

**APPENDIX D**

**COMPARISON OF NUTRIENT DATABASE WITH  
ROHM AND GRIFFIN SUB-ECOREGIONS**

**ENSR INTERNATIONAL**

## Memorandum

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**To:** Matt Liebman (EPA), Beth Card (NEIWPC)      **Date:** September 8, 2000  
**From:** Isabelle Morin, Dave Mitchell (ENSR)      **Project:** 4933-001  
**RE:** Comparison of Nutrient Database data with Rohm and Griffith sub-ecoregions      **CC:**

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### Introduction

Ecoregions have been proposed by various researchers as a way to define geographical areas that have relatively similar characteristics and observed nutrient levels within their waterbodies. Omernik (1987) divided the six New England states into four such geographical areas: the Atlantic Coastal Pine Barrens, Atlantic Coastal Zone, New England Highlands, and Laurentian Plains and Hills. The data collected for the Nutrient Database were evaluated to determine whether these ecoregions were good indicators of observed nutrient levels. The results of the evaluation were presented in the Data Summary Report (ENSR, 2000). The evaluation showed significant difference between the "lower coastal" and "inland" regions both in terms of the nutrient concentrations typically observed and the characteristics of the lakes (depth, color, alkalinity, etc.), with shallower more colored lakes in southern Massachusetts, Rhode Island and Connecticut showing higher nutrient concentrations than deeper, clearer lakes of northern Maine, New Hampshire and Vermont.

Additional sub-divisions have been proposed by Rohm (1995) and Griffith (XX) for New England and Massachusetts, respectively. The present memorandum discusses the findings of a comparison ranges of total phosphorus concentration reported in the literature for these sub-ecoregions with those found in the Nutrient Database..

### Rohm Sub-Ecoregions of New England

Rohm (1995) subdivided Northeastern United States into 61 sub-ecoregions. The sub-ecoregions were defined based on analysis of the soil types, land uses, and measured Total Phosphorus (TP) concentration for a population of 2,893 lakes larger than 1 hectare. The sub-ecoregions cover 8 phosphorus classes defined by range of TP concentrations.

ArcView, a Geographic Information System (GIS) software was used to combine the spatial coverage of Rohm's sub-ecoregions with the coordinates of the lakes, ponds and reservoirs in the Nutrient Database, and assign to each waterbody in the database its appropriate Rohm sub-ecoregion.

The corresponding phosphorus class was then determined from a table of the sub-ecoregion characteristics. Note that no sub-ecoregion of Class 1 (TP < 5ug/L) was found in the six New England state considered.

The sub-ecoregions located within the six EPA Region 1 states are listed in Table 1. The table provides, for each sub-ecoregion, its identifier, the states where it is located, Rohm phosphorus class, number of waterbodies from the Nutrient Database, and general comments on soil, land use or lake characteristics.

Table 1: Rohm Sub-Ecoregion in New England States.

Region ID	States	Phosphorus Class	Waterbodies in Nutrient Database	Comments
5801	ME	7	5	Land use dominated by agriculture, moderate population density. Enriched soils
5802	ME	3	13	Relatively low values. Lakes typically small in size, and mostly shallow.
5803	ME	4	12	Wide range of phosphorus values. Low topographic relief. Extensive agriculture.
5804	ME	3	73	Diversity of land use. Moderate population density.
5805	ME, NH	2	147	TP low but wide range of value.
5806	ME, NH	2	76	Phosphorus values consistently low.
5808	ME	2	66	
5809	ME	3	10	Most lakes are small and shallow.
5810	NH, VT	3	5	Relatively low TP
5811	NH, VT	6	5	High TP probably due to urbanization and agriculture
5812		2	31	Deep lakes with very low TP. Steep-sided low mountains.
5813	NH, MA	4	31	Bi-modal distribution of phosphorus.
5815	VT, NH, MA, CT	3	41	Most lakes small but deep.
5816	VT	2	14	High fraction of lakes with TP<10 ug/L. Most lakes are small but deep.
5829	VT, MA	3	3	
5901	ME	3	17	Lakes typically shallow. Predominantly hilly with low relief.
5902	ME, NH	5	123	TP highly variable.
5903	ME	4	27	Larger and deeper lakes.
5904	MA, NH, ME	7	34	
5905	MA, NH	3	5	
5906	MA	8	8	
5908	MA, RI	6	9	
5909	MA, RI	8	19	Glacial deposition surface. High degree of development
5910	MA, CT, RI	3	96	TP values range widely. Range attributed to amount of watershed development and lake origin and depth. Most lakes are small and shallow with many human-made.
5911	NH, VT, MA, CT	8	8	
5912	CT	5	7	Fairly high TP values. Natural lakes are uncommon.
5913		2	13	
6001	VT	6	6	
6003	VT	4	3	

