

# Population Analysis & Breeding and Transfer Plan

## White-naped Crane (*Grus vipio*) AZA Species Survival Plan® Yellow Program



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**PMC**

Population Management Center

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## Executive Summary

# White-naped Crane (*Grus vipio*) Yellow SSP<sup>®</sup>

The Gruiformes Taxon Advisory Group has set a target population size for this species of 90 specimens (2009 RCP). Current population is 70 specimens at 25 facilities including two non-member participants.

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 birth/hatch weights, smaller litter/clutch sizes, and greater neonatal mortality. Given the population parameters, gene diversity at 100 years from present is expected to be about 88%. Strategies to improve long-term projections of gene diversity retention for this population will focus on equalization of founder representation.

### Demography

Current size of population (N) - Total (Males, Females, Unknown)	70 (35.35.0)
# animals excluded from management	2
Population size following exclusions	68
Target population size	90
Mean generation time (yrs)	16.98
Historic/Projected population growth rate (lambda)	1.02

### Genetics

Genetic statistics calculated from the analytical studbook	<b>Current</b>	<b>Potential</b>
Founders	27	0
Founder genome equivalents (FGE)	12.40	17.89
Gene diversity retained (GD%)	95.97	97.21
Population mean kinship (MK)	0.0403	
Mean inbreeding (F)	0.0103	
Percentage of pedigree known before assumptions and exclusions	99.4	
Percentage of pedigree known after assumptions and exclusions	99.5	
Effective population size/census size ratio ( $N_e / N$ )	0.4255	
Years To 90% Gene Diversity	78	
Years to 10% Loss of Gene Diversity	136	
Gene Diversity at 100 Years From Present (%) Assuming $\lambda = 1.01$ , Target size = 90	88.5	

As with most SSP populations, pairings are prioritized to maintain or increase gene diversity through considerations of mean kinship, avoidance of inbreeding, differences in sire and dam mean kinships, and the degree of uncertainty within a pedigree.

**Summary Actions:** The SSP will recommend 16 breeding pairs intended to produce at least 4 chicks per year. Pairs should produce only one surviving clutch during the three years addressed within this plan, 2013 to 2015. 11 transfers are recommended for this period. Several of these transfers serve to set up pairings of juvenile birds for possible future breeding.

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# Description of Population Status

**Introduction:** White-naped cranes were first seen in North American zoos in 1910 and were first bred in 1943, though the population continued to be supported by imports into the 1970s. Comprehensive genetic and demographic analyses of the White-naped Crane North American Regional Studbook (current to 1 SEPT 12) were performed in October 2012, resulting in the breeding and transfer plan for this species. Recommendations contained in this plan supercede those made by earlier plans. Master plan analyses were performed using PopLink 2.3 and PM2000 1.213.

**Managed Population:** The current population size is 72 (TAG recommended size = 90, 2009 RCP), distributed among 25 institutions including 2 non-AZA participants. This represents an increase in number of both specimens held and participating institutions from the previous Breeding and Transfer Plans (2009) due to both the inclusion of some non-AZA facilities and recent hatches. One individual has been removed from the potentially breeding population due to medical concerns (0243) and one due to unknown pedigree (974). The population remaining following these exclusions is 68 specimens.

**Demography:** The North American Regional population was sustained solely by imports from it's time of founding in 1910 until the 1940s when the first captive hatches occurred. It was not until the 1970s that captive breeding became commonplace and replaced importation as the main source of recruitment into the population and the population began a period of significant growth. Since the population's inception the annual growth rates have varied ( $\lambda = 0.95 - 1.15$ ) though the general trend has been one of positive growth (mean  $\lambda = 1.04$ ). Since the mid 1980s, however, a slow decrease in population size has been observed. While this decline is in part due to a planned reduction in breeding, it appears that the population may also be exhibiting a decrease in the proportion of fertile eggs produced and this decline is of some concern. Since the 2009 Breeding and Transfer Plan, however, 31 hatches have occurred with 14 chicks surviving.

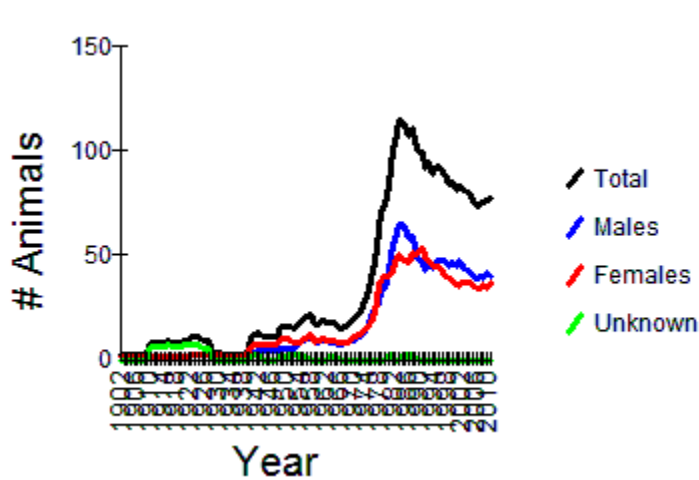


Figure 1. Census of specimens in the SSP.

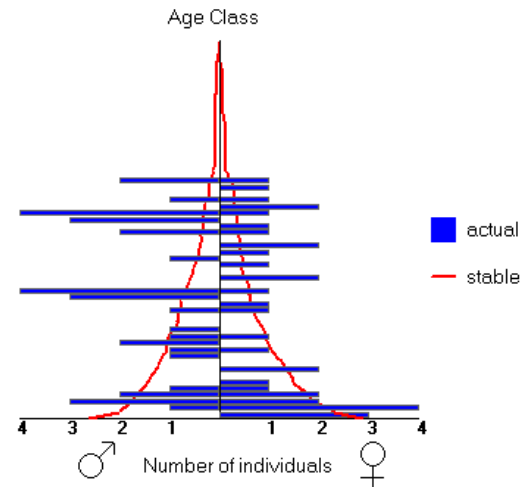


Figure 2. Age distribution of specimens in the SSP.

The age structure of the population is far from approaching stable as recent declines are illustrated by small numbers of animals in the early age-classes relative to the middle age classes (Figure 2) and a female skew in the earliest age classes.

