Population Analysis & Breeding and Transfer Plan

River Hippopotamus (*Hippopotamus amphibius*)
AZA Species Survival Plan®
Yellow Program

AZA Species Survival Plan® Coordinator & AZA Studbook Keeper
John Davis, Riverbanks Zoo & Garden (jdavis@riverbanks.org)

Adjunct Population Advisor
Colleen Lynch, Riverbanks Zoo & Garden (clynch@riverbanks.org)

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PMC
Population Management Center
Lincoln Park Zoo
ASSOCIATION OF ZOOS & AQUARIUMS

RIVERBANKS ZOO AND GARDEN

Executive Summary

Species Survival Plan® for the River Hippopotamus (*Hippopotamus amphibius*)

The river hippopotamus population at the time of analysis consists of 98 (37.60.1) individuals at 37 institutions in Canada, the United States, and Mexico. The Wild Pig, Peccary, and Hippo Taxon Advisory Group (TAG) designated the River hippopotamus to be managed as a SSP in their 2008 Regional Collection Plan (RCP) with a target population size of 101. This population currently qualifies as a Yellow SSP Program.

Of special concern to this population is the high degree of unknownness in the pedigree. Only 55% of the living population's pedigree is known (i.e., traces back to known or assumed wild ancestors). Genetic management of this population can only be conducted in a rudimentary fashion by avoiding close inbreeding where possible and by attempting to keep family lines equal. However, due to the long lifespans of these animals, even a simple genetic management strategy such as avoidance of close inbreeding will be difficult to implement for those animals with unknown pedigrees and unknown origins. **The Program should continue to investigate unknown origin & unknown pedigree animals in order to facilitate future genetic management**.

Demography	
Current size of population (N) - Total (Males, Females, Unknown)	98 (37.60.1)
# animals excluded from management	11
Population size following exclusions	87
Target population size	101
Mean generation time (yrs)	16.19
Historic/Projected population growth rate (lambda)	1.031/1.031

Genetics (Genetic statistics calculated from the analytical studbook)	***Current***	***Potential***
Founders	33	0
Founder genome equivalents (FGE)	9.47	16.17
Gene diversity (GD%)	94.72	96.91
Population mean kinship (MK)	0.0528	
Mean inbreeding (F)	0.0228	
Percentage of pedigree known before assumptions and exclusions	44	
Percentage of pedigree known after assumptions and exclusions	55	
Effective population size/census size ratio (Ne / N)	0.3346	
Years To 90% Gene Diversity	53	
Years to 10% Loss of Gene Diversity	127	
Gene Diversity at 100 Years From Present (%) Assuming λ = 1.031, Target size = 101	86	

**Note: Genetic analyses are based solely on the portion of the pedigree that is known or assumed in the analytical studbook (55%) and as a result do not accurately reflect the genetic status of the entire living population.*

According to demographic projections, the population can be maintained at its current size (0% growth rate or lambda = 1.00) with approximately three to four births per year. Any additional births are expected to result in population growth. The SSP will need to be careful that breeding is not limited to a small number of individuals so that representation of family lineages remains relatively equal and future inbreeding is avoided.

New institutions or institutions interested in housing additional animals should contact the SSP Coordinator. It is especially important that breeding facilities be recruited to the program and facilities housing only females may be asked in the near future to accept males and initiate breeding.

Summary Actions: The SSP recommends 4 females for breeding, though only two pairs are logistically possible in the next year. In addition, 3 transfers are recommended.

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SSP Coordinator/AZA Studbook Keeper:
John Davis, Riverbanks Zoo & Botanical Gardens, 803-602-0886, jdavis@riverbanks.org

Report and Analyses Prepared By: ADJUNCT PMC ADVISOR
Colleen Lynch, Riverbanks Zoo and Garden, clynch@riverbanks.org

The river hippopotamus planning session was hosted by the Riverbanks Zoo and Garden on 14 AUG 2014

Photo courtesy of Richard W. Rokes.

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

This Animal Program is currently a Yellow 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 the River (Nile) Hippopotamus (*Hippopotamus amphibius*)

Introduction: The river hippopotamus population at the time of analysis is 98 animals (37.60.1) at 37 AZA institutions. The Wild Pig, Peccary, and Hippo Taxon Advisory Group has designated the river hippopotamus to be managed as a SSP in the 2008 Regional Collection Plan with a target population size of 101 individuals. This population currently qualifies as a Yellow SSP Program.

Comprehensive genetic and demographic analyses of the population were performed in August 2014 resulting in the current Breeding and Transfer Plan for this species. Analyses of the North American Regional River Hippopotamus Studbook (current to 7/15/2014) were performed using PopLink 2.1 and PM2000 1.213 software. Recommendations in this plan are intended to help insure the genetic and demographic health of this population. This is the fourth formal breeding and transfer report for this species, with the last report distributed in 2011. All recommendations proposed in a Yellow SSP Plan are non-binding; participation is voluntary.

Analytical Population: Eleven animals (4.7) were excluded from the genetic analyses and the potential breeding population due to age, sterility, or reproductive issues (Appendix C). After exclusions the potentially breeding population consists of 87 (33.53.1) individuals.

The pedigree of this population is approximately 44% known and over half the living animals in AZA zoos have some part of their pedigree that is not known tracing back to 26 animals with unknown parentage (Appendix A). Parentage assumptions were made for 10 of these ancestors that were of probable wild origin or that had only two potential parents on record at the institution at time of birth (also Appendix A); these assumptions increased the pedigree to 55% known. Even after all reasonable assumptions are applied, only 34 of the 87 animals remaining after exclusions have 100% known pedigrees; 27 individuals remain having 0% known pedigrees. No further assumptions were developed due to the serious implications of making incorrect assumptions for long-lived animals with a potentially shallow pedigree. **Institutions holding unknown pedigree individuals are encouraged to investigate the origins of their unknown pedigree animals in order to help determine relatedness and genetic importance of animals in the living population.**

Demography: Studbook records indicate that the first hippopotamus in North American arrived at the Philadelphia Zoo in 1884. The first well-documented zoo birth attributed to known parents occurred at the Memphis Zoo in 1916. Births in zoos began to become more common in the 1950s, and noticeably increased in the 1970s and again in the late 1990s (Figure 1). In addition to zoo births, periodic imports from other regions have supplemented the North American population, the latest occurring in 1998. Since 1998, the population has been in decline with a mean annual lambda of 0.997, and an overall decline of 8%.

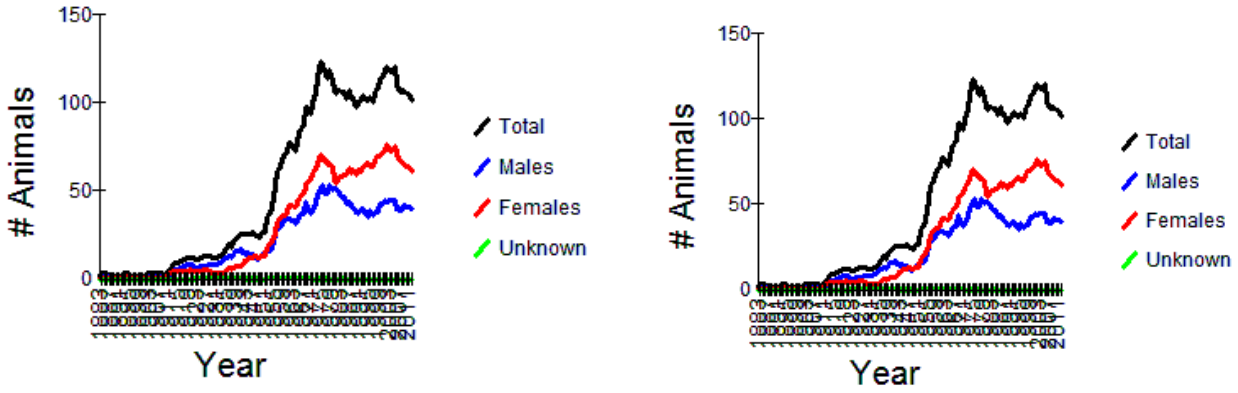


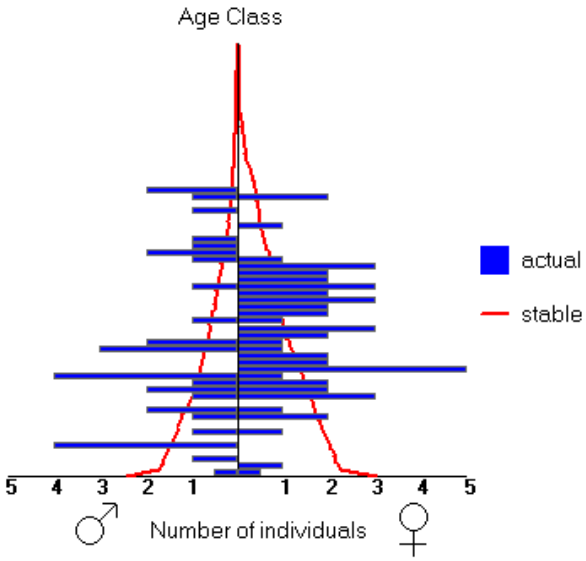
Figure 1. Census of river (Nile) hippos in North America and Mexico between 1930 – 2013 by birth type (left) and sex (right).

