Population Analysis and Breeding Plan

Keel-billed Toucan

Ramphastos sulfuratus

Species Survival Plan

Species Coordinator
Ken Naugher
Montgomery Zoo, Montgomery, AL
knaugher@montgomeryal.gov

Regional Studbook Keeper
Cyndi Laljer
Sea World San Antonio, San Antonio, TX
Cyndi.Laljer@SeaWorld.com

PMC/SPMAG Advisor
Sarah Long, AZA Population Management Center

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PMC Population Management Center

Lincoln Park Zoo ASSOCIATION OF ZOOS & AQUARIUMS

Executive Summary

Species Survival Plan for Keel-billed Toucans

The Piciformes Taxon Advisory Group in their 2003 Regional Collection Plan recommended keel-billed toucans to be managed under the Toucan SSP with a target size of 75 individuals. At the time of analyses, the SSP population consists of 62 (33 males, 28 females, and one unknown sex) birds at 24 institutions.

The current gene diversity of this population is only 71.43% because only two founders have living offspring in the population. Potential gene diversity is very high (98.68%) due to the 36 unrepresented potential founders in the population. Managed breeding resulting in equalization of founder representation and recruitment of the existing potential founders, increasing the population growth rate, and improving the N_e/N ratio would all allow this population to increase and maintain gene diversity. Determining the pedigree of unknown pedigree birds would also increase gene diversity by allowing existing but unknown lineages to be included in the genetic calculations. When gene diversity decreases below 90%, it is expected that reproduction will be increasingly compromised by, among other factors, lower hatch weights, smaller clutch sizes, and greater neonatal mortality.

DEMOGRAPHICS

	Current
Population Size (at time of analyses)	62 (33.28.1)
Specimens Excluded from Genetic Analyses	19
Mean Generation Time (Years)	7*
Current Population Growth Rate	0.809

**based on very small sample size but similar to Toco Toucan.*

GENETICS

	Current	***Potential***
Founders	2	36
Founder genome equivalents	1.75	37.99
Gene diversity retained (%)	71.43	98.68
Population mean kinship	0.2857	--
Mean inbreeding	0	--
Effective population size/census size ratio (Ne/N)	0	--
Percent of pedigree known (before exclusions)	34.8	--
Percent of pedigree known (after exclusions)	100	--
Years to 90% gene diversity	n/a - GD already below 90%	
Gene diversity at 100 years from present (%)	0%	

Precise growth rates and a recommended number of hatches for this population cannot be accurately determined due to poor demographic data. However, to offset deaths and increase the probability of successful reproduction, the SSP has recommended 21 breeding pairs. The SSP should focus breeding the unrepresented birds of known wild origin, and in so doing increase gene diversity and increase the population towards its target size. Unpedigreed birds should also be encouraged to breed in the coming year to avoid demographic problems and until husbandry has improved sufficiently that genetically desirable pairs can be prioritized.

Summary Actions: The SSP recommends 21 breeding pairs and 3 transfers to meet institutional needs or set up breeding pairs.

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Species Coordinator
Ken Naugher
Montgomery Zoo, Montgomery, AL
knaugher@montgomeryal.gov

Regional Studbook Keeper
Cyndi Laljer
Sea World San Antonio, San Antonio, TX
Cyndi.Laljer@SeaWorld.com

Report and Analyses prepared by:
Sarah Long, Senior Population Biologist
AZA Population Management Center
slong@lpzoo.org

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

Description of Population Status
Keel-billed Toucan Species Survival Plan

Introduction: At the time of analyses, the Keel-Billed Toucan SSP population is 62 (33.28.1) distributed among 24 AZA institutions. The Piciformes Taxon Advisory Group's 2003 Regional Collection Plan recommended keel-billed toucans be managed with a target size of 75 individuals under the Toucan SSP.

Genetic and demographic analyses of the population were performed in March 2008 at the AZA Regional Conference in Birmingham, Alabama, resulting in the current SSP Breeding and Transfer Plan. Analyses were based on the American Regional Keel-billed Toucan Studbook (current to 30 November 2008) using PopLink 1.30, SPARKS 1.52 and PM2000 1.212. This is the first breeding and transfer plan for this species. The goal of these recommendations is to help insure the genetic and demographic health of this population.

Analytical Population: Nineteen birds were excluded from the genetic analyses unknown pedigree or health issues. Exclusions are listed in Appendix A. No assumptions were made in connection with unknown pedigree birds. One bird (male 269) died during the comment period.

Demography: Records indicate keel-billed toucans first appeared in North American zoos in 1932. Small numbers were held until the current population was founded with imports from the wild starting in the early 1970s and continuing sporadically since then (Figures 1 & 2). Captive breeding first occurred in 1975 but became consistent only in the 1990s; captive breeding. Over the past decade, population annual growth rates attributed to captive hatches have varied greatly (range of annual λ = 0.84 – 1.83) but in general, captive breeding in AZA facilities has not been sufficient to sustain the population (see Figure 3).

