

Population Analysis & Breeding and Transfer Plan

Cape Vulture (*Gyps coprotheres*) AZA Species Survival Plan® Red Program



AZA Species Survival Plan® Coordinator

Mike Maxcy, Los Angeles Zoo
mike.maxcy@lacity.org

AZA Species Survival Plan® Studbook Keeper

Jenny Schmidt, Los Angeles Zoo
Jennybschmidt27@gmail.com

AZA Population Advisor

Andrea Putnam, PhD, San Diego Zoo Global
aputnam@sandiegozoo.org

9 June 2017

PMC

Population Management Center

 LINCOLN PARK ZOO.

ASSOCIATION
OF ZOOS &
AQUARIUMS



Executive Summary

Species Survival Plan® for Cape Vulture (*Gyps coprotheres*)

The current, managed Cape Vulture SSP population includes 35 birds (17 males, 18 females, 0 unknown) held by 6 AZA institutions (16 males; 18 females) and 1 non-AZA institution (1 male). The Raptor Taxon Advisory Group set a target size of 50 individuals for this population (RCP 2015). At present, the Cape Vulture SSP population qualifies as a Red Program (<50 individuals). This is a two-year breeding and transfer plan.

Genetic and demographic analyses of the North American Regional Cape Vulture Studbook (current to 16 January 2017) were performed using PopLink 2.4 and PMx 1.4, resulting in the current breeding and transfer plan for this species. The current gene diversity in the population is 84.55% of that present in the founding population. Gene diversity at 100 years from present is projected to be 60.7% if the population grows to reach the RCP target size ($\lambda = 1.0184$). 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. 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 8 potential founders.

Demography

Current SSP population size – Total (males.females.unknown)	35 (17.18.0)
Number of animals excluded from genetic analyses	0
Population size following exclusions	35 (17.18.0)
Target population size (2015 RCP)	50
Mean generation time (T; years)	16.1
Projected population growth rate (λ ; lambda) from life tables	1.018
Recent population growth rate (average λ 2012-2016)	1.013

Genetics

	2017	Current Potential
Founders	8	8 additional
Founder genome equivalents (FGE)	3.20	9.00
Current gene diversity (GD %)	84.55	96.85
Population mean kinship (MK)	0.1545	-----
Mean inbreeding (F)	0.0188	-----
% pedigree known before assumptions and exclusions	97	-----
% pedigree known after assumptions and exclusions	100	-----
Effective population size/census size ratio (N_e / N)	0.20	-----
Years To 90% Gene Diversity	na	-----
Years To 10% Loss of GD	37*	-----
Gene Diversity at 100 Years From Present (%)	60.7 *	-----

*projections based on the breeding population grows to a size of 50 individuals ($\lambda = 1.018$)

Analyses suggest that 2 hatches are needed over the next two years (1 per year) to maintain the current population size, while 3 hatches are needed over the next two years (1- 2 per year) if the projected growth rate of 1.8% can be maintained to grow toward the RCP target size of 50 birds. Increasing reproduction beyond the projected growth rate will help the SSP maintain greater gene diversity and demographic stability in the long-term. 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 11 females to be placed in breeding situations and 9 transfers to create new breeding pairs and meet institutional needs.

Cape Vulture (Gyps coprotheres) – 2017 Final

This Animal Program is currently a Red SSP and recommendations proposed are non-binding – Participation is voluntary. Dispositions to non-AZA institutions should comply with each institution's acquisition/disposition policy.

Table of Contents

Executive Summary	1
Description of Population Status	
Introduction	3
Analytical Population	3
Demography	3
Genetics	4
Management Strategy	5
Recommendations	
Summary Recommendations	6
BRIGHTSFA, COLO SPRG, DISNEY AK	7
LOSANGELE, MEMPHIS, RIO GRAND	8
SD-WAP, ST AUGUST, TOLEDO	9
Appendices	
A. Analytical Assumptions	10
B. Summary of Data Exports	10
C. Life Tables	11
D. Individuals Excluded from Genetic Analyses	13
E. Ordered Mean Kinships	13
F. Definitions	14
G. Directory of Institutional Representatives	16

Cover Photo Courtesy of Vulpro

Report and Analyses prepared by:

Andrea Putnam, Ph.D., Population Biologist – San Diego Zoo Global, aputnam@sandiegozoo.org

Planning occurred on March 28th, 2017 during an open meeting at the AZA Mid-year Conference in Albuquerque.

