

# The Influence of Environmental Contamination on Riparian Bird Populations at Tumacacori National Historical Park

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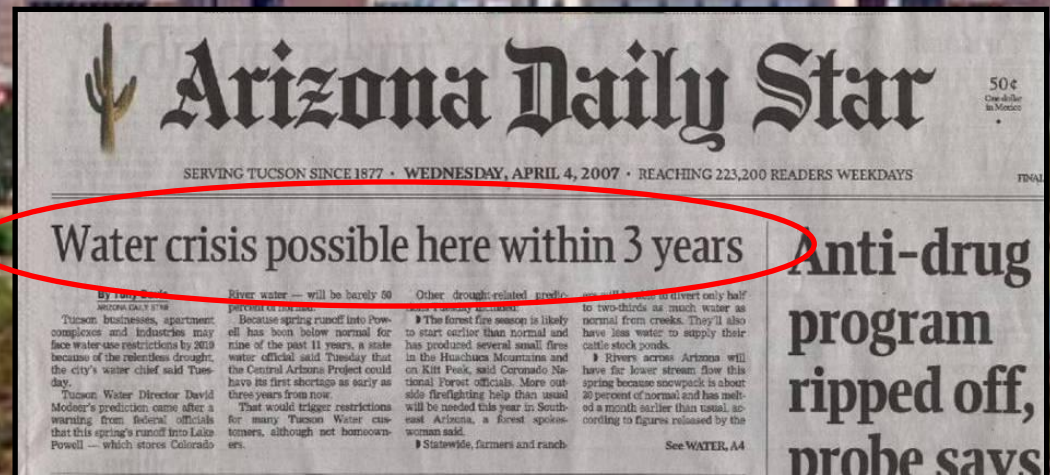
# Arizona's Riparian Woodlands



- Cover <1% of the State's landmass
- Support >50% of breeding bird species, including birds of conservation concern
- Provide critical stopover habitat for numerous species of long-distance migratory birds

# Increasing demand for limited water resources in Arizona

Population growth  
Continued drought  
Climate change





Effluent from wastewater treatment plants can provide a novel solution to diminishing water resources

The Santa Cruz River at Tumacacori National Historic Park with surface water flow restored by the Nogales International Wastewater Treatment Plant

# A Potential Problem?

Since 1997, researchers have monitored bird populations at Tumacacori National Historic Park through the MAPS program

- Signs of physical abnormalities or disease:
  - lesions around eyes/bills
  - lesions on legs/feet
  - subcutaneous tumors
  - bill deformities



Photo: Larry Norris (NPS)

Virtually no similar problems at a nearby MAPS station

# A Potential Problem?

Possible explanations for observed abnormalities:

- Birds infected with avian pox?
- Birds negatively affected by environmental contaminants?
- Interaction between environmental contaminants and disease?

# Project Objectives

At both Tumacacori NHP and a control site at Cienega Creek:

- Quantify prevalence of physical abnormalities or disease in adult and nestling birds
- Measure avian reproductive parameters
- Identify underlying causes of any observed abnormalities or disease

