**Table 3.9-7. Nitrates Detected in Oregon Groundwater by Basin (1984-1996).**

| Drainage Basin | Number of wells | Number of analyses | Detection limit (mg/l) | Number of detections | Low (mg/l) | High (mg/l) | Mean (mg/l) | Median (mg/l) | Standard deviation |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |
| Deschutes | 66 | 118 | 0.02 | 106 | 0.02 | 28.00 | 3.52 | 0.74 | 5.51 |
| Grand Ronde | 40 | 44 | 0.02 | 31 | 0.02 | 14.00 | 1.67 | 0.55 | 3.08 |
| Hood River | 11 | 14 | 0.02 | 13 | 0.20 | 11.00 | 2.64 | 1.10 | 3.88 |
| John Day | 8 | 19 | 0.02 | 19 | 0.02 | 4.70 | 1.62 | 2.30 | 1.54 |
| Lower Willamette | 82 | 482 | 0.02 | 404 | 0.02 | 27.00 | 2.33 | 0.29 | 4.29 |
| Malheur Lake | 17 | 19 | 0.02 | 13 | 0.04 | 5.20 | 1.57 | 0.90 | 1.68 |
| Malheur | 122 | 1382 | 0.02 | 1338 | 0.02 | 250.00 | 15.21 | 13.00 | 14.02 |
| Mid Coast | 1 | 18 | 0.02 | 18 | 0.02 | 0.37 | 0.10 | 0.06 | 0.10 |
| Mid Willamette | 70 | 330 | 0.02 | 281 | 0.02 | 21.00 | 1.98 | 0.73 | 2.73 |
| North Coast | 37 | 108 | 0.02 | 87 | 0.02 | 59.00 | 2.84 | 0.48 | 8.72 |
| Owyhee | 8 | 150 | 0.02 | 148 | 0.03 | 10.00 | 5.04 | 4.50 | 2.63 |
| Rogue | 58 | 194 | 0.02 | 161 | 0.02 | 31.00 | 2.49 | 0.22 | 4.41 |
| South Coast | 4 | 5 | 0.02 | 5 | 0.02 | 1.80 | 0.65 | 0.28 | 0.75 |
| Umatilla | 187 | 1704 | 0.02 | 1637 | 0.02 | 160.00 | 9.25 | 5.70 | 10.92 |
| Umpqua | 2 | 12 | 0.02 | 8 | 0.02 | 0.09 | 0.03 | 0.02 | 0.02 |
| Upper Willamette | 50 | 112 | 0.02 | 89 | 0.02 | 31.00 | 5.04 | 1.20 | 7.03 |

of the groundwater sampled was old. For example, low tritium levels in ground water sampled in 1993, suggests that this water entered the ground before 1953. As the increasing fertilizer applications of the past continues to infiltrate ground water downslope from irrigation, we may expect to see increasing concentrations in the water that is pumped from groundwater sources.

The Oregon Groundwater Protection Act specifies that Oregon Health Division require groundwater (if present) to be tested for nitrates and fecal coliform as a part of real estate transactions in Oregon. DEQ utilizes this information to assess groundwater vulnerability in different regions of the state. In addition, DEQ uses this nitrate monitoring data to target groundwater monitoring for pesticides.

Nitrates are a public health concern, particularly for infants and small children. Nitrates may be converted to nitrite by microorganisms in soil, water, sewage, and the alimentary (digestive) tract. A blood disorder called methemoglobinemia is caused by elevated nitrite levels.

### Nitrates in Willamette Basin surface waters

Over 60,000 tons of nitrogen are applied in the Willamette Valley each year. Ninety eight percent of stream samples contain detectable nitrate concentrations: values range from 0.054 to 22 mg/L (Wentze (et al), 1998). Forested basins had the lowest nitrate levels, particularly those where the forested area exceeded 90%. The EPA sets the maximum contaminant level for drinking water at 10 mg/L, and although none of these streams were used for drinking water, this provides some guidance concerning one measure of potential risk that is in wide use. Nitrate concentrations exceeded the maximum contaminant level in Bear and Zollner Creeks in the Pudding basin, northeast of Salem. Both drain an area of more than 50% agricultural land.

### Phosphates in Willamette basin surface waters

Ninety-five percent of stream samples contained detectable concentrations of total phosphorus, ranging from 0.01 to 1.3 mg/L. SRP, or dissolved orthophosphate, was detected in 89% of steams, at concentrations ranging from 0.01 to 0.93 mg/L.