This plan was reviewed and distributed with the assistance of the Population Management Center.
pmc@lpzoo.org

Cape Vulture (Gyps coprotheres) – 2017 Final
This Animal Program is currently a Red SSP and recommendations proposed are non-binding – Participation is voluntary.
Dispositions to non-AZA institutions should comply with each institution's acquisition/disposition policy.

Description of Population Status

Species Survival Plan® for Cape Vulture (*Gyps coprotheres*)

Introduction: The current, managed Cape Vulture SSP population includes 35 birds (17 males, 18 females, 0 unknown) held by 6 AZA institutions (16 males; 18 females) and 1 non-AZA institution (1 male). The Raptor Taxon Advisory Group set a target size of 50 individuals for this population (RCP 2015). At present, the Cape Vulture SSP population qualifies as a Red Program (<50 individuals). This is a two-year breeding and transfer plan.

Genetic and demographic analyses of the North American Regional Cape Vulture Studbook (current to 16 January 2017) were performed using PopLink 2.4 and PMx 1.4, resulting in the current breeding and transfer plan for this species.

Conservation Status: IUCN Red List – Endangered (listed in 2015, www.iucnredlist.org); USFWS – not listed; CITES – Appendix II

Analytical Population: Ninety-seven percent of the pedigree of the current, living population can be traced to documented founders. After two pedigree assumptions were created, 100% of the pedigree can be traced to founders (Appendix A). No birds were excluded from genetic analyses (Appendix D). A total of 35 birds (17 males, 18 females, 0 unknown) were included in the breeding population.

Demography: Based on the Studbook, Cape vultures have been held consistently in North American zoos since the mid-1980's. The first North American captive hatch occurring in 1992 at the Los Angeles Zoo. Since that time, the population size has remained under 40 individuals with small but steady numbers of zoo hatches (Figures 1 and 2). Wild-caught individuals have continued to enter the SSP population sporadically. The majority of captive hatched chicks have come from a single breeding pair (SB# 8 and 9), and both were wild-caught. Successful reproduction from other breeding pairs is a priority for this SSP. The average growth rate for the past 20 years has been 6.7% ($\lambda = 1.067$). Based on the current life tables (Appendix C) and age structure (Figure 3), the population has a projected growth rate of 1.8% per year (projected $\lambda = 1.018$).

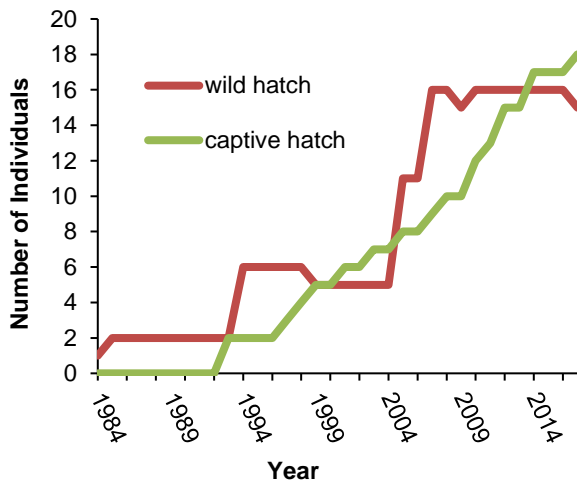


Figure 1. Census of Cape vultures in North America from 1984 to 2017, by hatch type.

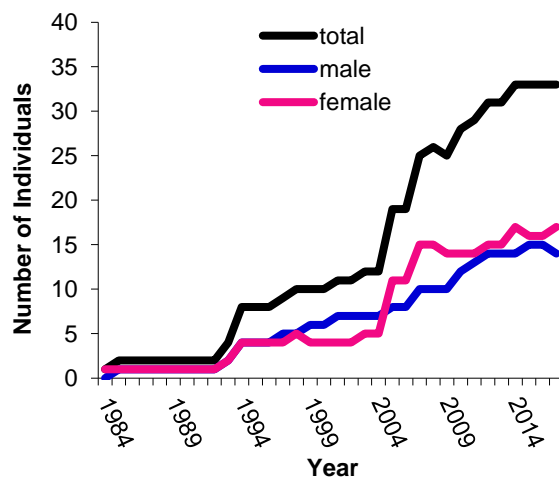


Figure 2. Census of Cape vultures in North America from 1984 to 2017, by sex.

