

Population Analysis & Breeding and Transfer Plan

Wattled Crane (*Buggeranus carunculatus*) AZA Species Survival Plan® Yellow Program



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PMC

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Executive Summary

Wattled Crane (*Bugeranus carunculatus*) Yellow SSP[®]

The Gruiformes Taxon Advisory Group has set a target population size for this species of 75 specimens. The current population is 57 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 26 years; gene diversity at 100 years is expected to be about 77%.

Demography	
Current size of population (N) - Total (Males, Females, Unknown)	57 (30.26.1)
# animals excluded from management	0
Population size following exclusions	57
Target population size	75
Mean generation time (yrs)	17.31
Historic/Projected population growth rate (lambda)	1.00

Genetics (Genetic statistics calculated from the analytical studbook)	<i>Current</i>	<i>Potential</i>
Founders	22	4
Founder genome equivalents (FGE)	10.93	22.14
Gene diversity retained (GD%)	95.43	97.74
Population mean kinship (MK)	0.0457	
Mean inbreeding (F)	0	
Percentage of pedigree known before assumptions and exclusions	100	
Percentage of pedigree known after assumptions and exclusions	100	
Effective population size/census size ratio (Ne / N)	0.2456	
Years To 90% Gene Diversity	26	
Years to 10% Loss of Gene Diversity	52	
Gene Diversity at 100 Years From Present (%) Assuming $\lambda = 1.01$, Target size = 75	76.79	

Special Concerns: In spite of 26 recommended breeding pairs, only six surviving offspring have been produced since the previous Breeding and Transfer Plan in 2010. 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.

Summary Actions: The SSP will recommend 24 breeding pairs and 6 transfers for this period. Recommendations contained in this master plan supersede those made by earlier plans. **Unfortunately nine requests for additional birds were placed while only one bird is available as institutional surplus; most requests could therefore not be filled at this time.**

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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Description of Population Status

Introduction: Wattled cranes have been designated by the Gruiformes TAG as an SSP with a target population size of 75 specimens (2009 RCP). The population currently qualifies as a Yellow SSP. Comprehensive genetic and demographic analyses of the International Wattled Crane Studbook (N.A. data current to 4 June 2013) were performed in July 2013, resulting in the current Breeding and Transfer Plan for this species. Recommendations contained in this master plan supersede those made by earlier plans. Analyses were performed using SPARKS 1.5, PopLink 2.3, PM2000 1.213, and PMX1.02.

Managed Population: The current SSP population size is 57 distributed among 25 AZA institutions.

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 ($\lambda = 0.93 - 1.14$). Over the past fifteen years the population has declined at an average rate of 2% per annum.

In spite of 30 recommended breeding pairs, no surviving offspring were produced between 2003 and 2007. In 2007, 26 breeding pairs were recommended and 9 offspring were produced (6 surviving) in the SSP from 2007-present. These efforts at breeding are commendable and continued efforts are critically important. Institutions receiving breeding recommendations are encouraged to consider the successful breeding of this species a priority. In 2010, twenty six pairs were recommended to breed. Since that time, 5 pairs have produced 8 offspring, six of which are alive at this time.

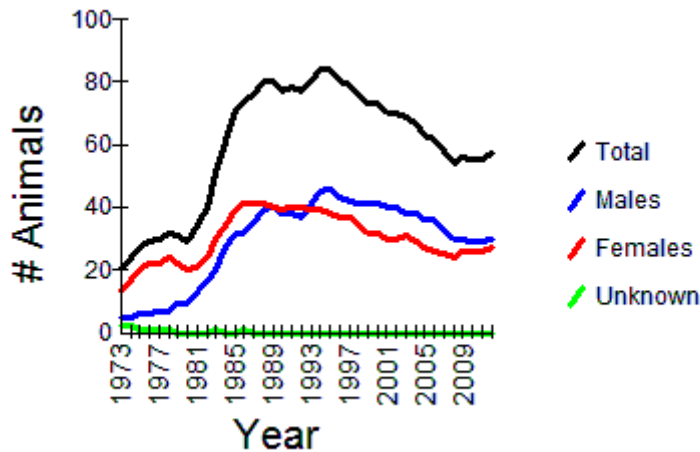


Figure 1. Census of wattled cranes in North American zoos.

