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Information Supporting the Development of State and Tribal Nutrient Criteria

Rivers and Streams in Nutrient Ecoregion I

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AMBIENT WATER QUALITY CRITERIA RECOMMENDATIONS

INFORMATION SUPPORTING THE DEVELOPMENT OF STATE AND TRIBAL NUTRIENT CRITERIA

FOR

RIVERS AND STREAMS IN NUTRIENT ECOREGION I

Willamette and Central Valleys

including all or parts of the States of:

Washington, Oregon, and California,

and the authorized Tribes within the Region

U.S. ENVIRONMENTAL PROTECTION AGENCY

OFFICE OF WATER
OFFICE OF SCIENCE AND TECHNOLOGY
HEALTH AND ECOLOGICAL CRITERIA DIVISION
WASHINGTON, DC

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FOREWORD

This document presents EPA's nutrient criteria for **Rivers and Streams in Nutrient Ecoregion I**. These criteria provide EPA's recommendations to States and authorized Tribes for use in establishing their water quality standards consistent with section 303(c) of the Clean Water Act (CWA). Under section 303(c) of the CWA, States and authorized Tribes have the primary responsibility for adopting water quality standards as part of State or Tribal law or regulation. Federal regulations require State and Tribal standards to contain scientifically defensible water quality criteria that are protective of designated uses. EPA's recommended section 304(a) criteria are not laws or regulations; they are guidance that States and Tribes may use as a starting point in creating their own water quality standards.

The term "water quality criteria" is used in two sections of the CWA, section 304(a)(1) and section 303(c)(2). The term has a different impact in each section. On the one hand, in section 304, the term represents a scientific assessment of ecological and human health effects that EPA recommends to States and authorized Tribes for establishing water quality standards that ultimately provide a basis for controlling discharges or releases of pollutants or related parameters. On the other hand, in section 303, ambient water quality criteria are developed by States and Tribes as part of their water quality standards, to define the level of a pollutant (or in the case of nutrients, a condition) necessary to protect designated uses in ambient waters.

Quantified water quality criteria contained within State or Tribal water quality standards are essential to a water quality-based approach to pollution control. Whether expressed numerically or as quantified translations of narrative criteria within State or Tribal water quality standards, quantified criteria are critical for assessing attainment of designated uses and measuring progress toward meeting CWA goals.

EPA is developing section 304(a) water quality criteria for nutrients because States and Tribes consistently identify excessive levels of nutrients as a major reason that as many as half of the Nation's surface waters surveyed do not meet water quality objectives, such as full support of aquatic life. EPA expects to develop nutrient criteria that cover four major types of waterbodies—lakes and reservoirs, rivers and streams, estuarine and coastal areas, and wetlands—across 14 major ecoregions of the United States. EPA's section 304(a) criteria are intended to provide for the protection and propagation of aquatic life and recreation. To support the development of nutrient criteria, EPA has published and will continue to publish technical guidance manuals that describe a process for assessing nutrient conditions in the four waterbody types listed above.

EPA's section 304(a) water quality criteria for nutrients provide numeric water quality criteria and procedures to help establish quantified criteria within State or Tribal water quality standards. In the case of nutrients, EPA section 304(a) criteria establish values for causal variables (e.g., total nitrogen and total phosphorus) and response variables (e.g., turbidity and chlorophyll *a*). EPA believes that State and Tribal water quality standards need to include quantified endpoints for causal and response variables to provide sufficient protection of uses and to maintain downstream uses. These endpoints will most often be expressed as numeric water quality criteria or as procedures to translate a State or Tribal narrative criterion into a quantified endpoint.

States and authorized Tribes have several options in adopting these criteria. EPA recommends the following approaches, in order of preference:

1. Wherever possible, develop nutrient criteria that fully reflect local conditions and protect specific designated uses through the process described in EPA's technical guidance manuals for nutrient criteria development. Such criteria may be expressed either as numeric criteria or as procedures to translate a State or Tribal narrative criterion into a quantified endpoint in State or Tribal water quality standards.