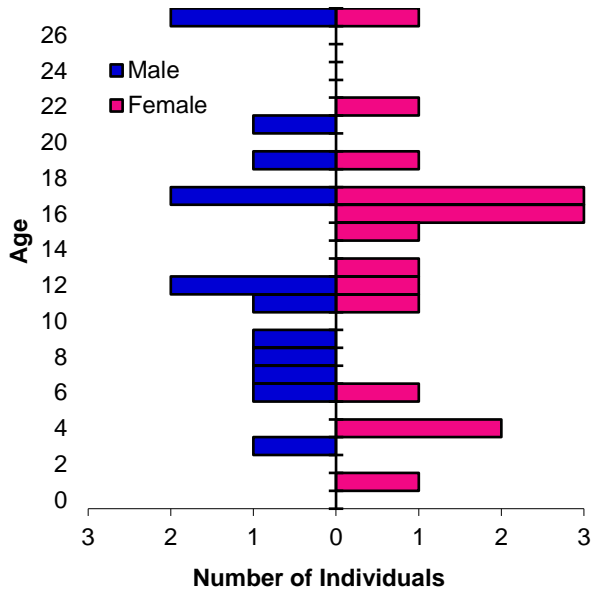


Figure 3. Age distribution of the current population of Cape vultures in North America.

The age structure of the managed Cape 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. The sex ratio is almost equal, with 1.06 females for every male in the population.

Because a relatively small number of Cape vultures have been held in North America, demographic data for this population may not yet accurately reflect the true biology of the species. Two wild-hatched males (with estimated hatch dates) have survived through their early- to mid-thirties. Data for Cape 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 32.2 years for males and 21.6 years for 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 Cape 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 3 hatches are needed over the next two years (1-2 per year) if a growth rate of 1.8% can be maintained to grow toward the RCP target size of 50 birds. The population has been averaging 1.2 hatches per year for the last 5 years, thus reproduction is sufficient to maintain or slowly grow the population toward the SSP target size. Increasing reproduction beyond the projected growth rate will help the SSP maintain greater gene diversity and demographic stability in the long-term.

Genetics: The Studbook indicates that the managed Cape vulture population is descended from 8 founders with 8 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 84.55%, which is equivalent to that found in ~3 unrelated animals (FGE = 3.20). Founder representation is very skewed, as SB# 8 and 9 are very over-represented within the SSP. Breeding the 8 potential founders and under-represented individuals will reduce future inbreeding and improve long-term gene diversity.



Figure 4: Founder representation, including the 8 potential founders (on the left side of the graph) in the managed Cape vulture population in North America.

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 Cape vulture pedigree yields a current gene diversity of ~85%, and is predicted to decline to 60.7% over the next 100 years if the population can grow to 50 individuals (1.8% growth rate).

Although inbreeding is currently low within the SSP population, the population's mean kinship is 0.1545. 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. The high mean kinship is a result of one successful breeding pair producing the majority of hatches. Breeding un- and under-represented individuals will help decrease mean kinship and maintain low average inbreeding.

Genetics Summary

	2017	Current Potential
Founders	8	8 additional
Founder genome equivalents (FGE)	3.24	9.00
Current gene diversity (GD %)	84.55	96.85
Population mean kinship (MK)	0.1545	-----
Mean inbreeding (F)	0.0188	-----
% pedigree known before assumptions and exclusions	97	-----
% pedigree known after assumptions and exclusions	100	-----
Effective population size/census size ratio (Ne / N)	0.20	-----
Years To 90% Gene Diversity	na	-----
Years To 10% Loss of GD	37*	-----
Gene Diversity at 100 Years From Present (%)	60.7 *	-----

*projections based on the breeding population grows to a size of 50 individuals ($\lambda = 1.018$)