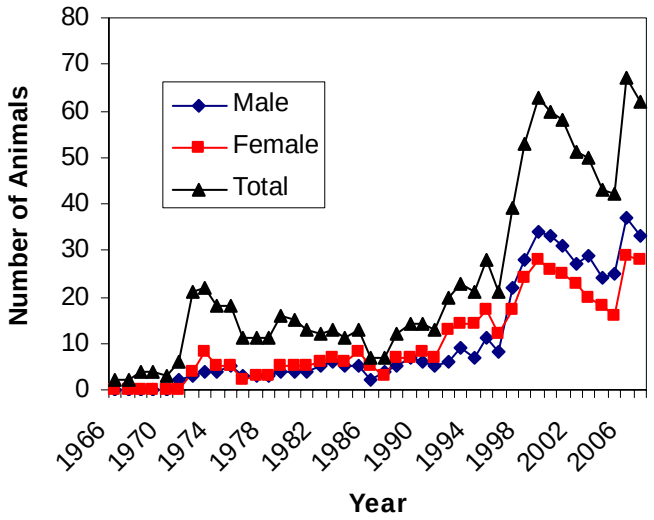

Figure 1. Population census by sex, showing the number of keel-billed in AZA zoos from 1966– present (data current to 30 November 2008).

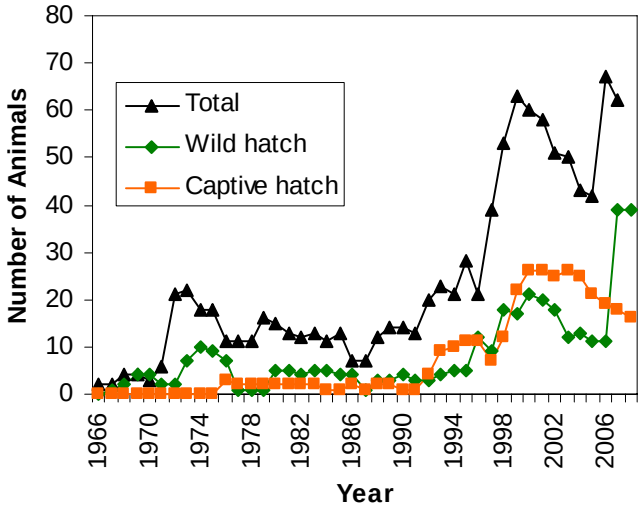

Figure 2. Population census by hatch type, showing the number of keel-billed in AZA zoos from 1966– present (data current to 30 November 2008).

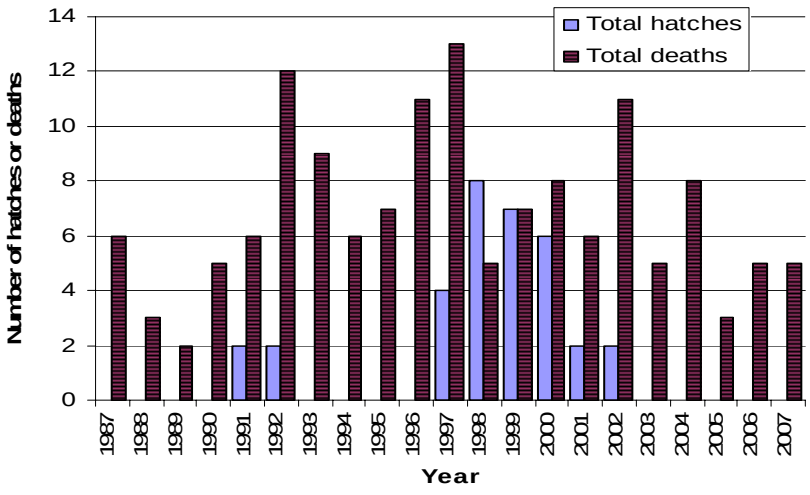

Figure 3. Number of hatches and deaths of keel-billed toucans in AZA institutions per year (1987 – 2007).

The age distribution of the Keel-billed SSP population appears to have a fairly even sex ratio but is unstable in terms of proportion of birds known to be of reproductive age (Figure 3). The bulk of birds are in the two year old age class, recently brought in from the wild as juveniles.

Demographic data for this species is unreliable because there has been very little captive breeding (only seven known breeding pairs are recorded in the studbook) and 43% of hatches were to unidentified or unknown age parents. Observed age of first reproduction is about 3 years old for both males and females. The oldest males and females to have bred were estimated to be eight years old. Data is sparse, but it is estimated that this species can live at least into their early teens.

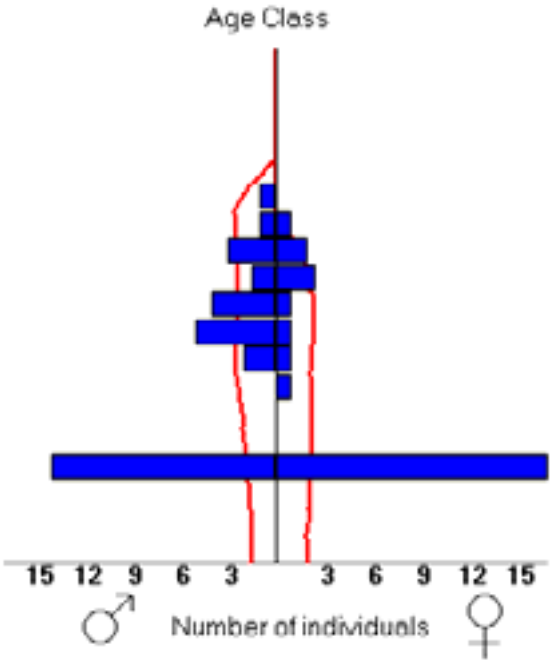

Figure 4. Age structure of the Keel-billed Toucan SSP population showing age classes 0 – 13 years. The large number of birds in age class 3 reflects an importation event.

Genetics: Only two founders have living descendants in the AZA keel-billed toucan population, a breeding pair with seven surviving offspring (Figure 5). The gene diversity in these descendents is 71.43%.

