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Friends of the Russian River
P.O. Box 83
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SHOULD BE 2005

3 December, 2003

Arthur G. Baggett, Jr., Chair and Members
State Water Resources Control Board
1001 I Street
Sacramento, CA 95814

Subject: Comments Regarding Proposed 303(D) Listings For Santa Rosa-Area Waters

Dear Chairman Baggett and Members:

I have reviewed several comments forwarded to your committee regarding recommendations by the North Coast Regional Board Staff to include phosphate on the 303(D) list update for the Laguna de Santa Rosa. I have had the opportunity to exhaustively review extant data on phosphate pollution in the Laguna and am enclosing a report that I prepared for the City of Santa Rosa under contract. I am forwarding this report to you along with another study I conducted for the City on nutrient elimination from treated wastewater discharged to an innovative subsurface irrigation system at a redwood grove on the Sonoma State University Campus.

Both of these reports relate to lobbying efforts by the City to have your board rescind the well overdue listing of the Laguna for nutrients, especially phosphate. The Laguna Phosphate study I am forwarding is comprehensive and requires a thorough review by your agency, however the following points summarize the most important findings.

1. The Laguna de Santa Rosa has consistently exhibited phosphate concentrations that exceed all but a few fresh water bodies in the United States. Typical readings range from 1000-2000 ug/L where, as acknowledged by the City's consultant, the EPA criterion is 100 ug/L. The EPA criterion is based on widely accepted classifications of trophic states defining Oligotrophic (the likely original pre-civilization state of the Laguna) at <20 ug/L phosphate; mesotrophic at 20-80 ug/L; and eutrophic at >80 ug/L phosphate. Concentrations greater than 1

nitrogen to the algal community through algal fixation and loading of nitrogen oxides. The excess phosphate therefore remains biologically available and algal blooms can reach phenomenal concentrations.

6. The City is proud to credit the nitrogen removed from the effluent in the treatment plant through denitrification to their account. This is misguided for the following reason. In natural systems the ratio of carbon to nitrogen to phosphorus is approximately 100:10:1. In the circumstance of Santa Rosa this means that even though a good deal of the nitrogen is removed during treatment, the release of every 1 lb. of phosphorus in the effluent stimulates fixation of 10 lbs. of nitrogen downstream due to growth of nitrogen fixing alga and bacteria. At the phosphate concentration cited for the City's effluent, approximately 2000 ug/L in 20 MGD of effluent, the city typically releases about 330 lbs of phosphate per day, as P, to the Laguna. This would stimulate a downstream load of approximately 3300 lb. of N into the Laguna. This is very close to the amount removed in the plant during denitrification. Assuming the plant receives 20 MGD of influent with approximately 30 mg/L of ammonia (as N) the plant receives 4950 lbs of N per day. Denitrification removes about 2/3 of that in the plant so approximately 3316 lbs. of N are removed by the plant each day. This is strikingly similar to the calculated amount of 3300 lbs. of N that the residual phosphate would cause to be recaptured from atmospheric sources. **In effect, the City has no nitrogen reduction program since they neglect to control phosphate. They should not receive any credit for nitrogen reduction in their TMDL until they also reduce phosphate.**

7. Sediment stores of phosphate in the Laguna are the primary point of relese to the water column during the summer growing period. Phosphate is bound to fine clay sediments. The City of Santa Rosa releases the largest portion of phosphate enriched wastewater in winter when fine sediments are prevalent in the water column where they act as foci for adsorption. This occurs when flows in the Russian River are high, backing up the Laguna so the phosphate enriched sediments can settle out. Summer release of phosphate is exacerbated when oxygen tension at the bottom approaches zero and phosphor becomes soluble. This sets in motion a positive feedback loop of ever worsening algal hypertrophy as increasing blooms lead to increased dark period O_2 depletion that then solubilizes more phosphorus. Nitrogen is never limiting because diminished dissolved nitrate favors nitrogen fixing algal species that readily capture it from the atmosphere.

