Nest Box Monitoring Report for the Upper Pajarito Canyon Watershed

Introduction

This report presents analytical data obtained in 2010 from insect samples collected in the upper Pajarito Canyon watershed at Los Alamos National Laboratory (LANL or Laboratory), as specified in the "Nest Box Monitoring Plan for the Upper Pajarito Canyon Watershed" (the monitoring plan) (LANL 2009, 108170) and approved by the New Mexico Environment Department (NMED) (2010, 109015). This report addresses uncertainties in exposure from chemicals of potential ecological concern (COPECs) for invertebrate-eating birds.

The study design COPECs for the cavity-nesting bird studies that are included in this report are the metals cadmium, copper, lead, mercury, vanadium, and zinc and the polychlorinated biphenyls (PCBs) Aroclor-1248 and Aroclor-1254, based on the evaluation presented in the "Pajarito Canyon Investigation Report, Revision 1" (PCIR) (LANL 2009, 106939, p. 77). As discussed in the PCIR, insects collected from nest boxes in five sediment investigation reaches in 2007 were analyzed for inorganic COPECs. The concentrations of some COPECs in insects collected from a single location in reach AW-1 were greater than other Pajarito watershed insect samples and were well outside the range of concentrations reported from other canyons. In addition, no analyses were obtained for mercury or PCBs because of insufficient sample mass. The single set of relatively high results, the small number of samples, and the incomplete analytical suite resulted in uncertainties concerning potential ecological risk. Therefore, additional analytical data were obtained from insect samples collected in 2009 to address these uncertainties.

Approach

Insects collected from nest boxes occupied in 2009 in reaches AW-1, PAS-1E, and TWSE-1W, which are close to contaminant sources, were analyzed for key COPECs, as allowed by available sample mass and target detection limits and as specified in the monitoring plan (LANL 2009, 108170). In addition, analyses were performed on insect samples collected from nest boxes on an adjacent mesa in Technical Area 14 (TA-14), which serves as a local reference area. The monitoring plan also specified analyses of insects collected from a downcanyon reach, PA-2W, but sample mass was not sufficient for any analyses from this reach. Nest box locations are shown in Figure 8.1-1 of the PCIR (LANL 2009, 106939, p. 145). Insects were sorted from other items collected from the nest boxes, weighed, and identified before analysis. Insects from each reach were composited to increase sample mass before submittal to analytical laboratories.

Insect samples were analyzed using up to three methods, dependent on available sample mass. Metals obtained with the U.S. Environmental Protection Agency (EPA) Method 6010A (including cadmium, copper, lead, vanadium, and zinc) were obtained first, followed by mercury using EPA Method 7471 and PCBs using EPA Method 8082, if sufficient sample mass was available. The target detection limits are specified in the monitoring plan (LANL 2009, 108170). Table 1 presents dry weights for insects collected from each area in 2009 and analyses performed. Concentrations of COPECs in insects from 2007 and 2009 were qualitatively tested for relationships with reproductive parameters of nest productivity.

Results

The insects collected from nest boxes in the three reaches and the TA-14 reference area in 2009 had sufficient mass for analyses of metals using EPA Method 6010A and mercury using EPA Method 7471. In addition, there was sufficient sample mass to analyze the insects collected from reach TWSE-1W for PCBs. These data are presented in Attachment 1 (on CD included with this document).

Table 2 presents a comparison of metals concentrations in the 2009 samples with previous data obtained from the Pajarito watershed in 2007 (LANL 2009, 106939) and other areas in 2005 (Colestock 2007, 102994). The concentrations of all metals in this table from the 2007 AW-1 samples, except copper, were higher than all other samples in this data set, showing that the 2007 AW-1 results were anomalously high and were not reproduced in the 2009 samples. The concentrations reported for the 2009 insect samples were within the range of values reported from the other sites with the exception of cadmium and lead, which were highest in AW-1. Therefore, the analytical data from 2009, in combination with the 2007 data, indicate elevated cadmium and lead in insects in this reach. These metals also have higher concentrations in sediment samples from AW-1 than the other reaches sampled for insects (LANL 2009, 106939).

The potential dose to robins as representative invertebrate-eating birds was calculated using the metals concentrations in the insects collected from the nest boxes, following the process used in previous investigations (LANL 2009, 106939). The equation for calculating hazard quotients (HQs) was presented in Section 8.1.3.2 of the PCIR (LANL 2009, 106939, p. 74), and exposure parameters for the robin are from the screening-level ecological risk assessment methods document (LANL 2004, 087630, p. 37) and are listed in Appendix E-1.0 of the PCIR (LANL 2009, 106939). The toxicity reference values (TRVs) used for the robin are from the Ecorisk Database, Version 2.4 (LANL 2009, 107524), and the TRVs for cadmium, copper, and zinc differ from those used in the PCIR (although none of these had any significant changes).

