FINAL TECHNICAL REPORT

DOE AWARD NUMBER – DE-FG29-04SR20282

AWARDEE – CENTER OF EXCELLENCE FOR HAZARDOUS MATERIALS MANAGEMENT

PROJECT TITLE – Establish and operate the Center of Excellence in Hazardous Materials at the WIPP Site in Carlsbad, NM which will focus its activities on reducing waste streams that threaten public health along the U.S.-Mexico border

PROJECT DIRECTOR – DOUGLAS C. LYNN

CONSORTIUM/TEAMING MEMBERS – N/A

DISTRIBUTION LIMITATIONS – NONE

EXECUTIVE SUMMARY

The Center of Excellence for Hazardous Materials Management (CEHMM) was awarded $1,987,000.00 on September 3, 2004, award number DE-FG29-04SR20282. This award was used to establish the organization and initiate investigations of hazardous waste issues along the U.S.-Mexico border.

Through cooperation with Federal agencies, Texas state agencies and New Mexico state agencies data derived from the main project proved to be of significant benefit to the public. Benefits derived included research and communication (e.g, education and outreach) that were initiated by CEHMM. CEHMM maintained open communication and cooperation with state and federal regulatory agencies including national labs and universities. CEHMM has exhibited a willingness to share any information resulting from the research conducted along the U.S.-Mexico border.

Scientific investigations conducted during the execution of this grant contributed significant data and established new sampling protocols to the dimension, frequency and severity of hazardous materials (e.g., heavy metals) along the U.S.-Mexico border. Additionally, new protocols and assessments with distinct Homeland Security implications were embedded thus establishing a baseline that will be significant for related investigations in the future.

PROJECT SUMMARY

The Center of Excellence for Hazardous Materials Management (CEHMM) was awarded $1,987,000.00 on September 3, 2004, award number DE-FG29-04SR20282. This award was used to establish the organization and initiate investigations of hazardous waste issues along the U.S.-Mexico border. The project concluded September 30, 2009.

The first action under the grant was to establish CEHMM. CEHMM was formed as a 501(c)(3) not-for-profit organization. CEHMM was granted not-for-profit classification on April 22, 2005. In parallel with forming the organization a web site was developed (www.cehmm.org) to disseminate information on the progress of CEHMM and any information that pertained to the research being conducted and information on the issues that were of interest to the award. The web site continues to be maintained and updated. The information from this award will continue to be accessible at the web site.

Project dimensions included the following:

- Education
- Monitoring
- Research and Development
- Information/Technical support
- Risk Management and Policy

Information/technical support was accomplished quickly with the design and formulation of the CEHMM web site. The web site continues to be a useful tool for the organization.

Initially, education and training were examined to see if there were interests and a market to hold OSHA approved environmental, safety and health short courses in the Carlsbad, NM and El Paso TX areas. Meetings were held with the University of Texas-El Paso, New Mexico Junior College, Carlsbad Environmental Monitoring and Research Center, New Mexico State University and Texas Engineering Extension Service to pursue the educational aspect of the award. After the meetings and one OSHA class (with the help of Texas Engineering Extension Service) in Carlsbad, NM, the decision was made with the support of the DOE contracting officer to halt the education efforts due to lack of interest and need.

In response to public concerns and in alignment with the subject grant’s terms and conditions, monitoring, research and development were consolidated into one project (see attached report). This project lasted 2.5 years and provided valuable information for the border region and the scientific community at large.

Risk management and policy was not pursued due to funding constraints and the success of the biomonitoring project.

The attached report, Biomonitoring of Chihuahuan Ravens: Prevalence of Environmental Contaminants, Avian Influenza Virus, and West Nile Virus, by Dr. Marco Restani, and the CEHMM web site (www.cehmm.org) were the two items produced under this award. No license agreements, patents or patent applications were produced under the auspices of this grant.

BIOMONITORING OF CHIHUAHUAN RAVENS: PREVALENCE OF ENVIRONMENTAL CONTAMINANTS, AVIAN INFLUENZA VIRUS, AND WEST NILE VIRUS

--- Final Report ---

<u>Submitted by</u>

Marco Restani, Ph.D.

Department of Biological Sciences

St. Cloud State University

St. Cloud, MN 56301

29 September 2009

<u>Submitted to</u>

Center of Excellence for Hazardous Materials Management

505 North Main Street

Carlsbad, NM 88220

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Cover photograph: Chihuahuan ravens and American crows arriving at a large, seasonal nocturnal roost in El Paso, Texas, 2009.

ABSTRACT--The goal of this study, based on CEHMM Request For Proposals (RFP) # 002-2007 (as amended), was to collect baseline data on prevalence of environmental contaminants, West Nile Virus, and Avian Influenza in Chihuahuan ravens (*Corvus cryptoleucus)*. The study area extended from Hobbs, NM to El Paso, TX. We banded 202 ravens (101 nestlings, 101 adults) from 2007-2009. All ravens sampled for heavy metals had detectable levels of selenium in blood. Nestling ravens (n = 14) had mean ± SE ppm levels representative of background exposure (0.33 ± 03 ppm). Adult ravens (n = 36) had significantly higher mean levels (t = 7.21, df = 48, p < 0.001; test conducted on log transformed data), but which were nonetheless relatively low (0.85 ± 0.08 ppm). Only 15 of 61 (25%) ravens sampled had detectable levels of lead in blood (0.11 ± 0.01 ppm, range 0.06 – 0.23 ppm). Mercury was detected in 21 of 61 (34%) ravens sampled, and all levels in blood were very low (0.034 ± 0.003 ppm, range 0.020-0.056 ppm). PCBs within Arcolor mixtures were not detected in either nestling or adult ravens during 2007. Forty-four raven samples were analyzed for organochlorine pesticides. Twelve of 44 (27%) ravens – all adults - had detectable levels of pp-DDE in blood (range 16-270 ppb, mean 77 ± 20 ppb). Neither virus was detected in ravens (n = 170 for Avian Influenza, n = 180 for West Nile Virus). None of the contaminant levels reported were of environmental concern despite the extensive sampling conducted both across the study area and within specific regions considered at risk to pollution (e.g., El Paso).

BACKGROUND

The Center of Excellence for Hazardous Materials Management (CEHMM) in Carlsbad, New Mexico established a Biomonitoring Project in the border region of New Mexico, Texas, and Mexico in 2007. Environmental health along the U.S. – Mexico border has been a concern to residents of both countries because of the increased level of industrialization in the region following enactment of the North American Free Trade Agreement. Mexico has exercised less stringent environmental controls and enforcement than the U.S. (Carter et al. 1996). For example, the use of DDT has been banned in the U.S. for nearly 40 years, whereas Mexico produced and used more DDT in antimalaria campaigns than other Latin American country during the 1970s and 1980s, which created a significant local public health problem (Lopez-Carrillo 1996). Public health experts have urged increased monitoring of hazardous wastes and of chemical exposure in air, water, floral, and faunal resources within the border region to address these environmental concerns (Carter et al. 1996). Recent studies conducted along the border have reported contaminant levels in fish (Wainwright et al. 2001), snakes (Clark et al. 2000), raptors (Mora et al. 2002), and doves (Fredricks et al. 2009). In some individuals, levels were high and of concern.

Birds are particularly valuable indicators of environmental contamination (Beyer et al. 1996). Upper trophic level species, such as raptors and colonial waterbirds, bioaccumulate contaminants contained within terrestrial and aquatic prey and thus provide early warning of harmful environmental levels of heavy metals, organochlorines (OCs), polychlorinated biphenyls (PCBs), and organophosphates. These contaminants exhibit both sublethal and lethal effects, ranging from behavioral aberrations to widespread wildlife population declines. These compounds also continue to pose a threat to human health.

