Population Analysis and Breeding Plan

Wattled Crane

Bugeranus carunculatus

Species Survival Plan®

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This report prepared with assistance from the

PMC Population Management Center

Lincoln Park Zoo ASSOCIATION OF ZOOS & AQUARIUMS

Executive Summary

Wattled Crane (*Bugeranus carunculatus*) SSP®

The Gruiformes Taxon Advisory Group has set a target population size for this species of 100 specimens. The current population is 63 specimens.

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 weights, smaller clutch sizes, and greater neonatal mortality. Given the current gene diversity, this population will likely remain above the 90% level for 40 to 50 years; gene diversity at 100 years is expected to be about 84%.

DEMOGRAPHY

Current Population Size	63(37.26)
Specimens Excluded from Genetic Analyses	1
Mean Generation Time (years)	16.29
Projected Population Growth Rate	1.02

GENETICS

	Current	***Potential***
Current Gene Diversity (%)	96.24	98.20
Founder Genome Equivalents	13.30	22.78
% Pedigree Known	100	
Years To 90% Gene Diversity	84	
Gene Diversity at 100 Years From Present (%)	47	

Special Concerns: In spite of 30 recommended breeding pairs, no surviving offspring have been produced since the previous Breeding and Transfer Plan in 2003. Institutions receiving breeding recommendations are encouraged to consider the successful breeding of this species a priority.

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 100 in approximately 15 years.

Summary Actions: The SSP will recommend 26 breeding pairs and 10 transfers for this period. Recommendations contained in this master plan supersede those made by earlier plans.

A number of institutions are interested in placing surplus males. If any institutions have the facilities/staff capable of dealing with difficult hand-reared males, please contact the Species Coordinator.

Those institutions managing difficult individuals may contact the Species Coordinator for Shift Shed construction plans and advice on shift training their cranes.

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Cover Art: Forshaw, J. Ed. 1991. Encyclopedia of Birds. Smithmark Publishers. New York.

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Description of Population Status

Introduction: Wattled cranes have been designated by the Gruiformes TAG as an SSP with a target population size of 100 specimens. Comprehensive genetic and demographic analyses of the International Wattled Crane Studbook (N.A. data current to 31/11/2006) were performed in January 2007, resulting in the current master plan for this species. Recommendations contained in this master plan supersede those made by earlier plans. Master plan analyses were performed using SPARKS 1.5 and PM2000 1.211.

Managed Population: The current population size is 63 (TAG recommended size = 100), distributed among 26 AZA institutions. At present, 1 individual is considered to be non-reproductive due to advanced age (SB# 8). The managed population that remains following this exclusion is 62 individuals.

Demography: Wattled cranes were first seen in North American zoos in small numbers in 1937 and were bred sporadically beginning in 1945. The North American Regional population remained small from its appearance in 1937 until 1980s when captive propagation became a significant source of recruitment to the population. Since the population's inception the annual growth rates due to captive births have varied (λ = 0.96 – 1.14) though the general trend has been one of positive growth (mean λ = 1.07).

Over the past decade, however, the population has exhibited a decline (λ = 0.97 - 0.99) (Figure 1.) as both animals and eggs have been exported to other regional collections. Historical data suggest that the population, given intense management, could grow to reach the target size 5-15 years (λ = 1.02 – 1.05). Data from other crane populations indicate mean annual growth rates slightly higher than this (λ = 1.06-1.19) and data from wild populations also suggest higher growth rates in other cranes. Under intense management, however, the wattled crane population may be capable of exhibiting growth rates greater than those currently observed. **In spite of 30 recommended breeding pairs, no surviving offspring have been produced since the previous Breeding and Transfer Plan in 2003. Institutions receiving breeding recommendations are encouraged to consider the successful breeding of this species a priority.**

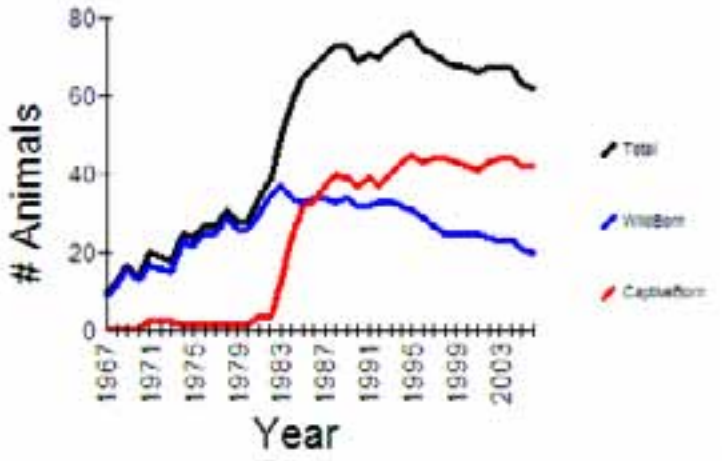

Figure 1. Census of wattled cranes in North American zoos.