The remaining birds in the population are 36 wild-hatched unrepresented potential founders and 15 birds of unknown pedigree. The 36 potential founders contribute to a potential gene diversity of 98.68%, much of which could be recruited if these birds were to successfully breed. No genetic values can be calculate for the unknown pedigree birds (i.e., it is unknown if or how they are related to other birds in the population or if they represent unique lineages). Efforts should be made to ascertain the origin or relatedness of these birds (primarily from private sector breeders) or remove them from the breeding pool once demographic goals have been met and the population becomes more self-sustaining.

GENETICS

	Current	***Potential***
Founders	2	36
Founder genome equivalents	1.75	37.99
Gene diversity retained (%)	71.43	98.68
Population mean kinship	0.2857	--
Mean inbreeding	0	--
Effective population size/census size ratio (Ne/N)	0	--
Percent of pedigree known (before exclusions)	34.8	--
Percent of pedigree known (after exclusions)	100	--
Years to 90% gene diversity	n/a - GD already below 90%	
Gene diversity at 100 years from present (%)	0%	

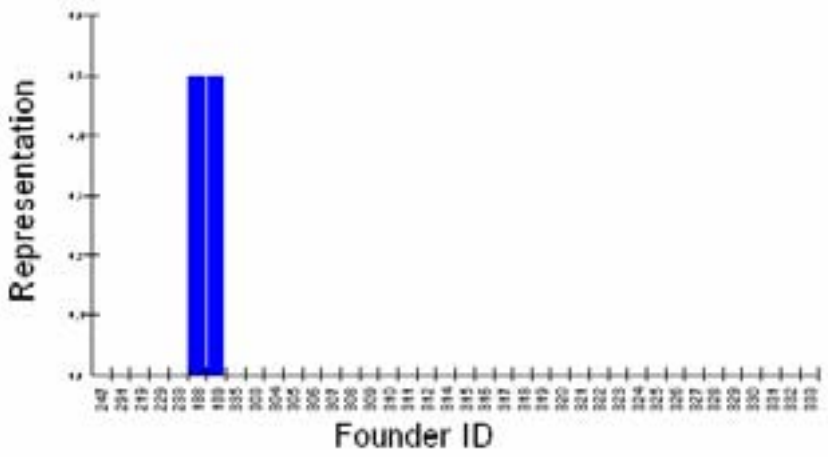

Figure 5. Founder representation in keel-billed toucans illustrating inequality of various founder lineages and large number of unrepresented founders (36).

Management Strategy: Precise growth rates and a recommended number of hatches for this population cannot be accurately determined due to poor demographic data. However, to offset deaths and increase the probability of successful reproduction, the SSP has recommended 21 breeding pairs. The SSP should focus breeding the unrepresented birds of known wild origin, and in so doing increase gene diversity and increase the population towards its target size. Unpedigreed birds should also be encouraged to breed in the coming year to avoid demographic problems and until husbandry has improved sufficiently that genetically desirable pairs can be prioritized.

1. Recommend 21 breeding pairs.
2. Recommend 3 transfers to set up breeding pairs or meet institutional needs.
3. Determine and report sex of all unsexed birds.

Summary Breeding and Transfer Recommendations

ID	Location	Sex	Age	Disposition	Location	Breeding	With	Notes
203	BUSCH TAM	M	13	HOLD	BUSCH TAM	BREED WITH	273	Unknown pedigree
213	DALLAS WA	M	12	HOLD	DALLAS WA	DO NOT BREED		unknown pedigree
219	NY BRONX	F	12	HOLD	NY BRONX	BREED WITH	274	
229	SAN ANTON	M	11	SEND TO	SEAWLD TX	BREED WITH	329	
231	CHICAGOBR	M	11	HOLD	CHICAGOBR	DO NOT BREED		*program bird
233	AUDUBON	F	11	HOLD	AUDUBON	BREED WITH	249	
241	DALLAS WA	F	0	HOLD	DALLAS WA	DO NOT BREED		Unknown pedigree
243	DALLAS WA	M	0	HOLD	DALLAS WA	DO NOT BREED		Unknown pedigree
245	DALLAS WA	M	11	HOLD	DALLAS WA	DO NOT BREED		Unknown pedigree
246	DALLAS WA	F	11	HOLD	DALLAS WA	DO NOT BREED		Unknown pedigree
247	DALLAS WA	M	0	HOLD	DALLAS WA	DO NOT BREED		
249	AUDUBON	M	10	HOLD	AUDUBON	BREED WITH	233	Unknown pedigree
251	DALLAS WA	U	10	HOLD	DALLAS WA	DO NOT BREED		Unknown pedigree
257	DALLAS WA	F	10	HOLD	DALLAS WA	DO NOT BREED		Unknown pedigree
264	CENTRALPK	F	10	HOLD	CENTRALPK	SEE NOTES		SSP will seek appropriate mate.
266	MINNESOTA	M	9	HOLD	MINNESOTA	DO NOT BREED		prioritize wild caught birds for breeding.
268	ORLANDO	M	9	HOLD	ORLANDO	BREED WITH		breed for demographic purposes
~~269~~	~~SACRAMNTO~~	~~M~~	~~9~~	~~HOLD~~	~~SACRAMNTO~~	~~SEE NOTES~~		Died during comment period
273	SACRAMNTO	F	9	SEND TO	BUSCH TAM	BREED WITH	203	
274	NY BRONX	M	9	HOLD	NY BRONX	BREED WITH	219	
280	SEATTLE	M	8	HOLD	SEATTLE	BREED WITH	327	Unknown pedigree
282	BALTIMORE	M	8	HOLD	BALTIMORE	DO NOT BREED		program bird
284	WORLDBIRD	M	8	HOLD	WORLDBIRD	DO NOT BREED		program bird; unknown pedigree.
285	BATONROUG	M	8	HOLD	BATONROUG	BREED WITH	336	Unknown pedigree
289	SEATTLE	M	7	HOLD	SEATTLE	BREED WITH	315	
291	SEATTLE	F	0	HOLD	SEATTLE	BREED WITH	326	
295	COLUMBIA	F	7	HOLD	COLUMBIA	DO NOT BREED		for display
296	COLUMBIA	M	7	HOLD	COLUMBIA	DO NOT BREED		for display
299	ORLANDO	F	6	HOLD	ORLANDO	BREED WITH		Unknown pedigree
303	FRESNO	M	3	HOLD	FRESNO	BREED WITH	321	
304	BRIDGEPRT	M	3	HOLD	BRIDGEPRT	BREED WITH	312	
305	DENVER	F	3	HOLD	DENVER	BREED WITH	311	
306	DENVER	F	3	HOLD	DENVER	BREED WITH	320	

