Spatial Patterns of Atmospherically Deposited Organic Contaminants at High-Elevation in the Southern Sierra Nevada Mountains, California

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Abstract

Atmospherically deposited organic contaminants in the Sierra Nevada mountains of California have been implicated in adversely affecting amphibians and fish, yet the distributions and concentrations in the highest-elevation areas remain largely unknown. We tested the hypothesis that concentrations are highest in high-elevation areas of Southern Sierra Nevada and lowest in the San Joaquin Valley, the nearest lower-elevation area. We sampled air, sediment, and tadpoles at 12 sites in 10 dispersed areas (Period 1: 2005; Period 2: 2006) across a 140-km transect from the San Joaquin Valley edge to high-elevation areas. Air was sampled in air filters, sediment in cores retrieved from lakes and ponds, and tadpoles of a non-declining, abundant species (Pseudacris sierra) in refuges within the high-elevation areas. Concentrations of all contaminants (pesticides and polychlorinated biphenyls/polycyclic aromatic hydrocarbons) were generally similar among sites, and there was no evidence of higher concentrations near the San Joaquin Valley. The general relationship of concentrations with distance from the Valley was negatively related. However, the magnitude of these distance effects among high-elevation sites was small relative to differences found in other studies between the valley edge and the nearest high-elevation site.

Introduction

Previous studies of pesticide contamination of freshwater and biota through air deposition from the watershed of the San Joaquin Valley have shown that pesticide concentrations generally decline from the Valley edge to the crest of the Sierra Nevada with distance away from the Valley [1, 2]. Our results suggest that this gradient is true for high-elevation areas as well. However, values generally concur with previous studies, as sites in high-elevation areas were subject to lower contamination inputs than those in lower-elevation areas due to lower atmospheric deposition rates and lower population densities of amphibians and other biota. Thus, the primary reason for lower contamination inputs at high-elevation sites is likely increased distance from the Valley.

Objective

The present study tested the hypothesis that atmospherically deposited pesticides and polychlorinated biphenyls/polycyclic aromatic hydrocarbons are generally greater in lower-elevation areas than in high-elevation areas. This gradient is due to lower deposition rates at high-elevation areas than at low-elevation areas. We tested this hypothesis by measuring air, sediment, and tadpole concentrations at 10 dispersed areas across a 140-km transect from the San Joaquin Valley edge to the high-elevation areas of the Southern Sierra Nevada. These areas were sampled at two time periods (Period 1: 2005; Period 2: 2006). The primary reason for this gradient is likely increased distance from the Valley.

Methods

- The study area was Sequoia and Kings Canyon National Parks, California, at high-elevation sites (Fig. 1).
- Tadpole samples were collected during June through September of various years.
- Air, sediment, and tadpole samples were collected from 10 dispersed areas across a 140-km transect from the San Joaquin Valley edge to high-elevation areas.
- Air was sampled in air filters, sediment in cores retrieved from lakes and ponds, and tadpoles of a non-declining, abundant species (Pseudacris sierra) in refuges within the high-elevation areas.
- Concentrations of all contaminants (pesticides and polychlorinated biphenyls/polycyclic aromatic hydrocarbons) were generally similar among sites, and there was no evidence of higher concentrations near the San Joaquin Valley.
- The general relationship of concentrations with distance from the Valley was negatively related. However, the magnitude of these distance effects among high-elevation sites was small relative to differences found in other studies between the valley edge and the nearest high-elevation site.

Results and Discussion

- Air concentrations were generally higher in low-elevation areas than in high-elevation areas.
- Sediment, PCB 187, and PAH 6 were significantly higher in low-elevation areas than in high-elevation areas.
- Results of principal component analysis (eight chemicals and PAH 6) suggested that the overall chemical composition of air, sediment, and tadpoles was similar across all sampling sites.
- Concentrations of most chemicals were generally similar among sites, and there was no evidence of higher concentrations near the San Joaquin Valley.
- The general relationship of concentrations with distance from the Valley was negatively related. However, the magnitude of these distance effects among high-elevation sites was small relative to differences found in other studies between the valley edge and the nearest high-elevation site.

Conclusions

- Air concentrations were generally higher in low-elevation areas than in high-elevation areas.
- Sediment, PCB 187, and PAH 6 were significantly higher in low-elevation areas than in high-elevation areas.
- Results of principal component analysis (eight chemicals and PAH 6) suggested that the overall chemical composition of air, sediment, and tadpoles was similar across all sampling sites.
- Concentrations of most chemicals were generally similar among sites, and there was no evidence of higher concentrations near the San Joaquin Valley.

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