The white-naped crane population has not been established long enough to provide much demographic data from the older age classes of these long-lived birds. Demographic data suggests the lifespan of white-naped cranes is greater than 56 years. The age at first reproduction has been observed to be as early as 2 years but is more typically 4 or 5 years old for both sexes. Males have been observed to breed into their fifties and females into their forties. Infant mortality is low with approximately 73% of all chicks surviving their first year.

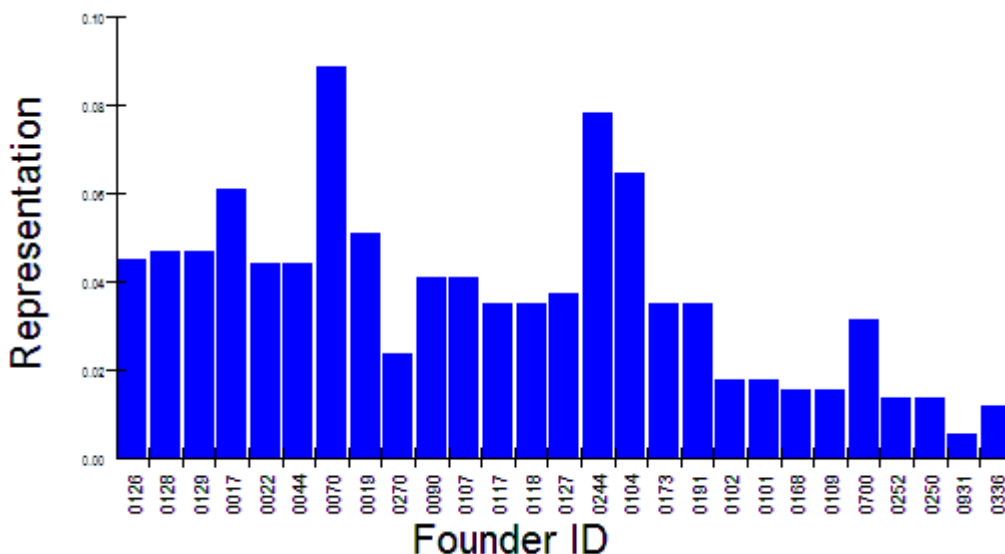
**Genetics:** The managed population is descended from 27 founders and 1 potential founder remains. Genetic diversity in the population (~96%) is high relative to the average SSP (93%). The population gene diversity could fall below 90% in approximately 78 years given current population parameters. Projections of gene diversity indicate 88% at 100 years from present. When gene diversity falls below 90% of that in the founding population, it is expected that reproduction will be increasingly compromised by, among other factors, lower hatch weights and greater neonatal mortality.

**Historic Genetics Summary Table:**

	2009	2007	2004
Founders	28	28	33
Founder genome equivalents	11.75	11.49	12.52
Gene diversity retained	0.9574	95.65	96
Population mean kinship	0.0426	0.0435	0.04
Mean inbreeding	0.0078	0.0119	0.013
$N_e / N$	0.3431	0.2285	0.28
% of pedigree known	99.4	99.2	100

<b>Current GENETIC SUMMARY</b> Genetic statistics calculated from an analytical studbook	<b>Current</b> <b>2012</b>	<b>Potential</b>
Founders	27	0
Founder genome equivalents (FGE)	12.40	17.89
Gene diversity retained (GD%)	95.97	97.21
Population mean kinship (MK)	0.0403	
Mean inbreeding (F)	0.0103	
Pedigree known before assumptions and exclusions (%)	99.4	
Pedigree known after assumptions and exclusions (%)	99.5	
Effective population size / census size ratio ( $N_e / N$ )	0.4255	
Years To 90% Gene Diversity	78	
Gene Diversity at 100 Years From Present (%) Assuming $\lambda = 1.02$ , Target size = 90	88.5	

The potential gene diversity is high (96%) and the time to 90% gene diversity could be extended beyond 78 years given managed breeding targeted at equalization of founder representation (Figure 3). Careful selection of breeding pairs targeted at equalizing founder representation as well as increased production may help to exploit potential gene diversity and increase time to 90% GD.



**Figure 3.** Founder Representation of specimens in AZA institutions illustrating the inequality of founder representation.

**Management Strategy:** Demographic analyses indicate that 4 hatches per annum in the coming three years are needed to maintain the current population size. Births in excess of this number are expected to result in population growth. As with most SSP populations, pairings are prioritized to maintain or increase gene diversity through considerations of mean kinship, avoidance of inbreeding, differences in sire and dam mean kinships, and the degree of uncertainty within a pedigree.

1. 16 breeding pairs are recommended. Pairs are recommended to produce one surviving clutch in the 2013-2015 breeding seasons (with the exception of a single noted pair).
2. 11 transfers are recommended to establish pairs currently recommended and to establish pairings for possible recommended breeding in the future, as well as to place institutional surplus. Young animals (under 2 years of age) should not be shipped before the holding institution determines the animal is ready to be moved.
3. Pairs not recommended to breed should continue to have eggs monitored for fertility to increase understanding of fertility rates and reproductive senescence in this species.
4. Hand-rearing be avoided when at all possible. Surrogate, puppet, or ghost rearing is recommended as an alternative to hand-rearing when attempts at parent-rearing have been exhausted.
5. Place transponders in all individuals – especially those being transferred between institutions.

