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# Avian Individual and Population Health on Los Alamos National Laboratory 2003: Large-scale Piñon Pine Tree Mortality Impacts and Egg Contaminant Residues

**Jeanne M. Fair and Kaia Colestock, Los Alamos National Laboratory, Risk Reduction and Environmental Stewardship, Ecology Group, MS M887, Los Alamos, NM 87545**

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## 1.0 Introduction to the Project

In 1997, an avian nestbox monitoring network was established on Los Alamos National Laboratory (LANL), Los Alamos County and U.S. Forest Service land in northern New Mexico to investigate the health and condition of cavity-nesting bird populations on the Pajarito Plateau. The purpose of this study is to evaluate the magnitude and sources of ecological risks from contaminants and other environmental stressors for cavity-nesting birds at LANL. The main objective is to evaluate the ecological and physiological costs of exposure to various contaminants at LANL and their potential impact on population processes. During the past two decades it has become increasingly important to be able to predict risks from potential adverse effects of exposure to chemical and physical hazards in the environment. This has resulted in the critical need for estimates of the relationship between exposure of organisms to contaminants and the response of the population.

This project was started in 1997 with 450 nest boxes placed in potentially contaminated and noncontaminated areas on LANL. Data on individual bird health and condition and population-level parameters have been collected for six consecutive years through 2002. During the six years the nest box monitoring project has seen the Cerro Grande fire that burned ¼ of the boxes and several areas of bluebird habitat, several years of severe drought, a large-scale tree thinning project, and now an 80% mortality of pine trees from bark beetles in several of the areas where nest boxes are placed. Many of the trees that boxes are placed on have died during the 2002-breeding season. Although each of

these events will undoubtedly add variation in any study attempting to understand the environment, it also gives us the opportunity to gain insight into the effects of environmental change and stress.

## 1.1 Methods

### *Avian Monitoring Network*

To investigate health and condition of birds in areas of concern for contaminants, an avian monitoring network of nest boxes was initiated at LANL. During the winter of 1997, 438 nest boxes were placed on LANL in total of 18 both potentially contaminated and reference areas. Nest boxes were placed approximately two meters off the ground on trees and spaced approximately 50-75 meters apart. Boxes were placed in the open ponderosa pine forest of the canyons and piñon–juniper woodland on the plateau mesas. Boxes were placed in 18 locations or areas on LANL land with an average of 29 boxes per location.

The western bluebird (*Sialia mexicana*) (WEBL) is a widely distributed, sexually dichromatic, and monogamous species. The ash-throated flycatcher (*Myiarchus cinerascens*) (ATFL) is not as widely distributed or sexually dichromatic. Both species nest in secondary nest cavities, are insectivorous during the breeding season, and use small amounts of grit in their gizzards that are potentially important exposure pathways. These two species have similar life history traits, although the ATFL has a faster rate of development, fledging 4-5 days earlier than the bluebird, and has a significantly higher field metabolic rate during development (Mock et al. 1991). This difference in duration of development period could affect the relative exposure and risks to contaminants.

If intake of contaminants in soil is proportional to dry matter intake as is assumed in ecological risk methodology, the higher metabolic rate for the ATFL compared to the WEBL may increase their relative risk of toxic exposure. Sexual dichromatisim differs in the two species, with the WEBL being sexually dichromatic and the ATFL having no sexual differences. Although the specific migratory pattern of both species is unknown, WEBLs are more common in the winter months in the study area and it is thought that the ATFLs migrate farther south, even in mild winter years. Both bird species in this study readily utilized nest boxes and are common in northern New Mexico.

The main objective of the avian nest box-monitoring network is to investigate population level parameters such as survival, nest productivity, and return rates or recruitment into the population. All adults and nestlings western bluebirds are to be banded and return band numbers are recorded. This data will be used in a population viability analysis that can determine the status of the population. The LANL bluebird population will be compared with a western bluebird population in Oregon, California, and Arizona.

***Data Analysis***

The Statistical Analysis System (SAS, Institute, Inc. 1987) was used for all statistical analyses, and assumptions for parametric statistics were examined. Growth and physiological parameters were compared among antigen treatments using repeated measures Analysis of Variance models (ANOVA). Means for each treatment were compared with Duncan's Multiple Range Test. Data not

normally distributed or having unequal variances were compared with Kruskal-Wallis nonparametric tests.

**1.2 Avian Monitoring Network 2003 Summary**

The number of active boxes in the project returned to the pre–fire numbers of 1998 with a total of 98 active boxes (Figure 1). However, there are 33% more boxes placed for 2002 bringing the percentage of active boxes down to 15.5%. Population dynamics are dependent on two primary things: the number of offspring produced and the survival of individuals from each year. An accurate estimate of survival rates requires the banding and recapture of numerous individuals over multiple years. For the estimation of annual survival rates, individuals must be recaptured over time, which will give valuable information on dispersal distance as well. For example in the California central valley western bluebirds have been found to have a 33% recruitment of nestlings into the breeding population (C. Graham, personal communication). For the LANL bluebird population, the recruitment is a much lower 2-3%. Clearly, one of the future goals of the project should be to determine the reason for such a low recruit into the population on the Pajarito Plateau. It could be the due to the fire, drought, anthropogenic reasons, or other environmental variables such as heterogeneity of habitat.

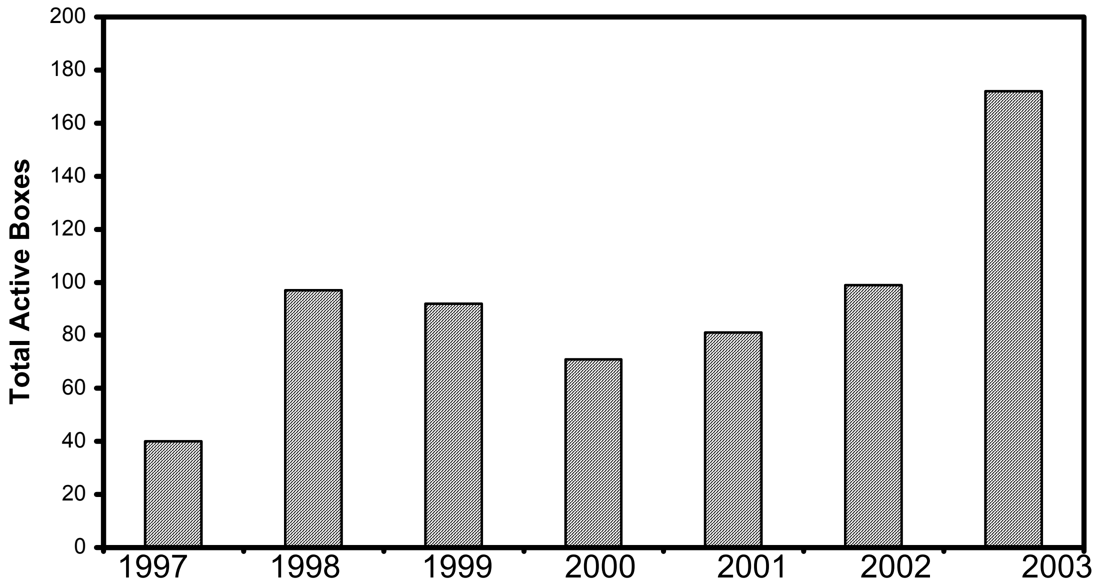



Figure 1. Total active nests for 1997-2003 for the entire laboratory nest box network.