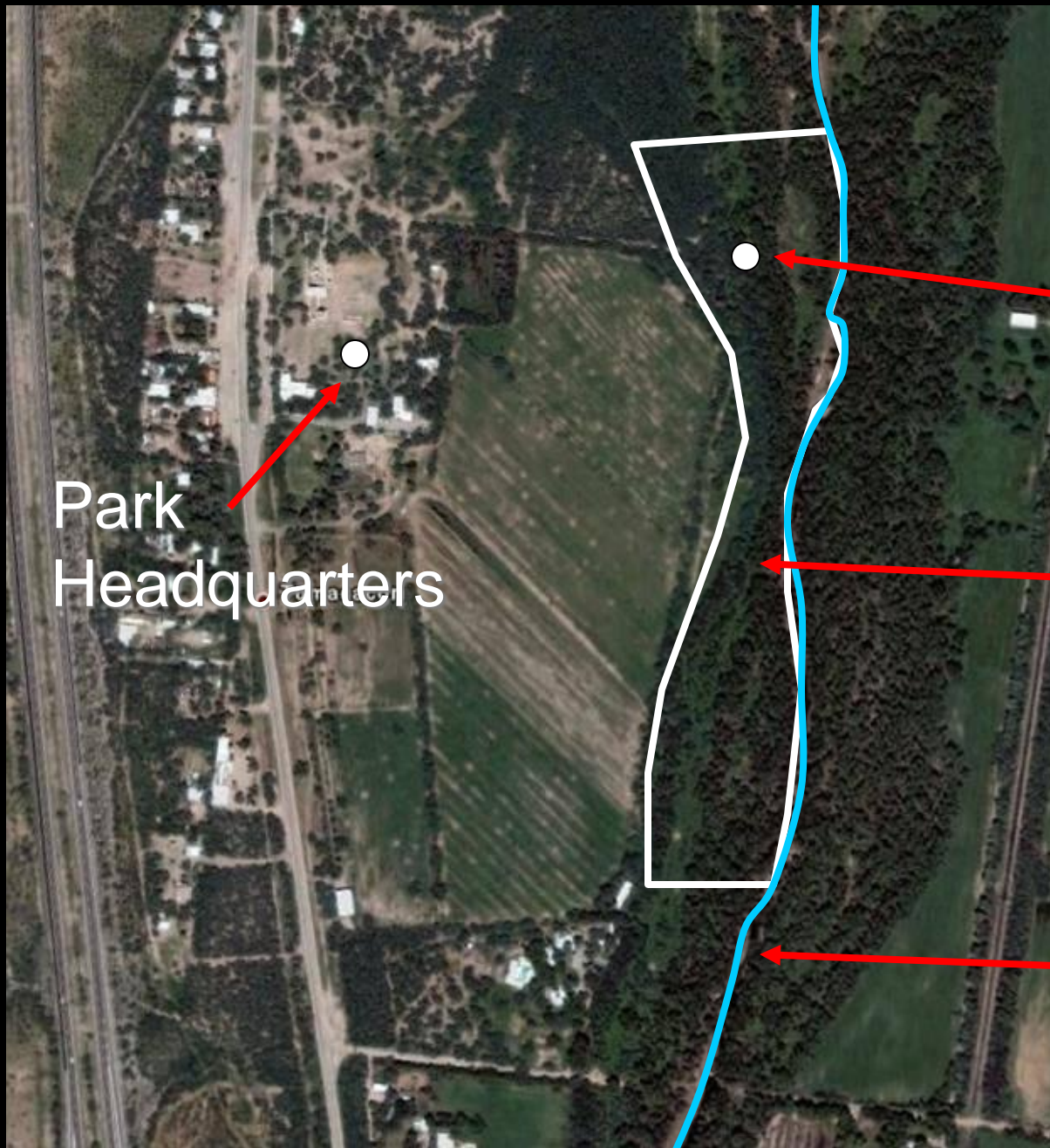


# Study Sites

Cienega Creek

Tumacacori NHP





# Tuma Site

MAPS station

nest-monitoring plot (~150 x 800 m)

Santa Cruz River

Park Headquarters

# Methods

- Nest Monitoring
  - Measure reproductive parameters
  - Conduct physical examination of nestlings
  - Collect tissue samples at nests
- Adult Birds
  - Collect tissue samples from adult birds
  - Conduct physical examinations on adult birds

# Nest Monitoring

- 2008 Located and monitored nest of all riparian bird species at both study sites
- 2009 Only located and monitored nests of 5 focal species:



# Nest Monitoring

- Measured reproductive parameters including:
  - clutch size
  - egg volume
  - hatching success
  - nestling growth rates
- Conducted physical examinations of nestlings
- Collected infertile egg and nestling feather samples



# Adult Birds

Worked with MAPS researchers at Tumacacori and target netted at both sites:

- Conducted physical examinations
- Collected blood and feather samples
- Collected skin scrapings from pox-like lesions



# Blood and Feather Analysis

- Collected 102 blood samples and >300 feather samples
- Analyzed 29 blood and feather samples for metal concentrations at Trace Elements Research Laboratory (TERL; College Station, Texas)
  - Only tested feathers for Hg (Direct Hg Analysis)
  - Tested blood for AS, Cd, Cr, Cu, Hg, Ni, Se, Pb, and Zn