According to studbook data for North American institutions from 1980 to present, first year mortality for river hippos is 40% for males and 37% for females. Adult mortality appears to be very low but increases slightly starting in the mid 30s. Median life expectancy is estimated at 34 years. Maximum longevity for hippos appears to be at least the mid-50s, with the oldest male and female are currently alive at ages 57 years (SB#124) and 53 years (SB#538), respectively.

Ages at first reproduction have been observed as early as 2 years old for males and 3 years for females. Males have reproduced up until age 50 and females up to age 42, although female fecundity appears to decline starting in the early 30s. It is unclear whether this decline is biological or an artifact of management, long lifespans, and small sample sizes.

The age structure of the SSP population is fairly columnar in shape, reflecting the long lifespan of hippos and relatively consistent births (or imports) filling in most age classes (Figure 2). One weakness in the age structure is a lower number of individuals in the youngest age classes, especially females. This is complicated through management by the practice of maintaining females in herds or pairs in the absence of males. However, at this time the population has good reproductive potential with many breeding-aged or pre-reproductive animals, IF those animals can be placed in breeding situations. An additional concern is the female-biased sex ratio of the population. While a biased sex ratio may be compatible with the natural breeding biology of this species, having fewer males breeding can hasten the loss of gene diversity in the population.

Figure 2. Age structure of the potentially breeding SSP River Hippopotamus population.



Demographic projections estimate that maintaining the population at its current size (0% growth rate or lambda = 1.00), requires approximately three to four births per annum. This number of births exceeds the birth rate of the past 10 years (average of 2.1 births/year). Management should encourage the addition of breeding institutions in order to maintain a steady amount of births and a sufficient number of mixed-sex breeding groups into the future. Institutional interest, however, has been declining over the last several years and focus should be placed on encouraging additional institutions to join the Program and maintain breeding or exhibit groups.

Genetics: The living population of river hippos in North America is only 44% known (55% known with genetic assumptions) and the genetic status of the overall population and individuals within it cannot be accurately determined. Statistics below are based upon the known pedigree portion of the population and represent, at best, only estimates of true values.

GENETIC SUMMARY	2006	2009	2011	2014	Potential
Current Founders	24	32	33	33	0
Founder genome equivalents (FGE)	8.30	10.96	10.28	9.47	16.17
Gene diversity (GD %)	93.97	95.44	95.14	94.72	96.91
Population mean kinship (MK)	0.0603	0.0456	0.0486	0.0528	--
Mean inbreeding (F)	0.0232	0.0263	0.0245	0.0228	--
Effective population size/census size ratio (Ne / N)	0.3100	0.3380	0.3374	0.3346	--
Percentage of pedigree known before assumptions & exclusions	47.1	47.0	55.4	44	--
Percentage of pedigree known after assumptions & exclusions	51.2	63.2	62.0	55	--
Years To 90% Gene Diversity	42	48	56	53	--
Years to 10% Loss of Gene Diversity	N/A	N/A	<100	127	--
Gene Diversity at 100 Years From Present (%)	85.06	84.70	86.29	86	--
Assumptions used for 2014 genetic projections $\lambda = 1.00$, $K_t = 101$					--

**Note: Genetic analyses were based only on the portion of the pedigree that is known and as a result do not accurately reflect the genetic status of the entire living population. Due to differences in assumptions and changes in the population, genetic values from different analyses are not directly comparable across years.*

Due to the long lifespans of these animals, even a simple genetic management strategy such as avoidance of close inbreeding will be difficult to implement for those animals with unknown pedigrees and unknown origins. Assumptions about the origin of animals cannot be easily made because births occurred as early as the early

1900s and imports from the wild occurred often enough to be a realistic source for some of today's living animals or their parents. Furthermore, evidence of animals transferring between regions (Europe, USA, Mexico--in all directions) implies that there may be undocumented relatedness among regions. Genetic management of this population can only be conducted in a rudimentary fashion by avoiding close inbreeding where possible and by attempting to keep family lines equal. **Any additional information from institutions regarding the origin of the animals in their care would be useful to the management of this population.**

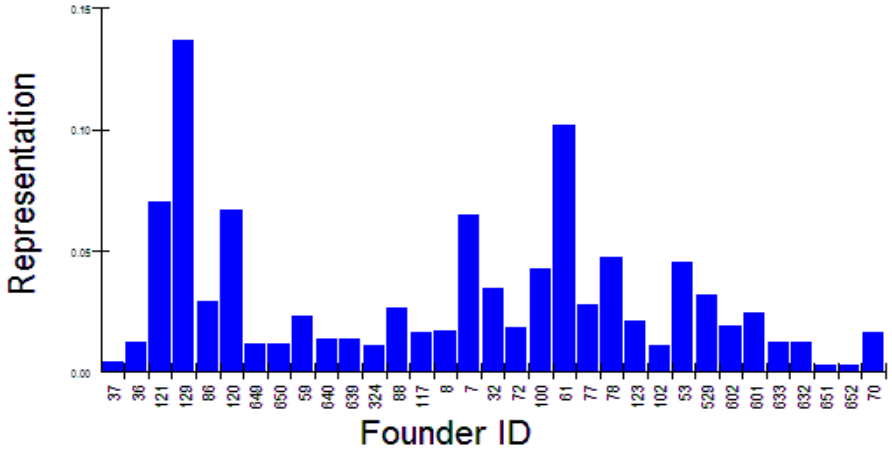


Figure 3. Founder representation graph illustrating the inequality of the 33 known founder lineages represented in the current river hippo population. Animals of unknown origin are not represented in this graph.

Management Strategy: The current river hippopotamus population is 98 individuals at 37 institutions. Demographic analyses indicate that 3-4 in the coming year are required to maintain the current population size (lambda = 1.00). Any births in addition to this are expected to result in population growth.

Where possible pairing recommendations have been recommended with the consideration of mean kinship, avoidance of close inbreeding, and demographic needs of the population.

1. The SSP recommends 4 females for breeding situations; though only two pairs are logistically feasible in 2015 as transfers are required to set up the additional pairs.
    - Institutions recommended to breed are expected to hold offspring for at least 3 years.

2. The SSP recommends 3 transfers.

3. The recruitment of breeding facilities is essential for the sustainability of this population. Facilities holding female herds or pairs may be needed in the short-term future to acquire males and produce offspring.

4. Institutions that interested in placing, receiving, or breeding should contact the SSP Coordinator.

5. The SSP will begin to investigate a strategy for housing multiple males in bachelor groups as a demographic management strategy.
    - Institutions interested in participating in this research are asked to contact the SSP Coordinator.

6. Regarding unknown pedigree animals:
    - Any additional information from institutions regarding the origin of the animals in their care (from paper records, old newspaper articles, internal zoo publications, etc.) could be useful in the management of this population and should be sent to the SSP Coordinator.