Hinds (1984) stated that a successful ecological monitoring program must be ecologically relevant, statistically credible, and cost-effective. The LANL nestbox network has collected data over six breeding seasons. The LANL nestbox network has sought to reach all parts of the tripartite requirements. The large sample size of birds utilizing the nestboxes allows for significant statistical power in the analyses. A total of over 1,100 birds have been banded in the six years of this project with a total of 134 adult western bluebirds.

The two burned areas of Mortandad and Canada del Buey continue to be the most used areas on LANL (Table 1).

Table 1. Total active boxes for 2003.

| Location | # Boxes | # Burned | 2003 Active WEBL | 2003 Active ATFL | 2003 Active Other | 2003 % Occupancy |
|---|---|---|---|---|---|---|
| **Acid Canyon** | 31 | 0 | 0 | 0 | 0 | 0 |
| **Ancho Canyon** | 18 | 0 | 2 | 2 | 0 | 22.2 |
| **Ancho Mesa** | 12 | 0 | 0 | 1 | 2 | 25 |
| **Ancho/Water Mesa** | 12 | 0 | 0 | 0 | 0 | 0 |
| **Bayo Canyon** | 82 | 0 | 6 | 2 | 3 | 13.4 |
| **Canada del Buey** | 29 | 0 | 8 | 2 | 6 | 55.2 |
| **DP Canyon** | 12 | 0 | 1 | 0 | 2 | 25 |
| ***DX-EF** | 13 | **13** | 0 | 0 | 0 | 0 |
| **DX-R44** | 8 | 0 | 2 | 0 | 0 | 25 |
| **Gate 11** | 10 | 0 | 3 | 1 | 2 | 60 |
| **Gate 9** | 6 | 0 | 1 | 1 | 0 | 33.3 |
| **Golf Course** | 10 | 0 | 5 | 0 | 3 | 80 |
| **Guaje Canyon** | 11 | 0 | 0 | 0 | 0 | 0 |
| ***Guaje Pines Cemetery** | 16 | **3** | 3 | 0 | 2 | 38.5 |
| **LA Canyon** | 112 | 0 | 2 | 0 | 2 | 3.6 |
| **Lower Sandia** | 11 | 0 | 0 | 0 | 0 | 0 |
| ***Mortandad Canyon** | 111 | **51** | 19 | 6 | 34 | 98.3 |
| **Pueblo Canyon** | 61 | 0 | 17 | 9 | 6 | 52.5 |
| **Sandia Wetland** | 22 | 0 | 0 | 0 | 0 | 0 |
| **TA-33** | 27 | 0 | unk | unk | unk | unk |
| ***TA-35** | 28 | **3** | 1 | 0 | 4 | 20 |
| **TA-51** | 5 | 0 | 1 | 0 | 0 | 20 |
| **Water Canyon** | 39 | 0 | 5 | 0 | 4 | 23.1 |
| **Water DX** | 16 | 0 | unk | unk | unk | unk |

*** Burned areas**

There were eight species that utilized the boxes in 2003 (Table 2). A large majority of the trees that boxes were placed on succumbed to the drought-induced bark beetle infestation. Tree mortalities continued throughout the breeding season through October, 2003.

Table 2. Total active boxes by species in 2003 (N = 172).

| Species | Number of Active Boxes |
|---|---|
| Western Bluebird | 78 |
| Ash-throated Flycatcher | 24 |
| Violet-green Swallow | 31 |
| Mountain Bluebird | 15 |
| House Finch | 13 |
| Mountain Chickadee | 6 |
| House Wren | 4 |
| White-breasted Nuthatch | 1 |

## 2.0 Pine Tree Mortality Effects on Cavity-Nesting Birds

### 2.1 Introduction

The 2002 field season was the sixth year of the nestbox network-monitoring program. This many years of data offer the opportunity to investigate the impact of the Cerro Grande fire of May 2000. Additional environmental stress can increase the impact of other anthropogenic stresses such as contaminants. This field monitoring study was begun with the intention of comparing two similar cavity nesting bird species in a gradient of potential exposure to a mixture of contaminants at Los Alamos National Laboratory (LANL) in New Mexico. While contamination effects are still being studied, other environmental conditions have since occurred (wildfire, drought) for which the project provides an ideal

framework for studying. This summary covers the preliminary findings on the effects of the Cerro Grande wildfire on the local cavity-nesting bird populations.

### 2.2 Methods

The 2002 monitoring began with 636 nestboxes across the 112 $km^2$ LANL, Los Alamos County and U.S. Forest Service land (Table 3). Ninety-nine active nests in 16 different canyons were monitored throughout 2002, with an occupancy rate of 27.7% LANL-wide. This is up from 18.9% in 2002, and 18.3% immediately after the fire in 2000. Nine different species were found nesting in the boxes, with the majority being Western Bluebirds (42%), Ash-throated Flycatchers (19%), and Violet-green Swallows (15%). Physiological measurements such as tarsus, wing chord and weight were taken, and blood and feather samples were collected from the majority of the adults.

Table 3. LANL-wide nestbox occupancy for all species.

| | **1997** | **1998** | **1999** | **2000** | **2001** | **2002** | **2003** |
|---|---|---|---|---|---|---|---|
| Percent Occupancy | 9.2 | 22.3 | 21.2 | 18.3 | 16.1 | 18.9 | 27.7 |
| Total Active Nests | 40 | 97 | 92 | 71 | 81 | 99 | 172 |
| Total Number of Boxes | 435 | 435 | 435 | 388 | 502 | 523 | 636 |

Four breeding seasons have passed since the Cerro Grande wildfire that occurred in the spring of 2000, and it is possible to begin to look at potential effects of the fire on the local cavity-nesting bird populations. This study with its six-year data set is a perfect opportunity to do this. The fire burned an estimated 47,650 acres on the Pajarito Plateau, with 8,100 acres on LANL. Three of the sixteen study locations/canyons were hardest hit, with a total of 79 nestboxes being burned. The three areas that are considered ‘burned areas’ for the study are: Mortandad Canyon, Canada del Buey, and DX (EF and R-44 sites). All

three areas sustained moderate to high burn levels. Mortandad canyon had 98% of the nestboxes destroyed by the fire. Three boxes in each of the cemetery and TA-35 areas were burned, but it did not cover a substantial enough area to consider these as burned habitats for our purposes. “Pre-fire” years will be considered 1997-1999, while mention of “post-fire” years will refer to 2000-2002.

