At present, the best management strategy for the population is to increase reproduction, and breed the 5 potential founders.

Demography

Current SSP population size – Total (males.females.unknown)	11 (6.5.0)
Number of animals excluded from genetic analyses	0
Population size following exclusions	11 (6.5.0)
Target population size (2015 RCP)	50
Mean generation time (T; years)	17.5
Projected population growth rate (λ; lambda) from life tables	0.940
Recent population growth rate (average λ 2012-2016)	0.958

Genetics

	2017	Current Potential
Founders	6	5 additional
Founder genome equivalents (FGE)	3.20	9.00
Current gene diversity (GD %)	84.38	94.44
Population mean kinship (MK)	0.1563	-----
Mean inbreeding (F)	0.0000	-----
% pedigree known before assumptions and exclusions	100	-----
% pedigree known after assumptions and exclusions	100	-----
Effective population size/census size ratio (Ne / N)	na[1]	-----
Years To 90% Gene Diversity	na (already below 90%)	-----
Years To 10% Loss of GD	7*	-----
Gene Diversity at 100 Years From Present (%)	33.0 *	-----

[1] insufficient data to calculate Ne/N in PMx because only 1.1 living individuals have produced offspring.

*projections based on the breeding population maintaining its size of 11 individuals (λ = 1.000, Ne/N = 0.30)

Analyses suggest that 2 hatches are needed over the next two years (1 per year) to maintain the current population size, while 4 hatches are needed over the next two years (2 per year) if a growth rate of 2.0% can be maintained to grow toward the RCP target size of 50 birds. The breeding recommendations are intended to produce sufficient offspring to increase the population to the target size, fill new institutions if recruited, and replace individuals as needed. As with most managed AZA populations, breeding groups are prioritized to maintain or increase gene diversity through considerations of mean kinship, avoidance of inbreeding, differences in sire and dam mean kinships, and the degree of uncertainty within a pedigree.

Summary Actions: The Program recommends all 5 females to be placed in breeding situations and 3 transfers to create new breeding pairs and meet institutional needs.

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Cover Photo Courtesy of Kevin Graham, Dallas Zoo

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Planning occurred on January 25th, 2017 during an open meeting at the Dallas Zoo.

This plan was reviewed and distributed with the assistance of the Population Management Center.
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Description of Population Status

Species Survival Plan® for African White-backed Vulture (*Gyps africanus*)

Introduction: The current, managed African White-backed Vulture SSP population includes 11 birds (6 males, 5 females, 0 unknown) held by 4 AZA institutions. The Raptor Taxon Advisory Group set a target size of 50 individuals for this population (RCP 2015). At present, the African White-backed Vulture SSP population qualifies as a Red SSP because of its IUCN Red List status as Critically Endangered. This is a two-year breeding and transfer plan.

Genetic and demographic analyses of the North American Regional African White-backed Vulture Studbook (current to 26 January 2017) were performed using PopLink 2.4 and PMx 1.2, resulting in the current breeding and transfer plan for this species.

Conservation Status: IUCN Red List – Critically Endangered (www.iucnredlist.org); USFWS – not listed; CITES – Appendix II

Analytical Population: No analytic assumptions were necessary as the pedigree of the current, living population can be traced to documented founders. No birds were excluded from genetic analyses (Appendix D). A total of 11 birds (6 males, 5 females, 0 unknown) were included in the breeding population.

Demography: Based on the Studbook, African white-faced vultures were first recorded in North American zoos in the 1920's. However, they were not consistently held until the late 1960's, with the first North American captive hatch occurring in 1994 at Cleveland Metroparks Zoo. Since that time, the population size has remained under 40 individuals with very small numbers of zoo hatches replacing older wild caught individuals as they aged out of the population (Figures 1 and 2). Only 2 currently living birds have produced offspring (SB# 74 and 65), and both were wild-caught. No captive bred African white-backed vultures in North America have produce offspring. The average growth rate for the past 20 years has been -4.2% (λ = 0.958). Based on the current life tables (Appendix C) and age structure (Figure 3), the population has a negative projected growth rate of -15.2% per year (projected λ = 0.848). **Without an increase in reproduction this SSP population is projected to go extinct within 25 years**.

