Idaho State Department of Agriculture
Division of Agricultural Resources

Regional Ground Water Quality Monitoring Results for Payette and Gem Counties, Idaho 2003-2006

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ISDA Technical Results Summary # 33 March 2007

Introduction

The Idaho State Department of Agriculture (ISDA) developed the Regional Agricultural Ground Water Quality Monitoring Program to characterize degradation of ground water quality by contaminants leaching from agricultural sources. The objectives of the program are to: (1) characterize ground water quality related primarily to nitrate and pesticides, (2) determine if legal pesticide use contributes to aquifer degradation, (3) relate data to agricultural land use practices, and (4) provide data to support Best Management Practices (BMPs) and/or regulatory decision making and evaluation processes. ISDA currently is implementing 13 regional ground water quality monitoring projects in Idaho. Additional projects currently are being planned for other areas of the state.

The regional ground water monitoring project in Payette and Gem Counties (Figure 1) was initiated in 1998 as a result of completion of the Idaho Ground Water Quality Plan and Agricultural Ground Water Quality Protection Program for Idaho. In part, these documents mandate regional-scale monitoring of aquifers in the state that may be vulnerable to agricultural activities. Nutrients, common ions, stable isotopes, field parameters, and pesticides have been and are being evaluated to determine impacts to ground water and locate potential sources.

The original boundary of the project established in 1998 was redrawn in 2003 to better capture the local aquifer system. Wells randomly selected in 1998 that were situated in areas north and south of Emmett were eliminated from the regional area and not sampled from 2003 through 2006. Additionally, the boundary was expanded to the west and a matching number of replacement wells were randomly selected for the western area. This reports focuses on water quality findings from 2003 through 2006 after the project boundary was restructured.

Laboratory results from testing in 2003 through 2006 indicate areas showing water quality degradation from nitrate and to a lesser extent pesticides. Four wells in an area to the east of Fruitland tested above the Environmental Pro-

