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Estimating Nutrient Loads from the San Joaquin River Watershed

SJR Low DO TMDL Technical Committee

At several of the previous meetings of the SJR Low DO TMDL Technical Committee I have mentioned the need to develop nutrient export coefficients for various types of land use within the San Joaquin River watershed. Nutrient export coefficients were first developed in the early 1960s by a group of faculty at the University of Wisconsin, Madison as part of understanding the sources and relative significance of nutrient sources for Lake Mendota, located in part in Madison, Wisconsin. Lake Mendota, which is 5 by 7 miles across, and the other Madison lakes have experienced excessive bluegreen algal blooms that have been recorded since the early 1900s. Lake Mendota is often characterized as the most studied lake in the world. I served as Vice-Chair of the Lake Mendota Problems Committee, working with other faculty, principally in the Ag School Department of Soils, where we developed estimates of the amounts of nitrogen and phosphorus derived from various types of land use in the Lake Mendota watershed.

In the 1970s I was under contract with the US EPA to develop the synthesis reports for the US part of the international OECD eutrophication studies. Twenty-two countries over a 5-year period investigated nutrient load eutrophication response relationships for over 200 waterbodies located in Western Europe, North America, Japan, and Australia. The cost of the total effort was in excess of $50 million. Dr. Walter Rast, then a graduate student working for his PhD, and I developed national nutrient export coefficients for various types of land use across the US based on the OECD eutrophication study waterbodies.

The original Lake Mendota watershed, as well as the follow-up OECD nutrient export coefficients were derived from measurement of the amounts of various nutrients transported past a sampling/gaging point over a year. In 1983 Dr. Rast and I published a review paper on this topic, "Nutrient Loading Estimates for Lakes" (Rast and Lee 1983). I have attached a summary table from that publication, which presents our best estimates from our, as well as other work. We found that with very few exceptions, these nutrient export coefficients can be used to estimate the annual amount of nitrogen and phosphorus derived from various types of land use within a factor of 2. I have used these nutrient export coefficients in many parts of the world to estimate the amount of planktonic algae that will develop in a waterbody. They have proven to be reliable for that purpose.

There is need to evaluate the reliability of these nutrient export coefficients for the San Joaquin River watershed. As a first cut, it may be possible, from the information provided by Kratzer and Shelton (1998), in which they reviewed the nutrient data for various parts of the San Joaquin River watershed, to evaluate whether the national nutrient export coefficients are applicable to ag and urban areas within the San Joaquin River watershed.

A potential cause of significant differences between the standard nutrient export coefficients presented in the attached table and parts of the San Joaquin River watershed is the dairies and other areas where large numbers of livestock are maintained. Such areas can export large amounts of nitrogen and phosphorus.

Unmanaged or inadequately managed cow manure is equivalent in nutrients to the wastewater discharges of 1,000 people per cow. The nitrogen can be exported through surface runoff and wastewater discharges, as well as through polluted shallow groundwater that discharges to surface waters.

I suggest that as part of the rough-cut TMDL nutrient loads we first examine, based on total land area and general use within a watershed above where there is flow and nutrient data, the annual nutrient export coefficients for that watershed. Land use should be considered in the broadest sense of undeveloped open space, agricultural crops, dairies and other animal husbandry areas, and urban areas. Eventually, we may want to further refine the agricultural nutrient export coefficients to types of crops, irrigation practices, etc.

In developing nutrient export coefficients for the San Joaquin River that are applicable to the deep water channel low DO situation, it will be important to develop export coefficients for each month, rather than for the year, since much of the nutrients that run off the land during the late fall, winter, and early spring are likely carried through the deep water channel without stimulating the growth of algae that affects the DO levels within the channel.

This exercise will point to areas where we need to conduct additional, more detailed nutrient monitoring. It will also help us estimate nutrient loads from some of the areas where there is inadequate monitoring at this time.

If there are questions about this approach, please contact me.

References

Kratzer, C. and Shelton, J., “Water Quality Assessment of the San Joaquin–Tulare Basins, California: Analysis of Available Data on Nutrients and Suspended Sediment in Surface Water, 1972-1990,” US Geological Survey Professional Paper 1587, Sacramento (1998).

Rast, W. and Lee, G.F., “Nutrient Loading Estimates for Lakes,” *Journal of Environmental Engineering* 109:2 502-517 (1983).

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WATERSHED NUTRIENT EXPORT COEFFICIENTS

Watershed Land Use	Watershed Export Coefficient (g/m^2 yr)	
	A. Total Phosphorus, P	
Urban	0.1	
Rural/Agriculture	0.05	
Forest	0.01	
Atmosphere[a]	0.025[b]	
	B. Total Nitrogen, N	
Urban	0.5	(0.25)[c]
Rural/Agriculture	0.5	(0.2)[c]
Forest	0.3	(0.1)[c]
Atmosphere[a]	2.4	(1.0)[b,c]

[a]Atmospheric load consists of precipitation and dry fallout directly onto the surface of the waterbody.

[b](g/m^2 of waterbody yr).

[c]Parenthetical values are export coefficients to be used in calculating nitrogen loads for waterbodies in the western U.S.

From Rast, W. and Lee, G.F., "Nutrient Loading Estimates for Lakes," *Journal of Environmental Engineering* 109:2 502-517 (1983).