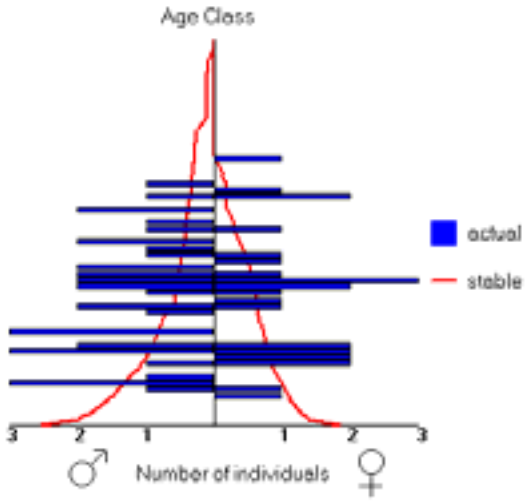

Figure 2. Age distribution of wattled cranes in SSP population.

The age structure of the population is far from approaching stable as the small numbers of animals in the juvenile age classes reflect the recent population decline and some reproductive age classes are empty (Figure 2). If this trend of decline continues, the numbers of individuals entering reproductive age classes will limit population growth rates. The sex ratio of the population is male biased.

Demographic data suggests the life history traits such as lifespan and reproductive span exhibit disparity between the sexes. Males may reach sexual maturity by the age of two years but many do not reproduce until after the age of four. Females have reproduced at the age of two years but most do not until greater than seven years of age. Observations of animals breeding at very young ages may be artifacts of estimated ages of wild-caught specimens and may represent biological limits on reproduction. Males have lived longer than 50 years and have reproduced until the age of 34. Females, however, have not been observed to live beyond

the age of 38 or produce offspring beyond the age of 30 years. This disparity observed between the sexes may be attributable to the small number of specimens that have been held in captivity for the entirety of their long life span. Infant mortality has been observed between 30 and 40%.

Genetics: The managed population is descended from 23 founders and 7 potential founders remain. The youngest of these potential founders is 25 years of age.

Genetic Summary

	2006	Potential	2003
Founder Genome Equivalents	13.30	27.78	14.18
Gene Diversity Retained (%)	96.24	98.20	96.47
Population Mean Kinship	0.0376		0.0353
Mean Inbreeding	0		0.0
% Pedigree Known	100		100
Years to 90%	47		67
Diversity at 100 Years (%)	84.28		87.11
N_e/N	0.2540		0.3021

Gene diversity in the population (96%) is high relative the average SSP (93%). The population's gene diversity could fall below 90% in 40-50 years. Projections of gene diversity indicate 84% at 100 years from present. These projections are lower than those in the presented in the 2003 Breeding and Transfer Plan due to a decrease in the Ne/N ratio of the population as proven breeders and their offspring have been lost to attrition without replacement. Increasing the proportion of individuals in the population that breed will improve projections of gene diversity retention. 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.

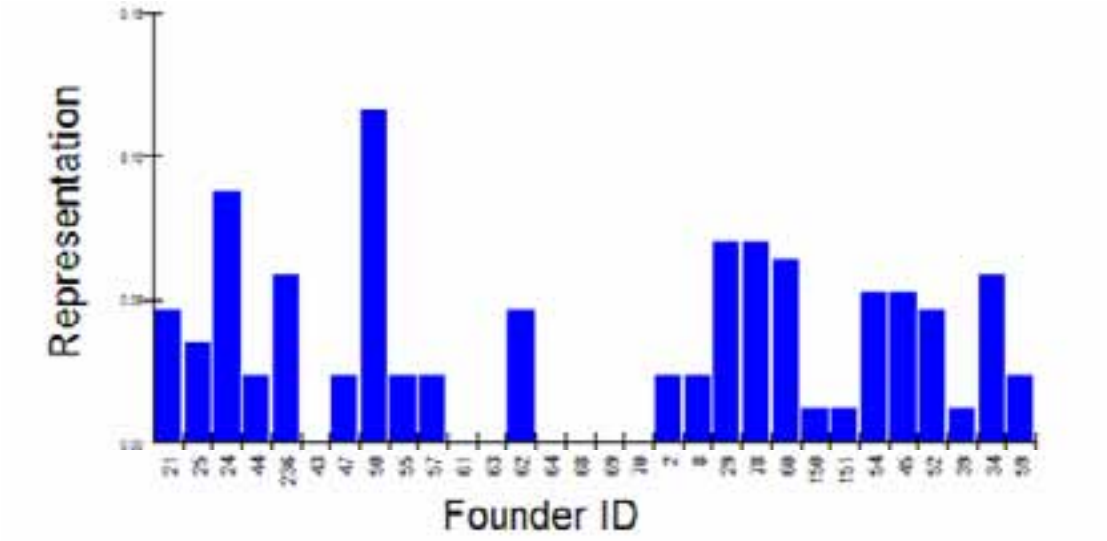

Figure3. Founder representation in the Wattled Crane SSP.