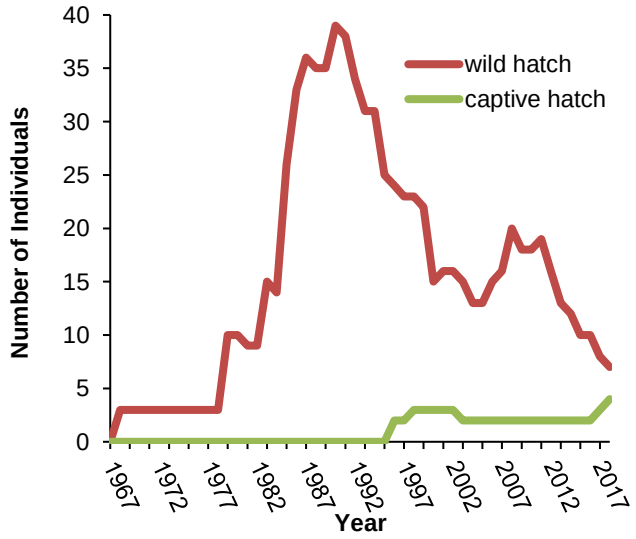

Figure 1. Census of African white-backed vultures in North America from 1967 to 2017, by birth type.

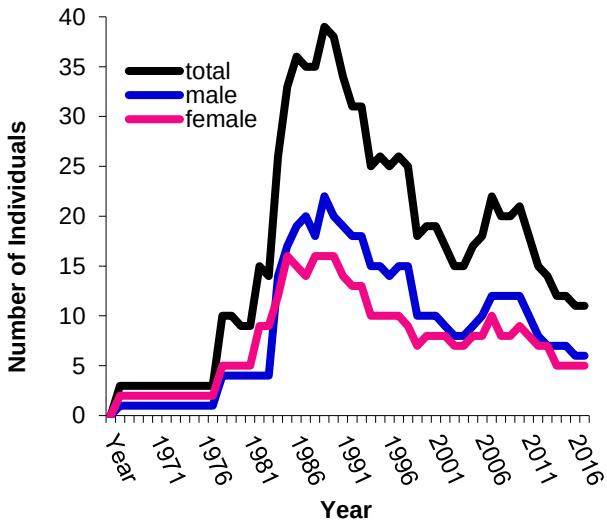

Figure 2. Census of African white-backed vultures in North America from 1967 to 2017, by sex.

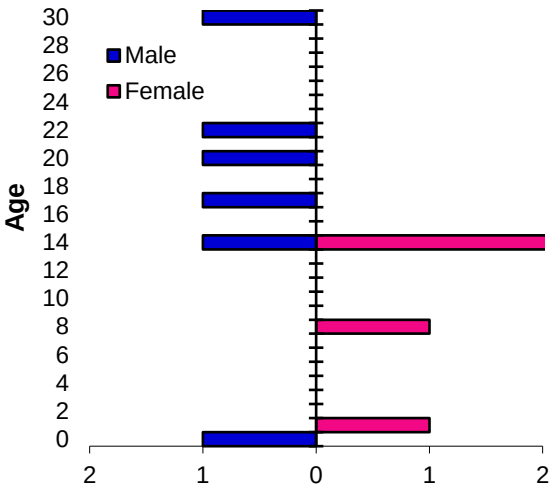

Figure 3. Age distribution of the current population of African white-backed vultures in North America.

The age structure of the managed African white-backed vulture population has gaps in several age classes reflecting sporadic reproductive success in captivity (Figure 3). Although the species is long-lived, consistent reproduction will be necessary to maintain a stable age distribution and growth potential.

Because a relatively small number of African white-backed vultures have been held in North America, demographic data for this population may not yet accurately reflect the true biology of the species. Wild-hatched males and females (with estimated hatch dates) have survived through their mid- to late-thirties. Data for African white-backed vultures were not sufficiently robust to calculate formal survival statistics (see www.aza.org/survival-stats/ for the complete report). However, current life tables (Appendix C) indicate that median life expectancy is 11 years for males and females (50% of males and females die before these ages and 50% die after). While there is insufficient fecundity data to make predictions, Studbook data from other Old World vulture SSPs (Ruppell's Griffon and Lappet-faced) suggest it is likely that African white-backed vultures become reproductive between the ages of 5 -7 years and have a long reproductive span.