ID	Location	Sex	Age	Disposition	Location	Breeding	With	Notes
307	EVANSVLLE	M	3	HOLD	EVANSVLLE	BREED WITH	316	
308	MINNESOTA	F	3	HOLD	MINNESOTA	BREED WITH	309	
309	MINNESOTA	M	3	HOLD	MINNESOTA	BREED WITH	308	
310	TUCSON	M	3	HOLD	TUCSON	BREED WITH	318	
311	DENVER	M	3	HOLD	DENVER	BREED WITH	305	
312	BRIDGEPRT	F	3	HOLD	BRIDGEPRT	BREED WITH	304	
314	MINNESOTA	M	3	HOLD	MINNESOTA	BREED WITH	317	
315	SEATTLE	F	3	HOLD	SEATTLE	BREED WITH	289	
316	EVANSVLLE	F	3	HOLD	EVANSVLLE	BREED WITH	307	
317	MINNESOTA	F	3	HOLD	MINNESOTA	BREED WITH	314	
318	TUCSON	F	3	HOLD	TUCSON	BREED WITH	310	
319	NZP-WASH	M	3	HOLD	NZP-WASH	BREED WITH	323	
320	DENVER	M	3	HOLD	DENVER	BREED WITH	306	
321	FRESNO	F	3	HOLD	FRESNO	BREED WITH	303	
322	TUCSON	M	3	HOLD	TUCSON	BREED WITH	328	
323	NZP-WASH	F	3	HOLD	NZP-WASH	BREED WITH	319	
324	SOUTHBEND	M	3	HOLD	SOUTHBEND	BREED WITH	333	
325	NZP-WASH	F	3	HOLD	NZP-WASH	BREED WITH	319	
326	SEATTLE	M	3	HOLD	SEATTLE	BREED WITH	291	
327	SEATTLE	F	3	HOLD	SEATTLE	BREED WITH	280	
328	TUCSON	F	3	HOLD	TUCSON	BREED WITH	322	
329	HOUSTON	F	3	SEND TO	SEAWLD TX	BREED WITH	229	
330	PITTS CA	M	3	HOLD	PITTS CA	BREED WITH	331	
331	PITTS CA	F	3	HOLD	PITTS CA	BREED WITH	330	
332	HOUSTON	M	3	HOLD	HOUSTON	BREED WITH	323	
333	SOUTHBEND	F	3	HOLD	SOUTHBEND	BREED WITH	324	
334	DALLAS WA	F	8	HOLD	DALLAS WA	DO NOT BREED		Unknown pedigree
335	DALLAS WA	M	8	HOLD	DALLAS WA	DO NOT BREED		
336	BATONROUG	F	3	HOLD	BATONROUG	BREED WITH	285	Unknown pedigree

AUDUBON

Audubon Zoo
New Orleans, LA

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
233	2740	F	11	HOLD	AUDUBON	BREED WITH	249	Genetically valuable potential founder.
249	100352	M	10	HOLD	AUDUBON	BREED WITH	233	Unknown pedigree but assumed unrelated to mate.

BALTIMORE

The Maryland Zoo in Baltimore
Baltimore, MD

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
282	642	M	8	HOLD	BALTIMORE	DO NOT BREED		program bird

BATONROUG

BREC's Baton Rouge Zoo
Baker, LA
Institutional notes: Both birds are unknown pedigree but allow to breed for demographic purposes. Investigate pedigree to facilitate genetic management.

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
285	10175_	M	8	HOLD	BATONROUG	BREED WITH	336	Unknown pedigree
336	10104	F	3	HOLD	BATONROUG	BREED WITH	285	Unknown pedigree

BRIDGEPRT

Connecticut's Beardsley Zoo
Bridgeport, CT
Institutional notes: Both birds are genetically valuable and should breed.

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
304	_____	M	3	HOLD	BRIDGEPRT	BREED WITH	312	
312	_____	F	3	HOLD	BRIDGEPRT	BREED WITH	304	

BUSCH TAM

Busch Gardens
Tampa, FL

Institutional notes: Male birds is unknown pedigree; please investigate pedigree to facilitate genetic management. Female is an F1 from only AZA breeding pair with living offspring. Allow to breed for demographic purposes.

