Population Analysis and Breeding Plan

White-naped Crane

Grus vipio

Species Survival Plan®

SPECIES COORDINATOR / Studbook Keeper

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Executive Summary

White-naped Crane (*Grus vipio*) SSP®

The Gruiformes Taxon Advisory Group has set a target population size for this species of 90 specimens (2009 RCP). Current space available is less than the target size and pairings will be limited as a result. Current population is 57 specimens. This represents a decline in number of both specimens held and participating institutions from the previous Breeding and Transfer Plans (2004, 2007).

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 85%. 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)	57 (29.28.0)
# animals excluded from management	5
Population size following exclusions	52
Target population size	90
Mean generation time (yrs)	16.59
Historic/Projected population growth rate (lambda)	1.01/1.01

Genetics*

	Current	***Potential***
Founders	28	1
Founder genome equivalents (FGE)	11.75	18.50
Gene diversity retained (GD%)	0.9574	97.30
Population mean kinship (MK)	0.0426	
Mean inbreeding (F)	0.0078	
Percentage of pedigree known before assumptions and exclusions	99.6	
Percentage of pedigree known after assumptions and exclusions	99.6	
Effective population size/census size ratio (Ne / N)	0.3431	
Years To 90% Gene Diversity	50	
Years to 10% Loss of Gene Diversity	107	
Gene Diversity at 100 Years From Present (%) Assuming λ = 1.01, Target size = 90	85.6	

*Genetic statistics calculated from the analytical studbook

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. The number of pairs recommended is intended to result in a population size of 90 in approximately 10-20 years. Due to a lack of expected population growth resulting from the previous Breeding and Transfer Plan, a more aggressive strategy, increasing the number of recommended pairs, is being undertaken.

Summary Actions: The SSP will recommend 18 breeding pairs intended to produce greater than 4 chicks per year. 12 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 4 SEPT 09) were performed in October 2009, resulting in the current master plan for this species. Recommendations contained in this master plan supercede those made by earlier plans. Master plan analyses were performed using SPARKS 1.5, PopLink 1.3, and PM2000 1.213.

Managed Population: The current population size is 57 (TAG recommended size = 90, 2009 RCP), distributed among 20 AZA institutions. This represents a decline in number of both specimens held and participating institutions from the previous Breeding and Transfer Plans (2004, 2007). Five specimens have been removed from the potentially breeding population due to medical concerns (0128; 0129; 0165; 0200; 0243). The population remaining following these exclusions is 52 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 (λ = 0.95 – 1.15) though the general trend has been one of positive growth (mean λ = 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. The current trend of decline continues with 8 deaths and 7 hatches having occurred since the previous Breeding and Transfer Plan (2007).

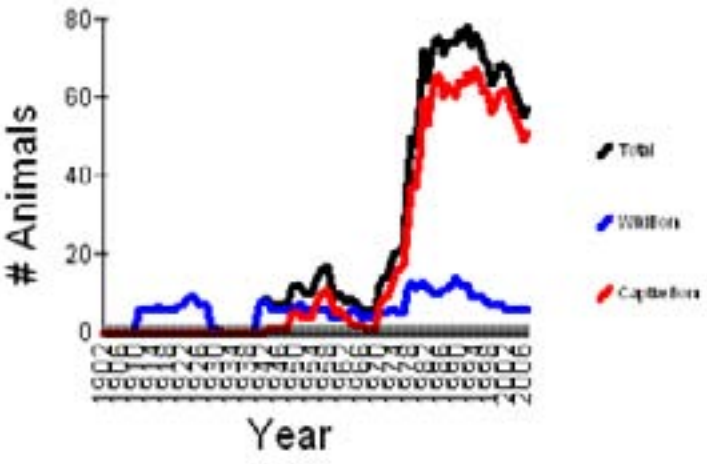

Figure 1. Census of specimens in the SSP.

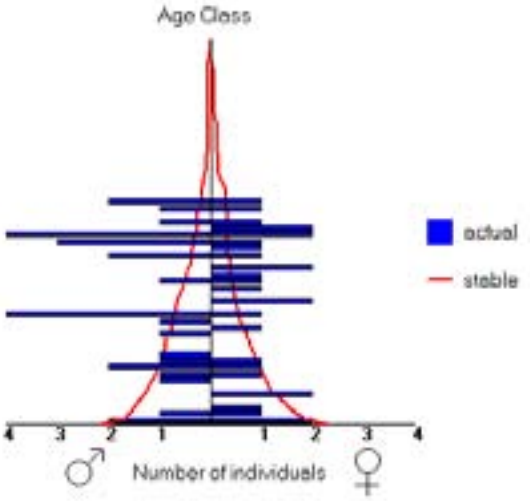

Figure 2. Age distribution of specimens in the SSP.