### 2.3 Known effects of bark beetle infestation on birds

The drought of 2000–2002 in the southwestern United States, although not unprecedented, has been one of the most severe in 50 years. Precipitation for this region was 25% below average during 2000 and 2001 and 65% below average through the summer breeding months (August 2002). This has led to a severe outbreak of bark beetles (*Ips confuses*) that has resulted in high mortality levels in ponderosa (*Pinus ponderosa*) douglas-fir (*Pseudotsuga menziesii*) and piñon (*Pinus edulis*) pine trees. Many areas in piñon-juniper habitat have had the entire stand of piñon die leaving only juniper (*Juniperus monosperma*). Bark beetles in western North America have been documented to cause large areas of high mortality that has been linked to both drought and fire in the region (McHugh et al. 2003). The Pajarito Plateau, where Los Alamos National Laboratory (LANL) is located, has an average 80% tree mortality for trees over 1.5 meters tall from 2002 to 2003 (R. Balice, per. comm.). This mortality has left a mosaic of live and dead trees.

The piñon pine bark beetle feeds primarily on the inner bark (phloem tissue). This has the same effect as girdling (peeling off the bark) of the tree. Damage caused by their feeding acts as an internal tourniquet cutting off the flow

of nutrients from the leaves to the other parts of the tree. As the damage progresses, sugars and other complex compounds cannot be translocated downward from the leaves to non-photosynthetic areas of the tree. During large beetle outbreaks, changes in vegetation are likely to have cascading effects on avian communities. The abundance and species composition of birds have been shown to change across temperate forests in response to outbreaks of bark beetles (Yeager and Riordan 1953, Bull 1983, Stone 1995, Matsuoka et al. 2001).

Habitat quality for migratory birds can be estimated from determining avian use of these areas during the critical breeding season when many species of birds utilize the Pajarito Plateau. However, the relationship between density of a species and quality of the habitat is not always clear. In some cases, high animal densities indicate high-quality habitat and in other cases they do not (Van Horne 1983, Vickery at al. 1992, Holmes et al. 1996). Avian use can indicate the usefulness of the habitat and in cases of extreme and rapid environmental change give insight into the effects of change. Habitat use by birds could be greatly impacted by either the increase in tree mortalities or tree thinning activities. LANL and the area subject to be transferred offer an opportunity to determine the effects of both of pine tree mortality and thinning activities on breeding bird populations. Random points will be chosen in a factorial design of both high-and low-tree-mortality areas and areas of tree- thinning activity and no activity. Breeding point counts of birds will be completed in the breeding season as well as mist netting of birds. Both methods combined will give a

reliable estimate of avian use in these habitats. Morphometric measurements were taken on mist netted birds to compare the general health and condition of the birds in the habitats. All birds were banded to determine new captures at each location.

Regional droughts have far-reaching, substantial, and easily recognizable impacts on populations and the environment. Rising temperatures could expand the distribution of vector-borne pathogens, exposing host populations to a longer transmission season and immunologically naïve individuals to newly introduced pathogens. In the course of a six-year study of cell-mediated immune function of three common cavity-nesting bird species at Los Alamos, New Mexico, we already discovered a dramatic decrease in the immune responsiveness of developing nestlings associated with unusually dry conditions (Fair and Whitaker 2002). A drought-induced reduction in immune function would further magnify the risk of bird populations to newly introduced diseases such as West Nile virus that has been found to increase with drought. Therefore, it is critical that we investigate the effects of natural and anthropogenic environmental disturbances on avian habitat and populations as soon as possible to better estimate and possibly mitigate the long-term consequences to populations.

Stand structure has been documented to influence the distribution and abundance of a variety of bird species (Bennetts et al. 1996, Sharpe 1996, Easton and Martin 1998). The influence of a disturbance on a community is largely a function of the severity and spatial event of the event (Souza 1984, Pickett and White 1985). Forests with greater heterogeneity of vegetation have

more species (Recher 1969, Willson 1974, Freemark and Merriam 1986). Once the bark beetle infestation and die-off are complete, a landscape-sized region will be essentially homogeneous. Temporally early in this infestation, the habitat structure may still be heterogeneous, with thinning adding another level of edge and diversity. Other studies have documented higher numbers of birds in manually thinned forests (Slagsvold 1977, Easton and Martin 1998).

Woodlands with high herbaceous plant cover may increase the availability of grasshoppers (Orthopetera) and caterpillars (Lepidoptera) (Kleintjes and Dahlsten 1992). Currently, the effects of thinning and high piñon pine mortality on arthropods that are important food resource in the breeding season are unknown. When there is an increase in edge on a landscape level, a natural increase in populations is expected due to the increase in foraging areas, although the impacts on arthropods are not known. This knowledge gap will be critical in predicting the long-term effects of high piñon pine mortality on avian use. Additional years of study are necessary in these areas of thinning to determine if these differences are only temporal edge effect or if foraging quality has been increased.

## 2.4 Results

Clutch size decreased for both the ATFLs and WEBLS after the fire (Table 4). The average pre-fire clutch size for ATFL was 3.88 and for WEBLS was 4.46.

Post-fire, these averages dropped to 3.43 for ATFLs and to 4.07 for WEBLS.

Table 4. Clutch size for western bluebirds and ash-throated flycatchers.

| Year | ATFL | WEBL |
|---|---|---|
| 1997 | 3.94 | 4.55 |
| 1998 | 4.06 | 4.28 |
| 1999 | 3.63 | 4.56 |
| 2000 | 3.4 | 3.87 |
| 2001 | 3.79 | 4.54 |
| 2002 | 3.1 | 3.81 |
| 2003 | | |

There was a significant decrease in the percentage of eggs that successfully hatched in 2003 for all species combined (Table 5). It is not known if this decrease was due to behavioral abandonment or physiology of the eggs.

Table 5. Percent of egg hatched across all species.

| Year | Percent Eggs Hatched |
|---|---|
| 1997 | 80 |
| 1998 | 66 |
| 1999 | 81 |
| 2000 | 82 |
| 2001 | 75 |
| 2003 | 65 |

Average hatch date for all species across LANL was significantly earlier in 2003. The average Julian date of hatching was nine days earlier than the previous 6 years (Table 6).

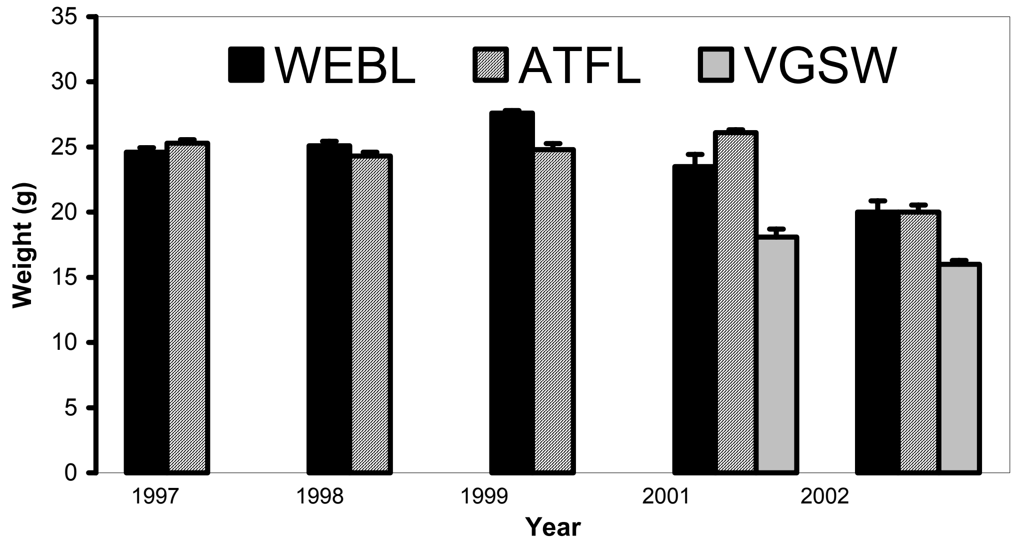
Table 6. Average Julian hatch date for all species.

| Year | Date |
|---|---|
| 1997 | 169 |
| 1998 | 167 |
| 1999 | 169 |
| 2000 | 173 |
| 2001 | 165 |
| 2002 | 170 |
| 2003 | 157 |

Adult condition can be used as an indicator of health across a population. Adult mass was measured for the three species and compared across years.