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
203	60932	M	13	HOLD	BUSCH TAM	BREED WITH	273	Unknown pedigree
273	201395	F	9	RECEIVE FROM	SACRAMNTO	BREED WITH	203	

CENTRALPK

Central Park Zoo
Bronx, NY

Note: This female is an F1 from only AZA breeding pair with living offspring.

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
264	C07027	F	10	HOLD	CENTRALPK	SEE NOTES		SSP will seek appropriate mate.

CHICAGOBR

Chicago Zoological Park
Brookfield, IL

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
231	2222	M	11	HOLD	CHICAGOBR	DO NOT BREED		program bird

COLUMBIA

Riverbanks Zoological Park

Columbia, SC

Note: Draft recommendation for exchange with Denver has been cancelled because pair is currently nesting at Denver. SSP will consider Riverbanks for future breeding pairs due to their history of breeding this species.

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
295	7441	F	7	HOLD	COLUMBIA	DO NOT BREED		Not suitable for breeding. Available for display
296	7440	M	7	HOLD	COLUMBIA	DO NOT BREED		Not suitable for breeding. Available for display

DALLAS WA

Dallas World Aquarium

Dallas, TX

Note: Please determine sex and parentage/origin of unknown pedigree birds in order to facilitate breeding and genetic management. Males 247 & 335 are valuable to the SSP as potential breeders if suitable mates can be identified at DALLAS WA or elsewhere.

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
213	97A012	M	12	HOLD	DALLAS WA	DO NOT BREED		unknown pedigree
241	98A053	F	0	HOLD	DALLAS WA	DO NOT BREED		unknown pedigree
243	98A057	M	0	HOLD	DALLAS WA	DO NOT BREED		unknown pedigree
245	98A069	M	11	HOLD	DALLAS WA	DO NOT BREED		unknown pedigree
246	98A070	F	11	HOLD	DALLAS WA	DO NOT BREED		unknown pedigree
247	99A065	M	0	HOLD	DALLAS WA	DO NOT BREED		Wild parentage; potential founder.
251	98A101	U	10	HOLD	DALLAS WA	DO NOT BREED		unknown pedigree
257	99A031	F	10	HOLD	DALLAS WA	DO NOT BREED		unknown pedigree
334	5A001	F	8	HOLD	DALLAS WA	DO NOT BREED		unknown pedigree
335	5A002	M	8	HOLD	DALLAS WA	DO NOT BREED		Wild parentage; potential founder.

DENVER

Denver Zoological Gardens
Denver, CO

Note: Both pairs at Denver are currently nesting; hold at current institution for now.

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
306	A06171	F	3	HOLD	DENVER	BREED WITH	320	Unrepresented potential founder
320	A06169	M	3	HOLD	DENVER	BREED WITH	306	Unrepresented potential founder
305	A06170	F	3	HOLD	DENVER	BREED WITH	311	Unrepresented potential founder
311	A06168	M	3	HOLD	DENVER	BREED WITH	305	Unrepresented potential founder

EVANSVLLE

Mesker Park Zoo
Evansville, IN

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
307	206003	M	3	HOLD	EVANSVLLE	BREED WITH	316	Unrepresented potential founder
316	206002	F	3	HOLD	EVANSVLLE	BREED WITH	307	Unrepresented potential founder

FRESNO

Chaffee Zoological Gardens of Fresno
Fresno, CA

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
303	260021	M	3	HOLD	FRESNO	BREED WITH	321	Unrepresented potential founder
321	260022	F	3	HOLD	FRESNO	BREED WITH	303	Unrepresented potential founder

HOUSTON

Houston Zoo, Inc.
Houston, TX

Note: Draft recommendation changed to hold 319 and 323 at NZP (rather than send male 323 to Houston) because this pair is now exhibiting breeding behavior at NZP. The SSP will continue to seek a more suitable mate for Houston male 332.

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
329	22435	F	3	SEND TO	SEAWLD TX	BREED WITH	229	Unrepresented potential founder
332	22433	M	3	HOLD	HOUSTON	BREED WITH	323	Unrepresented potential founder

MINNESOTA

Minnesota Zoological Garden
Apple Valley, MN

Notes: Breed any wild parentage bird with any other wild parentage bird.

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
266	9681	M	9	HOLD	MINNESOTA	DO NOT BREED		F1 bird; prioritize wild caught birds for breeding.
308	11633	F	3	HOLD	MINNESOTA	BREED WITH	309 or 314	
309	11631	M	3	HOLD	MINNESOTA	BREED WITH	308 or 317	
314	11632	M	3	HOLD	MINNESOTA	BREED WITH	317 or 308	
317	11634	F	3	HOLD	MINNESOTA	BREED WITH	314 or 309	

NY BRONX

Bronx Zoo/Wildlife Conservation Society
Bronx, NY

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
219	972178	F	12	HOLD	NY BRONX	BREED WITH	274	Unrepresented potential founder
274	B07001	M	9	HOLD	NY BRONX	BREED WITH	219	F1 bird

NZP-WASH

Smithsonian National Zoological Park
Washington, DC

Note: Draft recommendation changed to hold 319 and 323 at NZP because this pair is exhibiting breeding behavior.

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
319	215582	M	3	HOLD	NZP-WASH	BREED WITH	323	Unrepresented potential founder
323	215549	F	3	HOLD	NZP-WASH	BREED WITH	319	Unrepresented potential founder
325	215550	F	3	HOLD	NZP-WASH	DO NOT BREED		Not suitable for breeding due to physical and behavioral issues.