2. Adopt EPA's section 304(a) water quality criteria for nutrients, either as numeric criteria or as procedures to translate a State or Tribal narrative nutrient criterion into a quantified endpoint.

3. Develop nutrient criteria protective of designated uses using other scientifically defensible methods and appropriate water quality data.

EPA developed the nutrient criteria recommendations in this document with the intent that they serve as a starting point for States and Tribes to develop more refined criteria, as appropriate, to reflect local conditions. The values presented in this document generally represent nutrient levels that protect against the adverse effects of nutrient overenrichment. They are based on the information that was available to the Agency at the time of this publication. EPA expects States and Tribes may have additional information and data that may be utilized in the refinement of these criteria. EPA offers to work with States and authorized Tribes to establish the necessary quantitative endpoints to reduce the excess nutrient inputs into our nation's waters and to prevent any further impairments.

Geoffrey H. Grubbs, Director
Office of Science and Technology

DISCLAIMER

This document provides technical guidance and recommendations to States, authorized Tribes, and other authorized jurisdictions to develop water quality criteria and water quality standards under the Clean Water Act (CWA) to protect against the adverse effects of nutrient overenrichment. Under the CWA, States and authorized Tribes are to establish water quality criteria to protect designated uses. State and Tribal decisionmakers retain the discretion to adopt approaches on a case-by-case basis that differ from this guidance when appropriate and scientifically defensible. Even though this document contains EPA's scientific recommendations regarding ambient concentrations of nutrients that will protect aquatic resource quality, it does not substitute for the CWA or EPA regulations, nor is it a regulation itself. Thus it cannot impose legally binding requirements on EPA, States, authorized Tribes, or the regulated community, and it might not apply to a particular situation or circumstance. EPA may change this guidance in the future.

EXECUTIVE SUMMARY

Nutrient Program Goals

EPA developed the National Strategy for the Development of Regional Nutrient Criteria (National Strategy) in June 1998. The strategy presents EPA's intentions to develop technical guidance manuals for four types of waters (lakes and reservoirs, rivers and streams, estuaries and coastal waters, and wetlands) and produce section 304(a) criteria for specific nutrient Ecoregions by the end of 2000. In addition, the Agency formed Regional Technical Assistance Groups (RTAGs), which include State and Tribal representatives working to develop more refined and localized nutrient criteria based on approaches described in the waterbody guidance manuals. This document presents EPA's current recommended criteria for total phosphorus (TP), total nitrogen (TN), chlorophyll *a*, and turbidity for rivers and streams in Nutrient Ecoregion I, which were derived using the procedures described in the *Rivers and Streams Nutrient Criteria Technical Guidance Manual* (U.S. EPA, 2000b).

EPA's ecoregional nutrient criteria address cultural eutrophication—the adverse effects of excess human-caused nutrient inputs. The criteria are empirically derived to represent surface waters that are minimally impacted by human activities and protective of aquatic life and recreational uses. The information contained in this document represents starting points for States and Tribes to develop (with assistance from EPA) more refined nutrient criteria.

In developing these criteria recommendations, EPA followed a process that included, to the extent they were readily available, the following critical elements:

- **Historical and recent nutrient data in Nutrient Ecoregion I.** Data sets from Legacy STORET, NASQAN, NAWQA, and EPA Region 10 were used to assess nutrient conditions from 1990 to 2000.

- **Reference sites/reference conditions in Nutrient Ecoregion I.** Reference conditions presented are based on 25th percentiles of all nutrient data, including a comparison of reference conditions for the Aggregate Ecoregion versus the subecoregions. States and Tribes are urged to determine their own reference sites for rivers and streams at different geographic scales and to compare them to EPA's reference conditions.

- **Models employed for prediction or validation.** EPA did not identify any specific models to develop nutrient criteria. States and Tribes are encouraged to identify and apply appropriate models to support nutrient criteria development.

- **RTAG expert review and consensus.** EPA recommends that when States and Tribes prepare their nutrient criteria, they obtain the expert review and consent of the RTAG.

- **Downstream effects of criteria.** EPA encourages the RTAG to assess the potential effects of the proposed criteria on downstream water quality and uses.