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). The earlier age-classes vary greatly in size and this could result widely varying annual population growth rates if breeding is not closely managed.

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 55 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 74% of all chicks surviving their first year.

Genetics: The managed population is descended from 28 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 50 years given current population parameters. Projections of gene diversity indicate 85% 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:

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

Current GENETIC SUMMARY Genetic statistics calculated from an analytical studbook	***Current*** ***2009***	***Potential***
Founders	28	1
Founder genome equivalents (FGE)	11.75	18.50
Gene diversity retained (GD%)	0.9574	97.30
Population mean kinship (MK)	0.0426	
Mean inbreeding (F)	0.0078	
Pedigree known before assumptions and exclusions (%)	99.6	
Pedigree known after assumptions and exclusions (%)	99.6	
Effective population size / census size ratio (Ne / N)	0.3431	
Years To 90% Gene Diversity	50	
Gene Diversity at 100 Years From Present (%) Assuming λ = 1.01, Target size = 90	85.6	

The potential gene diversity is high (96%) and the time to 90% gene diversity could be extended beyond 50 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.

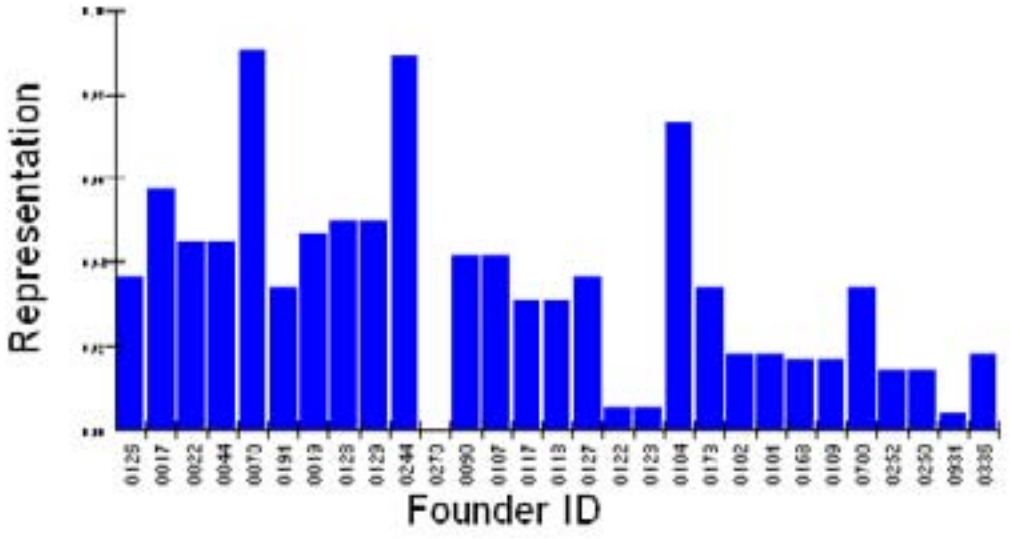

Figure 3. Founder Representation of specimens in AZA institutions illustrating the inequality of founder representation.

Management Strategy: Demographic analyses indicate that 4 hatches in the coming year 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. The number of pairs recommended is intended to result in a population size of 90 in 10-20 years. Planned growth is slow as the RCP target size exceeds the current space available.

1. 18 breeding pairs are recommended.