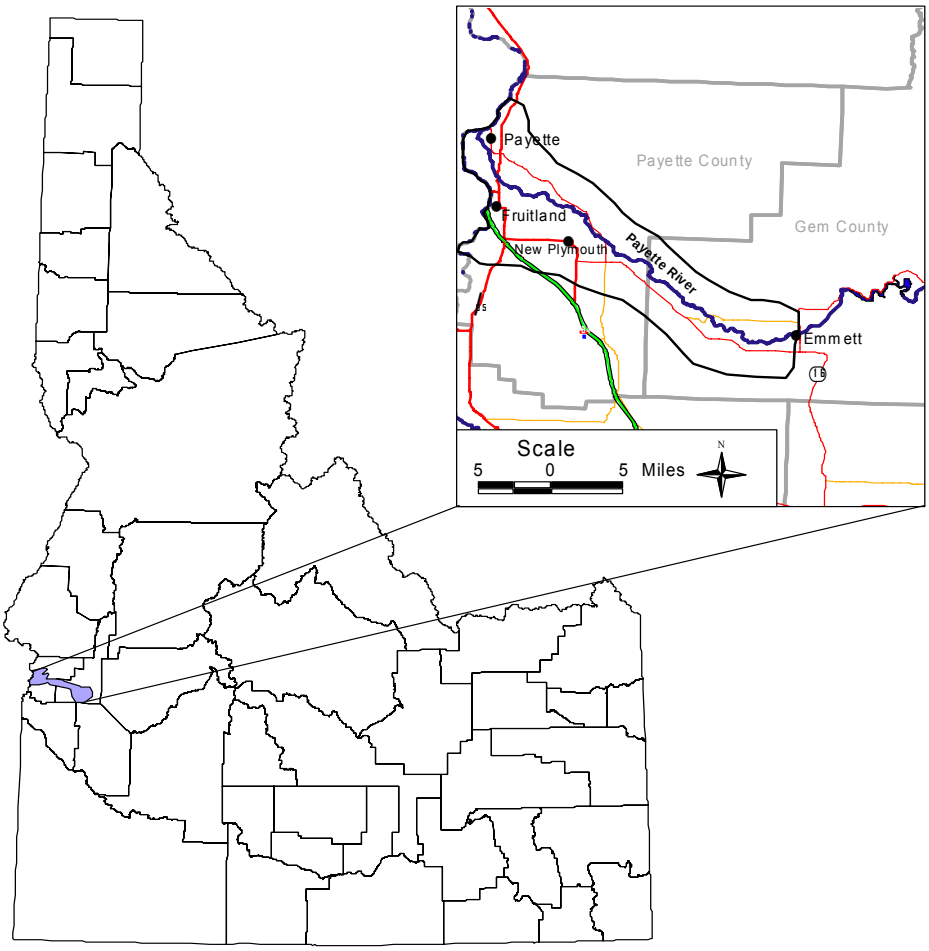

Figure 1. Location of ISDA Payette and Gem Counties Regional Project.

tection Agency (EPA) Maximum Contaminant Level (MCL) for nitrate of 10 milligrams per liter (mg/L). Also, numerous wells within the project tested positive for pesticides at low concentration levels. One well east of Fruitland has had detections of the herbicide atrazine and the breakdown product desethyl atrazine at levels that have warranted increased monitoring activity.

Description of Project Area

The Payette and Gem Counties regional monitoring project area is located in southwestern Idaho adjacent to the Idaho-Oregon border (Figure 1). The 45 randomly selected wells are distributed across central portions of Payette and Gem Counties on either side of the Payette River (Figures 1 and 2). The area encompasses approximately 230 square miles.

The project area overlies an aquifer system confined to the Payette River Valley that resides in unconsolidated sands and gravels. Well yields in the valley range from 1 to 3,300 gallons per minute (Whitehead, 1994). Ground water depths range from 14 to 314 feet below land surface in wells tested as part of the project (Table 1). Typical depth to ground water is less than 64 feet below land surface (Table 1). All project wells are completed in unconsolidated sands and gravels. Locally, shallow ground water flow is likely towards the Payette and Snake Rivers. Overall, regional flow is to the south and west towards the Snake River. Recharge in the area primarily comes from applied irrigation water, canal leakage, other surface water leakage, and precipitation.

Land use within the area is primarily agriculture. Agricultural activities include dairies, irrigated agriculture, and confined animal feeding operations. Alfalfa, grains, corn, sugar beets, potatoes, onions and beans are the chief crops grown in the two county area (Idaho Agricultural Statistic Services, 2005). As of 2005, the total number of cattle inventoried in Payette and Gem Counties was approximately 105,000 (Idaho Agricultural Statistic Services, 2005). These activities as well as other possible human sources from the local communities and rural residences (i.e, septic systems, waste land application sites, industrial sites) have the potential to impact ground water quality of the area.

Table 1. Well information.

Well Depth (feet)	Wells	Average Depth to Water (Feet)	Dominant Aquifer-Geology
< 100	30	14	Sand/ Gravel
100 to < 200	14	45	Sand/ Gravel
200 to < 300	9	64	Sand
300 to < 400	1	50	Gravel/ Sand
400 to < 500	1	314	Gravel/ Sand

Methods

To establish this project, ISDA statistically assessed Idaho Department of Water Resources Statewide Program nitrate, chloride, and atrazine monitoring data. ISDA statistically determined that sampling 45 randomly selected domestic wells would provide adequate data to evaluate overall ground water quality underlying the area. All sampling was conducted after a quality assurance project plan (QAPP) was developed and approved. Permission was gained from the home owners prior to sampling.

Water samples have been collected annually in the spring from 2003 to 2006. All sample collections followed established ISDA protocols (on file at ISDA main office) for handling, storage, and shipping. Testing of common ions was completed at the University of Idaho Analytical Sciences Laboratory (UIASL) in Moscow. Tests included nitrate, nitrite, ammonia, orthophosphorous, chloride, sulfate, bromide, and fluoride using EPA Methods 300.0 and 350.1. Duplicates and blank samples were collected and submitted as a part of the QAPP.