Management Strategy: Demographic analyses indicate that an annual population growth rate of greater than 3% will be attained if 5 offspring are produced in the coming year. Two to three offspring are required to maintain the current population size, preventing further decline. Given the lack of production from 30 recommended breeding pairs since 2003, a large number of pairings will again be recommended. In spite of 30 recommended breeding pairs, no surviving offspring have been produced since the previous Breeding and Transfer Plan in 2003. **Institutions receiving breeding recommendations are encouraged to consider the successful breeding of this species a priority.** Genetic standards for pairings have been relaxed to accomplish demographic goals and effect population growth, reversing the trend of decline. Over-represented pairs have been recommended, but within pairings MKs are well matched.

1. Recommend 26 pairings.

2. Recommend 10 transfers.

3. There are a number of institutions interested in placing surplus and/or aggressive non-breeding males. If any institutions have the facilities/staff capable of dealing with difficult hand-reared or surplus males, please contact the Species Coordinator.

4. Those institutions managing difficult individuals may contact the Species Coordinator for Shift Shed construction plans and advice on shift training their cranes.

5. Due to the difficulty of managing hand-reared cranes, it is recommended that 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.

Summary of Breeding and Transfer Recommendations

ID	Location	Local ID	Sex	Disposition	Location	Breeding	With	Notes
634	ASHEBORO	22730	M	HOLD	ASHEBORO	DO NOT BREED		requested placement unavailable at this time
583	ASHEBORO	22521	M	HOLD	ASHEBORO	BREED WITH	517	
517	ASHEBORO	22355	F	HOLD	ASHEBORO	BREED WITH	583	
92	ASHEBORO	21634	M	HOLD	ASHEBORO	BREED WITH	24	
24	ASHEBORO	21427	F	HOLD	ASHEBORO	BREED WITH	92	
541	BALTIMORE	960538	M	SEND TO	FORTWORTH	BREED WITH	154	
62	BARABOO	050010	M	HOLD	BARABOO	BREED WITH	21	
47	BARABOO	050022	M	HOLD	BARABOO	BREED WITH	44	
44	BARABOO	050027	F	HOLD	BARABOO	BREED WITH	47	
21	BARABOO	050011	F	HOLD	BARABOO	BREED WITH	62	
588	BATONROUG	8734	F	HOLD	BATONROUG	BREED WITH	129	
129	BATONROUG	7650	M	HOLD	BATONROUG	BREED WITH	588	
481	BROWNSVIL	8435	M	HOLD	BROWNSVIL	DO NOT BREED		
70	BROWNSVIL	9528	F	HOLD	BROWNSVIL	BREED WITH	363	
569	BUSCH TAM	60817	F	HOLD	BUSCH TAM	BREED WITH	159	
159	BUSCH TAM	61923	M	HOLD	BUSCH TAM	BREED WITH	569	
626	COLUMBIA	8976	M	SEND TO	JACKSONVL	BREED WITH	136	
105	DALLAS	96B428	F	HOLD	DALLAS	BREED WITH	86	
86	DALLAS	864848	M	HOLD	DALLAS	BREED WITH	105	
367	DISNEY AK	020083	F	HOLD	DISNEY AK	BREED WITH	140	
140	DISNEY AK	020082	M	HOLD	DISNEY AK	BREED WITH	367	
363	FORTWORTH	930533	M	HOLD	FORTWORTH	DO NOT BREED		requested placement unavailable at this time
154	FORTWORTH	01663	F	HOLD	FORTWORTH	BREED WITH	541	
520	FRANKLINP	A03406	F	SEND TO	SD-WAP	BREED WITH	64	
491	FRANKLINP	A01448	M	HOLD	FRANKLINP	BREED WITH	68	
134	GREENBAY	990052	F	HOLD	GREENBAY	BREED WITH	128	

ID	Location	Local ID	Sex	Disposition	Location	Breeding	With	Notes
128	GREENBAY	200671	M	HOLD	GREENBAY	BREED WITH	134	
534	JACKSON	200235	M	SEND TO	FT WAYNE	DO NOT BREED		
524	JACKSON	200440	M	HOLD	JACKSON	BREED WITH	118	
136	JACKSON	200441	F	SEND TO	JACKSONVL	BREED WITH	626	
118	JACKSON	200231	F	HOLD	JACKSON	BREED WITH	524	
635	LOUISVILL	202107	F	HOLD	LOUISVILL	BREED WITH	631	
631	LOUISVILL	201806	M	HOLD	LOUISVILL	BREED WITH	635	
55	LOUISVILL	201050	M	SEND TO	FRANKLINP	BREED WITH	68	
589	LOWRY	205291	F	HOLD	LOWRY	BREED WITH	132	
132	LOWRY	205290	M	HOLD	LOWRY	BREED WITH	589	
8	METROZOO	B50371	M	HOLD	METROZOO	DO NOT BREED		excluded - age/medical
151	METROZOO	B50370	F	HOLD	METROZOO	BREED WITH	69	
150	METROZOO	B50368	F	HOLD	METROZOO	BREED WITH	61	
69	METROZOO	B50369	M	HOLD	METROZOO	BREED WITH	151	
61	METROZOO	B50367	M	HOLD	METROZOO	BREED WITH	150	
544	NZP-WASH	215031	F	HOLD	NZP-WASH	BREED WITH	372	
372	NZP-WASH	211900	M	HOLD	NZP-WASH	BREED WITH	544	
97	OMAHA	15718	M	HOLD	OMAHA	DO NOT BREED		
699	RIO GRAND	_____	F	HOLD	RIO GRAND	BREED WITH	630	
630	RIO GRAND	B04032	M	HOLD	RIO GRAND	BREED WITH	699	
144	SAN ANTON	980572	F	HOLD	SAN ANTON	BREED WITH	137	
137	SAN ANTON	S02103	M	HOLD	SAN ANTON	BREED WITH	144	
573	SCOTTSBLU	1347	F	HOLD	SCOTTSBLU	BREED WITH	96	
96	SCOTTSBLU	1349	M	HOLD	SCOTTSBLU	BREED WITH	573	
68	SD-WAP	887036	F	SEND TO	FRANKLINP	BREED WITH	491 OR 55	
64	SD-WAP	889173	M	HOLD	SD-WAP	BREED WITH	520	
538	ST LOUIS	970300	F	HOLD	ST LOUIS	BREED WITH	489	
489	ST LOUIS	UNK	M	HOLD	ST LOUIS	BREED WITH	538	