CEHMM proposed the Chihuahuan raven (*Corvus cryptoleucus*), a predatory/scavenger species that bioaccumulates toxins and pathogens, as the model organism to monitor environmental contaminants within the border region. In addition to environmental contaminants, CEHMM proposed ravens to assess prevalence of West Nile Virus and Avian Influenza. Ravens were an appropriate choice as the model organism because they 1) are a top-of-the-food-chain omnivore, thus their foraging samples a large ecological range of environmentally sensitive prey, from insects to small mammals to birds; 2) are abundant throughout different habitat types within the region; and 3) are largely non-migratory, which reduces the confounding effects of point exposure outside the U.S. and subsequent data interpretation (Bednarz and Raitt 2002).

The CEHMM Biomonitoring Project was intended to collect baseline information for a period of three years, beginning in 2007. Extending the study over multiple years was necessary to establish mean levels, and associated variation, of environmental contaminants and pathogens, and to obtain the statistical power to detect trends and distributions over the large study area. The project included several important collaborators and cooperators: the Los Alamos National Laboratory, the New Mexico Department of Agriculture's Veterinary Diagnostic Services, and the California Animal Health and Food Safety Laboratory (University of California-Davis). The New Mexico Game and Fish Department, Texas Parks and Wildlife, and the U.S.G.S. Bird Banding Laboratory (Patuxent Wildlife Research Center) permitted field activities and sample collections. The project was conducted through the Department of Biological Sciences, St. Cloud State University (SCSU), Minnesota.

The goal of this study, based on CEHMM Request For Proposals (RFP) # 002-2007 (as amended), was to collect baseline data on prevalence of environmental contaminants, West Nile Virus, and Avian Influenza. Non-destructive sampling of ravens was advocated for the following contaminants: heavy metals (lead, mercury, and selenium), organophosphates (indicated by cholinesterase activity), organochlorine pesticides (OCs), and polychlorinated biphenyl compounds (PCBs). Specific RFP requirements/objectives included:

- locate and sample raven nestlings from not less than 15 nests
- sample ravens for contaminants and viruses
- band ravens and submit banding reports
- prepare scientific publications.

This report summarizes field data collected during the 2007-2009 calendar years. See Restani (2008, 2009) for earlier results and interpretations from the 2007 and 2008 field seasons, respectively.

STUDY AREA and METHODS

The study area extended along a corridor from near Hobbs, New Mexico through the greater Carlsbad area (Los Medanos), south to Dell City, Texas, and west to El Paso, Texas (Fig. 1). All field efforts were confined to the U.S. During 2007-2009, field work extended throughout the calendar year and was focused near Carlsbad, Eunice, Sierra Blanca, Dell City, and El Paso. My assistants and I searched suitable raven habitat for stick nests beginning in April (Fuller and Mosher 1987). Nests were located from a distance with a spotting scope or with the use of a mirror pole (Fig. 2), and locations were plotted with a handheld Global Positioning System (UTM, NAD 27). We did not search for nests at midday, when temperatures commonly exceeded 35°C, or during inclement weather, so as to reduce egg and nestling exposure (Grier and Fyfe 1987). Nest activity and chronology were established by use of a mirror pole. We returned to nests once after eggs hatched when young were 3-5 weeks old to collect samples (blood, oral-pharyngeal and cloacal swabs – see below) for analyses and to band young. Young ravens were returned to nests following sampling, which averaged 30 minutes and sampling nestlings typically took place from late June to early July.

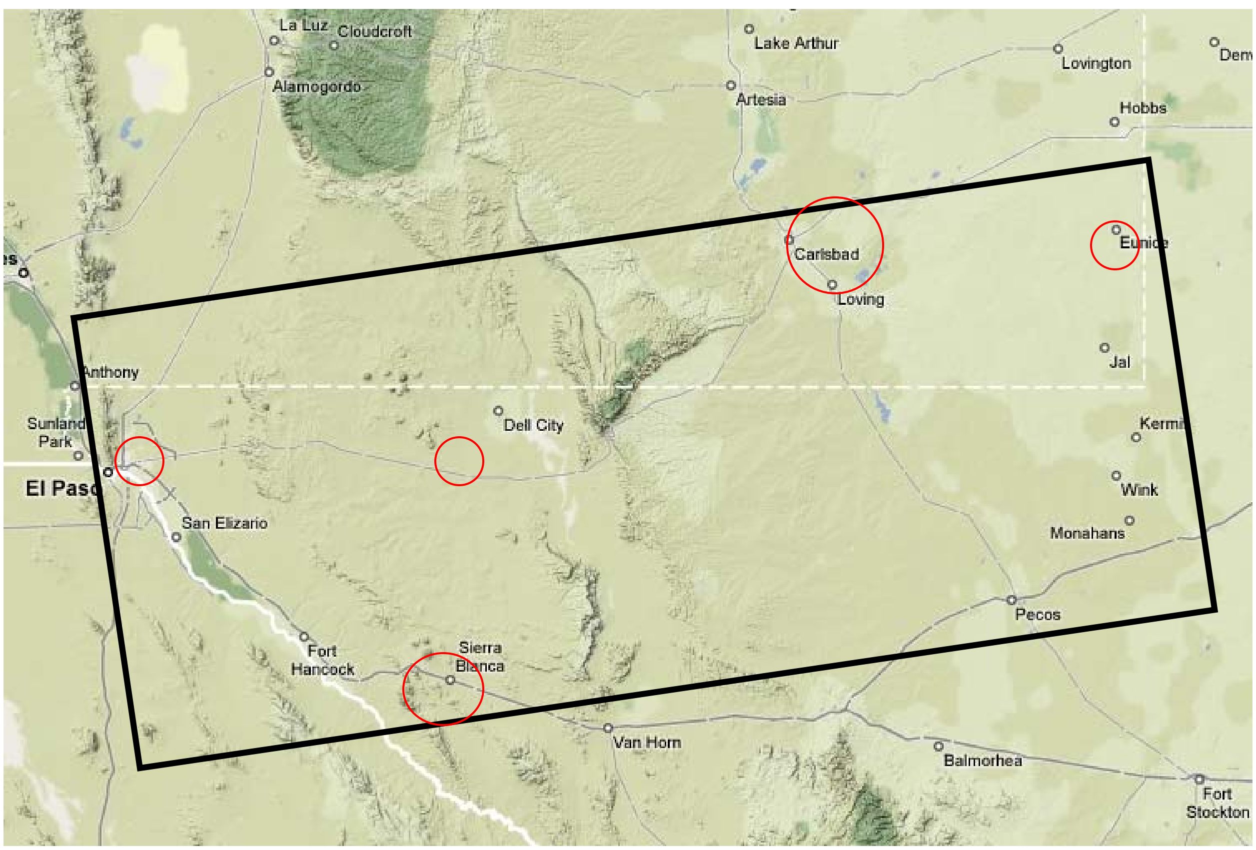

Figure 1. Approximate location of the study area corridor along the border region of the U.S. and Mexico, 2007-2009. Red circles identify areas where most raven sampling occurred (circle size represents relative sampling effort).

A)

Figure 2. A) Locating raven nests with the aid of a mirror pole. B) A brood of raven nestlings nearing fledging age.

B)

We used a remotely-triggered net launcher (Coda Enterprises, Inc.) to capture free-flying ravens attracted to garbage bait at municipal landfills (Fig. 3) and nocturnal roosts (Caffrey 2001). We collected samples (blood, oral-pharyngeal and cloacal swabs) and banded captured ravens, which were released at the site of capture within one hour. Trapping for ravens occurred in January, February, April, June, July, November, and December.

Figure 3. The capture of 15 Chihuahuan ravens a the Eunice, New Mexico, landfill. Arrow indicates the location of the net launcher.