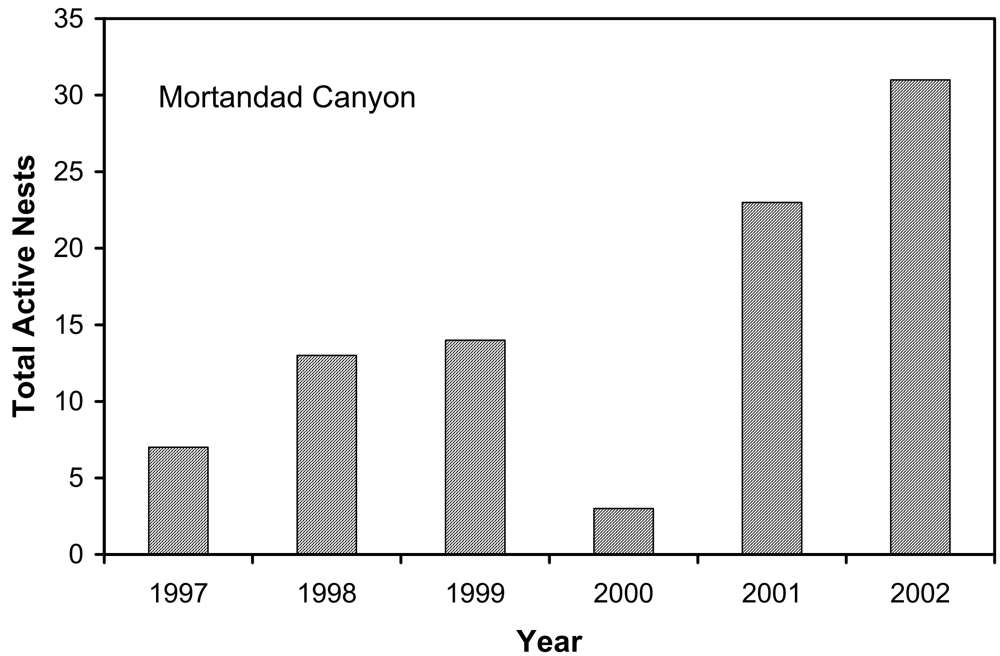
Body weight was considerably lower for the two years after the fire as compared to pre-fire years (Figure 2).

Figure 2. Adult body weight (g) for 1997 to 2002 for all three species.




One of the most obvious results of the recent and rapid environmental changes on the Pajarito Plateau of both the fire and pine tree mortality was increase of occupancy rates of the nestboxes in the burned areas. Burned areas such as Mortandad canyon dramatically increased the occupancy rates and was much higher from unburned locations (Figure 3).

Figure 3. Total active nests for Mortandad Canyon from 1997-2002 for all avian species.




**2.5 Discussion**

The immediate effects of the Cerro Grande wildfire appear to be minimal, if not beneficial, to the local cavity-nesting bird populations on the Pajarito Plateau. During the breeding seasons since the fire occurred, occupancy rates are clearly higher in the burned versus non-burned areas, and a trend towards higher survival rates in burned areas can also be seen. This may be correlated with the increase in standing snags, which provide sites for nesting, roosting, and foraging. All the study species are secondary cavity-nesters that depend on an availability of existing cavities for nesting. Survival was the lowest during the breeding season immediately following the fire, and one confounding factor for this may be the spraying of a million gallons of fire retardant over LANL lands during the fire. This retardant contained arsenic, which may have acted as a pesticide to lower arthropod populations. Adult mass significantly decreased as

well since the fire, possibly in response to this decrease in food availability since the study species are all primarily insectivores. While hatch date has not changed in the years since the fire, hatch rates have increased slightly by three percent. There is no apparent change in the types of nestling mortality between pre and post-fire years. The percent of nestlings that fledged versus were predated versus died in the nest did not significantly change. The number of eggs that did not hatch also did not show a change between pre and post-fire years.

The impacts of the 2000 Cerro Grande fire on the Pajarito Plateau landscape and wildlife will be felt for years to come. This nestbox network project, in collaboration with other local long-term avian studies, will be important in monitoring the health of cavity-nesting bird populations as the forests go through the post-fire stages of succession.

**3.0 Contaminant and Residue Exposure of Cavity-Nesting Birds**

Each breeding season a percentage of eggs do not hatch or are abandoned. These eggs are collected and refrigerated for eggshell and contaminant residue analysis. Dead nestlings are also collected and frozen for residue analysis. There were 38 dead western bluebirds and 11 eggs collected in 2002 (Table 7).

Table 7. Salvaged unhatched eggs and dead nestlings for each species for 2002.

| | **WEBL** | **ATFL** | **MOCH** | **HOWR** | **MOBL** | **VGSW** | **PYNU** |
|---|---|---|---|---|---|---|---|
| Eggs | 11 | 11 | 3 | 0 | 4 | 3 | 0 |
| Dead nestlings | 38 | 7 | 11 | >12 | 3 | 13 | 4 |

At total of 77 eggs from 1997 to 2002 were sent in for contaminant residue analysis in 2002 (Table 8). Eggs sent in for analysis were from most locations of the nest-boxes at LANL collected from 1997 to 2002. All eggs collected were eggs that did not hatch or were abandoned. Lower quantitation limits for most organic analytes will be 1-10 ng/mL range. Limits for eggs, in ppb, will be the detection limits divided by the mass of the eggs (g). Lower quantitation limit for most metal will be the 1-10 ppb range. Another subset of eggs will be sent in for radionuclide analysis in the winter of 2003 (Figure 4). A variety of pesticides and herbicides will be analyzed from the eggs (Table 9) as well as PCBs (Table 10). Fifteen major elements will be analyzed (Table 11) and 15 PAH compounds (Table 12).

