Population Analysis & Breeding and Transfer Plan

Eurasian Black Vulture (*Aegypius monachus*)
AZA Species Survival Plan®
Yellow Program

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PMC Population Management Center

Lincoln Park Zoo

ASSOCIATION OF ZOOS & AQUARIUMS

Executive Summary

Eurasian Black Vulture (*Aegypius monachus*) Yellow Species Survival Plan®

The Raptor Taxon Advisory Group has designated this population as an SSP and has set a target population size of 70 specimens (2015 Raptor TAG RCP). The current population is 56 specimens distributed among 19 AZA institutions and 3 non-member facilities.

When gene diversity falls below 90% of that in the founding population, it is expected that reproduction may be increasingly compromised by, among other factors, lower birth/hatch weights, smaller litter/clutch sizes, and greater neonatal mortality. Given the current gene diversity, this population will likely remain above the 90% level for 19 years; gene diversity at 100 years is expected to be about 80%.

Demography	
Current size of population (N) - Total (Males, Females, Unknown)	56 (24.30.2)
# animals excluded from management	1
Population size following exclusions	54
Target population size	70
Mean generation time (yrs)	21.24
Life Table Lambda / 5-year lambda / lambda used in projections	1.007 / 1.004 / 1.004

Genetics (Genetic statistics calculated from the analytical studbook)	***Current***	***Potential***
Founders	14	2
Founder genome equivalents (FGE)	7.02	13.28
Gene diversity retained (GD%)	92.88	96.23
Population mean kinship (MK)	0.0712	
Mean inbreeding (F)	0	
Percentage of pedigree known before assumptions and exclusions	100	
Percentage of pedigree known after assumptions and exclusions	100	
Effective population size/census size ratio (Ne / N)	0.2715	
Years To 90% Gene Diversity	19	
Years to 10% Loss of Gene Diversity	89	
Gene Diversity at 100 Years From Present (%) Assuming λ = 1.004, Target size = 70	80.9	

Of special concern to this population is continued low production in spite of high numbers of recommended pairs. Since 1 Jan 2009, 25 hatches have occurred at 8 facilities, but only 12 chicks were successfully raised. While the number of hatches is increasing, egg breakage during parent incubation remains a concern for this population. As a result, the SSP is recommending the artificial incubation of all eggs from pairs with histories of egg breakage. Dummies should be placed under incubating parents and eggs should typically be returned to parents between the chick's internal pip and 24 hours post-hatch, although some pairs have done better with a hatched chick placed back into the eggshell prior before placing back into the nest. Contact the SSP with any questions regarding egg pulling and artificial incubation.

As with most SSP populations, pairings 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 SSP will recommend 21 breeding pairs intended to produce at least 3-4 chicks in the coming year and 6 transfers for this period. Recommendations contained in this master plan supercede those made by earlier plans.

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Description of Population Status

Introduction: Studbook records indicate Eurasian black vultures first appeared in North American zoos in 1958. Their numbers remained extremely small (<20) into the 1970's and captive hatches occurred infrequently until the late 1980s. The population is currently managed as a Yellow SSP with a target size of 70 specimens.

Comprehensive genetic and demographic analyses of the Eurasian Black Vulture Regional Studbook (current to 6/26/2016) were performed in October 2016, resulting in the current Breeding and Transfer Plan for this species. Recommendations contained in this plan supercede those made by earlier plans (last planned in 2013). Master plan analyses were performed using PopLink 2.4, PM2000 1.213, and PMX V1.2.20140424.

Status and Conservation: The Eastern black vulture population in the wild is listed as Near Threatened by IUCN and has declined over much of its range in the last 200 years. Declines in the western portion of the range have been severe with the species being extirpated from several Western European countries and Northwest Africa. The species is the subject of reintroduction efforts in some former range countries. Secondary poisoning and habitat loss still impacts the species and the worldwide population of cinereous vultures is estimated at 4500–5000 individuals as of the year 2000.

Managed Population: The current population size is 56 (TAG recommended size = 70), distributed among 19 AZA and 3 non-AZA facilities. Exclusions: #44, blind, has not been successfully paired in the past.

Demography: The North American Regional population grew slowly following its appearance in 1958. Initially population growth was attributable to imports with captive hatches not becoming a significant source of recruitment in the 1980s. Since the population's inception the annual growth rates attributed to captive propagation have varied though the general trend has been one of slow but positive growth (mean λ = 1.011 over past decade). The population has grown since the 2013 breeding and transfer plan by two individuals (Figure 1).

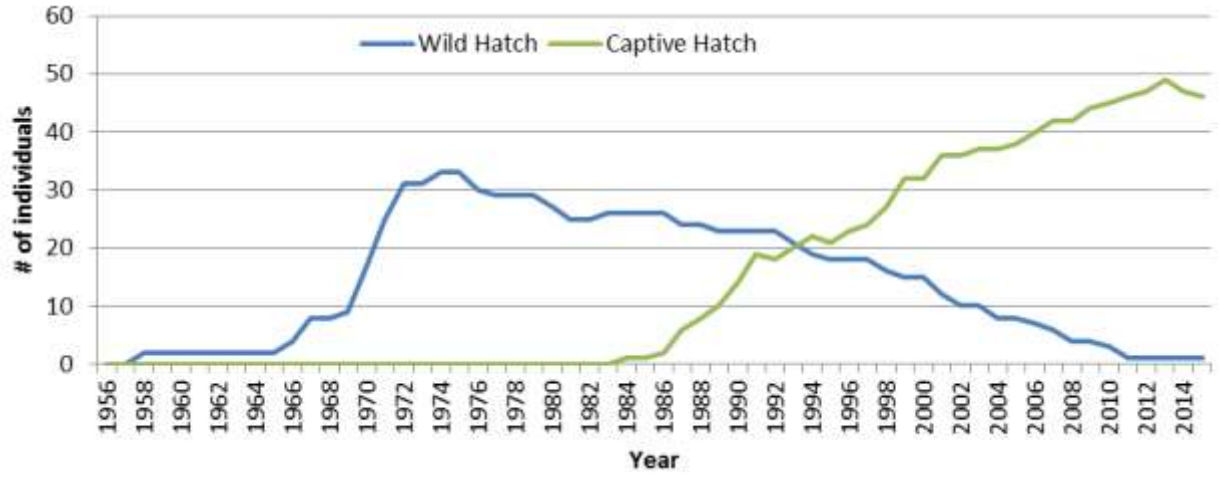

Figure 1. Census of individuals in currently AZA accredited facilities.