We used a heparinized 25-gauge needle and 6 cc syringe to collect approximately 3 cc of blood from the brachial vein of nestling and free-flying ravens following standard sterile field procedures (see Harmata and Restani 1996, Miller et al. 1998) (Fig. 4). Oral-pharyngeal (Avian Influenza) and cloacal (West Nile Virus) swabs were also collected following procedures established by the U.S.G.S. National Wildlife Health Laboratory (*http://www.nwhc.usgs.gov/disease _ information/avian_influenza/2007%20NWHC%20Protocol%20Combined%20OP%20&% 20CL%20Swabs%20v5-29-07.pdf*; Fig. 4). To ensure the well-being of field biologists, we followed recommendations for human health safety practices established by the U.S.G.S. Bird Banding Laboratory in conjunction with the Centers for Disease Control and Prevention (*http://www.doi.gov/issues/appendixOHSguidanceforAvian%20Influenza12-18.pdf* and *http://www.nwhc.usgs.gov/publications/wildlife_health_bulletins/WHB_05_03.jsp*). All ravens were banded prior to release (Fig. 5).

A)

B)

Figure 4. Collecting biological samples from a Chihuahuan raven captured at the Sierra Blanca, Texas landfill. A) Drawing blood for environmental contaminants. B) Swabbing cloaca for West Nile Virus.

Laboratory analyses of environmental contaminants (heavy metals, OCs, PCBs) and cholinesterase activity (to assess organophosphate and carbamate exposure) were conducted in the California Animal Health and Food Safety Laboratory by Dr. Robert Poppenga (University of California-Davis). Metals in blood samples were analyzed after the samples were prepared by Nitric Acid digestion in open vessel heating blocks. After digestion, samples were diluted into another dilute acid solution and analyzed by Inductively Coupled Plasma Optical Emission Spectrometry (ICP-OES).

PCBs in blood samples were identified via Arcolor analyses. Arcolors were common commercial mixtures of PCB congeners, and were an appropriate metric for this study, which was in the preliminary stages of risk assessment (Bernhard and Petron 2001). PCBs were first extracted into an ethanol:ethyl acetate solvent mixture, and sample extracts were then run through a Florisil column. PCBs were identified according to Aroclor mixture. Identification was made by comparing chromatograms of sample extracts with the chromatograms produced by standards. Analyses were performed utilizing Gas Chromatography coupled with a Mass Selective Detector.

Figure 5. Marking a Chihuahuan raven with a U.S. Geological Service band prior to release.

PCBs were not detected in any samples from 2007, so in 2008-2009 we had the laboratory screen for a number of organochlorines pesticides (Appendix, Table 1). Organochlorine pesticide sample preparation, for serum or plasma samples, consisted of liquid/solid extraction using solid phase extraction (SPE) cartridges after the addition of urea to each sample. Isotopically labeled internal standards were added to each sample. Organochlorine pesticides were then analyzed using gas chromatography with mass spectrometric detection (GC-MSD) and quantitated by isotope dilution.

Cholinesterase in blood serum was analyzed by the classic Ellman method, which is an enzyme kinetic, spectrophotometric method. Cholinesterase enzyme present in the sample hydrolyzed acetylthiocholine to thiocholine. Thiocholine reacted with 5,5′-dithiobis-2-nitrobenzoic acid (DTNB) to produce a yellow color. The rate of color production was measured at 405 nm using a Microplate Reader. Activity of the cholinesterase was expressed in micromoles of acetylthiocholine hydrolyzed per mL (blood) of sample per minute.

Oral-pharyngeal swab samples were collected to monitor Avian Influenza (H5 and H7 subtypes) in collaboration with Dr. Flint Taylor of the New Mexico Department of Agriculture's Veterinary Diagnostic Services (Albuquerque). Because of the very low probability of detecting Avian Influenza, samples were pooled into groups of five for analyses. A PCR assay was run to detect either H5 or H7 subtypes within pooled samples.

Cloacal swabs (PCR test) and blood samples (for ELISA antibody tests) were sent to Dr. Jeanne Fair, Los Alamos National Laboratories, for West Nile Virus analyses. Positive samples were verified with a crow (*C. brachyrhynchos*) from a West Nile Virus infection study at Colorado State University.

With the exception of selenium, environmental contaminants were detected in fewer than 50% of raven samples (range 0-34%, depending on the analysis). Therefore, I followed the statistical guidelines of Helsel (1990:1772) and have presented only summary statistics.

RESULTS and DISCUSSION

My field assistants and I began surveys for raven nests in April 2007, one month after contract paperwork had been approved by CEHMM and St. Cloud State University. All field work was completed by August 2009. In general, we surveyed the extensive study area in sections, focusing on specific areas during specific years, generally working from east (Hobbs and Eunice, NM) to west (Dell City, Sierra Blanca and El Paso, TX) (Table 1).

Table 1. General field work schedule. New Mexico study areas included Eunice and the greater Carlsbad region. Texas study areas included the greater Dell City region, Sierra Blanca, and El Paso. Much effort was also expended surveying the Route 62/180 corridor and the I-10 corridor for nestling and congregating adult ravens.

	2007	**2008**	**2009**
January			Adult sampling – TX
February			Adult sampling – TX
March	PROJECT START	Nest surveys – TX	Nest survey – TX
April	Nest surveys – NM		Adult sampling – TX
May	Nest surveys – NM		
June	Nestling sampling – NM	Nestling sampling – TX	Nestling sampling – TX
July	Nestling sampling – NM	Nestling sampling – TX	Nestling sampling – TX
August		Adult sampling – TX	Adult sampling – TX
September		Adult sampling – TX	PROJECT END
October			
November	Adult sampling – NM	Adult sampling – TX	
December	Adult sampling – NM	Adult sampling – TX	

We banded 202 ravens (101 nestlings, 101 adults). Number of ravens banded varied by location: Carlsbad (n = 81), Eunice (n = 25), Dell City (n = 22), Sierra Blanca (n = 48), and El Paso (n = 26). Sixty one ravens were sampled for elements (heavy metals), 44 for OCs, 11 for PCBs, and 65 for cholinesterase. We sampled 180 ravens for West Nile Virus and 170 for Avian Influenza.

All ravens sampled for heavy metals had detectable levels of selenium (Appendix, Table 3). Combining data from 2007-2009, nestling ravens (n = 14) had mean ± SE ppm levels representative of background exposure (0.33 ± 03 ppm) (Fig. 6). Adult ravens (n = 36) had significantly (t = 7.21, df = 48, $p < 0.001$; test conducted on log transformed data) higher mean levels (0.85 ± 0.08 ppm), but which were nonetheless relatively low and probably not of concern. Source of selenium found in raven blood remained unknown but probably included the metal dissolving naturally from local soils. Other common sources of selenium in the U.S. that were not observed on the study area were sewage sludge, fly ash, and emissions from smelters. Egg and liver tissue concentrations of selenium were the best predictors of harm to birds (Heinz 1996), but given the low levels currently observed in Chihuahuan ravens, destructive sampling of ravens to analyze eggs or livers is unwarranted.