## Summary of Breeding and Transfer Recommendations

ID	Location	Local ID	Sex	Age	Disposition	Location	FLT or PIN	Breeding	With	Notes
0126	BARABOO	100015	M	36	HOLD	BARABOO		BREED WITH	0128	
0128	BARABOO	100017	F	36	HOLD	BARABOO		BREED WITH	0126	
0129	BARABOO	100011	M	36	HOLD	BARABOO		DO NOT BREED		may use for AI with below average MK females
0165	BARABOO	100022	F	33	HOLD	BARABOO		DO NOT BREED		over-represented
0200	BARABOO	100028	M	31	HOLD	BARABOO		BREED WITH	0680	
0680	BARABOO	100055	F	21	HOLD	BARABOO		BREED WITH	0200	
0219	BIRMINGHM	2155	M	30	HOLD	BIRMINGHM		BREED WITH	0951	
0951	BIRMINGHM	205053	F	12	HOLD	BIRMINGHM		BREED WITH	0219	
1007	BIRMINGHM	212061	F	0	SEND TO	PUEBLA via NY BRONX	FLT	DO NOT BREED		Over-represented, Ship when old enough to ship and pair safely
0810	CENTRALPK	942241	M	19	HOLD	CENTRALPK		BREED WITH	0886	
0886	CENTRALPK	C10035	F	17	HOLD	CENTRALPK		BREED WITH	0810	
0133	COLUMBUS	107041	F	35	HOLD	COLUMBUS		DO NOT BREED		over-represented
0236	COLUMBUS	107040	M	30	HOLD	COLUMBUS		DO NOT BREED		over-represented
0175	DETROIT	2857	F	32	HOLD	DETROIT		DO NOT BREED		over-represented
0194	DETROIT	2858	M	31	HOLD	DETROIT		DO NOT BREED		over-represented
0972	DISNEY AK	110947	M	2	HOLD	DISNEY AK		BREED WITH	992	pre-reproductive at this time but manage pair for future breeding
992	DISNEY AK	110948	F	1	HOLD	DISNEY AK		BREED WITH	0972	pre-reproductive at this time but manage pair for future breeding
0828	DULUTH	833000	M	18	HOLD	DULUTH		DO NOT BREED		
0927	DULUTH	200002	F	16	HOLD	DULUTH		DO NOT BREED		over-represented
0421	FARGO	210020	F	26	HOLD	FARGO		BREED WITH	0888	
0888	FARGO	298004	M	18	HOLD	FARGO		BREED WITH	0421	

*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.*

ID	Location	Local ID	Sex	Age	Disposition	Location	FLT or PIN	Breeding	With	Notes
0970	FORTWORTH	206563	M	3	HOLD	FORTWORTH		BREED WITH	0973	pre-reproductive at this time but manage pair for future breeding
0973	FORTWORTH	206570	F	2	HOLD	FORTWORTH		BREED WITH	0970	pre-reproductive at this time but manage pair for future breeding
0300	JACKSON	200955	F	28	HOLD	JACKSON		BREED WITH	0779	
0779	JACKSON	200954	M	19	HOLD	JACKSON		BREED WITH	0300	
0966	KNOXVILLE	4121	F	3	HOLD	KNOXVILLE		BREED WITH	0968	pre-reproductive at this time but manage pair for future breeding
0968	KNOXVILLE	4173	M	3	HOLD	KNOXVILLE		BREED WITH	0966	pre-reproductive at this time but manage pair for future breeding
0954	MEMPHIS	22440	M	11	HOLD	MEMPHIS		BREED WITH	0971	
0963	MEMPHIS	22739	F	5	SEND TO	UTICA		DO NOT BREED		over-represented
979	NORFOLK	211096	F	1	SEND TO	BINGHAMTO		DO NOT BREED		over-represented
981	NORFOLK	212003	M	2	HOLD	NORFOLK		BREED WITH	1009	pre-reproductive at this time but manage pair for future breeding
0270	NY BRONX	832015	M	31	HOLD	NY BRONX		BREED WITH	0283	This low MK pair may produce more than one clutch in the years 2013-2015
0283	NY BRONX	842058	F	29	HOLD	NY BRONX		BREED WITH	0270	This low MK pair may produce more than one clutch in the years 2013-2015
0523	NY BRONX	B01091	M	24	HOLD	NY BRONX		BREED WITH	0682	
0682	NY BRONX	912097	F	21	HOLD	NY BRONX		BREED WITH	0523	
0971	NY BRONX	B10108	F	2	SEND TO	MEMPHIS	PIN	BREED WITH	0954	pre-reproductive at this time but manage pair for future breeding



ID	Location	Local ID	Sex	Age	Disposition	Location	FLT or PIN	Breeding	With	Notes
1009	NY BRONX	B12142	F	0	SEND TO	NORFOLK	PIN	BREED WITH	981	Ship when old enough to ship and pair safely, pre-reproductive at this time but manage pair for future breeding
0199	NZP-CRC	215327	F	31	HOLD	NZP-CRC		DO NOT BREED		average MK
0385	NZP-CRC	216050	M	28	HOLD	NZP-CRC		DO NOT BREED		may use for AI with below average MK females
0614	NZP-CRC	215730	F	23	HOLD	NZP-CRC		BREED WITH	0957	
0777	NZP-CRC	215847	M	19	HOLD	NZP-CRC		DO NOT BREED		may use for AI with below average MK females
0921	NZP-CRC	214146	M	16	HOLD	NZP-CRC		DO NOT BREED		over-represented
0941	NZP-CRC	215700	M	13	HOLD	NZP-CRC		DO NOT BREED		over-represented
0957	NZP-CRC	214949	M	10	HOLD	NZP-CRC		BREED WITH	0614	
0960	NZP-CRC	215047	M	9	HOLD	NZP-CRC		BREED WITH	0969	
0961	NZP-CRC	215415	F	7	HOLD	NZP-CRC		DO NOT BREED		over-represented
0969	NZP-CRC	215846	F	3	HOLD	NZP-CRC		BREED WITH	0960	pre-reproductive at this time but manage pair for future breeding
980	NZP-CRC	215869	M	2	SEND TO	TOLEDO	FLT	BREED WITH	987	pre-reproductive at this time but manage pair for future breeding
985	NZP-CRC	215952	M	1	SEND TO	PUEBLA via NY BRONX	FLT	DO NOT BREED		Over-represented, Ship when old enough to ship and pair safely
987	NZP-CRC	215981	F	1	SEND TO	TOLEDO	FLT	BREED WITH	980	pre-reproductive at this time but manage pair for future breeding
1006	NZP-CRC	216100	F	0	SEND TO	BINGHAMTO	FLT	DO NOT BREED		
0182	OKLAHOMA	435902	F	32	HOLD	OKLAHOMA		DO NOT BREED		over-represented
0324	OKLAHOMA	638903	M	28	HOLD	OKLAHOMA		DO NOT BREED		over-represented
0887	SCOT NECK	NONE	M	18	SEND TO	BARABOO	UN K	DO NOT BREED		over-represented