In 2005, samples were sent to UIASL for pesticide analysis. UIASL used gas chromatography scans for pesticides analysis. Duplicates, blanks, and matrix spikes/matrix spike duplicates were collected and submitted as a part of the QAPP. Due to a relatively high concentrations of atrazine and desethyl atrazine found at one well east of Fruitland, a localized project was initiated and monitoring of wells in the area is ongoing. More information on these detections from this monitoring study can be found on the ISDA website at http://www.agri.idaho.gov/Categories/Environment/water/gwinorganics.php.

In 2004 and 2005, samples were collected from selected wells following ISDA protocols for nitrogen isotope analysis. Samples were frozen and shipped via Federal Express one-day service to the University of Idaho Stable Isotopes Laboratory in Moscow.

Results

The following section provides a summary of nitrate, pesticide, and stable isotope testing from 2003 through 2006. Other water quality data (e.g., sulfate, ammonia, chloride) not presented in this report is available on the ISDA website at http://www.agri.idaho.gov/Categories/Environment/water/gwinorganics.php.

Nitrate

Of the constituents being sampled, nitrate presents a concern because of potential adverse health effects. Al-

though chronic, long term health risks of nitrate consumption are not fully understood; short term effects have been documented. Methemoglobinemia (blue baby syndrome), which is characterized by the reduced ability of the blood to carry oxygen in infants, can afflict infants consuming water with high levels of nitrate (Parliman, 2000). Consumption of large concentrations of nitrate also may be associated with non-Hodgkins lymphoma (Parliman, 2000).

Results of ground water sampling in the Payette and Gem Counties area from 2003 to 2006 indicate nitrate problems in an area bounded approximately by Fruitland to the west and New Plymouth to the east. Figure 2 illustrates nitrate concentrations found in ground water underlying the area in 2006. Based on evaluation of 38 wells consistently sampled over the four-year period of ISDA testing, five to 11 percent of wells exceeded the EPA MCL of 10 mg/L for any given year (Table 2). Maximum concentrations per year ranged from 16 mg/L to 22 mg/L. Highest nitrate levels appear to occur consistently in an area two to four miles east and northeast of Fruitland.

Evaluation of mean values from the 38 wells consecutively sampled from 2003 to 2006 and shown in Table 2 suggest that levels appear to be somewhat constant or slightly increasing (Figure 3). Mean concentrations ranges from 2.4 mg/L in 2003 to 3.0 mg/L from the most current testing event in 2006. Median concentrations suggest no trend with a median 0.6 mg/L in 2003 to a 0.5 mg/L median calculated from testing in 2006 (Table 2). The highest median (1.2 mg/L) was calculated from monitoring data collected from the 2004 sampling event (Table 2). In general, ground water quality with respect to nitrate appears to be better in eastern portions of the study area with no nitrate concentrations exceeding 5.0 mg/L detected in Gem County from the most recent sampling event in 2006 (Figure 2).

Pesticides

During the 2003 to 2006 timeframe, ISDA conducted pesticide sampling of all wells in 2005 that were part of