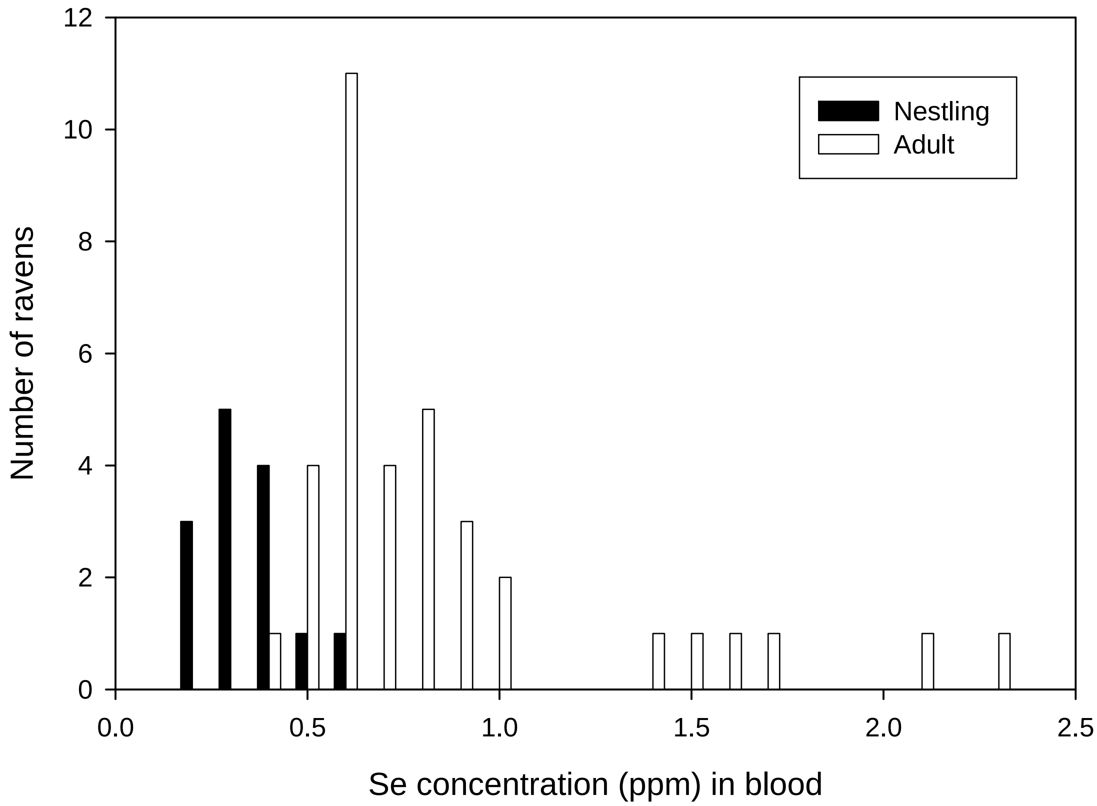

Figure 6. Distribution of selenium (ppm) concentrations in blood by raven age group.

Only 15 of 61 (25%) ravens sampled had detectable levels of lead in blood, and these levels were quite low given toxicity reported in the literature (Franson 1996). Mean ± SE ppm level was 0.11 ± 0.01 (range 0.06 – 0.23 ppm). Only adults had detectable levels. Sources of lead on the study area remained unknown. Recent scientific investigations have focused on the role of lead fragments from bullets and shot in environmental contamination (Fisher et al. 2006). The possibility existed that ravens may have ingested lead by scavenging small game wounded or killed during sport hunting but which went unrecovered in the field.

Mercury was detected in 21 of 61 (34%) ravens sampled, and all levels were very low (range 0.020-0.056 ppm). Mean ± SE ppm level was 0.034 ± 0.003 in blood. As with lead, mercury was detected only in adult ravens. At present, mercury contamination was not of concern.

PCBs within Arcolor mixtures were not detected in either nestling or adult ravens during 2007 and we did not repeat analyses in 2008. Instead, we analyzed 44 raven samples for organochlorine pesticides (Appendix, Table 1). Twelve of 44 (27%) ravens – all adults - had detectable levels of pp-DDE (range 16-270 ppb, mean 77 ± 20 ppb). Pesticide levels were generally low and not of concern. Raw data for all contaminant levels has been provided in Appendix, Tables 3-5.

It will be difficult to ascertain the exact relevance of cholinesterase levels in Chihuahuan ravens in southeastern New Mexico because standards for the species and area have not been established. A laboratory study run in conjunction with this field study would provide interpretative power, but given that cholinesterase activity was generally low (Appendix, Table 6) compared to published values for other species, exposure to organophosphates and carbamates on the study area is low and not of immediate concern.

Despite testing 170 ravens for the H5 and H7 subtypes of Avian Influenza and 180 ravens for West Nile Virus, neither virus detected in nestling or adult ravens from 2007-2009. The result for West Nile Virus was encouraging because over 125 humans tested positive in Texas, including in El Paso county (http://www.dshs.state.tx.us/idcu/disease/arboviral/westNile/), and over 10 humans tested positive for West Nile Virus in several southern counties of New Mexico (http://www.health.state.nm.us/epi/wnv.html).

In conclusion, none of the contaminant levels reported from this study are of environmental concern despite the extensive sampling we conducted both across the study area and within specific regions considered at risk to pollution (e.g., El Paso). It is difficult to generalize the findings from other studies conducted along the Texas – Mexico border; some found high levels of environmental contaminants (e.g., Mora et al. 2006), whereas others did not (e.g., Fredricks et al. 2009). Therefore, it might be prudent to continue sampling, but only at 3-5 year intervals. Missing from our study is a determination of raven habitat use, thus collecting data of raven movements via telemetry would provide additional insight into linkages between Texas and Mexico.

ACKNOWLEDGMENTS

D. Lynn at CEHMM provided the impetus to develop this study, and without his foresight and effort none of this work would have been possible. M. Davies, G. Doney, J. Frye, E. Lynn, M. Mathis, and J. O'Connell provided dedicated field assistance. The following individuals and organizations generously offered useful background information and kindly granted land access: F. Armstrong, L. Balin, R. Beard, L. Blakely, R. Brantly, S. Brooks, R. Carpenter, G. Dees, G. Gilmore, R. Johnson, A. Ortiz, R. Rakes, J. Sproul, and M. Sumner. K. Etheridgehill, J. Fair, G. Jillson, R. Poppenga, and F. Taylor facilitated laboratory analyses and provided helpful data interpretation. K. Mower supported our Avian Influenza sampling in New Mexico. G. Brown (CEHMM), L. Donnay (SCSU), M. McKenzie (SCSU), and S. Stokum (CEHMM) kindly administered the contract and provided office support. The SCSU Institutional Animal Care and Use Committee approved field procedures through permits to M. Restani (Federal: # 22513, New Mexico: #3358 Texas: #SPR-0707-1397).

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Appendix
(Tables 1-6)

Table 1. List of screened organochlorines pesticides.

Analyte	Reporting Limit (ppb except op-DDE)
alpha-BHC	5
HCB (hexachlorobenzene)	5
bamma-BHC (Lindane)	5
Heptachlor	5
Aldrin	5
Dicofol	5
Heptachlor Epoxide	5
op-DDE (ppm)	10
Chlordane (cis and trans)	5
Endosulfan I	5
trans-Nonachlor	5
Dieldrin	5
pp-DDE	10
op-DDD	10
Endrin	5
op-DDT	10
cis-Nonachlor	5
pp-DDD	5
pp-DDT	10
Methoxychlor	10
Mirex	5

Table 2. Summary of banding data of Chihuahuan ravens in New Mexico and Texas, 2007-2009.