ID	Location	Local ID	Sex	Disposition	Location	Breeding	With	Notes
629	STCATHERN	S00074	M	HOLD	STCATHERN	DO NOT BREED		
50	STCATHERN	753518	M	HOLD	STCATHERN	DO NOT BREED		
25	TORONTO	29580	M	HOLD	TORONTO	DO NOT BREED		requested female unavailable at this time
536	YULEE	Y55303	M	HOLD	YULEE	DO NOT BREED		Requested placement unavailable at this time
518	YULEE	950306	M	HOLD	YULEE	DO NOT BREED		
236	YULEE	920532	M	HOLD	YULEE	BREED WITH	57	
63	YULEE	Y55301	M	HOLD	YULEE	BREED WITH	43	
57	YULEE	960333	F	HOLD	YULEE	BREED WITH	236	
43	YULEE	Y55302	F	HOLD	YULEE	BREED WITH	63	

ASHEBORO

North Carolina Zoological Park
Asheboro, NC

ID	Local ID	Sex	Disposition	Location	Breeding	With	Notes
24	21427	F	HOLD	ASHEBORO	BREED WITH	92	
92	21634	M	HOLD	ASHEBORO	BREED WITH	24	
517	22355	F	HOLD	ASHEBORO	BREED WITH	583	
583	22521	M	HOLD	ASHEBORO	BREED WITH	517	
634	22730	M	HOLD	ASHEBORO	DO NOT BREED		requested placement unavailable at this time

BALTIMORE

The Maryland Zoo in Baltimore
Baltimore, MD

ID	Local ID	Sex	Disposition	Location	Breeding	With	Notes
541	960538	M	SEND TO	FORTWORTH	BREED WITH	154	

BARABOO

International Crane Foundation
Baraboo, WI

ID	Local ID	Sex	Disposition	Location	Breeding	With	Notes
21	050011	F	HOLD	BARABOO	BREED WITH	62	
44	050027	F	HOLD	BARABOO	BREED WITH	47	
47	050022	M	HOLD	BARABOO	BREED WITH	44	
62	050010	M	HOLD	BARABOO	BREED WITH	21	

BATONROUG

BREC's Baton Rouge Zoo
Baker, LA

ID	Local ID	Sex	Disposition	Location	Breeding	With	Notes
129	7650	M	HOLD	BATONROUG	BREED WITH	588	
588	8734	F	HOLD	BATONROUG	BREED WITH	129	

BROWNSVIL

Gladys Porter Zoo
Brownsville, TX

ID	Local ID	Sex	Disposition	Location	Breeding	With	Notes
70	9528	F	HOLD	BROWNSVIL	BREED WITH	363	
481	8435	M	HOLD	BROWNSVIL	DO NOT BREED		
363		M	RECEIVE FROM	FORTWORTH	BREED WITH	70	

BUSCH TAM

Busch Gardens
Tampa, FL

ID	Local ID	Sex	Disposition	Location	Breeding	With	Notes
159	61923	M	HOLD	BUSCH TAM	BREED WITH	569	
569	60817	F	HOLD	BUSCH TAM	BREED WITH	159	

COLUMBIA

Riverbanks Zoological Park
Columbia, SC

ID	Local ID	Sex	Disposition	Location	Breeding	With	Notes
626	8976	M	SEND TO	JACKSONVL	BREED WITH	136	

DALLAS

Dallas Zoo
Dallas, TX

ID	Local ID	Sex	Disposition	Location	Breeding	With	Notes
86	864848	M	HOLD	DALLAS	BREED WITH	105	
105	96B428	F	HOLD	DALLAS	BREED WITH	86	

DISNEY AK

Disney's Animal Kingdom/The Living Seas
Bay Lake, FL

ID	Local ID	Sex	Disposition	Location	Breeding	With	Notes
140	020082	M	HOLD	DISNEY AK	BREED WITH	367	
367	020083	F	HOLD	DISNEY AK	BREED WITH	140	