**TP Measurements in Rohm Sub-Ecoregions**

The distribution of TP measurements from the Nutrient Database is shown in Figure 1. The TP measurements are grouped by the Rohm phosphorus class (on the x-axis) corresponding to the sub-ecoregion where the waterbody is located. Range of TP concentration as defined by Rohm for each phosphorus class are given in parenthesis.

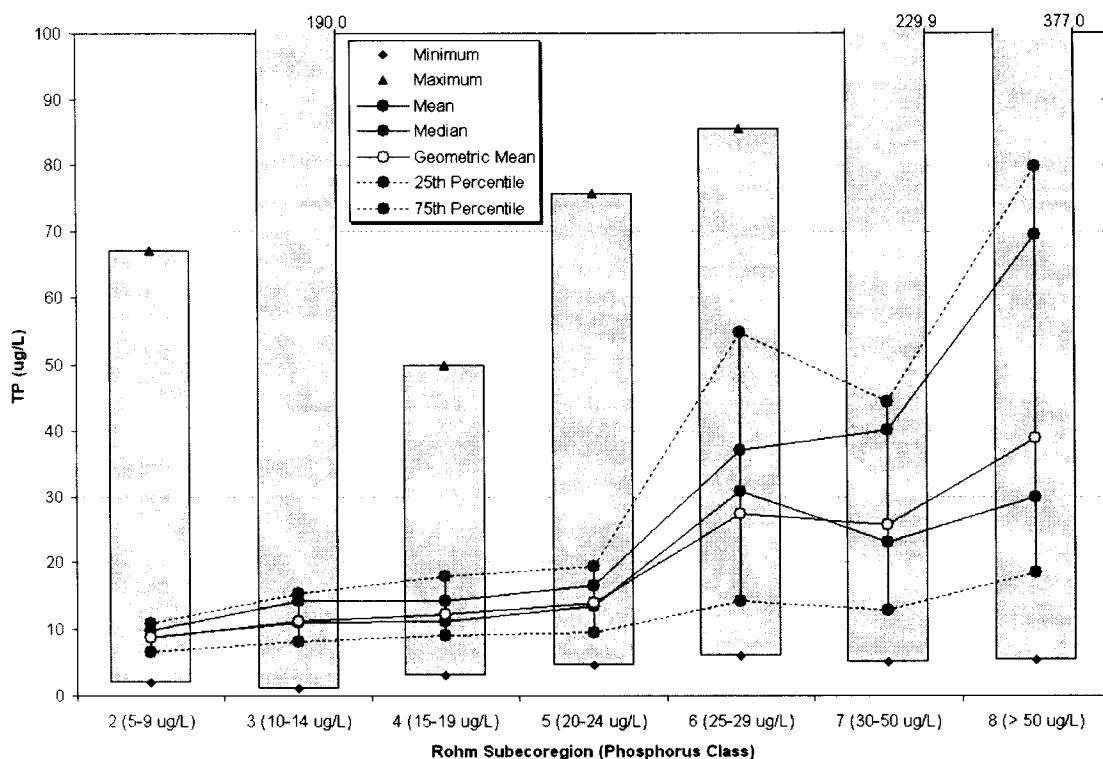


Figure 1: Comparison of phosphorus classes defined by Rohm with distribution of TP measurements from the Nutrient Database.

Overall, we can note a good agreement between the indicators of central tendencies calculated from the Nutrient Database waterbodies and the phosphorus classes defined by Rohm for the sub-ecoregions where the waterbodies are located. The maximum and indicators of central tendencies of TP in the Nutrient Database vary from class to class, with a tendency for mean TP value to increase as expected from class 2 through class 8. Table 2 presents a comparison of the arithmetic and geometric means of the TP measurements in the Nutrient Database with ranges defined for each sub-ecoregion phosphorus class.