Band number	Sampling location	Sampling date	Zone	UTM E	UTM N
1045-79001	Nest 47	31-May-07	13 S	628377	3630333
1045-79002	Nest 47	31-May-07	13 S	628377	3630333
1045-79003	Nest 47	31-May-07	13 S	628377	3630333
1045-79004	Nest 47	31-May-07	13 S	628377	3630333
1045-79005	Nest 47	31-May-07	13 S	628377	3630333
1045-79006	Nest 47	31-May-07	13 S	628377	3630333
1045-79007	Nest 8	26-Jun-07	13 S	607642	3599390
1045-79008	Nest 8	26-Jun-07	13 S	607642	3599390
1045-79009	Nest 8	26-Jun-07	13 S	607642	3599390
1045-79010	Nest 8	26-Jun-07	13 S	607642	3599390
1045-79011	Nest 8	26-Jun-07	13 S	607642	3599390
1045-79012	Nest 13	26-Jun-07	13 S	634101	3601172
1045-79013	Nest 13	26-Jun-07	13 S	634101	3601172
1045-79014	Nest 13	26-Jun-07	13 S	634101	3601172
1045-79015	Nest 13	26-Jun-07	13 S	634101	3601172
1045-79016	Nest 13	26-Jun-07	13 S	634101	3601172
1045-79017	Nest 5	26-Jun-07	13 S	633962	3601455
1045-79018	Nest 5	26-Jun-07	13 S	633962	3601455
1045-79019	Nest 5	26-Jun-07	13 S	633962	3601455
1045-79020	Nest 47	26-Jun-07	13 S	633962	3601455
1045-79021	Nest 16	27-Jun-07	13 S	633817	3600100
1045-79022	Nest 16	27-Jun-07	13 S	633817	3600100
1045-79023	Nest 16	27-Jun-07	13 S	633817	3600100
1045-79024	Nest 16	27-Jun-07	13 S	633817	3600100
1045-79025	Nest 10	27-Jun-07	13 S	628880	3597491
1045-79026	Nest 10	27-Jun-07	13 S	628880	3597491
1045-79027	Nest 10	27-Jun-07	13 S	628880	3597491
1045-79028	Nest 9	27-Jun-07	13 S	630378	3601918
1045-79029	Nest 9	27-Jun-07	13 S	630378	3601918
1045-79030	Nest 9	27-Jun-07	13 S	630378	3601918
1045-79031	Nest 30	29-Jun-07	13 S	615668	3641509
1045-79032	Nest 30	29-Jun-07	13 S	615668	3641509
1045-79033	Nest 32	29-Jun-07	13 S	614514	3641957
1045-79034	Nest 32	29-Jun-07	13 S	614514	3641957
1045-79035	Nest 32	29-Jun-07	13 S	614514	3641957
1045-79036	Nest 32	29-Jun-07	13 S	614514	3641957
1045-79037	Nest 34	29-Jun-07	13 S	614135	3641817
1045-79038	Nest 34	29-Jun-07	13 S	614135	3641817
1045-79039	Nest 55	30-Jun-07	13 S	612827	3648400
1045-79040	Nest 55	30-Jun-07	13 S	612827	3648400

1045-79041	Nest 55	30-Jun-07	13 S	612827	3648400
1045-79042	Nest 35	30-Jun-07	13 S	617253	3642221
1045-79043	Nest 35	30-Jun-07	13 S	617253	3642221
1045-79044	Nest 35	30-Jun-07	13 S	617253	3642221
1045-79045	Nest 35	30-Jun-07	13 S	617253	3642221
1045-79046	Nest 35	30-Jun-07	13 S	617253	3642221
1045-79047	Nest 44	01-Jul-07	13 S	618868	3640611
1045-79048	Nest 44	01-Jul-07	13 S	618868	3640611
1045-79049	Nest 58	01-Jul-07	13 S	617931	3640637
1045-79050	Nest 16	27-Jun-07	13 S	633817	3600100
1045-79051	Nest 32	29-Jun-07	13 S	614514	3641957
1045-79052	Nest 55	30-Jun-07	13 S	612827	3648400
1045-79053	Nest 44	01-Jul-07	13 S	618868	3640611
1045-79054	Nest 58	01-Jul-07	13 S	617931	3640637
1045-79055	Nest 37	01-Jul-07	13 S	617931	3640637
1045-79056	Nest 36	01-Jul-07	13 S	617737	3641166
1045-79057	Nest 20	02-Jul-07	13 S	629933	3601037
1045-79058	Nest 22	02-Jul-07	13 S	629011	3601367
1045-79059	Nest 23	02-Jul-07	13 S	627066	3600657
1045-79060	Nest 61	04-Jul-07	13 S	648988	3617613
1045-79061	Nest 64	04-Jul-07	13 S	664622	3614918
1045-79062	Nest 67	06-Jul-07	13 S	657028	3593932
1045-79063	Eunice, NM landfill	09-Nov-07	13 S	681024	3589533
1045-79064	Eunice, NM landfill	09-Nov-07	13 S	681024	3589533
1045-79065	Eunice, NM landfill	10-Nov-07	13 S	681024	3589533
1045-79066	Eunice, NM landfill	10-Nov-07	13 S	681024	3589533
1045-79067	Eunice, NM landfill	10-Nov-07	13 S	681024	3589533
1045-79068	Eunice, NM landfill	10-Nov-07	13 S	681024	3589533
1045-79069	Eunice, NM landfill	10-Nov-07	13 S	681024	3589533
1045-79070	Eunice, NM landfill	10-Nov-07	13 S	681024	3589533
1045-79071	Nest 37	01-Jul-07	13 S	617931	3640637
1045-79072	Nest 37	01-Jul-07	13 S	617931	3640637
1045-79073	Nest 36	01-Jul-07	13 S	617737	3641166
1045-79074	Nest 36	01-Jul-07	13 S	617737	3641166
1045-79075	Nest 36	01-Jul-07	13 S	617737	3641166
1045-79076	Nest 20	02-Jul-07	13 S	629933	3601037
1045-79077	Nest 20	02-Jul-07	13 S	629933	3601037
1045-79078	Nest 22	02-Jul-07	13 S	629011	3601367
1045-79079	Nest 22	02-Jul-07	13 S	629011	3601367
1045-79080	Nest 23	02-Jul-07	13 S	627066	3600657
1045-79081	Nest 23	02-Jul-07	13 S	627066	3600657
1045-79082	Nest 61	04-Jul-07	13 S	648988	3617613
1045-79083	Nest 61	04-Jul-07	13 S	648988	3617613

1045-79084	Nest 64	04-Jul-07	13 S	664622	3614918
1045-79085	Nest 64	04-Jul-07	13 S	664622	3614918
1045-79086	Nest 67	06-Jul-07	13 S	657028	3593932
1045-79087	Nest 67	06-Jul-07	13 S	657028	3593932
1045-79088	Nest 68	06-Jul-07	13 S	653838	3593864
1045-79089	Eunice, NM landfill	27-Dec-07	13 S	681024	3589533
1045-79090	Eunice, NM landfill	27-Dec-07	13 S	681024	3589533
1045-79091	Eunice, NM landfill	27-Dec-07	13 S	681024	3589533
1045-79092	Eunice, NM landfill	27-Dec-07	13 S	681024	3589533
1045-79093	Eunice, NM landfill	27-Dec-07	13 S	681024	3589533
1045-79094	Eunice, NM landfill	27-Dec-07	13 S	681024	3589533
1045-79095	Eunice, NM landfill	27-Dec-07	13 S	681024	3589533
1045-79096	Eunice, NM landfill	27-Dec-07	13 S	681024	3589533
1045-79097	Eunice, NM landfill	27-Dec-07	13 S	681024	3589533
1045-79098	Eunice, NM landfill	27-Dec-07	13 S	681024	3589533
1045-79099	Eunice, NM landfill	27-Dec-07	13 S	681024	3589533
1045-79100	Eunice, NM landfill	27-Dec-07	13 S	681024	3589533
1045-79101	Eunice, NM landfill	27-Dec-07	13 S	681024	3589533
1045-79102	Eunice, NM landfill	28-Dec-07	13 S	681024	3589533
1045-79103	Eunice, NM landfill	28-Dec-07	13 S	681024	3589533
1045-79104	Eunice, NM landfill	28-Dec-07	13 S	681024	3589533
1045-79105	Nest 1	29-Jun-08	13R	421553	3523609
1045-79106	Sierra Blanca, TX Landfill	30-Jun-08	13R	465510	3443475
1045-79107	Sierra Blanca, TX Landfill	30-Jun-08	13R	465510	3443475
1045-79108	Sierra Blanca, TX Landfill	30-Jun-08	13R	465510	3443475
1045-79109	Sierra Blanca, TX Landfill	30-Jun-08	13R	465510	3443475
1045-79110	Eunice, NM landfill	27-Dec-07	13 S	681024	3589533
1045-79111	Sierra Blanca, TX Landfill	30-Jun-08	13R	465510	3443475
1045-79112	Sierra Blanca, TX Landfill	30-Jun-08	13R	465510	3443475
1045-79113	Sierra Blanca, TX Landfill	30-Jun-08	13R	465510	3443475
1045-79114	Sierra Blanca, TX Landfill	30-Jun-08	13R	465510	3443475
1045-79115	Sierra Blanca, TX Landfill	30-Jun-08	13R	465510	3443475
1045-79116	Nest 2	01-Jul-08	13R	460294	3515056
1045-79117	Nest 2	01-Jul-08	13R	460294	3515056
1045-79118	Sierra Blanca, TX Landfill	02-Jul-08	13R	465510	3443475
1045-79119	Sierra Blanca, TX Landfill	02-Jul-08	13R	465510	3443475
1045-79120	Sierra Blanca, TX Landfill	02-Jul-08	13R	465510	3443475
1045-79121	Sierra Blanca, TX Landfill	02-Jul-08	13R	465510	3443475
1045-79122	Sierra Blanca, TX Landfill	02-Jul-08	13R	465510	3443475
1045-79123	Sierra Blanca, TX Landfill	02-Jul-08	13R	465510	3443475
1045-79124	Sierra Blanca, TX Landfill	02-Jul-08	13R	465510	3443475
1045-79125	Sierra Blanca, TX Landfill	02-Jul-08	13R	465510	3443475
1045-79126	Sierra Blanca, TX Landfill	02-Jul-08	13R	465510	3443475