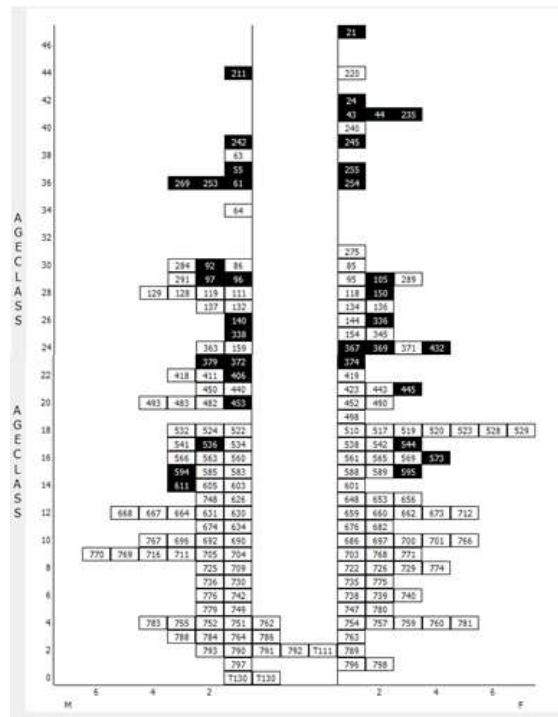


Figure 2. Age distribution of wattled cranes in SSP population indicating breeders in black and non-breeders in white..

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. Infant mortality has been observed at approximately 30%.

Males may reach sexual maturity by the age of two years but many do not reproduce until after the age of four. Females have reportedly 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 57 years and have reproduced until the age of 34. Females have not been observed to live beyond the age of 48 or produce offspring beyond the age of 40 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. While onset at breeding is generally thought to occur around the age of 7 years, no individuals currently under the age of 14 are breeding, suggesting a failure to recruit young animals as breeders.

Genetics: The managed population is descended from 22 founders and 4 potential founders remain. The youngest of these potential founders is 35 years of age.

Genetic Summary

	2013	Potential	2010	2006	2003
Founder Genome Equivalents	10.93	22.13	12.04	13.30	14.18
Gene Diversity Retained (%)	95.43	97.74	95.85	96.24	96.47
Population Mean Kinship	0.0457		0.0415	0.0376	0.0353
Mean Inbreeding	0		0	0	0.0
% Pedigree Known	100		100	100	100
Years to 90%	26		30	47	67
Diversity at 100 Years (%)	77		79.81	84.28	87.11
N_e/N	0.24		0.2365	0.2540	0.3021

Gene diversity in the population (~95%) is high relative the average SSP (93%). The population's gene diversity could fall below 90% in 26 years. Projections of gene diversity indicate 77% at 100 years from present. These projections are lower than those in the presented in the 2003 and 2006 Breeding and Transfer Plans due to a decrease in the N_e/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.

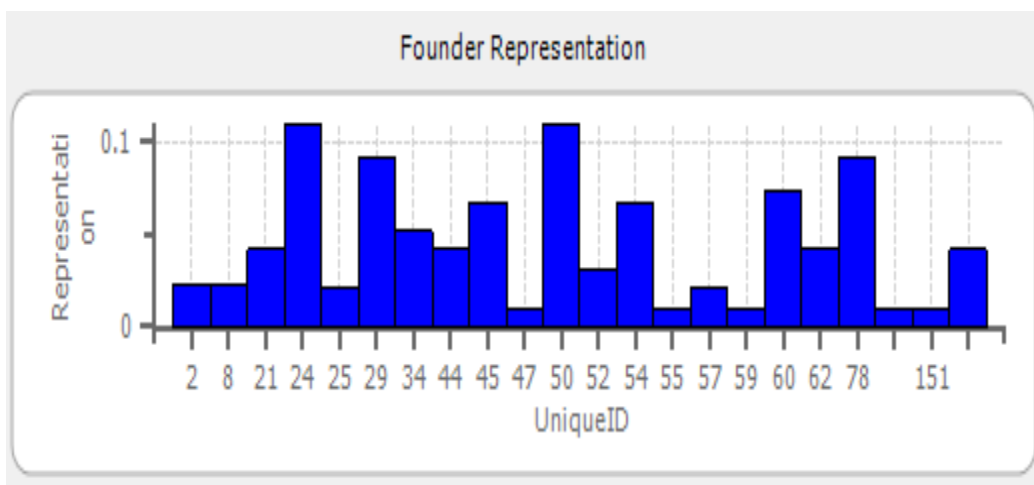


Figure3. Founder representation in the Wattle Crane SSP.

Management Strategy: Four offspring per annum are required to maintain the current population size, preventing further decline. Any offspring in excess of this number is expected to result in population growth. Due to difficulty breeding this species a large number of pairings will be recommended. **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. Over-represented pairs have been recommended, but within pairings MKs are well matched.