FORTWORTH

Fort Worth Zoological Park
Ft Worth, TX

ID	Local ID	Sex	Disposition	Location	Breeding	With	Notes
541	960538	M	RECEIVE FROM	BALTIMORE	BREED WITH	154	
154	01663	F	HOLD	FORTWORTH	BREED WITH	541	
363	930533	M	SEND TO	BROWNSVIL	BREED WITH	70	

FRANKLINP

Zoo New England / Franklin Park Zoo
Boston, MA

ID	Local ID	Sex	Disposition	Location	Breeding	With	Notes
491	A01448	M	HOLD	FRANKLINP	BREED WITH	68	
520	A03406	F	SEND TO	SD-WAP	BREED WITH	64	
68	887036	F	RECEIVE FROM	SD-WAP	BREED WITH	491 OR 55	

55	201050	M	RECEIVE FROM	LOUISVILLE	BREED WITH	68	

FT WAYNE

Fort Wayne Children's Zoo
Fort Wayne, IN

ID	Local ID	Sex	Disposition	Location	Breeding	With	Notes
534	200235	M	RECEIVE FROM	JACKSON	DO NOT BREED		no female available at this time

GREENBAY

NEW Zoo
Green Bay, WI

ID	Local ID	Sex	Disposition	Location	Breeding	With	Notes
128	200671	M	HOLD	GREENBAY	BREED WITH	134	
134	990052	F	HOLD	GREENBAY	BREED WITH	128	

JACKSON

Jackson Zoological Park
Jackson, MS

ID	Local ID	Sex	Disposition	Location	Breeding	With	Notes
118	200231	F	HOLD	JACKSON	BREED WITH	524	
136	200441	F	SEND TO	JACKSONVL	BREED WITH	626	
524	200440	M	HOLD	JACKSON	BREED WITH	118	
534	200235	M	SEND TO	FT WAYNE	DO NOT BREED		

JACKSONVL

Jacksonville Zoo
Jacksonville, FL

ID	Local ID	Sex	Disposition	Location	Breeding	With	Notes
626	8976	M	RECEIVE FROM	COLUMBIA	BREED WITH	136	
136	200441	F	RECEIVE FROM	JACKSON	BREED WITH	626	

LOUISVILL

Louisville Zoological Garden
Louisville, KY

ID	Local ID	Sex	Disposition	Location	Breeding	With	Notes
55	201050	M	SEND TO	FRANKLINP	BREED WITH	68	
631	201806	M	HOLD	LOUISVILL	BREED WITH	635	
635	202107	F	HOLD	LOUISVILL	BREED WITH	631	

LOWRY

Tampa's Lowry Park Zoo
Tampa, FL

ID	Local ID	Sex	Disposition	Location	Breeding	With	Notes
132	205290	M	HOLD	LOWRY	BREED WITH	589	
589	205291	F	HOLD	LOWRY	BREED WITH	132	

METROZOO

Miami Metrozoo
Miami, FL

ID	Local ID	Sex	Disposition	Location	Breeding	With	Notes
61	B50367	M	HOLD	METROZOO	BREED WITH	150	
69	B50369	M	HOLD	METROZOO	BREED WITH	151	
150	B50368	F	HOLD	METROZOO	BREED WITH	61	
151	B50370	F	HOLD	METROZOO	BREED WITH	69	

8	B50371	M	HOLD	METROZOO	DO NOT BREED		excluded - age/medical

NZP-WASH

Smithsonian National Zoological Park
Washington, DC

ID	Local ID	Sex	Disposition	Location	Breeding	With	Notes
372	211900	M	HOLD	NZP-WASH	BREED WITH	544	
544	215031	F	HOLD	NZP-WASH	BREED WITH	372	

OMAHA

Omaha's Henry Doorly Zoo
Omaha, NE

ID	Local ID	Sex	Disposition	Location	Breeding	With	Notes
97	15718	M	HOLD	OMAHA	DO NOT BREED		

RIO GRAND

Albuquerque Biological Park
Albuquerque, NM

ID	Local ID	Sex	Disposition	Location	Breeding	With	Notes
630	B04032	M	HOLD	RIO GRAND	BREED WITH	699	
699	_____	F	HOLD	RIO GRAND	BREED WITH	630	

SAN ANTON

San Antonio Zoological Gardens & Aqua
San Antonio, TX

ID	Local ID	Sex	Disposition	Location	Breeding	With	Notes
137	S02103	M	HOLD	SAN ANTON	BREED WITH	144	
144	980572	F	HOLD	SAN ANTON	BREED WITH	137	

SCOTTSBLU

Riverside Zoo
Scottsbluff, NE

ID	Local ID	Sex	Disposition	Location	Breeding	With	Notes
96	1349	M	HOLD	SCOTTSBLU	BREED WITH	573	
573	1347	F	HOLD	SCOTTSBLU	BREED WITH	96	

SD-WAP

San Diego Wild Animal Park
Escondido, CA

ID	Local ID	Sex	Disposition	Location	Breeding	With	Notes
520	A03406	F	RECEIVE FROM	FRANKLINP	BREED WITH	64	
64	889173	M	HOLD	SD-WAP	BREED WITH	520	
68	887036	F	SEND TO	FRANKLINP	BREED WITH	491 OR 55	

