Population Analysis & Breeding and Transfer Plan

Rüppell's Griffon Vulture (*Gyps rueppellii*)

AZA Species Survival Plan®
Yellow Program

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

Disney's ANIMALS, SCIENCE and ENVIRONMENT

Executive Summary
Species Survival Plan® for Rüppell's Griffon Vulture (*Gyps rueppellii*)

The current SSP population of Rüppell's griffon vultures is N = 60 animals (29 males; 31 females; 0 unknown sex) at 15 (26.28) AZA institutions and 3 (3.3) non-member participating institutions. This Population Analysis and Breeding and Transfer Plan was prepared April 2017 at Disney's Animal Kingdom®. The last Breeding and Transfer Plan for this species was published 16 March 2015. Analyses were based on the North American Studbook (current to 1 August 2016) and were performed using PopLink 2.4 and PMx 1.4.20160831.

The target population size designated by the Raptor Taxon Advisory Group 2015 Regional Collection Plan is 75. This population currently qualifies as a Yellow SSP.

Genetic diversity in this population is currently 88.26%. 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 chick mortality. Gene diversity in 100 years is projected to be 75.8% (based on current statistics, assuming a target population for projections of 75 and lambda = 1.03). Gene diversity in 10 generations (154 years) is projected to be 69.9%. Equalizing the founder representation by breeding individuals from underrepresented lineages and increasing the effective size, and target population size could extend gene diversity retention. This population could become a Green SSP by incorporating one new founder every 5 years, which is potentially an achievable goal for this population with imports and reproduction of the current potential founders.

Demography	
Current size of population (N) – Total (Males.Females.Unknown Sex)	60(29.31.0)
Number of individuals excluded from the potentially breeding population	5 (0.5)
Population size following exclusions	55(29.26.0)
Target population size (Kt) from the Raptor TAG's 2015 RCP	75
Mean generation time (T; years)	15.4
Historical population growth rate (λ; life table lambda 1987-present) / 5 – year from Poplink census / Projected growth rate from PMx stochastic 20 yr projections	1.030 / 1.024 / 1.005 <> 1.019 <> 1.034

Genetics		
	2017	***Potential***
Founders	13	6
Founder genome equivalents (FGE)	4.26	15.60
Gene diversity (GD %)	88.26%	96.80%
Population mean kinship (MK)	0.1174	-----
Mean inbreeding (F)	0.0122	-----
N_e/N (Effective population size/census size ratio)	0.2813*	-----
% Pedigree Known prior to assumptions and exclusions	93.1%	-----
% Pedigree Known after assumptions and exclusions	100.0%	-----
% Pedigree Certain after assumptions and exclusions	97.3%	-----
Projections		
	[a]Historical/Projected λ = 1.030	-----
Years to 90% GD	N/A	-----
Years to 10% loss of GD	69	-----
Gene Diversity at 100 Years (%)	75.8%	-----
Gene Diversity in 10 Generations (%)	69.9%	-----
Generation time (*T*) and Target population size used in projections	*T*=15.4 x 10 = 154 Target = 75	

*Value includes founders in calculations.
[a]Historical λ is population growth rate from demographic window (1987-2016) from life table calculated in PMx and Projected λ is growth rate within the range of PMx stochastic 20 yr projections.

Demographic analyses indicated that to increase the population size to 75 in 7 years, approximately 4-6 hatches are required (λ = 1.03) each year. To remain at the current size (λ = 1.00), approximately 3 hatches are needed in the next year. As with most SSP populations, breeding pairings or groupings 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 recommends 19 breeding males and 20 breeding females, as well as 8 transfers for this period. Approximately 4-6 hatches per year are required to grow this population to a size of 75 in the next 7 years.

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

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Acknowledgments

A master planning session was held 23 January 2017 at Disney's Animal Kingdom and was attended by Bryan Emberton, Chris Barth, and Gina Ferrie, all of Disney's Animal Kingdom.

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This plan was prepared and distributed with the assistance of the AZA Population Management Center (pmc@lpzoo.org).

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

Description of Population Status
Species Survival Plan® for the Rüppell's Griffon Vulture (*Gyps rueppellii*)

Introduction: The Raptor Taxon Advisory Group Regional Collection Plan (2015) designated the Rüppell's griffon vulture population to be managed as a Yellow SSP with a target size of 75. The current population consists of 60 individuals (29 males; 31 females; 0 unknown sex) distributed among 15 (26.28) AZA institutions and 3 (3.3) non-member participating institutions. This population currently qualifies as a Yellow SSP.

Comprehensive genetic and demographic analyses of the population were performed in April 2017 resulting in the current Breeding and Transfer Plan for the Rüppell's griffon vulture SSP population. The last Breeding and Transfer Recommendations for this species were published 16 March 2015. Recommendations contained in this report represent the results of these analyses. Demographic and genetic analyses were performed on the North American Studbook (current to 1 August 2016) using PopLink 2.4 and PMx 1.4.20160831. The goal of these recommendations is to help ensure the genetic and demographic health of this population. Recommendations contained in this plan supersede those made in earlier plans.

Status and Conservation: Rüppell's griffon vultures are endemic to the Sahel and Eastern regions of Africa and are currently listed as Critically Endangered by IUCN due to habitat loss and conversion to agro-pastoral systems, declines in wild ungulate populations, hunting, collision, and poisoning.

Analytical Population: The current population size is 60 (TAG recommended size = 75). A few assumptions were required for this population to account for unknown origin animals that likely are founders to the population, and a few birds with MULT parentage (Appendix A). Prior to assumptions and exclusions, the population's pedigree was 93.1% known. After assumptions and adding MULT parentage to the pedigree (with equal probability), this population's pedigree is 100% known and 97.3% certain. A total of 5 individuals (0.5) were excluded from the potentially breeding population due to advanced age and health concerns (Appendix C). The population of potentially breeding animals following all exclusions is 55 (29.26).

Demography: Rüppell's griffon vultures were first seen in North American facilities in the early 1920s but in very small numbers, with the original imports being done by Philadelphia Zoo. The first hatch occurred in 1967, but hatches were not regular in the population until 1987. Since then, the population has grown fairly consistently, peaking at 61 birds in 2016. The North American managed population has displayed a general trend of increase since 1987 with an average growth rate of about 4.1% (average λ last 30 years from census = 1.021; Figure 1). Average growth for the last 10 years was positive (average λ = 1.028), and in the last five years the growth rate has slowed a little (average λ = 1.024). In the last five years, number of hatches has varied from 0-4 each year with an average of 2.2 hatches per year.