1. Recommend 24 pairings. Every female in the population has received a breeding recommendation.
2. Recommend 6 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	Age	Disposition	Location	Breeding	With	Notes
92	ASHEBORO	216	M	30	HOLD	ASHEBORO	BREED WITH	24	
24	ASHEBORO	214	F	43	HOLD	ASHEBORO	BREED WITH	92	
43	ATLANTA	B000	F	42	HOLD	ATLANTA	BREED WITH	63	could be ai'd with 583, YULEE
63	ATLANTA	B000	M	39	HOLD	ATLANTA	BREED WITH	43	
363	BARABOO	0500	M	24	HOLD	BARABOO	BREED WITH	21	
55	BARABOO	0500	M	38	HOLD	BARABOO	DO NOT BREED		requested mate unavailable
21	BARABOO	0500	F	48	HOLD	BARABOO	BREED WITH	363	
588	BATONROUG	87	F	15	HOLD	BATONROUG	BREED WITH	129	
129	BATONROUG	76	M	28	HOLD	BATONROUG	BREED WITH	588	
573	BUSCH TAM	644	F	16	HOLD	BUSCH TAM	BREED WITH	96	
569	BUSCH TAM	608	F	16	HOLD	BUSCH TAM	BREED WITH	159	
159	BUSCH TAM	619	M	25	HOLD	BUSCH TAM	BREED WITH	569	
96	BUSCH TAM	644	M	29	HOLD	BUSCH TAM	BREED WITH	573	
T13002	BUSCH TAM	654	F	0	HOLD	BUSCH TAM	DO NOT BREED		
105	DALLAS	96B4	F	29	HOLD	DALLAS	BREED WITH	541	
86	DALLAS	8648	M	30	SEND TO	FORTWORTH	BREED WITH	154	
367	DISNEY AK	0200	F	24	HOLD	DISNEY AK	BREED WITH	140	
140	DISNEY AK	0200	M	26	HOLD	DISNEY AK	BREED WITH	367	
541	FORTWORTH	2049	M	17	SEND TO	DALLAS	BREED WITH	105	
154	FORTWORTH	016	F	25	HOLD	FORTWORTH	BREED WITH	86	
134	FOSSILRIM	115	F	27	HOLD	FOSSILRIM	BREED WITH	128	
128	FOSSILRIM	115	M	28	HOLD	FOSSILRIM	BREED WITH	134	
97	FRANKLINP	A125	M	29	HOLD	FRANKLINP	BREED WITH	520	
520	FRANKLINP	A034	F	18	HOLD	FRANKLINP	BREED WITH	97	
759	FT WAYNE	983	F	4	HOLD	FT WAYNE	BREED WITH	634	
634	FT WAYNE	982	M	11	HOLD	FT WAYNE	BREED WITH	759	

ID	Location	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
793	GREENBAY	2011	M	2	HOLD	GREENBAY	DO NOT BREED		requested mate unavailable
534	JACKSON	2002	M	18	HOLD	JACKSON	BREED WITH	118	
118	JACKSON	2002	F	28	HOLD	JACKSON	BREED WITH	534	
524	JACKSON	2004	M	18	SEND TO	TORONTO	BREED WITH	136	
764	JACKSONVL	6113	M	3	HOLD	JACKSONVL	BREED WITH	757	
757	JACKSONVL	6113	F	4	HOLD	JACKSONVL	BREED WITH	764	
631	LOUISVILL	2018	M	12	HOLD	LOUISVILL	DO NOT BREED		
589	LOWRY	2052	F	15	HOLD	LOWRY	BREED WITH	132	
132	LOWRY	2052	M	27	HOLD	LOWRY	BREED WITH	589	
150	METROZOO	B503	F	29	HOLD	METROZOO	BREED WITH	61	
61	METROZOO	B503	M	37	HOLD	METROZOO	BREED WITH	150	
544	NZP-WASH	2150	F	17	SEND TO	SD-WAP	BREED WITH	64	
372	NZP-WASH	2119	M	23	SEND TO	SD-WAP	BREED WITH	747	
798	OMAHA	218	F	1	HOLD	OMAHA	BREED WITH	797	
797	OMAHA	218	M	1	HOLD	OMAHA	BREED WITH	798	
760	RIO GRAND	B090	F	4	HOLD	RIO GRAND	BREED WITH	630	
630	RIO GRAND	B040	M	12	HOLD	RIO GRAND	BREED WITH	760	
626	SAN ANTON	J110	M	13	HOLD	SAN ANTON	DO NOT BREED		requested mate unavailable
144	SAN ANTON	9805	F	26	HOLD	SAN ANTON	BREED WITH	137	
137	SAN ANTON	S021	M	27	HOLD	SAN ANTON	BREED WITH	144	
747	SD-WAP	8082	F	6	HOLD	SD-WAP	BREED WITH	372	
64	SD-WAP	8891	M	35	HOLD	SD-WAP	BREED WITH	544	
742	ST LOUIS	1065	M	6	HOLD	ST LOUIS	BREED WITH	538	
538	ST LOUIS	9703	F	17	HOLD	ST LOUIS	BREED WITH	742	
136	TORONTO	454	F	27	HOLD	TORONTO	BREED WITH	524	requested mate unavailable
T13001	YULEE	U	M	0	HOLD	YULEE	DO NOT BREED		
583	YULEE	9703	M	16	HOLD	YULEE	BREED WITH	517	