ID	Location	Local ID	Sex	Age	Disposition	Location	FLT or PIN	Breeding	With	Notes
0481	SEATTLE	880081	F	25	HOLD	SEATTLE		BREED WITH	0950	
0950	SEATTLE	204033	M	12	HOLD	SEATTLE		BREED WITH	0481	
0781	SOUTHBEND	98089	F	19	HOLD	SOUTHBEND		BREED WITH	0830	
0830	SOUTHBEND	98022	M	19	HOLD	SOUTHBEND		BREED WITH	0781	
0964	ST LOUIS	107875	F	4	HOLD	ST LOUIS	FLT	DO NOT BREED		over-represented
0965	ST LOUIS	107975	M	4	HOLD	ST LOUIS	PIN	DO NOT BREED		
0956	TOLEDO	5372	M	11	SEND TO	WINSTON		BREED WITH	990	
0962	TOLEDO	5373	F	7	SEND TO	BARABOO	FLT	DO NOT BREED		over-represented
0163	TREVOR	1018	M	33	HOLD	TREVOR		DO NOT BREED		over-represented
0959	TREVOR	A4B659	F	10	HOLD	TREVOR		DO NOT BREED		
0195	UTICA	211005	M	31	HOLD	UTICA		DO NOT BREED		over-represented
0221	W ORANGE	6098	M	30	HOLD	W ORANGE		DO NOT BREED		over-represented
0425	W ORANGE	6097	F	26	HOLD	W ORANGE		DO NOT BREED		
990	WINSTON	270508	F	1	HOLD	WINSTON		BREED WITH	0956	

**BARABOO****International Crane Foundation**

Baraboo, WI

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
0126	100015	M	36	HOLD	BARABOO	BREED WITH	0128	
0128	100017	F	36	HOLD	BARABOO	BREED WITH	0126	
0129	100011	M	36	HOLD	BARABOO	DO NOT BREED		may use for AI with below average MK females
0165	100022	F	33	HOLD	BARABOO	DO NOT BREED		over-represented
0200	100028	M	31	HOLD	BARABOO	BREED WITH	0680	
0680	100055	F	21	HOLD	BARABOO	BREED WITH	0200	
0887	NONE	M	18	RECEIVE FROM	SCOT NECK	DO NOT BREED		over-represented
0962	5373	F	7	RECEIVE FROM	TOLEDO	DO NOT BREED		over-represented

**BINGHAMTO****Ross Park Zoo**

Binghamton, NY

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
979	211096	F	1	RECEIVE FROM	NORFOLK	DO NOT BREED		over-represented
1006	216100	F	0	RECEIVE FROM	NZP-CRC	DO NOT BREED		

**BIRMINGHAM****Birmingham Zoo**

Birmingham, AL

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
0219	2155	M	30	HOLD	BIRMINGHAM	BREED WITH	0951	
0951	205053	F	12	HOLD	BIRMINGHAM	BREED WITH	0219	
1007	212061	F	0	SEND TO	PUEBLA via NY BRONX	DO NOT BREED		Ship when old enough to ship and pair safely – Birds will be paired at Bronx prior to export

**CENTRALPK****Central Park Zoo**

New York, NY

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
0810	942241	M	19	HOLD	CENTRALPK	BREED WITH	0886	
0886	C10035	F	17	HOLD	CENTRALPK	BREED WITH	0810	

**COLUMBUS****Columbus Zoo and Aquarium**

Powell, OH

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
0133	107041	F	35	HOLD	COLUMBUS	DO NOT BREED		over-represented
0236	107040	M	30	HOLD	COLUMBUS	DO NOT BREED		over-represented

**DETROIT****Detroit Zoological Society**

Royal Oak, MI

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
0175	2857	F	32	HOLD	DETROIT	DO NOT BREED		over-represented
0194	2858	M	31	HOLD	DETROIT	DO NOT BREED		over-represented

**DISNEY AK****Disney's Animal Kingdom**

Bay Lake, FL

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
0972	110947	M	2	HOLD	DISNEY AK	BREED WITH	992	pre-reproductive at this time but manage pair for future breeding
992	110948	F	1	HOLD	DISNEY AK	BREED WITH	0972	pre-reproductive at this time but manage pair for future breeding

**DULUTH****Lake Superior Zoological Gardens**

Duluth, MN

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
0828	833000	M	18	HOLD	DULUTH	DO NOT BREED		
0927	200002	F	16	HOLD	DULUTH	DO NOT BREED		over-represented

**FARGO****Red River Zoo**

Fargo, ND

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
0421	210020	F	26	HOLD	FARGO	BREED WITH	0888	
0888	298004	M	18	HOLD	FARGO	BREED WITH	0421	

**FORTWORTH****Fort Worth Zoological Park**

Ft Worth, TX

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
0970	206563	M	3	HOLD	FORTWORTH	BREED WITH	0973	pre-reproductive at this time but manage pair for future breeding
0973	206570	F	2	HOLD	FORTWORTH	BREED WITH	0970	pre-reproductive at this time but manage pair for future breeding

**JACKSON****Jackson Zoological Park**  
Jackson, MS

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
0300	200955	F	28	HOLD	JACKSON	BREED WITH	0779	
0779	200954	M	19	HOLD	JACKSON	BREED WITH	0300	

**KNOXVILLE****Knoxville Zoological Gardens**  
Knoxville, TN

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
0966	4121	F	3	HOLD	KNOXVILLE	BREED WITH	0968	pre-reproductive at this time but manage pair for future breeding
0968	4173	M	3	HOLD	KNOXVILLE	BREED WITH	0966	pre-reproductive at this time but manage pair for future breeding

**MEMPHIS****Memphis Zoological Garden & Aquarium**  
Memphis, TN

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
0971	B10108	F	2	RECEIVE FROM	NY BRONX	BREED WITH	0954	pre-reproductive at this time but manage pair for future breeding
0954	22440	M	11	HOLD	MEMPHIS	BREED WITH	0971	
0963	22739	F	5	SEND TO	UTICA	DO NOT BREED		over-represented

**NORFOLK****Virginia Zoological Park**  
Norfolk, VA

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
979	211096	F	1	SEND TO	BINGHAMTO	DO NOT BREED		over-represented
981	212003	M	2	HOLD	NORFOLK	BREED WITH	1009	pre-reproductive at this time but manage pair for future breeding
1009	B12142	F	0	RECEIVE FROM	NY BRONX	BREED WITH	981	Ship when old enough to ship and pair safely, pre-reproductive at this time but manage pair for future breeding