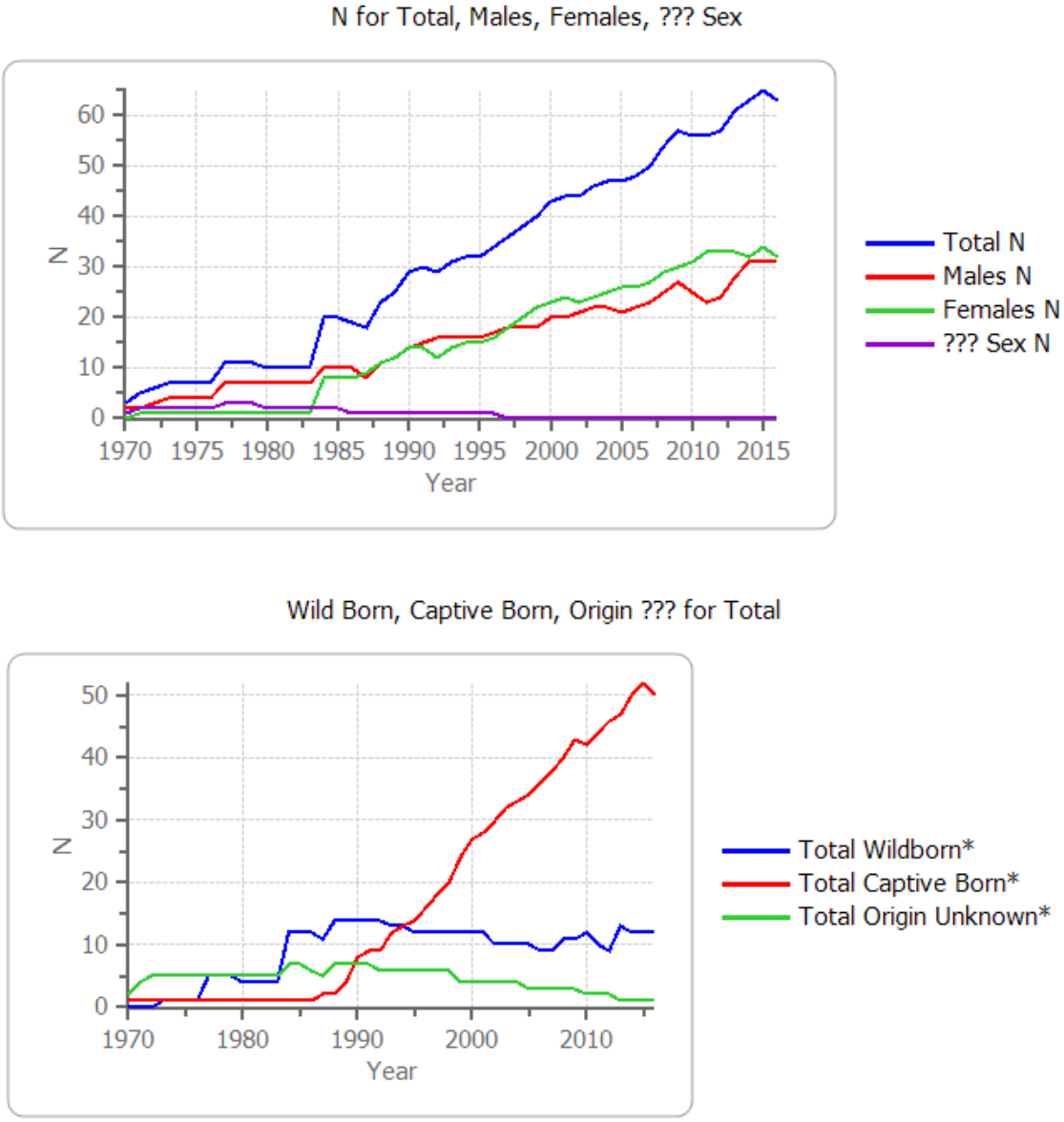
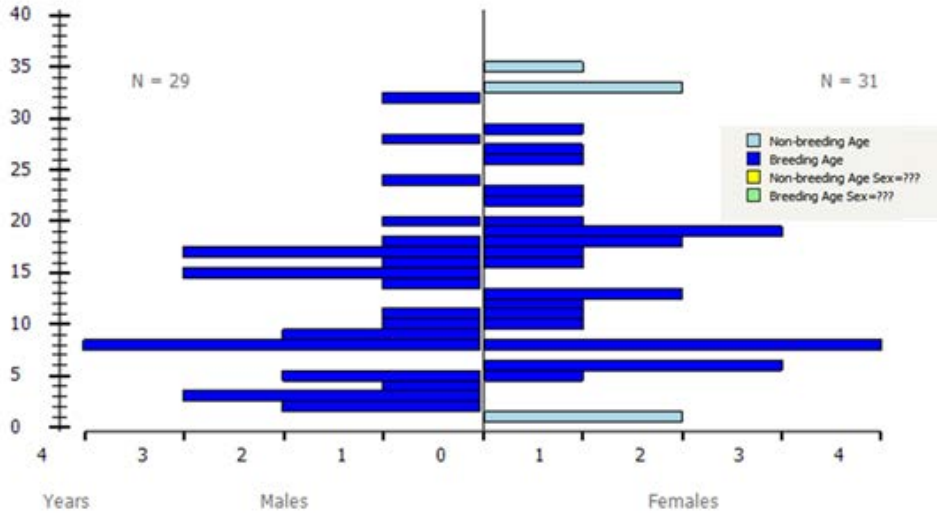


Figure 1. Census of Rüppell's griffon vultures in North America 1970 - 2016 by sex and by birth type.

The age structure of the total population is somewhat columnar to pyramidal, with approximately even number of individuals of each sex and most age classes filled, although not always filled with individuals of both sexes (Figure 2A). Additionally, the youngest age classes have very low female recruitment, which could become a concern for reproductive management in 5-10 years. The age pyramid after exclusions (Figure 2B) shows the removal of five females from the upper age classes, and the resulting male sex-bias in reproductively managed birds. Efforts should be made to stabilize the age distribution in the interest of easing future management by increasing the number of recommended breeding pairs and producing more chicks.

A)



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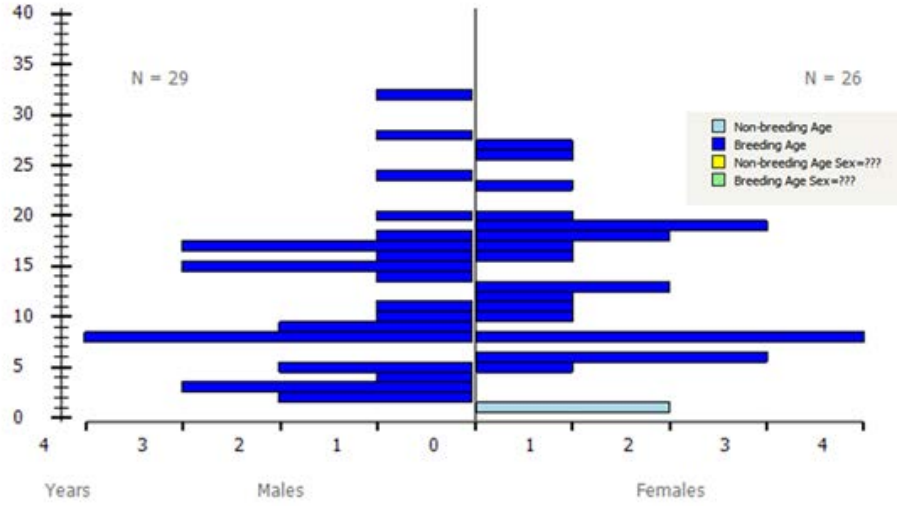

Figure 2. Age structure of the Rüppell's griffon vultures population in AZA and non-member participating institutions prior to (A) and after (B) genetic exclusions showing age classes 0-35 as of April 2017.

According to studbook records from 1987-2016, first year mortality in the SSP population is 13% for males and 16% for females. This is relatively low hatchling mortality, but as this studbook does not have very robust life tables as this point, most demographic variables may not represent the future capacity of this population. Both males and females become sexually mature at approximately 5-6 years of age, although there are some records which may indicate breeding at 2-3 years. There is too little reproductive data to make any good predictions about fecundity but it is likely that senescence is reached at approximately age 32 for males and 30 for females, although data in the upper age classes is limited. The oldest male Rüppell's griffon vulture lived to be older than 38 years, and was likely a wild capture with an estimated hatch year. The oldest female Rüppell's griffon vulture is still living at slightly older than 35 years old and was assumed to be wild caught. Survival statistics could not be calculated on this population due to limited demographic data. Clutch size is one egg, and all recorded hatchings have occurred from December-April with most occurring in January.

Genetics: The Rüppell's griffon vulture population is descended from 13 founders and 6 potential founders remain. Given current population parameters, gene diversity is estimated to be approximately 88.26%. This is equivalent to approximately 4 unrelated individuals (FGE = 4.26). Population mean kinship (MK) is 0.1174, and mean inbreeding (F) is 0.0122. While inbreeding remains currently low, mean kinship is increasing, likely due to the prolific pairing of two founders (#24 and #25), whose genes are 27% of the founder representation (Figure 3). The ratio of N_e/N in this population, including founders in the calculations (0.2813) is approximately average for monogamous species, and likely reflects the success of more breeding in previous years but also the short reproductive history of this population.

Based on current statistics, at 100 years from present with a positive growth rate of about 3% (historical λ = 1.030) and a target population size of 75, gene diversity is estimated at 75.8%. In 10 generations, or 154 years, gene diversity is estimated at 69.9%. 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 chick mortality. To retain gene diversity for a longer period of time, pairings should be made in order to maintain or minimize low population mean kinship and mean inbreeding values and to equalize the founder representation (Figure 3).

At this time, this population meets the standards of a Yellow SSP. In order to become a Green SSP, or maintain 90% gene diversity for 100 years or 10 generations, more founders would need to be incorporated into this population. Incorporating one new founder every 5 years would lead to retention of 90% gene diversity for 107 years. There is a possibility to add new founders to this population through importation, and incorporation of potential founders that currently are present in the population.