1045-79127	El Paso, TX City Park	08-Dec-08	13R	374773	3502106
1045-79128	El Paso, TX City Park	08-Dec-08	13R	374773	3502106
1045-79129	El Paso, TX City Park	08-Dec-08	13R	374773	3502106
1045-79130	El Paso, TX City Park	08-Dec-08	13R	375386	3502230
1045-79131	El Paso, TX City Park	08-Dec-08	13R	375386	3502230
1045-79132	El Paso, TX City Park	08-Dec-08	13R	375386	3502230
1045-79133	El Paso, TX City Park	08-Dec-08	13R	375386	3502230
1045-79134	El Paso, TX City Park	08-Dec-08	13R	375386	3502230
1045-79135	El Paso, TX City Park	08-Dec-08	13R	375386	3502230
1045-79136	El Paso, TX City Park	08-Dec-08	13R	375386	3502230
1045-79137	El Paso, TX City Park	09-Dec-08	13R	375386	3502230
1045-79138	El Paso, TX City Park	09-Dec-08	13R	375386	3502230
1045-79139	El Paso, TX City Park	09-Dec-08	13R	375386	3502230
1045-79140	El Paso, TX City Park	09-Dec-08	13R	375386	3502230
1045-79141	El Paso, TX City Park	09-Dec-08	13R	375386	3502230
1045-79142	El Paso, TX City Park	09-Dec-08	13R	375386	3502230
1045-79143	El Paso, TX City Park	09-Dec-08	13R	374773	3502106
1045-79144	El Paso, TX City Park	09-Dec-08	13R	374773	3502106
1045-79145	El Paso, TX City Park	09-Dec-08	13R	374773	3502106
1045-79146	El Paso, TX City Park	29-Jan-09	13R	374773	3502106
1045-79147	El Paso, TX City Park	29-Jan-09	13R	374773	3502106
1045-79148	El Paso, TX City Park	31-Jan-09	13R	374773	3502106
1045-79149	El Paso, TX City Park	31-Jan-09	13R	374773	3502106
1045-79150	El Paso, TX City Park	31-Jan-09	13R	374773	3502106
1045-79151	El Paso, TX City Park	31-Jan-09	13R	374773	3502106
1045-79152	El Paso, TX City Park	01-Feb-09	13R	374773	3502106
1045-79153	Sierra Blanca, TX Landfill	09-Apr-09	13R	465510	3443475
1045-79154	Sierra Blanca, TX Landfill	09-Apr-09	13R	465510	3443475
1045-79155	Sierra Blanca, TX Landfill	09-Apr-09	13R	465510	3443475
1045-79156	Sierra Blanca, TX Landfill	09-Apr-09	13R	465510	3443475
1045-79157	Sierra Blanca, TX Landfill	09-Apr-09	13R	465510	3443475
1045-79158	Sierra Blanca, TX Landfill	09-Apr-09	13R	465510	3443475
1045-79159	Sierra Blanca, TX Landfill	09-Apr-09	13R	465510	3443475
1045-79160	Sierra Blanca, TX Landfill	09-Apr-09	13R	465510	3443475
1045-79161	Sierra Blanca, TX Landfill	09-Apr-09	13R	465510	3443475
1045-79162	Sierra Blanca, TX Landfill	09-Apr-09	13R	465510	3443475
1045-79163	Sierra Blanca, TX Landfill	09-Apr-09	13R	465510	3443475
1045-79164	Sierra Blanca, TX Landfill	09-Apr-09	13R	465510	3443475
1045-79165	Sierra Blanca, TX Landfill	09-Apr-09	13R	465510	3443475
1045-79166	Sierra Blanca, TX Landfill	09-Apr-09	13R	465510	3443475
1045-79167	Sierra Blanca, TX Landfill	10-Apr-09	13R	465510	3443475
1045-79168	Sierra Blanca, TX Landfill	10-Apr-09	13R	465510	3443475
1045-79169	Sierra Blanca, TX Landfill	10-Apr-09	13R	465510	3443475

1045-79170	Sierra Blanca, TX Landfill	10-Apr-09	13R	465510	3443475
1045-79171	Sierra Blanca, TX Landfill	10-Apr-09	13R	465510	3443475
1045-79172	Sierra Blanca, TX Landfill	10-Apr-09	13R	465510	3443475
1045-79173	Sierra Blanca, TX Landfill	10-Apr-09	13R	465510	3443475
1045-79174	Sierra Blanca, TX Landfill	10-Apr-09	13R	465510	3443475
1045-79175	Sierra Blanca, TX Landfill	10-Apr-09	13R	465510	3443475
1045-79176	Sierra Blanca, TX Landfill	10-Apr-09	13R	465510	3443475
1045-79177	Sierra Blanca, TX Landfill	10-Apr-09	13R	465510	3443475
1045-79178	Sierra Blanca, TX Landfill	11-Apr-09	13R	465510	3443475
1045-79179	Sierra Blanca, TX Landfill	11-Apr-09	13R	465510	3443475
1045-79180	Sierra Blanca, TX Landfill	11-Apr-09	13R	465510	3443475
1045-79181	Sierra Blanca, TX Landfill	11-Apr-09	13R	465510	3443475
1045-79182	Sierra Blanca, TX Landfill	11-Apr-09	13R	465510	3443475
1045-79183	Nest 1	27-Jun-09	13R	438725	3519611
1045-79184	Nest 1	28-Jun-09	13R	438725	3519611
1045-79185	Nest 1	28-Jun-09	13R	438725	3519611
1045-79186	Nest 1	28-Jun-09	13R	438725	3519611
1045-79187	Nest 1	28-Jun-09	13R	438725	3519611
1045-79188	Nest 2	28-Jun-09	13R	443425	3518668
1045-79189	Nest 3	28-Jun-09	13R	433583	3520716
1045-79190	Nest 3	28-Jun-09	13R	433583	3520716
1045-79191	Nest 4	30-Jun-09	13R	446186	3516187
1045-79192	Nest 4	30-Jun-09	13R	446186	3516187
1045-79193	Nest 4	30-Jun-09	13R	446186	3516187
1045-79194	Nest 5	02-Jul-09	13R	459672	3515207
1045-79195	Nest 6	02-Jul-09	13R	433583	3520716
1045-79196	Nest 6	02-Jul-09	13R	433583	3520716
1045-79197	Nest 6	02-Jul-09	13R	433583	3520716
1045-79198	Nest 6	02-Jul-09	13R	433583	3520716
1045-79199	Nest 7	02-Jul-09	13R	438355	3519938
1045-79200	Nest 7	02-Jul-09	13R	438355	3519938
1095-07901	Nest 7	02-Jul-09	13R	438355	3519938
wpt.80 #3	Nest 35	30-Jun-07	13 S	617253	3642221

Table 3. Element concentrations measured in blood of Chihuahuan ravens in New Mexico and Texas, 2007-2009.