**NY BRONX**

**Bronx Zoo/Wildlife Conservat'n Society**  
Bronx, NY

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
0270	832015	M	31	HOLD	NY BRONX	BREED WITH	0283	This low MK pair may produce more than one clutch in the years 2013-2015
0283	842058	F	29	HOLD	NY BRONX	BREED WITH	0270	This low MK pair may produce more than one clutch in the years 2013-2015
0523	B01091	M	24	HOLD	NY BRONX	BREED WITH	0682	
0682	912097	F	21	HOLD	NY BRONX	BREED WITH	0523	
1009	B12142	F	0	SEND TO	NORFOLK	BREED WITH	981	Ship when old enough to ship and pair safely, pre-reproductive at this time but manage pair for future breeding
0971	B10108	F	2	SEND TO	MEMPHIS	BREED WITH	0954	pre-reproductive at this time but manage pair for future breeding
1007	212061	F	0	RECEIVE FROM	BIRMINGHM	DO NOT BREED		Ship when old enough to ship and pair safely, pair at Bronx for export to Puebla
985	215952	M	1	RECEIVE FROM	NZP-CRC	DO NOT BREED		Ship when old enough to ship and pair safely, <b>this male is blind in one eye</b> , pair at Bronx for export to Puebla
1007	212061	F	0	SEND TO	PUEBLA via NY BRONX	DO NOT BREED		Ship when old enough to ship and pair safely – Birds will be paired at Bronx prior to export
985	215952	M	1	SEND TO	PUEBLA via NY BRONX	DO NOT BREED		Ship when old enough to ship and pair safely, <b>this male is blind in one eye</b>

**NZP-CRC**

**Smithsonian Conservation Biology Inst**  
Front Royal, VA

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
0199	215327	F	31	HOLD	NZP-CRC	DO NOT BREED		average MK
0385	216050	M	28	HOLD	NZP-CRC	DO NOT BREED		may use for AI with below average MK females
0614	215730	F	23	HOLD	NZP-CRC	BREED WITH	0957	
0777	215847	M	19	HOLD	NZP-CRC	DO NOT BREED		may use for AI with below average MK females
0921	214146	M	16	HOLD	NZP-CRC	DO NOT BREED		over-represented
0941	215700	M	13	HOLD	NZP-CRC	DO NOT BREED		over-represented
0957	214949	M	10	HOLD	NZP-CRC	BREED WITH	0614	
0960	215047	M	9	HOLD	NZP-CRC	BREED WITH	0969	
0961	215415	F	7	HOLD	NZP-CRC	DO NOT BREED		over-represented
0969	215846	F	3	HOLD	NZP-CRC	BREED WITH	0960	pre-reproductive at this time but manage pair for future breeding
980	215869	M	2	SEND TO	TOLEDO	BREED WITH	987	pre-reproductive at this time but manage pair for future breeding
985	215952	M	1	SEND TO	PUEBLA via NY BRONX	DO NOT BREED		Ship when old enough to ship and pair safely, this male is blind in one eye, pair at Bronx for export to Puebla
987	215981	F	1	SEND TO	TOLEDO	BREED WITH	980	pre-reproductive at this time but manage pair for future breeding
1006	216100	F	0	SEND TO	BINGHAMTO	DO NOT BREED		

**OKLAHOMA**

**Oklahoma City Zoological Park**  
Oklahoma City, OK

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
0182	435902	F	32	HOLD	OKLAHOMA	DO NOT BREED		over-represented
0324	638903	M	28	HOLD	OKLAHOMA	DO NOT BREED		over-represented



**PUEBLA****Africam Safari**

Puebla, MX

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
1007	212061	F	0	RECEIVE FROM	NY BRONX	DO NOT BREED		Ship when old enough to ship and pair safely
985	215952	M	1	RECEIVE FROM	NY BRONX	DO NOT BREED		Ship when old enough to ship and pair safely, <b>this bird is blind in one eye</b>

**SCOT NECK****Sylvan Heights Waterfowl**

Scotland Neck, NC

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
0887	NONE	M	18	SEND TO	BARABOO	DO NOT BREED		over-represented

**SEATTLE****Woodland Park Zoo**

Seattle, WA

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
0481	880081	F	25	HOLD	SEATTLE	BREED WITH	0950	
0950	204033	M	12	HOLD	SEATTLE	BREED WITH	0481	

**SOUTHBEND****Potawatomi Zoo**

South Bend, IN

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
0781	98089	F	19	HOLD	SOUTHBEND	BREED WITH	0830	
0830	98022	M	19	HOLD	SOUTHBEND	BREED WITH	0781	

**ST LOUIS****Saint Louis Zoological Park**

St. Louis, MO

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
0964	107875	F	4	HOLD	ST LOUIS	DO NOT BREED		over-represented
0965	107975	M	4	HOLD	ST LOUIS	DO NOT BREED		

**TOLEDO****Toledo Zoological Gardens**

Toledo, OH

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
0956	5372	M	11	SEND TO	WINSTON	DO NOT BREED		
0962	5373	F	7	SEND TO	BARABOO	DO NOT BREED		over-represented
980	215869	M	2	RECEIVE FROM	NZP- CRC	BREED WITH	987	pre-reproductive at this time but manage pair for future breeding
987	215981	F	1	RECEIVE FROM	NZP- CRC	BREED WITH	980	Ship when old enough to ship and pair safely, pre-reproductive at this time but manage pair for future breeding

**TREVOR****Trevor Zoo at Millbrook School**

Millbrook, NY

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
0163	1018	M	33	HOLD	TREVOR	DO NOT BREED		over-represented
0959	A4B659	F	10	HOLD	TREVOR	DO NOT BREED		

**UTICA****Utica Zoo**

Utica, NY

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
0195	211005	M	31	HOLD	UTICA	DO NOT BREED		over-represented
0963	22739	F	5	RECEIVE FROM	MEMPHIS	DO NOT BREED		over-represented

**W ORANGE****Turtle Back Zoo**

West Orange, NJ

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
0221	6098	M	30	HOLD	W ORANGE	DO NOT BREED		over-represented
0425	6097	F	26	HOLD	W ORANGE	DO NOT BREED		