Analyses suggest that 2 hatches are needed over the next two years (1 per year) to maintain the current population size, while 4 hatches are needed over the next two years (2 per year) if a growth rate of 2.0% can be maintained to grow toward the RCP target size of 50 birds. The population has been averaging 0.4 hatches per year for the last 5 years, thus reproduction must be increased to maintain the current population size or grow the population toward the SSP target size. Successful reproduction, not institutional holding capacity, is the limiting factor in population growth for this SSP.

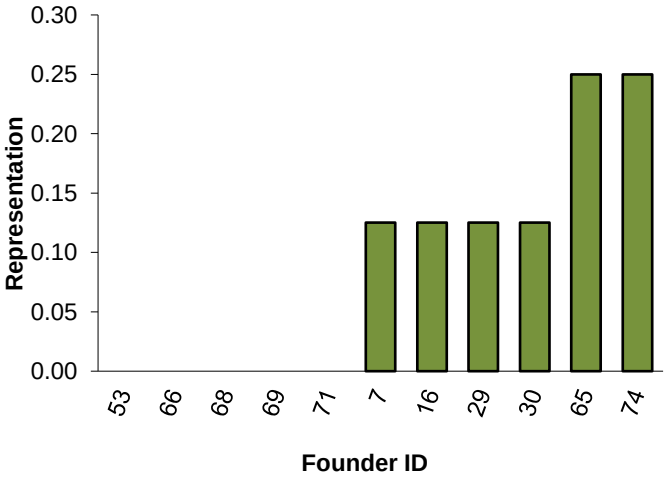

Figure 4: Founder representation, including the 5 potential founders in the managed African white-backed vulture population in North America.

Genetics: The Studbook indicates that the managed African white-backed vulture population is descended from 6 founders with 5 potential founders remaining (Figure 4). Breeding the potential founders to increase gene diversity is a priority for this SSP Program. The gene diversity of the population is currently 84.38%, which is equivalent to that found in ~3 unrelated animals (FGE = 3.20).

Typical AZA program goals include thresholds for tolerance of gene diversity loss over time; 90% gene diversity retention for 100 years is not an uncommon management goal. Decreases in gene diversity below 90% of that in the founding population have been associated with increasingly compromised reproduction by, among other factors, lower hatch weights, and greater neonatal mortality. The African white-backed vulture pedigree yields a current gene diversity of ~84%, and is predicted to decline to 33% over the next 100 years if the population maintains its population size of 11 individuals. If the population can slowly grow (2% per year) to reach the RCP target size of 50 individuals, gene diversity is projected to be 56.2%.

Although inbreeding is currently negligible within the SSP population, the population's mean kinship is 0.1563. Half-siblings have a kinship of 0.125, which means that the average relationship of the captive-hatched individuals is greater than that of half-siblings. Breeding un- and under-represented individuals will help decrease mean kinship and maintain low average inbreeding.

Genetics Summary

	2017	Current Potential
Founders	6	5 additional
Founder genome equivalents (FGE)	3.20	9.00
Current gene diversity (GD %)	84.38	94.44
Population mean kinship (MK)	0.1563	-----
Mean inbreeding (F)	0.0000	-----
% pedigree known before assumptions and exclusions	100	-----
% pedigree known after assumptions and exclusions	100	-----
Effective population size/census size ratio (Ne / N)	na[1]	-----
Years To 90% Gene Diversity	na (already below 90%)	-----
Years To 10% Loss of GD	7*	-----
Gene Diversity at 100 Years From Present (%)	33.0 *	-----

[1]insufficient data to calculate Ne/N in PMx because only 1.1 living individuals have produced offspring.
*projections based on the breeding population maintaining its size of 11 individuals (λ = 1.000, Ne/N = 0.30)

Management Strategy: The current population of managed African white-backed vultures in North America includes 11 individuals (6 males, 5 females, 0 unknown) held by 4 AZA institutions. To offset deaths and maintain the population size (λ = 1.00) demographic analyses indicate that 2 hatches are needed over the next two years (1 per year). Four hatches are needed over the next two years (2 per year) if a growth rate of 2.0% can be maintained to grow toward the RCP target size of 50 birds. Recommended pairings are intended to maintain or increase the population's gene diversity, and are based on mean kinship, avoidance of inbreeding, avoidance of linking rare and common lineages, as well as the needs of the participating institutions

This is a 2-year plan. Interim recommendations will continue to be made as needed.