Table 2: Comparison of geometric mean of Nutrient Database TP measurements with Rohm phosphorus classes.

Class	Rohm phosphorus range (ug/L)	Arithmetic/geometric mean of TP in Nutrient Database
2	5-9	8.7 / 9.8
3	10-14	11.2 / 14.2
4	15-19	12.2 / 14.2
5	20-24	14.0 / 16.5
6	25-29	27.4 / 37.1
7	30-50	25.6 / 40.2
8	> 50	39.0 / 69.5

TP measurements from the Nutrient Database compare favorably with expected phosphorus range, with the exception of phosphorus classes 4 and 5 where the measurements are lower than expected. For the other classes, either the arithmetic or the geometric mean, or both, are within the range expected from Rohm's definition of the sub-ecoregions.

Figure 2 shows the distribution of TP measurements for individual sub-ecoregions. On that figure, the box represents the range of TP as defined by Rohm for the various sub-ecoregions (phosphorus class).

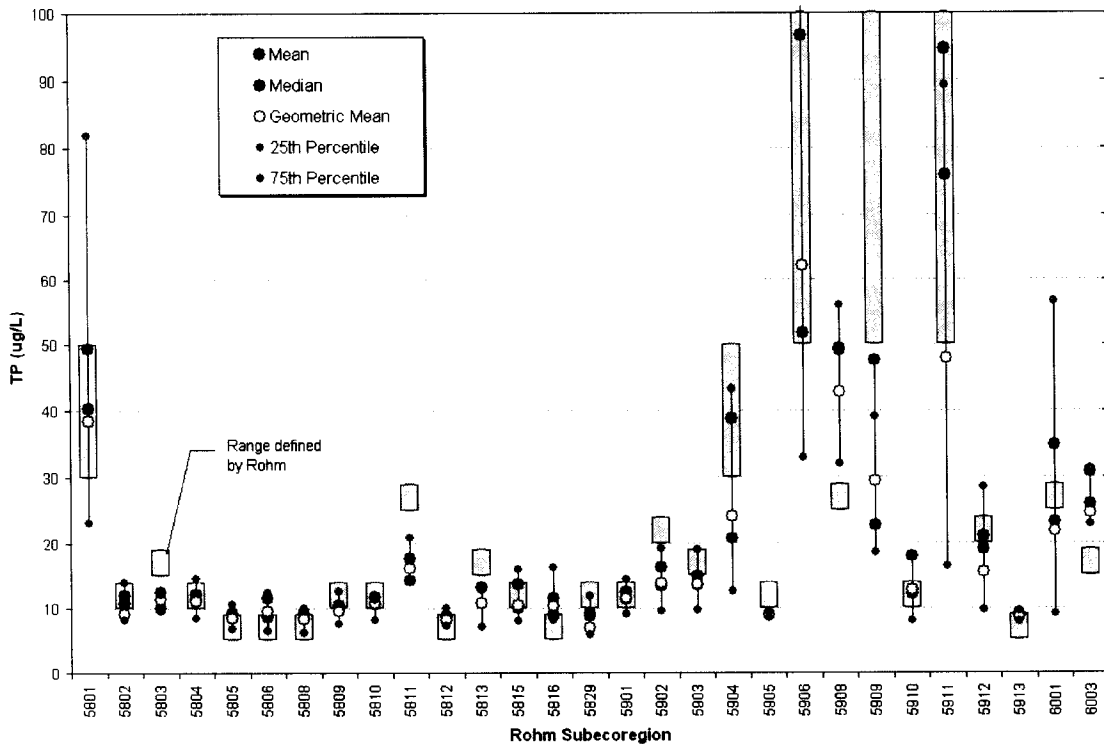


Figure 2: Comparison of phosphorus data from Nutrients Database with range defined by Rohm for sub-ecoregions of New England.

### Griffith Sub-Ecoregions of Massachusetts

Griffith has defined 5 sub-ecoregions in Massachusetts. The sub-ecoregions were sub-divided based on observed TP measurements, land use, and soil types. Coordinates of the 60 lakes, ponds, and reservoirs in Massachusetts were used to assign the corresponding Griffith sub-ecoregion.