Genetics				
	2009	***2015***	***2017***	***Potential***
Founders	12	15	13	6
Founder genome equivalents (FGE)	4.29	4.14	4.26	15.60
Gene diversity (GD %)	88.3%	87.91%	88.26%	96.80%
Population mean kinship (MK)	0.117	0.1209	0.1174	-----
Mean inbreeding (F)	0.0931	0.0168	0.0122	-----
N_e/N (Effective population size/census size ratio)	0.32	0.3396*	0.2813*	-----
% Pedigree Known prior to assumptions and exclusions	----	93.0%	93.1%	-----
% Pedigree Known after assumptions and exclusions	95.0%	100.0%	100.0%	-----
% Pedigree Certain after assumptions and exclusions	----	97.0%	97.3%	-----
Projections				
	[a]Projected λ = 1.03	[b]Historical λ = 1.039	[c]Historical/Projected λ = 1.030	-----
Years to 90% GD	N/A	N/A	N/A	-----
Years to 10% loss of GD	-----	75	69	-----
Gene Diversity at 100 Years (%)	77.0%	76.5%	75.8%	-----
Gene Diversity in 10 Generations (%)	-----	72.0%	69.9%	-----
Generation time (*T*) and Target population size used in projections		*T*=14.4 x 10 = 144 Target = 75	*T*=15.4 x 10 = 154 Target = 75	

*Value includes founders in calculations.
[a]Projected λ was used in 2009 for projections with PM2000.
[b]Historical λ is population growth rate from demographic window (1987-2013) from life table calculated in PMx.
[c]Historical λ is population growth rate from demographic window (1987-2016) from life table calculated in PMx and Projected λ is growth rate within the range of PMx stochastic 20 yr projections.

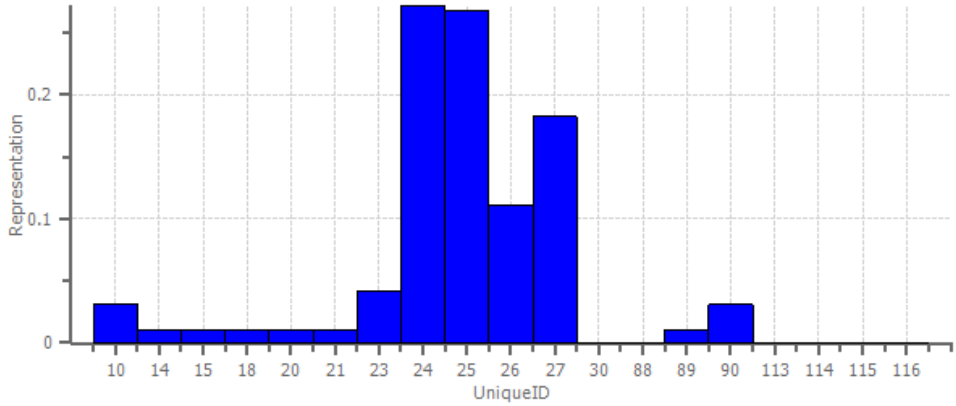

Figure 3. Founder representation graph illustrating the unequal distribution of founder lines in the Rüppell's griffon vulture SSP population as of April 2017.

Management Strategy: The current total population is 60 with a TAG recommended target of 75. According to demographic projections, approximately 4-6 hatches are needed each year to increase the population to the target size in 7 years at a growth rate of 3.0% (λ = 1.03). Because there have been five birds imported in the last 7 years and population growth is currently being driven by imports, this projected hatch rate may be higher than the population can realistically attain. Every effort should be made to increase the number of hatches. To simply maintain the population at its current size (λ = 1.00), approximately 3 hatches are required in the next year.

This is a 2-year plan (2017-2019). Another full set of recommendations will be produced in 2019 but interim recommendations will be made as needed. **Please promptly report hatches and deaths to the SSP Coordinator so that interim recommendations can be made as soon as possible.**

To meet population goals, the SSP:

1) Recommends 19 males and 20 females to breed in pairs or small flocks for this plan.

2) Recommends 8 transfers to set up new breeding pairs and fulfill institutional requests.

Summary of Breeding and Transfer Recommendations

Sorted by Studbook Number

SB#	Location	Sex	Age	Disposition	Location	Breeding	With	Notes
20	LOUISVILL	F	35	HOLD	LOUISVILL	DO NOT BREED		Excluded due to age
25	PHOENIX	F	33	HOLD	PHOENIX	DO NOT BREED		At least 33 years, excluded due to age
28	COLUMBIA	F	33	HOLD	COLUMBIA	DO NOT BREED		Excluded due to age, genetically valuable potential founder
30	INDIANAPL	M	32	HOLD	INDIANAPL	BREED WITH	42	Mis-matched pair, male genetically valuable potential founder, female over-represented, unlikely pair based on male's age
35	COLUMBIA	F	29	HOLD	COLUMBIA	DO NOT BREED		Excluded due to age, genetically valuable potential founder
36	SD-WAP	M	28	HOLD	SD-WAP	BREED WITH	SEE MATERX	Genetically valuable
39	SD-WAP	F	27	HOLD	SD-WAP	BREED WITH	SEE MATERX	
42	INDIANAPL	F	26	HOLD	INDIANAPL	BREED WITH	30	Mis-matched pair, male genetically valuable potential founder, female over-represented, unlikely pair based on male's age
47	S BARBARA	M	24	HOLD	S BARBARA	DO NOT BREED		
50	DETROIT	F	23	~~HOLD~~ SEND TO	~~DETROIT~~ SD-WAP	BREED WITH	~~51~~ SEE MATERX	~~Mis-matched pairing, male genetically valuable, female over-represented, breed for demographics, successful pair~~
~~51~~	~~DETROIT~~	~~M~~	~~23~~	~~HOLD~~	~~DETROIT~~	~~BREED WITH~~	~~50~~	~~Mis-matched pairing, male genetically valuable, female over-represented, breed for demographics, successful pair~~ Reported dead during comment period
52	LOUISVILL	F	22	HOLD	LOUISVILL	DO NOT BREED		Excluded due to health
56	SD-WAP	F	20	~~SEND TO~~ HOLD	~~NY BRONX~~ SD-WAP	~~DO NOT BREED~~ BREED WITH	SEE MATERX	Available
57	S BARBARA	M	20	HOLD	S BARBARA	DO NOT BREED		
58	SD-WAP	F	19	HOLD	SD-WAP	BREED WITH	SEE MATERX	Genetically valuable
59	DISNEY AK	F	19	HOLD	DISNEY AK	BREED WITH	SEE MATERX	
60	WINNIPEG	F	19	SEND TO	DISNEY AK	BREED WITH	SEE MATERX	Genetically valuable
61	WINNIPEG	F	18	SEND TO	DISNEY AK	BREED WITH	SEE MATERX	Genetically valuable
62	DISNEY AK	M	18	HOLD	DISNEY AK	BREED WITH	SEE MATERX	
63	DISNEY AK	F	18	HOLD	DISNEY AK	BREED WITH	SEE MATERX	
64	FRANKLINP	M	17	SEND TO	PHOENIX	BREED WITH	SEE MATERX	Genetically valuable
65	DISNEY AK	M	17	HOLD	DISNEY AK	BREED WITH	SEE MATERX	Genetically valuable
66	SD-WAP	F	17	HOLD	SD-WAP	BREED WITH	SEE MATERX	
67	DISNEY AK	M	17	HOLD	DISNEY AK	BREED WITH	SEE MATERX	
70	PHOENIX	~~M~~ F	16	HOLD	PHOENIX	BREED WITH	SEE MATERX	
71	PHOENIX	~~F~~ M	16	HOLD	PHOENIX	BREED WITH	SEE MATERX	
73	DETROIT	M	15	~~HOLD~~ SEND TO	~~DETROIT~~ SD-WAP	~~DO NOT BREED~~ BREED WITH	SEE MATERX	
74	DISNEY AK	M	15	HOLD	DISNEY AK	BREED WITH	SEE MATERX	
75	METRORICH	M	15	HOLD	METRORICH	DO NOT BREED		
76	PHOENIX	M	14	~~SEND TO~~ HOLD	~~DALLAS~~ PHOENIX	~~DO NOT BREED~~ BREED WITH	SEE MATERX	
77	GREENVISC	F	13	HOLD	GREENVISC	DO NOT BREED		
78	GREENVISC	F	13	HOLD	GREENVISC	DO NOT BREED		