SUMMARY OF BREEDING AND TRANSFER RECOMMENDATIONS

ID	Location	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
590	ADVENTURE	2281	F	14	HOLD	ADVENTURE	DO NOT BREED		genetically valuable - may be needed for future breeding
537	ADVENTURE	2282	F	17	HOLD	ADVENTURE	DO NOT BREED		
625	ALDERGROV	207019	M	9	HOLD	ALDERGROV	DO NOT BREED		
618	ALDERGROV	204095	F	11	HOLD	ALDERGROV	DO NOT BREED		
357	BIRMINGHM		M	36	HOLD	BIRMINGHM	DO NOT BREED		excluded - advanced age
631	BUSCH TAM	63269	F	8	HOLD	BUSCH TAM	DO NOT BREED		
538	BUSCH TAM		F	53	HOLD	BUSCH TAM	DO NOT BREED		excluded - advanced age
520	BUSCH TAM	59784	M	18	HOLD	BUSCH TAM	DO NOT BREED		
637	CALGARY	109024	M	8	HOLD	CALGARY	DO NOT BREED		
455	CALGARY	102964	F	27	HOLD	CALGARY	DO NOT BREED		
597	COLO SPRG	21M008	F	15	HOLD	COLO SPRG	DO NOT BREED		
500	COLO SPRG	93M040	F	22	HOLD	COLO SPRG	DO NOT BREED		
237	COLO SPRG		F	45	HOLD	COLO SPRG	DO NOT BREED		excluded - advanced age
124	DENVER		M	58	HOLD	DENVER	DO NOT BREED		excluded - advanced age
621	DENVER	A02488	M	12	HOLD	DENVER	DO NOT BREED		
397	DICKERSON	1121	M	33	SEND TO	CINCINNAT	BREED WITH	543	for 2016 exhibit opening
615	DISNEY AK	020458	M	12	HOLD	DISNEY AK	DO NOT BREED		
607	DISNEY AK	010256	M	13	HOLD	DISNEY AK	DO NOT BREED		genetically valuable - may be needed for future breeding
589	DISNEY AK	000264	M	14	SEND TO	MEMPHIS	BREED WITH	474	after 2016 exhibit renovation
541	DISNEY AK	981748	F	20	HOLD	DISNEY AK	DO NOT BREED		
540	DISNEY AK	981747	F	24	HOLD	DISNEY AK	DO NOT BREED		
539	DISNEY AK		s	24	HOLD	DISNEY AK	DO NOT BREED		excluded - sterile
534	DISNEY AK	980045	F	18	HOLD	DISNEY AK	DO NOT BREED		genetically valuable - may be needed for future breeding
533	DISNEY AK	980044	M	19	HOLD	DISNEY AK	DO NOT BREED		genetically valuable - may be needed for future breeding

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ID	Location	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
531	DISNEY AK	980042	F	40	HOLD	DISNEY AK	DO NOT BREED		genetically valuable - may be needed for future breeding
510	DISNEY AK	970124	F	21	HOLD	DISNEY AK	DO NOT BREED		
507	DISNEY AK		F	21	HOLD	DISNEY AK	DO NOT BREED		excluded - reproductive issues
268	DISNEY AK		F	42	HOLD	DISNEY AK	DO NOT BREED		excluded - advanced age
430	FORTWORTH	587	F	30	HOLD	FORTWORTH	DO NOT BREED		genetically valuable - may be needed for future breeding
428	FORTWORTH	521	F	30	HOLD	FORTWORTH	DO NOT BREED		
542	GRANBY	M00088	F	17	HOLD	GRANBY	SEE NOTES		Breed at institutional discretion
498	GRANBY	M92146	M	22	HOLD	GRANBY	SEE NOTES		Unknown pedigree but assumed to be unrelated to SSP
668	GUADALJR	M04075	U	0	HOLD	GUADALJR	DO NOT BREED		breed at institutional discretion but offspring cannot be placed in SSP facilities due to current space constraints
667	GUADALJR	M04015	F	1	HOLD	GUADALJR	DO NOT BREED		breed at institutional discretion but offspring cannot be placed in SSP facilities due to current space constraints
662	GUADALJR	M03742	M	9	HOLD	GUADALJR	DO NOT BREED		breed at institutional discretion but offspring cannot be placed in SSP facilities due to current space constraints
655	GUADALJR	M03302	F	6	HOLD	GUADALJR	DO NOT BREED		breed at institutional discretion but offspring cannot be placed in SSP facilities due to current space constraints
634	GUADALJR	M02830	F	9	HOLD	GUADALJR	DO NOT BREED		breed at institutional discretion but offspring cannot be placed in SSP facilities due to current space constraints
460	GUADALJR	M00265	M	27	HOLD	GUADALJR	DO NOT BREED		breed at institutional discretion but offspring cannot be placed in SSP facilities due to current space constraints
459	GUADALJR	M00266	F	27	HOLD	GUADALJR	DO NOT BREED		breed at institutional discretion but offspring cannot be placed in SSP facilities due to current space constraints

ID	Location	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
154	HOMOSASSA		M	55	HOLD	HOMOSASSA	DO NOT BREED		excluded - advanced age
494	HONOLULU	920146	F	23	HOLD	HONOLULU	DO NOT BREED		Available for placement
485	HONOLULU	910075	F	24	HOLD	HONOLULU	DO NOT BREED		reported as dead following analysis
450	KANSASCTY	102654	F	28	HOLD	KANSASCTY	DO NOT BREED		
415	KANSASCTY	102682	F	31	HOLD	KANSASCTY	DO NOT BREED		
522	LEON	MAR327	M	18	HOLD	LEON	DO NOT BREED		
518	LEON	MAR005	M	19	HOLD	LEON	DO NOT BREED		
514	LEON	MAR004	F	20	HOLD	LEON	DO NOT BREED		
478	LEON	MAM168	F	25	HOLD	LEON	DO NOT BREED		
439	LEON	MAM167	F	29	HOLD	LEON	DO NOT BREED		
403	LEON	MAM166	M	32	HOLD	LEON	DO NOT BREED		
653	LOSANGELE	992953	M	4	HOLD	LOSANGELE	DO NOT BREED		genetically valuable - may be needed for future breeding
613	LOSANGELE	993116	F	11	HOLD	LOSANGELE	DO NOT BREED		
614	LUFKIN	10034	F	11	HOLD	LUFKIN	DO NOT BREED		
545	LUFKIN	9465	F	15	HOLD	LUFKIN	DO NOT BREED		
594	MEMPHIS	13M016	F	16	HOLD	MEMPHIS	DO NOT BREED		
474	MEMPHIS	10118	F	26	HOLD	MEMPHIS	BREED WITH	589	
390	MILWAUKEE	5637	M	34	HOLD	MILWAUKEE	DO NOT BREED		genetically valuable - may be needed for future breeding
247	MILWAUKEE		F	44	HOLD	MILWAUKEE	DO NOT BREED		excluded - advanced age
468	MONROE	18237A	F	26	HOLD	MONROE	DO NOT BREED		genetically valuable - may be needed for future breeding
481	PHILADELP	102078	F	25	HOLD	PHILADELP	DO NOT BREED		genetically valuable - may be needed for future breeding
477	PHILADELP	102153	F	25	HOLD	PHILADELP	DO NOT BREED		
505	PORTLAND	94030	F	21	HOLD	PORTLAND	DO NOT BREED		
504	PORTLAND	94029	F	21	HOLD	PORTLAND	DO NOT BREED		genetically valuable - may be needed for future breeding
660	PUEBLA	8073	M	2	HOLD	PUEBLA	DO NOT BREED		

ID	Location	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
656	PUEBLA	7598	M	4	HOLD	PUEBLA	DO NOT BREED		
636	PUEBLA	4734	F	12	HOLD	PUEBLA	DO NOT BREED		
462	PUEBLA	1685	F	27	HOLD	PUEBLA	DO NOT BREED		
421	PUEBLA	1683	M	31	HOLD	PUEBLA	DO NOT BREED		
630	RIO GRAND	M06032	F	8	HOLD	RIO GRAND	DO NOT BREED		
619	RIO GRAND	M04058	F	13	HOLD	RIO GRAND	BREED WITH	276	
276	RIO GRAND	M05010	M	41	HOLD	RIO GRAND	BREED WITH	619	
296	SAN ANTON	750165	F	40	HOLD	SAN ANTON	DO NOT BREED		
292	SAN ANTON	750108	M	40	HOLD	SAN ANTON	DO NOT BREED		
616	SAN FRAN	111002	M	11	HOLD	SAN FRAN	DO NOT BREED		genetically valuable - may be needed for future breeding
427	SANDIEGOZ	595217	F	30	HOLD	SANDIEGOZ	BREED WITH	324	
324	SANDIEGOZ	509002	M	38	HOLD	SANDIEGOZ	BREED WITH	427	
595	SEATTLE	201151	F	15	HOLD	SEATTLE	DO NOT BREED		genetically valuable - may be needed for future breeding
355	SEATTLE	21055	F	36	HOLD	SEATTLE	DO NOT BREED		
274	SEDGWICK		F	42	HOLD	SEDGWICK	DO NOT BREED		excluded - advanced age
263	SEDGWICK		F	43	HOLD	SEDGWICK	DO NOT BREED		excluded - advanced age
629	ST LOUIS	103498	F	13	HOLD	ST LOUIS	DO NOT BREED		
583	ST LOUIS	103497	F	15	HOLD	ST LOUIS	DO NOT BREED		genetically valuable - may be needed for future breeding
544	ST LOUIS	101261	F	15	HOLD	ST LOUIS	DO NOT BREED		
543	ST LOUIS	101260	F	16	SEND TO	CINCINNAT	BREED WITH	397	for 2016 exhibit opening
617	STEVENSVI	H1A66	F	12	HOLD	STEVENSVI	DO NOT BREED		
588	STEVENSVI	H1066	M	14	HOLD	STEVENSVI	DO NOT BREED		genetically valuable - may be needed for future breeding
596	TOLEDO	1465	M	14	HOLD	TOLEDO	DO NOT BREED		
516	TOLEDO	960068	F	19	HOLD	TOLEDO	DO NOT BREED		
654	TOPEKA	101910	M	4	HOLD	TOPEKA	DO NOT BREED		