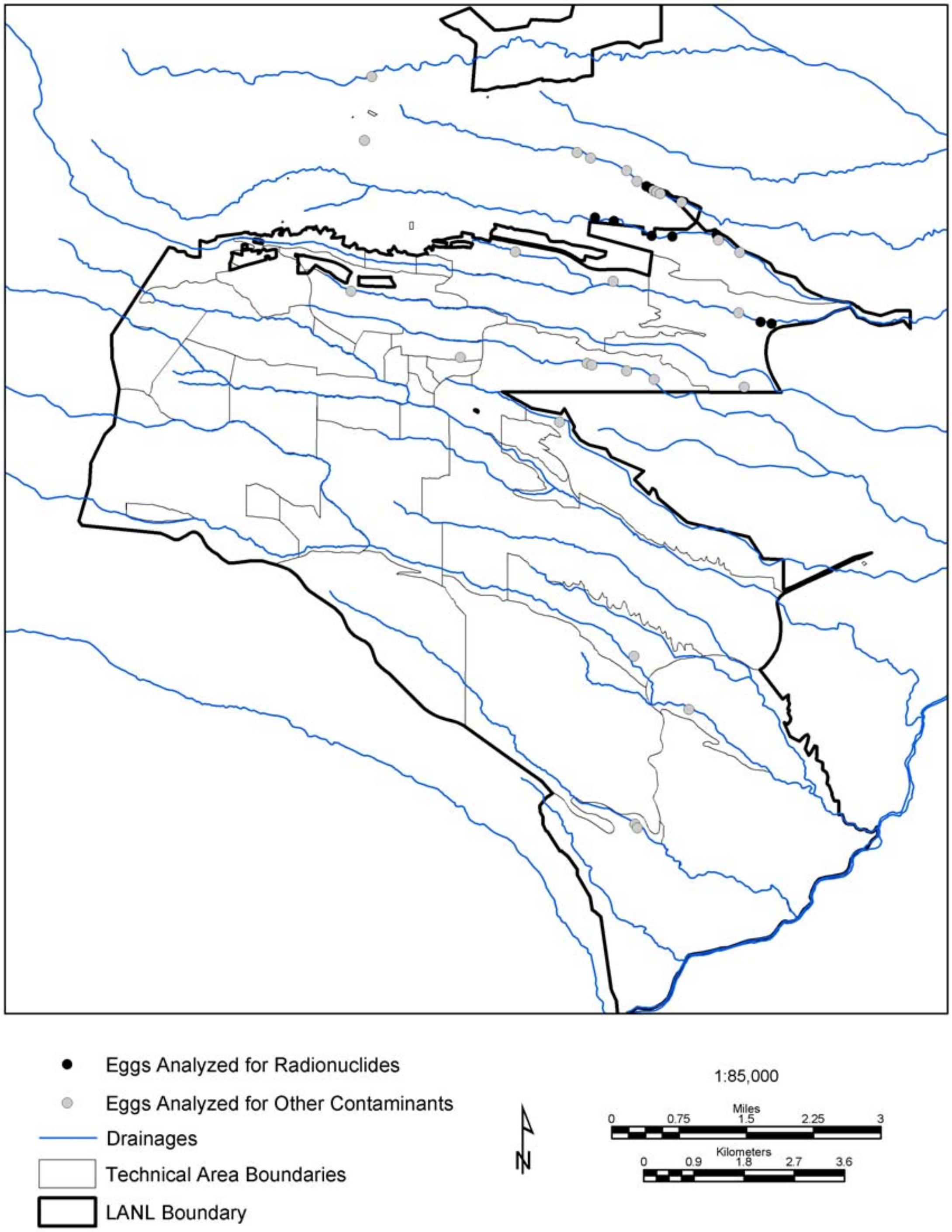



Figure 4. Locations of eggs sent in for contaminant residue analysis at LANL from 1997-2003.

Table 9. Eggs sent in for metal and organic residue analysis.

| Date | Location | Species | # Eggs | Analysis | Wt | Wt | Wt | Wt | Wt |
|---|---|---|---|---|---|---|---|---|---|
| 6/10/1999 | Ancho Canyon 190 | WEBL | 1 | Metal | 2.04 | | | | |
| 6/22/1998 | Ancho Canyon 193 | WEBL | 1 | Metal | 1.89 | | | | |
| 6/20/1998 | Bayo 112 | WEBL | 1 | Metal | 2.45 | | | | |
| 7/10/1998 | Bayo 12 | WEBL | 1 | Metal | 0.42 | | | | |
| 7/27/1998 | Bayo 12 | WEBL | 1 | Metal | 0.71 | | | | |
| 7/6/1999 | Bayo 14 | WEBL | 1 | Metal | 1.46 | | | | |
| 6/15/1998 | Bayo 14 | WEBL | 1 | Metal | 1.44 | | | | |
| 6/10/1998 | Bayo 2 | WEBL | 1 | Metal | 2.24 | | | | |
| 6/24/1998 | Bayo 27 | WEBL | 1 | Metal | 1.99 | | | | |
| 7/23/1999 | Bayo 325 | WEBL | 1 | Metal | 1.39 | | | | |
| 7/16/1999 | Bayo 4 | ATFL | 1 | Metal | 1.38 | | | | |
| 7/26/2001 | Bayo 5 | WEBL | 1 | Metal | no wt | | | | |
| 7/4/1997 | Bayo 8 | WEBL | 1 | Metal | 2.53 | | | | |
| 6/11/1998 | DP 397 | WEBL | 1 | Metal | 1.86 | | | | |
| 6/19/1998 | DX Water B66383 | WEBL | 1 | Metal | 1.88 | | | | |
| 6/26/2001 | Gate 11 599 | ATFL | 1 | Metal | no wt | | | | |
| 6/21/1999 | Gate 9 | WEBL | 1 | Metal | 1.96 | | | | |
| 7/28/1998 | LA 14 | ATFL | 4 | Metal | 0.98 | 1.19 | 1.4 | 1.2 | |
| 6/28/1999 | LA 264 | ATFL | 1 | Metal | 1.65 | | | | |
| 7/7/1997 | LA 288 | ATFL | 1 | Metal | 2.094 | | | | |
| 6/20/2001 | LA 307 | ATFL | 1 | Metal | 0.481 | | | | |
| 7/12/1999 | LA 312 | ATFL | 1 | Metal | 2.07 | | | | |
| 6/8/1998 | LA 319 | WEBL | 1 | Metal | 1.6 | | | | |
| 6/12/1998 | Mort 254 | ATFL | 1 | Metal | 1.27 | | | | |
| 6/19/2001 | Mort 512 | WEBL | 1 | Metal | 1.699 | | | | |
| 6/25/2001 | Mort 548 | ATFL | 1 | Metal | 2.455 | | | | |
| 6/24/1999 | Mort 68 | WEBL | 1 | Metal | 1.79 | | | | |
| 6/15/1998 | Pueblo 355 | WEBL | 1 | Metal | 2.11 | | | | |
| 7/7/1998 | Pueblo 361 | WEBL | 1 | Metal | 1 | | | | |
| 7/9/2001 | Pueblo 608 | ATFL | 2 | Metal | 0.596 | | | | |
| 5/21/1998 | TA 33 141 | MOBL | 1 | Metal | 1.37 | | | | |
| 6/11/1997 | TA 33 159 | WEBL | 1 | Metal | 2.418 | | | | |
| 6/20/2001 | LA 204 | ATFL | 1 | Metal | | | | | |
| 7/9/2002 | LA 267 | ATFL | 1 | Metal | 0.933 | | | | |
| 7/10/2002 | LA 317 | ATFL | 3 | Metal | 2.313 | 1.06 | 0.7 | | |