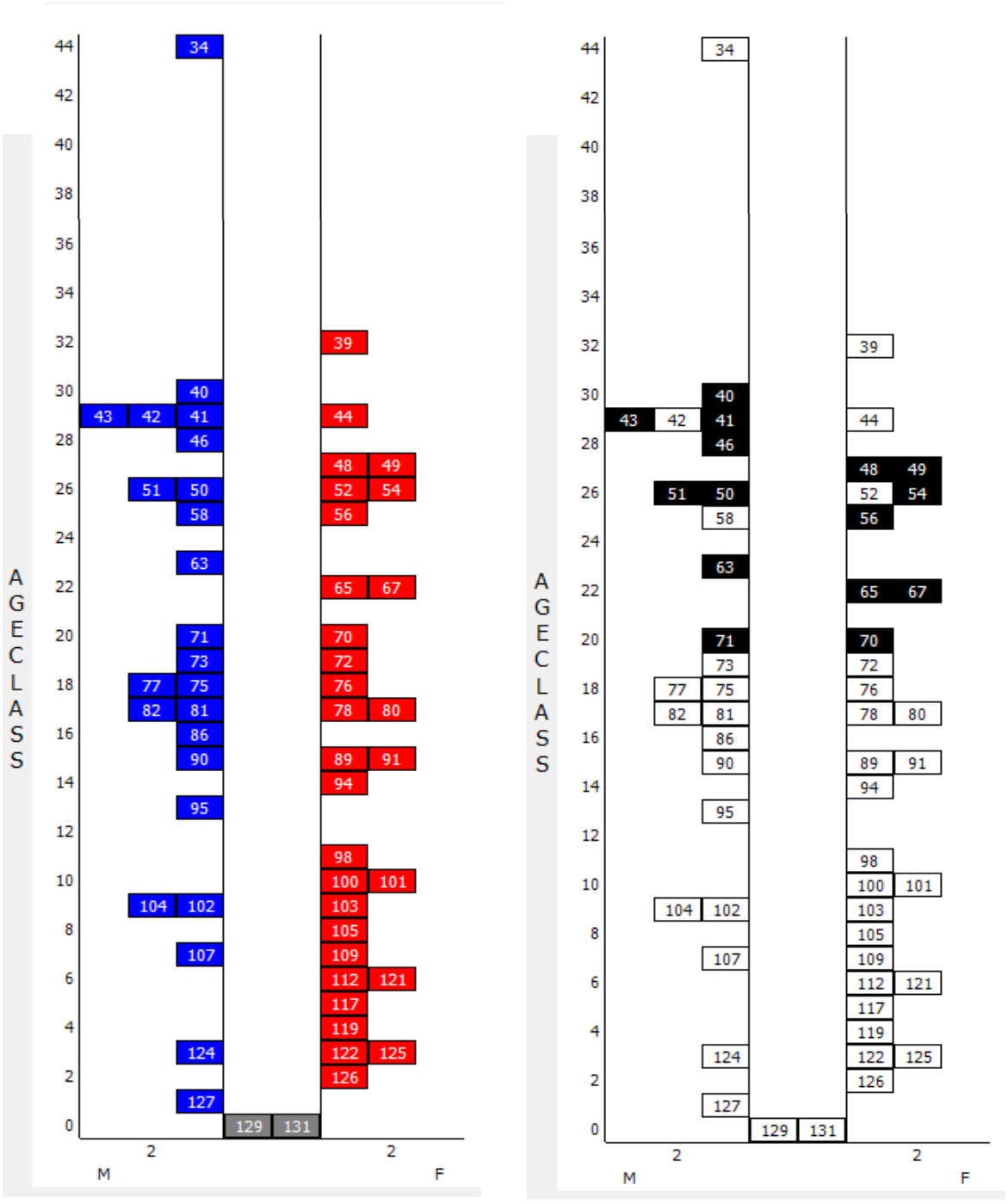

Figure 2. Age distribution of individuals in the SSP by sex on left (blue males, red females) and by breeding status on right (proven black, unproven white).

The age structure of the population deviates from a stable distribution with a paucity of animals in the lower age classes indicating that breeding rates are insufficient to replace older animals lost to attrition (Figure 2). In the cinereous vulture, this effect should be mitigated by a long reproductive span but efforts should be made to stabilize the age distribution in the interest of easing future management. Additional the younger age classes are female skewed, limiting the number of young pairs that can be added.

Demographic data suggests the lifespan of Eurasian black vultures is greater than 40 years. Some living animals, however, entered the population with indeterminate ages and it is possible that life spans may exceed this age. Males and females have reproduced at ages as young as seven years old in captivity, although wild birds are observed nesting at younger age in the wild at~3-4 years of age. Individuals have been observed to breed in at ages as great as 37 years thus indicating little or no period of reproductive senescence. Infant mortality has been observed to be low with approximately 69% of chicks surviving their first year.

Examining the age structure and life tables in concert presents serious concerns regarding the population's future. While animals have historically been observed to reproduce at the age of 7 years, there are currently no living breeders in the population younger than 20 years of age. One might assume that older animals are more likely to be wild-caught and that a lack of breeding in younger animals might be correlated with birth type but this does not appear to be the case. In the living population, however, 54 of the 56 living animals are known to captive born; one is wild born and 1 is unknown but likely wild born. Only 15 of those 56 are animals are proven breeders; 45 of the 56 are old enough to be considered reproductively mature. 15 of 45 animals over the age of 20 are proven breeders while 0 animals in age classes 7 to 20 have produced offspring. If younger animals are not successfully recruited as breeders the population will enter a period of decline as older breeders are lost to attrition.

When rearing type was examined in 2013, it appears that this factor has little impact on breeding success. Thirty-two individuals in the population have produced offspring; 13 of these were hand-reared, 19 were parent reared. This sample is somewhat confounded as historically the population has had large numbers of animals who were wild caught and which are therefore also parent reared. Examining only captive born individuals, we find that 14 captive born individuals have produced offspring; 13 of those were hand-reared, suggesting that hand-rearing does not have a deleterious effect on reproductive success. This finding does not, however, negate the need for ghost or puppet-rearing as these practices have been used historically by many institutions practicing hand-rearing. There have been some hand-reared birds exhibiting significant behavioral deficits and the methods of rearing and post-rearing socialization may be critical to future reproductive success.

Genetics: The managed population is descended from 14 founders and 2 potential founders remain. Genetic diversity in the population (92.88%) is moderate relative to the average SSP (93%). The population gene diversity could fall below 90% in 19 years. Projections of gene diversity indicate 80% at 100 years from present. 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 hatch weights and greater neonatal mortality.