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

SB#	Location	Sex	Age	Disposition	Location	Breeding	With	Notes
81	GREENVISC	F	12	HOLD	GREENVISC	DO NOT BREED		
82	PHOENIX	M	11	HOLD	PHOENIX	BREED WITH	SEE MATERX	
83	FT WAYNE	F	11	HOLD	FT WAYNE	BREED WITH	89	Mis-matched pair, male genetically valuable founder, female over-represented, breed for demographics, successful pair
85	DETROIT	F	8	~~HOLD~~ SEND TO	~~DETROIT~~ SD-WAP	~~DO NOT BREED~~ BREED WITH	SEE MATERX	
86	LOUISVILL	M	8	HOLD	LOUISVILL	DO NOT BREED		
87	DISNEY AK	F	8	HOLD	DISNEY AK	BREED WITH	SEE MATERX	
88	DISNEY AK	F	6	HOLD	DISNEY AK	BREED WITH	SEE MATERX	At least 6 years old, genetically valuable potential founder
89	FT WAYNE	M	8	HOLD	FT WAYNE	BREED WITH	83	Mis-matched pair, male genetically valuable founder, female over-represented, breed for demographics, successful pair
90	SD-WAP	M	10	HOLD	SD-WAP	BREED WITH	SEE MATERX	Genetically valuable founder
92	FT WAYNE	M	9	HOLD	FT WAYNE	DO NOT BREED		
93	UTICA	F	10	HOLD	UTICA	DO NOT BREED		
97	NZP-WASH	M	6	HOLD	NZP-WASH	BREED WITH	98	Mis-matched pair, male genetically valuable, female over-represented, breed for demographics
98	NZP-WASH	F	5	HOLD	NZP-WASH	BREED WITH	97	Mis-matched pair, male genetically valuable, female over-represented, breed for demographics
99	PHOENIX	M	9	HOLD	PHOENIX	BREED WITH	SEE MATERX	
100	PHOENIX	F	6	SEND TO	FRANKLINP	BREED WITH	103	Mis-matched pairing, male genetically valuable, female over-represented, breed for demographics
101	PHOENIX	F	6	HOLD	PHOENIX	BREED WITH	SEE MATERX	Genetically valuable
102	SD-WAP	M	5	HOLD	SD-WAP	BREED WITH	SEE MATERX	
103	DISNEY AK	M	5	SEND TO	FRANKLINP	BREED WITH	100	Mis-matched pairing, male genetically valuable, female over-represented, breed for demographics
104	DISNEY AK	M	3	HOLD	DISNEY AK	BREED WITH	SEE MATERX	Genetically valuable
105	CINCINNAT	M	3	HOLD	CINCINNAT	DO NOT BREED		
108	DALLAS	M	2	~~SEND TO~~ HOLD	~~PHOENIX~~ DALLAS	~~BREED WITH~~ DO NOT BREED	~~SEE MATERX~~	Genetically valuable
109	DALLAS	M	3	HOLD	DALLAS	DO NOT BREED		
110	SD-WAP	M	2	HOLD	SD-WAP	BREED WITH	SEE MATERX	
111	SD-WAP	F	2	HOLD	SD-WAP	BREED WITH	SEE MATERX	Genetically valuable
112	SD-WAP	F	1	~~SEND TO~~ HOLD	~~NY BRONX~~ SD-WAP	~~DO NOT BREED~~ BREED WITH	SEE MATERX	Fully flighted, Available
113	VA SAFARI	M	8	HOLD	VA SAFARI	SEE NOTES		Genetically valuable
114	VA SAFARI	M	8	HOLD	VA SAFARI	SEE NOTES		Genetically valuable
115	VA SAFARI	F	8	HOLD	VA SAFARI	SEE NOTES		Genetically valuable
116	VA SAFARI	F	8	HOLD	VA SAFARI	SEE NOTES		Genetically valuable

Breeding and Transfer Recommendations by Institution

CINCINNAT

Cincinnati Zoo and Botanical Garden

Cincinnati, OH

Note: Institution requested to receive a female. The only available female at this time is a full sibling to this male. The SSP Coordinator will continue to look for a female to breed with this male in the future.

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
105	214033	M	3	HOLD	CINCINNAT	DO NOT BREED		

COLUMBIA

Riverbanks Zoo and Garden

Columbia, SC

Note: All current individuals likely to be senescent, but contact SSP Coordinator if females still lay regularly. Institution has requested to place birds at a somewhat geographically close location as soon as possible. During comment period, it was noted that the last egg that was laid was in 2010.

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
28	9674	F	33	HOLD	COLUMBIA	DO NOT BREED		Excluded due to age, genetically valuable founder
35	10227	F	29	HOLD	COLUMBIA	DO NOT BREED		Excluded due to age, genetically valuable founder

DALLAS

Dallas Zoo

Dallas, TX

Note: SB#108 is valuable to get into breeding situation. ~~Receive SB#76 to keep numbers the same or discuss future directions with SSP Coordinator.~~ Institution requested to maintain 2.0 at this time but is open to sending out and swapping birds when SB#108 is closer to breeding age.

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
~~76~~	~~9762~~	~~M~~	~~14~~	~~RECEIVE FROM~~	~~PHOENIX~~	~~DO NOT BREED~~		
108	16T013	M	2	~~SEND TO~~ HOLD	~~PHOENIX~~ DALLAS	~~BREED WITH~~ DO NOT BREED	~~SEE MATERX~~	Genetically valuable
109	15T012	M	3	HOLD	DALLAS	DO NOT BREED		

DETROIT

Detroit Zoological Society

Royal Oak, MI

Note: Institution requested to place all birds and phase out of this species during the comment period.

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
50	4498	F	23	~~HOLD~~ SEND TO	~~DETROIT~~ SD-WAP	BREED WITH	~~51~~ SEE MATERX	~~Mis-matched pairing, male genetically valuable, female over-represented, breed for demographics, successful pair~~
~~51~~	~~4499~~	~~M~~	~~23~~	~~HOLD~~	~~DETROIT~~	~~BREED WITH~~	~~50~~	Reported dead during comment period
73	8756	M	15	~~HOLD~~ SEND TO	~~DETROIT~~ SD-WAP	~~DO NOT BREED~~ BREED WITH	SEE MATERX	
85	12068	F	8	~~HOLD~~ SEND TO	~~DETROIT~~ SD-WAP	~~DO NOT BREED~~ BREED WITH	SEE MATERX	

DISNEY AK

Disney's Animal Kingdom

Bay Lake, FL

Note: All birds are held at Disney's Animal Kingdom Lodge.

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
59	110531	F	19	HOLD	DISNEY AK	BREED WITH	SEE MATERX	
60	B01656	F	19	RECEIVE FROM	WINNIPEG	BREED WITH	SEE MATERX	Genetically valuable
61	B01657	F	18	RECEIVE FROM	WINNIPEG	BREED WITH	SEE MATERX	Genetically valuable
62	010229	M	18	HOLD	DISNEY AK	BREED WITH	SEE MATERX	
63	100126	F	18	HOLD	DISNEY AK	BREED WITH	SEE MATERX	
65	110357	M	17	HOLD	DISNEY AK	BREED WITH	SEE MATERX	Genetically valuable
67	010211	M	17	HOLD	DISNEY AK	BREED WITH	SEE MATERX	
74	110530	M	15	HOLD	DISNEY AK	BREED WITH	SEE MATERX	
87	090021	F	8	HOLD	DISNEY AK	BREED WITH	SEE MATERX	
88	100728	F	6	HOLD	DISNEY AK	BREED WITH	SEE MATERX	At least 6 years old, genetically valuable potential founder
103	140663	M	5	SEND TO	FRANKLINP	BREED WITH	100	Mis-matched pairing, male genetically valuable, female over-represented, breed for demographics
104	140664	M	3	HOLD	DISNEY AK	BREED WITH	SEE MATERX	Genetically valuable

Using the **MateRx** Matrix:

MateRx should be used to pair up or re-pair birds if necessary.

Pairs with Mate Suitability Indices (MSIs) of 1, 2, or 3 should be prioritized for breeding, while pairs with MSIs 5,6, or — are discouraged. MSI ratings of 4 may be bred for demographic purposes.

For more explanation on **MateRx**, please refer to Appendix F at the back of this document.