ID	Location	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
536	YULEE	Y553	M	18	HOLD	YULEE	BREED WITH	44	
517	YULEE	1153	F	18	HOLD	YULEE	BREED WITH	583	
44	YULEE	Y853	F	42	HOLD	YULEE	BREED WITH	536	

ASHEBORO

North Carolina Zoological Park
Asheboro, NC

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
24	214	F	43	HOLD	ASHEBORO	BREED WITH	92	
92	216	M	30	HOLD	ASHEBORO	BREED WITH	24	

ATLANTA

Zoo Atlanta
Atlanta, GA

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
43	B000	F	42	HOLD	ATLANTA	BREED WITH	63	could be ai'd with 583, YULEE
63	B000	M	39	HOLD	ATLANTA	BREED WITH	43	

BARABOO

International Crane Foundation
Baraboo, WI

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
21	0500	F	48	HOLD	BARABOO	BREED WITH	363	
55	0500	M	38	HOLD	BARABOO	DO NOT BREED		requested mate unavailable
363	0500	M	24	HOLD	BARABOO	BREED WITH	21	

BATONROUG

BREC's Baton Rouge Zoo
Baker, LA

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
129	76	M	28	HOLD	BATONROUG	BREED WITH	588	
588	87	F	15	HOLD	BATONROUG	BREED WITH	129	

BUSCH TAM**Busch Gardens Tampa Bay**
Tampa, FL

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
T13002	654	F	0	HOLD	BUSCH TAM	DO NOT BREED		
96	644	M	29	HOLD	BUSCH TAM	BREED WITH	573	
159	619	M	25	HOLD	BUSCH TAM	BREED WITH	569	
569	608	F	16	HOLD	BUSCH TAM	BREED WITH	159	
573	644	F	16	HOLD	BUSCH TAM	BREED WITH	96	

DALLAS**Dallas Zoo**
Dallas, TX

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
86	8648	M	30	SEND TO	FORTWORTH	BREED WITH	154	
105	96B4	F	29	HOLD	DALLAS	BREED WITH	541	
541	2049	M	17	RECEIVE FROM	FORTWORTH	BREED WITH	105	

DISNEY AK**Disney's Animal Kingdom**
Bay Lake, FL

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
140	0200	M	26	HOLD	DISNEY AK	BREED WITH	367	
367	0200	F	24	HOLD	DISNEY AK	BREED WITH	140	

FORTWORTH**Fort Worth Zoological Park**
Ft Worth, TX

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
86	8648	M	30	RECEIVE FROM	DALLAS	BREED WITH	154	
154	016	F	25	HOLD	FORTWORTH	BREED WITH	86	
541	2049	M	17	SEND TO	DALLAS	BREED WITH	105	

FOSSILRIM

Fossil Rim Wildlife Center
Glen Rose, TX

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
128	115	M	28	HOLD	FOSSILRIM	BREED WITH	134	
134	115	F	27	HOLD	FOSSILRIM	BREED WITH	128	

FRANKLINP

Zoo New England, Franklin Park Zoo
Boston, MA

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
97	A125	M	29	HOLD	FRANKLINP	BREED WITH	520	
520	A034	F	18	HOLD	FRANKLINP	BREED WITH	97	

FT WAYNE

Fort Wayne Children's Zoo
Fort Wayne, IN

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
634	982	M	11	HOLD	FT WAYNE	BREED WITH	759	
759	983	F	4	HOLD	FT WAYNE	BREED WITH	634	

GREENBAY

NEW Zoo
Green Bay, WI

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
793	2011	M	2	HOLD	GREENBAY	DO NOT BREED		requested mate unavailable

JACKSON

Jackson Zoological Park
Jackson, MS

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
118	2002	F	28	HOLD	JACKSON	BREED WITH	534	
524	2004	M	18	SEND TO	TORONTO	BREED WITH	136	
534	2002	M	18	HOLD	JACKSON	BREED WITH	118	

JACKSONVL

Jacksonville Zoo and Gardens
Jacksonville, FL

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
757	6113	F	4	HOLD	JACKSONVL	BREED WITH	764	
764	6113	M	3	HOLD	JACKSONVL	BREED WITH	757	