#### TP Measurements in Griffith Sub-Ecoregions

Figure 3 shows the distribution and statistical indicators of TP measurements in Massachusetts lakes, ponds and reservoirs for each of the 5 Griffith sub-ecoregion class. The figure shows noticeable differences between the Griffith sub-ecoregions with regards to the range and central tendency of TP measured. Although the population of waterbodies in the Nutrient Database is relatively small for Massachusetts (only 60 with known geographical coordinates), the figure shows a general trend towards increased TP concentration as the sub-ecoregion increases. A copy of the original paper by Griffith could not be located, and the expected phosphorus concentration range could therefore not be used for comparison.

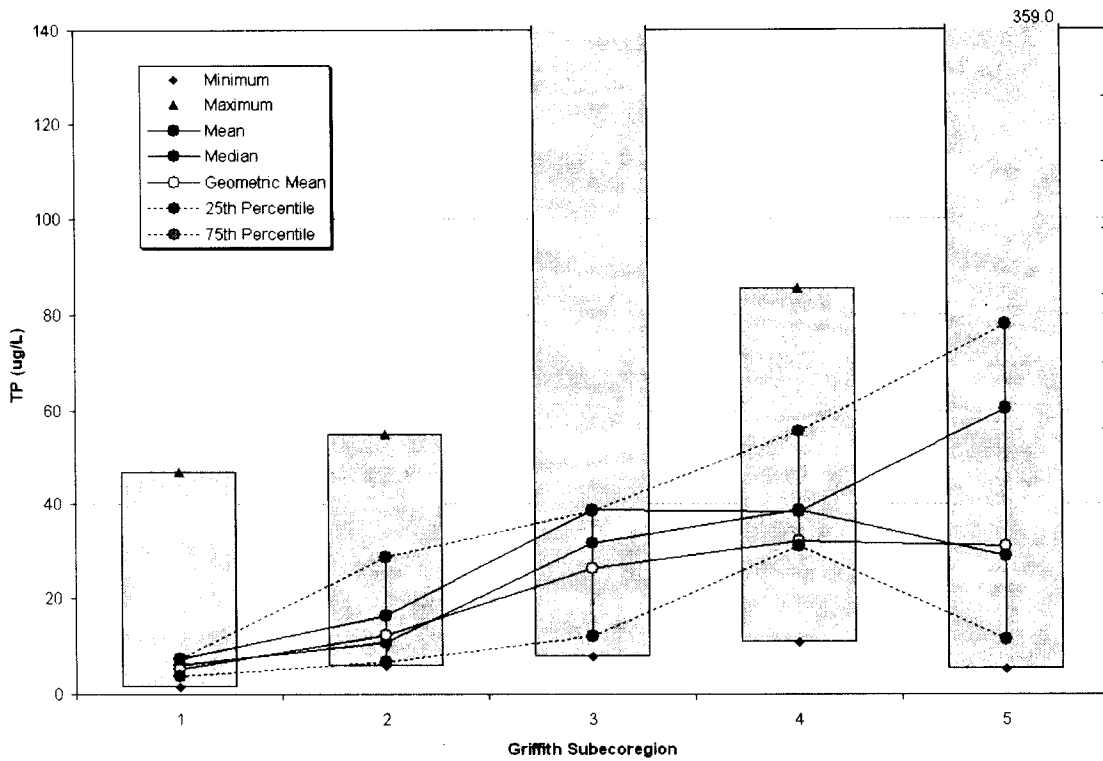


Figure 3: Comparison of phosphorus classes defined by Griffith with distribution of TP measurements in Massachusetts waterbodies from the Nutrient Database.

### References

ENSR (2000). Data Synthesis Report, Interim Final, report submitted to the New England Interstate Pollution Prevention Commission, EPA Region 1 and the Nutrient Assessment Team, April, 87 pp.

Griffith (XX).

Omerik, J.M. (1987). Ecoregions of the Conterminous United States. *Annals of the Association of American Geographers*. 77(1), pp. 118-125.

Rohm, C.M., Omerik, J.M., and Kiilgaard, C.W. (1995). Regional Patters of Total Phosphorus in Lakes of the Northeastern United States, *Lakes and Reservoir Management*, 11(1), pp. 1-14.