Management Strategy: The current population of managed Cape vultures in North America includes 35 individuals (17 males, 18 females, 0 unknown) held by 6 AZA institutions and 1 non-AZA institution. To offset deaths and maintain the population size ($\lambda = 1.00$) demographic analyses indicate that 2 hatches are needed over the next two years (1 per year). Three hatches are needed over the next two years (1 - 2 per year) if a growth rate of 1.8% 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 11 females to breed to increase the population size. A particular emphasis for the SSP is breeding the 8 potential founders.
2. The SSP recommends 9 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
8	LOSANGELE	4941	M	27	HOLD	LOSANGELE	BREED WITH	9	
9	LOSANGELE	4942	F	27	HOLD	LOSANGELE	BREED WITH	8	
11	ST AUGUST	A0705	M	27	HOLD	ST AUGUST	DO NOT BREED		
15	COLO SPRG	24A021	F	22	HOLD	COLO SPRG	DO NOT BREED		Potential founder
17	RIO GRAND	B04045	M	21	SEND TO	DISNEY AK	BREED WITH	24	
19	RIO GRAND	B04046	F	19	HOLD	RIO GRAND	BREED WITH	43	
20	LOSANGELE	985225	M	19	HOLD	LOSANGELE	BREED WITH	32	
21	COLO SPRG	24A022	M	17	SEND TO	SD-WAP	BREED WITH	22	Potential founder
22	COLO SPRG	24A023	F	17	SEND TO	SD-WAP	BREED WITH	21	wing injury; potential founder
23	COLO SPRG	24A024	F	17	HOLD	COLO SPRG	DO NOT BREED		wing injury; potential founder
24	TOLEDO	3727	F	17	SEND TO	DISNEY AK	BREED WITH	17	wing injury; potential founder
25	RIO GRAND	B04043	M	17	SEND TO	DISNEY AK	BREED WITH	28	
26	ST AUGUST	A0604	F	16	HOLD	ST AUGUST	BREED WITH	34	Potential founder
27	ST AUGUST	A0605	F	16	HOLD	ST AUGUST	BREED WITH	34	wing injury
28	TOLEDO	3726	F	16	SEND TO	DISNEY AK	BREED WITH	25	wing injury; potential founder
29	RIO GRAND	B04044	F	15	HOLD	RIO GRAND	BREED WITH	43	
32	LOSANGELE	990893	F	13	HOLD	LOSANGELE	BREED WITH	20	
33	ST AUGUST	A0601	M	12	HOLD	ST AUGUST	BREED WITH	35	
34	ST AUGUST	A0602	M	12	HOLD	ST AUGUST	BREED WITH	26, 27	wing injury
35	ST AUGUST	A0603	F	12	HOLD	ST AUGUST	BREED WITH	33	
37	LOSANGELE	991144	F	11	SEND TO	COLO SPRG	DO NOT BREED		
38	MEMPHIS	15A116	M	10	HOLD	MEMPHIS	DO NOT BREED		
39	MEMPHIS	15A114	M	9	HOLD	MEMPHIS	DO NOT BREED		
40	LOSANGELE	991778	M	8	HOLD	LOSANGELE	BREED WITH	44	
41	MEMPHIS	15A115	M	8	HOLD	MEMPHIS	DO NOT BREED		
42	MEMPHIS	15A113	M	7	HOLD	MEMPHIS	DO NOT BREED		
43	LOSANGELE	992325	M	6	SEND TO	RIO GRAND	BREED WITH	19, 29	
44	LOSANGELE	994146	F	6	HOLD	LOSANGELE	BREED WITH	40	
45	BRIGHTSFA	126	M	11	HOLD	BRIGHTSFA	SEE NOTES	SEE NOTES	Potential founder
47	LOSANGELE	992847	F	4	HOLD	LOSANGELE	DO NOT BREED		
48	LOSANGELE	992883	F	4	HOLD	LOSANGELE	DO NOT BREED		
50	RIO GRAND	B14004	M	3	SEND TO	COLO SPRG	DO NOT BREED		
51	ST AUGUST	A1601	F	1	HOLD	ST AUGUST	DO NOT BREED		
52	ST AUGUST	A1704	M	0	HOLD	ST AUGUST	DO NOT BREED		
53	LOSANGELE	994256	F	0	HOLD	LOSANGELE	DO NOT BREED		