Genetic Summary	**2016**	**Potential**	**2013**	**2008**	**2006**	**2004**
Gene Diversity Retained (%)	92.88	96.23	93.05	93.51	93.52	93.88
Founder Genome Equivalents	7.02	13.28	7.19	7.71	7.72	8.17
Population Mean Kinship	0.0712		0.0695	0.0649	0.0648	0.0612
Mean Inbreeding	0		0	0.00	0.000	0
% Pedigree Known	100		100	100	100	100
N_e/N	0.2715		0.2308	0.2637	0.3246	0.3529
Years to 90%	19		16	20	35	41
Diversity at 100 Years (%)	80		79	81	84	85

The potential gene diversity is high (96.0%) and the time to 90% gene diversity could be extended through management beyond the 19 years currently projected. Strategies to do so would include equalizing founder representation, recruiting existing potential founders, and increasing population growth rate and effective population size.

Additional potential founders may become available from South Korea where animals are found in wildlife rehabilitation facilities. Modeled founder scenarios with outcomes are described below. It is important to note that the population currently has a relatively strong founder base and current population challenges to gene

diversity retention are more demographic than genetic in basis. Some scenarios addressing demographic improvements in the absence of additional founders are also modeled. Importing animals could improve projections of gene diversity retention but will not have the projected results if breeding success and population growth across the entire SSP are not improved.

Founder Scenarios (modeled in 2013)	Years to 90% GD	GD at 100 Years (%)	Notes
Baseline	16	79.32	0 founders, 0 changes in demography
One time – 3 pairs	22	80.06	1 import – 6 birds
One pair every 5 years for 25 years	37	81.84	5 imports – 10 birds
0 imports – increase population growth	19	79.67	Lambda 1.03 from 1.01
0 imports – increase effective size ratio	22	82.33	Ne/N 0.3 from 0.23
0 imports – increase growth and effective size	26	82.64	Ne/N 0.3 and Lambda 1.03
One time – 3 pairs – increase growth and effective size	32	83.24	1 import, 6 birds, plus Ne/N 0.3 and Lambda 1.03

Management Strategy: Demographic analyses indicate that 3-4 offspring are required in the coming year to maintain the current population size. Chicks in excess of this number are expected to result in population growth. An annual population growth rate of approximately 2% will be attained if 4-5 offspring are produced in the coming year. Continued growth at 2% per annum is projected to result in the target size in approximately 12 years.

Of special concern to this population is continued low production in spite of high numbers of recommended pairs. While the number of hatches is increasing, egg breakage during parent incubation remains a concern for this population. As a result, the SSP is recommending the artificial incubation of all eggs from pairs with histories of egg breakage. Dummies should be placed under incubating parents and eggs should typically be returned to parents between the chick's internal pip and 24 hours post-hatch, although some pairs have done better with a hatched chick placed back into the eggshell prior be placing back into the nest. Contact the SSP with any questions regarding egg pulling and artificial incubation.

In cases where chicks can not be returned to nests (e.g., dummy eggs are abandoned or chick disappeared or are injured/killed by adults), hand-rearing or egg transfer between institutions with represented pairs that have proven chick rearing skills may be recommended. Contact the SSP with any questions regarding egg transfer between institutions. In cases where hand-rearing is necessary, puppet or blind rearing is recommended.

1. Recommend 21 pairings.

2. Recommend 6 transfers.

Summary of Breeding and Transfer Recommendations

ID	Location	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
72	BATTLE CR	98B11	F	20	HOLD	BATTLE CR	BREED WITH	73	
119	BINGHAMTO	13036	F	4	HOLD	BINGHAMTO	DO NOT BREED		juvenile group
125	BINGHAMTO	14012	F	3	HOLD	BINGHAMTO	DO NOT BREED		juvenile group
43	BIRMINGHM	2250	M	29	HOLD	BIRMINGHM	BREED WITH	49	
49	BIRMINGHM	2251	F	27	HOLD	BIRMINGHM	BREED WITH	43	
50	BUFFALO	91B9	M	26	HOLD	BUFFALO	BREED WITH	54	
54	BUFFALO	90B27	F	26	HOLD	BUFFALO	BREED WITH	50	
122	CHICAGOLP	23724	F	3	SEND TO	PUEBLO	BREED WITH	90	
41	CHICAGOLP	B8774	M	29	HOLD	CHICAGOLP	BREED WITH	109	
82	COLUMBIA	6769	M	17	HOLD	COLUMBIA	BREED WITH	91	
91	COLUMBIA	7152	F	15	HOLD	COLUMBIA	BREED WITH	82	
44	DENVER		F	29	HOLD	DENVER	DO NOT BREED		excluded - blind and has never been successfully paired
51	DENVER	A07476	M	26	HOLD	DENVER	BREED WITH	67	
67	DENVER	A11298	F	22	HOLD	DENVER	BREED WITH	51	
121	DENVER	A12184	F	6	HOLD	DENVER	BREED WITH	124	
124	DENVER	A14113	M	3	HOLD	DENVER	BREED WITH	121	
126	DENVER	A16038	F	2	HOLD	DENVER	DO NOT BREED		
98	DES MOINE	2173	F	11	HOLD	DES MOINE	DO NOT BREED		
100	DES MOINE	2174	F	10	HOLD	DES MOINE	DO NOT BREED		
40	DETROIT	1903	M	30	HOLD	DETROIT	BREED WITH	48	
48	DETROIT	3361	F	27	HOLD	DETROIT	BREED WITH	40	
86	DETROIT	10711	M	16	HOLD	DETROIT	BREED WITH	89	
89	DETROIT	8928	F	15	HOLD	DETROIT	BREED WITH	86	