2. 12 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	Disposition	Location	Breeding	With	Notes
0421	AKRON	992363	F	SEND TO	FARGO	BREED WITH	0888	
0300	AUDUBON	2149	F	SEND TO	JACKSON	BREED WITH	0779	
0779	AUDUBON	101511	M	SEND TO	JACKSON	BREED WITH	0300	
0126	BARABOO	100015	M	HOLD	BARABOO	BREED WITH	0680	
0128	BARABOO	100017	F	HOLD	BARABOO	DO NOT BREED		excluded - veterinary concerns
0129	BARABOO	100011	M	HOLD	BARABOO	DO NOT BREED		excluded - veterinary concerns
0165	BARABOO	100022	F	HOLD	BARABOO	DO NOT BREED		excluded - veterinary concerns
0200	BARABOO	100028	M	HOLD	BARABOO	DO NOT BREED		excluded - veterinary concerns
0680	BARABOO	100055	F	HOLD	BARABOO	BREED WITH	0126	
0219	BIRMINGHM	2155	M	HOLD	BIRMINGHM	BREED WITH	0951	
0951	BIRMINGHM	205053	F	HOLD	BIRMINGHM	BREED WITH	0219	
0969	BIRMINGHM	209096	F	SEND TO	NZP-CRC	SEE NOTES		pair with 0960 - DNB
0133	COLUMBUS	107041	F	HOLD	COLUMBUS	DO NOT BREED		
0236	COLUMBUS	107040	M	HOLD	COLUMBUS	DO NOT BREED		
0175	DETROIT	2857	F	HOLD	DETROIT	BREED WITH	0194	
0194	DETROIT	2858	M	HOLD	DETROIT	BREED WITH	0175	
0888	FARGO	298004	M	HOLD	FARGO	BREED WITH	0421	
0954	MEMPHIS	22440	M	HOLD	MEMPHIS	BREED WITH	0963	
0963	MEMPHIS	22739	F	HOLD	MEMPHIS	BREED WITH	0954	
0195	NY BRONX	892309	M	HOLD	NY BRONX	DO NOT BREED		requested placement unavailable at this time
0270	NY BRONX	832015	M	HOLD	NY BRONX	BREED WITH	0283	
0283	NY BRONX	842058	F	HOLD	NY BRONX	BREED WITH	0270	
0523	NY BRONX	B01091	M	HOLD	NY BRONX	BREED WITH	0682	
0682	NY BRONX	912097	F	HOLD	NY BRONX	BREED WITH	0523	
0810	NY BRONX	942241	M	SEND TO	CENTRALPK	BREED WITH	0886	
0199	NZP-CRC	215327	F	HOLD	NZP-CRC	DO NOT BREED		
0243	NZP-CRC		F	HOLD	NZP-CRC	DO NOT BREED		excluded - veterinary concerns

ID	Location	Local ID	Sex	Disposition	Location	Breeding	With	Notes
0614	NZP-CRC	215730	F	HOLD	NZP-CRC	BREED WITH	0777	AI may be necessary
0921	NZP-CRC	214146	M	HOLD	NZP-CRC	DO NOT BREED		
0941	NZP-CRC	215700	M	HOLD	NZP-CRC	DO NOT BREED		
0957	NZP-CRC	214949	M	HOLD	NZP-CRC	BREED WITH	0961	
0960	NZP-CRC	215047	M	HOLD	NZP-CRC	SEE NOTES		pair with 0969 - DNB
0961	NZP-CRC	215415	F	HOLD	NZP-CRC	BREED WITH	0957	
0964	NZP-CRC	215747	F	SEND TO	MILL MTN	SEE NOTES		pair with 0967 DNB
0966	NZP-CRC	215795	F	SEND TO	KNOXVILLE	SEE NOTES		pair with 0968 - DNB
0182	OKLAHOMA	435902	F	HOLD	OKLAHOMA	DO NOT BREED		related pair
0324	OKLAHOMA	638903	M	HOLD	OKLAHOMA	DO NOT BREED		related pair
0886	OMAHA	9359	F	SEND TO	CENTRALPK	BREED WITH	0810	
0244	SAN ANTON	J07031	F	HOLD	SAN ANTON	BREED WITH	0385	
0385	SAN ANTON	910759	M	HOLD	SAN ANTON	BREED WITH	0244	
0965	SAN ANTON	U08003	M	SEND TO	ST LOUIS	BREED WITH	0551	
0950	SD-WAP	802311	M	HOLD	SD-WAP	BREED WITH	0955	
0955	SD-WAP	802312	F	HOLD	SD-WAP	BREED WITH	0950	
0191	SEATTLE	202595	M	HOLD	SEATTLE	BREED WITH	0481	
0481	SEATTLE	880081	F	HOLD	SEATTLE	BREED WITH	0191	AI may be necessary
0781	SOUTHBEND	98089	F	HOLD	SOUTHBEND	BREED WITH	0830	
0830	SOUTHBEND	98022	M	HOLD	SOUTHBEND	BREED WITH	0781	
0967	SOUTHBEND	29034	M	SEND TO	MILL MTN	SEE NOTES		pair with 0964 - DNB
0551	ST LOUIS	920526	F	HOLD	ST LOUIS	BREED WITH	0965	
0777	ST LOUIS	100108	M	SEND TO	NZP-CRC	BREED WITH	0614	
0956	TOLEDO	5372	M	HOLD	TOLEDO	DO NOT BREED		
0962	TOLEDO	5373	F	HOLD	TOLEDO	DO NOT BREED		
0968	TOLEDO	6134	M	SEND TO	KNOXVILLE	SEE NOTES		pair with 0968 - DNB
0163	TREVOR	1018	M	HOLD	TREVOR	BREED WITH	0959	
0959	TREVOR	A4B659	F	HOLD	TREVOR	BREED WITH	0163	

ID	Location	Local ID	Sex	Disposition	Location	Breeding	With	Notes
0221	W ORANGE	980444	M	HOLD	W ORANGE	BREED WITH	0425	
0425	W ORANGE	980445	F	HOLD	W ORANGE	BREED WITH	0221	AI may be necessary