LOUISVILL

Louisville Zoological Garden
Louisville, KY

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
631	2018	M	12	HOLD	LOUISVILL	DO NOT BREED		

LOWRY

Tampa's Lowry Park Zoo
Tampa, FL

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
132	2052	M	27	HOLD	LOWRY	BREED WITH	589	
589	2052	F	15	HOLD	LOWRY	BREED WITH	132	

METROZOO

Zoo Miami
Miami, FL

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
61	B503	M	37	HOLD	METROZOO	BREED WITH	150	
150	B503	F	29	HOLD	METROZOO	BREED WITH	61	

NZP-WASH

Smithsonian National Zoological Park
Washington, DC

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
372	2119	M	23	SEND TO	SD-WAP	BREED WITH	747	
544	2150	F	17	SEND TO	SD-WAP	BREED WITH	64	

OMAHA**Omaha's Henry Doorly Zoo**

Omaha, NE

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
797	218	M	1	HOLD	OMAHA	BREED WITH	798	
798	218	F	1	HOLD	OMAHA	BREED WITH	797	

RIO GRAND**Albuquerque Biological Park**

Albuquerque, NM

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
630	B040	M	12	HOLD	RIO GRAND	BREED WITH	760	
760	B090	F	4	HOLD	RIO GRAND	BREED WITH	630	

SAN ANTON**San Antonio Zoological Gardens & Aquarium**

San Antonio, TX

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
137	S021	M	27	HOLD	SAN ANTON	BREED WITH	144	
144	9805	F	26	HOLD	SAN ANTON	BREED WITH	137	
626	J110	M	13	HOLD	SAN ANTON	DO NOT BREED		requested mate unavailable

SD-WAP**San Diego Wild Animal Park**

Escondido, CA

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
372	2119	M	23	RECEIVE FROM	NZP-WASH	BREED WITH	747	
544	2150	F	17	RECEIVE FROM	NZP-WASH	BREED WITH	64	
64	8891	M	35	HOLD	SD-WAP	BREED WITH	544	
747	8082	F	6	HOLD	SD-WAP	BREED WITH	372	

ST LOUIS**Saint Louis Zoological Park**
St. Louis, MO

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
538	9703	F	17	HOLD	ST LOUIS	BREED WITH	742	
742	1065	M	6	HOLD	ST LOUIS	BREED WITH	538	

TORONTO**Toronto Zoo**
Scarborough, Ontario

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
524	2004	M	18	RECEIVE FROM	JACKSON	BREED WITH	136	
136	454	F	27	HOLD	TORONTO	BREED WITH	524	requested mate unavailable

YULEE**White Oak Conservation Center**
Yulee, FL

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
T13001	U	M	0	HOLD	YULEE	DO NOT BREED		
44	Y853	F	42	HOLD	YULEE	BREED WITH	536	
517	1153	F	18	HOLD	YULEE	BREED WITH	583	
536	Y553	M	18	HOLD	YULEE	BREED WITH	44	
583	9703	M	16	HOLD	YULEE	BREED WITH	517	

Appendix A Life Table

Males

Age	Qx	Px	lx	Mx	Risk (Qx)	Risk (Mx)
0	0.28	0.72	1	0	90.7	68.9
1	0.09	0.91	0.72	0	64.4	61.7
2	0.05	0.95	0.655	0	56.4	54.4
3	0.02	0.98	0.622	0	51	50.6
4	0.04	0.96	0.61	0	50.6	49.4
5	0.02	0.98	0.586	0.02	48.9	48.9
6	0.02	0.98	0.574	0.05	49.1	49
7	0.02	0.98	0.562	0.16	49.5	48.9
8	0.08	0.92	0.551	0.12	49.9	47.5
9	0.04	0.96	0.507	0.13	46	45.2
10	0.04	0.96	0.487	0.11	44.9	43.9
11	0.02	0.98	0.467	0.17	41.3	40.9
12	0.03	0.97	0.458	0.16	37.2	37
13	0.06	0.94	0.444	0.13	35.4	34.1
14	0	1	0.418	0.17	32.9	32.9
15	0.03	0.97	0.418	0.21	32.6	32.6
16	0	1	0.405	0.11	32	32
17	0.03	0.97	0.405	0.1	30.3	29.9
18	0.11	0.89	0.393	0.08	27.2	26.1
19	0.08	0.92	0.35	0.06	24	23.1
20	0	1	0.322	0.02	22.1	22.1
21	0	1	0.322	0.07	23	23
22	0	1	0.322	0.15	23	23
23	0	1	0.322	0.18	22.5	22.5
24	0	1	0.322	0.09	21.4	21.4
25	0	1	0.322	0.15	20	20
26	0	1	0.322	0.08	19.4	19.4
27	0	1	0.322	0.09	17.5	17.5
28	0.07	0.93	0.322	0.07	15.1	14.4
29	0.16	0.84	0.299	0.04	12.9	12.4
30	0	1	0.251	0.05	9.3	9.3
31	0	1	0.251	0	9	9
32	0	1	0.251	0.06	9	9
33	0.11	0.89	0.251	0	9	9
34	0	1	0.224	0.07	7.5	7.5