Forty five percent of streams yielded total phosphorus concentrations that exceeded the 0.1mg/L maximum value cited by the EPA as a goal for prevention of nuisance plant growth in streams. Sixty-eight percent of steams exceeding this limit, drained largely agricultural land.

**Conclusions:** nitrate and phosphate levels exceed the limits of acceptability for drinking water and for healthy aquatic life in certain locations. Evidence of increasing fertilizer use and the long delays in nitrate entry to certain aquifers suggests that concentrations may rise in some locations. Although a great deal of emphasis is laid upon nutrient management, there is no systematic monitoring of nutrient concentrations of impacts, to guide management, or to predict and quantify the extent of ecological impairment. Excess nutrient loadings adversely impact the ecological health of aquatic systems, and too little attention is being paid to this problem.

## Livestock manure management

Industry trends in livestock management are expected to continue through the next decade. There will be fewer livestock operations that manage many more livestock on a farm. For example, there were currently 385 dairy farms in Oregon with about 90,000 cows in business at the end of 1999. This compares to more than 1,300 farms milking about 100,000 cows in 1975.

There is increasing interest from producers outside of Oregon moving into the drier areas of the state, east of the Cascade Mountains. In fact, there will be 20,000 more dairy cows near Morrow County by June, 2001 to supply milk for a new cheese plant being built in Boardman. Most of these livestock enterprises use manure on their farms or neighboring farms as fertilizer. These manure-fertilized fields produce runoff water that carries some contamination to surface waters and therefore need some management. The volumes produced and level of contamination will dictate the degree of concern and management required by the operator. Accidental manure spills and those caused by inadequate storage facilities can also contaminate waters of the state with nitrogen, phosphorus, and fecal coliform bacteria.

The Oregon Department of Agriculture regulates Confined Animal Feeding Operations (CAFOs) in the state. All dairy farms and most animal feedlots are required to maintain an up-to-date CAFO permits that regulates manure management on their farm. USEPA oversees the state program to maintain sufficient rigor and uniformity across states. With EPA planning to inspect 10% of Oregon CAFOs each year, producers are stepping up investment in improved manure storage and handling facilities to comply with regulations.

In addition to appropriate facilities for collecting, storing, and distributing manure, best management practices must be used to limit the chance of surface or ground water contamination. Every new CAFO in Oregon is required to have an animal waste management plan that lists facilities and manure management practices to be followed. All dairies will have such a plan by July, 2002.

Nutrient budgeting is becoming part of every farm management plan as farmers attempt to comply with the increased scrutiny of federal, state, and local rules concerning non-point source pollution. Whole farm nutrient budgeting requires that producers realistically look at what nutrients they bring on the farm minus the nutrients shipped off the farm to develop their farm nutrient balance.

**Conclusions:** there is a national effort to develop and adopt animal waste management practices that result in reduced environmental impact. In theory, this means that the ecological impact of animal production will decline. There are no systematic surveys of the extent or importance of these impacts however, and without such measurements we lack a basis for more focused management, or direct measurements of the success of new practices.

## Risks to resource health and current strengths

### Soil health

The biggest threat to sustainability in Oregon agriculture is the high rate of soil erosion found in northeast Oregon and possibly in smaller areas of western Oregon on sloping ground. This is routinely monitored by the NRCS and is a well known problem. NRCS provides a reasonable indicator of soil erosion on 10-year intervals. However, unless there are significant changes in soil management and other landscape conservation practices, there is strong evidence that productivity will decline over the next 50 to 100 years in northeast Oregon.

The second concern is the loss of organic matter and overall soil quality in the intensively managed soils of NE Oregon and western Oregon. This is accompanied by increase in soil compaction and reduction in soil biological properties. In western Oregon, this is a fairly recent development, as evidenced by farmers who report an increased need to subsoil (deep ripping below plough layer) up to twice a year to decrease compaction. Cover crop and reduced till systems are evolving that hold potential to improve soil quality but more research is needed to develop agronomically viable alternatives in relation to soil quality.

There does not appear to be any clear evidence that loss of soil quality has affected crop yields. However, the loss of soil quality has been masked by the infusion of new technologies such as hybrids and semi-dwarf cereals in combination with increased fertilizer applications and pesticides. The rate of yield increase has declined and it is unclear whether new technologies can continue to increase crop productivity.