Table 9 (Cont.) Eggs sent in for metal and organic residue analysis.

| Date | Location | Species | # Eggs | Analysis | Wt | Wt | Wt | Wt | Wt |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Metal | | | | | |
| | | | | Organic | | | | | |
| 7/1/2002 | C del Buey 580 | WEBL | 1 | Organic | 0.509 | | | | |
| 6/10/1998 | Ancho Canyon 185 | WEBL | 1 | Organic | 7 | | | | |
| 6/15/1999 | Ancho Canyon 186 | WEBL | 2 | Organic | 1.8 | 1.39 | | | |
| 6/26/2001 | Bayo 119 | ATFL | 1 | Organic | 0.949 | | | | |
| 7/17/1997 | Bayo 13 | WEBL | 1 | Organic | 1.824 | | | | |
| 6/27/1999 | Bayo 14 | WEBL | 1 | Organic | 1.51 | | | | |
| 7/5/1998 | Bayo 15 | WEBL | 1 | Organic | 1.01 | | | | |
| 7/29/1999 | Bayo 20 | ATFL | 3 | Organic | 2.29 | 2.31 | 1.2 | | |
| 6/9/1997 | Bayo 22 | WEBL | 1 | Organic | 2.175 | | | | |
| 6/27/1997 | Bayo 5 | ATFL | 2 | Organic | 0.692 | 0.68 | | | |
| 6/18/1999 | Bayo 5 | WEBL | 1 | Organic | 1.74 | | | | |
| 6/15/1998 | Bayo 9 | WEBL | 3 | Organic | no wt | | | | |
| 7/30/1998 | Cem 169 | WEBL | 2 | Organic | 1.47 | 1.65 | | | |
| 7/23/1997 | Cem Boyscout | WEBL | 1 | Organic | 2.456 | | | | |
| 6/12/2001 | DP 394 | WEBL | 1 | Organic | 1.653 | | | | |
| 5/29/1998 | GC 3 | WEBL | 1 | Organic | 1.33 | | | | |
| 5/29/1998 | GC 3 | WEBL | 1 | Organic | 1.45 | | | | |
| 6/20/2001 | LA 264 | ATFL | 1 | Organic | 1.252 | | | | |
| 7/6/1999 | LA 270 | ATFL | 1 | Organic | 1.28 | | | | |
| 6/27/2001 | LA 307 | ATFL | 1 | Organic | 1.653 | | | | |
| 7/2/1997 | LA 310 | ATFL | 1 | Organic | 2.31 | | | | |
| 7/19/2001 | Mort 506 | ATFL | 1 | Organic | 1.557 | | | | |
| 7/9/2001 | Mort 547 | WEBL | 1 | Organic | 1.603 | | | | |
| 6/11/1997 | Mort 58 | WEBL | 1 | Organic | 1.986 | | | | |
| 6/23/1998 | Mort 73 | WEBL | 1 | Organic | 1.43 | | | | |
| 6/26/1998 | Mort 87 | ATFL | 1 | Organic | 1.91 | | | | |
| 7/26/1999 | Pueblo 356 | WEBL | 1 | Organic | 2.04 | | | | |
| 7/13/2001 | Sandia 334 | WEBL | 2 | Organic | 2.141 | | | | |
| 6/14/2001 | Sandia 566 | ATFL | 1 | Organic | 2.071 | | | | |
| 6/6/1998 | Water 240 | WEBL | 1 | Organic | 2.53 | | | | |
| 7/1/1999 | Bayo 115 | WEBL | 2 | Organic | | | | | |
| 7/1/2002 | TA-35 31 | WEBL | 1 | Organic | 0.356 | | | | |
| 6/10/2002 | Mort 545 | WEBL | 1 | Organic | 0.49 | | | | |
| 7/8/2002 | Bayo 119 | WEBL | 1 | Organic | 2.903 | | | | |
| 7/15/2002 | Golf 3 | WEBL | 1 | Practice Metal | 1.955 | | | | |
| 7/25/2002 | Pueblo 26 | ATFL | 2 | Practice Metal | 1.61 | 2.15 | | | |
| 6/19/2001 | Mort 500 | MOBL | 1 | Practice | 2.174 | | | | |
| 7/25/2002 | Gate 9 259 | ATFL | 1 | Organic | 1.993 | | | | |
| 6/25/1998 | Bayo 343 | ATFL | 1 | Practice | 2.29 | | | | |
| 6/19/2002 | Water 164 | WEBL | 1 | Organic | 1.993 | | | | |

Table 10. Pesticides and herbicides analyzed in eggs.

| |
|---|
| α-Chlordane (cis) |
| Γ-Chlordane (trans) |
| DDD (probably the p,p'-) |
| DDE |
| DDT |
| Dieldrin |
| Heptachlor |
| Heptachlor epoxide |
| α-hexachlorocyclohexane |
| ß-hexachlorocyclohexane |
| Lindane |
| Methoxychlor ** |
| trans-nonachlor |
| Oxychlordane |

Table 11. PCB analytes analyzed in eggs.

| |
|---|
| 2,3-Dichlorobiphenyl |
| 2,4'-Dichlorobiphenyl |
| 2,2',5-Trichlorobiphenyl |
| 2,4,4'-Trichlorobiphenyl [a] |
| 2,4',5-Trichlorobiphenyl |
| 2',3,4-Trichlorobiphenyl |
| 2,2',3,5'-Tetrachlorobiphenyl |
| 2,2',4,5'-Tetrachlorobiphenyl |
| 2,2',5,5'-Tetrachlorobiphenyl [a] |
| 2,3',4,4'-Tetrachlorobiphenyl |
| 2,3',4',5-Tetrachlorobiphenyl |
| 2,4,4',5-Tetrachlorobiphenyl |
| 3,3',4,4'-Tetrachlorobiphenyl |
| 2,2',3,3',6-Pentachlorobiphenyl |
| 2,2',3,5',6-Pentachlorobiphenyl |
| 2,2',4,4',5-Pentachlorobiphenyl |
| 2,2',4,5,5'-Pentachlorobiphenyl [a] |
| 2,3,3',4,4'-Pentachlorobiphenyl |
| 2,3,3',4',6-Pentachlorobiphenyl |
| 2,3',4,4',5-Pentachlorobiphenyl [a] |
| 2,2',3,3',4,4'-Hexachlorobiphenyl |
| 2,2',3,4,4',5'-Hexachlorobiphenyl [a] |
| 2,2',3,4',5',6-Hexachlorobiphenyl |
| 2,2',4,4',5,5'-Hexachlorobiphenyl [a] |
| 2,3,3',4',5,6-Hexachlorobiphenyl |
| 2,2',3,4,4',5,5'-Heptachlorobiphenyl [a] |
| 2,2',3,4,4',5',6-Heptachlorobiphenyl |
| 2,2',3,4',5,5',6-Heptachlorobiphenyl |
| 2,2',3,3',4,4',5,5'-Octochlorobiphenyl |
| 2,2',3,3',4,5',6,6'-Octochlorobiphenyl |
| **PCB Surrogates** |
| 3,5-Dichlorobiphenyl |
| 2,3,5,6-Tetrachlorobiphenyl |
| 2,2',4,4',6,6'-Hexachlorobiphenyl |