# Pox Analysis

- Collected 9 skin samples from 6 species:
  - Bewick's wren
  - Yellow-breasted Chat
  - Lucy's Warbler
  - Yellow Warbler
  - Abert's Towhee
  - Hermit Thrush
- Shipped 3 best skin samples on ice to the Diagnostic Laboratory at the USGS National Wildlife Health Center (Madison, Wisconsin)



# Sediment Sampling

- Collected 5 river sediment and 5 floodplain sediment samples at each site
- Collected samples in late fall to coincide with low stream conditions
- Tested samples for AS, Cd, Cr, Cu, Hg, Ni, Se, Pb, and Zn





# Results



- Located and monitored 420 nests of 39 species including:
  - 117 Yellow-breasted chat
  - 62 Bell's vireo
  - 59 Abert's towhee
  - 24 Northern cardinal
  - 8 Song sparrow

# Results

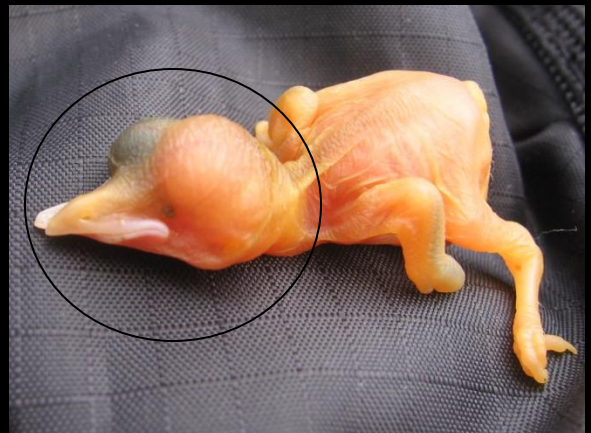
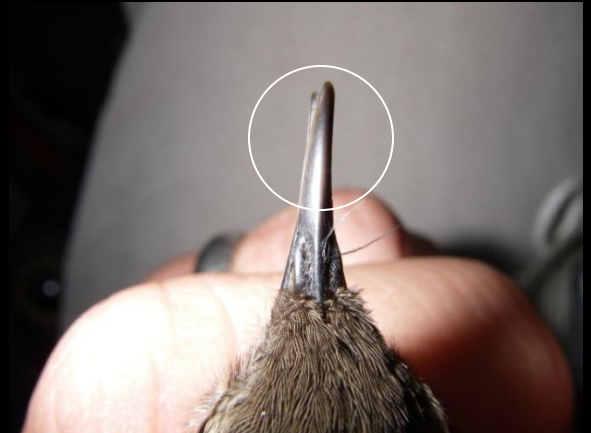


- Captured and examined 245 adult birds including:
  - 106 Yellow-breasted chat
  - 36 Bell's vireo
  - 30 Abert's towhee
  - 15 Northern cardinal
  - 10 Song sparrow



# Prevalence of Physical Abnormalities or Disease

## Examples of Deformities



# Prevalence of Physical Abnormalities or Disease

- Examined 338 nestling birds at our 2 sites
- Found physical abnormalities in 2 Yellow-breasted chat nestlings, 1 in 2009 and 1 in 2008
- 2% of Yellow-breasted Chat nestlings in 2008
- 1.7% of Yellow-breasted Chat nestlings in 2009



Abnormal



Normal

# Prevalence of Physical Abnormalities or Disease

## 2008 Adult Bird Examinations

- Found signs of physical abnormalities or disease in **11%** of adults at Tumacacori NHP
- Reduced to **4%** after accounting for deformities possibly due to injury or previous illness



# Prevalence of Physical Abnormalities or Disease

## 2009 Adult Bird Examinations

- Found signs of physical abnormalities or disease in **5%** of adults at Tumacacori NHP
- Reduced to **3%** after accounting for deformities possibly due to injury or previous disease