**Conclusions:** there is a serious risk of reduced soil environmental health and reduced agricultural productivity, as a result of erosion and loss of organic carbon.

## Pesticides

All types of synthetic pesticide pose risks to the environment, and all are subject to strict regulations concerning permitted uses, application rates and procedures, storage and disposal. When used according to label instructions, most chemicals will not prove hazardous to users or consumers; damage to the environment is however much less easy to predict. During regulatory testing, the toxicity to a small number of terrestrial and aquatic species is determined, to ensure that chemicals to not exceed the toxicity of currently marketed materials. Our idea of acceptable levels of toxicity are constantly evolving, and many older pesticides are broad spectrum in their action, and potentially harmful, even at very low doses, to organisms that are exposed to them. Growers can therefore apply a pesticide according to label instructions, and even within quite advanced pest management programs, and still have unforeseen impacts on the environment.

There is ample evidence that reductions in pesticide use have benefits for biodiversity that often benefit agricultural production directly. Pollinators and the predators and parasites of crop pests are particularly susceptible to many insecticides and pest management practices are deliberately designed to protect and conserve them. It is not possible to say, for any pesticide used in Oregon, what the level or extent of ecological impact is.

### Pesticide tracking legislation in Oregon

New legislation in Oregon (HB3602) directs the Oregon Department of Agriculture to establish a pesticide use reporting system, and a pilot project is currently under development. The system will, for the first time, enable the level of use of pesticides in each major category, agriculture, forestry, industrial, urban commercial and urban homeowner, to be recorded. This is a highly complex procedure, but, for the first time, it may generate data that may be employed to improve management practices for pesticides and minimize environmental impacts. For example, the data will permit analysis of the extent of use of leachable materials in susceptible soil types and aquifers. It will also permit the pattern of use of the more toxic and hazardous materials to be mapped, identifying those circumstances where adverse environmental impacts are more likely to result because of intensive use of similar materials for multiple purposes. At the watershed level, this information will be invaluable for managing pesticides, and it will form a basis for interpreting ground and surface water residues and residues in wildlife.

### Organophosphate and carbamate use

Of greatest environmental concern is the continued reliance in many crops on the continued use of organophosphate and carbamate insecticides with broad spectra of activity, and high mammalian toxicity. Our survey indicated that 1,297,029 pounds of active ingredient for these materials was used per annum in the 1990's. In 1996, Congress passed the Food Quality Protection Act that significantly amended the laws governing the registration of pesticides. The act broadens consideration of health risk factors while reducing the role that pesticide benefits play in granting tolerances. Pesticides belonging to the organophosphate and carbamate classes of chemistry are under review in phase 1. Some materials could be cancelled in order to reduce calculated risks. However, many of these materials have been in use for a considerable period, and alternatives to them are either not available or not tested. Although a large number of new pesticides, with substantially reduced risks, have entered the market place, they will not solve all current problems, and they need to be evaluated; a process that might take years. Some of the crops that were determined (by the National Center for Food and Agricultural Policy) to be challenged by the Food Quality Protection Act in Oregon, should some of these compounds be revoked at short notice include apples, pears, blackberries, raspberries, hops, mint, peas and sugarbeets. In many cases, alternatives to organophosphates and carbamates could actually have adverse impacts environmentally, because they are less efficient, more toxic to beneficial species, and would need to be used more often. The solution in these cases is to encourage better management of existing materials, rather than assume naively, that more modern modes of action must, by definition, be less hazardous.

Such a process requires the trust and involvement of growers and collaboration between agencies and researchers concerned with both agricultural productivity and environmental protection. Something that in practice is hard won, and easily lost.

Further details of analyses of organophosphate use in specific commodities, including some Oregon crops can be found on the World Wide Web **http://www.epa.gov/oppbead1/matrices/.** This site represents efforts by the Biological and Economic Analysis Division of EPA's Office of Pesticide Programs, to address critical needs for organophosphates, and alternatives to them.