ID	Location	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
490	TORONTO	28015	F	23	HOLD	TORONTO	DO NOT BREED		
449	TORONTO	30201	F	28	HOLD	TORONTO	DO NOT BREED		
281	TORONTO	28307	M	41	HOLD	TORONTO	DO NOT BREED		
592	WINSTON	270507	M	14	HOLD	WINSTON	DO NOT BREED		
401	WINSTON	505825	M	32	HOLD	WINSTON	DO NOT BREED		genetically valuable - may be needed for future breeding

RECOMMENDATIONS BY INSTITUTION

ADVENTURE

Adventure Aquarium
Camden, NJ

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
537	2282	F	17	HOLD	ADVENTURE	DO NOT BREED		
590	2281	F	14	HOLD	ADVENTURE	DO NOT BREED		genetically valuable - may be needed for future breeding

ALDERGROV

Greater Vancouver Zoo
Aldergrove, BC

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
618	204095	F	11	HOLD	ALDERGROV	DO NOT BREED		
625	207019	M	9	HOLD	ALDERGROV	DO NOT BREED		

BIRMINGHM

Birmingham Zoo
Birmingham, AL

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
357		M	36	HOLD	BIRMINGHM	DO NOT BREED		excluded - advanced age

BUSCH TAM

Busch Gardens Tampa Bay
Tampa, FL

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
520	59784	M	18	HOLD	BUSCH TAM	DO NOT BREED		
538		F	53	HOLD	BUSCH TAM	DO NOT BREED		excluded - advanced age
631	63269	F	8	HOLD	BUSCH TAM	DO NOT BREED		

CALGARY

Calgary Zoo, Garden & Prehistoric Pa
Calgary, Alberta

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
455	102964	F	27	HOLD	CALGARY	DO NOT BREED		
637	109024	M	8	HOLD	CALGARY	DO NOT BREED		

CINCINNAT

Cincinnati Zoo & Botanical Garden
Cincinnati, OH

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
397	1121	M	33	RECEIVE FROM	DICKERSON	BREED WITH	543	for 2016 exhibit opening
543	101260	F	16	RECEIVE FROM	ST LOUIS	BREED WITH	397	for 2016 exhibit opening

COLO SPRG

Cheyenne Mtn Zoological Park
Colorado Springs, CO

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
237		F	45	HOLD	COLO SPRG	DO NOT BREED		excluded - advanced age
500	93M040	F	22	HOLD	COLO SPRG	DO NOT BREED		
597	21M008	F	15	HOLD	COLO SPRG	DO NOT BREED		

DENVER

Denver Zoological Gardens
Denver, CO

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
621	A02488	M	12	HOLD	DENVER	DO NOT BREED		
124		M	58	HOLD	DENVER	DO NOT BREED		excluded - advanced age

DICKERSON

Dickerson Park Zoo
Springfield, MO

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
397	1121	M	33	SEND TO	CINCINNAT	BREED WITH	543	for 2016 exhibit opening

DISNEY AK

Disney's Animal Kingdom
Bay Lake, FL

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
268		F	42	HOLD	DISNEY AK	DO NOT BREED		excluded - advanced age
507		F	21	HOLD	DISNEY AK	DO NOT BREED		excluded - reproductive issues
510	970124	F	21	HOLD	DISNEY AK	DO NOT BREED		
531	980042	F	40	HOLD	DISNEY AK	DO NOT BREED		genetically valuable - may be needed for future breeding
533	980044	M	19	HOLD	DISNEY AK	DO NOT BREED		genetically valuable - may be needed for future breeding
534	980045	F	18	HOLD	DISNEY AK	DO NOT BREED		genetically valuable - may be needed for future breeding
539		s	24	HOLD	DISNEY AK	DO NOT BREED		excluded - sterile
540	981747	F	24	HOLD	DISNEY AK	DO NOT BREED		
541	981748	F	20	HOLD	DISNEY AK	DO NOT BREED		
589	000264	M	14	SEND TO	MEMPHIS	BREED WITH	474	after 2016 exhibit renovation
607	010256	M	13	HOLD	DISNEY AK	DO NOT BREED		genetically valuable - may be needed for future breeding
615	020458	M	12	HOLD	DISNEY AK	DO NOT BREED		

FORTWORTH

Fort Worth Zoological Park
Ft Worth, TX

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
428	521	F	30	HOLD	FORTWORTH	DO NOT BREED		
430	587	F	30	HOLD	FORTWORTH	DO NOT BREED		genetically valuable - may be needed for future breeding

GRANBY

Granby Zoo / Zoo de Granby
Granby, Quebec

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
498	M92146	M	22	HOLD	GRANBY	SEE NOTES		Breed at institutional discretion
542	M00088	F	17	HOLD	GRANBY	SEE NOTES		Unknown pedigree but assumed to be unrelated to SSP

GUADALJR

Guadalajara Zoo
Guadalajara, Jalisco

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
459	M00266	F	27	HOLD	GUADALJR	DO NOT BREED		breed at institutional discretion but offspring cannot be placed in SSP facilities due to current space constraints
460	M00265	M	27	HOLD	GUADALJR	DO NOT BREED		breed at institutional discretion but offspring cannot be placed in SSP facilities due to current space constraints
634	M02830	F	9	HOLD	GUADALJR	DO NOT BREED		breed at institutional discretion but offspring cannot be placed in SSP facilities due to current space constraints
655	M03302	F	6	HOLD	GUADALJR	DO NOT BREED		breed at institutional discretion but offspring cannot be placed in SSP facilities due to current space constraints
662	M03742	M	9	HOLD	GUADALJR	DO NOT BREED		breed at institutional discretion but offspring cannot be placed in SSP facilities due to current space constraints
667	M04015	F	1	HOLD	GUADALJR	DO NOT BREED		breed at institutional discretion but offspring cannot be placed in SSP facilities due to current space constraints
668	M04075	U	0	HOLD	GUADALJR	DO NOT BREED		breed at institutional discretion but offspring cannot be placed in SSP facilities due to current space constraints

HOMOSASSA

Homosassa Springs Wildlife State Park
Homosassa, FL

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
154		M	55	HOLD	HOMOSASSA	DO NOT BREED		excluded - advanced age

HONOLULU

Honolulu Zoo
Honolulu, HI

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
485	910075	F	24	HOLD	HONOLULU	DO NOT BREED		reported as dead following analysis
494	920146	F	23	HOLD	HONOLULU	DO NOT BREED		AVAILABLE for placement

KANSASCTY

Kansas City Zoo
Kansas City, MO

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
415	102682	F	31	HOLD	KANSASCTY	DO NOT BREED		
450	102654	F	28	HOLD	KANSASCTY	DO NOT BREED		

LEON

Patronato del Parque Zoologico de Leon
Leon, Guanajuato

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
403	MAM166	M	32	HOLD	LEON	DO NOT BREED		
439	MAM167	F	29	HOLD	LEON	DO NOT BREED		
478	MAM168	F	25	HOLD	LEON	DO NOT BREED		
514	MAR004	F	20	HOLD	LEON	DO NOT BREED		
518	MAR005	M	19	HOLD	LEON	DO NOT BREED		
522	MAR327	M	18	HOLD	LEON	DO NOT BREED		

LOSANGELE

Los Angeles Zoo & Botanical Gardens
Los Angeles, CA

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
613	993116	F	11	HOLD	LOSANGELE	DO NOT BREED		
653	992953	M	4	HOLD	LOSANGELE	DO NOT BREED		genetically valuable - may be needed for future breeding

LUFKIN

Ellen Trout Zoo
Lufkin, TX

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
545	9465	F	15	HOLD	LUFKIN	DO NOT BREED		
614	10034	F	11	HOLD	LUFKIN	DO NOT BREED		

MEMPHIS

Memphis Zoological Garden & Aquarium
Memphis, TN

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
589	000264	M	14	RECEIVE FROM	DISNEY AK	BREED WITH	474	after 2016 exhibit renovation
474	10118	F	26	HOLD	MEMPHIS	BREED WITH	589	
594	13M016	F	16	HOLD	MEMPHIS	DO NOT BREED		