Cape Vulture (Gyps coprotheres) – 2017 Final

*This Animal Program is currently a Red SSP and recommendations proposed are non-binding – Participation is voluntary.
Dispositions to non-AZA institutions should comply with each institution's acquisition/disposition policy.*

Recommendations by Institution

BRIGHTSFA

Bright's Zoo
Limestone, TN

Institutional Note: Please contact the Program Leader if your institution is successful in importing a founder.

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
45	126	M	11	HOLD	BRIGHTSFA	SEE NOTES	SEE NOTES	Potential founder

COLO SPRG

Cheyenne Mountain Zoo
Colorado Springs, CO

Institutional Note: Please exchange male 21 and female 22 for a non-breeding pair. Females 15 and 23 may be given an interim breeding recommendation when suitable males can be identified.

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
15	24A021	F	22	HOLD	COLO SPRG	DO NOT BREED		Potential founder
21	24A022	M	17	SEND TO	SD-WAP	BREED WITH	22	Potential founder
22	24A023	F	17	SEND TO	SD-WAP	BREED WITH	21	wing injury; potential founder
23	24A024	F	17	HOLD	COLO SPRG	DO NOT BREED		wing injury; potential founder
50	B14004	M	3	RECEIVE FROM	RIO GRAND	DO NOT BREED		
37	991144	F	11	RECEIVE FROM	LOSANGELE	DO NOT BREED		

DISNEY AK

Disney's Animal Kingdom
Orlando, FL

Institutional Note: Breeding pairs may be re-configured at your institution's discretion.

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
17	B04045	M	21	RECEIVE FROM	RIO GRAND	BREED WITH	24	
25	B04043	M	17	RECEIVE FROM	RIO GRAND	BREED WITH	28	
24	3727	F	17	RECEIVE FROM	TOLEDO	BREED WITH	17	
28	3726	F	16	RECEIVE FROM	TOLEDO	BREED WITH	25	

Cape Vulture (Gyps coprotheres) – 2017 Final

*This Animal Program is currently a Red SSP and recommendations proposed are non-binding – Participation is voluntary.
Dispositions to non-AZA institutions should comply with each institution's acquisition/disposition policy.*

LOSANGELE
Los Angeles Zoo
 Los Angeles, CA

Institutional Note: Female 44 may pair with any male at LOSANGELE if necessary.

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
8	4941	M	27	HOLD	LOSANGELE	BREED WITH	9	
9	4942	F	27	HOLD	LOSANGELE	BREED WITH	8	
20	985225	M	19	HOLD	LOSANGELE	BREED WITH	32	
32	990893	F	13	HOLD	LOSANGELE	BREED WITH	20	
37	991144	F	11	SEND TO	COLO SPRG	DO NOT BREED		
40	991778	M	8	HOLD	LOSANGELE	BREED WITH	44	
43	992325	M	6	SEND TO	RIO GRAND	BREED WITH	19, 29	
44	994146	F	6	HOLD	LOSANGELE	BREED WITH	40	
47	992847	F	4	HOLD	LOSANGELE	DO NOT BREED		Outreach
48	992883	F	4	HOLD	LOSANGELE	DO NOT BREED		Outreach
53	994256	F	0	HOLD	LOSANGELE	DO NOT BREED		

MEMPHIS
Memphis Zoo
 Memphis, TN

Institutional Note: Please continue to hold male birds. In a future Plan, the SSP may ask your institution to place birds in breeding situations in exchange for display birds.