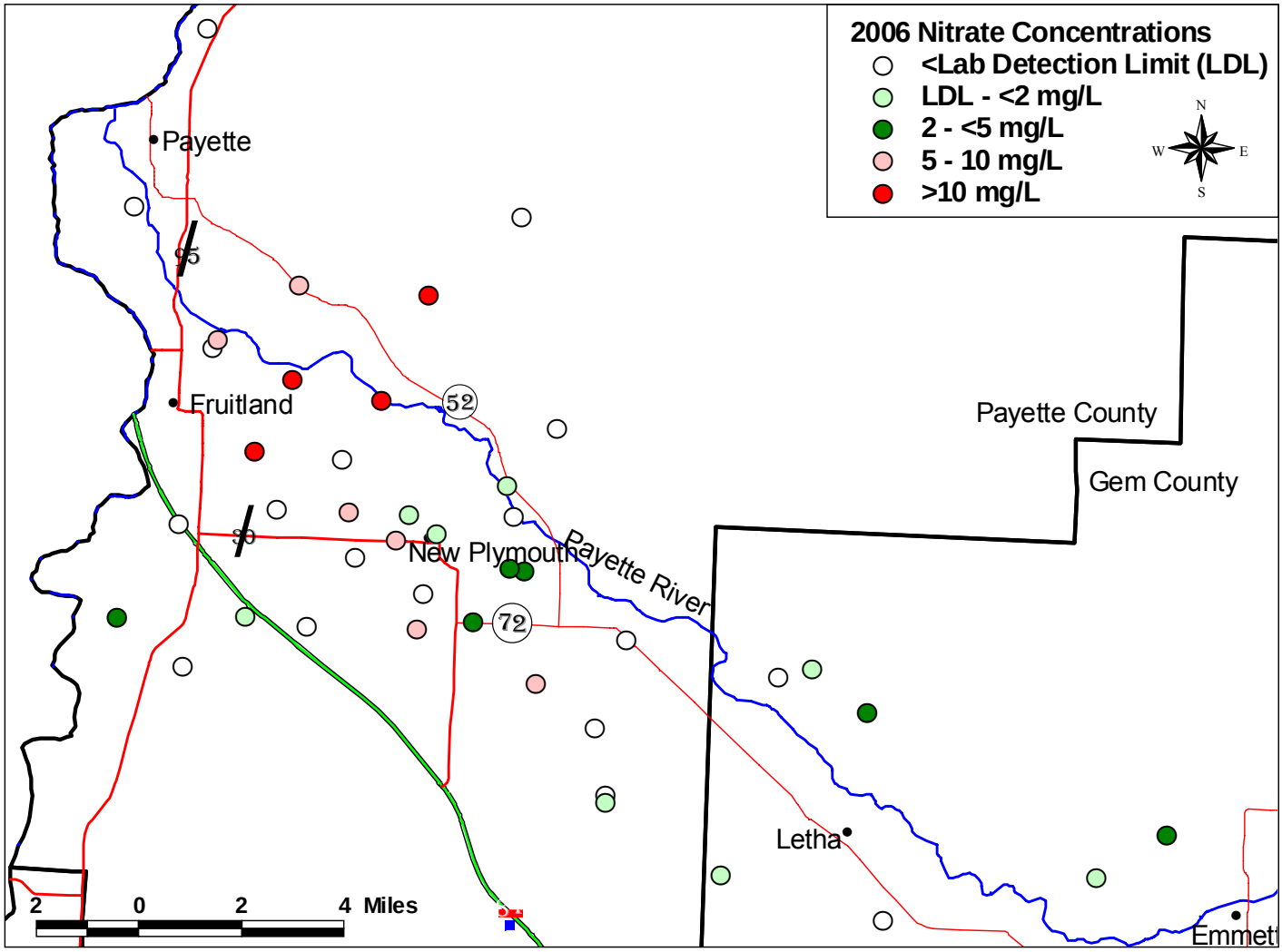

Figure 2. Map of wells locations and ground water nitrate concentration ranges from sampling in 2006.

Table 2. Statistical summary of nitrate detections in ground water from 63 domestic wells tested from 2003 through 2006.

Statistical Category	2003	2004	2005	2006
Number of Wells Tested	38	38	38	38
<LDL* (0.025 mg/L)	17 (45%)	15 (39%)	17 (45%)	18 (47%)
LDL* to < 2.0 mg/L	9 (24%)	9 (24%)	8 (21%)	8 (21%)
2.0 mg/L to < 5.0mg/L	7 (7%)	4 (11%)	5 (13%)	4 (11%)
5.0 mg/L to < 10 mg/L	2 (5%)	8 (21%)	5(13%)	4(11%)
≥ 10 mg/L	3 (8%)	2 (5%)	3 (8%)	4(11%)
Mean (mg/L)	2.4	2.8	2.5	3.0
Median (mg/L)	0.6	1.2	0.7	0.5
High (mg/L)	17	16	16	22