In addition, EPA followed specific **QA/QC procedures** during data collection and analysis. All data were reviewed for duplications. All data were from ambient waters that were not located directly outside a permitted discharger. The following States indicated that their data were sampled and analyzed using either standard methods or EPA-approved methods: Washington, and Oregon. California indicated that standard or EPA-approved methods were used for some specific nutrient parameters.

The following tables contain a summary of aggregate and level III Ecoregion values for TN, TP, water column chlorophyll *a*, and turbidity.

BASED ON 25th PERCENTILES ONLY

Nutrient Parameters	Aggregate Nutrient Ecoregion I Reference Conditions
Total phosphorus (µg/L)	47
Total nitrogen (mg/L) (reported)	0.31
Chlorophyll *a* (µg/L) (fluorometric method)	1.8
Turbidity (FTU)	4.25

For subecoregions 3 and 7 the ranges of nutrient parameter reference conditions are as follows:

BASED ON 25th PERCENTILE ONLY

Nutrient Parameters	Range of Level III Subecoregions Reference Conditions
Total phosphorus (µg/L)	40-77
Total nitrogen (mg/L) (reported)	0.32-0.4
Chlorophyll *a* (µg/L) (fluorometric method)	Insufficient data; N/A
Turbidity (FTU)	3.94-7.13

NOTICE OF DOCUMENT AVAILABILITY

This document is available electronically to the public through the Internet at http://www.epa.gov/OST/standards/nutrient.html. Requests for hard copies of the document should be made to EPA's National Service Center for Environmental Publications (NSCEP), 11029 Kenwood Road, Cincinnati, OH 45242; telephone (513) 489-8190 or toll free (800) 490-9198. Please refer to EPA document number EPA 822-B-01-012.

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1.0 INTRODUCTION

Background

Nutrients are essential to the health and diversity of surface waters. However, in excessive amounts nutrients cause eutrophication or hypereutrophication, which results in overgrowth of plant life and decline of the biological community. Excessive nutrients can also result in human health risks, such as the growth of harmful algal blooms, most recently manifested in the *Pfiesteria* outbreaks on the Gulf and East Coasts. Chronic nutrient overenrichment of a waterbody can lead to the following consequences: algal blooms, low dissolved oxygen, fish kills, overabundance of macrophytes, likely increased sedimentation, and species shifts of both flora and fauna.

Historically, National Water Quality Inventories have repeatedly shown that nutrients are a major cause of ambient water quality use impairments. EPA's 1996 National Water Quality Inventory report identifies excessive nutrients as the leading cause of impairment in lakes and the second leading cause of impairment in rivers (behind siltation). In addition, nutrients were the second leading cause of impairments after siltation reported by the States in their 1998 lists of impaired waters. Where use impairment is documented, nutrients contribute roughly 25%-50% of the impairment nationally. The Clean Water Act (CWA) establishes that, wherever possible, water quality must provide for the protection and propagation of fish, shellfish, and wildlife, and recreation in and on the water and/or protecting the physical, chemical, and biological integrity of those waters. In adopting water quality standards, States and Tribes designate uses for their waters in consideration of these CWA goals, and establish water quality criteria that contain sufficient parameters to protect that integrity and those uses. To date, EPA has not published information and recommendations under section 304(a) for nutrients to assist States and Tribes in establishing numeric nutrient criteria to protect uses when adopting water quality standards.

In 1995, EPA gathered a set of national experts and asked them how best to deal with the national nutrient problem. The experts recommended that the Agency not develop single criteria values for phosphorus (P) or nitrogen (N) applicable to all waterbodies and regions of the country. Rather, they recommended that EPA put a premium on regionalization, develop guidance (assessment tools and control measures) for specific waterbodies and ecological regions across the country, and use reference conditions (conditions that reflect pristine or minimally impacted waters) as a basis for developing nutrient criteria.