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
38	15A116	M	10	HOLD	MEMPHIS	DO NOT BREED		
39	15A114	M	9	HOLD	MEMPHIS	DO NOT BREED		
41	15A115	M	8	HOLD	MEMPHIS	DO NOT BREED		
42	15A113	M	7	HOLD	MEMPHIS	DO NOT BREED		

RIO GRAND
Albuquerque Biological Park
 Albuquerque, NM

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
17	B04045	M	21	SEND TO	DISNEY AK	BREED WITH	24	
19	B04046	F	19	HOLD	RIO GRAND	BREED WITH	43	
25	B04043	M	17	SEND TO	DISNEY AK	BREED WITH	28	
29	B04044	F	15	HOLD	RIO GRAND	BREED WITH	43	
50	B14004	M	3	SEND TO	COLO SPRG	DO NOT BREED		
43	992325	M	6	RECEIVE FROM	LOSANGELE	BREED WITH	19, 29	

SD-WAP

San Diego Zoo Safari Park
Escondido, CA

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
21	24A022	M	17	RECEIVE FROM	COLO SPRG	BREED WITH	22	Potential founder
22	24A023	F	17	RECEIVE FROM	COLO SPRG	BREED WITH	21	Wing injury; potential founder

ST AUGUST

Saint Augustine Alligator Farm Zoological Park
Augustine, FL

Institutional Note: The SSP is currently trying to identify an institution who could take male SB# 11.

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
11	A0705	M	27	HOLD	ST AUGUST	DO NOT BREED		
26	A0604	F	16	HOLD	ST AUGUST	BREED WITH	34	
27	A0605	F	16	HOLD	ST AUGUST	BREED WITH	34	
33	A0601	M	12	HOLD	ST AUGUST	BREED WITH	35	
34	A0602	M	12	HOLD	ST AUGUST	BREED WITH	26, 27	
35	A0603	F	12	HOLD	ST AUGUST	BREED WITH	33	
51	A1601	F	1	HOLD	ST AUGUST	DO NOT BREED		
52	A1704	M	0	HOLD	ST AUGUST	DO NOT BREED		

TOLEDO

Toledo Zoo
Toledo, OH

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
24	3727	F	17	SEND TO	DISNEY AK	BREED WITH	17	wing injury; potential founder
28	3726	F	16	SEND TO	DISNEY AK	BREED WITH	25	wing injury; potential founder

Cape Vulture (Gyps coprotheres) – 2017 Final

This Animal Program is currently a Red SSP and recommendations proposed are non-binding – Participation is voluntary. Dispositions to non-AZA institutions should comply with each institution's acquisition/disposition policy.

Appendix A Analytical Assumptions

SB#	Old Sire	New Sire	Old Dam	New Dam	Notes
13	UNK	8	UNK	9	SB# 8 and 9 were the only pair that produced surviving hatches of the 4 wild-caught imports at SUTTON.
52	UNK	MULT999	35		2 potential sires (11 and 33)

Appendix B Summary of Data Exports

Report compiled under PopLink V. 2.4 and Population Management x, V. 1.4.
PMx Vulture_Cape_2017

Studbook information:

Data compiled by: Jenny Schmidt
Data current thru: 1/16/2017
Scope of data: North America

Demographic data from:

Vulture_Cape_2017.csv
Demographic filter conditions:
Locations: N. America, During 1/1/1985-3/28/2017
Census file: Exhcens.txt

Genetic data from:

Vulture_Cape_2017.ped
Genetic filter conditions:
Locations: N. America, During 1/1/1985-3/28/2017