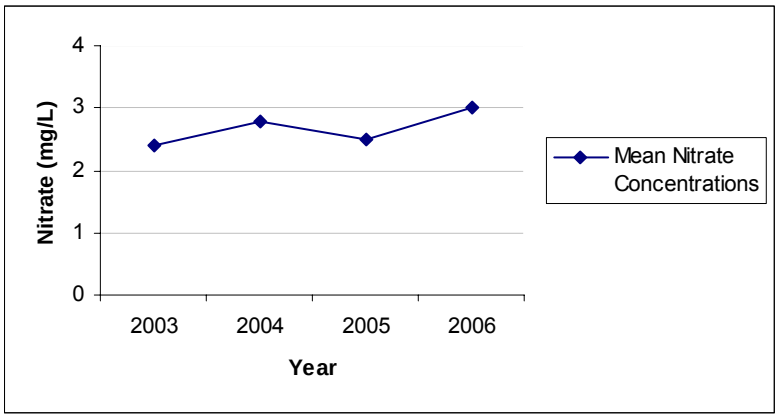

Figure 3. Plot of mean nitrate concentrations found in Payette and Gem Counties ground water based on 39 randomly selected wells tested consecutively from 2003 to 2006.

the project during that year. Subsequently, ISDA has conducted one or more follow-up testing events at wells having a positive pesticide detection. Although there were a number of detections from the 2005 testing, only detections at one well site have warranted increased monitoring activity. This well located one mile east of Fruitland returned a 1.3 micrograms per liter (µg/L) detection for desethyl atrazine (Table 3 and Figure 4). This concentration level is 43 percent of the health standard of 3 µg/L used by ISDA. ISDA plans to do another full round of pesticide testing in 2008 for all wells in the Payette and Gem County Regional project.

Other points of interest from the 2005 round of pesticide sampling are the number, variety, and location of pesticides detected. There were 15 well sites out of 41 tested that had one or more positive pesticide detections (Figure 4). This represents 34 percent. Of the 15 wells with positive detections, seven had multiple compounds detected (Figure 4). From the 15 wells with positive detections, six different compounds were found (Table 3). They include in order from most to least commonly detected: dacthal, atrazine, desethyl atrazine, bentazon, malathion, and terbacil. Most detections occurred in the area east of Fruitland to just east of New Plymouth. One isolated detection of atrazine and desthyl atrazine occurred just northwest of Emmett.

Nitrogen and Oxygen Isotopes

Overview

The ratio (denoted $\delta^{15}N$) of the common nitrogen isotope ^{14}N to its less abundant counterpart ^{15}N can be useful in determining sources of nitrate. Common sources of nitrate in ground water include applied commercial fertilizers, animal or human waste, precipitation, residues from legume crops, and other organic nitrogen sources within the soil. Each of these nitrate source categories has a nitrogen isotopic signature. Figure 5 illustrates ranges of $\delta^{15}N$ determined through numerous research studies. Typical $\delta^{15}N$ ranges for fertilizer and waste are -5 to +5 per mil ($^0/_{00}$) and greater than $10^0/_{00}$, respectively. Numbers between $5^0/_{00}$ and $10^0/_{00}$ generally are believed to indicate an organic or mixed source.

Use of nitrogen isotopes as the sole means to determine nitrate source should be done with great care. $\delta^{15}N$

Table 3. Project 770 pesticide detections in 2003.

Pesticide	Trade Name	No. of Detections	Range (µg/L)	Health Standard (µg/L)	Lab Detection Limit (µg/L)
Atrazine	Atrazine, Aatrex	6	0.025 - 0.33	3 (MCL)[1]	0.025
Bentazon	Basagran	1	0.43	200 (HAL)[2]	0.2
Dacthal	Dacthal	7	0.15 - 3.5	70 (HAL)	0.08
Desethyl Atrazine	----[3]	7	0.027 - 1.3	----[3]	0.025
Malathion	Malathion, Fyfanon	1	0.73	100 (HAL)	0.05
Terbacil	Sinbar	1	0.089	90 (HAL)	0.05

[1]MCL - EPA Maximum Contaminant Level
[2]HAL - EPA Health Advisory Level
[3]Desethyl atrazine is breakdown product of atrazine.