1. The SSP recommends 5 females to breed to increase the population size.
2. The SSP recommends 3 transfers to meet institutional needs and establish new breeding pairs.
3. Recommends contacting the Studbook Keeper with information on egg production, regardless of hatching success.

Summary of Breeding and Transfer Recommendations
by Studbook ID

SB ID	Location	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
53	DALLAS	16T376	M	30	HOLD	DALLAS	BREED WITH	66	
62	BIRMINGHM	213050	M	22	SEND TO	FORTWORTH	BREED WITH	75	
65	DALLAS	06G880	M	17	HOLD	DALLAS	BREED WITH	74	
66	CLEVELAND	M40940	F	14	SEND TO	DALLAS	BREED WITH	53	
68	CLEVELAND	M40942	F	14	HOLD	CLEVELAND	BREED WITH	69	
69	CLEVELAND	M40943	M	14	HOLD	CLEVELAND	BREED WITH	68	
71	BOISE	213031	F	14	HOLD	BOISE	BREED WITH	73	
73	BOISE	213029	M	20	HOLD	BOISE	BREED WITH	71	
74	DALLAS	09J873	F	8	HOLD	DALLAS	BREED WITH	65	
75	DALLAS	15Q199	F	1	SEND TO	FORTWORTH	BREED WITH	62	
76	DALLAS	16T074	M	0	HOLD	DALLAS	DO NOT BREED		

Recommendations by Institution

BIRMINGHM

Birmingham Zoo
Birmingham, AL

Institutional Note: Please transfer male 62 to FORTWORTH to receive a breeding recommendation.

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
62	213050	M	22	SEND TO	FORTWORTH	BREED WITH	75	

BOISE

Zoo Boise
Boise, ID

Institutional Note: This breeding pair is very genetically valuable, and any hatches are considered a success for the SSP. If your institution is not set up to breed this pair, please contact the Program Leaders and the SSP may recommend exchanging them for 2 birds of the same sex.

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
71	213031	F	14	HOLD	BOISE	BREED WITH	73	
73	213029	M	20	HOLD	BOISE	BREED WITH	71	Potential founder

CLEVELAND

Cleveland Metroparks Zoo
Cleveland, OH

Institutional Note: Please transfer female 66 to DALLAS for a breeding recommendation. CLEVELAND's breeding pair is very genetically valuable, and any hatches are considered a success for the SSP.

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
66	M40940	F	14	SEND TO	DALLAS	BREED WITH	53	Potential founder
68	M40942	F	14	HOLD	CLEVELAND	BREED WITH	69	Potential founder
69	M40943	M	14	HOLD	CLEVELAND	BREED WITH	68	Potential founder

DALLAS

Dallas Zoo
Dallas, TX

Institutional Note: The SSP is recommending DALLAS transfer female 75 to breed at FORTWORTH and receive female 66 to pair with male 53. DALLAS's breeding pair 53 and 66 are very genetically valuable, and any hatches are considered a success for the SSP.

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
53	16T376	M	30	HOLD	DALLAS	BREED WITH	66	Potential founder
65	06G880	M	17	HOLD	DALLAS	BREED WITH	74	
74	09J873	F	8	HOLD	DALLAS	BREED WITH	65	
75	15Q199	F	1	SEND TO	FORTWORTH	BREED WITH	62	
76	16T074	M	0	HOLD	DALLAS	DO NOT BREED		
66	M40940	F	14	RECEIVE FROM	CLEVELAND	BREED WITH	53	Potential founder

FORTWORTH

Fort Worth Zoo
Fort Worth, TX

Institutional Note: The SSP is recommending FORTWORTH receive breeding pair 62 and 75.