ID	Location	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
94	EMPORIA	174403	F	14	HOLD	EMPORIA	BREED WITH	95	
95	EMPORIA	185105	M	13	HOLD	EMPORIA	BREED WITH	94	
78	MANHATTAN	990040	F	17	SEND TO	NY BRONX	BREED WITH	75	
77	MANHATTAN	200940	M	18	HOLD	MANHATTAN	BREED WITH	80	
107	METROZOO	10B042	M	7	HOLD	METROZOO	BREED WITH	112	
112	METROZOO	11B089	F	6	HOLD	METROZOO	BREED WITH	107	
109	METROZOO	10B034	F	7	SEND TO	CHICAGOLP	BREED WITH	41	
103	MILL MOUN	581	F	9	SEND TO	TBD	TBD		SSP is working to identify a placement
104	~~MILL MOUN~~	~~8009~~	~~M~~	~~9~~	~~HOLD~~	~~MILL MOUN~~	~~BREED WITH~~	~~103~~	Reported as dead during draft period
127	MILWAUKEE	B4758	M	1	HOLD	MILWAUKEE	DO NOT BREED		Bachelor group
129	MILWAUKEE	B4821	M	0	HOLD	MILWAUKEE	DO NOT BREED		Bachelor group
70	MILWAUKEE	B4260	F	21	HOLD	MILWAUKEE	BREED WITH	71	
71	MILWAUKEE	B4259	M	20	HOLD	MILWAUKEE	BREED WITH	70	
76	MILWAUKEE	B3664	F	18	HOLD	MILWAUKEE	BREED WITH	81	
81	MILWAUKEE	B4109	M	17	HOLD	MILWAUKEE	BREED WITH	76	May be placed in bachelor group or paired with 76
101	NORFOLK	214046	F	10	HOLD	NORFOLK	DO NOT BREED		
117	NORFOLK	212141	F	5	HOLD	NORFOLK	DO NOT BREED		
75	NY BRONX	B03123	M	19	HOLD	NY BRONX	BREED WITH	78	
80	NY BRONX	B00020	F	17	SEND TO	MANHATTAN	BREED WITH	77	
131	PALM DES	316001	U	0	SEND TO	TBD	DO NOT BREED		determine and report sex
46	PALM DES	392001	M	28	HOLD	PALM DES	BREED WITH	56	
56	PALM DES	392002	F	25	HOLD	PALM DES	BREED WITH	46	
90	PUEBLO	B25012	M	15	HOLD	PUEBLO	BREED WITH	122	
73	PUEBLO	B25011	M	19	SEND TO	BATTLE CR	BREED WITH	72	
34	ROCKTON	_____	M	45	HOLD	ROCKTON	BREED WITH	39	

ID	Location	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
39	ROCKTON	00-01C	F	32	HOLD	ROCKTON	BREED WITH	34	
58	ROCKTON	00-00F	M	25	HOLD	ROCKTON	DO NOT BREED		
102	SPRINGFIE	978	M	9	HOLD	SPRINGFIE	BREED WITH	105	
105	SPRINGFIE	974	F	8	HOLD	SPRINGFIE	BREED WITH	102	
42	ST LOUIS	102387	M	29	HOLD	ST LOUIS	BREED WITH	52	
52	ST LOUIS	107691	F	26	HOLD	ST LOUIS	BREED WITH	42	
63	TOLEDO	941616	M	23	HOLD	TOLEDO	BREED WITH	65	
65	TOLEDO	951548	F	23	HOLD	TOLEDO	BREED WITH	63	

BATTLE CR

Binder Park Zoo

Battle Creek, MI

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
72	98B11	F	20	HOLD	BATTLE CR	BREED WITH	73	
73	B25011	M	19	RECEIVE FROM	PUEBLO	BREED WITH	72	

BINGHAMTO

Binghamton Zoo at Ross Park

Binghamton, NY

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
119	13036	F	4	HOLD	BINGHAMTO	DO NOT BREED		juvenile group
125	14012	F	3	HOLD	BINGHAMTO	DO NOT BREED		juvenile group

BIRMINGHM

Birmingham Zoo

Birmingham, AL

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
43	2250	M	29	HOLD	BIRMINGHM	BREED WITH	49	
49	2251	F	27	HOLD	BIRMINGHM	BREED WITH	43	

BUFFALO

Buffalo Zoo

Buffalo, NY

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
50	91B9	M	26	HOLD	BUFFALO	BREED WITH	54	
54	90B27	F	26	HOLD	BUFFALO	BREED WITH	50	

CHICAGOLP

Lincoln Park Zoological Gardens

Chicago, IL

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
41	B8774	M	29	HOLD	CHICAGOLP	BREED WITH	109	
122	23724	F	3	SEND TO	PUEBLO	BREED WITH	90	
109	10B034	F	7	RECEIVE FROM	METROZOO	BREED WITH	41	

COLUMBIA

Riverbanks Zoo and Garden

Columbia, SC

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
82	6769	M	17	HOLD	COLUMBIA	BREED WITH	91	
91	7152	F	15	HOLD	COLUMBIA	BREED WITH	82	

DENVER

Denver Zoological Gardens

Denver, CO

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
51	A07476	M	26	HOLD	DENVER	BREED WITH	67	
67	A11298	F	22	HOLD	DENVER	BREED WITH	51	
121	A12184	F	6	HOLD	DENVER	BREED WITH	124	
124	A14113	M	3	HOLD	DENVER	BREED WITH	121	
126	A16038	F	2	HOLD	DENVER	DO NOT BREED		
44		F	29	HOLD	DENVER	DO NOT BREED		excluded - blind and has never been successfully paired

DES MOINE

Blank Park Zoo of Des Moines

Des Moines, IA

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
98	2173	F	11	HOLD	DES MOINE	DO NOT BREED		
100	2174	F	10	HOLD	DES MOINE	DO NOT BREED		

DETROIT

Detroit Zoological Society

Royal Oak, MI

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
40	1903	M	30	HOLD	DETROIT	BREED WITH	48	
48	3361	F	27	HOLD	DETROIT	BREED WITH	40	
86	10711	M	16	HOLD	DETROIT	BREED WITH	89	
89	8928	F	15	HOLD	DETROIT	BREED WITH	86	

EMPORIA

David Traylor Zoo of Emporia

Emporia, KS

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
94	174403	F	14	HOLD	EMPORIA	BREED WITH	95	
95	185105	M	13	HOLD	EMPORIA	BREED WITH	94	

MANHATTAN

Sunset Zoo

Manhattan, KS

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
77	200940	M	18	HOLD	MANHATTAN	BREED WITH	80	
78	990040	F	17	SEND TO	NY BRONX	BREED WITH	75	
80	B00020	F	17	RECEIVE FROM	NY BRONX	BREED WITH	77	

METROZOO

Zoo Miami

Miami, FL

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
107	10B042	M	7	HOLD	METROZOO	BREED WITH	112	
109	10B034	F	7	SEND TO	CHICAGOLP	BREED WITH	41	
112	11B089	F	6	HOLD	METROZOO	BREED WITH	107	

MILL MOUN

Mill Mountain Zoo

Roanoke, VA

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
103	581	F	9	SEND TO	TBD	TBD		SSP is working to identify a placement
104	~~8009~~	~~M~~	~~9~~	~~HOLD~~	~~MILL MOUN~~	~~BREED WITH~~	~~103~~	Reported as dead during draft period