With these suggestions as starting points, EPA developed the National Strategy for the Development of Regional Nutrient Criteria (National Strategy), published in June 1998. This strategy presented EPA's intentions to develop technical guidance manuals for four types of waters (lakes and reservoirs, rivers and streams, estuaries and coastal waters, and wetlands), and thereafter to publish section 304(a) criteria recommendations for specific nutrient Ecoregions. Technical guidance manuals for lakes/reservoirs and rivers/streams were published in April 2000 and July 2000, respectively. The technical guidance manual for estuaries/coastal waters was published in fall 2001, and the draft wetlands technical guidance manual will be published by

December 2001. Each manual presents EPA's recommended approach for developing nutrient criteria values for a specific waterbody type. In addition, EPA is committed to working with States and Tribes to develop more refined and localized nutrient criteria based on approaches described in the waterbody guidance manuals and this document.

Overview of the Nutrient Criteria Development Process

For each nutrient Ecoregion, EPA developed a set of recommendations for two causal variables (total nitrogen and total phosphorus) and two early indicator response variables (chlorophyll *a* [chl *a*] and some measure of turbidity). Other indicators such as dissolved oxygen, macrophyte or benthic algal growth or speciation, and other fauna and flora changes are also useful. However, the first four variables are considered to be the best suited for protecting designated uses.

The technical guidance manuals describe a process for developing nutrient criteria that involves consideration of five factors. The first of these is the Regional Technical Assistance Group (RTAG), which is a body of qualified regional specialists able to objectively evaluate all of the available evidence and select the value(s) appropriate to nutrient control in the water bodies of concern. These specialists may come from such disciplines as limnology, biology, or natural resources management—especially water resource management, chemistry, and ecology. The RTAG evaluates and recommends appropriate classification techniques, usually physical, for criteria determination within an ecoregional construct.

The second factor is the historical information available to establish a perspective of the resource base. This is usually data and anecdotal information available within the past 10-25 years. This information gives evidence about the background and enrichment trend of the resource.

The third factor is the existing reference condition, a selection of reference sites chosen to represent the least culturally impacted waters of the class at the present time. The data from these sites are combined and a value is selected to represent the reference condition, the best attainable, most natural condition of the resource base at this time.

The RTAG comprehensively evaluates these three elements to propose a candidate criterion (initially one each for TP, TN, chl *a*, and some measure of turbidity).

A fourth factor often employed is mechanistic or empirical models of the historical and reference condition data to better understand the condition of the resource.

The final element of the process is assessment by the RTAG of the likely downstream effects of the criterion. Will there be a negative, positive, or neutral effect on the downstream waterbody? If the RTAG judges that a negative effect is likely, then the proposed State/Tribal water quality criteria should be revised to ameliorate the potential for any adverse downstream effects.

Although States and authorized Tribes do not necessarily need to incorporate all five elements into their water quality criteria setting process (e.g., modeling may be significant in only some instances), the best assurance of a representative and effective criterion is a balanced incorporation of all five elements.

Because some parts of the country have naturally different soil and parent material nutrient content, and different precipitation regimes, the application of the criterion development process should reflect this regional variation. Therefore, an ecoregional approach was chosen. Initially, the continental United States was divided into 14 separate Ecoregions of similar geographical characteristics and similar nutrient condition (Figure 1a). Ecoregions are defined as regions of relative homogeneity in ecological systems; they depict areas within which the mosaic of ecosystem components (biotic and abiotic as well as terrestrial and aquatic) is different from adjacent areas in a holistic sense. Geographic characteristics such as soils, vegetation, climate, geology, and land cover are relatively similar within each Ecoregion (Omernik, 2000).

The nutrient Ecoregions are aggregates of EPA's hierarchical level III Ecoregions (see Figure 1b for map of level III Ecoregions). As such, they are more generalized and less defined than level III Ecoregions. EPA determined that setting ecoregional criteria for the large-scale aggregates is not without its drawbacks: variability is high because of the lumping of many waterbody classes, seasons, and years worth of multipurpose data over a large geographic area. For these reasons, the Agency recommends that States and Tribes develop nutrient criteria at the level III ecoregional scale and at the waterbody-class scale, where those data are readily available. Data analyses and recommendations on both the large Aggregate Ecoregion scale and the more refined scales (level III Ecoregions and waterbody classes), where data were available to make such assessments, are presented for comparison and completeness of analysis.