MILWAUKEE

Milwaukee County Zoological Gardens
Milwaukee, WI

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
247		F	44	HOLD	MILWAUKEE	DO NOT BREED		excluded - advanced age
390	5637	M	34	HOLD	MILWAUKEE	DO NOT BREED		genetically valuable - may be needed for future breeding

MONROE

Louisiana Purchase Gardens & Zoo
Monroe, LA

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
468	18237A	F	26	HOLD	MONROE	DO NOT BREED		genetically valuable - may be needed for future breeding

PHILADELP

The Philadelphia Zoo
Philadelphia, PA

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
477	102153	F	25	HOLD	PHILADELP	DO NOT BREED		
481	102078	F	25	HOLD	PHILADELP	DO NOT BREED		genetically valuable - may be needed for future breeding

PORTLAND

Oregon Zoo
Portland, OR

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
504	94029	F	21	HOLD	PORTLAND	DO NOT BREED		genetically valuable - may be needed for future breeding
505	94030	F	21	HOLD	PORTLAND	DO NOT BREED		

PUEBLA

Africam Safari (Africam, S. A.)
Puebla,

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
421	1683	M	31	HOLD	PUEBLA	DO NOT BREED		
462	1685	F	27	HOLD	PUEBLA	DO NOT BREED		
636	4734	F	12	HOLD	PUEBLA	DO NOT BREED		
656	7598	M	4	HOLD	PUEBLA	DO NOT BREED		
660	8073	M	2	HOLD	PUEBLA	DO NOT BREED		

RIO GRAND

Albuquerque Biological Park
Albuquerque, NM

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
276	M05010	M	41	HOLD	RIO GRAND	BREED WITH	619	
619	M04058	F	13	HOLD	RIO GRAND	BREED WITH	276	
630	M06032	F	8	HOLD	RIO GRAND	DO NOT BREED		

SAN ANTON

San Antonio Zoological Gardens & Aquarium
San Antonio, TX

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
292	750108	M	40	HOLD	SAN ANTON	DO NOT BREED		
296	750165	F	40	HOLD	SAN ANTON	DO NOT BREED		

SAN FRAN

San Francisco Zoological Gardens
San Francisco, CA

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
616	111002	M	11	HOLD	SAN FRAN	DO NOT BREED		genetically valuable - may be needed for future breeding

SANDIEGOZ

San Diego Zoo
San Diego, CA

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
324	509002	M	38	HOLD	SANDIEGOZ	BREED WITH	427	
427	595217	F	30	HOLD	SANDIEGOZ	BREED WITH	324	

SEATTLE

Woodland Park Zoo
Seattle, WA

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
355	21055	F	36	HOLD	SEATTLE	DO NOT BREED		
595	201151	F	15	HOLD	SEATTLE	DO NOT BREED		genetically valuable - may be needed for future breeding

SEDGWICK

Sedgwick County Zoo
Wichita, KS

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
263		F	43	HOLD	SEDGWICK	DO NOT BREED		excluded - advanced age
274		F	42	HOLD	SEDGWICK	DO NOT BREED		excluded - advanced age

ST LOUIS

Saint Louis Zoological Park
St. Louis, MO

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
543	101260	F	16	SEND TO	CINCINNAT	BREED WITH	397	for 2016 exhibit opening
544	101261	F	15	HOLD	ST LOUIS	DO NOT BREED		
583	103497	F	15	HOLD	ST LOUIS	DO NOT BREED		genetically valuable - may be needed for future breeding
629	103498	F	13	HOLD	ST LOUIS	DO NOT BREED		

STEVENSVI

Safari Niagara
Stevensville, Ontario

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
588	H1066	M	14	HOLD	STEVENSVI	DO NOT BREED		genetically valuable - may be needed for future breeding
617	H1A66	F	12	HOLD	STEVENSVI	DO NOT BREED		

TOLEDO

Toledo Zoological Gardens
Toledo, OH

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
516	960068	F	19	HOLD	TOLEDO	DO NOT BREED		
596	1465	M	14	HOLD	TOLEDO	DO NOT BREED		

TOPEKA

Topeka Zoological Park
Topeka, KS

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
654	101910	M	4	HOLD	TOPEKA	DO NOT BREED		

TORONTO

Toronto Zoo
Scarborough, Ontario

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
281	28307	M	41	HOLD	TORONTO	DO NOT BREED		
449	30201	F	28	HOLD	TORONTO	DO NOT BREED		
490	28015	F	23	HOLD	TORONTO	DO NOT BREED		

WINSTON

Wildlife Safari Inc
Winston, OR

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
401	505825	M	32	HOLD	WINSTON	DO NOT BREED		genetically valuable - may be needed for future breeding
592	270507	M	14	HOLD	WINSTON	DO NOT BREED		

Appendix A Pedigree Assumptions

Source of Unknownness in True Studbook

The following animals with unknown parentage have descendants in the living AZA population. IDs in bold do not have any assumptions at this time and their descendants' genetic values cannot be accurately calculated. IDs in light font have had pedigree assumptions developed for the analytical studbook

SB ID	Status	Sire	Dam	Birth Date	Date Est.	First Location	Current Location	% AZA Living Population	Living Descendants' SB ID
58	Dead	UNK	UNK	7/1/1935	Y	UNKNOWN	FRANKFURT	12.64%	401, 397, 485, 504, 531, 544, 590, 642, 643, 610, 534, 607, 616, 654
59	Dead	UNK	UNK	8/1/1938	N	MUNICH	FRANKFURT	12.64%	401, 397, 485, 504, 531, 544, 590, 642, 643, 610, 534, 607, 616, 654
72	LTF	UNK	UNK	1/15/1949	M	UNKNOWN	LCS DOS	4.60%	401, 397, 485, 504
105	**Dead**	**UNK**	**UNK**	**7/1/1955**	**Y**	**UNKNOWN**	**CHICAGOBR**	**1.15%**	**237**
107	**Dead**	**UNK**	**UNK**	**7/1/1955**	**Y**	**UNKNOWN**	**CHICAGOBR**	**1.15%**	**237**
117	Dead	UNK	UNK	3/15/1956	M	UNKNOWN	NZP-WASH	2.30%	390, 430
132	**Dead**	**UNK**	**UNK**	**7/30/1957**	**N**	**ST LOUIS**	**TORONTO**	**4.60%**	**438, 631, 648, 659, 455, 498, 521, 617, 618, 625, 637**
137	Dead	UNK	UNK	7/1/1957	Y	KANSASCTY	DENVER	1.15%	263
139	**Dead**	**UNK**	**UNK**	**7/1/1958**	**Y**	**UNKNOWN**	**GRANBY**	**4.60%**	**281, 449, 477, 490**
212	**Dead**	**UNK**	**UNK**	**7/1/1967**	**Y**	**UNKNOWN**	**GRANBY**	**5.75%**	**281, 449, 477, 490, 521, 631, 648, 659**
216	**Dead**	**UNK**	**UNK**	**6/1/1967**	**Y**	**UNKNOWN**	**WINSTON**	**1.15%**	**401**
236	Dead	UNK	UNK	7/1/1969	Y	DALLAS	MILWAUKEE	1.15%	329
244	**LTF**	**UNK**	**UNK**	**3/5/1970**	**N**	**MEXICOCTY**	**CENTANARI**	**4.60%**	**421, 571, 636, 656, 497, 462**
247	Living	UNK	UNK	7/1/1970	Y	DALLAS	MILWAUKEE	2.30%	247, 329
252	Dead	UNK	UNK	9/15/1970	M	DALLAS	DETROIT	4.60%	351, 417, 583, 614, 629
439	**Living**	**UNK**	**UNK**	**7/15/1985**	**N**	**MEXICOCTY**	**LEON**	**13.79%**	**439, 478, 507, 514, 522, 510, 545, 613, 654, 592, 518, 537**
529	Dead	UNK	UNK	7/1/1970	Y	UNKNOWN	S.AFRICA	4.60%	533, 543, 588, 595, 607
530	**Released**	**644**	**UNK**	**7/1/1978**	**Y**	**PRAHA**	**S.AFRICA**	**4.60%**	**533, 543, 588, 595, 607**
538	**Living**	**UNK**	**UNK**	**7/1/1961**	**Y**	**UNKNOWN**	**BUSCH TAM**	**1.15%**	**538**
539	**Living**	**UNK**	**UNK**	**7/1/1990**	**Y**	**UNKNOWN**	**DISNEY AK**	**5.75%**	**539, 590, 613, 654, 616**
540	**Living**	**UNK**	**UNK**	**7/1/1990**	**Y**	**UNKNOWN**	**DISNEY AK**	**3.45%**	**540, 613, 654**
541	**Living**	**UNK**	**UNK**	**7/15/1994**	**Y**	**SONORA EC**	**DISNEY AK**	**2.30%**	**541, 595**
542	**Living**	**UNK**	**UNK**	**6/15/1997**	**M**	**SONORA EC**	**GRANBY**	**2.30%**	**542, 588, 617, 618, 625, 637**
561	**Dead**	**UNK**	**UNK**	**5/5/1970**	**N**	**MEXICOCTY**	**PUEBLA**	**4.60%**	**421, 571, 636, 656, 497, 462**
574	**LTF**	**UNK**	**UNK**	**7/1/1973**	**Y**	**UNKNOWN**	**DURANGO**	**13.79%**	**403, 478, 507, 514, 522, 510, 545, 613, 654, 592, 518, 537, 577, 578**
575	**Dead**	**UNK**	**UNK**	**7/1/1973**	**Y**	**UNKNOWN**	**MORELIA**	**13.79%**	**403, 478, 507, 514, 522, 510, 545, 613, 654, 592, 518, 537, 577, 578**