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
75	15Q199	F	1	RECEIVE FROM	DALLAS	BREED WITH	62	
62	213050	M	22	RECEIVE FROM	BIRMINGHM	BREED WITH	75	

Appendix A
Analytical Assumptions

No analytical assumptions were used for this plan.

Appendix B
Summary of Data Exports

Report compiled under PopLink V. 2.4 and Population Management x, V. 1.2.
PMx Vulture_African_white_backed_2017
Report compiled under Population Management x, version 1.2

Studbook information:
Data compiled by: Debbie Milligan
Data current thru: 1/26/2017
Scope of data: North America

Demographic data from:
Vulture_African_White_backed _2017.csv
Demographic filter conditions:
Locations: N. America, During 1/1/1980-1/26/2017
Census file: Exchcens.txt

1st year mortality was adjusted to 20% for males and females based on an average of other Old World vulture SSPs.

Genetic data from:
Vulture_African_White_backed_2017.ped
Genetic filter conditions:
Locations: N. America, During 1/1/1980-1/26/2017

Appendix C
Life Tables

MALES								
Age	**Qx**	**Px**	**lx**	**Mx**	**Vx**	**Ex**	**Risk (Qx)**	**Risk (Mx)**
0	0.00	1.00	1.00	0.000	1.00	13.64	3.6	3.6
1	0.10	0.90	1.00	0.000	0.88	13.30	12.0	12.0
2	0.15	0.85	0.90	0.000	0.85	14.02	19.4	19.4
3	0.10	0.90	0.77	0.000	0.81	14.89	23.7	23.7
4	0.05	0.95	0.69	0.000	0.74	15.05	26.3	26.3
5	0.04	0.96	0.65	0.000	0.65	14.75	26.2	26.2
6	0.04	0.96	0.63	0.000	0.57	14.33	26.1	26.1
7	0.05	0.95	0.60	0.000	0.50	13.97	27.3	27.3
8	0.04	0.96	0.57	0.000	0.44	13.61	25.7	25.7
9	0.08	0.92	0.55	0.000	0.40	13.42	23.8	23.8
10	0.00	1.00	0.50	0.000	0.35	12.98	22.0	22.0
11	0.07	0.93	0.50	0.000	0.30	12.43	21.7	21.7
12	0.02	0.98	0.47	0.000	0.27	12.00	20.1	20.1
13	0.16	0.84	0.46	0.000	0.25	12.05	17.9	17.9
14	0.00	1.00	0.39	0.063	0.23	12.08	16.2	16.2
15	0.00	1.00	0.38	0.031	0.14	11.10	16.0	16.0
16	0.00	1.00	0.38	0.031	0.09	10.10	16.0	16.0
17	0.00	1.00	0.38	0.000	0.05	9.10	16.0	16.0
18	0.33	0.67	0.38	0.050	0.05	9.72	10.7	10.7
19	0.01	0.99	0.26	0.000	0.00	10.93	10.0	10.0
20	0.10	0.90	0.26	0.000	0.00	10.45	9.9	9.9
21	0.00	1.00	0.23	0.000	0.00	9.95	9.0	9.0
22	0.00	1.00	0.23	0.000	0.00	8.95	8.8	8.8
23	0.14	0.86	0.23	0.000	0.00	8.56	6.2	6.2
24	0.00	1.00	0.20	0.000	0.00	8.19	6.0	6.0
25	0.01	0.99	0.20	0.000	0.00	7.23	6.0	6.0
26	0.08	0.92	0.20	0.000	0.00	6.53	6.0	6.0
27	0.08	0.92	0.18	0.000	0.00	6.02	6.0	6.0
28	0.00	1.00	0.16	0.000	0.00	5.25	5.0	5.0
29	0.00	1.00	0.16	0.000	0.00	4.25	5.0	5.0
30	0.25	0.75	0.16	0.000	0.00	3.71	4.8	4.8
31	0.33	0.67	0.12	0.000	0.00	3.80	2.9	2.9
32	0.00	1.00	0.08	0.000	0.00	3.50	2.0	2.0
33	0.50	0.50	0.08	0.000	0.00	3.33	1.4	1.4
34	0.00	1.00	0.04	0.000	0.00	3.50	1.0	1.0
35	0.00	1.00	0.04	0.000	0.00	2.50	1.0	1.0
36	0.00	1.00	0.04	0.000	0.00	1.50	1.0	1.0