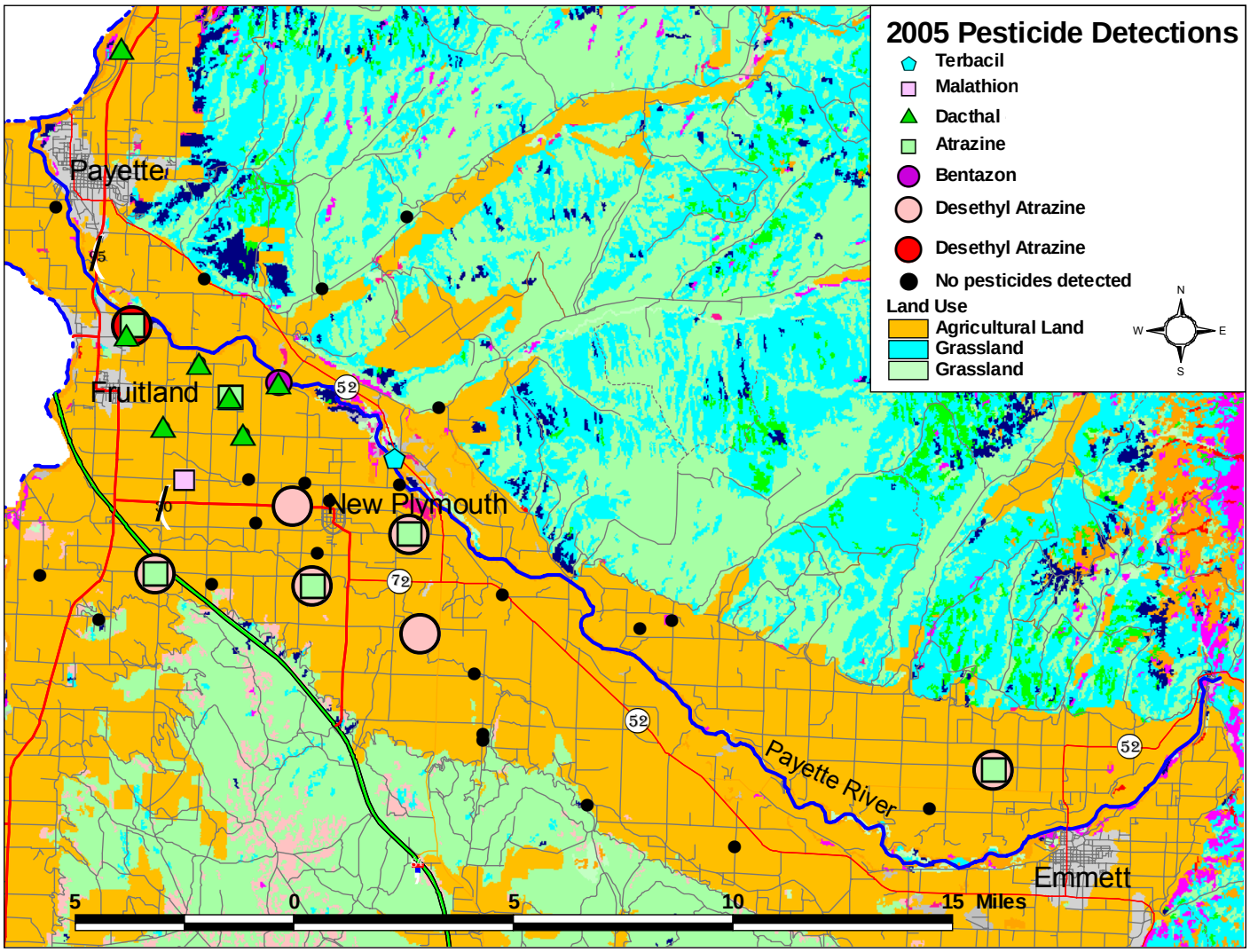

Figure 4. Map showing location and pesticide detection from ISDA testing in 2005.

values of fertilizer and animal waste in ground water can be complicated by several reactions (e.g., ammonia volatilization, nitrification, denitrification, ion exchange, and plant uptake) that can significantly modify the $\delta^{15}N$ values (Kendall and McDonnel, 1998). Furthermore, mixing of sources along shallow flowpaths makes determination of sources and extent of denitrification very difficult (Kendall and McDonnell, 1998).