Band number	Sample location	Age	Lead (ppm)	Mercury (ppm)	Selenium (ppm)
1045-79050	Nest 16 - 2007	Nestling	ND[1]	ND	0.39
1045-79051	Nest 32 - 2007	Nestling	ND	ND	0.26
1045-79052	Nest 55 - 2007	Nestling	ND	ND	0.27
1045-79053	Nest 44 - 2007	Nestling	ND	ND	0.27
1045-79054	Nest 58 - 2007	Nestling	ND	ND	0.23
1045-79055	Nest 37 - 2007	Nestling	ND	ND	0.19
1045-79056	Nest 36 - 2007	Nestling	ND	ND	0.30
1045-79057	Nest 20 - 2007	Nestling	ND	ND	0.27
1045-79058	Nest 22 - 2007	Nestling	ND	ND	0.36
1045-79059	Nest 23 - 2007	Nestling	ND	ND	0.35
1045-79060	Nest 61 - 2007	Nestling	ND	ND	0.52
1045-79061	Nest 64 - 2007	Nestling	ND	ND	0.23
1045-79062	Nest 67 - 2007	Nestling	ND	ND	0.36
1045-79063	Eunice, NM Landfill	Adult	0.23	ND	0.86
1045-79064	Eunice, NM Landfill	Adult	0.07	ND	0.64
1045-79065	Eunice, NM Landfill	Adult	ND	ND	0.61
1045-79066	Eunice, NM Landfill	Adult	0.09	ND	1.00
1045-79067	Eunice, NM Landfill	Adult	0.10	ND	0.54
1045-79068	Eunice, NM Landfill	Adult	0.06	ND	0.58
1045-79069	Eunice, NM Landfill	Adult	0.12	ND	0.67
1045-79070	Eunice, NM Landfill	Adult	0.17	ND	0.68
1045-79098	Eunice, NM Landfill	Adult	0.20	0.038	0.80
1045-79100	Eunice, NM Landfill	Adult	0.09	0.055	0.51
1045-79101	Eunice, NM Landfill	Adult	0.21	0.024	0.57
1045-79102	Eunice, NM Landfill	Adult	0.06	0.026	0.78
1045-79103	Eunice, NM Landfill	Adult	ND	ND	0.59
1045-79104	Eunice, NM Landfill	Adult	ND	ND	0.63
1045-79105	Nest 1 - 2008	Nestling	ND	ND	0.56
1045-79106	Sierra Blanca, TX Landfill	Adult	ND	ND	0.56
1045-79107	Sierra Blanca, TX Landfill	Adult	ND	ND	0.99
1045-79108	Sierra Blanca, TX Landfill	Adult	ND	ND	0.86
1045-79109	Sierra Blanca, TX Landfill	Adult	ND	ND	1.50
1045-79110	Eunice, NM Landfill	Adult	ND	ND	0.55
1045-79111	Sierra Blanca, TX Landfill	Adult	ND	ND	0.77
1045-79112	Sierra Blanca, TX Landfill	Adult	ND	ND	0.92
1045-79113	Sierra Blanca, TX Landfill	Adult	ND	ND	2.10
1045-79114	Sierra Blanca, TX Landfill	Adult	0.07	ND	1.40
1045-79115	Sierra Blanca, TX Landfill	Adult	ND	ND	0.77
1045-79116	Nest 2 - 2008	Adult	ND	ND	0.59
1045-79117	Nest 2 - 2008	Adult	ND	ND	0.56
1045-79118	Sierra Blanca, TX Landfill	Adult	ND	ND	2.30
1045-79119	Sierra Blanca, TX Landfill	Adult	ND	ND	0.62
1045-79120	Sierra Blanca, TX Landfill	Adult	ND	ND	0.77
1045-79121	Sierra Blanca, TX Landfill	Adult	ND	ND	0.69
1045-79138	El Paso, TX City Park	Adult	ND	0.02	0.50
1045-79139	El Paso, TX City Park	Adult	ND	0.029	1.60

1045-79141	El Paso, TX City Park	Adult	ND	0.056	0.46
1045-79142	El Paso, TX City Park	Adult	ND	0.025	0.70
1045-79143	El Paso, TX City Park	Adult	0.07	0.021	1.70
1045-79145	El Paso, TX City Park	Adult	0.06	0.021	0.39
1045-79167	Sierra Blanca, TX Landfill	Adult	ND	0.048	--
1045-79168	Sierra Blanca, TX Landfill	Adult	ND	0.056	--
1045-79169	Sierra Blanca, TX Landfill	Adult	ND	0.037	--
1045-79170	Sierra Blanca, TX Landfill	Adult	ND	0.035	--
1045-79171	Sierra Blanca, TX Landfill	Adult	ND	0.056	--
1045-79172	Sierra Blanca, TX Landfill	Adult	ND	0.035	--
1045-79173	Sierra Blanca, TX Landfill	Adult	ND	0.05	--
1045-79174	Sierra Blanca, TX Landfill	Adult	ND	0.032	--
1045-79175	Sierra Blanca, TX Landfill	Adult	0.08	0.029	--
1045-79176	Sierra Blanca, TX Landfill	Adult	ND	0.025	--
1045-79177	Sierra Blanca, TX Landfill	Adult	ND	0.03	--

[1] ND = none detected. Reporting limits: lead (0.06 ppm), mercury (0.005-0.05 ppm), selenium (0.005-0.05 ppm).

Table 4. Sample concentrations of pp-DDE in blood of Chihuahuan ravens in Texas, 2008-2009.