AKRON

ID	Local ID	Sex	Disposition	Location	Breeding	With	Notes
0421	992363	F	SEND TO	FARGO	BREED WITH	0888	

AUDUBON

ID	Local ID	Sex	Disposition	Location	Breeding	With	Notes
0300	2149	F	SEND TO	JACKSON	BREED WITH	0779	
0779	101511	M	SEND TO	JACKSON	BREED WITH	0300	

BARABOO

ID	Local ID	Sex	Disposition	Location	Breeding	With	Notes
0126	100015	M	HOLD	BARABOO	BREED WITH	0680	
0680	100055	F	HOLD	BARABOO	BREED WITH	0126	
0128	100017	F	HOLD	BARABOO	DO NOT BREED		excluded - veterinary concerns
0129	100011	M	HOLD	BARABOO	DO NOT BREED		excluded - veterinary concerns
0165	100022	F	HOLD	BARABOO	DO NOT BREED		excluded - veterinary concerns
0200	100028	M	HOLD	BARABOO	DO NOT BREED		excluded - veterinary concerns

BIRMINGHM

ID	Local ID	Sex	Disposition	Location	Breeding	With	Notes
0219	2155	M	HOLD	BIRMINGHM	BREED WITH	0951	
0951	205053	F	HOLD	BIRMINGHM	BREED WITH	0219	
0969	209096	F	SEND TO	NZP-CRC	SEE NOTES		pair with 0960 - DNB

CENTRALPK

ID	Local ID	Sex	Disposition	Location	Breeding	With	Notes
0810	942241	M	RECEIVE FROM	NY BRONX	BREED WITH	0886	
0886	9359	F	RECEIVE FROM	OMAHA	BREED WITH	0810	

COLUMBUS

ID	Local ID	Sex	Disposition	Location	Breeding	With	Notes
0133	107041	F	HOLD	COLUMBUS	DO NOT BREED		
0236	107040	M	HOLD	COLUMBUS	DO NOT BREED		

DETROIT

ID	Local ID	Sex	Disposition	Location	Breeding	With	Notes
0175	2857	F	HOLD	DETROIT	BREED WITH	0194	
0194	2858	M	HOLD	DETROIT	BREED WITH	0175	

FARGO

ID	Local ID	Sex	Disposition	Location	Breeding	With	Notes
0888	298004	M	HOLD	FARGO	BREED WITH	0421	
0421	992363	F	RECEIVE FROM	AKRON	BREED WITH	0888	

JACKSON

ID	Local ID	Sex	Disposition	Location	Breeding	With	Notes
0300	2149	F	RECEIVE FROM	AUDUBON	BREED WITH	0779	
0779	101511	M	RECEIVE FROM	AUDUBON	BREED WITH	0300	

KNOXVILLE

ID	Local ID	Sex	Disposition	Location	Breeding	With	Notes
0966	215795	F	RECEIVE FROM	NZP-CRC	SEE NOTES		pair wit 0968 - DNB
0968	6134	M	RECEIVE FROM	TOLEDO	SEE NOTES		pair with 0968 - DNB

MEMPHIS

ID	Local ID	Sex	Disposition	Location	Breeding	With	Notes
0954	22440	M	HOLD	MEMPHIS	BREED WITH	0963	
0963	22739	F	HOLD	MEMPHIS	BREED WITH	0954	

MILL MTN

ID	Local ID	Sex	Disposition	Location	Breeding	With	Notes
0964	215747	F	RECEIVE FROM	NZP-CRC	SEE NOTES		pair with 0967 DNB
0967	29034	M	RECEIVE FROM	SOUTHBEND	SEE NOTES		pair with 0964 - DNB

NY BRONX

ID	Local ID	Sex	Disposition	Location	Breeding	With	Notes
0195	892309	M	HOLD	NY BRONX	DO NOT BREED		requested placement unavailable at this time
0270	832015	M	HOLD	NY BRONX	BREED WITH	0283	
0283	842058	F	HOLD	NY BRONX	BREED WITH	0270	
0523	B01091	M	HOLD	NY BRONX	BREED WITH	0682	
0682	912097	F	HOLD	NY BRONX	BREED WITH	0523	
0810	942241	M	SEND TO	CENTRALPK	BREED WITH	0886	