ORLANDO

Sea World Orlando
Orlando, FL

Notes: Breed for demographic purposes (unk pedigree female with F1 male are not genetically desirable).

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
268	KBT250	M	9	HOLD	ORLANDO	BREED WITH		F1 bird
299	KBT251	F	6	HOLD	ORLANDO	BREED WITH		Unknown pedigree (but likely unrelated to mate)

PITTS CA

National Aviary in Pittsburgh
Pittsburgh, PA

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
330	7443	M	3	HOLD	PITTS CA	BREED WITH	331	Unrepresented potential founder
331	7445	F	3	HOLD	PITTS CA	BREED WITH	330	Unrepresented potential founder

SACRAMNTO

Sacramento Zoo

Sacramento, CA

Notes: Following death of sibling, the SSP still recommends sending out this female (F1 offspring from only AZA breeding pair) for breeding breeding. SSP will seek replacement bird or pair.

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
~~269~~	~~201589~~	~~M~~	~~9~~	~~HOLD~~	~~SACRAMNTO~~	~~SEE NOTES~~		~~SSP will seek appropriate mate~~. Died during comment period.
273	201395	F	9	SEND TO	BUSCH TAM	BREED WITH	203	

SAN ANTON

San Antonio Zoological Gardens & Aqua

San Antonio, TX

Note: This institution wishes to phase-out this species.

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
229	971043	M	11	SEND TO	SEAWLD TX	BREED WITH	329	

SEATTLE

Woodland Park Zoological Gardens
Seattle, WA

Notes: Prioritize breeding wild origin birds (male 326 with females 291, 315, or 327) over unk pedigree or F1 birds. For demographic reasons, all may breed if space/conditions allow.

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
280	200978	M	8	HOLD	SEATTLE	BREED WITH	327	Unknown pedigree
289	200372	M	7	HOLD	SEATTLE	BREED WITH	315	F1 bird
291	202364	F	0	HOLD	SEATTLE	BREED WITH	326	Unrepresented potential founder
315	202143	F	3	HOLD	SEATTLE	BREED WITH	289	Unrepresented potential founder
326	202142	M	3	HOLD	SEATTLE	BREED WITH	291	Unrepresented potential founder
327	202144	F	3	HOLD	SEATTLE	BREED WITH	280	Unrepresented potential founder

SEAWLD TX

Sea World San Antonio
San Antonio, TX

Note: This institution is new to the SSP.

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
329	22435	F	3	RECEIVE FROM	HOUSTON	BREED WITH	229	Unrepresented potential founder
229	971043	M	11	RECEIVE FROM	SAN ANTON	BREED WITH	329	Unrepresented potential founder

SOUTHBEND

Potawatomi Zoo
South Bend, IN

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
324	25056	M	3	HOLD	SOUTHBEND	BREED WITH	333	Unrepresented potential founder
333	26065	F	3	HOLD	SOUTHBEND	BREED WITH	324	Unrepresented potential founder

TUCSON

Reid Park Zoo
Tucson, AZ

Note: Ok to breed any combination of wild caught birds.

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
310	T65168	M	3	HOLD	TUCSON	BREED WITH	318 or 328	Unrepresented potential founder
318	T65169	F	3	HOLD	TUCSON	BREED WITH	310 or 322	Unrepresented potential founder
322	T65152	M	3	HOLD	TUCSON	BREED WITH	328 or 318	Unrepresented potential founder
328	T65153	F	3	HOLD	TUCSON	BREED WITH	322 or 310	Unrepresented potential founder

WORLDBIRD

Steve Martin Natural Encounters, Inc.
Winter Haven, FL

ID	Local ID	Sex	Age	Disposition	Location	Breeding	With	Notes
284	MO7026	M	8	HOLD	WORLDBIRD	DO NOT BREED		program bird; unknown pedigree.

Appendix A
Animals Excluded from Genetic Analyses

ID	Location	Sex	Age	Reason
249	AUDUBON	M	10	Unknown pedigree
282	BALTIMORE	M	8	program bird
285	BATONROUG	M	8	Unknown pedigree
336	BATONROUG	F	3	Unknown pedigree
203	BUSCH TAM	M	13	Unknown pedigree
231	CHICAGOBR	M	11	program bird (aggressive w/ other birds)
295	COLUMBIA	F	7	health (wing impairment)
296	COLUMBIA	M	7	health
213	DALLAS WA	M	12	Unknown pedigree
241	DALLAS WA	F	0	Unknown pedigree
243	DALLAS WA	M	0	Unknown pedigree
245	DALLAS WA	M	11	Unknown pedigree
246	DALLAS WA	F	11	Unknown pedigree
251	DALLAS WA	U	10	Unknown pedigree
257	DALLAS WA	F	10	Unknown pedigree
334	DALLAS WA	F	8	Unknown pedigree
299	ORLANDO	F	6	Unknown pedigree
280	SEATTLE	M	8	Unknown pedigree
284	WORLDBIRD	M	8	program bird; unknown pedigree.

Appendix B
Assumptions

No assumptions were made for this year's plan.