		Females					
		59	60	61	63	87	88
Males	62	-	**3**	**3**	4	-	**3**
	65	**3**	**2**	**2**	**3**	**3**	**1**
	67	4	**3**	**3**	4	-	**3**
	74	4	**3**	**3**	4	-	**3**
	103	**3**	**3**	**3**	4	**3**	**2**
	104	**3**	**3**	**3**	**3**	**3**	**1**

FRANKLINP

Zoo New England, Franklin Park Zoo

Boston, MA

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
64	A08467	M	17	SEND TO	PHOENIX	BREED WITH	SEE MATERX	Genetically valuable
100	11394	F	6	RECEIVE FROM	PHOENIX	BREED WITH	103	Mis-matched pairing, male genetically valuable, female over-represented, breed for demographics
103	140663	M	5	RECEIVE FROM	DISNEY AK	BREED WITH	100	

FT WAYNE

Fort Wayne Children's Zoo

Fort Wayne, IN

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
83	98207	F	11	HOLD	FT WAYNE	BREED WITH	89	Mis-matched pair, male genetically valuable founder, female over-represented, breed for demographics, successful pair
89	98096	M	8	HOLD	FT WAYNE	BREED WITH	83	
92	98209	M	9	HOLD	FT WAYNE	DO NOT BREED		

GREENVISC

Greenville Zoo

Greenville, SC

Note: All females over-represented at this time.

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
77	XGA004	F	13	HOLD	GREENVISC	DO NOT BREED		
78	XGA003	F	13	HOLD	GREENVISC	DO NOT BREED		
81	XGA005	F	12	HOLD	GREENVISC	DO NOT BREED		

INDIANAPL

Indianapolis Zoo

Indianapolis, IN

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
30	880366	M	32	HOLD	INDIANAPL	BREED WITH	42	Mis-matched pair, male genetically valuable potential founder, female over-represented, unlikely pair based on male's age
42	920036	F	26	HOLD	INDIANAPL	BREED WITH	30	

LOUISVILL

Louisville Zoological Garden

Louisville, KY

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
20	200116	F	35	HOLD	LOUISVILL	DO NOT BREED		Excluded due to age
52	201037	F	22	HOLD	LOUISVILL	DO NOT BREED		Excluded due to health
86	202430	M	8	HOLD	LOUISVILL	DO NOT BREED		

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

METRORICH – *non-AZA SSP participant*

Metro Richmond Zoo

Moseley, VA

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
75		M	15	HOLD	METRORICH	DO NOT BREED		

NY BRONX

Bronx Zoo/Wildlife Conservation Society

Bronx, NY

Note: ~~This is a new institution to the SSP. Both females are over-represented at this time, but SSP Coordinator will look for a male or two males for pairing in the future.~~ Institution reported during comment period that they cannot accept birds at this time.

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
~~56~~	~~814248~~	~~F~~	~~20~~	~~RECEIVE FROM~~	~~SD-WAP~~	~~DO NOT BREED~~		
~~112~~	~~815241~~	~~F~~	~~1~~	~~RECEIVE FROM~~	~~SD-WAP~~	~~DO NOT BREED~~		

NZP-WASH

Smithsonian National Zoological Park

Washington, DC

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
97	216126	M	6	HOLD	NZP-WASH	BREED WITH	98	Mis-matched pair, male genetically valuable, female over-represented, breed for demographics
98	216127	F	5	HOLD	NZP-WASH	BREED WITH	97	

PHOENIX

Phoenix Zoo

Phoenix, AZ

Note: Most current individuals are over-represented and related as this institution has produced many of the chicks in the population. Bring in new birds to make genetic matches that are more appropriate. This institution has had a lot of success and we would like to set up this colony with birds that are unrelated to each other. Males have been recommended to transfer in for now and the SSP Coordinator will continue to look for available females.

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
25	4408	F	33	HOLD	PHOENIX	DO NOT BREED		At least 33 years, excluded due to age
64	A08467	M	17	RECEIVE FROM	FRANKLINP	BREED WITH	SEE MATERX	Genetically valuable
70	9275	~~M~~ F	16	HOLD	PHOENIX	BREED WITH	SEE MATERX	
71	9280	~~F~~ M	16	HOLD	PHOENIX	BREED WITH	SEE MATERX	
76	9762	M	14	~~SEND TO~~ HOLD	~~DALLAS~~ PHOENIX	~~DO NOT BREED~~ BREED WITH	SEE MATERX	
82	10572	M	11	HOLD	PHOENIX	BREED WITH	SEE MATERX	
99	10960	M	9	HOLD	PHOENIX	BREED WITH	SEE MATERX	
100	11394	F	6	SEND TO	FRANKLINP	BREED WITH	103	Mis-matched pairing, male genetically valuable, female over-represented, breed for demographics
101	11687	F	6	HOLD	PHOENIX	BREED WITH	SEE MATERX	Genetically valuable
~~108~~	~~16T013~~	~~M~~	~~2~~	~~RECEIVE FROM~~	~~DALLAS~~	~~BREED WITH~~	~~SEE MATERX~~	~~Genetically valuable~~

Using the **MateRx** Matrix:

MateRx should be used to pair up or re-pair birds if necessary.

Pairs with Mate Suitability Indices (MSIs) of 1, 2, or 3 should be prioritized for breeding, while pairs with MSIs 5,6, or — are discouraged. MSI ratings of 4 may be bred for demographic purposes.

For more explanation on **MateRx**, please refer to Appendix F at the back of this document.

		Females		
		~~71~~ 70	100	101
Males	64	**3**	**3**	**2**
	~~70~~ 71	4	-	4
	76	4	-	-
	82	-	-	4
	99	-	-	4
	~~108~~	~~**3**~~	~~**3**~~	~~**2**~~

S BARBARA

Santa Barbara Zoological Gardens

Santa Barbara, CA

Note: Both individuals are over-represented, but SSP coordinator will continue to look for female that might be a good match for breeding in the future.

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
47	700430	M	24	HOLD	S BARBARA	DO NOT BREED		
57	700431	M	20	HOLD	S BARBARA	DO NOT BREED		

SD-WAP

San Diego Zoo Safari Park

Escondido, CA

Note: Institution reported that they would like to maintain 5-6 breeding pairs. SB#s 56 and 112 are available for placement. The SSP Coordinator is working on a potential transfer location and will report back with a plan ASAP. Please continue discussions on placement of these two females with SSP. It would be beneficial to have them placed in a breeding situation.

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
36	804304	M	28	HOLD	SD-WAP	BREED WITH	SEE MATERX	Genetically valuable
39	991912	F	27	HOLD	SD-WAP	BREED WITH	SEE MATERX	
50	4498	F	23	RECEIVE FROM	DETROIT	BREED WITH	~~51~~ SEE MATERX	~~Mis-matched pairing, male genetically valuable, female over-represented, breed for demographics, successful pair~~
56	814248	F	20	~~SEND TO~~ HOLD	~~NY BRONX~~ SD-WAP	~~DO NOT BREED~~ BREED WITH	SEE MATERX	Available
58	897258	F	19	HOLD	SD-WAP	BREED WITH	SEE MATERX	Genetically valuable
66	814249	F	17	HOLD	SD-WAP	BREED WITH	SEE MATERX	
73	8756	M	15	RECEIVE FROM	DETROIT	~~DO NOT BREED~~ BREED WITH	SEE MATERX	
85	12068	F	8	RECEIVE FROM	DETROIT	~~DO NOT BREED~~ BREED WITH	SEE MATERX	
90	809246	M	10	HOLD	SD-WAP	BREED WITH	SEE MATERX	Genetically valuable founder
102	812003	M	5	HOLD	SD-WAP	BREED WITH	SEE MATERX	
110	814261	M	2	HOLD	SD-WAP	BREED WITH	SEE MATERX	
111	815012	F	2	HOLD	SD-WAP	BREED WITH	SEE MATERX	Genetically valuable
112	815241	F	1	~~SEND TO~~ HOLD	~~NY BRONX~~ SD-WAP	~~DO NOT BREED~~ BREED WITH	SEE MATERX	Fully flighted, Avaiable

Using the **MateRx** Matrix:

MateRx should be used to pair up or re-pair birds if necessary.

Pairs with Mate Suitability Indices (MSIs) of 1, 2, or 3 should be prioritized for breeding, while pairs with MSIs 5,6, or — are discouraged. MSI ratings of 4 may be bred for demographic purposes.

For more explanation on **MateRx**, please refer to Appendix F at the back of this document.