Band number	Sample location	Age	pp-DDE (ppb)
1045-79122	Sierra Blanca, TX Landfill	Adult	ND[1]
1045-79123	Sierra Blanca, TX Landfill	Adult	44.0
1045-79124	Sierra Blanca, TX Landfill	Adult	56.0
1045-79125	Sierra Blanca, TX Landfill	Adult	33.0
1045-79126	Sierra Blanca, TX Landfill	Adult	16.0
1045-79127	El Paso, TX City Park	Adult	ND
1045-79128	El Paso, TX City Park	Adult	ND
1045-79131	El Paso, TX City Park	Adult	ND
1045-79132	El Paso, TX City Park	Adult	ND
1045-79133	El Paso, TX City Park	Adult	92.0
1045-79134	El Paso, TX City Park	Adult	ND
1045-79135	El Paso, TX City Park	Adult	ND
1045-79136	El Paso, TX City Park	Adult	ND
1045-79147	El Paso, TX City Park	Adult	ND
1045-79148	El Paso, TX City Park	Adult	61.0
1045-79149	El Paso, TX City Park	Adult	110.0
1045-79150	El Paso, TX City Park	Adult	ND
1045-79151	El Paso, TX City Park	Adult	ND
1045-79167	Sierra Blanca, TX Landfill	Adult	ND
1045-79169	Sierra Blanca, TX Landfill	Adult	ND
1045-79170	Sierra Blanca, TX Landfill	Adult	ND
1045-79171	Sierra Blanca, TX Landfill	Adult	ND
1045-79172	Sierra Blanca, TX Landfill	Adult	ND
1045-79177	Sierra Blanca, TX Landfill	Adult	ND
1045-79178	Sierra Blanca, TX Landfill	Adult	60.0
1045-79179	Sierra Blanca, TX Landfill	Adult	110.0
1045-79180	Sierra Blanca, TX Landfill	Adult	270.0
1045-79183	Nest 1 - 2009	Adult	43.0
1045-79184	Nest 1 - 2009	Nestling	ND
1045-79185	Nest 1 - 2010	Nestling	ND
1045-79186	Nest 1 - 2011	Nestling	ND
1045-79187	Nest 1 - 2012	Nestling	ND
1045-79188	Nest 2 - 2009	Nestling	ND
1045-79189	Nest 3 - 2009	Adult	26.0
1045-79190	Nest 3 - 2010	Nestling	ND
1045-79191	Nest 4 - 2009	Nestling	ND
1045-79192	Nest 4 - 2010	Nestling	ND
1045-79193	Nest 4 - 2011	Nestling	ND
1045-79194	Nest 5 - 2009	Nestling	ND
1045-79195	Nest 6 - 2009	Nestling	ND
1045-79197	Nest 6 - 2010	Nestling	ND
1045-79198	Nest 6 - 2011	Nestling	ND
1045-79199	Nest 7 - 2009	Nestling	ND
1045-07901	Nest 7 - 2010	Nestling	ND

[1] ND = none detected. Reporting limit: 20 ppb.

Table 5. Sample concentrations of PCBs in Arcolor mixtures in Chihuahuan ravens in New Mexico, 2007.

			Arcolor tested						
Band number	Sampling location	Age	1221	1232	1242	1248	1254	1260	1262
1045-79063	Eunice, NM landfill	Adult	ND[1]	ND	ND	ND	ND	ND	ND
1045-79064	Eunice, NM landfill	Adult	ND	ND	ND	ND	ND	ND	ND
1045-79065	Eunice, NM landfill	Adult	ND	ND	ND	ND	ND	ND	ND
1045-79068	Eunice, NM landfill	Adult	ND	ND	ND	ND	ND	ND	ND
1045-79069	Eunice, NM landfill	Adult	ND	ND	ND	ND	ND	ND	ND
1045-79089	Eunice, NM landfill	Adult	ND	ND	ND	ND	ND	ND	ND
1045-79090	Eunice, NM landfill	Adult	ND	ND	ND	ND	ND	ND	ND
1045-79091	Eunice, NM landfill	Adult	ND	ND	ND	ND	ND	ND	ND
1045-79093	Eunice, NM landfill	Adult	ND	ND	ND	ND	ND	ND	ND
1045-79094	Eunice, NM landfill	Adult	ND	ND	ND	ND	ND	ND	ND
1045-79096	Eunice, NM landfill	Adult	ND	ND	ND	ND	ND	ND	ND

1 ND = none detected. Reporting limits: 0.1-0.2 ppb.

Table 6. Cholinesterase activity in blood of Chihuahuan ravens in New Mexico and Texas, 2007-2009.

Band number	Sample location	Age	Cholinesterase (uM/ml/min)[1]
1045-79089	Eunice, NM Landfill	Adult	1.3
1045-79090	Eunice, NM Landfill	Adult	1.7
1045-79091	Eunice, NM Landfill	Adult	1.7
1045-79093	Eunice, NM Landfill	Adult	1.2
1045-79094	Eunice, NM Landfill	Adult	1.2
1045-79096	Eunice, NM Landfill	Adult	1.0
1045-79101	Eunice, NM Landfill	Adult	1.3
1045-79102	Eunice, NM Landfill	Adult	0.8
1045-79104	Eunice, NM Landfill	Adult	1.4
1045-79105	Nest 1 - 2008	Nestling	0.5
1045-79106	Sierra Blanca, TX Landfill	Adult	0.8
1045-79107	Sierra Blanca, TX Landfill	Adult	1.3
1045-79108	Sierra Blanca, TX Landfill	Adult	0.8
1045-79109	Sierra Blanca, TX Landfill	Adult	1.3
1045-79111	Sierra Blanca, TX Landfill	Adult	1.4
1045-79112	Sierra Blanca, TX Landfill	Adult	0.8
1045-79113	Sierra Blanca, TX Landfill	Adult	0.8
1045-79114	Sierra Blanca, TX Landfill	Adult	0.7
1045-79115	Sierra Blanca, TX Landfill	Adult	1.0
1045-79116	Nest 2 - 2008	Adult	0.4
1045-79117	Nest 2 - 2008	Adult	0.9
1045-79118	Sierra Blanca, TX Landfill	Adult	1.5
1045-79119	Sierra Blanca, TX Landfill	Adult	0.7
1045-79120	Sierra Blanca, TX Landfill	Adult	0.5
1045-79121	Sierra Blanca, TX Landfill	Adult	1.0
1045-79122	Sierra Blanca, TX Landfill	Adult	1.0
1045-79123	Sierra Blanca, TX Landfill	Adult	1.3
1045-79124	Sierra Blanca, TX Landfill	Adult	0.9
1045-79125	Sierra Blanca, TX Landfill	Adult	0.9
1045-79126	Sierra Blanca, TX Landfill	Adult	1.3
1045-79127	El Paso, TX City Park	Adult	1.0
1045-79128	El Paso, TX City Park	Adult	1.0
1045-79154	Sierra Blanca, TX Landfill	Adult	1.3
1045-79155	Sierra Blanca, TX Landfill	Adult	1.0
1045-79156	Sierra Blanca, TX Landfill	Adult	1.5
1045-79157	Sierra Blanca, TX Landfill	Adult	0.6
1045-79158	Sierra Blanca, TX Landfill	Adult	0.8
1045-79159	Sierra Blanca, TX Landfill	Adult	1.6
1045-79160	Sierra Blanca, TX Landfill	Adult	0.9
1045-79162	Sierra Blanca, TX Landfill	Adult	0.8
1045-79164	Sierra Blanca, TX Landfill	Adult	1.0
1045-79166	Sierra Blanca, TX Landfill	Adult	1.0
1045-79168	Sierra Blanca, TX Landfill	Adult	0.8
1045-79169	Sierra Blanca, TX Landfill	Adult	1.3
1045-79171	Sierra Blanca, TX Landfill	Adult	1.0
1045-79172	Sierra Blanca, TX Landfill	Adult	1.0

1045-79173	Sierra Blanca, TX Landfill	Adult	1.4
1045-79176	Sierra Blanca, TX Landfill	Adult	0.4
1045-79183	Nest 1 - 2009	Nestling	0.9
1045-79184	Nest 1 - 2009	Nestling	0.8
1045-79185	Nest 1 - 2009	Nestling	0.8
1045-79186	Nest 1 - 2009	Nestling	1.0
1045-79187	Nest 1 - 2009	Nestling	0.8
1045-79188	Nest 2 - 2009	Nestling	0.7
1045-79189	Nest 3 - 2009	Nestling	1.2
1045-79190	Nest 3 - 2009	Nestling	1.3
1045-79191	Nest 4 - 2009	Nestling	0.6
1045-79192	Nest 4 - 2009	Nestling	0.9
1045-79193	Nest 4 - 2009	Nestling	0.5
1045-79194	Nest 5 - 2009	Nestling	0.8
1045-79195	Nest 6 - 2009	Nestling	0.6
1045-79197	Nest 6 - 2009	Nestling	0.8
1045-79198	Nest 6 - 2009	Nestling	0.6
1045-79199	Nest 7 - 2009	Nestling	0.6
1095-07901	Nest 7 - 2009	Nestling	0.7

[1] Reporting limit: 0.1 uM/ml/min.