Assumptions Applied to the Analytical Studbook

SB_ID	SIRE_ID	xx_SIRE	DAM_ID	xx_DAM	Notes
650	UNK	WILD	UNK	WILD	Given wild/wild parents as a baseline assumption to root the pedigree.
58	UNK	WILD	UNK	WILD	Given wild/wild parents as a baseline assumption to root the pedigree.
59	UNK	WILD	UNK	WILD	Given wild/wild parents as a baseline assumption to root the pedigree.
72	UNK	WILD	UNK	WILD	Assumed wild born because of early date and per 2006 assumptions.
236	UNK	66	UNK	101	66 and 101 selected as parents of 252 because they were the only potential parents at Dallas at the time of birth.
247	UNK	66	UNK	101	66 and 101 selected as parents of 252 because they were the only potential parents at Dallas at the time of birth.
252	UNK	66	UNK	101	66 and 101 selected as parents of 252 because they were the only potential parents at Dallas at the time of birth.
529	UNK	WILD	UNK	WILD	Came out of PRETORIA, assumed wild born or at least unrelated to N. American animals.
117	UNK	WILD	UNK	WILD	Came to NZP c. 1956, assumed wild or at least unrelated to N. American population.
137	UNK	72	UNK	79	Master Analytical Notes: Only potential parents at Kansas City at the time of birth were 72 and 77.

Appendix B
Mean Kinship List

Parentage and origin is unknown for many hippos and the pedigree of the population is approximately 55% known (with assumptions). As a result, genetic analyses based on these pedigrees are not accurate and mean kinship values may not be meaningful. However, for informational purposes, shown below are mean kinship values based on the known fraction of pedigrees.

Average MK =0.0528

Males

SB#	MK	Known	Age	Location
324	0.005	100.0	38	SANDIEGOZ
390	0.019	100.0	34	MILWAUKEE
653	0.029	100.0	4	LOSANGELE
533	0.030	75.0	19	DISNEY AK
397	0.033	100.0	33	DICKERSON
588	0.034	37.5	14	STEVENSVI
607	0.035	87.5	13	DISNEY AK
401	0.036	50.0	32	WINSTON
616	0.038	50.0	11	SAN FRAN
276	0.045	100.0	41	RIO GRAND
589	0.051	100.0	14	DISNEY AK
596	0.052	100.0	14	TOLEDO
654	0.053	37.5	4	TOPEKA
292	0.066	100.0	40	SAN ANTON
621	0.069	100.0	12	DENVER
520	0.072	100.0	18	BUSCH TAM
648	0.074	43.8	6	GULF BREZ
659	0.074	43.8	4	GULF BREZ
615	0.078	100.0	12	DISNEY AK
592	0.079	50.0	14	WINSTON
498	0.082	75.0	22	GRANBY
625	0.085	37.5	9	ALDERGROV
637	0.085	37.5	8	CALGARY
521	0.090	37.5	18	GULF BREZ
281	0.500	0.0	41	TORONTO
403	0.500	0.0	32	LEON
421	0.500	0.0	31	PUEBLA
460	0.500	0.0	27	GUADALJR
518	0.500	0.0	19	LEON
522	0.500	0.0	18	LEON
656	0.500	0.0	4	PUEBLA
660	0.500	0.0	2	PUEBLA
662	0.500	0.0	9	GUADALJR
668	0.500	0.0	U0	GUADALJR

Females

SB#	MK	%Known	Age	Location
430	0.021	100.0	30	FORTWORTH
474	0.023	100.0	26	MEMPHIS
531	0.027	100.0	40	DISNEY AK
543	0.027	87.5	16	ST LOUIS
534	0.030	100.0	18	DISNEY AK
590	0.032	50.0	14	ADVENTURE
485	0.033	100.0	24	HONOLULU
504	0.033	100.0	21	PORTLAND
595	0.034	37.5	15	SEATTLE
583	0.038	75.0	15	ST LOUIS
614	0.038	75.0	11	LUFKIN
629	0.038	75.0	13	ST LOUIS
468	0.039	100.0	26	MONROE
481	0.039	100.0	25	PHILADELP
427	0.043	100.0	30	SANDIEGOZ
450	0.053	100.0	28	KANSASCTY
544	0.055	100.0	15	ST LOUIS
355	0.056	100.0	36	SEATTLE
415	0.056	100.0	31	KANSASCTY
296	0.059	100.0	40	SAN ANTON
438	0.063	50.0	29	GULF BREZ
630	0.063	100.0	8	RIO GRAND
455	0.067	50.0	27	CALGARY
428	0.068	100.0	30	FORTWORTH
505	0.068	100.0	21	PORTLAND
494	0.069	100.0	23	HONOLULU
500	0.069	100.0	22	COLO SPRG
597	0.069	100.0	15	COLO SPRG
619	0.071	100.0	13	RIO GRAND
516	0.072	100.0	19	TOLEDO
594	0.072	100.0	16	MEMPHIS
631	0.077	71.9	8	BUSCH TAM
545	0.083	50.0	15	LUFKIN
613	0.083	25.0	11	LOSANGELE
617	0.085	37.5	12	STEVENSVI
618	0.085	37.5	11	ALDERGROV
439	0.500	0.0	29	LEON
449	0.500	0.0	28	TORONTO
459	0.500	0.0	27	GUADALJR
462	0.500	0.0	27	PUEBLA
477	0.500	0.0	25	PHILADELP
478	0.500	0.0	25	LEON
490	0.500	0.0	23	TORONTO
510	0.500	0.0	21	DISNEY AK
514	0.500	0.0	20	LEON
537	0.500	0.0	17	ADVENTURE
540	0.500	0.0	24	DISNEY AK
541	0.500	0.0	20	DISNEY AK
542	0.500	0.0	17	GRANBY
634	0.500	0.0	9	GUADALJR
636	0.500	0.0	12	PUEBLA
655	0.500	0.0	6	GUADALJR
667	0.500	0.0	1	GUADALJR
668	0.500	0.0	U0	GUADALJR

Appendix C
Summary of Data Exports

Project: hippo14
Report compiled under Population Management 2000, version 1.213
1:33:48 PM, 8/12/2014

Comments:

Date to be used for calculations: 8/12/2014

Demographic data from: C:\Users\clynch\Documents\PopLink\PopLink Databases\HippoNile_8July2014\mXXHippoNile_8July2014.prn and C:\Users\clynch\Documents\PopLink\PopLink Databases\HippoNile_8July2014\fXXHippoNile_8July2014.prn

Genetic data from: C:\Users\clynch\Documents\PopLink\PopLink Databases\HippoNile_8July2014\XXHippoNile_8July2014.ped

Studbook information:
Data exported on: 8/12/2014
Data compiled by: John A. Davis
Contact info: John A. Davis jdavis@riverbanks.org
Data current thru: 7/1/2014
Scope of data: Regional

Demographic filter conditions:
Locations = N.AMERICA MEXICO During 1/1/1980 - 8/12/2014 Status = Living

Genetic filter conditions:
Locations = N.AMERICA, MEXICO
As of 8/12/2014
Status = Living

Appendix D
Animals Excluded from the Genetic Analyses

124	Denver	M	Bertie	Age/Pedigree
154	Homosassa	M	Lu	Age
237	Colo sprg	F	Wicket	Age
247	Milwaukee	F	Patti	Age
263	Sedgwick	F	Sweetie Pie	Age
268	Disney AK	F	Geraldine	Age
274	Sedgwick	F	Pudgie	Age
357	Birmingham	M	Tadpole	Age
507	Disney AK	F	Tequila	Reproductive
538	Busch Tam	F	Eva	Age
539	Disney AK	M	Nacho	Sterile