Appendix C
Summary of Data Exports

Project: touc_KB_genetic
Report compiled under Population Management 2000, version 1.212
4:01:47 PM, 3/14/2008
Comments: created with correct genetic selection

Date to be used for calculations: 3/14/2008

Studbook information:
Data exported on: 3/5/2008
Data compiled by: Cyndi Laljer
Contact info: Sea World San Antonio cyndi.laljer@seaworld.com
Data current thru: 11/30/2007
Scope of data: North American regional

Demographic data from: C:\Program Files\PopLink 1.3\PopLink Databases\KEELBIL3\mKEELBIL3.prn and C:\Program Files\PopLink 1.3\PopLink Databases\KEELBIL3\fKEELBIL3.prn
Demographic filter conditions:
Locations = N.AMERICA During 1/1/1970 - 3/5/2008 Status = Living

Genetic data from: C:\Program Files\PopLink 1.3\PopLink Databases\KEELBIL3\KEELBIL3.ped
Genetic filter conditions:
Locations = N.AMERICA
As of 3/5/2008
Status = Living

Appendix D
Life Tables

Males

Age (x)	*Qx*	*Px*	*lx*	*Mx*	*Vx*	*Ex*	*Risk (Qx)*	*Risk (Mx)*
0	0.240	0.760	1.000	0.000	1.136	6.747	26.700	20.300
1	0.160	0.840	0.760	0.000	1.192	7.232	51.300	44.700
2	0.040	0.960	0.638	0.020	1.110	6.965	47.600	46.400
3	0.140	0.860	0.613	0.050	0.998	6.548	39.300	34.600
4	0.050	0.950	0.527	0.120	0.876	6.153	36.800	35.900
5	0.100	0.900	0.501	0.200	0.681	5.567	40.400	38.900
6	0.080	0.920	0.451	0.180	0.441	5.022	35.900	34.700
7	0.100	0.900	0.415	0.120	0.239	4.418	31.400	29.600
8	0.260	0.740	0.373	0.120	0.120	4.147	23.400	21.200
9	0.100	0.900	0.276	0.000	0.000	3.894	14.400	13.700
10	0.270	0.730	0.249	0.000	0.000	3.532	11.100	9.600
11	0.000	1.000	0.181	0.000	0.000	3.000	5.400	5.400
12	0.250	0.750	0.181	0.000	0.000	2.286	4.000	3.200
13	0.000	1.000	0.136	0.000	0.000	1.500	1.200	1.200
14	1.000	0.000	0.136	0.000	0.000	1.000	1.000	0.900
15	0.000	1.000	0.000	0.000	0.000	0.000	0.000	0.000
16	0.000	1.000	0.000	0.000	0.000	0.000	0.000	0.000
17	1.000	0.000	0.000	0.000	0.000	0.000	1.000	0.100

r = -0.1821
lambda = 0.8335
T = 6.89
N = 33.50
N(at 20 yrs) = 0.88

Females

Age (x)	*Qx*	*Px*	*lx*	*Mx*	*Vx*	*Ex*	*Risk (Qx)*	*Risk (Mx)*
0	0.280	0.720	1.000	0.000	1.163	6.253	34.500	25.400
1	0.060	0.940	0.720	0.000	1.215	6.468	51.100	48.100
2	0.020	0.980	0.677	0.020	1.075	5.699	50.100	49.500
3	0.170	0.830	0.663	0.100	0.989	5.188	38.600	34.400
4	0.170	0.830	0.551	0.140	0.909	5.046	34.600	31.100
5	0.060	0.940	0.457	0.190	0.741	4.599	33.600	32.900
6	0.260	0.740	0.430	0.240	0.555	4.268	30.800	25.300
7	0.090	0.910	0.318	0.170	0.329	4.024	21.400	20.500
8	0.110	0.890	0.289	0.150	0.150	3.358	18.400	17.200
9	0.100	0.900	0.257	0.000	0.000	2.635	15.500	14.100
10	0.330	0.670	0.232	0.000	0.000	2.067	12.300	9.700
11	0.170	0.830	0.155	0.000	0.000	1.454	5.900	5.800
12	1.000	0.000	0.129	0.000	0.000	1.000	4.000	1.600
13	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
14	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
15	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
16	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
17	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
18	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

r = -0.1640
lambda = 0.8487
T = 6.66
N = 28.50
N(at 20 yrs) = 1.07

Appendix E

Ordered Mean Kinship List

Note: This list is current to March 2008 and values are subject to change with any birth, death, import, export, inclusion, or exclusion.

Population MK = 0.2857

MALES

SB#	MK	%Known	Age	Location
304	0.000	100.0	3	BRIDGEPRT
247	0.000	100.0	0	DALLAS WA
335	0.000	100.0	8	DALLAS WA
311	0.000	100.0	3	DENVER
320	0.000	100.0	3	DENVER
307	0.000	100.0	3	EVANSVLLE
303	0.000	100.0	3	FRESNO
332	0.000	100.0	3	HOUSTON
309	0.000	100.0	3	MINNESOTA
314	0.000	100.0	3	MINNESOTA
319	0.000	100.0	3	NZP-WASH
330	0.000	100.0	3	PITTS CA
229	0.000	100.0	11	SAN ANTON
326	0.000	100.0	3	SEATTLE
324	0.000	100.0	3	SOUTHBEND
310	0.000	100.0	3	TUCSON
322	0.000	100.0	3	TUCSON
266	0.286	100.0	9	MINNESOTA
274	0.286	100.0	9	NY BRONX
268	0.286	100.0	9	ORLANDO
269	0.286	100.0	9	SACRAMNTO
289	0.286	100.0	7	SEATTLE