ST LOUIS

Saint Louis Zoological Park
St. Louis, MO

ID	Local ID	Sex	Disposition	Location	Breeding	With	Notes
489	UNK	M	HOLD	ST LOUIS	BREED WITH	538	
538	970300	F	HOLD	ST LOUIS	BREED WITH	489	

STCATHERN

St. Catherine's Island / WCS
Midway, GA

ID	Local ID	Sex	Disposition	Location	Breeding	With	Notes
50	753518	M	HOLD	STCATHERN	DO NOT BREED		
629	S00074	M	HOLD	STCATHERN	DO NOT BREED		

TORONTO

Toronto Zoo
Scarborough, Ontario

ID	Local ID	Sex	Disposition	Location	Breeding	With	Notes
25	29580	M	HOLD	TORONTO	DO NOT BREED		requested female unavailable at this time

YULEE

White Oak Conservation Center
Yulee, FL

ID	Local ID	Sex	Disposition	Location	Breeding	With	Notes
43	Y55302	F	HOLD	YULEE	BREED WITH	63	
57	960333	F	HOLD	YULEE	BREED WITH	236	
63	Y55301	M	HOLD	YULEE	BREED WITH	43	
236	920532	M	HOLD	YULEE	BREED WITH	57	
518	950306	M	HOLD	YULEE	DO NOT BREED		
536	Y55303	M	HOLD	YULEE	DO NOT BREED		Requested placement unavailable at this time

Appendix A
Life Table

	Males					Females				
Age	Qx	Px	Lx	Mx	Vx	Qx	Px	Lx	Mx	Vx
0	0.270	0.730	1.000	0.000	1.156	0.350	0.650	1.000	0.000	1.212
1	0.100	0.900	0.730	0.000	1.489	0.070	0.930	0.650	0.000	1.620
2	0.040	0.960	0.657	0.020	1.655	0.040	0.960	0.605	0.000	1.743
3	0.020	0.980	0.631	0.020	1.741	0.070	0.930	0.580	0.010	1.873
4	0.050	0.950	0.618	0.040	1.840	0.030	0.970	0.540	0.010	1.994
5	0.030	0.970	0.587	0.030	1.936	0.000	1.000	0.524	0.000	2.048
6	0.030	0.970	0.570	0.050	2.029	0.050	0.950	0.524	0.010	2.134
7	0.000	1.000	0.552	0.220	2.074	0.030	0.970	0.497	0.010	2.249
8	0.080	0.920	0.552	0.150	1.994	0.050	0.950	0.482	0.030	2.369
9	0.030	0.970	0.508	0.190	2.017	0.030	0.970	0.458	0.200	2.476
10	0.030	0.970	0.493	0.130	1.944	0.030	0.970	0.445	0.200	2.384
11	0.030	0.970	0.478	0.200	1.931	0.000	1.000	0.431	0.190	2.254
12	0.000	1.000	0.464	0.180	1.814	0.030	0.970	0.431	0.260	2.129
13	0.040	0.960	0.464	0.130	1.721	0.000	1.000	0.418	0.340	1.928
14	0.000	1.000	0.445	0.210	1.677	0.030	0.970	0.418	0.110	1.639
15	0.000	1.000	0.445	0.270	1.514	0.000	1.000	0.406	0.130	1.577
16	0.040	0.960	0.445	0.120	1.311	0.040	0.960	0.406	0.040	1.501
17	0.040	0.960	0.428	0.090	1.281	0.000	1.000	0.389	0.040	1.515
18	0.100	0.900	0.410	0.100	1.321	0.000	1.000	0.389	0.100	1.499
19	0.000	1.000	0.369	0.000	1.330	0.000	1.000	0.389	0.110	1.421
20	0.000	1.000	0.369	0.000	1.373	0.000	1.000	0.389	0.130	1.332
21	0.000	1.000	0.369	0.070	1.418	0.050	0.950	0.389	0.200	1.253
22	0.000	1.000	0.369	0.140	1.391	0.000	1.000	0.370	0.000	1.098
23	0.000	1.000	0.369	0.310	1.292	0.000	1.000	0.370	0.060	1.116
24	0.000	1.000	0.369	0.150	1.013	0.060	0.940	0.370	0.120	1.106
25	0.000	1.000	0.369	0.200	0.891	0.000	1.000	0.348	0.070	1.034
26	0.000	1.000	0.369	0.170	0.714	0.070	0.930	0.348	0.250	1.015
27	0.000	1.000	0.369	0.120	0.561	0.080	0.920	0.323	0.290	0.840
28	0.000	1.000	0.369	0.160	0.455	0.080	0.920	0.298	0.290	0.607
29	0.000	1.000	0.369	0.000	0.305	0.180	0.820	0.274	0.100	0.370
30	0.000	1.000	0.369	0.080	0.315	0.000	1.000	0.225	0.190	0.304
31	0.000	1.000	0.369	0.000	0.242	0.130	0.870	0.225	0.060	0.124
32	0.000	1.000	0.369	0.100	0.250	0.000	1.000	0.195	0.070	0.070
33	0.000	1.000	0.369	0.000	0.155	0.290	0.710	0.195	0.000	0.000
34	0.000	1.000	0.369	0.160	0.160	0.000	1.000	0.139	0.000	0.000
35	0.000	1.000	0.369	0.000	0.000	0.000	1.000	0.139	0.000	0.000
36	0.000	1.000	0.369	0.000	0.000	0.000	1.000	0.139	0.000	0.000
37	0.000	1.000	0.369	0.000	0.000	0.000	1.000	0.139	0.000	0.000
38	0.000	1.000	0.369	0.000	0.000	0.000	1.000	0.139	0.000	0.000
39	0.000	1.000	0.369	0.000	0.000	0.500	0.500	0.139	0.000	0.000
40	0.000	1.000	0.369	0.000	0.000	0.000	1.000	0.069	0.000	0.000
41	0.000	1.000	0.369	0.000	0.000	1.000	0.000	0.069	0.000	0.000
42	0.000	1.000	0.369	0.000	0.000	1.000	0.000	0.000	0.000	0.000
43	0.000	1.000	0.369	0.000	0.000	1.000	0.000	0.000	0.000	0.000
44	0.000	1.000	0.369	0.000	0.000	1.000	0.000	0.000	0.000	0.000
45	0.000	1.000	0.369	0.000	0.000	1.000	0.000	0.000	0.000	0.000
46	0.000	1.000	0.369	0.000	0.000	1.000	0.000	0.000	0.000	0.000
47	0.500	0.500	0.369	0.000	0.000	1.000	0.000	0.000	0.000	0.000
48	0.000	1.000	0.185	0.000	0.000	1.000	0.000	0.000	0.000	0.000
49	0.000	1.000	0.185	0.000	0.000	1.000	0.000	0.000	0.000	0.000
50	0.000	1.000	0.185	0.000	0.000	1.000	0.000	0.000	0.000	0.000
51	0.000	1.000	0.185	0.000	0.000	1.000	0.000	0.000	0.000	0.000
52	0.000	1.000	0.185	0.000	0.000	1.000	0.000	0.000	0.000	0.000
53	0.000	1.000	0.185	0.000	0.000	1.000	0.000	0.000	0.000	0.000
54	0.000	1.000	0.185	0.000	0.000	1.000	0.000	0.000	0.000	0.000
55	0.000	1.000	0.185	0.000	0.000	1.000	0.000	0.000	0.000	0.000
56	0.000	1.000	0.185	0.000	0.000	1.000	0.000	0.000	0.000	0.000
57	0.000	1.000	0.185	0.000	0.000	1.000	0.000	0.000	0.000	0.000
58	1.000	0.000	0.185	0.000	0.000	1.000	0.000	0.000	0.000	0.000
59	1.000	0.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000	0.000