Comparison of Nutrient Criteria to Biological Criteria

Biological criteria are quantitative expressions of the desired condition of the aquatic community. Such criteria can be based on data from sites that represent the least impacted attainable condition for a particular waterbody type in an Ecoregion, subecoregion, or watershed. EPA's nutrient criteria recommendations and biological criteria recommendations have many similarities in their basic approaches to development and data requirements. Both are empirically derived from statistical analysis of field-collected data and expert evaluation of current reference conditions and historical information. Both use direct measurements from the environment to integrate the effects of complex processes that vary according to type and location of waterbody. The resulting criteria recommendations, in both cases, are efficient uses of existing resources and are holistic indicators of the water quality necessary to protect uses.

States and authorized Tribes can develop and apply nutrient and biological criteria in tandem, with each providing important and useful information to interpret both the nutrient enrichment levels and the biological condition of sampled waterbodies. For example, using the same reference sites for both types of criteria can lead to efficiencies in both sample design and data analysis. In one effort, environmental managers can obtain information to support assessment of biological and nutrient condition, either through evaluating existing data sets or

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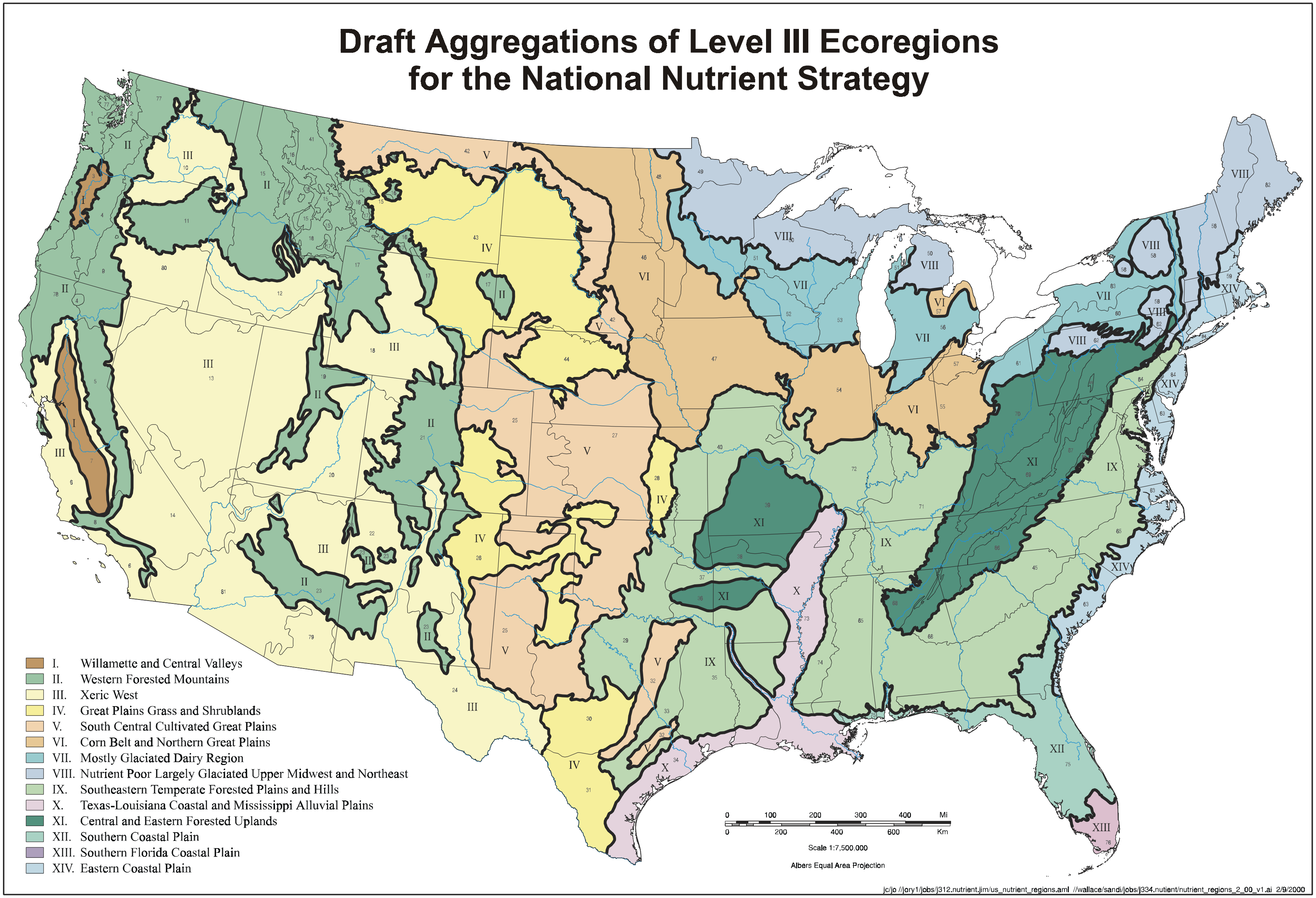