MILWAUKEE

Milwaukee County Zoological Gardens

Milwaukee, WI

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
70	B4260	F	21	HOLD	MILWAUKEE	BREED WITH	71	
71	B4259	M	20	HOLD	MILWAUKEE	BREED WITH	70	
76	B3664	F	18	HOLD	MILWAUKEE	BREED WITH	81	
81	B4109	M	17	HOLD	MILWAUKEE	BREED WITH	76	May be placed in bachelor group or paired with 76
127	B4758	M	1	HOLD	MILWAUKEE	DO NOT BREED		Bachelor group
129	B4821	M	0	HOLD	MILWAUKEE	DO NOT BREED		Bachelor group

NORFOLK

Virginia Zoological Park

Norfolk, VA

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
101	214046	F	10	HOLD	NORFOLK	DO NOT BREED		
117	212141	F	5	HOLD	NORFOLK	DO NOT BREED		

NY BRONX

Bronx Zoo/Wildlife Conservat'n Society

Bronx, NY

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
78	990040	F	17	RECEIVE FROM	MANHATTAN	BREED WITH	75	
75	B03123	M	19	HOLD	NY BRONX	BREED WITH	78	
80	B00020	F	17	SEND TO	MANHATTAN	BREED WITH	77	

PALM DES

The Living Desert

Palm Desert, CA

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
46	392001	M	28	HOLD	PALM DES	BREED WITH	56	
56	392002	F	25	HOLD	PALM DES	BREED WITH	46	
131	316001	U	0	SEND TO	TBD	DO NOT BREED		determine and report sex to facilitate placement

PUEBLO

Pueblo Zoo

Pueblo, CO

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
122	23724	F	3	RECEIVE FROM	CHICAGOLP	BREED WITH	90	
73	B25011	M	19	SEND TO	BATTLE CR	BREED WITH	72	
90	B25012	M	15	HOLD	PUEBLO	BREED WITH	122	

ROCKTON

African Lion Safari & Game Farm Ltd

Cambridge, Ontario

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
34	_____	M	45	HOLD	ROCKTON	BREED WITH	39	
39	00-01C	F	32	HOLD	ROCKTON	BREED WITH	34	
58	00-00F	M	25	HOLD	ROCKTON	DO NOT BREED		

SPRINGFIE

Henson Robinson Zoo

Springfield, IL

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
102	978	M	9	HOLD	SPRINGFIE	BREED WITH	105	
105	974	F	8	HOLD	SPRINGFIE	BREED WITH	102	

ST LOUIS

Saint Louis Zoological Park

St. Louis, MO

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
42	102387	M	29	HOLD	ST LOUIS	BREED WITH	52	
52	107691	F	26	HOLD	ST LOUIS	BREED WITH	42	

TOLEDO

Toledo Zoological Gardens

Toledo, OH

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
63	941616	M	23	HOLD	TOLEDO	BREED WITH	65	
65	951548	F	23	HOLD	TOLEDO	BREED WITH	63	

Appendix A Life Table

Males

Qx = mortality; Px = survival; Lx = cumulative survivorship; Mx = fecundity; Risk = sample size

Age	Qx	Px	lx	Mx	Risk (Qx)	Risk (Mx)
0	0.31	0.69	1	0	47.8	33.3
1	0	1	0.69	0	41.9	41.9
2	0	1	0.69	0	41.5	41.5
3	0	1	0.69	0	40.9	40.9
4	0.03	0.97	0.69	0	43	41.6
5	0.05	0.95	0.669	0	41	39.9
6	0	1	0.636	0	39	39
7	0	1	0.636	0.01	38.5	38.5
8	0	1	0.636	0	38	38
9	0.03	0.97	0.636	0.03	37.2	36.6
10	0	1	0.617	0.04	35	35
11	0.03	0.97	0.617	0.06	35	34.8
12	0	1	0.598	0.05	34	34
13	0	1	0.598	0.06	33.4	33.4
14	0.03	0.97	0.598	0.07	35	34.5
15	0	1	0.58	0.05	33.4	33.4
16	0.03	0.97	0.58	0.02	32.4	32.3
17	0	1	0.563	0.09	29.8	29.8
18	0.02	0.98	0.563	0.09	28.1	28
19	0	1	0.552	0.14	26	26
20	0	1	0.552	0.1	24.9	24.9
21	0.04	0.96	0.552	0.19	24.5	24.3
22	0	1	0.53	0.09	23.5	23.5
23	0.04	0.96	0.53	0.11	22.6	22.2
24	0	1	0.508	0.12	21	21
25	0	1	0.508	0.13	19.9	19.9
26	0.06	0.94	0.508	0.15	17.9	17.5
27	0	1	0.478	0.06	16	16
28	0	1	0.478	0	15.5	15.5
29	0.08	0.92	0.478	0.12	13.2	12.3
30	0.1	0.9	0.44	0	10.4	10
31	0.11	0.89	0.396	0.12	9	8.2
32	0.12	0.88	0.352	0.14	8	7.4
33	0	1	0.31	0	7	7
34	0	1	0.31	0.07	7	7
35	0	1	0.31	0.07	7	7
36	0.14	0.86	0.31	0	7	6.1
37	0.3	0.7	0.267	0.21	6.7	4.9

Age	Qx	Px	lx	Mx	Risk (Qx)	Risk (Mx)
38	0.25	0.75	0.187	0	4	3.7
39	0.67	0.33	0.14	0	3	2.1
40	0	1	0.046	0	1	1
41	0	1	0.046	0	1	1
42	0	1	0.046	0	1	1
43	0	1	0.046	0	1	1
44	0	1	0.046	0	0.8	0.8
45	1	0	0.046	0	0	0

r	=	0.006		
lambda	=	1.006		
T	=	22.28		
N	=	25		
N(at	20	yrs)	=	28.2

Females

Qx = mortality; Px = survival; Lx = cumulative survivorship; Mx = fecundity; Risk = sample size

Age	Qx	Px	lx	Mx	Risk (Qx)	Risk (Mx)
0	0.31	0.69	1	0	55.4	39.2
1	0	1	0.69	0	45.5	45.5
2	0	1	0.69	0	44.8	44.8
3	0	1	0.69	0	47.3	47.3
4	0.01	0.99	0.69	0	47	46.6
5	0	1	0.683	0	45.3	45.3
6	0.02	0.98	0.683	0	43.8	42.9
7	0	1	0.669	0.01	41.5	41.5
8	0	1	0.669	0.05	40.4	40.4
9	0.05	0.95	0.669	0.04	39.8	38.7
10	0	1	0.636	0.07	35.7	35.7
11	0.03	0.97	0.636	0.03	34.4	33.8
12	0.03	0.97	0.617	0.05	33	32.5
13	0	1	0.598	0.08	32	32
14	0	1	0.598	0.07	31.4	31.4
15	0	1	0.598	0.05	29.8	29.8
16	0	1	0.598	0.05	29	29
17	0	1	0.598	0.15	27.8	27.8
18	0.02	0.98	0.598	0.06	26.5	26.4
19	0	1	0.586	0.1	25.2	25.2
20	0.04	0.96	0.586	0.11	24.1	23.7
21	0	1	0.563	0.16	22.5	22.5
22	0.05	0.95	0.563	0.17	21.6	21.6