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

Projected population growth rates

Males: r = 0.0318; lambda = 1.0323; R0 = 1.609; T = 14.96 Females: r = 0.0160; lambda = 1.0161; R0 = 1.325; T = 17.61

Appendix B
Ordered Mean Kinship

Males

SB#	MK	%Known	Age	Location
61	0.000	100.0	30	METROZOO
63	0.000	100.0	28	YULEE
64	0.000	100.0	27	SD-WAP
69	0.000	100.0	26	METROZOO
47	0.012	100.0	33	BARABOO
55	0.012	100.0	31	LOUISVILL
25	0.017	100.0	37	TORONTO
491	0.017	100.0	14	FRANKLINP
631	0.017	100.0	6	LOUISVILL
62	0.023	100.0	28	BARABOO
630	0.023	100.0	6	RIO GRAND
159	0.026	100.0	18	BUSCH TAM
583	0.026	100.0	9	ASHEBORO
236	0.029	100.0	35	YULEE
481	0.029	100.0	14	BROWNSVIL
489	0.029	100.0	14	ST LOUIS
128	0.032	100.0	22	GREENBAY
129	0.032	100.0	22	BATONROUG
137	0.032	100.0	21	SAN ANTON
140	0.035	100.0	20	DISNEY AK
363	0.038	100.0	18	FORTWORTH
541	0.038	100.0	11	BALTIMORE
132	0.041	100.0	21	LOWRY
372	0.041	100.0	17	NZP-WASH
97	0.044	100.0	23	OMAHA
86	0.047	100.0	24	DALLAS
92	0.047	100.0	24	ASHEBORO
518	0.047	100.0	12	YULEE
524	0.047	100.0	12	JACKSON
534	0.047	100.0	11	JACKSON
536	0.049	100.0	11	YULEE
626	0.049	100.0	7	COLUMBIA
629	0.049	100.0	6	STCATHERN
634	0.051	100.0	5	ASHEBORO
96	0.052	100.0	23	SCOTTSBLU
50	0.058	100.0	33	STCATHERN