NZP-CRC

ID	Local ID	Sex	Disposition	Location	Breeding	With	Notes
0969	209096	F	RECEIVE FROM	BIRMINGHM	SEE NOTES		pair with 0960 - DNB
0199	215327	F	HOLD	NZP-CRC	DO NOT BREED		
0614	215730	F	HOLD	NZP-CRC	BREED WITH	0777	AI may be necessary
0921	214146	M	HOLD	NZP-CRC	DO NOT BREED		
0941	215700	M	HOLD	NZP-CRC	DO NOT BREED		
0957	214949	M	HOLD	NZP-CRC	BREED WITH	0961	
0960	215047	M	HOLD	NZP-CRC	SEE NOTES		pair with 0969 - DNB
0961	215415	F	HOLD	NZP-CRC	BREED WITH	0957	
0964	215747	F	SEND TO	MILL MTN	SEE NOTES		pair with 0967 DNB
0966	215795	F	SEND TO	KNOXVILLE	SEE NOTES		pair with 0968 - DNB
0777	100108	M	RECEIVE FROM	ST LOIUS	BREED WITH	0614	
0243		F	HOLD	NZP-CRC	DO NOT BREED		excluded - veterinary concerns

OKLAHOMA

ID	Local ID	Sex	Disposition	Location	Breeding	With	Notes
0182	435902	F	HOLD	OKLAHOMA	DO NOT BREED		related pair
0324	638903	M	HOLD	OKLAHOMA	DO NOT BREED		related pair

OMAHA

ID	Local ID	Sex	Disposition	Location	Breeding	With	Notes
0886	9359	F	SEND TO	CENTRALPK	BREED WITH	0810	

SAN ANTON

ID	Local ID	Sex	Disposition	Location	Breeding	With	Notes
0244	J07031	F	HOLD	SAN ANTON	BREED WITH	0385	
0385	910759	M	HOLD	SAN ANTON	BREED WITH	0244	
0965	U08003	M	SEND TO	ST LOUIS	BREED WITH	0551	

SD-WAP

ID	Local ID	Sex	Disposition	Location	Breeding	With	Notes
0950	802311	M	HOLD	SD-WAP	BREED WITH	0955	
0955	802312	F	HOLD	SD-WAP	BREED WITH	0950	

SEATTLE

ID	Local ID	Sex	Disposition	Location	Breeding	With	Notes
0191	202595	M	HOLD	SEATTLE	BREED WITH	0481	
0481	880081	F	HOLD	SEATTLE	BREED WITH	0191	AI may be necessary

SOUTHBEND

ID	Local ID	Sex	Disposition	Location	Breeding	With	Notes
0781	98089	F	HOLD	SOUTHBEND	BREED WITH	0830	
0830	98022	M	HOLD	SOUTHBEND	BREED WITH	0781	
0967	29034	M	SEND TO	MILL MTN	SEE NOTES		pair with 0964 - DNB

ST LOUIS

ID	Local ID	Sex	Disposition	Location	Breeding	With	Notes
0965	U08003	F	RECEIVE FROM	SAN ANTON	BREED WITH	0551	
0551	920526	F	HOLD	ST LOIUS	BREED WITH	0965	
0777	100108	M	SEND TO	NZP-CRC	BREED WITH	0614	

TOLEDO

ID	Local ID	Sex	Disposition	Location	Breeding	With	Notes
0956	5372	M	HOLD	TOLEDO	DO NOT BREED		
0962	5373	F	HOLD	TOLEDO	DO NOT BREED		
0968	6134	M	SEND TO	KNOXVILLE	SEE NOTES		pair with 0968 - DNB

TREVOR

ID	Local ID	Sex	Disposition	Location	Breeding	With	Notes
0163	1018	M	HOLD	TREVOR	BREED WITH	0959	
0959	A4B659	F	HOLD	TREVOR	BREED WITH	0163	

W ORANGE

ID	Local ID	Sex	Disposition	Location	Breeding	With	Notes
0221	980444	M	HOLD	W ORANGE	BREED WITH	0425	
0425	980445	F	HOLD	W ORANGE	BREED WITH	0221	AI may be necessary

