EVALUATING REGIONAL TRENDS IN GROUND-WATER NITRATE CONCENTRATIONS OF THE COLUMBIA BASIN GROUNDWATER MANAGEMENT AREA, WASHINGTON

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The Columbia Basin Groundwater Management Area (GWMA) includes Adams, Franklin, and Grant Counties in eastern Washington, encompassing an area of 5,985 mi^2 (figure 1). The Columbia Basin is one of the Nation's top two producers of potatoes and wheat and is a significant producer of apples and many specialty crops. Much of the southeastern part of the GWMA is intensively irrigated with Columbia River water, whereas dryland or ground-water-irrigated farming and rangeland grazing dominate other parts of the GWMA. More than 80 percent of drinking water in the Columbia Basin comes from ground water.

In a recent study of nitrite plus nitrate as nitrogen (hereafter referred to as nitrate) in ground water in Adams, Franklin, and Grant Counties, the concentrations of nitrate in 23 percent of the more than 550 wells that were sampled exceeded the U.S. Environmental Protection Agency maximum contaminant level (MCL) for nitrate in drinking water of 10 mg/L, and concentrations in an additional 37 percent of the wells were between 3 and 10 mg/L. Concentrations of nitrate greater than 3 mg/L usually are indicative of anthropogenic impacts on ground water. The Columbia Basin GWMA was formed in 1998 with the goal of reducing concentrations of nitrate in ground water of the area by implementing agricultural best management practices including improving irrigation water management and using nutrient management guidelines for fertilizer use. As part of the GWMA's ground-water monitoring activities, water samples are collected every 2 years from wells in 17 sampling subregions (figure 1), defined geographically by irrigation systems, natural boundaries, and communities. Most of the subregions are dominated by irrigated agricultural lands with the exception of Hartline, Adams Dryland, Esquatzel, and Franklin Dryland, which are predominately dryland agriculture, and Range, which is predominately rangeland. The goal of this study is to evaluate changes (trends) of nitrate concentrations in ground water to determine if the GWMA is meeting its goal of reducing nitrate concentrations.

Methods

- Datasets analyzed include 474 wells in Grant, Adams, and Franklin Counties with data from 1998 to 2002 and 51 wells in the irrigated agricultural areas of Franklin County with data from 1986 to 2003 (figure 1).
- The Friedman test was used to determine if there was any statistically significant differences between the data collection years.
- The seasonal Kendall test for trends was modified into a regional Kendall test by using individual well locations as the 'season' variable. This allowed for the determination of whether a trend existed across a particular region. The effects of well depth on nitrate concentrations (figure 2) was subtracted out prior to trend analysis so that well water concentrations could be compared regardless of the depth.

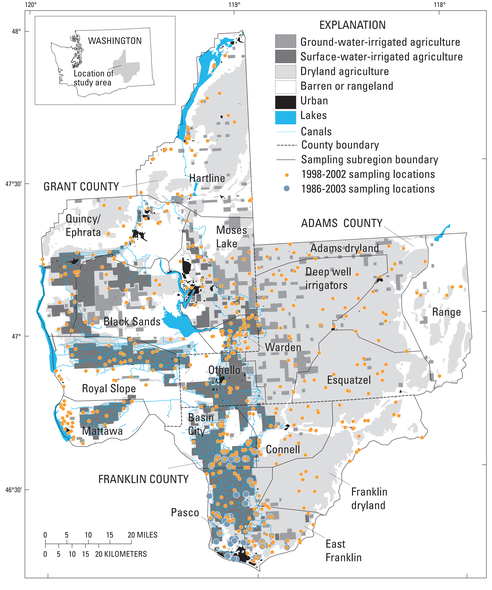

Figure 1. Major land use categories and locations of wells sampled for nitrate concentrations in the Columbia Basin Groundwater Management Area, Washington.