Females

SB#	MK	%Known	Age	Location
43	0.000	100.0	35	YULEE
68	0.000	100.0	26	SD-WAP
70	0.000	100.0	25	BROWNSVIL
150	0.006	100.0	22	METROZOO
151	0.006	100.0	22	METROZOO
44	0.012	100.0	35	BARABOO
57	0.012	100.0	30	YULEE
699	0.017	100.0	4	RIO GRAND
21	0.023	100.0	41	BARABOO
635	0.023	100.0	5	LOUISVILL
134	0.026	100.0	21	GREENBAY
569	0.026	100.0	10	BUSCH TAM
589	0.026	100.0	9	LOWRY
520	0.029	100.0	12	FRANKLINP
544	0.029	100.0	11	NZP-WASH
517	0.038	100.0	12	ASHEBORO
136	0.041	100.0	21	JACKSON
144	0.041	100.0	20	SAN ANTON
24	0.044	100.0	36	ASHEBORO
154	0.044	100.0	19	FORTWORTH
367	0.044	100.0	18	DISNEY AK
118	0.047	100.0	22	JACKSON
538	0.049	100.0	11	ST LOUIS
588	0.049	100.0	9	BATONROUG
573	0.051	100.0	10	SCOTTSBLU
105	0.052	100.0	23	DALLAS

Appendix C
Summary of Data Exports

Report compiled under SPARKS V. 1.5 & Population Management 2000, V. 1.211

Data exported on: 1 JAN 2007
Data compiled by: FREDERICK B. C. BEALL
Data current thru: 31 NOV 2006 (for N.A. data)
Scope of data: International

Filter Conditions In Effect:

Genetics: Locations: AZA/ Dates: As of End of date <= 1/01/2007 Status: Living by 1 Jan 2007
Demography : Locations: AZA/ Dates: During 01/01/1980 <= date .and. date <= 1/01/2007

Appendix D
Animals Excluded from Genetic Analysis

Studbook ID #8 was excluded due to advanced age

Appendix E
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

Name	Organization	Mnemonic	Phone	E-Mail
James Mejeur	Disney's Animal Kingdom	DISNEY AK	4079392468	James.h.mejeur@disney.com
Peter Shannon	Albuquerque Biological Park	RIOGRANDE	5057646258	pshannon@cabq.gov
Frederick Beall	Zoo New England	FRANKLINP	6179892052	fbeall@zoonewengland.com
Debbie Belgio	St. Catherine's		9128845005	dbelgio@scisland.net
Gary Michael	Louisville Zoological Garden	LOUISVILL	5024592181	gary.michael@louisvilleky.gov
Sam Winslow	Greater Baton Rouge Zoo	BATONROUG	2257753877	swinslow@brzoo.org
Leah Kintner	Maryland Zoo in Baltimore	BALTIMORE	4103967638	lkintner@marylandzoo.org
Michael Macek	St. Louis Zoo	ST LOUIS	3147810900 ext 362	macek@stlzoo.org
Ken Reininger	North Carolina Zoo	ASHEBORO	3368797605	Ken.reininger@nczoo.org
Patrick Burchfield	Gladys Porter Zoo	BROWNSVIL	9565467187	pburchfield@gpz.org
Chris Brown	Dallas Zoo	DALLAS	2146706833	cdbrown@mail.ci.dallas.tx.us
Katy Unger	Fort Worth Zoo	FORTWORTH	8177597170	kunger@fortworthzoo.org
Josef San Miguel	San Antonio Zoo	SAN ANTON	2107347184	curbirds@sazoo-aq.org
Michael Putnam	International Crane Foundation	BARABOO	6083569462	cranes@savingcranes.org
Neil Anderson	North Eastern Wisconsin Zoo	GREENBAY	9024347841	Anderson_NS@co.brown.wi.us
Gretchen Bickert	Phoenix Zoo	PHOENIX	6029144377	gbickert@thephxzoo.com
Mike Mace	San Diego Wild Animal Park	SD-WAP	7607385078	mmace@sandiegozoo.org
Sara Hallager	National Zoo	NZP- WASH		HallagerS@si.edu
Mike Wells	Busch Gardens Tampa Bay	BUSCHTAM	8139875250	michael.wells@buschgardens.com
Carl Burch	Miami Metrozoo	METROZOO	3052510403	cburch@miamidade.gov
Mike Taylor	White Oak Conservation Center	YULEE	9042253396	miket@wogilman.com
Dr. W. A. Rapley	Metro Toronto Zoo	TORONTO	4163925901	wrapley@torontozoo.ca

Name	Organization	Mnemonic	Phone	E-Mail
Dave Wetzel	Jackson Zoological Park	JACKSON	6013522590	dlwetzel@msn.com
Lex Salisbury	Tampa's Lowry Park Zoo	LOWRY	8139358552 ext 202	Lex.salisbury@lowryparkzoo.com
Dan Cassidy	Omaha's Henry Doorly Zoo	OMAHA	4027382034	danc@omahazoo.com
Joe Clawson	Riverside Zoo	SCOTTBLU	3086306236	jclawson@scottsbluff.org
Martin Vince	Riverbanks Zoo & Garden	COLUMBIA	8037798717 ext 1159	mvince@riverbanks.org
Mark Weldon	Fort Wayne Children's Zoo	FT WAYNE	2064276806	mark@kidszoo.org