Table 3 shows the calculated HQs for the robin based on exposure to concentrations measured in nest box insects. In all cases, there is a single sample result for insects in each reach for a given year. Table 3 displays all results for the food pathway if the HQ for a COPEC in any reach was greater than 1. Aroclor-1248 and Aroclor-1254, which were study design COPECs for avian studies, were not detected in the TWSE-1W sample and were not included in the exposure evaluation. Aroclor-1260 was detected in reach TWSE-1W insects, and the associated pathway HQ was 0.1.

The HQs for the insect ingestion pathway are shown in Table 3 and predict a potential for adverse ecological effects. The exposure evaluation for the robin also identifies reaches where COPECs have HQs greater than 1. HQs greater than 1 were observed for all reaches or locations where insects were sampled (AW-1, PAS-1E, PA-2W, PA-3E, TWSE-1W, and TA-14 mesa). Note that the TA-14 mesa location was selected as a reference comparison location for the Pajarito watershed reaches.

Calculating exposure to be greater than the effect level (as the HQ > 1 suggests) is one factor in establishing a linkage between contamination and ecological effects. Another consideration is the relationship of exposure to potential contamination sources. In the Pajarito watershed, reaches AW-1, PAS-1E, and TWSE-1W are closest to contaminant sources and therefore are expected to have greater levels of contamination than other reaches. Reaches AW-1 and PAS-1E have the highest exposure concentrations and HQs for the 2007 insect pathway results for five of the six COPECs in Table 3 (all but copper). This trend does not hold for the majority of the 2009 insect sample results, and potential exposures (HQs) are comparable for four of the six COPECs (copper, mercury, vanadium, and zinc). However, insect concentrations of cadmium and lead in 2009 are greatest in reach AW-1, with lower concentrations reported in PAS-1E and other locations (Table 3). Therefore, concentrations of cadmium and lead in insects represent a potential for adverse ecological effects (based on the HQ > 1), and their distribution is consistent with a Laboratory source. Other than the 2007 samples, the maximum HQs for cadmium and lead were between 1 and 3.

Other lines of evidence for evaluating risks to cavity-nesting birds include field measures of nest success. Such studies have not identified any potential for ecological risk in the Pajarito watershed. For example, robust evaluations based on a long record of observations of sex ratios of fledgling birds have shown no statistically significant differences in sex ratios between canyons or watersheds (Fair et al. 2009, 106686). Thus, there is no indication of contaminant effects on sex ratios across the monitoring network or based on the field measures of nest success evaluated in this report. Overall, the weight-of-evidence indicates that COPECs in the Pajarito reaches do not pose a potential risk to population abundance or persistence and species diversity of avian ground invertivore feeding guild species.

In conclusion, further characterization of cavity-nesting birds and their food for metals in the Pajarito watershed reaches is not warranted based on the exposure evaluation calculated using nest box insects collected in 2009. However, no PCB data have been obtained from insects from the reach with the highest concentrations in sediment, AW-1, and potential effects of PCBs on cavity-nesting birds in this reach remains an uncertainty. Therefore, it is proposed that the Laboratory will submit insects collected in 2010 from nest boxes in the upper Pajarito Canyon watershed reaches for PCB analyses if sufficient sample mass is available. If sample mass is insufficient for PCB analyses, samples from 2010 will be combined with samples from subsequent years. These data will be reported by August 31, 2011, or by August 31 of subsequent years if sample submission is delayed because of insufficient sample mass.

References

The following list includes all documents cited in this report. Parenthetical information following each reference provides the author(s), publication date, and ER ID. This information is also included in text citations. ER IDs are assigned by the Environmental Programs Directorate's Records Processing Facility (RPF) and are used to locate the document at the RPF and, where applicable, in the master reference set.

Copies of the master reference set are maintained at the New Mexico Environment Department Hazardous Waste Bureau and the Directorate. The set was developed to ensure that the administrative authority has all material needed to review this document, and it is updated with every document submitted to the administrative authority. Documents previously submitted to the administrative authority are not included.

Colestock, K.L., 2007. "Landscape Scale Assessment of Contaminant Effects on Cavity-Nesting Birds," master's thesis for a Master of Science in Ecology, Utah State University, Logan, Utah. (Colestock 2007, 102994)

Fair, J.M., R.T. Ryti, M.D. Jankowski, and S.L. Reneau, August 10, 2009. "Sex Ratio and Contaminant Impacts on Reproduction: Adaptive and Environmental Constraints," Los Alamos National Laboratory document LA-UR-09-05092, Los Alamos, New Mexico. (Fair et al. 2009, 106686)

LANL (Los Alamos National Laboratory), December 2004. "Screening-Level Ecological Risk Assessment Methods, Revision 2," Los Alamos National Laboratory document LA-UR-04-8246, Los Alamos, New Mexico. (LANL 2004, 087630)

LANL (Los Alamos National Laboratory), August 2009. "Pajarito Canyon Investigation Report, Revision 1," Los Alamos National Laboratory document LA-UR-09-4670, Los Alamos, New Mexico. (LANL 2009, 106939)