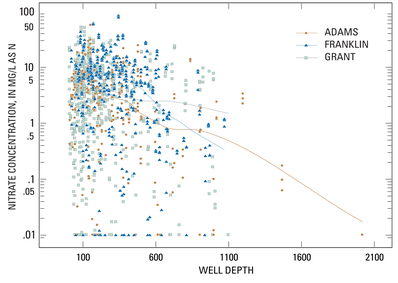

Figure 2. LOWESS smooth of nitrate concentrations in ground water by well depth in Adams, Franklin, and Grant Counties, Washington.

Trends From 1998 to 2002

- LOWESS (locally weighted scatterplot smoothing) smooths indicate that nitrate concentrations in Franklin County remained constant while Adams and Grant Counties showed a slight decrease (Figure 3).
- The regional Kendall test for trends indicated no statistically significant trends in nitrate concentrations through time for the GWMA as a whole, for each of the three counties individually, nor for each of the 17 subregions (Table 1).
- The regional Kendall test for trends indicated a statistically significant downward trend for those wells with a starting nitrate concentration greater than 10 mg/L at a rate of -0.4 mg/L per year for the whole GWMA, -0.35 mg/L per year for Adams County, and -0.46 mg/L per year for Franklin County.

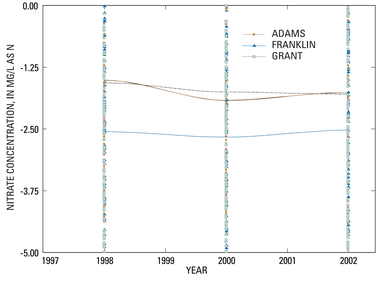

Figure 3. LOWESS smooth of residual nitrate concentrations in ground water during 1998, 2000, and 2002, in Adams, Franklin, and Grant Counties, Washington.

Table 1. Summary of results from regional Kendall test for trends in nitrate concentrations in ground water in the Columbia Basin Groundwater Management Area, Washington, 1998-2002.

Area	Kendall's *Tau*	*p*-value	Rate of change (mg/L per year)
GWMA	-0.05	0.09	-0.002
Adams County	-0.014	0.72	-0.018
Adams dryland	-.066	.39	-.070
Deep well irrigators	.029	.69	.044
Esquatzel	.017	.87	.025
Othello	-.040	.66	-.036
Range	-.048	.83	-.073
Franklin County	0.004	0.89	0.004
Basin City	-.041	.49	-.042
Connell	.073	.31	.052
East Franklin	.007	.91	.008
Franklin dryland	.025	.73	.025
Pasco	.0	1.0	.0
Grant County	-0.015	0.52	-0.02
Black Sands	-.007	.94	-.008
Hartline	-.008	.90	-.015
Mattawa	.0	1.0	.0
Moses Lake	-.03	.60	-.046
Quincy/Ephrata	-.022	.72	-.018
Royal Slope	-.024	.70	-.027
Warden	-.031	.62	-.032

Trends From 1986 to 2003

- LOWESS smooth indicates an increasing trend in nitrate concentrations in Basin City, Pasco and East Franklin since 1986, but with an apparent leveling off since about 1995 (figure 4).
- The regional Kendall test for trend indicates that the graphical pattern of an increasing trend is statistically significant for the dataset as a whole with a rate of increase of 0.1 mg/L per year. No statistically significant trends were observed for the three subregions individually (table 2).

Table 2. Summary of results from regional Kendall test for trends in nitrate concentrations of the western part of Franklin County, Washington, 1986-2003.

Area	Kendall's *Tau*	*p*-value	Rate of change (mg/L per year)
Franklin County	0.257	<0.0001	0.1
Basin City	.014	.87	.0
East Franklin	.132	.13	.21
Pasco	.067	.25	.10

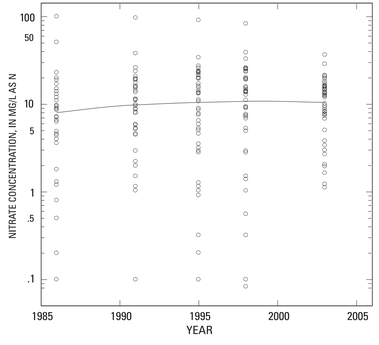

Figure 4. Nitrate concentrations of ground water sampled in the Basin City, Pasco, and East Franklin subregions, 1986 through 2003.

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