Age	Qx	Px	lx	Mx	Risk (Qx)	Risk (Mx)
35	0	1	0.224	0	7.2	7.2
36	0.27	0.73	0.224	0	7.5	7.2
37	0.22	0.78	0.163	0	4.6	4.2
38	0	1	0.127	0	2.5	2.5
39	0	1	0.127	0	2	2
40	0	1	0.127	0	2	2
41	0	1	0.127	0	2	2
42	0	1	0.127	0	2	2
43	0	1	0.127	0	2	2
44	0	1	0.127	0	2	2
45	0	1	0.127	0	2	2
46	0	1	0.127	0	2	2
47	0	1	0.127	0	2	2
48	0.5	0.5	0.127	0	2	1
49	0	1	0.064	0	1	1
50	0	1	0.064	0	1	1
51	0	1	0.064	0	1	1
52	0	1	0.064	0	1	1
53	0	1	0.064	0	1	1
54	0	1	0.064	0	1	1
55	0	1	0.064	0	1	1
56	0	1	0.064	0	1	1
57	0	1	0.064	0	1	1
58	1	0	0.064	0	1	0.7
59	1	0	0	0	0	0
60	1	0	0	0	0	0

30-day mortality (both sexes): 19.20% (34 of 177 neonates)

r = 0.009

lambda = 1.0091

T = 15.78

N = 30.5

N(at 20 yrs) = 36.54

Females

Age	Qx	Px	lx	Mx	Risk (Qx)	Risk (Mx)
0	0.34	0.66	1	0	82.6	59.3
1	0.06	0.94	0.66	0	57.1	55.1
2	0.04	0.96	0.62	0	53.3	52.7
3	0.06	0.94	0.596	0	51.9	50.4
4	0.09	0.91	0.56	0	45.7	43.7
5	0.05	0.95	0.509	0.01	40.6	39.7
6	0.05	0.95	0.484	0.01	40.7	39.9
7	0.05	0.95	0.46	0.01	39	37.6
8	0.07	0.93	0.437	0.04	40.6	39.4
9	0.03	0.97	0.406	0.18	40	39.8
10	0.07	0.93	0.394	0.18	42.8	40.7
11	0	1	0.366	0.16	39.9	39.9
12	0.03	0.97	0.366	0.22	39	38.9
13	0	1	0.355	0.3	37.2	37.2
14	0.03	0.97	0.355	0.08	37.9	37
15	0	1	0.345	0.11	35.5	35.5
16	0.03	0.97	0.345	0.06	33.7	33.2
17	0	1	0.334	0.03	30.5	30.5
18	0.03	0.97	0.334	0.1	28.8	28.7
19	0	1	0.324	0.15	27	27
20	0	1	0.324	0.13	27	27
21	0.04	0.96	0.324	0.15	26.5	26
22	0	1	0.311	0.02	25.9	25.9
23	0	1	0.311	0.04	26.9	26.9
24	0.04	0.96	0.311	0.1	26.2	26
25	0	1	0.299	0.02	24.3	24.3
26	0.09	0.91	0.299	0.18	23.3	22.6
27	0.15	0.85	0.272	0.17	19.4	17.8
28	0.07	0.93	0.231	0.24	14.9	14.8
29	0.33	0.67	0.215	0.1	12.2	10.2
30	0	1	0.144	0.19	8	8
31	0.13	0.87	0.144	0.06	8	7.9
32	0	1	0.125	0.07	7	7
33	0.29	0.71	0.125	0	7	6
34	0	1	0.089	0	5	5
35	0	1	0.089	0	5	5
36	0	1	0.089	0	5	5
37	0	1	0.089	0	5	5
38	0	1	0.089	0.1	5	5

Age	Qx	Px	lx	Mx	Risk (Qx)	Risk (Mx)
39	0.2	0.8	0.089	0	5	4.1
40	0	1	0.071	0.25	4	4
41	0	1	0.071	0.16	3.1	3.1
42	0	1	0.071	0	1.5	1.5
43	0	1	0.071	0	1	1
44	0	1	0.071	0	1	1
45	0	1	0.071	0	1	1
46	0	1	0.071	0	1	1
47	0	1	0.071	0	0.5	0.5
48	1	0	0.071	0	0	0
49	1	0	0	0	0	0
50	1	0	0	0	0	0