Proposals to release the effluent directly into the main stem of the Russian River near Healdsburg would not address the issue. Every small bend or pool in the river would capture adsorbed phosphates in the sediments since it is virtually impossible to remove all of the suspended clays in the river during winter flows. At the same time, proposals to pump the effluents to a closed system like Lake Sonoma would have a disastrous effect on water quality, likely resulting in a water body similar to Clear Lake which has astronomical concentrations of algae.

8. The only biologically relevant DO readings in the Laguna are those taken between midnight and dawn. Algal blooms produce supersaturation with DO to as high as 20-30 mg/L during full sunshine because of excess photosynthesis. This is a transient reading with a rapid loss of this oxygen to the atmosphere as photosynthesis proceeds. Water can only hold about 7 mg/L at the temperatures typical of the Laguna. The supersaturation of oxygen reflects the excessive production of algal biomass. This same biomass respires at night, consuming very nearly the same amount of oxygen that the algae produced during the day. Unfortunately most of that oxygen escaped into the atmosphere because it is in excess of the 7 mg/L that the water can hold in dissolved form. As a consequence the algae remove virtually all of the oxygen during the night. My own readings in the Laguna have consistently shown that DO drops to near zero in most locations in the Laguna during the summer bloom period if measured just before dawn.

Presenting DO readings as averages over the course of a day has no biological validity. Ten minutes of zero oxygen in the predawn will kill aquatic animals that have lived for 23 hours and 50 minutes in saturated conditions. The only biologically valid reading for DO is the **minimum** tension experienced in a day since that reflects the bottleneck that animals must pass through to survive.

8; The City's sampling of subsurface water in their irrigation fields shows that virtually all of the phosphate applied to land through irrigation is sequestered by the soils and never reaches the Laguna .

The City should be recognized for the great strides it has made in managing their wastewater over the past 30 years. The single most important component of this is their implementation of an extensive land application system that reclaims virtually all of their wastewater during the summer months. The State Water Resources Board, as early as 1970 identified the summer releases of phosphate by the City as the single most important source of pollution to the Russian River. There can be no doubt that the cause of the improvements to the Russian River during the 70's, 80's, and 90's was due to the land application program and its dramatic uptake of the nutrients that otherwise would have reached the Laguna.

I have included in this letter a paper I presented to the Annual Symposium of the California Water Environment Association that documents the tremendous level of nutrient reduction the City achieved at the Redwood irrigation site at SSU. More important was the fact that this system showed that Santa Rosa could irrigate year around if they were to utilize subsurface forest irrigation in addition to their summer pasture irrigation program.

The State Water Quality Control Board should recognize that Santa Rosa has no justification for requesting relaxation of standards that your own regional staff has assiduously worked towards. The City has already implemented pilot scale projects proving the viability of systems that could allow it to virtually eliminate loading of the critical nutrient phosphorus.

It is unconscionable for the City to continue to fly in the face of literally the entire scientific community in their denial of the essential need for phosphate control. The persistence of their supposedly scientifically literate consultants in supporting this absurd position suggests that the Santa Rosa ratepayers, City council and PUC, as well as the regulatory agencies receiving these consultant comments, are being defrauded by these same consultants. It is well past time for your board to support positions presented to you by staff members at the Regional Boards who have proven over and again a level of competence and responsibility sorely lacking in the City of Santa Rosa's counterparts. The recommendation to list phosphate as a non-compliant nutrient by your board is essential to finally restoring water quality in that body.

Respectfully,

Daniel E. Wickham, Ph.D.
President, Friends of the Russian River and Russian Riverkeeper Program

PO$_4$

Phosphorus

BACKGROUND

What is Phosphorus and Why is it Important?

Phosphorus is an essential nutrient for plant growth and for metabolic reactions in plants and animals. Together with nitrogen, this nutrient is the basis of a river's food web. Phosphorus is the nutrient in shortest supply in most fresh waters. Thus, even a small increase in phosphorus can cause a large increase in the growth of aquatic vegetation like algae and submerged plants.

Pure, elemental phosphorus (P) is rare in nature. In aquatic ecosystems, phosphorus occurs mainly in the form of phosphate (PO_4^{-3})in one of two primary forms: organic and inorganic. Organic phosphate is bound in plant and animal tissues and not available to plants. Inorganic phosphate is the form that is available to and required by plants. It is also called reactive phosphate or orthophosphate. Plants absorb it from the surrounding water and convert it into organic phosphate. Animals that feed on plants use this organic phosphate. Both organic and reactive phosphate can be either dissolved in the water or attached to suspended particles in the water.