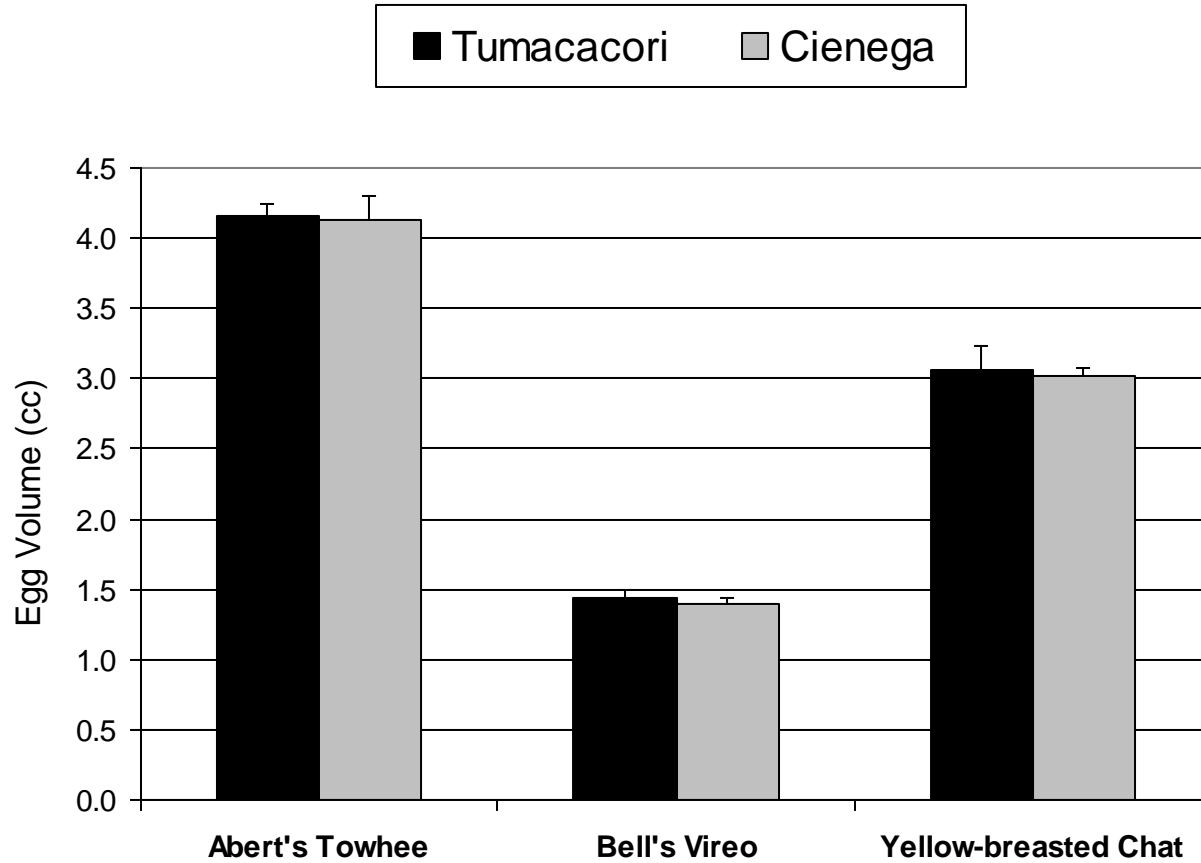
# Prevalence of Physical Abnormalities or Disease