30-day mortality (both sexes): 19.20% (34 of 177 neonates)

r = 0.009

lambda = 0.9993

T = 18.83

N = 26.5

N(at 20 yrs) = 26.13

Appendix B Ordered Mean Kinship

Males

<u>SB#</u>	<u>MK</u>	<u>%Known</u>	<u>Age</u>	<u>Location</u>
63	0.000	100.0	39	ATLANTA
61	0.000	100.0	37	METROZOO
64	0.000	100.0	35	SD-WAP
55	0.005	100.0	38	BARABOO
631	0.010	100.0	12	LOUISVILL
630	0.016	100.0	12	RIO GRAND
159	0.018	100.0	25	BUSCH TAM
583	0.021	100.0	16	YULEE
363	0.035	100.0	24	BARABOO
129	0.039	100.0	28	BATONROUG
128	0.039	100.0	28	FOSSILRIM
137	0.039	100.0	27	SAN ANTON
T13001	0.041	100.0	0	YULEE
541	0.042	100.0	17	FORTWORTH
86	0.044	100.0	30	DALLAS
524	0.044	100.0	18	JACKSON
534	0.044	100.0	18	JACKSON
626	0.046	100.0	13	SAN ANTON
97	0.051	100.0	29	FRANKLINP
132	0.051	100.0	27	LOWRY
536	0.051	100.0	18	YULEE
96	0.052	100.0	29	BUSCH TAM
140	0.052	100.0	26	DISNEY AK
793	0.054	100.0	2	GREENBAY
742	0.054	100.0	6	ST LOUIS
92	0.060	100.0	30	ASHEBORO
372	0.061	100.0	23	NZP-WASH
764	0.062	100.0	3	JACKSONVL
797	0.062	100.0	1	OMAHA
634	0.063	100.0	11	FT WAYNE
T13002	0.064	100.0	U0	BUSCH TAM

Females

<u>SB#</u>	<u>MK</u>	<u>%Known</u>	<u>Age</u>	<u>Location</u>
43	0.000	100.0	42	ATLANTA
150	0.005	100.0	29	METROZOO
134	0.018	100.0	27	FOSSILRIM
21	0.021	100.0	48	BARABOO
569	0.021	100.0	16	BUSCH TAM
44	0.021	100.0	42	YULEE
520	0.026	100.0	18	FRANKLINP
589	0.034	100.0	15	LOWRY
544	0.036	100.0	17	NZP-WASH
796	0.041	100.0	1	YULEE
517	0.042	100.0	18	YULEE
118	0.044	100.0	28	JACKSON
588	0.046	100.0	15	BATONROUG
538	0.046	100.0	17	ST LOUIS
154	0.051	100.0	25	FORTWORTH
144	0.051	100.0	26	SAN ANTON
136	0.051	100.0	27	TORONTO
798	0.054	100.0	1	OMAHA
760	0.054	100.0	4	RIO GRAND
24	0.055	100.0	43	ASHEBORO
105	0.056	100.0	29	DALLAS
367	0.061	100.0	24	DISNEY AK
759	0.062	100.0	4	FT WAYNE
747	0.062	100.0	6	SD-WAP
757	0.063	100.0	4	JACKSONVL
T13002	0.064	100.0	U0	BUSCH TAM
573	0.065	100.0	16	BUSCH TAM

Appendix C

Summary of Data Exports

Project: wacr13
Report compiled under Population Management 2000, version 1.213
12:48:22 PM, 7/4/2013

Date to be used for calculations: 7/4/2013
Demographic data from: C:\SPARKS\WATTLED\MWATTLED.PRN and C:\SPARKS\WATTLED\FWATTLED.PRN
Genetic data from: C:\SPARKS\WATTLED\wacr13.ped

Studbook information:
Data exported on: 4 Jul 2013 from Sparks v1.52
Data compiled by: Frederick B. C. Beall
Contact info: Zoo New England fbeall@zoonewengland.com
Data current thru: 4 Jun 2013
Scope of data: International

Genetic filter conditions: Locations: N.AMERICA/ Dates: As of 03/07/2013 Status: Living on 3 Jul 2013
Demography 1980-present