Non-AZA institution: BRIGHTSFA

Appendix C Life Tables

MALES								
Age	Qx	Px	lx	Mx	Vx	Ex	Risk (Qx)	Risk (Mx)
0	0.29	0.71	1.00	0.000	1.17	25.52	11.6	11.6
1	0.00	1.00	0.71	0.000	1.44	29.53	12.8	12.8
2	0.00	1.00	0.71	0.000	1.47	28.54	14.0	14.0
3	0.00	1.00	0.71	0.036	1.51	27.54	14.0	14.0
4	0.00	1.00	0.71	0.000	1.50	26.54	16.3	16.3
5	0.00	1.00	0.71	0.000	1.54	25.54	17.0	17.0
6	0.00	1.00	0.71	0.059	1.57	24.54	17.0	17.0
7	0.00	1.00	0.71	0.033	1.55	23.54	15.6	15.6
8	0.00	1.00	0.71	0.067	1.55	22.54	14.2	14.2
9	0.00	1.00	0.71	0.077	1.52	21.54	12.7	12.7
10	0.00	1.00	0.71	0.042	1.47	20.54	12.0	12.0
11	0.00	1.00	0.71	0.045	1.46	19.54	10.4	10.4
12	0.00	1.00	0.71	0.150	1.45	18.54	10.0	10.0
13	0.00	1.00	0.71	0.125	1.33	17.54	8.2	8.2
14	0.00	1.00	0.71	0.063	1.23	16.54	8.0	8.0
15	0.00	1.00	0.71	0.063	1.20	15.54	8.0	8.0
16	0.09	0.91	0.71	0.063	1.21	15.21	8.0	8.0
17	0.04	0.96	0.65	0.171	1.26	15.20	6.4	6.4
18	0.00	1.00	0.62	0.100	1.13	14.50	5.0	5.0
19	0.00	1.00	0.62	0.100	1.06	13.50	5.0	5.0
20	0.00	1.00	0.62	0.250	0.98	12.50	4.0	4.0
21	0.00	1.00	0.62	0.125	0.75	11.50	3.9	3.9
22	0.00	1.00	0.62	0.167	0.63	10.50	3.0	3.0
23	0.00	1.00	0.62	0.167	0.48	9.50	3.0	3.0
24	0.00	1.00	0.62	0.000	0.32	8.50	3.0	3.0
25	0.00	1.00	0.62	0.167	0.33	7.50	3.0	3.0
26	0.00	1.00	0.62	0.000	0.16	6.50	3.0	3.0
27	0.00	1.00	0.62	0.167	0.17	5.50	3.0	3.0
28	0.00	1.00	0.62	0.000	0.00	4.50	3.0	3.0
29	0.00	1.00	0.62	0.000	0.00	3.50	3.0	3.0
30	0.00	1.00	0.62	0.000	0.00	2.50	3.0	3.0
31	0.00	1.00	0.62	0.000	0.00	1.50	3.0	3.0

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:
 $r = 0.022$; $\lambda = 1.022$; $T = 16.5$

FEMALES								
Age	Qx	Px	lx	Mx	Vx	Ex*	Risk (Qx)	Risk (Mx)
0	0.26	0.74	1.00	0.000	1.15	---	9.9	9.9
1	0.00	1.00	0.74	0.000	1.37	---	9.0	9.0
2	0.00	1.00	0.74	0.000	1.39	---	10.0	10.0
3	0.00	1.00	0.74	0.050	1.41	---	10.3	10.3
4	0.00	1.00	0.74	0.000	1.38	---	12.9	12.9
5	0.00	1.00	0.74	0.000	1.40	---	14.8	14.8
6	0.00	1.00	0.74	0.033	1.41	---	15.2	15.2
7	0.00	1.00	0.74	0.033	1.40	---	15.0	15.0
8	0.00	1.00	0.74	0.067	1.38	---	15.0	15.0
9	0.00	1.00	0.74	0.033	1.33	---	15.3	15.3
10	0.00	1.00	0.74	0.094	1.32	---	16.0	16.0
11	0.00	1.00	0.74	0.031	1.24	---	16.0	16.0
12	0.00	1.00	0.74	0.067	1.22	---	15.0	15.0
13	0.00	1.00	0.74	0.110	1.17	---	13.4	13.4
14	0.00	1.00	0.74	0.077	1.08	---	13.0	13.0
15	0.07	0.93	0.74	0.038	1.05	---	12.7	12.7
16	0.02	0.98	0.69	0.199	1.07	---	10.5	10.5
17	0.00	1.00	0.68	0.063	0.89	---	7.9	7.9
18	0.00	1.00	0.68	0.200	0.84	---	5.0	5.0
19	0.20	0.80	0.68	0.125	0.72	---	4.1	4.1
20	0.00	1.00	0.54	0.167	0.67	---	3.1	3.1
21	0.13	0.87	0.54	0.000	0.55	---	3.0	3.0
22	0.23	0.77	0.47	0.250	0.68	---	2.1	2.1
23	0.00	1.00	0.36	0.500	0.50	---	1.2	1.2
24	0.00	1.00	0.36	0.000	0.00	---	1.0	1.0
25	0.00	1.00	0.36	0.000	0.00	---	1.0	1.0
26	0.00	1.00	0.36	0.000	0.00	---	1.0	1.0
27	0.00	1.00	0.36	0.000	0.00	---	1.0	1.0
28	0.00	1.00	0.36	0.000	0.00	---	1.0	1.0
29	0.00	1.00	0.36	0.000	0.00	---	1.0	1.0
30	0.00	1.00	0.36	0.000	0.00	---	1.0	1.0
31	0.00	1.00	0.36	0.000	0.00	---	1.0	1.0