More complex inorganic phosphate compounds are called condensed phosphates, or polyphosphates. These are mostly human-made for use in laundry detergents, commercial cleaning preparations, water supply treatment, and boiler water treatment. In time, these polyphosphates breakdown into orthophosphates (reactive phosphate).

Typically, in freshwater ecosystems, phosphate is usually the nutrient that is least available for plant growth. This is called the limiting factor. If phosphate is added to a freshwater system, even in very small amounts, the plant growth usually increases significantly, having a large effect on the aquatic ecosystem. In saltwater, nitrogen is usually the limiting factor.

The Phosphorus Cycle

Understanding phosphorus in the aquatic ecosystem is complicated by the fact that phosphorus does not stay put in one form or another—it cycles (see the diagram below). Aquatic plants take in dissolved inorganic phosphorus (reactive or orthophosphate) from the water column and convert it to organic phosphate as a part of the plant tissues. Depending on their dietary preferences, animals get the organic phosphate they need in various ways: plant eating animals get phosphorus as organic phosphate when they eat plants; predators get organic phosphate from other animals; and scavengers get phosphorus by eating decomposing plant and animal material. As plants and animals

What are the Sources of Phosphate?

The human body releases about a pound of phosphorus per year.

The large number of sources and the variety of routes that phosphates can take to a stream make it difficult to pinpoint and correct specific sources of phosphate enrichment.

Natural sources of phosphate include the soil, phosphate-containing rocks, animal wastes, and decomposing plants. Phosphate comes from many human-induced sources including human wastes, animal wastes, fertilizers, detergents, and disturbed land. A description of each is below.

Animal Wastes: Phosphate from animal wastes can enter the river system in runoff from manure storage areas, feedlots, and barnyards.

Human Wastes: The main contributions of phosphate from human waste come from leaking septic systems or systems that are not properly maintained, and from waste water treatment facilities. Unless wastewater treatment plants are specifically designed to remove phosphate, they remove only a portion of the phosphate that enters them. Many wastewater treatment plants have a limit, which is set in their permit, on how much phosphate can be discharged. Outdated treatment plants often fail to meet this standard, and some industrial wastes that flow through the facility with the wastewater can interfere with the removal of phosphate. When the storm sewers are connected to the wastewater treatment plant (combined sewer overflows) storms can overload the treatment plant dumping raw sewage directly into the river.

Fertilizer: Phosphate-rich fertilizers enter our waterways through runoff from fertilized lawns and cropland. Nearly all fertilizers contain phosphates.

Detergents: Most detergents and commercial cleaning preparations contain phosphates. They enter the river with the wastewater from our plumping through the wastewater treatment facility or a failing septic system (see above). There are an increasing number of detergents that have a reduced phosphate content. These have 0% to 10% phosphorus by weight. Some states have a phosphate ban on detergents. Read the labels to find a detergent with no phosphate.

Disturbed Land: Phosphate occurs naturally in the soil and is bound to soil particles. Soil erosion from disturbed land introduces the phosphate to the water when the soil enters the river. Wetlands that are drained for development release phosphate that has accumulated in the sediments over time.

Other: Urban and suburban runoff contains phosphate from a variety of sources that can enter waterways through the storm sewers. Road salts used in the winter contain phosphate as an anticaking agent and enter the river as runoff and through the storm sewers.

How Does Phosphate Affect Water Quality?

In most fresh water, phosphate is the nutrient in shortest supply and therefore limits the growth of aquatic plants. Human addition of phosphorus can stimulate great increases in aquatic plant growth (often seen as an algae bloom). An algal bloom may cause an initial increase of dissolved oxygen (as the plants photosynthesize). After the algae die, they break down with the help of decomposing bacteria. Because these bacteria use oxygen, the more organic matter present, the more the decomposing bacteria are active and the more oxygen they use. This ultimately decreases the amount of dissolved oxygen available to other organisms in the river system. Eventually, increased decaying matter affects temperature and other river characteristics, and the stream becomes choked with aquatic weeds and filled with vegetation. The result is that the types of plants and animals that live in the river changes. This process of human-created increase of nutrients in the river is called cultural eutrophication.