Qx = mortality; Px = survival; lx = cumulative survivorship; Mx = fecundity; Vx = reproductive value; Ex = life expectancy;
At Risk (Qx and Mx) = number of animals corresponding values are estimated from:
r =-0.174; lambda =0.840; T = 16

FEMALES								
Age	**Qx**	**Px**	**lx**	**Mx**	**Vx**	**Ex**	**Risk (Qx)**	**Risk (Mx)**
0	0.00	1.00	1.00	0.000	1.00	13.51	1.6	1.6
1	0.13	0.88	1.00	0.000	0.91	13.34	11.2	11.2
2	0.15	0.85	0.88	0.000	0.91	14.27	19.4	19.4
3	0.10	0.90	0.75	0.000	0.89	15.18	19.9	19.9
4	0.00	1.00	0.67	0.000	0.80	14.97	21.7	21.7
5	0.02	0.98	0.67	0.000	0.70	14.13	22.3	22.3
6	0.04	0.96	0.66	0.000	0.62	13.58	22.2	22.2
7	0.12	0.88	0.63	0.050	0.57	13.67	20.9	20.9
8	0.00	1.00	0.55	0.000	0.48	13.50	18.8	18.8
9	0.06	0.94	0.55	0.000	0.42	12.90	17.4	17.4
10	0.04	0.96	0.52	0.000	0.38	12.53	17.0	17.0
11	0.14	0.86	0.50	0.000	0.36	12.63	16.1	16.1
12	0.07	0.93	0.43	0.000	0.34	13.03	13.6	13.6
13	0.00	1.00	0.40	0.000	0.31	12.49	13.0	13.0
14	0.03	0.97	0.40	0.083	0.27	11.66	12.5	12.5
15	0.09	0.91	0.39	0.000	0.17	11.33	11.4	11.4
16	0.06	0.94	0.35	0.000	0.15	11.16	10.3	10.3
17	0.10	0.90	0.33	0.000	0.14	11.01	9.1	9.1
18	0.00	1.00	0.30	0.000	0.13	10.57	9.0	9.0
19	0.00	1.00	0.30	0.000	0.11	9.57	9.0	9.0
20	0.00	1.00	0.30	0.000	0.09	8.57	9.0	9.0
21	0.00	1.00	0.30	0.000	0.08	7.57	9.0	9.0
22	0.11	0.89	0.30	0.000	0.07	6.96	8.9	8.9
23	0.13	0.88	0.27	0.071	0.07	6.75	7.2	7.2
24	0.11	0.89	0.23	0.000	0.00	6.52	7.0	7.0
25	0.20	0.80	0.21	0.000	0.00	6.50	6.1	6.1
26	0.00	1.00	0.17	0.000	0.00	6.18	5.0	5.0
27	0.00	1.00	0.17	0.000	0.00	5.19	5.0	5.0
28	0.09	0.91	0.17	0.000	0.00	4.41	5.0	5.0
29	0.10	0.90	0.15	0.000	0.00	3.78	5.0	5.0
30	0.04	0.96	0.14	0.000	0.00	3.00	4.1	4.1
31	0.27	0.73	0.13	0.000	0.00	2.35	3.1	3.1
32	0.52	0.48	0.09	0.000	0.00	2.16	2.4	2.4
33	0.40	0.60	0.05	0.000	0.00	2.22	1.3	1.3
34	0.31	0.69	0.03	0.000	0.00	1.92	1.0	1.0
35	0.46	0.54	0.02	0.000	0.00	1.46	1.0	1.0
36	0.84	0.16	0.01	0.000	0.00	1.14	1.0	1.0

Qx = mortality; Px = survival; lx = cumulative survivorship; Mx = fecundity; Vx = reproductive value; Ex = life expectancy
At Risk (Qx and Mx) = number of animals corresponding values are estimated from
r = -0.155; lambda = 0.857; T = 19.0

Appendix D
Individuals Excluded from Genetic Analyses

No individuals were excluded from genetic analyses.