Appendix E
Life Tables

Males

Qx = mortality; Px = survival; Lx = cumulative survivorship; Mx = fecundity;

Age	Qx	Px	lx	Mx	Risk (Qx)	Risk (Mx)
0	0.4	0.6	1	0	244.9	154.5
1	0.03	0.97	0.6	0	98.5	96.6
2	0.01	0.99	0.582	0.01	89	88.3
3	0	1	0.576	0.05	89.1	89.1
4	0	1	0.576	0.07	87.1	87.1
5	0.02	0.98	0.576	0.12	88.3	87
6	0.01	0.99	0.565	0.09	85	84.2
7	0.01	0.99	0.559	0.1	83.8	83.4
8	0.01	0.99	0.553	0.11	83.1	82.5
9	0.01	0.99	0.548	0.12	81.3	80.6
10	0.05	0.95	0.542	0.15	80	78
11	0.03	0.97	0.515	0.1	73.9	72.6
12	0	1	0.5	0.13	68.1	68.1
13	0.01	0.99	0.5	0.15	66.9	66.8
14	0	1	0.495	0.12	62.2	62.2
15	0.02	0.98	0.495	0.13	62	62
16	0	1	0.485	0.15	61	61
17	0	1	0.485	0.1	60.9	60.9
18	0.02	0.98	0.485	0.14	59.2	58.4
19	0	1	0.475	0.14	56.6	56.6
20	0.02	0.98	0.475	0.13	56.8	56.4
21	0.02	0.98	0.466	0.13	56.5	55.6
22	0.01	0.99	0.456	0.11	54.5	54
23	0.04	0.96	0.452	0.08	54	53.1
24	0.02	0.98	0.434	0.12	51.1	50.8
25	0	1	0.425	0.11	50	50
26	0.02	0.98	0.425	0.08	50.3	49.6
27	0.02	0.98	0.417	0.07	49	48.8
28	0.04	0.96	0.408	0.18	48	46.4
29	0.02	0.98	0.392	0.08	46	45.9
30	0	1	0.384	0.16	45	45
31	0.07	0.93	0.384	0.07	44.2	43.8
32	0.07	0.93	0.357	0.09	40.2	39.1
33	0.08	0.92	0.332	0.15	35.6	34.6
34	0	1	0.306	0.15	32	32
35	0.03	0.97	0.306	0.12	30.9	30.8
36	0.07	0.93	0.296	0.13	29	28.2
37	0	1	0.276	0.08	27	27
38	0.08	0.92	0.276	0.15	26.5	24.5
39	0.04	0.96	0.254	0.04	24	23.5
40	0.09	0.91	0.244	0.17	22	21.7
41	0.06	0.94	0.222	0.06	17.1	16.6
42	0.06	0.94	0.208	0.07	16	15.6
43	0.13	0.87	0.196	0.04	15	14.8
44	0.08	0.92	0.17	0.13	13	12.1
45	0	1	0.157	0.04	12	12
46	0.08	0.92	0.157	0.18	12	11.9
47	0	1	0.144	0.05	11	11
48	0.1	0.9	0.144	0.05	10	10
49	0.22	0.78	0.13	0	9	8.4
50	0	1	0.101	0.07	7	7

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

Age	Qx	Px	lx	Mx	Risk (Qx)	Risk (Mx)
51	0.14	0.86	0.101	0	7	6.5
52	0.17	0.83	0.087	0	6	5.5
53	0.4	0.6	0.072	0	5	4.2
54	0	1	0.043	0	2.5	2.5
55	0	1	0.043	0	2	2
56	0	1	0.043	0	2	2
57	0	1	0.043	0	2	2
58	0	1	0.043	0	1	1
59	1	0	0.043	0	1	0.5
60	1	0	0	0	0	0
61	1	0	0	0	0	0
62	1	0	0	0	0	0

r	=	0.0374		
lambda	=	1.0381		
T	=	16.64		
N	=	33.5		
N(at	20	yrs)	=	70.74

Females

Qx = mortality; Px = survival; Lx = cumulative survivorship; Mx = fecundity;

Age	Qx	Px	lx	Mx	Risk (Qx)	Risk (Mx)
0	0.37	0.63	1	0	224.6	147.5
1	0.03	0.97	0.63	0	117.4	115.1
2	0	1	0.611	0	114.1	114.1
3	0	1	0.611	0.02	113.2	113.2
4	0.01	0.99	0.611	0.07	115	114.1
5	0	1	0.605	0.09	117.1	117.1
6	0.03	0.97	0.605	0.09	119	116.9
7	0.01	0.99	0.587	0.06	117.3	116.4
8	0.01	0.99	0.581	0.12	114.6	113.9
9	0.01	0.99	0.575	0.13	114.7	114.4
10	0.01	0.99	0.569	0.11	112.7	111.7
11	0	1	0.564	0.11	109.6	109.6
12	0	1	0.564	0.1	108.8	108.8
13	0.02	0.98	0.564	0.12	108.2	107.2
14	0.03	0.97	0.552	0.11	104.7	103
15	0	1	0.536	0.1	97.4	97.4
16	0.01	0.99	0.536	0.15	95.6	94.7
17	0.05	0.95	0.531	0.07	93.4	90
18	0.05	0.95	0.504	0.1	88.6	86.3
19	0.01	0.99	0.479	0.1	82.5	82
20	0.04	0.96	0.474	0.14	80.7	78.6
21	0.01	0.99	0.455	0.07	73.5	72.6
22	0.01	0.99	0.45	0.1	71.5	71
23	0.01	0.99	0.446	0.1	70.2	69.8
24	0.03	0.97	0.442	0.06	67.5	66.2
25	0	1	0.428	0.08	62.7	62.7
26	0	1	0.428	0.07	60.7	60.7
27	0.02	0.98	0.428	0.09	59.2	58.4
28	0	1	0.42	0.07	56.2	56.2
29	0.02	0.98	0.42	0.07	55	54.7
30	0	1	0.411	0.07	51	51
31	0.06	0.94	0.411	0.06	49	46.8
32	0	1	0.387	0.06	46	46
33	0.07	0.93	0.387	0.01	46	43.9
34	0.05	0.95	0.36	0.04	43	41.3

Age	Qx	Px	lx	Mx	Risk (Qx)	Risk (Mx)
35	0.07	0.93	0.342	0.04	41	39.6
36	0.05	0.95	0.318	0.01	37	36.2
37	0.03	0.97	0.302	0.05	34.3	33.9
38	0	1	0.293	0.03	33	33
39	0.03	0.97	0.293	0	32.6	32
40	0.03	0.97	0.284	0.04	29.3	29
41	0.07	0.93	0.275	0.04	27.8	27.4
42	0	1	0.256	0.02	24.2	24.2
43	0.04	0.96	0.256	0	23	22.1
44	0.14	0.86	0.246	0	21.1	19.6
45	0.18	0.82	0.211	0	17	15.6
46	0.21	0.79	0.173	0	14	12.9
47	0.18	0.82	0.137	0	11	10.2
48	0	1	0.112	0	9	9
49	0.11	0.89	0.112	0	9	8.7
50	0.12	0.88	0.1	0	8	7.4
51	0.14	0.86	0.088	0	7	6.7
52	0.33	0.67	0.076	0	6	5.1
53	0.32	0.68	0.051	0	3.1	2.4
54	0	1	0.034	0	2	2
55	0	1	0.034	0	2	2
56	0	1	0.034	0	2	2
57	0	1	0.034	0	2	2
58	0.5	0.5	0.034	0	2	1.5
59	0	1	0.017	0	1	1
60	0	1	0.017	0	1	1
61	0	1	0.017	0	1	0.1
62	1	0	0.017	0	0	0

r	=	0.0374		
lambda	=	1.023		
T	=	15.75		
N	=	53.5		
N(at	20	yrs)	=	84.39

Appendix F
Survival Statistics

NILE HIPPOPOTAMUS Studbook
HIPPOPOTAMUS AMPHIBIUS
Regional Studbook

Studbook data current as of 7/1/2014

Compiled by
John A. Davis
jdavis@riverbanks.org

PopLink Studbook filename: HippoNile_8July2014
PopLink User Who Exported Report: c
Date of Export: 8/13/2014
Data Filtered by: Locations = N.AMERICA, MEXICO AND StartDate = 8/13/1980 AND EndDate = 8/13/2014
PopLink Version: 2.4

REPORT OVERVIEW:

Based on this analysis, if a NILE HIPPOPOTAMUS survives to its first birthday, its median life expectancy is 34.3 years. Please see the body of the report for more details.