Findings

ISDA Water Program staff implemented $\delta^{15}N$ testing in order to use it as a possible indicator of source(s) of nitrate in the ground water. Because of the cost of testing, only limited isotope testing was undertaken. Only select sites testing above 5 mg/L nitrate the previous year had samples collected for stable isotope testing.

Results from testing during 2004 and 2005 showed three sites that may represent locations having potential animal or human waste impacts; sites 7701701, 7705101, and 7702001 (Table 4 and Figure 6). No sites had a potential fertilizer nitrate source. The remainder of sites tested had $\delta^{15}N$ results indicative of an organic or mixed source (Table 4 and Figure 6).

Conclusions

Results of ground water sampling in the Payette and Gem Counties area from 2003 to 2006 indicate nitrate problems in an area bounded approximately by Fruitland to the west and New Plymouth to the southeast. Five to 11 percent of wells exceeded the EPA MCL of 10 mg/L for any given year (Table 2). Maximum concentrations per year ranged from 16 mg/L to 22mg/L. Highest nitrate levels appear to occur consistently in an area east and northeast of Fruitland.

Evaluation of mean values from the 38 wells consecutively sampled from 2003 to 2006 and shown in Table 2 suggest that levels appear to be somewhat constant or slightly increasing. In general, ground water quality with respect to nitrate appears to be better in eastern portions of the study area

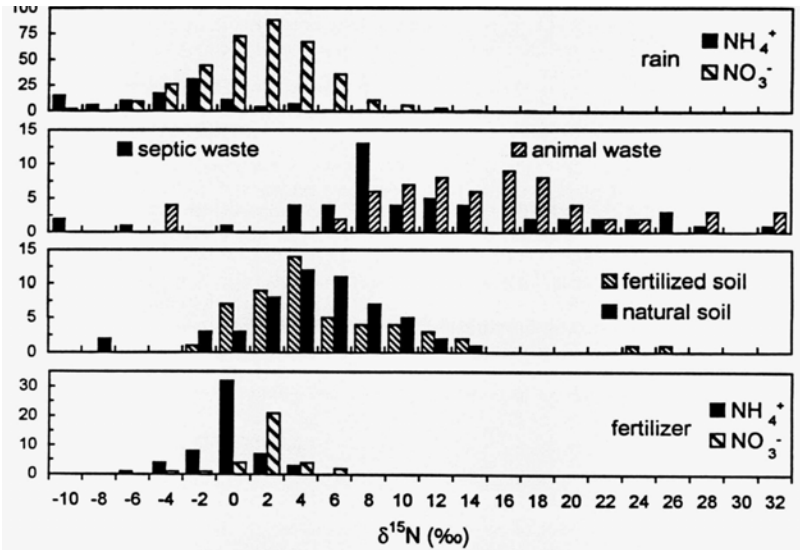

Figure 5. Ranges of δ ^{15}N found in the hydrosphere based on a number of nitrogen isotope studies (after Kendall and McDonnell, 1998).