		Females							
		39	50	56	58	66	85	111	112
Males	36	4	**3**	**3**	**2**	**3**	**3**	**2**	-
	73	5	-	4	**3**	4	-	**3**	4
	90	4	**3**	**3**	**1**	**3**	**3**	-	**3**
	102	-	4	4	**3**	4	4	**3**	-
	110	-	4	4	**3**	4	4	**3**	-

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UTICA – *non-AZA SSP participant*

Utica Zoo

Utica, NY

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
93	213003	F	10	HOLD	UTICA	DO NOT BREED		

VA SAFARI – *non-AZA SSP participant*

Virginia Safari Park & Preserv Ctr, Inc

Natural Bridge, VA

Note: These birds are potential founders and are genetically valuable to the population. Allow to breed in any combination and discuss placement of any future chicks who would be priority for breeding.

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
113		M	8	HOLD	VA SAFARI	SEE NOTES		Genetically valuable
114		M	8	HOLD	VA SAFARI	SEE NOTES		Genetically valuable
115		F	8	HOLD	VA SAFARI	SEE NOTES		Genetically valuable
116		F	8	HOLD	VA SAFARI	SEE NOTES		Genetically valuable

WINNIPEG

Assiniboine Park Zoo

Winnipeg, Manitoba, CA

Note: This institution requested to phase out this species.

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
60	B01656	F	19	SEND TO	DISNEY AK	BREED WITH	SEE MATERX	Genetically valuable
61	B01657	F	18	SEND TO	DISNEY AK	BREED WITH	SEE MATERX	Genetically valuable

Appendix A
Pedigree Assumptions

Assumptions are based on an analytical studbook (RUPPELLS_3Jan2016 + XXRUPPEL2014) created by the Adjunct Population Biologist (Gina Ferrie) in November 2014. These assumptions were used to assume WILD/WILD parentage for birds with unknown origin that entered early in the population, and to assign MULT parentage to a few birds with UNK/UNK parentage listed.

MULT parentage assumptions were calculated using probabilistic parents with equal probabilities to each individual in the MULT.

Analytical data for true individuals:

Studbook ID	Field	TRUE	Overlay	Notes
15	Dam	UNK	WILD	Based on date showing up in population, assume WILD/WILD.
	Sire	UNK	WILD	
20	Dam	UNK	WILD	Based on date showing up in population, assume WILD/WILD.
	Sire	UNK	WILD	
21	Dam	UNK	WILD	Based on date showing up in population, assume WILD/WILD.
	Sire	UNK	WILD	
57	Sire	UNK	MULT2	MULT2 is 24, 27, 36
60	Dam	UNK	MULT1	MULT1 is 23 and 39
61	Dam	UNK	MULT1	MULT1 is 23 and 39
68	Dam	UNK	MULT1	MULT1 is 23 and 39

PMx MULTs
ID:MULT1
*DAMS: 23; 39
ID:MULT2
*SIRES: 24; 27; 36

Appendix B
Summary of Data Exports

PMx Project: Ruppells Vulture 15 Feb 2017
Created: 2017-02-15 by PMx version 1.4.20160831
File: C:\PMxProjects\Ruppells Vulture 15 Feb 2017.pmxproj

Primary data file
Data File Name: XXRUPPELLS_3Jan2016.ped
Common Name: Ruppell's griffon vulture
Scientific Name: Gyps rueppelli
Data Source: PopLink
Studbook Name: RUPPELLS_3Jan2016
Exported On: 2017-02-15
Software version: PopLink 2.4
Current through: 2016-08-01
Compiled by: Bryan Emberton
Scope: North American regional
Dates: 2017-02-15
Locations: N.AMERICA
Association:
Other Filters: Status = Living
User: Gina Ferrie

Locations data file
Data File Name: location.txt

Demographic input files
MPrn file: mXXRUPPELLS_3Jan2016.prn
FPrn file: fXXRUPPELLS_3Jan2016.prn
Census1 file: Exchcens.txt

Male LifeTable filter:
*Common Name: Ruppell's griffon vulture
*Scientific Name: Gyps rueppelli
*Data Source: PopLink
*Studbook Name: RUPPELLS_3Jan2016
*Exported On: 2017-02-15
*Software version: PopLink 2.4
*Current through: 2016-08-01
*Compiled by: Bryan Emberton
*Scope: North American regional
***Dates: 1987-01-01 to 2017-02-15**
***Locations: N.AMERICA**
*Association:
*Other Filters: Status = Living
*User: Gina Ferrie

Female LifeTable filter:
*Common Name: Ruppell's griffon vulture
*Scientific Name: Gyps rueppelli
*Data Source: PopLink
*Studbook Name: RUPPELLS_3Jan2016
*Exported On: 2017-02-15
*Software version: PopLink 2.4
*Current through: 2016-08-01
*Compiled by: Bryan Emberton
*Scope: North American regional
***Dates: 1987-01-01 to 2017-02-15**
***Locations: N.AMERICA**
*Association:
*Other Filters: Status = Living
*User: Gina Ferrie

Demographic data from: C:\Documents and Settings\FERRG014\My Documents\PopLink\PopLink Databases\RUPPELLS_3Jan2017\PMx Exports\mXXRUPPELLS_3Jan2017.prn and fRUPPELLS_3Jan2017.prn

Genetic data from: C:\Documents and Settings\FERRG014\My Documents\PopLink\PopLink Databases\ RUPPELLS_3Jan2017\PMx Exports\XXRUPPELLS_3Jan2017.ped

Please note that the following numbers are calculated slightly differently from SPARKS:
For each offspring, each parent gets 0.5 of the birth attributed to him/her.
There are 74 total births in the demographic window.
57 births are attributed to known parents with a known age.
15 births are attributed to known parents with an unknown age.
2 births are attributed to unknown parents.
This means that 23% of the total births are attributed to unknown parents or parents with unknown ages.

Data changes after studbook submitted:

- SB#48 reported dead, updated death date
- Age estimate of "Year" was giving to following birds for demographic analysis – SB#s 25, 24, 25, 88
- SB#91 reported dead, removed from analyses

Changes between DRAFT and FINAL:

- DALLAS requested change to recommendations to keep current males at this time
- PHOENIX reported that SB# 70 and 71 had their sexes reversed, so updates have been made throughout plan to reflect this
- SB# 51 DETROIT reported dead, removed from tables and from population numbers, all birds from DETROIT will transfer to SD-WAP

Appendix C

Animals Excluded from the Genetic Analysis

Summary of Exclusions: 5 (0.5)
Age: 4 (0.4)
Health: 1 (0.1)

SB#	Location	Sex	Age	Reason for Exclusion
20	LOUISVILL	F	35	Age
25	PHOENIX	F	33	Age
28	COLUMBIA	F	33	Age
35	COLUMBIA	F	29	Age
52	LOUISVILL	F	22	Health

Appendix D
Life Tables

*Birth flow was changed from continuous to pulse. Ruppel's griffon vultures are seasonal breeders and when comparing seasonality the distribution is significantly different from uniform (χ^2= 96.32, df=11, p<0.05).