Appendix A
Life Table

Females								
Age (x)	*Qx*	*Px*	*lx*	*Mx*	*Vx*	*Ex*	*Risk (Qx)*	*Risk (Mx)*
0	0.23	0.77	1	0	1.13	15.561	88.3	70.9
1	0.11	0.89	0.77	0	1.395	17.71	79.9	73
2	0.1	0.9	0.685	0.07	1.582	18.676	70.9	66.9
3	0.05	0.95	0.617	0.08	1.662	19.136	63.2	62.1
4	0.11	0.89	0.586	0.15	1.744	19.697	64	58.8
5	0.04	0.96	0.521	0.14	1.753	20.258	56.6	54.9
6	0.06	0.94	0.501	0.06	1.723	20.267	53.4	51.4
7	0.02	0.98	0.471	0.08	1.759	20.082	46.7	45.9
8	0.05	0.95	0.461	0.09	1.766	19.771	43.6	42.5
9	0.05	0.95	0.438	0.11	1.79	19.759	41	40.5
10	0.05	0.95	0.416	0.09	1.795	19.747	38.6	37.9
11	0.06	0.94	0.395	0.13	1.831	19.835	35.4	34.2
12	0.06	0.94	0.372	0.06	1.837	20.037	33.5	33
13	0	1	0.349	0.03	1.861	19.645	33.3	33.3
14	0.09	0.91	0.349	0.08	1.946	19.524	33.3	31.1
15	0.1	0.9	0.318	0.18	2.092	20.463	30	28.5
16	0.04	0.96	0.286	0.12	2.091	20.963	26.4	25.7
17	0.08	0.92	0.275	0.06	2.127	21.228	24.6	23.7
18	0	1	0.253	0.09	2.189	21.108	21.9	21.9
19	0.05	0.95	0.253	0.23	2.185	20.623	22	21.3
20	0	1	0.24	0.31	2.037	20.14	19.6	19.6
21	0	1	0.24	0.22	1.753	19.14	18.3	18.3
22	0.11	0.89	0.24	0.15	1.646	19.195	17.4	16.5
23	0	1	0.214	0.26	1.613	19.32	13.7	13.7
24	0	1	0.214	0.19	1.373	18.32	13	13
25	0.08	0.92	0.214	0.17	1.251	18.042	12.4	11.9
26	0	1	0.197	0.09	1.144	17.783	11.4	11.4
27	0	1	0.197	0.05	1.07	16.783	10.1	10.1
28	0	1	0.197	0.06	1.036	15.783	8.4	8.4
29	0	1	0.197	0	0.99	14.783	6.8	6.8
30	0	1	0.197	0	1.005	13.783	5.3	5.3
31	0	1	0.197	0	1.02	12.783	5	5
32	0	1	0.197	0	1.035	11.783	4.2	4.2
33	0	1	0.197	0	1.051	10.783	3	3
34	0	1	0.197	0	1.067	9.783	4	4
35	0	1	0.197	0	1.083	8.782	4	4
36	0.25	0.75	0.197	0	1.256	8.894	4	3.6
37	0.33	0.67	0.147	0.24	1.781	11.03	3	2.1
38	0	1	0.099	0.75	1.949	12.5	2	2
39	0	1	0.099	0.25	1.217	11.5	2	2
40	0	1	0.099	0	0.982	10.5	2	2
41	0	1	0.099	0.75	0.996	9.5	2	2
42	0	1	0.099	0.25	0.25	8.5	2	2
43	0	1	0.099	0	0	7.5	2	2
44	0	1	0.099	0	0	6.5	2	2
45	0	1	0.099	0	0	5.5	2	2

46	0.5	0.5	0.099	0	0	6	2	1.2
47	0	1	0.049	0	0	7.5	1	1
48	0	1	0.049	0	0	6.5	1	1
49	0	1	0.049	0	0	5.5	1	1
50	0	1	0.049	0	0	4.5	1	1
51	0	1	0.049	0	0	3.5	1	1
52	0	1	0.049	0	0	2.5	1	1
53	0	1	0.049	0	0	1.5	1	1
54	1	0	0.049	0	0	1	1	0.3
55	1	0	0	0	0	0	0	0
56	1	0	0	0	0	0	0	0
57	1	0	0	0	0	0	0	0