Figure 1a. Fourteen nutrient Ecoregions as delineated by Omernik (2000). Ecoregions were based on geology, land use, ecosystem type, and nutrient conditions.

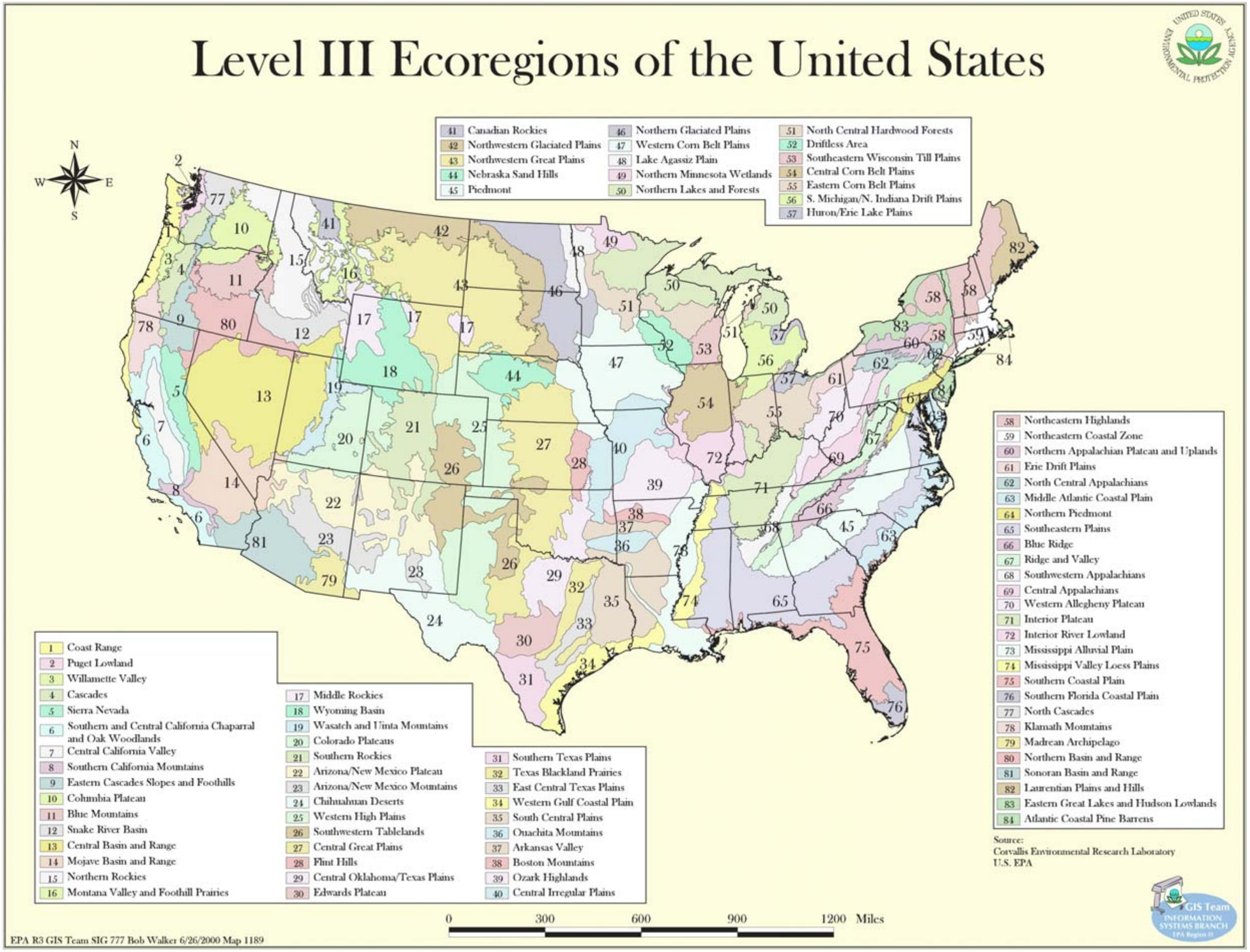


Figure 1b. Level III Ecoregions of the United States.

through designing and conducting a common sampling program. The traditional biological criteria variables of benthic invertebrate and fish sampling can be readily incorporated in a nutrient assessment. To investigate the effectiveness of this tandem approach, EPA has initiated pilot projects in both freshwater and marine environments to pursue the relationship between nutrient overenrichment and apparent declines in diversity of benthic invertebrates and fish.

2.0 BEST USE OF THIS INFORMATION

EPA recommendations published under section 304(a) of the CWA serve several purposes, including providing guidance to States and Tribes in adopting water quality standards for nutrients and ultimately controlling discharges or releases of pollutants. The recommendations also provide guidance to EPA when it determines that it is necessary to promulgate Federal water quality standards under section 303(c). Other uses include identification of overenrichment problems, management planning, project evaluation, and determination of status and trends of water resources.

State water quality inventories and listings of impaired waters consistently rank nutrient overenrichment as a top contributor to use impairments. EPA's water quality standards regulations at 40 CFR §131.11(a) require States and Tribes to adopt criteria that contain sufficient parameters and constituents to protect the designated uses of their waters. In addition, States and Tribes need quantifiable targets for nutrients to assess attainment of uses, develop water quality-based permit limits and source control plans, and establish targets for total maximum daily loads (TMDLs).