Males

Age (years)	Px	Mid Px	Qx	Risk Qx	Lx	Mx	Risk Mx	Ex	Vx
0	0.87	0.93	0.13	38.10	1.00	0.00	38.10	23.30	1.00
1	1.00	0.99	0.00	33.80	0.87	0.00	33.80	25.63	1.19
2	0.97	0.97	0.03	33.00	0.87	0.03	33.00	24.63	1.24
3	0.97	0.97	0.03	30.80	0.84	0.00	30.80	24.36	1.29
4	0.97	0.97	0.03	30.30	0.82	0.00	30.30	24.08	1.38
5	0.96	0.98	0.04	28.00	0.79	0.00	28.00	23.80	1.48
6	1.00	1.00	0.00	26.00	0.76	0.09	26.00	23.75	1.59
7	1.00	0.98	0.00	26.00	0.76	0.06	26.00	22.75	1.56
8	0.96	0.98	0.04	22.90	0.76	0.21	22.90	21.75	1.56
9	1.00	1.00	0.00	19.90	0.73	0.08	19.90	21.61	1.45
10	1.00	0.98	0.00	19.20	0.73	0.21	19.20	20.61	1.43
11	0.95	0.97	0.05	20.10	0.73	0.04	20.10	19.61	1.26
12	1.00	1.00	0.00	19.00	0.70	0.04	19.00	19.59	1.33
13	1.00	1.00	0.00	19.00	0.70	0.13	19.00	18.59	1.34
14	1.00	0.97	0.00	18.10	0.70	0.13	18.10	17.59	1.26
15	0.94	0.97	0.06	16.80	0.70	0.00	16.80	16.59	1.17
16	1.00	0.96	0.00	14.20	0.65	0.17	14.20	16.59	1.29
17	0.92	0.91	0.08	12.70	0.65	0.20	12.70	15.59	1.16
18	0.89	0.94	0.11	9.10	0.60	0.10	9.10	15.86	1.08
19	1.00	1.00	0.00	8.00	0.54	0.00	8.00	16.69	1.14
20	1.00	1.00	0.00	7.50	0.54	0.11	7.50	15.69	1.19
21	1.00	1.00	0.00	7.50	0.54	0.00	7.50	14.69	1.12
22	1.00	1.00	0.00	8.40	0.54	0.19	8.40	13.69	1.16
23	1.00	1.00	0.00	7.60	0.54	0.21	7.60	12.69	1.00
24	1.00	1.00	0.00	6.60	0.54	0.24	6.60	11.69	0.82
25	1.00	1.00	0.00	6.50	0.54	0.12	6.50	10.69	0.61
26	1.00	1.00	0.00	6.50	0.54	0.12	6.50	9.69	0.50
27	1.00	1.00	0.00	6.50	0.54	0.12	6.50	8.69	0.40
28	1.00	0.91	0.00	5.50	0.54	0.15	5.50	7.69	0.29
29	0.82	0.85	0.18	5.50	0.54	0.00	5.50	6.69	0.14
30	0.89	0.94	0.11	4.50	0.44	0.00	4.50	6.94	0.18
31	1.00	1.00	0.00	4.00	0.39	0.00	4.00	6.68	0.21
32	1.00	1.00	0.00	3.70	0.39	0.22	3.70	5.68	0.22
33	1.00	1.00	0.00	3.00	0.39	0.00	3.00	4.68	0.00
34	1.00	0.84	0.00	3.00	0.39	0.00	3.00	3.68	0.00
35	0.67	0.80	0.33	3.00	0.39	0.00	3.00	2.68	0.00
36	1.00	0.75	0.00	2.00	0.26	0.00	2.00	2.50	0.00
37	0.50	0.33	0.50	2.00	0.26	0.00	2.00	1.50	0.00
38	0.00	0.00	1.00	1.00	0.13	0.00	1.00	1.00	0.00
39	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00

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

r = 0.037
lambda = 1.030
T = 15.4
N = 32
N(at 20 yrs) = 47

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Females

Age (years)	Px	Mid Px	Qx	Risk Qx	Lx	Mx	Risk Mx	Ex	Vx
0	0.84	0.91	0.16	37.40	1.00	0.00	37.40	---	1.00
1	1.00	1.00	0.00	30.90	0.84	0.00	30.90	---	1.22
2	1.00	1.00	0.00	30.00	0.84	0.00	30.00	---	1.25
3	1.00	1.00	0.00	31.40	0.84	0.02	31.40	---	1.28
4	1.00	0.99	0.00	35.30	0.84	0.00	35.30	---	1.28
5	0.97	0.98	0.03	37.60	0.84	0.03	37.60	---	1.31
6	1.00	1.00	0.00	34.20	0.81	0.03	34.20	---	1.36
7	1.00	1.00	0.00	33.00	0.81	0.05	33.00	---	1.36
8	1.00	1.00	0.00	30.20	0.81	0.07	30.20	---	1.34
9	1.00	1.00	0.00	28.00	0.81	0.10	28.00	---	1.30
10	1.00	1.00	0.00	26.70	0.81	0.08	26.70	---	1.22
11	1.00	1.00	0.00	25.00	0.81	0.04	25.00	---	1.17
12	1.00	1.00	0.00	24.10	0.81	0.09	24.10	---	1.16
13	1.00	1.00	0.00	23.00	0.81	0.09	23.00	---	1.09
14	1.00	1.00	0.00	22.00	0.81	0.15	22.00	---	1.02
15	1.00	1.00	0.00	22.00	0.81	0.07	22.00	---	0.90
16	1.00	1.00	0.00	22.40	0.81	0.05	22.40	---	0.84
17	1.00	1.00	0.00	21.10	0.81	0.18	21.10	---	0.81
18	1.00	0.97	0.00	20.00	0.81	0.11	20.00	---	0.65
19	0.94	0.94	0.06	17.00	0.81	0.03	17.00	---	0.55
20	0.93	0.96	0.07	14.70	0.77	0.04	14.70	---	0.57
21	1.00	1.00	0.00	13.50	0.71	0.08	13.50	---	0.58
22	1.00	0.96	0.00	12.60	0.71	0.13	12.60	---	0.51
23	0.91	0.95	0.09	11.60	0.71	0.09	11.60	---	0.39
24	1.00	1.00	0.00	10.50	0.65	0.16	10.50	---	0.34
25	1.00	1.00	0.00	10.50	0.65	0.05	10.50	---	0.18
26	1.00	0.94	0.00	9.60	0.65	0.00	9.60	---	0.13
27	0.88	0.94	0.12	8.60	0.65	0.07	8.60	---	0.14
28	1.00	1.00	0.00	7.50	0.57	0.00	7.50	---	0.08
29	1.00	0.96	0.00	7.10	0.57	0.08	7.10	---	0.08
30	0.92	0.80	0.08	6.50	0.57	0.00	6.50	---	0.00
31	0.67	0.80	0.33	6.00	0.52	0.00	6.00	---	0.00
32	1.00	1.00	0.00	4.00	0.35	0.00	4.00	---	0.00
33	1.00	1.00	0.00	2.80	0.35	0.00	2.80	---	0.00
34	1.00	0.61	0.00	2.00	0.35	0.00	2.00	---	0.00
35	0.21	0.35	0.79	1.30	0.35	0.00	1.30	---	0.00
36	1.00	1.00	0.00	0.00	0.07	0.00	0.00	---	0.00
37	1.00	1.00	0.00	0.00	0.07	0.00	0.00	---	0.00
38	1.00	1.00	0.00	0.00	0.07	0.00	0.00	---	0.00
39	1.00	1.00	0.00	0.00	0.07	0.00	0.00	---	0.00
40	1.00	1.00	0.00	0.00	0.07	0.00	0.00	---	0.00

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

r = 0.023
lambda = 1.023
T = 15.5
N = 29
N(at 20 yrs) = 47

Appendix E

Ordered Mean Kinship

Note: This list is current to March 2017 and is based on studbook data with pedigree assumptions. Values are subject to change with any birth, death, import, export, inclusion, or exclusion. Unknown sex animals appear on both sides of the chart. U signifies a portion of the pedigree is unknown.

Average Population MK = 0.1174

Males

SB#	MK	%Known	Age	Location
30	0.0000	100%	32	INDIANAPL
113	0.0000	100%	8	VA SAFARI
114	0.0000	100%	8	VA SAFARI
89	0.0052	100%	8	FT WAYNE
64	0.0104	100%	17	FRANKLINP
65	0.0104	100%	17	DISNEY AK
90	0.0156	100%	10	SD-WAP
104	0.0299	100%	3	DISNEY AK
108	0.0299	100%	2	DALLAS
97	0.0794	100%	5	NZP-WASH
~~51~~	~~0.0864~~	~~100%~~	~~23~~	~~DETROIT~~
36	0.0924	100%	28	SD-WAP
103	0.0938	100%	4	DISNEY AK
73	0.1224	100%	15	DETROIT
74	0.1280	100%	15	DISNEY AK
67	0.1306	100%	17	DISNEY AK
76	0.1306	100%	14	PHOENIX
57	0.1372	100%	20	S BARBARA
102	0.1385	100%	5	SD-WAP
105	0.1385	100%	3	CINCINNAT
109	0.1385	100%	3	DALLAS
110	0.1385	100%	2	SD-WAP
47	0.1402	100%	24	S BARBARA
82	0.1402	100%	11	PHOENIX
99	0.1402	100%	9	PHOENIX
92	0.1406	100%	9	FT WAYNE
62	0.1428	100%	18	DISNEY AK
71	0.1428	100%	16	PHOENIX
75	0.1432	100%	15	METRORICH
86	0.1480	100%	8	LOUISVILL

Females

SB#	MK	%Known	Age	Location
115	0.0000	100%	8	VA SAFARI
116	0.0000	100%	8	VA SAFARI
88	0.0000	100%	6	DISNEY AK
111	0.0299	100%	1	SD-WAP
58	0.0339	100%	19	SD-WAP
101	0.0731	100%	6	PHOENIX
60	0.1036	100%	19	WINNIPEG
61	0.1036	100%	18	WINNIPEG
85	0.1224	100%	8	DETROIT
98	0.1224	100%	5	NZP-WASH
78	0.1280	100%	13	GREENVISC
70	0.1306	100%	16	PHOENIX
112	0.1385	100%	1	SD-WAP
42	0.1402	100%	26	INDIANAPL
59	0.1402	100%	19	DISNEY AK
81	0.1402	100%	12	GREENVISC
63	0.1406	100%	18	DISNEY AK
77	0.1406	100%	13	GREENVISC
93	0.1406	100%	10	UTICA
87	0.1419	100%	8	DISNEY AK
100	0.1419	100%	6	PHOENIX
56	0.1428	100%	20	SD-WAP
66	0.1428	100%	17	SD-WAP
83	0.1432	100%	11	FT WAYNE
50	0.1480	100%	23	DETROIT
39	0.1740	100%	27	SD-WAP

Appendix F
Recommendations Using MateRx

MateRx is analytical software developed jointly by the National Zoological Park and Lincoln Park Zoo. The primary output is a matrix of genetic ratings (Mate Suitability Indices = MSI) for every possible breeding pair in a population. MSIs allow managers to quickly discover how the genetic status of specimens in their collections compare to the rest of a managed population.