## Example of specific risks in Oregon

The Hood River watershed has a declining run of wild steelhead. In 1998, steelhead were listed as threatened in the Hood River Basin under the Endangered Species Act by the National Marine Fisheries Agency. Of the pesticides commonly used in pome fruit production in the Hood River basin, the organophosphate insecticides are among the most widely used and the most toxic to aquatic life. These pesticides are used on orchards in the winter, spring, and summer and may be used year round in urban areas. Use times overlap with mature wild winter steelhead migration upstream to spawn, spawning, early life stage development and juvenile steelhead migration downstream.

In a pilot study, a limited number of water samples were collected by DEQ from six locations in the Hood River basin in March, April and June of 1999. These samples were analyzed for total and dissolved organophosphate pesticides. Chlorpyrifos (Lorsban) was detected in the March and April samples at all locations but not in all samples. Findings were similar for azinphos-methyl (Guthion) samples collected in June. Average chlorpyrifos concentrations in Neal and Indian Creeks were above the state water quality standard. All 5 azinphos-methyl samples collected from Neal Creak contained concentrations above the water quality standard, and 1 sample of 5 from both Indian Creek and the Hood River exceeded the standard.

The state water quality standard for chlorpyrifos is 41 ng/l for chronic and 83 ng/l for acute exposures. The state water quality standard for azinphos-methyl is 10 ng/l for chronic exposures. No acute standard for azinphos-methyl has been established. The state standards for chlorpyrifos and azinphosmethyl were adopted from the U.S. Environmental Protection Agency water quality criteria for chlorpyrifos. There is no information available on chlorpyrifos or azinphos methyl effects on salmonid reproduction, early life stage development, growth, or smoltification from long term or intermittent exposures. In addition, the standards do not account for multiple exposures to individual or complex mixtures of chemicals.

The results of the pilot study suggest that there is a need to further define: (1) the mechanisms by which organophosphates are entering surface waters in the Hood Basin and (2) the organophosphate exposure patterns for salmonids in the mid and lower Hood River basin. Preliminary data and use patterns of chlorpyrifos and azinphos-methyl suggest that salmonids may be exposed for extended periods in spring and early summer. In addition there is very little toxicity data on native or introduced salmonid, including sublethal effects of intermittent exposures. Growers are now working with the Agricultural Experiment Station, and the DEQ, to develop solutions to this problem, that might include modified spraying practices in high risk areas, and possibly to adoption of new spray application technology.

**Conclusions:** there are some identifiable ecological risks posed by pesticides in Oregon. Solutions to these include amongst other things, the adoption of improved spray application practices, and the use of alternatives to organophosphate and carbamate insecticides. Great care must be taken in the process of transition to new chemistry, to avoid naïve errors that might result in more sever ecological impacts. Without a detailed knowledge of local environments, organisms at risk, and the toxicology, fate and behavior of different compounds, it will not be possible to make significant progress. Extensive databases of pesticide properties are available within the state, and these need to be incorporated within education and outreach programs that enhance the decision making process by growers.

# Nutrients and animal waste products

Although management practices that will avoid the problems associated with nutrient enrichment are well developed, there are no surveys of adoption of these practices, or of the environmental benefits associated with them. Without such surveys, it will not be possible to manage nutrient use in such a way that environmental impact is minimized without impairing crop productivity or animal production. There is evidence that concentrations of nitrates in ground water may increase before they subside, and continued monitoring and reporting of these concentrations will be of considerable importance for a number of years.

**Conclusions:** the risks associated with nutrient enrichment are unknown.

# What more do we need to understand?

The greatest gap in our current knowledge relates to the development of ecologically and economically sustainable agricultural practices. We have listed practices that require monitoring and documentation, including conservation tillage, pest management practices, animal waste and plant nutrient management practices, and efficient water use. All of these offer prospects of improved ecological health and sustainability in agroecosystems, but not all are currently measured. The development and adoption of measures will require collaboration between state agencies, researchers, farmers and growers, but the potential value of the measurements is immense.

In addition to practices, we have outlined measures of impact, in the area of soil health (erosion rates, soil organic carbon and soil biological activity), pesticide use (concentrations in streams, ground water and wildlife, and toxicological hazard), fertilizer use and animal waste management (nutrients and ground and surface waters and ecological impacts in those systems), and water use (ground water reserves and ecological function in streams and riparian zones).

Of these two dimensions of agriculture and ecology, we measure impacts more effectively than practices at present. Without explicit measurements of sustainable practices also, we will not be able to capitalize upon the potential for enhanced agroecosystem health. Therefore, we strongly support the development of the third proposed indicator.

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