FEMALES

SB#	MK	%Known	Age	Location
233	0.000	100.0	11	AUDUBON
312	0.000	100.0	3	BRIDGEPRT
305	0.000	100.0	3	DENVER
306	0.000	100.0	3	DENVER
316	0.000	100.0	3	EVANSVLLE
321	0.000	100.0	3	FRESNO
329	0.000	100.0	3	HOUSTON
308	0.000	100.0	3	MINNESOTA
317	0.000	100.0	3	MINNESOTA
219	0.000	100.0	12	NY BRONX
323	0.000	100.0	3	NZP-WASH
325	0.000	100.0	3	NZP-WASH
331	0.000	100.0	3	PITTS CA
291	0.000	100.0	0	SEATTLE
315	0.000	100.0	3	SEATTLE
327	0.000	100.0	3	SEATTLE
333	0.000	100.0	3	SOUTHBEND
318	0.000	100.0	3	TUCSON
328	0.000	100.0	3	TUCSON
264	0.286	100.0	10	CENTRALPK
273	0.286	100.0	9	SACRAMNTO

Appendix F
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 G
Directory of Institutional Representatives

Contact Name (IR)	Institution	E-mail	Phone	Fax
Dave Littlehale	ADVENTURE - Adventure Aquarium, Camden, NJ	dlittlehale@adventureaquarium.com	(856)365-3300x7335	(856)365-3311
Lee Schoen	AUDUBON - Audubon Zoo, New Orleans, LA	lschoen@audubooninstitute.org	(504)212-5369	(504)866-0819
Alice Bender	BALTIMORE - The Maryland Zoo in Baltimore, Baltimore, MD	abender@marylandzoo.org	(443)552-3351	(410)396-6464
Holly Taylor	BATONROUG - BREC's Baton Rouge Zoo, Baker, LA	htaylor@brzoo.org	(225)775-3877x242	(225)775-3931
Robert Tomas	BRIDGEPRT - Connecticut's Beardsley Zoo, Bridgeport, CT	rtomas@beardsleyzoo.org	(203)332-2636	(203)394-6566
Michael Wells	BUSCH TAM - Busch Gardens, Tampa, FL	mike.wells@buschgardens.com	(813)987-5588	(813)987-5548
Jeff Sailer	CENTRALPK - Central Park Zoo, Bronx, NY	jsailer@wcs.org	(212)439-6502	(212)988-0286
Anne Oiler	CHICAGOBR - Chicago Zoological Park, Brookfield, IL	anne.oiler@czs.org	(708)688-8473	(708)485-3140
Martin Vince	COLUMBIA - Riverbanks Zoological Park, Columbia, SC	mvince@riverbanks.org	(803)779-8717x1159	(803)253-6381
Cindy DiGesualdo	DALLAS WA - Dallas World Aquarium, Dallas, TX	vetcindy@dwazoo.com	(214)720-2224x333	(214)720-2242
Mary Jo Willis	DENVER - Denver Zoological Gardens, Denver, CO	mjwillis@denverzoo.org	(303)376-4915	(303)376-4801
Eric Beck	EVANSVLLE - Mesker Park Zoo, Evansville, IN	ebeck@meskerparkzoo.com	(812)435-6143x404	(812)435-6140
Andy Snider	FRESNO - Chaffee Zoological Gardens of Fresno, Fresno, CA	asnider@fresnochaffeezoo.com	(559)498-5914	(559)264-9226
Hannah Bailey	HOUSTON - Houston Zoo, Inc., Houston, TX	hbailey@houstonzoo.org	(713)533-6565	(713)533-6802
Lee Ann Rottman	LOWRY - Tampa's Lowry Park Zoo, Tampa, FL	curator@lowryparkzoo.com	(813)935-8552x221	(813)930-0106
Jim Pichner	MINNESOTA - Minnesota Zoological Garden, Apple Valley, MN	jimmy.pichner@state.mn.us	(952)431-9278	(952)431-9367
Christine Sheppard	NY BRONX - Bronx Zoo/Wildlife Conservation Societ, Bronx, NY	csheppard@wcs.org	(718)220-6882	(718)733-7748
Paul Tomasonni	NZP-WASH - Smithsonian National Zoological Park, Washington, DC	tomassonip@si.edu	(202)633-3087	(202)673-4766
Julie Ensor	ORLANDO - Sea World Orlando, Orlando, FL	julie.ensor@seaworld.com	(407)363-2156	(407)363-2378
Thomas Anderson	PITTS CA - National Aviary in Pittsburgh, Pittsburgh, PA	tom.anderson@aviary.org	(412)323-7235x207	(412)321-4364
Susan Healy	SACRAMNTO - Sacramento Zoo, Sacramento, CA	shealy@cityofsacramento.org	(916)808-5013	(916)264-5887
Josef San Miguel	SAN ANTON - San Antonio Zoological Gardens & Aqua, San Antonio, TX	curbirds@sazoo-aq.org	(210)734-7184x1350	(210)734-7291
Mark Myers	SEATTLE - Woodland Park Zoological Gardens, Seattle, WA	mark.myers@zoo.org	(206)684-4836	(206)684-4854
Cyndi Laljer	SEAWLD TX - Sea World San Antonio, San Antonio, TX	cyndi.laljer@seaworld.com	(210)523-3273	(210)523-3299
Laura Arriaga	SOUTHBEND - Potawatomi Zoo, South Bend, IN	larriaga@southbendind.gov	(574)245-6162	(574)235-9080
Jennifer Evans	TRACY AV - Tracy Aviary, Salt Lake City, UT	jennifere@tracyaviary.org	(801)596-8500x24	(801)596-7325
Scott Barton	TUCSON - Reid Park Zoo, Tucson, AZ	scott.barton@tucsonaz.gov	(520)791-3204x11	(520)791-5378