Age	Qx	Px	lx	Mx	Risk (Qx)	Risk (Mx)
23	0.05	0.95	0.535	0.19	19.2	19.1
24	0.06	0.94	0.508	0.21	18	17.3
25	0	1	0.478	0.09	16.4	16.4
26	0	1	0.478	0.14	14.8	14.8
27	0.16	0.84	0.478	0.05	12.9	11.3
28	0	1	0.401	0	10	10
29	0	1	0.401	0	9.3	9.3
30	0.22	0.78	0.401	0.06	9	8.3
31	0.14	0.86	0.313	0.09	7	6
32	0	1	0.269	0.09	5.4	5.4
33	0	1	0.269	0	5	5
34	0.2	0.8	0.269	0	5	4.1
35	0.25	0.75	0.215	0	4	3.3
36	0	1	0.161	0	3	3
37	0	1	0.161	0.17	3	3
38	0.33	0.67	0.161	0	3	2.7
39	0	1	0.108	0	2	2
40	0.71	0.29	0.108	0	2.8	1.3
41	1	0	0.031	0	0	0
42	1	0	0	0	0	0
43	1	0	0	0	0	0
44	1	0	0	0	0	0
45	1	0	0	0	0	0

r	=	0.006		
lambda	=	1.0081		
T	=	20.21		
N	=	30		
N(at	20	yrs)	=	35.23

Appendix B Ordered Mean Kinship

Note: This list is based on a studbook current to the date of analysis. Values are subject to change with any hatch, death, import, export, inclusion, or exclusion. Unknown sex individuals appear on both the male and female side of the mean kinship list. The population mean is indicated by the solid line.

Males

SB#	MK	%Known	Age	Location
34	0.000	0.0	45	ROCKTON
42	0.009	100.0	29	ST LOUIS
82	0.047	100.0	17	COLUMBIA
75	0.047	100.0	19	NY BRONX
58	0.059	100.0	25	ROCKTON
131	0.060	100.0	U0	PALM DES
124	0.060	100.0	3	DENVER
63	0.061	100.0	23	TOLEDO
50	0.066	100.0	26	BUFFALO
43	0.073	100.0	29	BIRMINGHM
104	0.075	100.0	9	MILL MOUN
95	0.075	100.0	13	EMPORIA
129	0.077	100.0	U0	MILWAUKEE
127	0.077	100.0	1	MILWAUKEE
107	0.087	100.0	7	METROZOO
90	0.087	100.0	15	PUEBLO
81	0.087	100.0	17	MILWAUKEE
51	0.090	100.0	26	DENVER
102	0.092	100.0	9	SPRINGFIE
86	0.092	100.0	16	DETROIT
77	0.092	100.0	18	MANHATTAN
73	0.092	100.0	19	PUEBLO
71	0.092	100.0	20	MILWAUKEE
41	0.092	100.0	29	CHICAGOLP
40	0.094	100.0	30	DETROIT
46	0.101	100.0	28	PALM DES

Females

SB#	MK	%Known	Age	Location
121	0.000	100.0	6	DENVER
91	0.019	100.0	15	COLUMBIA
67	0.021	100.0	22	DENVER
80	0.038	100.0	17	NY BRONX
72	0.047	100.0	20	BATTLE CR
65	0.050	100.0	23	TOLEDO
52	0.050	100.0	26	ST LOUIS
70	0.052	100.0	21	MILWAUKEE
48	0.054	100.0	27	DETROIT
103	0.055	100.0	9	MILL MOUN
125	0.057	100.0	3	BINGHAMTO
94	0.057	100.0	14	EMPORIA
131	0.060	100.0	U0	PALM DES
56	0.064	100.0	25	PALM DES
117	0.075	100.0	5	NORFOLK
112	0.075	100.0	6	METROZOO
109	0.075	100.0	7	METROZOO
98	0.075	100.0	11	DES MOINE
78	0.075	100.0	17	MANHATTAN
54	0.075	100.0	26	BUFFALO
129	0.077	100.0	U0	MILWAUKEE
122	0.079	100.0	3	CHICAGOLP
119	0.079	100.0	4	BINGHAMTO
89	0.079	100.0	15	DETROIT
126	0.087	100.0	2	DENVER
105	0.087	100.0	8	SPRINGFIE
100	0.087	100.0	10	DES MOINE
39	0.087	100.0	32	ROCKTON
101	0.092	100.0	10	NORFOLK
76	0.092	100.0	18	MILWAUKEE
49	0.101	100.0	27	BIRMINGHM

Appendix C Summary of Data Exports

Project: EBVu16
Report compiled under Population Management 2000, version 1.213
3:45:05 PM, 10/15/2016

Comments:

Date to be used for calculations: 10/15/2016

Demographic data from: C:\Users\clynch\Documents\PopLink\PopLink Databases\EBVu16\mEBVu16.prn and C:\Users\clynch\Documents\PopLink\PopLink Databases\EBVu16\fEBVu16.prn

Genetic data from: C:\Users\clynch\Documents\PopLink\PopLink Databases\EBVu16\EBVu16.ped

Studbook information:
Data exported on: 10/15/2016
Data compiled by: Mary Jo Willis
Contact info: Mary Jo Willis
Data current thru: 6/26/2016
Scope of data: North American Regional StudbookYHOSTCDenver Zoological Gardens YLASTACCSC 114YLASTEDITC 58YLASTTEMPC T206YMNEMONICC

Demographic filter conditions:
During 1/1/1970 - 10/15/2016 Status = Living

Genetic filter conditions:
As of 10/15/2016
Status = Living

Appendix D Survival Statistics

EURASIAN BLACK (CINEREOUS) VULTURE Studbook AEGYPIUS MONACHUS
North American Regional Studbook data current as of 6/26/2016
Compiled by Mary Jo Willis
PopLink Studbook filename: EBVu16
PopLink User Who Exported Report: c
Date of Export: 10/15/2016
Data Filtered by: StartDate = 1/1/1970 AND EndDate = 10/15/2016
PopLink Version: 2.4

REPORT OVERVIEW:

Data for EURASIAN BLACK (CINEREOUS) VULTURE were not of sufficient robustness to analyze and report survival statistics. See the body of the report for further details.