## Avian Pox

- Samples from both 2008 and 2009 tested negative for avian pox

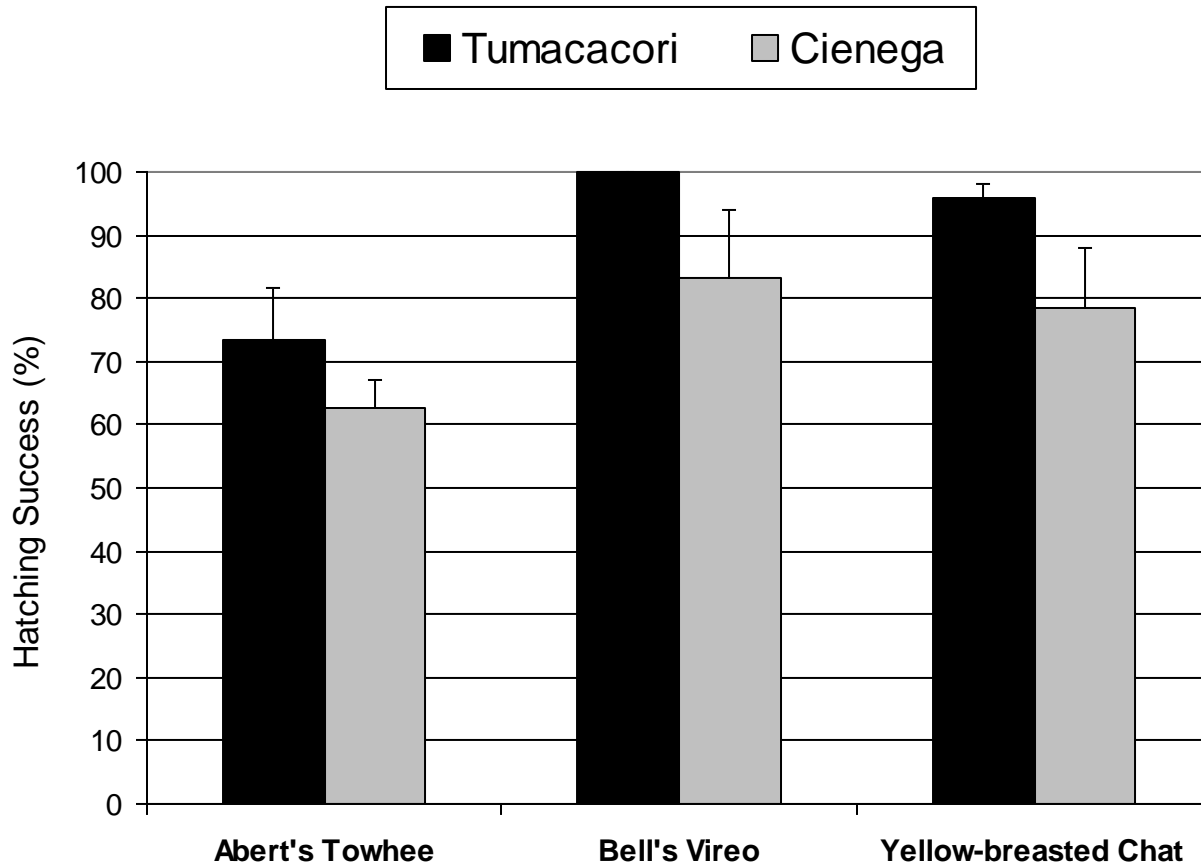


# Egg Volume





# Hatching Success



# Sediment and Soil Samples

- Higher concentrations of Cd, Cr, Pb, and Zn at Tumacacori NHP ( $P < 0.05$ )

"Metals"	River Sediment				Floodplain Soil			
	Cienega Creek	Tumacacori NHP	<i>t</i>	<i>P</i>	Cienega Creek	Tumacacori NHP	<i>t</i>	<i>P</i>
As	7.12 (1.00)	6.08 (0.57)	0.9	0.201	7.24 (0.65)	8.95 (1.19)	-1.27	0.126
<b>Cd</b>	0.04 (0.02)	1.34 (0.14)	-9.25	<b>0.000</b>	0.09 (0.01)	0.45 (0.08)	-4.46	<b>0.006</b>
<b>Cr</b>	10.50 (1.39)	9.09 (0.79)	0.88	0.206	10.85 (0.59)	13.27 (0.98)	-2.11	<b>0.036</b>
<b>Cu</b>	18.31 (2.26)	30.40 (2.26)	-3.79	<b>0.003</b>	23.06 (2.94)	49.09 (9.93)	-2.51	<b>0.027</b>
<b>Hg</b>	0.01 (0.01)	0.00 (0.00)	1.24	0.141	0.01 (0.00)	0.02 (0.01)	-2.78	<b>0.014</b>
Ni	10.52 (1.12)	9.74 (0.66)	0.6	0.285	11.30 (0.59)	11.84 (1.39)	-0.35	0.37
Se	nd	0.00 (0.00)	-	-	nd	0.00 (0.00)	-	-
<b>Pb</b>	16.54 (1.20)	20.34 (1.35)	-2.1	<b>0.034</b>	18.41 (0.97)	52.65 (15.54)	-2.35	<b>0.039</b>
<b>Zn</b>	37.06 (2.33)	64.75 (4.62)	-5.35	<b>0.001</b>	40.80 (2.61)	88.51 (13.81)	-3.4	<b>0.014</b>

# Blood and Feather Analysis

- Contaminants were generally low and similar to reference levels from uncontaminated sites
- Only small differences between the sites