Appendix E
Ordered Mean Kinships

Note: This list is current to January 26th, 2017. Values are subject to change with any birth, death, import, export, inclusion, exclusion, or changes in pedigree assumptions. **Average Population MK = 0.1563.**

MALES					FEMALES				
SB#	MK	% Known	Age	Location	SB#	MK	% Known	Age	Location
53	0	100	30	DALLAS	66	0	100	14	CLEVELAND
69	0	100	14	CLEVELAND	68	0	100	14	CLEVELAND
62	0.125	100	22	BIRMINGHM	71	0	100	14	BOISE
73	0.125	100	20	BOISE	74	0.125	100	8	DALLAS
65	0.125	100	17	DALLAS	75	0.1875	100	1	DALLAS
76	0.1875	100	0	DALLAS					

Appendix F
Definitions

Management Terms (as of July 2016)

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 Non–Member Participation 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 institutions is voluntary.

Red Species Survival Plan® (Red SSP) Program – A Red SSP has a population size of greater than 20 but fewer than 50 animals, at least three AZA member institutions, and a published studbook. Animal Programs that manage species designated as Extinct in the Wild, Critically Endangered, or Endangered (IUCN) do not need to meet minimum population size and number of participating institution criteria to be designated as an SSP Program. Red Program participation by AZA institutions is voluntary.

Full Participation – AZA policy stating that all AZA accredited institutions 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 institutional 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 institutions 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 two-way classification showing the numbers or percentages of individuals in various age and sex classes.

Ex, Life Expectancy – 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 expected lambda) or from observed changes in population size from year to year. A lambda of 1.11 means an 11% per year increase; lambda of 0.97 means a 3% decline in size per year.

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.

Mx, **Fecundity** – The average number of same-sexed young born to animals in that age class. Because studbooks typically have relatively small sample sizes, studbook software calculate Mx as 1/2 the average number of young 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 one time period; is conditional on an individual being alive at the beginning of the time period. Alternatively, the proportion of individuals which survive from the beginning of one age class to the next.

Qx, Mortality – Probability that an individual of age *x* dies during time period. 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.

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

Genetic Terms

Allele Retention – The probability that a gene present in a founder individual exists in the living, descendant population.

Current Gene Diversity (GD) -- The proportional gene diversity (as a proportion of the source population) is the probability that two alleles from the same locus sampled at random from the population will not be identical by descent. Gene diversity is calculated from allele frequencies, and is the heterozygosity expected in progeny produced by random mating, and if the population were in Hardy-Weinberg equilibrium.

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 gene 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 gene 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 wild-caught individuals (founders) that would produce 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 -- Proportion of the genes in the living, descendant population that are derived from that founder.

Inbreeding Coefficient (F) -- Probability that the two alleles at a genetic locus are identical by descent from an ancestor common to both parents. The mean inbreeding coefficient of a population will be the proportional decrease in observed heterozygosity relative to the expected heterozygosity of the founder population.

Mean Kinship (MK) – The mean kinship coefficient between an animal and all animals (including itself) in the living, captive-born population. The mean kinship of a population is equal to the proportional loss of gene diversity of the descendant (captive-born) population relative to the founders and is also the mean inbreeding coefficient of progeny produced by random mating. Mean kinship is also the reciprocal of two times the founder genome equivalents: MK = 1 / (2 * FGE). MK = 1 - GD.

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

Prob Lost – Probability that a random allele from the individual will be lost from the population in the next generation, because neither this individual nor any of its relatives pass on the allele to an offspring. Assumes that each individual will produce a number of future offspring equal to its reproductive value, Vx.

Appendix G
Directory of Institutional Representatives

Institution	Contact (IR)	Email
BIRMINGHM – Birmingham Zoo	Jessica Griswold	jgriswold@birminghamzoo.com
BOISE – Zoo Boise	Lindsay Ruffner	lruffner@cityofboise.org
CLEVELAND -- Cleveland Metroparks Zoo	Travis Vineyard	tgv@clevelandmetroparks.com
DALLAS – Dallas Zoo	Debbie Milligan	debbie.milligan@dallaszoo.com
FORTWORTH – Fort Worth Zoo	Shelly Collinsworth	scollinsworth@fortworthzoo.org
SD-WAP – San Diego Zoo Safari Park	Michael Mace	mmace@sandiegozoo.org