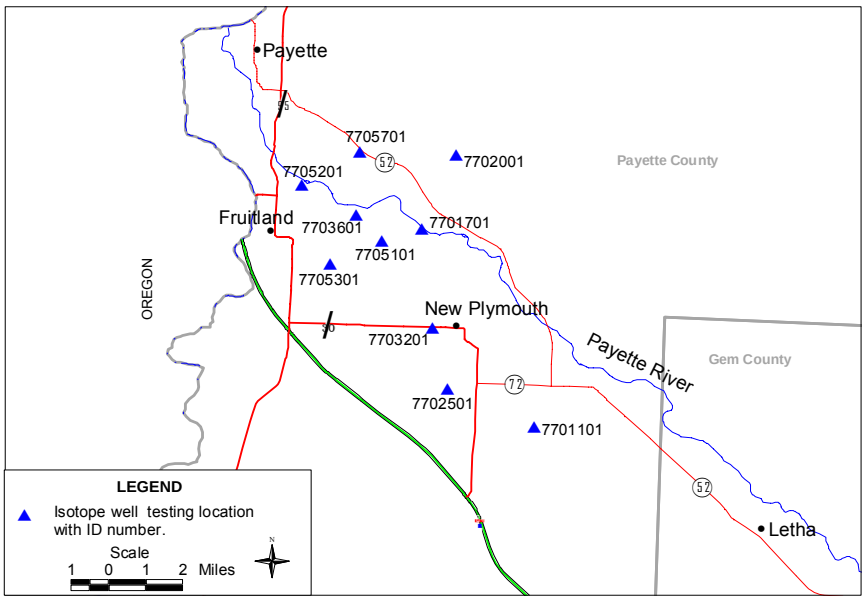

Figure 6. Location of wells tested for $^{\delta 15}$N.

Table 4. Nitrogen isotope testing information.

Well ID	Date	Nitrate (mg/L)	$^{\delta 15}$N(0/00)
7700417	5/19/2004	5.4	13.11
7700425	5/19/2004	7.3	8.84
7700436	5/20/2004	16	6.20
7700451	5/20/2004	10	10.82
7700453	5/20/2004	14	7.19
7700511	5/16/2005	5.1	8.68
7700517	5/12/2005	4.2	15.94
7700520	5/17/2005	10	11.96
7700525	5/11/2005	5	8.71
7700532	5/12/2005	5.1	7.95
7700536	5/17/2005	16	5.41
7700551	5/23/2005	9.4	6.40
7700552	5/17/2005	5.8	6.25
7700553	5/17/2005	13	5.79
7700557	5/17/2005	9.2	8.31

with no nitrate concentrations exceeding 5.0 mg/L detected in Gem County from the most recent sampling event in 2006.

Nitrogen isotope testing suggests that higher nitrate levels found at testing sites most commonly come from more than one source. Potential sources include fertilizer, animal or human waste, plow down of legume crops, or other organic sources. Additionally, results of nitrogen isotope testing suggest that three sites tested may specifically be impacted from a waste source, either animal or human.

Ground water samples taken at 15 sites had one or more positive pesticide detections from testing in 2005. Atrazine, desethyl atrazine , and dacthal were the compounds most commonly detected. However, the concentration level found at only one site has warranted increased monitoring activity. This well located one mile east of Fruitland returned a 1.3 µg/L for desthyl atrazine in 2005. Most detections occurred in the area east of Fruitland to just east of New Plymouth. One isolated detection of atrazine and desethyl atrazine occurred just northwest of Emmett. ISDA plans to do another full round of pesticide testing in 2008 for all wells in the Payette and Gem County Regional project.

Recommendations

ISDA recommends continued monitoring in the project area and additional work to determine nitrate sources near Fruitland and New Plymouth. ISDA further recommends that measures to reduce localized nitrate impacts and potential future pesticide impacts on ground water be addressed and implemented. ISDA recommends that:

- Pesticide applicators use the core Best Management Practices recommended by the ISDA Water Program, especially in the area near the elevated atrazine and de-

sethyl atrazine detections.

- Growers and agrichemical professionals conduct nutrient, pesticide, and irrigation water management evaluations.
- Producers follow the Idaho Agricultural Pollution Abatement Plan and Natural Resources Conservation Service (NRCS) Nutrient Management Standard.
- Pesticide applicators follow the NRCS Pesticide Management Standard.
- Producers and agrichemical dealers evaluate their storage, mixing, loading, rinsing, containment, and disposal practices.
- Homeowners assess lawn and garden practices, especially near wellheads with elevated nitrate or pesticide detections.
- Local residents assess animal waste management practices.
- State and local agencies assess impacts from private septic systems near impaired areas.
- Home and garden retail stores establish outreach programs to illustrate proper application and management of nutrients and pesticides.
- Responsible parties assess pesticide application practices to protect ground water.

Acknowledgments

The authors would like to thank the well owners in the study area. Without their participation and cooperation, this study would not be possible.

Technical review of this document from the following individuals is greatly appreciated:

Gary Bahr, ISDA
Kirk Campbell, ISDA
Kathyrn Dallas, ISDA

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