Increased nutrients in a river system eventually affect lakes and oceans. The input of nutrients in a lake can have large impacts in terms of weed growth and oxygen levels. In Lake Champlain, a very large lake between New York and Vermont, efforts are being made to reduce the amount of phosphate in the lake by reducing the amount of phosphate entering the lake's tributaries, which are the most significant source of phosphorus to the lake.

Phosphates do not pose a human or animal health risk unless they are present in very high concentrations. Even then, they probably do little more than interfere with digestion. Therefore phosphate is not regulated in our drinking water.

How is Phosphate Measured?

Phosphate is measured as mg/L. We can report results as phosphate or as phosphorus (P). Most state standards are reported "as P," therefore we suggest that results always be reported as P.

Small, naturally nutrient-poor upland streams may respond to P concentrations of 0.01 mg/L or less. Larger river systems may respond only when concentrations approach 0.1 mg/L. In general, any concentration over 0.05 mg/L will likely have an impact. Concentrations over 0.1 mg/L will certainly have an impact on the river.

From: SWHWG Newsservice <waterstrider@comcast.net>
Reply-To: riverissues@lists.sonic.net
To: SonomaWildlife <SonomaWildlife@yahoogroups.com>, River Issues <riverissues@lists.sonic.net>
Date: Tuesday, January 17, 2006 8:35 PM
Subject: [riverissues] WATER: Phosophorus Pollution Limits Plant Diversity

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Newspaper clippings on habitat issues are offered to provide information and encourage conversation.
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http://www.conbio.org/cip/article71jwpho.cfm

Journal Watch

Phosophorus Pollution Limits Plant Diversity

By Robin Meadows
Jan-Mar 2006 Vol.7 No.1

The conventional wisdom that nitrogen pollution threatens biodiversity may be wrong. Rather, the culprit might be too much phosphorus. New research shows that many more endangered plants are still surviving in areas where phosphorus is scarce than in those where nitrogen is scarce, which means these species are more likely to die out if phosphorus levels rise.

"These findings were a surprise," says Martin Wassen of Utrecht University in The Netherlands, who with three coauthors reported this work in Nature. "We expected to find many more endangered species on nitrogen-limited sites."

Nutrient pollution reduces plant biodiversity by favoring the species that grow fastest, which then block sunlight from reaching the many slower-growing species. In contrast, when nutrients are limited, slower-growing species also have a chance to thrive. Excess nitrogen has been blamed for local extinctions of plants in temperate forests, grasslands, and freshwater wetlands. However, this conclusion is based on studies that were done on a small scale and so might not apply universally.

Wassen's is the first large-scale study of how nutrient limitation affects plant diversity. The researchers surveyed plants at 274 sites from Western Europe to Siberia; the sites ranged from freshwater wetlands such as bogs and marshes to moist grasslands. Sites were classified as nitrogen- or phosphorus-limited, based on the ratios of these nutrients in the plants.

If nitrogen were the main threat to plant diversity, more endangered species should still be surviving in ecosystems that are low in this nutrient. But the researchers discovered the opposite: there were far more endangered plants in low-phosphorus ecosystems. "Thirty out of

40 European endangered plant species showed a clear preference for phosphorus-limited ecosystems," says Wassen. Further, the less phosphorus in an ecosystem, the more endangered plant species. This suggests that, when it comes to protecting plants, the focus should be shifted from reducing excess nitrogen to reducing excess phosphorus. "Policies biased towards reducing nitrogen enrichment are unlikely to provide adequate protection for the majority of endangered species in herbaceous ecosystems," say the researchers.

Now, the researchers are doing experiments to pinpoint the source of excess phosphorus in the freshwater wetlands studied. Possibilities include fertilizer and over-extraction of groundwater containing minerals such as calcium that bind phosphorus.

Wassen, M.J et al. 2005. Endangered plants persist under phosphorus limitation. Nature 437:547-550.

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