**WINSTON****Wildlife Safari Inc**

Winston, OR

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
990	270508	F	1	HOLD	WINSTON	BREED WITH	0956	
0956	5372	M	11	RECEIVE FROM	TOLEDO	BREED WITH	990	

## Appendix A Life Table

### Males

Age (x)	Qx	Px	lx	Mx	Risk (Qx)	Risk (Mx)
0	0.320	0.680	1.000	0.000	136.700	102.000
1	0.060	0.940	0.680	0.000	97.400	92.400
2	0.050	0.950	0.639	0.010	90.600	88.200
3	0.050	0.950	0.607	0.010	83.100	81.700
4	0.060	0.940	0.577	0.190	78.000	75.600
5	0.030	0.970	0.542	0.180	72.000	70.800
6	0.040	0.960	0.526	0.130	69.500	68.000
7	0.060	0.940	0.505	0.120	65.300	63.600
8	0.030	0.970	0.475	0.150	60.000	58.600
9	0.050	0.950	0.460	0.140	57.500	56.200
10	0.020	0.980	0.437	0.04	50.500	50.400
11	0.000	1.000	0.429	0.12	48.300	48.300
12	0.000	1.000	0.429	0.06	46.600	46.600
13	0.070	0.930	0.429	0.15	45.500	43.800
14	0.090	0.910	0.399	0.1	43.000	41.100
15	0.000	1.000	0.363	0.11	39.500	39.500
16	0.000	1.000	0.363	0.11	39.400	39.400
17	0.000	1.000	0.363	0.19	38.000	38.000
18	0.030	0.970	0.363	0.16	35.900	35.500
19	0.060	0.940	0.352	0.07	31.800	30.400
20	0.040	0.960	0.331	0.09	28.000	27.700
21	0.070	0.930	0.318	0.02	27.000	25.800
22	0.080	0.920	0.295	0.04	25.000	23.500
23	0.000	1.000	0.272	0.07	23.000	23.000
24	0.180	0.820	0.272	0	22.100	19.700
25	0.000	1.000	0.223	0	17.000	17.000
26	0.000	1.000	0.223	0	17.000	17.000
27	0.060	0.940	0.223	0.1	17.000	16.100
28	0.000	1.000	0.209	0.07	14.600	14.600
29	0.070	0.930	0.209	0.07	14.000	14.000
30	0.000	1.000	0.195	0.14	10.900	10.900
31	0.000	1.000	0.195	0	7.200	7.200
32	0.000	1.000	0.195	0	7.000	7.000
33	0.160	0.840	0.195	0	6.300	6.000
34	0.200	0.800	0.164	0.13	5.000	4.100
35	0.000	1.000	0.131	0	3.600	3.600
36	0.000	1.000	0.131	0	2.000	2.000
37	0.000	1.000	0.131	0	2.000	2.000

*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 (x)	Qx	Px	lx	Mx	Risk (Qx)	Risk (Mx)
38	0.500	0.500	0.131	0.39	2.000	1.300
39	0.000	1.000	0.065	0	1.000	1.000
40	0.000	1.000	0.065	0	1.000	1.000
41	0.000	1.000	0.065	0	1.000	1.000
42	0.000	1.000	0.065	0	1.000	1.000
43	0.000	1.000	0.065	1.56	1.000	1.000
44	0.000	1.000	0.065	2.08	1.000	1.000
45	0.000	1.000	0.065	0	1.000	1.000
46	0.000	1.000	0.065	0	1.000	1.000
47	0.000	1.000	0.065	0	1.000	1.000
48	0.000	1.000	0.065	0	1.000	1.000
49	0.000	1.000	0.065	0	1.000	1.000
50	0.000	1.000	0.065	0	1.000	1.000
51	0.000	1.000	0.065	0	1.000	1.000
52	0.000	1.000	0.065	0	1.000	1.000
53	0.000	1.000	0.065	0	1.000	1.000
54	0.000	1.000	0.065	0	1.000	1.000
55	0.000	1.000	0.065	0	1.000	1.000
56	1.000	0.000	0.065	4.8	1.000	0.300
57	1.000	0.000	0.000	0	0.000	0.000

Qx = mortality; Px = survival; Lx = cumulative survivorship; Mx = fecundity; Vx = expected future reproduction

$r = 0.0200$

$\lambda = 1.0203$

$T = 17.84$

$N = 34.00$

$N(\text{at } 20 \text{ yrs}) = 50.77$

## Females

Age	Qx	Px	lx	Mx	Risk (Qx)	Risk (Mx)
0	0.23	0.77	l	0	114.5	91.4
1	0.11	0.89	0.77	0	99.2	91
2	0.09	0.91	0.685	0.06	88	83.7
3	0.05	0.95	0.624	0.08	77.8	75.7
4	0.09	0.91	0.592	0.14	77	71.8
5	0.04	0.96	0.539	0.15	68.3	66.6
6	0.05	0.95	0.518	0.06	64.6	62.6
7	0.03	0.97	0.492	0.06	60.6	59.5
8	0.05	0.95	0.477	0.08	56	54.5
9	0.06	0.94	0.453	0.09	52.6	51.4
10	0.08	0.92	0.426	0.15	49.6	48.3
11	0.05	0.95	0.392	0.14	44.1	43
12	0.05	0.95	0.372	0.06	41.5	41
13	0	l	0.354	0.03	38.7	38.7
14	0.08	0.92	0.354	0.07	38	35.8
15	0.09	0.91	0.325	0.19	35	33.5
16	0.03	0.97	0.296	0.15	31.3	30.7
17	0.07	0.93	0.287	0.09	28.4	27.5
18	0	l	0.267	0.12	26	26
19	0.04	0.96	0.267	0.27	25.9	25.2
20	0	l	0.256	0.33	25	25
21	0.08	0.92	0.256	0.23	23.6	22.5
22	0.1	0.9	0.236	0.13	21	20.1
23	0	l	0.212	0.2	18.3	18.3
24	0	l	0.212	0.14	18	18
25	0.06	0.94	0.212	0.12	17.4	16.9
26	0	l	0.2	0.07	15.6	15.6
27	0	l	0.2	0.17	15	15
28	0.07	0.93	0.2	0.04	14.4	14.3
29	0	l	0.186	0.04	12.4	12.4
30	0	l	0.186	0	11.2	11.2
31	0	l	0.186	0.15	10.4	10.4
32	0.11	0.89	0.186	0	8.7	8.2
33	0	l	0.165	0	6.3	6.3
34	0	l	0.165	0	6.4	6.4
35	0	l	0.165	0	5.2	5.2
36	0.25	0.75	0.165	0	4	3.6
37	0.33	0.67	0.124	0.25	3	2.1
38	0	l	0.083	0.78	2	2
39	0	l	0.083	0.26	2	2