# Blood and Feather Analysis

Site <sup>3</sup>	Feather	Blood									
	Hg	As	Cd	Cr	Cu	Hg	Ni	Pb	Se	Sr	Zn
<b>Abert's towhee</b>											
CIE	0.124	0.045	nd	0.059	0.131	0.032	0.045	0.024	0.605	0.051	4.02
CIE	0.979	0.038	nd	nd	0.117	0.072	0.21	0.015	1.04	0.055	4.56
Mean	<b>0.552</b>	<b>0.041</b>		<b>0.059</b>	<b>0.124</b>	<b>0.052</b>	<b>0.127</b>	<b>0.019</b>	<b>0.823</b>	<b>0.053</b>	<b>4.29</b>
(SE) <sup>4</sup>	-0.302	-0.003		0	-0.005	-0.014	-0.058	-0.003	-0.154	-0.001	-0.19
TUM	0.196	0.033	0.002	nd	0.163	0.009	0.022	0.018	0.499	0.035	4.56
TUM	0.125	0.038	0.003	nd	0.073	0.018	0.018	0.029	0.45	0.078	4.35
TUM	0.084	0.042	nd	0.031	0.114	0.038	nd	0.02	0.462	0.071	4.19
Mean	<b>0.135</b>	<b>0.038</b>	<b>0.003</b>	<b>0.031</b>	<b>0.117</b>	<b>0.021</b>	<b>0.02</b>	<b>0.022</b>	<b>0.47</b>	<b>0.062</b>	<b>4.37</b>
(SE) <sup>4</sup>	-0.033	-0.003	0	0	-0.026	-0.008	-0.002	-0.003	-0.015	-0.013	-0.11
<b>Yellow-breasted chat</b>											
CIE	-	0.06	nd	0.043	0.966	0.038	0.029	0.016	0.936	0.061	6.03
CIE	-	0.06	nd	nd	0.45	0.038	0.244	0.016	1.01	0.072	7.44
CIE	-	0.041	nd	nd	0.505	0.069	0.161	0.012	1.2	0.092	5.08
Mean		<b>0.054</b>		<b>0.043</b>	<b>0.64</b>	<b>0.048</b>	<b>0.145</b>	<b>0.015</b>	<b>1.049</b>	<b>0.075</b>	<b>6.18</b>
(SE) <sup>4</sup>		-0.006		0	-0.164	-0.01	-0.063	-0.001	-0.079	-0.009	-0.69
TUM	0.276	nd	nd	0.073	0.419	0.022	0.123	0.026	0.48	0.287	6.57
TUM	0.111	0.051	nd	0.04	0.408	0.008	0.017	0.01	0.417	0.08	5.6
TUM	-	0.05	nd	0.062	0.504	0.035	nd	0.018	0.511	0.085	5.72
TUM	-	0.035	nd	nd	0.52	0.028	0.112	0.021	0.496	0.039	7.52
TUM	0.234	-	-	-	-	-	-	-	-	-	-
TUM	0.241	-	-	-	-	-	-	-	-	-	-
Mean	<b>0.216</b>	<b>0.046</b>		<b>0.058</b>	<b>0.463</b>	<b>0.023</b>	<b>0.084</b>	<b>0.019</b>	<b>0.476</b>	<b>0.123</b>	<b>6.35</b>
(SE) <sup>4</sup>	-0.036	-0.005		-0.01	-0.029	-0.006	-0.034	-0.003	-0.021	-0.056	-0.45

# Summary

- Prevalence of physical abnormalities and signs of disease were higher than expected for wild bird populations in adult birds at Tumacacori
- River and floodplain soils had higher concentrations of contaminants at Tumacacori
- Contamination in birds was generally low for both sites
- Reproductive parameters at Tumacacori were either equal to or greater than those at our control site at Cienega Creek
- Breeding populations appear to have been healthy at Tumacacori in 2008 and 2009

# Blood and Feather Analysis

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# Future Work

- Test collected egg samples for both metals and emerging contaminants
- Test blood samples for emerging contaminants
- Resample Tumacacori after treatment plant upgrade

# Thanks To:

- Field Techs: Ann Johnson, Robert Beatson, Jake Mohlmann, Moez Ali, Jan Wilson, & Art Schaub
- Larry Norris, Wade Leitner, and the entire MAPS banding crew
- Lisa Carrico, Jeremy Moss, and the staff at Tumacacori NHP
- Kerry Baldwin (PAG)