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

r = 0.0149
lambda = 1.0150
T = 16.46
N = 25.00
N(at 20 yrs) = 33.66

Males								
Age (x)	Qx	Px	lx	Mx	Vx	Ex	Risk (Qx)	Risk (Mx)
0	0.29	0.71	1	0	1.17	18.018	110.3	84.5
1	0.07	0.93	0.71	0	1.487	21.237	81.4	76.4
2	0.04	0.96	0.66	0.01	1.605	21.427	74.3	72.8
3	0.04	0.96	0.634	0.01	1.693	21.278	70.6	69.6
4	0.07	0.93	0.609	0.2	1.814	21.451	66.9	64.6
5	0.02	0.98	0.566	0.17	1.724	21.435	59.5	59.1
6	0.05	0.95	0.555	0.13	1.641	21.173	57.4	55.8
7	0.04	0.96	0.527	0.14	1.613	21.127	51.6	50.6
8	0.04	0.96	0.506	0.17	1.563	20.965	47.3	45.8
9	0.04	0.96	0.486	0.17	1.479	20.797	45	44.3
10	0.02	0.98	0.466	0.02	1.376	20.414	42.5	42.4
11	0	1	0.457	0.11	1.396	19.612	42.2	42.2
12	0	1	0.457	0.06	1.31	18.612	40.6	40.6
13	0.05	0.95	0.457	0.17	1.307	18.063	40.1	39.3
14	0.08	0.92	0.434	0.11	1.238	18.242	37.5	36.3
15	0	1	0.399	0.1	1.2	17.992	33.6	33.6
16	0	1	0.399	0.07	1.121	16.992	30.3	30.3
17	0	1	0.399	0.12	1.071	15.992	29	29
18	0.03	0.97	0.399	0.14	0.984	15.22	29	28.6
19	0.07	0.93	0.387	0.08	0.905	14.964	27.7	26.3
20	0.04	0.96	0.36	0.1	0.89	14.785	25	25
21	0.08	0.92	0.346	0	0.856	14.658	24.4	23.3
22	0.09	0.91	0.318	0	0.953	14.924	22	20.5
23	0	1	0.289	0.08	1.019	14.612	20	20
24	0.15	0.85	0.289	0	1.035	14.716	20.3	18.9
25	0	1	0.246	0	1.148	14.926	15.6	15.6
26	0	1	0.246	0	1.17	13.926	15	15
27	0.08	0.92	0.246	0.04	1.242	13.465	13	12.1
28	0	1	0.226	0	1.278	13.007	8.2	8.2
29	0.14	0.86	0.226	0	1.4	12.911	7	7
30	0	1	0.195	0	1.543	12.88	5.3	5.3
31	0	1	0.195	0	1.572	11.88	5	5
32	0	1	0.195	0	1.602	10.88	4.8	4.8
33	0.33	0.67	0.195	0	1.956	11.832	3	2.7
34	0	1	0.13	0	2.484	13.5	2	2
35	0	1	0.13	0	2.531	12.5	2	2
36	0	1	0.13	0	2.579	11.5	2	2
37	0	1	0.13	0	2.629	10.5	2	2
38	0.5	0.5	0.13	0.38	3.572	12.667	2	1.3
39	0	1	0.065	0	4.879	17.5	1	1
40	0	1	0.065	0	4.972	16.5	1	1
41	0	1	0.065	0	5.067	15.5	1	1
42	0	1	0.065	0	5.163	14.5	1	1
43	0	1	0.065	1.5	5.262	13.5	1	1

44	0	1	0.065	2	3.833	12.5	1	1
45	0	1	0.065	0	1.868	11.5	1	1
46	0	1	0.065	0	1.904	10.5	1	1
47	0	1	0.065	0	1.94	9.5	1	1
48	0	1	0.065	0	1.977	8.5	1	1
49	0	1	0.065	0	2.015	7.5	1	1
50	0	1	0.065	0	2.054	6.5	1	1
51	0	1	0.065	0	2.093	5.5	1	1
52	0	1	0.065	0	2.133	4.5	1	1
53	0	1	0.065	0	2.173	3.5	1	1
54	0	1	0.065	0	2.215	2.5	1	1
55	0	1	0.065	0	2.257	1.5	1	1
56	1	0	0.065	4.6	4.6	1	1	0.3
57	1	0	0	0	0	0	0	0

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

r = 0.0189
lambda = 1.0191
T = 16.73
N = 27.00
N(at 20 yrs) = 39.40

Appendix B
Ordered Mean Kinship

Males

SB#	MK	%Known	Age	Location
0270	0.000	100.0	28	NY BRONX
0191	0.017	100.0	32	SEATTLE
0126	0.018	100.0	33	BARABOO
0385	0.024	100.0	25	SAN ANTON
0777	0.025	87.5	16	ST LOUIS
0523	0.026	100.0	21	NY BRONX
0956	0.033	100.0	8	TOLEDO
0810	0.034	100.0	16	NY BRONX
0941	0.039	93.8	10	NZP-CRC
0950	0.039	100.0	9	SD-WAP
0954	0.039	100.0	8	MEMPHIS
0965	0.039	100.0	1	SAN ANTON
0779	0.044	100.0	16	AUDUBON
0888	0.044	100.0	15	FARGO
0194	0.045	100.0	28	DETROIT
0195	0.045	100.0	28	NY BRONX
0221	0.045	100.0	27	DENVER
0830	0.046	100.0	16	SOUTHBEND
0219	0.048	100.0	27	BIRMINGHM
0163	0.050	100.0	30	TREVOR
0960	0.051	100.0	6	NZP-CRC
0324	0.052	100.0	25	OKLAHOMA
0968	0.052	100.0	0	TOLEDO
0236	0.053	100.0	27	COLUMBUS
0967	0.053	100.0	0	SOUTHBEND
0957	0.054	100.0	7	NZP-CRC
0921	0.064	100.0	13	NZP-CRC