BACKGROUND ON ANALYSES:

These analyses were conducted using animals that lived during the period 13 August 1980 to 13 August 2014 at institutions within N.AMERICA, MEXICO. The analyses mainly focus on survival statistics from 1 year (e.g. excluding any individuals that did not survive past their first birthday). These statistics most accurately reflect typical survival for animals which can be seen on exhibit in zoos and aquariums.

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

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

SUMMARY OF ANALYSES:

SURVIVAL STATISTICS

The dataset used for analysis includes partial or full lifespans of 234 individuals, 98 (41.9%) of which had died by 13 August 2014.

If a NILE HIPPOPOTAMUS survives to its first birthday, its **median life expectancy**[2] is **34.3 years of age**. Given the quality of the data - how many animals are in the database and how many have died - there is a 95% chance that the true

median falls between 31.8 and 38.0 years of age (i.e., these are the 95% confidence limits). Only 25% of NILE HIPPOPOTAMUS can be expected to survive to be 46.1 years or older.

First-year (infant) survival[3] for NILE HIPPOPOTAMUS is 67%. The year after birth/hatching is a period of relatively low survival for many species and life histories.

The **maximum longevity**[4] observed for NILE HIPPOPOTAMUS is **61.1 years**; this longevity record is based on an individual which was DEAD as of the analysis end date (studbook number 83, sex = Female, origin = Captive Born, birth date estimate = Year).[5]

The correct interpretation of these statistics is that, if it survives the first year of life, the 'typical' NILE HIPPOPOTAMUS will live 34.3 years; that half of all NILE HIPPOPOTAMUS can be expected to die before they reach 34.3 and half will live longer than 34.3; that only 25% of all NILE HIPPOPOTAMUS can be expected to live 46.1 years; and that it is rare but possible for NILE HIPPOPOTAMUS to live 61.1 years.

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

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

DATA QUALITY

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

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

PopLink data validation has never been run; if errors are present in this studbook, they may affect the data in this analysis.

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

[2] The statistics analyzed for this report (median life expectancy, 95% confidence limits, and age to which 25% of individuals survive) exclude any individuals who did not survive to their first birthday; these individuals are excluded because this Report is focused on providing median survival estimates for the typical individual that survives the vulnerable infant stage. In other words, this report answers the question, 'how long is this species expected to live once it has reached its first birthday?' For this studbook, 71 individuals died before their first birthday and were excluded from these analyses.

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

[3]For reference, first-year survival is provided. For this studbook and the selected demographic window, 71 individuals did not survive to their first birthday and were excluded from the estimates provided above (median life expectancy, 95% confidence limits, and age to which 25% of individuals survive).

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

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

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

Appendix G
Definitions

Management Terms

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

Yellow Species Survival Plan® (Yellow SSP) Program – A Yellow SSP Program has a population size of 50 or more animals but cannot retain 90% gene diversity for 100 years or 10 generations. Yellow SSP participation by AZA institutions is voluntary.

Red Program – A Red Program has a population size of fewer than 50 animals. If the Taxon Advisory Group (TAG) recommends this species in their Regional Collection Plan (RCP), a Red Program will have an official AZA Regional Studbook but will not be required to produce a formal Breeding and Transfer Plan on a regular basis. 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 Acquisition and Disposition Policy, and well as the AZA Code of Professional Ethics. For more information on AZA policies, see http://www.aza.org/board-policies/.

Demographic Terms

Age Distribution – A two-way classification showing the numbers or percentages of individuals in various age and sex classes.

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

Lambda (λ) or Population Growth Rate – The proportional change in population size from one year to the next. Lambda can be based on life-table calculations (the expected lambda) or from observed changes in population size from year to year. A lambda of 1.11 means an 11% per year increase; lambda of .97 means a 3% decline in size per year.

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

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

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

Qx, Mortality – Probability that an individual of age *x* dies during time period. Qx = 1-Px

Risk (Qx or Mx) – The number of individuals that have lived during an age class. The number at risk is used to calculate Mx and Qx by dividing the number of births and deaths that occurred during an age class by the number of animals at risk of dying and reproducing during that age class.
The proportion of individuals that die during an age class. It is calculated from the number of animals that die during an age class divided by the number of animals that were alive at the beginning of the age class (i.e.-"at risk").

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

Genetic Terms

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

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

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

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

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

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

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

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

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

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

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

Kinship Value (KV) – The weighted mean kinship of an animal, with the weights being the reproductive values of each of the kin. The mean kinship value of a population predicts the loss of gene diversity expected in the subsequent generation if all animals were to mate randomly and all were to produce the numbers of offspring expected for animals of their age.

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

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

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

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

Appendix H
Directory of Institutional Representatives

Contact (IR)	Institution	phone	email
Michele Pagel	Adventure Aquarium	(856) 365-3300 x7366	mpagel@adventureaquarium.com
Pat Flora	Birmingham Zoo	(205)879-0409 ext 299	pflora@birminghamzoo.com
Tim Smith	Busch Gardens	(813) 989-5559	tim.j.smith@buschgardens.com
Jamie Dorgan	Calgary Zoo	403-294-7679	JamieD@calgaryzoo.com
Travis Vineyard	Cleveland Zoo	(216)635-3350	tgv@clevelandmetroparks.com
Tracy Thessing	Cheyenne Mountain	719-633-9925 x 113	tthessing@cmzoo.org
Dale Leeds	Denver Zoo	303-376-4927	Dleeds@denverzoo.org
Keith Zdrojewski	Dallas Zoo	469-554-7204	Keith.Zdrojewski@dallaszoo.com
Kesha Schreiber	Dickerson Park	417-833-1570	kschreib@springfieldmo.gov
Joe Christman	Disney AK	(407)938-2335	Joseph.Christman@disney.com
Susan Lindsey	Mesker Park Zoo	(812) 435-6143 ext 403	slindsey@meskerparkzoo.com
Daniel Subaitis	Fresno Chaffee Zoo	(480)760-5459	dsubaitis@fresnochaffeezoo.org
Ron Surratt	Fort Worth Zoo	817-759-7160	rsurratt@fortworthzoo.org
Pauline Leggett	Granby Zoo	450 372-9113, ext.2151	pleggett@zoodegranby.com
Liliana Abascal	Guadalajara		labascal@zooguadalajara.com.mx
Robert Porec	Honolulu Zoo	(808) 768 7166	rporec@honolulu.gov
Joni Hartmann	Kansas City Zoo	816-595-1323	jonihartman@fotzkc.org
Pavlova Sheffield	Leon Zoo	52 477 764 3143	curador@zooleon.org.mx
Jeff Holland	Los Angeles Zoo	323-644-4220	jeff.holland@lacity.org
Everett Harris	Louisiana Purchase	318-329-2400	zoo@ci.monroe.la.us
Celia Falzone	Ellen Trout Zoo	936-633-0399 x 11	cfalzone@ellentroutzoo.com
Matt Thompson	Memphis Zoo	(901)333-6703	mthompson@memphiszoo.org
Tim Wild	Milwaukee County Zoo	414-256-5457	timothy.wild@milwaukeecountywi.gov
Tammy Schmidt	Philadelphia Zoo	(314)322-2665	schmidt.tammy@phillyzoo.org
Robert Lee	Oregon Zoo	(503)548-2641	bob.lee@oregonzoo.org
Alberto Paras	Africam Safari Puebla	52 222 2817000	pago@africamsafari.com.mx
Lynn tupa	Albuquerque Biol. Park	(505)764-6216	ltupa@cabq.gov
John Davis	Riverbanks Zoo & Garden	803-602-0886	jdavis@riverbanks.org
Jim Nappi	San Francisco Zoo	(415)405-6015	JimN@sfzoo.org
Anita Santiago	San Antonio Zoo	210-734-7184, x1390	anitasantiago@sazoo.org
Carmi Penny	San Diego Zoo	619-557-3982	cpenny@sandiegozoo.org
Patrick Owens	Woodland Park Zoo	(206)548-2500 x 1307	Patrick.owens@zoo.org
Mike Quick	Sedgwick County Zoo	316-266-8237	mquick@scz.org
Cory Nordin	St. Louis Zoo	(314)646-4875	nordin@stlzoo.org
Randi Meyerson	Toledo Zoo	419-385-5721 x 2110	randi@toledozoo.org
Wrylie Guffey	Topeka Zoo	(785)554-2206	wguffey@topeka.org
Maria Franke	Toronto Zoo	416-392-5967	mfranke@torontozoo.ca
Dan Brands	Wildlife Safari	541-679-6761 x 201	curator@wildlifesafari.net
Erin Cantwell	The Zoo	850-932-2229 x 104	ecantwell@gulfbreezezoo.org
Mark Kamhout	Lincoln Park Zoo	312)742-7684	mkamhout@lpzoo.org