LANL (Los Alamos National Laboratory), December 2009. "Nest Box Monitoring Plan for the Upper Pajarito Canyon Watershed," Los Alamos National Laboratory document LA-UR-09-8073, Los Alamos, New Mexico. (LANL 2009, 108170)

LANL (Los Alamos National Laboratory), December 2009. "Ecorisk Database (Release 2.4)," on CD, LA-UR-09-7834, Los Alamos National Laboratory, Los Alamos, New Mexico. (LANL 2009, 107524)

NMED (New Mexico Environment Department), February 12, 2010. "Notice of Approval, Nest Box Monitoring Plan for the Upper Pajarito Canyon Watershed," New Mexico Environment Department letter to G.J. Rael (DOE-LASO) and M. Graham (LANL) from J.P. Bearzi (NMED-HWB), Santa Fe, New Mexico. (NMED 2010, 109015)

Table 1
Nest Box Insect Samples Collected and Analyses Performed

Area	Sample ID	Location ID	EPA 6010A Metals and EPA 7471 Mercury	PCBs	Nest Box Numbers	Sample Weight (g)	Average Sample Weight per Box (g)
Reach AW-1	CAPA-10-15045	PA-611896	X	—*	843, 844, 845, 847, 848	2.25	0.45
Reach PAS-1E	CAPA-10-15046	PA-611897	X	—	850, 852, 854, 855, 856, 857	2.50	0.42
Reach TWSE-1W	CATW-10-15049	TW-611900	X	X	831, 832, 833, 834, 835, 836, 837, 839, 840, 841	7.92	0.79
TA-14 mesa	CAPA-10-15048	PA-611899	X	—	823, 826, 827, 830	2.20	0.55

* — = No analyses performed.

Table 2
Comparison of Metals Concentrations in Insects

COPEC	Reach AW-1 2009 Concentration (mg/kg)	Reach AW-1 2007 Concentration (mg/kg)	2009 Concentration Range (mg/kg)	2007 Concentration Range, Excluding AW-1 (mg/kg)	2005 Concentration Range (mg/kg)
Cadmium	2.1	7.7	0.29–2.1	0.27–1.2	0.015–0.72
Copper	11	38	11–17	11–45	0.85–93
Lead	2.8	130	0.81–2.8	0.45–1.7	0.024–1.8
Mercury	0.044	—*	0.037–0.076	—	—
Vanadium	0.67	4.1	0.59–1.9	0.39–1.5	0.24–3.6
Zinc	95	5000	95–120	88–220	8.6–210

* — = No data.

Table 3
Exposure Evaluation for the Robin Based on the Insect Pathway

COPEC	Year	Reach	Sample Result (mg/kg)	Pathway HQ
Cadmium	2007	AW-1	7.7	8.0
		PAS-1E	1.2	1.2
		PA-3E	0.82	0.8
		TWSE-1W	0.33	0.3
		PA-2W	0.27	0.3
	2009	AW-1	2.1	2.2
		PAS-1E	0.5	0.5
		TWSE-1W	0.34	0.4
		TA-14 mesa	0.29	0.3
Copper	2007	PA-3E	45	16.9
		AW-1	38	14.3
		PA-2W	25	8.4
		TWSE-1W	18	6.8
		PAS-1E	11	4.1
	2009	PAS-1E	17	6.4
		TWSE-1W	17	6.4
		TA-14 mesa	14	5.3
		AW-1	11	4.1
Lead	2007	AW-1	130	121
		PAS-1E	1.7	1.6
		TWSE-1W	1.6	1.5
		PA-3E	1.5	1.4
		PA-2W	0.45	0.4
	2009	AW-1	2.8	2.6
		PAS-1E	2.4	2.2
		TWSE-1W	1.8	1.7
		TA-14 mesa	0.81	0.8
Mercury	2009	TA-14 mesa	0.076	6.1
		TWSE-1W	0.059	4.7
		AW-1	0.044	3.5
		PAS-1E	0.037	3.0

Table 3 (continued)

COPEC	Year	Reach	Sample Result (mg/kg)	Pathway HQ
Vanadium	2007	AW-1	4.1	18.1
		PAS-1E	1.5	6.6
		TWSE-1W	1.4	6.2
		PA-3E	1.1	4.9
		PA-2W	0.39	1.7
	2009	TWSE-1W	1.9	8.4
		PAS-1E	1.7	7.5
		AW-1	0.67	3.0
		TA-14 mesa	0.59	2.6
Zinc	2007	AW-1	5000	115
		PA-3E	220	5.1
		PAS-1E	180	4.1
		PA-2W	100	2.3
		TWSE-1W	88	2.0
	2009	TA-14 mesa	120	2.8
		TWSE-1W	110	2.5
		PAS-1E	100	2.3
		AW-1	95	2.2

Note: Cells are highlighted if the HQ is >1.