Females

SB#	MK	%Known	Age	Location
0551	0.022	100.0	21	ST LOUIS
0421	0.024	100.0	23	AKRON
0481	0.024	100.0	22	SEATTLE
0614	0.024	100.0	20	NZP-CRC
0283	0.026	100.0	26	NY BRONX
0425	0.030	100.0	23	DENVER
0886	0.030	100.0	14	OMAHA
0955	0.030	100.0	8	SD-WAP
0682	0.034	100.0	18	NY BRONX
0959	0.039	100.0	7	TREVOR
0199	0.042	100.0	28	NZP-CRC
0951	0.042	100.0	9	BIRMINGHM
0244	0.044	100.0	28	SAN ANTON
0966	0.044	100.0	0	NZP-CRC
0680	0.046	100.0	18	BARABOO
0781	0.048	100.0	16	SOUTHBEND
0175	0.050	100.0	29	DETROIT
0182	0.050	100.0	29	OKLAHOMA
0300	0.050	100.0	25	AUDUBON
0969	0.050	100.0	0	BIRMINGHM
0961	0.058	100.0	4	NZP-CRC
0963	0.058	100.0	2	MEMPHIS
0964	0.058	100.0	1	NZP-CRC
0133	0.059	100.0	32	COLUMBUS
0962	0.061	100.0	4	TOLEDO

Appendix C
Summary of Data Exports

Report compiled under SPARKS V. 1.5 & Population Management 2000, V. 1.213

Data exported on: 26 OCT 09

Data compiled by: Carol Hesch

Data current thru: 4 SEPT 09

Scope of data: North America

Filter Conditions In Effect:

Genetics: Dates: As of 26 OCT 09; Association: \SPARKS\WN_CRANE\AZA.fed; Status: Living on 26 OCT 09

Demography : Dates: Between 01/01/1970 and 26 OCT 09 Association: \SPARKS\WN_CRANE\AZA.fed

Appendix D
Definitions

Management Terms

SSP Master Plan – A document that provides complete breeding and transfer recommendations for a Species Survival Plan (SSP®) population. The document is based on genetic and demographic analyses with consideration of behavioral, social, and institutional wants and needs. A draft of the Master Plan must be published in the Members Only section of the AZA Web site for a 30-day comment period. After the Coordinator incorporates/responds to institutional comments, a final version of the Master Plan must be published in the Members Only section of the AZA Web site. SSP Participation by AZA institutions is required.

Full Participation – AZA policy stating that all AZA accredited institutions and certified related facilities having an SSP animal in their collection are required to participate in the SSP partnership process and abide by the recommendations of the SSP.

Population Management Plan (PMP)– A document that provides complete breeding and transfer recommendations for a PMP population. The document is based on genetic and demographic analyses with consideration of behavioral, social, and institutional wants and needs. A draft of the PMP must be published in the Members Only section of the AZA Web site for a 30-day comment period. After the PMP Manager incorporates/responds to institutional comments, a final version of the PMP must be published in the Members Only section of the AZA Web site. PMP Participation by AZA institutions is voluntary.

Demographic Terms

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

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

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

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

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

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

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

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

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

Genetic Terms

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

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

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

FOKE, First Order Kin Equivalents – The number of first-order kin (siblings or offspring) that would contain the number of copies of an 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 F

Directory of Institutional Representatives

First	Last	phone #	e-mail
Eric	Albers	330-375-2550, x7252	eralbers@akronzoo.org
Lee	Schoen	504-861-5124	lschoen@audubоninstitute.org
Kellly	Maguire	608-356-9462, x123	Kelly@savingcranes.org
Cindy	Pinger	205-879-0409, x233	cpinger@birminghamzoo.com
Nancy	Clum	718-220-5100	nclum@wcs.org
Jeff	Sailor	212-439-6513	jsailer@wcs.org
Kelly	Vineyard	614-724-3665	Kelly.vineyard@columbuszoo.org
Tom	Schneider	248-398-0903, X3128	tschneider@detroitzoo.org
Dave	Wetzel	601-352-2580, x237	dlwetzel@msn.com
Mark	Armstrong	865-637-5331, x392	marka@knoxville-zoo.org
Carol	Hesch	901-333-6706	chesch@memphiszoo.org
Warren	Lynch	540-635-6575	lynchw@si.edu
Darcy	Henthorn	405-425-0208	dhenthorn@okczoo.com
Bob	Lastovica	402-733-8401	birds@omahazoo.com
Josef	San Miguel	210-734-7184, X120	curbirds@sazoo-aq.org
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Mark	Myers	206-548-2500	Mark.myers@zoo.org
Laura	Arriaga	574-245-6162	larriaga@southbendin.gov
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Brint	Spencer	973-731-5800, x231	tbzcurator@yahoo.com
Robert	Webster	419-385-5721, X2008	robert.webster@toledozoo.org
Jonathon	Meigs	845-677-3704	jomeigs@millbrook.org
Mike	Schmidt	701-277-9240	mschmidt@redriverzoo.org