*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	Q <sub>x</sub>	P <sub>x</sub>	l <sub>x</sub>	M <sub>x</sub>	Risk (Q <sub>x</sub> )	Risk (M <sub>x</sub> )
40	0	1	0.083	0	2	2
41	0	1	0.083	0.78	2	2
42	0	1	0.083	0.26	2	2
43	0	1	0.083	0	2	2
44	0	1	0.083	0	2	2
45	0	1	0.083	0	2	2
46	0.5	0.5	0.083	0	2	1.2
47	0	1	0.041	0	1	1
48	0	1	0.041	0	1	1
49	0	1	0.041	0	1	1
50	0	1	0.041	0	1	1
51	0	1	0.041	0	1	1
52	0	1	0.041	0	1	1
53	0	1	0.041	0	1	1
54	1	0	0.041	0	1	0.3
55	1	0	0	0	0	0

Q<sub>x</sub> = mortality; P<sub>x</sub> = survival; L<sub>x</sub> = cumulative survivorship; M<sub>x</sub> = fecundity; V<sub>x</sub> = expected future reproduction

$r = 0.0200$

$\lambda = 1.0176$

$T = 16.12$

$N = 34.00$

$N(\text{at } 20 \text{ yrs}) = 48.16$

## Appendix B Ordered Mean Kinship

### Males

SB#	MK	%Known	Age	Location
0270	0.012	100.0	31	NY BRONX
0126	0.023	100.0	36	BARABOO
0129	0.024	100.0	36	BARABOO
0972	0.025	100.0	2	DISNEY AK
0385	0.026	100.0	28	NZP-CRC
0956	0.026	100.0	11	TOLEDO
0200	0.027	100.0	31	BARABOO
0777	0.029	87.5	19	NZP-CRC
0523	0.031	100.0	24	NY BRONX
0810	0.031	100.0	19	CENTRALPK
980	0.032	93.8	2	NZP-CRC
981	0.032	93.8	2	NORFOLK
0965	0.036	100.0	4	ST LOUIS
0950	0.037	100.0	12	SEATTLE
0954	0.037	100.0	11	MEMPHIS
0970	0.037	100.0	3	FORTWORTH
0828	0.039	100.0	18	DULUTH
0941	0.041	93.8	13	NZP-CRC
0779	0.042	100.0	19	JACKSON
0887	0.042	100.0	18	SCOT NECK
0888	0.042	100.0	18	FARGO
0968	0.043	100.0	3	KNOXVILLE
0830	0.044	100.0	19	SOUTHBEND
0960	0.044	100.0	9	NZP-CRC
0195	0.045	100.0	31	UTICA
0221	0.045	100.0	30	W ORANGE
0957	0.046	100.0	10	NZP-CRC
0194	0.047	100.0	31	DETROIT
0163	0.048	100.0	33	TREVOR
0219	0.049	100.0	30	BIRMINGHM
0236	0.050	100.0	30	COLUMBUS
985	0.051	96.9	1	NZP-CRC
0324	0.054	100.0	28	OKLAHOMA
0921	0.054	100.0	16	NZP-CRC

### Females

SB#	MK	%Known	Age	Location
0128	0.024	100.0	36	BARABOO
0421	0.025	100.0	26	FARGO
0481	0.025	100.0	25	SEATTLE
0971	0.025	100.0	2	CENTRALPK
1009	0.025	100.0	0	NY BRONX
0886	0.026	100.0	17	CENTRALPK
0425	0.027	100.0	26	W ORANGE
0614	0.027	100.0	23	NZP-CRC
0283	0.030	100.0	29	NY BRONX
990	0.033	100.0	1	WINSTON
0682	0.035	100.0	21	NY BRONX
1006	0.036	100.0	0	NZP-CRC
0959	0.037	100.0	10	TREVOR
987	0.037	100.0	1	NZP-CRC
992	0.037	100.0	1	DISNEY AK
0199	0.039	100.0	31	NZP-CRC
0951	0.041	100.0	12	BIRMINGHM
0966	0.041	100.0	3	KNOXVILLE
0781	0.042	100.0	19	SOUTHBEND
0680	0.044	100.0	21	BARABOO
0973	0.047	100.0	2	FORTWORTH
0300	0.048	100.0	28	JACKSON
0165	0.049	100.0	33	BARABOO
0969	0.049	100.0	3	NZP-CRC
1007	0.049	100.0	0	BIRMINGHM
0175	0.050	100.0	32	DETROIT
0182	0.050	100.0	32	OKLAHOMA
0963	0.051	100.0	5	MEMPHIS
0964	0.051	100.0	4	ST LOUIS
979	0.052	100.0	1	NORFOLK
0961	0.053	100.0	7	NZP-CRC
0962	0.053	100.0	7	TOLEDO
0927	0.056	100.0	16	DULUTH
0133	0.058	100.0	35	COLUMBUS



## Appendix C

### Summary of Data Exports

Date to be used for calculations: 10/14/2012

Demographic data from: C:\Users\CLynch.LPZ\_DOMAIN\Documents\PopLink\PopLink  
Databases\WNCr12\mWNCr12.prn and C:\Users\CLynch.LPZ\_DOMAIN\Documents\PopLink\PopLink  
Databases\WNCr12\fWNCr12.prn

Genetic data from: C:\Users\CLynch.LPZ\_DOMAIN\Documents\PopLink\PopLink Databases\WNCr12\WNCr12.ped

Studbook information:

Data exported on: 10/14/2012

Data compiled by: Carol Hesch

Contact info: Memphis Zoo chesch@memphiszoo.org

Data current thru: 9/1/2012

Scope of data: North American regional YHOSTC Memphis Zoo YLASTACCSC 0969 YLASTEDITC  
0421 YLASTTEMPC T34 YMNEMONICCMEMPHIS

Demographic filter conditions:

Locations = N.AMERICA During 1/1/1970 - 10/14/2012 Status = Living

Genetic filter conditions:

Locations = N.AMERICA

As of 10/14/2012

Status = Living

Planned by email OCT 2012

Non-member participants: UTICA, SCOT NECK

# Appendix D

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

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

**Mx, Fecundity** – The average number of same-sexed young born to animals in that age class. Because SPARKS is typically using relatively small sample sizes, SPARKS calculates  $M_x$  as 1/2 the average number of young born to animals in that age class. This provides a somewhat less "noisy" estimate of  $M_x$ , 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.  $Q_x = 1 - P_x$

**Risk (Qx or Mx)** – The number of individuals that have lived during an age class. The number at risk is used to calculate  $M_x$  and  $Q_x$  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  $x$ .