Qx = mortality; Px = survival; lx = cumulative survivorship; Mx = fecundity; Vx = reproductive value; Ex = life expectancy
 *Ex is blank because the oldest reported female is currently living. At Risk (Qx and Mx) = number of animals corresponding values are estimated from: r = 0.013; lambda = 1.013; T = 15.7

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 16th, 2017. Values are subject to change with any birth, death, import, export, inclusion, exclusion, or changes in pedigree assumptions. **Average Population MK = 0.1545.**

MALES					FEMALES				
SB#	MK	% Known	Age	Location	SB#	MK	% Known	Age	Location
21	0	100	17	COLO SPRG	15	0	100	22	COLO SPRG
45	0	100	11	BRIGHTSFA	22	0	100	17	COLO SPRG
11	0.0063	100	27	ST AUGUST	23	0	100	17	COLO SPRG
33	0.0063	100	12	ST AUGUST	24	0	100	17	TOLEDO
52	0.025	100	0	ST AUGUST	26	0	100	16	ST AUGUST
34	0.0375	100	12	ST AUGUST	28	0	100	16	TOLEDO
40	0.1344	100	8	LOSANGELE	35	0.0125	100	12	ST AUGUST
43	0.1344	100	6	LOSANGELE	27	0.0375	100	16	ST AUGUST
8	0.1781	100	27	LOSANGELE	44	0.05	100	6	LOSANGELE
25	0.1906	100	17	RIO GRAND	51	0.05	100	1	ST AUGUST
38	0.1906	100	10	MEMPHIS	53	0.05	100	0	LOSANGELE
39	0.1906	100	9	MEMPHIS	32	0.1406	100	13	LOSANGELE
41	0.1906	100	8	MEMPHIS	9	0.1781	100	27	LOSANGELE
42	0.1906	100	7	MEMPHIS	47	0.1813	100	4	LOSANGELE
17	0.1969	100	21	RIO GRAND	29	0.1906	100	15	RIO GRAND
20	0.1969	100	19	LOSANGELE	37	0.1906	100	11	LOSANGELE
50	0.2094	100	3	RIO GRAND	48	0.1906	100	4	LOSANGELE
					19	0.1969	100	19	RIO GRAND

Cape Vulture (Gyps coprotheres) – 2017 Final

*This Animal Program is currently a Red SSP and recommendations proposed are non-binding – Participation is voluntary.
Dispositions to non-AZA institutions should comply with each institution's acquisition/disposition policy.*

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.

Cape Vulture (Gyps coprotheres) – 2017 Final

This Animal Program is currently a Red SSP and recommendations proposed are non-binding – Participation is voluntary. Dispositions to non-AZA institutions should comply with each institution's acquisition/disposition policy.

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
BRIGHTSFA	Tony Bright	tonyb@brightszoo.com
COLO SPRG	Amy Schilz	Aschilz@cmzoo.org
DISNEY AK	Scott Tidmus	scott.tidmus@disney.com
LOSANGELE	Mike Maxcy	mike.maxcy@lacity.org
MEMPHIS	Farshid Mehrdadfar	FMehrdadfar@memphiszoo.org
RIO GRAND	Karen Waterfall	kwaterfall@cabq.gov
SD-WAP	Mike Mace	MMace@sandiegozoo.org
ST AUGUST	Gen Anderson	GAnderson@alligatorfarm.com
TOLEDO	Monica Blackwell	monica.blackwell@toledozoo.org

Cape Vulture (Gyps coprotheres) – 2017 Final

This Animal Program is currently a Red SSP and recommendations proposed are non-binding – Participation is voluntary. Dispositions to non-AZA institutions should comply with each institution's acquisition/disposition policy.