PMx Project: wacr13
Created: 2013-07-04
File: C:\PMxProjects\wacr13.pmxproj

Primary data file
Data File Name: EXCHANGE.DBF
Filter settings not specified

Primary data file
Data File Name: exchange.ped

Locations data file
Data File Name: location.txt

Demographic input files
MPrn file: mWATTLED.PRN
FPrn file: FWATTLED.PRN

Male LifeTable filter:
WATTLED CRANE
BUGERANUS CARUNCULATUS
male
Data exported on: 4 Jul 2013 from Sparks v1.52
Data compiled by: Frederick B. C. Beall
Data current thru: 4 Jun 2013
Scope of data: International
Locations: N.AMERICA/
Dates: Between 01/01/1980 and 03/07/2013

Female LifeTable filter:
WATTLED CRANE
BUGERANUS CARUNCULATUS
female
Data exported on: 4 Jul 2013
Data compiled by: Frederick B. C. Beall
Data current thru: 4 Jun 2013
Scope of data: International
Locations: N.AMERICA/
Dates: Between 01/01/1980 and 03/07/2013

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 (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 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 .

Appendix F

Directory of Institutional Representatives

Contact Name (IR)	Institution	Email	Phone
Debbie Zombeck	ASHEBORO - North Carolina Zoological Park, Asheboro, NC	debbie.zombeck@nczoo.org	3368797605
James Ballance	ATLANTA - Zoo Atlanta, Atlanta, GA	jballance@zooatlanta.org	4624569104
Bryant Tarr	BARABOO - International Crane Foundation, Baraboo, WI	btarr@savingcranes.org	6083569462 (154)
Sam Winslow	BATONROUG - BREC's Baton Rouge Zoo, Baker, LA	swinslow@brzoo.org	2257753877
Collette Adams	BROWNSVIL - Gladys Porter Zoo, Brownsville, TX	cadams@gpz.org	9565042895
Philip Hillary	BUSCH TAM - Busch Gardens Tampa Bay, Tampa, FL	philip.hillary@buschgardens.com	8139875236
Jocelyn Womack	DALLAS - Dallas Zoo, Dallas, TX	jocelyn.womack@dallaszoo.com	4695547243
James Mejeur	DISNEY AK - Disney's Animal Kingdom, Bay Lake, FL	james.h.mejeur@disney.com	4079382871
Janet Johnson	FOSSILRIM - Fossil Rim Wildlife Center, Glen Rose, TX	janetj@fossilrim.org	2548984236
Mark Weldon	FT WAYNE - Fort Wayne Children's Zoological Garden, Fort Wayne, IN	mark@kidszoo.org	2604276806
Katy Unger	FORTWORTH - Fort Worth Zoological Park, Ft Worth, TX	kunger@fortworthzoo.org	8177597170
Frederick Beall	FRANKLINP - Zoo New England / Franklin Park Zoo, Boston, MA	fbeall@zoonewengland.com	6179892052
Carmen Murach	GREENBAY - NEW Zoo, Green Bay, WI	Murach_CD@co.brown.wi.us	9206622403
Dave Wetzel	JACKSON - Jackson Zoological Park, Jackson, MS	dlwetzel@jacksonzoo.org	6013522580
Donna Bear-Hull	JACKSONVL - Jacksonville Zoo and Gardens, Jacksonville, FL	bear-hulld@jacksonvillezoo.org	9047574463
Gary Michael	LOUISVILL - Louisville Zoological Garden, Louisville, KY	gary.michael@louisvilleky.gov	5022385346
Julie Tomita	LOWRY - Tampa's Lowry Park Zoo, Tampa, FL	julie.tomita@lowryparkzoo.com	8139358552
Jim Dunster	METROZOO - Zoo Miami, Miami, FL	jdun@miamidade.gov	3052510400

Contact Name (IR)	Institution	Email	Phone
Sara Hallager	NZP-WASH - Smithsonian National Zoological Park, Washington, DC	hallagers@si.edu	2026333088
Stephanie Huettner	OMAHA - Omaha's Henry Doorly Zoo, Omaha, NE	stephanieh@omahazoo.com	4027382085
Peter Shannon	RIO GRAND - Albuquerque Biological Park, Albuquerque, NM	pshannon@cabq.gov	5057646258
Josef San Miguel	SAN ANTON - San Antonio Zoological Gardens & Aqua, San Antonio, TX	curbirds@sazoo-aq.org	2107347184
Mike Mace	SD-WAP - San Diego Zoo Safari Park, Escondido, CA	mmace@sandiegozoo.org	7607385077
Michael Macek	ST LOUIS - Saint Louis Zoological Park, St. Louis, MO	macek@stlzoo.org	3146464825
Kyla Greenham	TORONTO - Toronto Zoo, Scarborough, Ontario	kgreenham@torontozoo.ca	4163975202
Andrew Schumann	YULEE - White Oak Conservation Center, Yulee, FL	andrew_s@wogilman.com	9042253396