*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.* 25

## Genetic Terms

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

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

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

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

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

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

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

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

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

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

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

**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,  $V_x$ .

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voluntary. Dispositions to non-AZA institutions should comply with each institution's acquisition/disposition policy.*

## Appendix F

### Directory of Institutional Representatives

Contact Name (IR)	Institution	Email
Kelly Maguire	BARABOO - International Crane Foundation, Baraboo, WI	<a href="mailto:kelly@savingcranes.org">kelly@savingcranes.org</a>
Dave Orndorff	BINGHAMTO – Ross Park Zoo, Binghamton, NY	<a href="mailto:dornforff@rossparkzoo.com">dornforff@rossparkzoo.com</a>
Cindy Pinger	BIRMINGHAM - Birmingham Zoo, Birmingham, AL	<a href="mailto:cpinger@birminghamzoo.com">cpinger@birminghamzoo.com</a>
Nancy Clum	NY BRONX - Bronx Zoo/Wildlife Conservation Society, Bronx, NY	<a href="mailto:nclum@wcs.org">nclum@wcs.org</a>
Susan Cardillo	CENTRALPK - Central Park Zoo, Bronx, NY	<a href="mailto:scardillo@wcs.org">scardillo@wcs.org</a>
Kelly Vineyard	COLUMBUS - Columbus Zoo and Aquarium, Powell, OH	<a href="mailto:kelly.vineyard@columbuszoo.org">kelly.vineyard@columbuszoo.org</a>
Tom Schneider	DETROIT - Detroit Zoological Institute, Royal Oak, MI	<a href="mailto:tschneider@detroitzoo.org">tschneider@detroitzoo.org</a>
Lori Grady	DISNEY AK - Disney's Animal Kingdom/The Living Seas, Bay Lake, FL	<a href="mailto:lori.grady@disney.com">lori.grady@disney.com</a>
Peter Pruet	DULUTH- Lake Superior Zoo, Duluth, MN	<a href="mailto:ppruet@lszoo.org">ppruet@lszoo.org</a>
Dave Wetzel	JACKSON - Jackson Zoological Park, Jackson, MS	<a href="mailto:dlwetzel@msn.com">dlwetzel@msn.com</a>
Mark Armstrong	KNOXVILLE - Knoxville Zoological Gardens, Knoxville, TN	<a href="mailto:marka@knoxville-zoo.org">marka@knoxville-zoo.org</a>
Warren Lynch	NZP-CRC - NZP-Conservation & Research Center, Front Royal, VA	<a href="mailto:lynchw@si.edu">lynchw@si.edu</a>
Darcy Henthorn	OKLAHOMA - Oklahoma City Zoological Park, Oklahoma City, OK	<a href="mailto:dhenthorn@okczoo.com">dhenthorn@okczoo.com</a>
Josef San Miguel	SAN ANTON - San Antonio Zoological Gardens & Aqua, San Antonio, TX	<a href="mailto:curbirds@sazoo-aq.org">curbirds@sazoo-aq.org</a>
Michael Mace	SD-WAP - San Diego Wild Animal Park, Escondido, CA	<a href="mailto:mmace@sandiegozoo.org">mmace@sandiegozoo.org</a>
Mark Myers	SEATTLE - Woodland Park Zoological Gardens, Seattle, WA	<a href="mailto:mark.myers@zoo.org">mark.myers@zoo.org</a>
Laura Arriaga	SOUTHBEND - Potawatomi Zoo, South Bend, IN	<a href="mailto:larriaga@southbendin.gov">larriaga@southbendin.gov</a>
Michael Macek	ST LOUIS - Saint Louis Zoological Park, St. Louis, MO	<a href="mailto:macek@stlzoo.org">macek@stlzoo.org</a>
Brint Spencer	W ORANGE - Turtle Back Zoo, West Orange, NJ	<a href="mailto:tbzcurator@yahoo.com">tbzcurator@yahoo.com</a>
Robert Webster	TOLEDO - Toledo Zoological Gardens, Toledo, OH	<a href="mailto:robert.webster@toledozeo.org">robert.webster@toledozeo.org</a>
Jessica Bennett	TREVOR - Trevor Zoo, Millbrook, NY	<a href="mailto:jbennett@millbrook.org">jbennett@millbrook.org</a>
Jory Lum	FARGO - Red River Zoo, Fargo, ND	<a href="mailto:curator@redriverzoo.org">curator@redriverzoo.org</a>
Mike Bates	Utica Zoo - Utica New York (non-AZA)	<a href="mailto:mike.bates@uticzoo.org">mike.bates@uticzoo.org</a>
Carol Hesch	MEMPHIS - Memphis Zoological Garden & Aquarium, Memphis, TN	<a href="mailto:chesch@memphiszoo.org">chesch@memphiszoo.org</a>
Katy Cussen	FORTWORTH - Fort Worth Zoological Park, Ft Worth, TX	<a href="mailto:kcussen@fortworthzoo.org">kcussen@fortworthzoo.org</a>
Craig Pelke	NORFOLK - Virginia Zoological Park, Norfolk, VA	<a href="mailto:craig.pelke@norfolk.gov">craig.pelke@norfolk.gov</a>
Dan Brands	WINSTON - Wildlife Safari Inc, Winston, OR	<a href="mailto:curator@wildlifesafari.net">curator@wildlifesafari.net</a>
Brad Hazleton	Scotneck	<a href="mailto:brad@shwpark.com">brad@shwpark.com</a>

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