BACKGROUND ON ANALYSES:

These analyses were conducted using animals that lived during the period 1 January 1970 to 15 October 2016 at all institutions in the studbook. 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.

SUMMARY OF ANALYSES:

SURVIVAL STATISTICS

Unfortunately, **data were not robust enough to analyze and report survival statistics**[1] (see Data Quality section). The dataset used for analysis includes partial or full lifespans of 96 individuals, 40 (41.7%) of which had died by 15 October 2016. These data are not sufficient for further analysis.

For general reference, data are provided on the oldest individuals in the dataset defined with the analysis window. Please note that these are the individual's ages as of the end date of the demographic window (15 October 2016); for the most up-to-date ages of the oldest animals in this population, you should contact the studbook keeper for this species directly.

[1] 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, 32 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.

10 Oldest Censored Individuals[2]

Studbook ID	Sex	Birth Type	Age at Censoring	Birth Date Est.	Exit Method
34	Male	Captive Hatch	44.8	Year	alive at end of window
39	Female	Captive Hatch	32.4	None	alive at end of window
40	Male	Captive Hatch	30.4	None	alive at end of window
41	Male	Captive Hatch	29.4	None	alive at end of window
42	Male	Captive Hatch	29.4	None	alive at end of window
43	Male	Captive Hatch	29.4	None	alive at end of window
44	Female	Captive Hatch	29.3	None	alive at end of window
46	Male	Captive Hatch	28.5	None	alive at end of window
48	Female	Captive Hatch	27.4	None	alive at end of window
49	Female	Captive Hatch	27.4	None	alive at end of window

10 Oldest Dead Individuals

Studbook ID	Sex	Birth Type	Age at Death	Birth Date Est.
32	Female	Wild Hatch	40.9	Year
16	Female	Wild Hatch	40.4	Year
35	Male	Wild Hatch	40.0	Year
28	Male	Wild Hatch	39.1	Year
11	Female	Wild Hatch	38.7	Year
36	Male	Wild Hatch	38.7	Year
1	Male	Wild Hatch	37.9	Year
14	Male	Wild Hatch	37.1	Year
15	Male	Wild Hatch	36.1	Year
17	Female	Wild Hatch	34.1	Year

The PopLink Age Outliers report can give further information on these and other 'old' individuals within the studbook dataset.

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 failed at least one of the following 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? **FAIL**
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 has never been run; if errors are present in this studbook, they may affect the data in this analysis.

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[2] 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.

Appendix E Reproductive Report

EURASIAN BLACK (CINEREOUS) VULTURE Studbook
AEGYPIUS MONACHUS
North American Regional Studbook data current as of 6/26/2016
Compiled by Mary Jo Willis

PopLink Studbook filename: EBVu16
PopLink User Who Exported Report: c
Date of Export: 10/15/2016
PopLink Version: 2.4

Species Type: Egg Laying Incubation Period: 53 Days Maximum Hatch Date Range For Clutch Mates: 3 Days

DAM INFORMATION 17 reported dams, with 27.35.32 (94) offspring (not including 1 offspring of UNK/MULT dams)

Median size: 1 Mean size: 1.011

Clutch Size	Frequency	Percentage
1	92	98.92
2	1	1.08
Total	93	100.00

Hatch Seasonality
First of clutch must have a hatch date estimate of None, Day, or Month to be counted.

Month	Number of Clutches	Percentage
January	0	0.00
February	5	5.38
March	1	1.08
April	18	19.35
May	49	52.69
June	20	21.51
July	0	0.00
August	0	0.00
September	0	0.00
October	0	0.00
November	0	0.00
December	0	0.00
Total	93	100.01

Dam Age at First Reproduction Median age: 17.369 Mean age: 15.522

10 Youngest Dams at First Reproduction:

Studbook ID	Age At Hatch	Dam's Hatch Date	Estimate	First Offspring's ID	First Offspring's Hatch Date	First Offspring's Estimate
49	7.937	5/12/1989	None	73	4/19/1997	None
56	8.079	5/12/1991	None	81	6/10/1999	None
54	8.923	6/11/1990	None	78	5/14/1999	None
45	10.116	4/19/1988	None	84	6/1/1998	None
37	10.355	1/1/1974	Year	39	5/10/1984	None
48	11.989	5/11/1989	None	89	5/7/2001	None
70	13.166	3/10/1996	None	110	5/10/2009	None
32	17.358	1/1/1972	Year	48	5/11/1989	None
17	17.38	1/1/1970	Year	42	5/20/1987	None
16	17.443	1/1/1970	Year	44	6/12/1987	None

10 Oldest Dams at First Reproduction:

Studbook ID	Age At Hatch	Dam's Hatch Date	Estimate	First Offspring's ID	First Offspring's Hatch Date	First Offspring's Estimate
7	23.302	1/1/1967	Year	50	4/21/1990	None
33	22.305	1/1/1972	Year	66	4/22/1994	None
6	21.298	1/1/1967	Year	45	4/19/1988	None
67	20.999	4/27/1994	None	128	4/27/2015	None
65	19.28	2/9/1994	None	124	5/22/2013	None
10	18.426	1/1/1969	Year	43	6/6/1987	None
16	17.443	1/1/1970	Year	44	6/12/1987	None
17	17.38	1/1/1970	Year	42	5/20/1987	None
32	17.358	1/1/1972	Year	48	5/11/1989	None
70	13.166	3/10/1996	None	110	5/10/2009	None

Dam Age for All Reproduction Median age: 19.34 Mean age: 18.822

10 Oldest Dams to Have Reproduced

Studbook ID	Age At Hatch	Dam's Hatch Date	Estimate	Offspring's ID	Offspring's Hatch Date	Offspring's Estimate
16	37.363	1/1/1970	Year	103	5/14/2007	None
16	32.372	1/1/1970	Year	93	5/17/2002	None
16	31.4	1/1/1970	Year	91	5/27/2001	None
10	30.404	1/1/1969	Year	80	5/29/1999	None
32	27.299	1/1/1972	Year	82	4/20/1999	None
48	26.987	5/11/1989	None	130	5/6/2016	None
7	26.308	1/1/1967	Year	64	4/23/1993	None
32	26.111	1/1/1972	Year	75	2/10/1998	None
7	25.374	1/1/1967	Year	60	5/17/1992	None
45	25.133	4/19/1988	None	125	6/7/2013	None

SIRE INFORMATION 17 reported sires, with 27.35.32 (94) offspring (All ages are at dam conception)
Sire Age at First Reproduction Median age: 17.224 Mean age: 16.91
10 Youngest Sires at First Reproduction:

Studbook ID	Age At Estimated Conception	Sire's Hatch Date	Estimate	First Offspring's ID	First Offspring's Hatch Date	First Offspring's Estimate
50	8.917	4/21/1990	None	78	5/14/1999	None
43	9.725	6/6/1987	None	73	4/19/1997	None
41	10.908	5/13/1987	None	84	6/1/1998	None
46	10.968	4/29/1988	None	81	6/10/1999	None
71	12.862	5/7/1996	None	110	5/10/2009	None
36	14.209	1/1/1970	Year	39	5/10/1984	None
40	14.842	5/12/1986	None	89	5/7/2001	None
35	17.213	1/1/1972	Year	48	5/11/1989	None
18	17.235	1/1/1970	Year	42	5/20/1987	None
15	17.298	1/1/1970	Year	44	6/12/1987	None

10 Oldest Sires at First Reproduction:

Studbook ID	Age At Estimated Conception	Sire's Hatch Date	Estimate	First Offspring's ID	First Offspring's Hatch Date	First Offspring's Estimate
1	31.283	1/1/1956	Year	43	6/6/1987	None
51	24.816	5/11/1990	None	128	4/27/2015	None
30	22.16	1/1/1972	Year	66	4/22/1994	None
12	20.156	1/1/1970	Year	50	4/21/1990	None
63	19.814	6/6/1993	None	124	5/22/2013	None
14	18.152	1/1/1970	Year	45	4/19/1988	None
15	17.298	1/1/1970	Year	44	6/12/1987	None
18	17.235	1/1/1970	Year	42	5/20/1987	None
35	17.213	1/1/1972	Year	48	5/11/1989	None
40	14.842	5/12/1986	None	89	5/7/2001	None

Sire Age for All Reproduction Median age: 20.211 Mean age: 20.367
10 Oldest Sires to Have Reproduced

Studbook ID	Age At Estimated Conception	Sire's Hatch Date	Estimate	Offspring's ID	Offspring's Hatch Date	Offspring's Estimate
1	37.284	1/1/1956	Year	63	6/6/1993	None
36	37.218	1/1/1970	Year	103	5/14/2007	None
1	35.206	1/1/1956	Year	58	5/9/1991	None
1	34.297	1/1/1956	Year	54	6/11/1990	None
1	32.309	1/1/1956	Year	47	6/15/1988	None
15	32.227	1/1/1970	Year	93	5/17/2002	None
1	31.283	1/1/1956	Year	43	6/6/1987	None
15	31.255	1/1/1970	Year	91	5/27/2001	None
40	29.84	5/12/1986	None	130	5/6/2016	None
14	29.259	1/1/1970	Year	80	5/29/1999	None

Appendix F Definitions

Management Terms

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).

For more information on AZA policies, see http://www.aza.org/board-policies/.

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 a 11% per year increase; lambda of .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.

Mx, **Fecundity** – The average number of same-sexed young born to animals in that age class. Because SPARKS is typically using relatively small sample sizes, SPARKS calculates 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

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.
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").

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).

FOKE, First Order Kin Equivalents – The number of first-order kin (siblings or offspring) that would contain the number of copies of an individual's alleles (identical by descent) as are present in the captive-born population. Thus an offspring or sib contributes 1 to FOKE; each grand-offspring contributes 1/2 to FOKE; each cousin contributes 1/4 to FOKE. FOKE = 4*N*MK, in which N is the number of living animals in the captive population.

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 Contribution -- Number of copies of a founder's genome that are present in the living descendants. Each offspring contributes 0.5, each grand-offspring contributes 0.25, etc.

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 Genome Surviving – The sum of allelic retentions of the individual founders (i.e., the product of the mean allelic retention and the number of founders).

Founder Representation -- Proportion of the genes in the living, descendant population that are derived from that founder. I.e., proportional Founder Contribution.

GU, Genome Uniqueness – Probability that an allele sampled at random from an individual is not present, identical by descent, in any other living individual in the population. GU-all is the genome uniqueness relative to the entire population. GU-Desc is the genome uniqueness relative to the living non-founder, descendants.

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 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.

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.

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

Contact Name (IR)	Institution	Email
Brett Linsley	BATTLE CR - Binder Park Zoo, Battle Creek, MI	blinsley@binderparkzoo.org
Christina Sheehan	BINGHAMTO- Binghamton Zoo at Ross Park	csheehan@rossparkzoo.com
Cindy Pinger	BIRMINGHM - Birmingham Zoo, Birmingham, AL	cpinger@birminghamzoo.com
Shanna Dempsey	BUFFALO - Buffalo Zoo, Buffalo, NY	sdempsey@buffalozoo.org
Sunny Nelson	CHICAGOLP - Lincoln Park Zoological Gardens, Chicago, IL	Snelson@lpzoo.org
Colleen Lynch	COLUMBIA - Riverbanks Zoological Park, Columbia, SC	Clynch@riverbanks.org
Mary Jo Willis	DENVER - Denver Zoological Gardens, Denver, CO	MJWillis@denverzoo.org
Chad Comer	DES MOINE - Blank Park Zoo of Des Moines, Des Moines, IA	cjcomer@blankparkzoo.org
Tom Schneider	DETROIT - Detroit Zoological Institute, Royal Oak, MI	tschneider@detroitzoo.org
Lori Andrews	EMPORIA - Emporia Zoo, Emporia, KS	landrews@emporia-kansas.gov
Hannah Bailey	HOUSTON - Houston Zoo, Inc., Houston, TX	hbailey@houstonzoo.org
Brian Davoren	MANHATTAN - Sunset Zoo, Manhattan, KS	davoren@cityofmhk.com
Jim Dunster	METROZOO - Zoo Miami, Miami, FL	jdun@miamidade.gov
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Alex Waier	MILWAUKEE - Milwaukee County Zoological Gardens, Milwaukee, WI	alex.waier@milcnty.com
Roger Sweeney	NORFOLK - Virginia Zoological Park, Norfolk, VA	roger.sweeney@norfolk.gov
David Oehler	NY BRONX - Bronx Zoo/Wildlife Conservation Society, Bronx, NY	doehler@wcs.org
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Ashley Bowen	PUEBLO - Pueblo Zoo, Pueblo, CO	abowen@pueblozoo.org
Gareth Morgan	ROCKTON - African Lion Safari, Cambridge, Ontario	birds@lionsafari.com
Marikay Altes	SPRINGFIE - Henson Robinson Zoo, Springfield, IL	maltes@springfieldparks.org
Michael Macek	ST LOUIS - Saint Louis Zoological Park, St. Louis, MO	macek@stlzoo.org
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