Table 12. Elements analyzed in eggs.

| |
|---|
| Ag |
| As |
| Ba |
| Be** |
| Cd |
| Co |
| Cr |
| Cu |
| Hg |
| Mn |
| Pb |
| Sb* |
| Se |
| Tl |
| Zn |

Table 13. PAH compounds analyzed in the eggs.

| |
|---|
| Acenaphthene |
| Acenaphthylene |
| Anthracene |
| Benzo(a)anthracene |
| Chrysene |
| Benzo(a)pyrene** |
| Benzo(b)fluoranthene** |
| Benzo(k)fluoranthene** |
| Benzo(g,h,I)perylene** |
| Dibenzo(a,h)anthracene |
| Indeno(1,2,3-cd)perylene** |
| Fluoranthene |
| Fluorene |
| Phenanthrene |
| Pyrene |

### 3.1 Preliminary Results of Polyaeromatic Hydrocarbons and Insecticides

Table 14 contains the raw preliminary results of the polyaeromatic hydrocarbons for 33 western bluebird and ash-throated flycatcher samples. There were no eggs with obvisouly high residue amounts for polyaeromatic hydrocarbons. Although a western bluebird nest from TA-35 in 2002 contained higher PAHs across the board. There was also an ash-throated flycatchers for Bayo canyon in 2001 that was the only nest to contain Indeno(1,2,3-cd)perylene and at an extremely high level of 190 ug/g.

Table 14. Polyaromatic hydrocarbons (ng/g) for western bluebirds and ash-throated flycatchers from 1997-2003 on LANL

| | | | Polyaromatic Hydrocarbons[1] | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Species | Year | Location | ACY | ACE | ANT | BAA | CHR | BBF | BKF | FLA | FLU | PHE | PYR | BAP | IPE |
| ATFL | 2001 | Mortandad | 15 | ND | 15 | 15 | 15 | ND | ND | 15 | 15 | 15 | 15 | ND | ND |
| WEBL | 2002 | Mortandad | 117 | 117 | 117 | ND | 117 | ND | ND | 117 | 117 | 117 | 117 | ND | ND |
| WEBL | 2001 | Mortandad | 14 | ND | 14 | 14 | 14 | ND | ND | 14 | 14 | 14 | 14 | ND | ND |
| WEBL | 1997 | Mortandad | 12 | 12 | 12 | 12 | 12 | ND | ND | 12 | 12 | 12 | 12 | ND | ND |
| WEBL | 1998 | Mortandad | 16 | 16 | 16 | 16 | 16 | ND | ND | 16 | 16 | 16 | 16 | ND | ND |
| ATFL | 1998 | Mortandad | 12 | 12 | 12 | 12 | 12 | ND | ND | 12 | 12 | 12 | 12 | ND | ND |
| ATFL | 1998 | Pueblo | 6 | 6 | 6 | ND | ND | ND | ND | 6 | 6 | 6 | 6 | ND | ND |
| WEBL | 2001 | Sandia | 10 | 10 | 10 | 10 | 10 | ND | ND | 10 | 10 | 10 | 10 | ND | ND |
| ATFL | 2001 | Sandia | 11 | 11 | 11 | 11 | 11 | ND | ND | 11 | 11 | 11 | 11 | ND | ND |
| WEBL | 1998 | Water | 9 | 9 | 9 | 9 | 12 | ND | ND | 9 | 9 | 9 | 9 | ND | ND |
| AFTL | 1997 | Bayo | ND | 20 | ND | ND | 20 | ND | ND | 20 | 20 | 20 | 20 | ND | ND |
| WEBL | 1999 | Bayo | ND | 13 | 13 | ND | 13 | ND | ND | 13 | 13 | 13 | 13 | ND | ND |
| WEBL | 1998 | Bayo | 5 | 5 | 5 | ND | 5 | ND | ND | 5 | 5 | 5 | 5 | ND | ND |
| WEBL | 1998 | Cemetery | 7 | 7 | 7 | ND | 7 | ND | ND | 7 | 7 | 7 | 7 | ND | ND |
| WEBL | 1997 | Cemetery | 11 | 11 | 11 | 11 | 11 | ND | ND | 11 | 11 | 11 | 11 | ND | ND |
| WEBL | 2001 | DP | 13 | 13 | 13 | 13 | 13 | ND | ND | 13 | 13 | 13 | 13 | ND | ND |
| WEBL | 1998 | Cemetery | 18 | 18 | 18 | 18 | 18 | ND | ND | 18 | 18 | 18 | 18 | ND | ND |

Table 14 cont.

| | | | Polyaromatic Hydrocarbons | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Species | Year | Location | ACY | ACE | ANT | BAA | CHR | BBF | BKF | FLA | FLU | PHE | PYR | BAP | IPE |
| WEBL | 1998 | Cemetery | 15 | 15 | 15 | 15 | 15 | ND | ND | 15 | 15 | 15 | 15 | ND | ND |
| WEBL | 2002 | Golf | 12 | 12 | 12 | 12 | 12 | ND | ND | 12 | 12 | 12 | 12 | ND | ND |
| ATFL | 1999 | LA | 17 | 17 | 17 | ND | 17 | ND | ND | 17 | 17 | 17 | 17 | ND | ND |
| ATFL | 2001 | LA | 12 | 12 | 12 | ND | 12 | ND | ND | 12 | 12 | 12 | 12 | ND | ND |
| WEBL | 2002 | TA-35 | ND | 54 | 54 | 54 | 54 | ND | ND | ND | 54 | 54 | 54 | ND | ND |
| WEBL | 1998 | Ancho C | 12 | 12 | 12 | 12 | 12 | ND | ND | 12 | 12 | 12 | 12 | ND | ND |
| WEBL | 1999 | Ancho C | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 14 | ND |
| WEBL | 1999 | Bayo | ND | ND | 32 | 32 | ND | ND | ND | 32 | 32 | 32 | 32 | ND | ND |
| ATFL | 2001 | Bayo | ND | ND | ND | ND | 39 | 39 | 39 | 36 | 39 | 39 | 39 | 78 | 190 |
| WEBL | 2002 | Bayo | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | 8 | ND | ND |
| WEBL | 1997 | Bayo | 14 | 14 | ND | 12 | 14 | ND | ND | 14 | 14 | 14 | 14 | ND | ND |
| WEBL | 1999 | Bayo | 16 | ND | ND | 16 | 16 | ND | ND | ND | 16 | 16 | 26 | ND | ND |
| WEBL | 1999 | Bayo | ND | 23 | ND | ND | ND | ND | ND | 23 | 23 | 23 | 23 | ND | ND |
| ATFL | 1999 | Bayo | 4 | 4 | 4 | 4 | 4 | ND | ND | 4 | 4 | 4 | 4 | 8 | ND |
| WEBL | 1997 | Bayo | 12 | 12 | 12 | ND | 12 | ND | ND | 12 | 12 | 12 | 12 | ND | ND |

[1] There was no detectable amounts of BGP and DBA.

