Pesticides and Degradates (including Triazines) in Ground Water and Seepage Lakes in a Sand Aquifer: Implications for Persistence and Fate

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Significant hydraulic exchange occurs between ground water and lakes on the Lake Wales Ridge (the "Ridge", in this paper), a 1,800-km² region in central Florida that contains more than 200 seepage lakes[4]. The Ridge is particularly vulnerable to leaching of agrichemicals as a result of seasonally high precipitation, extensive citrus agriculture, and highly permeable sandy soils containing minimal organic matter. Pesticide concentrations in ground water and lake samples on the Ridge are elevated compared to concentrations in ground water and streams in agricultural areas nationally in the United States, confirming this vulnerability. Nitrate concentrations are also elevated in the region where maximum nitrate (as N) concentrations ranged from 12 to 71 mg/L among sampled wells and from 1.0 to 4.7 mg/l among most of the sampled lakes.

Sampling of eight Ridge lakes (surface area: 2 to 159 hectares) and ground water from 31 wells tapping the surficial aquifer (median depth to water table: 11 meters) yielded detections of 23 pesticides or degradates, some of which also occur relatively frequently in urban/suburban waters and in municipal water supplies nationally. Concentrations of simazine, norflurazon, diuron, and aldicarb, and their degradates are indicative of pesticide transport and degradation processes in Ridge ground water and lakes. Triazine pesticide degradates analyzed in the study included deisopropylatrazine (DIA; CEAT[5]), didealkylatrazine (DDA; CAAT[5]), deethylatrazine (DEA; CIAT[5]), deethylhydroxyatrazine (DEHA; OIAT[5]), deisopropylhydroxyatrazine (DIHA; OEAT[5]), hydroxyatrazine (HA; OIET[5]), and hydroxysimazine (HS; OEET[5]), with DIA, DDA, DEA, DIHA, HS, and HA detected in water samples. Simazine is the principal parent triazine pesticide; atrazine is not applied in Florida's citrus areas. Concentrations of pesticides and degradates were typically lower in samples from lakes compared to ground water, often by an order of magnitude or more. This pattern likely reflects chemical degradation and dilution as ground water moves through the subsurface into the lakes and the increased opportunity for biogeochemical degradation (including photolysis), sorption, and dilution of pesticides within the lakes compared to the ground-water system. Also, the ratios of pesticide degradate-to-parent concentrations typically were greater in lakes than in ground water, consistent with degradation along ground-water flow paths to the lakes and with further chemical breakdown within the lakes. Based on limited sampling in four study lakes, differences in pesticide and degradate concentrations between shallow and deep zones of the lake water column were notable only for norflurazon and its degradate. Norflurazon and demethyl norflurazon concentrations and parent-degradate ratios indicated more rapid degradation of norflurazon in shallow zones (1.5-meter sample depth) compared to deep zones near lake bottoms (6- to 14-meters), likely attributable in part to photodegradation by sunlight in these clear-water lakes (Secchi depths: 3.8 to 6.4 meters). Quarterly samples indicated that norflurazon concentrations were lowest during summer in nearly all sampled lakes. Detections of 20 pesticides or degradates in the lakes, including 12 compounds exceeding the 0.06-µg/L common reporting level and 11 compounds detected in more than half of the sampled lakes, indicate their persistence in the region's ground-water / lake systems and suggest relatively rapid ground-water transit times.

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[2] Current affiliation: Minnesota Pollution Control Agency, St. Paul, MN.
[3] Retired.
[4] Lakes which are fed predominantly by ground-water inflow as opposed to surface-water inflow.
[5] Refers to nomenclature recommended by the International Union of Pure and Applied Chemistry (IUPAC), at http://www.acdlabs.com/iupac/nomenclature/ .