Each MSI represents the genetic consequences for the population if a given pair were to produce offspring. There are seven values for MSIs: offspring of pairs rated 1, 2, or 3 would benefit the population's genetic situation; pairs rated 4, 5, or 6 would be detrimental to the population's genetic situation. Pairs without an MSI value (i.e., a dash [--]) should not be considered under any circumstances without consulting an SPMAG advisor. These MSI values are defined as:

1 – very beneficial
2 – moderately beneficial
3 – slightly beneficial
4 – slightly detrimental
5 – moderately detrimental
6 – very detrimental

MateRx integrates four genetic factors to produce the Mate Suitability Index (MSI). These four components are currently used by SPMAG members to develop pairing recommendations for SSPs and PMPs. In decreasing order of "importance," they are:

1. the expected change in genetic diversity (increase, decrease) that would result if an offspring of a pair is added to the population;
2. the relative rareness or commonness of the parents genetic information (i.e., the relative dissimilarity of parental mean kinships);
3. the inbreeding coefficient of offspring that would be produced by a pair; and
4. the proportion, if any, of the dam and/or sire's pedigree that is of unknown origin.

Each **MateRx** MSI value represents a continuous range of rankings which SPMAG advisors can use to fine tune recommendations for the maximum possible genetic benefits to a population.

Questions about the interpretation of **MateRx** output should be directed to the Adjunct Population Biologist at (gina.m.ferrie@disney.com).

Because this population is so heavily weighted by those descendants of a single founder pair, the Weighted Method was used in place of the standard Tulsa Method, with less weight given to inbreeding (75%). Although the current population has relatively low inbreeding, many potential pairings will produce inbred offspring in the next generation. Therefore, the inbreeding bin of the Mate Rx was altered to represent a more inbred population, with the No Way point set at 0.1875.

Bin	1	2	3	Break Point	4	5	6	No Way
Percentile	0.00	0.50	1.00	----	0.33	0.67	1.00	----
Value	0.000	0.02674	0.05348	0.05348	0.09121	0.12894	0.16667	0.1875
#	342	0	6	----	57	243	8	
%	0.44	0.00	0.01	----	0.07	0.31	0.01	

Appendix G
Descriptive Survival Statistics Report

Ruppell's griffon vulture Studbook
Gyps rueppelli
North American regional Studbook

Studbook data current as of 8/1/2016

Compiled by
Bryan Emberton
bryan.emberton@disney.com

PopLink Studbook filename: RUPPELLS_3Jan2017
PopLink User Who Exported Report: Gina Ferrie
Date of Export: 2/15/2017
Data Filtered by: Locations = N.AMERICA AND StartDate = 1/1/1987 AND EndDate = 2/15/2017
PopLink Version: 2.4

REPORT OVERVIEW:

Data for Ruppell's griffon 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 1987 to 15 February 2017 at institutions within N.AMERICA. 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 83 individuals, 21 (25.3%) of which had died by 15 February 2017. 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 February 2017); for the most up-to-date ages of the oldest animals in this population, you should contact the studbook keeper for this species directly.

10 Oldest Censored Individuals[2]

Studbook ID	Sex	Birth Type	Age at Censoring	Birth Date Est.	Exit Method
20	Female	Unknown	35.3	Year	alive at end of window
28	Female	Wild Hatch	33.2	Month	alive at end of window
30	Male	Wild Hatch	32.7	Year	alive at end of window
36	Male	Captive Hatch	28.0	None	alive at end of window
39	Female	Captive Hatch	27.1	None	alive at end of window
42	Female	Captive Hatch	26.1	None	alive at end of window
47	Male	Captive Hatch	24.1	None	alive at end of window
50	Female	Captive Hatch	23.1	None	alive at end of window
~~51~~	~~Male~~	~~Captive Hatch~~	~~23.1~~	~~None~~	~~alive at end of window~~
52	Female	Captive Hatch	22.1	None	alive at end of window

10 Oldest Dead Individuals

Studbook ID	Sex	Birth Type	Age at Death	Birth Date Est.
15	Male	Unknown	38.4	Year
10	Male	Wild Hatch	37.6	Year
18	Male	Wild Hatch	35.6	Year
14	Female	Wild Hatch	35.4	Year
21	Female	Unknown	31.5	Year
22	Female	Wild Hatch	31.1	Month
11	Unknown	Captive Hatch	30.5	Year
37	Female	Captive Hatch	27.1	None
48	Female	Captive Hatch	23.9	None
49	Female	Captive Hatch	20.1	None

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 was last run on 2/15/2017. This validation found 0 errors, including 0 high priority errors, 0 medium priority errors, and 0 low priority errors. These errors may or may not directly affect the data in this analysis.

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[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, 11 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.

[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 H
Definitions

Management Terms (as of June 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 I
Directory of Institutional Representatives

Organization	First Name	Last Name	Email	Phone
Fort Worth Zoo	Shelly	Collinsworth	scollinsworth@fortworthzoo.org	(817)759-7212
Disney's Animal Kingdom	Bryan	Emberton	bryan.emberton@disney.com	(321)239-0911
Phoenix Zoo	C Drew	Foster	dfoster@phoenixzoo.org	(602)914-4369
Indianapolis Zoological Society Inc.	Tim	Littig	tlittig@indyzoo.com	
Dallas Zoo	Sprina	Liu	sprina.liu@dallaszoo.com	(469)554-7240
Riverbanks Zoo & Garden	Colleen	Lynch	clynch@riverbanks.org	(803)978-1059
San Diego Zoo Safari Park	Michael	Mace	mmace@sandiegozoo.org	(760)738-5077
Franklin Park Zoo	Josh	Meyerchick	jmeyerchick@zoonewengland.com	
Smithsonian National Zoological Park	Gilbert	Myers	myersg@si.edu	(202)633-4189
Santa Barbara Zoological Gardens	Rachel	Ritchason	rritchason@sbzoo.org	(805)962-5339 (139)
The Zoo at Chehaw	Ben	Roberts	broberts@chehaw.org	(229)364-3360
Fort Wayne Children's Zoo	Joseph	Smith	joe.smith@kidszoo.org	(260)427-6246
Kansas City Zoo	Timothy	Steinmetz	timsteinmetz@fotzkc.org	(816)595-1324
Saint Louis Zoo	Anne	Tieber	tieber@stlzoo.org	(314)646-4684
Assiniboine Park Zoo	John	Toothill	jtoothill@assiniboinepark.ca	(204)927-8016
Cleveland Metroparks Zoo	Travis	Vineyard	tgv@clevelandmetroparks.com	(216)635-3350
Louisville Zoo	Gary	Michael	Gary.michael@louisvilleky.gov	
Detroit Zoo	Tom	Schneider	tschneider@dzs.org	(248) 336-5828
Greenville Zoo	Keith	Gilchrist	kgilchrist@greenvillesc.gov	(864) 467-4520
Utica Zoo	Mike	Bates	Mike.Bates@uticazoo.org	(315) 738-0425
Metro Richmond	Jim	Andelin	jim@metrorichmondzoo.com	(804) 739-5666
Bronx Zoo WCS	David	Oehler	doehler@wcs.org	(718) 220-5159
Virginia Safari Park	Eric	Mogenson	emogensen@zoofariparks.com	(540) 291-3205
Cincinnati Zoo	Jenny	Gainer	jennifer.gainer@cincinnatizoo.org	