The most common chlorinated insecticide was 4,4' –DEE with 100% of the eggs containing detectable levels. The range for 4,4' –DEE was 8 to 282 ug/g (wet weight) in eggs from Sandia canyon. This Sandia clutch did not contain an abnormally high contaminants. All three of the golf course clutches contained high amounts of t-nonachlor, α-hexachlorocyclohexane, and Oxychlordane. Dieldrin was also detected in all but two of the of the egg samples with a range of 1 to 8 ug/g. All analysis will be completed in the fall of 2003 that will include radionuclide results as well.

Table 15. Chlorinated insecticides (ng/g wet wt.) for western bluebirds and ash-throated flycatchers from 1997-2003 on LANL

| Species | Year | Location | a-BHC | p-BHC | a-Chlordane | y-Chlordane | DDD | DDE | DDT | Dieidrin | Heptachior | Lindane | Methoxychior | t-nonachlor | HPX+OXC | HPX | OXC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ATFL | 2001 | Mortandad | ND | ND | ND | ND | ND | 17 | ND | 3 | ND | <1 | ND | <1 | <3 | <3 | ND |
| WEBL | 2002 | Mortandad | ND | ND | ND | ND | ND | 53 | ND | <11 | ND | ND | ND | ND | <22 | <22 | ND |
| WEBL | 2001 | Mortandad | ND | ND | ND | ND | <1 | 23 | ND | <1 | ND | ND | ND | <1 | <3 | NR | <3 |
| WEBL | 1997 | Mortandad | ND | ND | ND | ND | <1 | 10 | 1 | <1 | ND | ND | ND | <1 | <2 | NR | <2 |
| WEBL | 1998 | Mortandad | ND | ND | ND | ND | <1 | 18 | 2 | <1 | ND | ND | ND | <1 | <3 | <3 | ND |
| ATFL | 1998 | Mortandad | ND | ND | ND | ND | <1 | 53 | 8 | ND | ND | ND | ND | <1 | <2 | NR | <2 |
| ATFL | 1998 | Pueblo | ND | ND | ND | ND | ND | 3 | 0.8 | 0.8 | ND | ND | ND | 0.9 | <1 | NR | <1 |
| WEBL | 2001 | Sandia | ND | ND | <0.9 | ND | <0.9 | 282 | 2 | ND | ND | ND | ND | 4 | 4 | ND | 4 |
| ATFL | 2001 | Sandia | ND | ND | ND | ND | <1 | 26 | ND | ND | ND | ND | ND | <1 | <2 | NR | <2 |
| WEBL | 1998 | Water | ND | ND | <0.8 | ND | <0.8 | 5 | <0.8 | <0.8 | ND | ND | ND | 4 | 2 | NR | 3 |
| AFTL | 1997 | Bayo | ND | ND | <2 | ND | ND | 68 | ND | 5 | ND | ND | ND | <2 | <4 | NR | 6 |
| WEBL | 1999 | Bayo | ND | ND | ND | ND | ND | 40 | ND | 2 | ND | ND | ND | 4 | 5 | NR | 7 |
| WEBL | 1998 | Bayo | ND | ND | ND | ND | ND | 16 | 2 | 0.6 | ND | 0.4 | <1 | 0.9 | 2 | 0.4 | 2 |
| WEBL | 1998 | Cemetery | ND | ND | ND | ND | ND | 167 | 2 | 2 | ND | <0.6 | <1 | 2 | 4 | NR | 5 |
| WEBL | 1997 | Cemetery | ND | ND | ND | ND | <1 | 26 | 2 | <1 | ND | <1 | <2 | <1 | <2 | NR | <2 |
| WEBL | 2001 | DP | ND | ND | ND | ND | <1 | 118 | 7 | 8 | ND | <1 | ND | <1 | 8 | 0.6 | 7 |

Table 15 Cont. Chlorinated insecticides (ng/g wet wt.) for western bluebirds and ash-throated flycatchers from 1997-2003 on LANL

| Species | Year | Location | a-BHC | p-BHC | a-Chlordane | y-Chlordane | DDD | DDE | DDT | Dieidrin | Heptachior | Lindane | Methoxychior | t-nonachlor | HPX+OXC | HPX | OXC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| WEBL | 1998 | GC | ND | ND | 2 | ND | ND | 160 | ND | 5 | ND | ND | ND | 23 | 48 | 8 | 40 |
| WEBL | 1998 | GC | ND | ND | <1 | ND | ND | 136 | ND | 5.0 | ND | ND | ND | 19 | 51 | 16 | 35 |
| WEBL | 2002 | Golf | ND | ND | <1 | ND | ND | 41 | ND | 5 | ND | ND | <1 | 2 | 10 | 0.4 | 10 |
| ATFL | 1999 | LA | ND | ND | <1 | ND | ND | 21 | ND | 2 | ND | ND | ND | <2 | 4 | NR | <4 |
| ATFL | 2001 | LA | ND | ND | ND | ND | ND | 64 | ND | 2 | ND | ND | ND | <1 | <2 | <2 | ND |
| WEBL | 2002 | TA-35 | ND | ND | ND | 10 | ND | 52 | <5 | <5 | ND | ND | ND | <5 | <10 | <10 | ND |
| WEBL | 1998 | Ancho C | ND | ND | <1 | ND | ND | 8 | ND | <1 | ND | ND | <2 | <1 | <2 | NR | <2 |
| WEBL | 1999 | Ancho C | <1 | ND | <0.6 | ND | ND | 12 | ND | 4 | ND | ND | <2 | 0.7 | <1 | NR | <1 |
| WEBL | 1999 | Bayo | ND | ND | ND | ND | ND | 60 | <3 | <3 | ND | ND | ND | <3 | <6 | NR | <6 |
| ATFL | 2001 | Bayo | ND | ND | <4 | ND | ND | 71 | ND | <4 | ND | ND | ND | <4 | <7 | NR | <10 |
| WEBL | 2002 | Bayo | ND | ND | <0.7 | ND | <0.7 | 14 | ND | 1 | ND | ND | <2 | <0.7 | <2 | NR | <2 |
| WEBL | 1997 | Bayo | ND | ND | ND | ND | ND | 89 | 2 | 2 | ND | ND | ND | 1 | 5 | NR | 6 |
| WEBL | 1999 | Bayo | ND | ND | ND | ND | <1 | 40 | 2 | 4.0 | ND | ND | 3 | 2 | 12 | 0.7 | 11 |
| WEBL | 1998 | Bayo | ND | ND | ND | ND | <2 | 88 | 3 | <2 | <2 | ND | ND | <2 | 4 | NR | 8 |
| ATFL | 1999 | Bayo | ND | ND | <0.3 | ND | 0.4 | 19 | 1 | 1 | 0.4 | <0.3 | 2 | 0.6 | 1 | ND | 1 |
| WEBL | 1997 | Bayo | ND | ND | ND | ND | ND | 20 | ND | 3 | ND | ND | ND | <1 | 3 | NR | 4 |

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