EPA expects States and Tribes to address nutrient overenrichment in their water quality standards and to build on existing State and Tribal efforts where possible. States and Tribes can address nutrient overenrichment through establishment of numerical criteria or use of narrative criteria statements (e.g., "free from excess nutrients that cause or contribute to undesirable or nuisance aquatic life or produce adverse physiological response in humans, animals, or plants"). In the case of narrative criteria, EPA expects that States and Tribes will establish procedures to quantitatively translate these statements for both assessment and source control purposes.

Ecoregional nutrient criteria are developed to represent surface waters that are minimally impacted by human activities and thus protect against the adverse effects of nutrient overenrichment from cultural eutrophication. EPA's recommended process for developing such criteria includes physical classification of waterbodies, determination of current reference conditions, evaluation of historical data and other information (such as published literature), use of models to simulate physical and ecological processes or determine empirical relationships among causal and response variables (if necessary), expert judgment, and evaluation of downstream effects. EPA has used elements of this process to produce the information contained in this document. The causal (total nitrogen, total phosphorus) and biological and physical response (chlorophyll *a*, turbidity) variables represent a set of starting points for States and Tribes to use in establishing their own criteria.

EPA recommends that States and Tribes establish numerical criteria based on section 304(a) guidance, section 304(a) guidance modified to reflect site-specific conditions, or other scientifically defensible methods. For many pollutants, such as toxic chemicals, EPA expects that section 304(a) guidance will provide an appropriate level of protection without further modification. EPA has also published methods for modifying 304(a) criteria, such as the water effect ratio, on a site-specific basis where conditions warrant modification to achieve the intended level of protection. For nutrients, however, EPA expects that it will usually be necessary for States and authorized Tribes to be more precise in identifying the nutrient levels that protect aquatic life and recreational uses. This can be achieved through criteria modified to reflect a smaller geographic scale than an Ecoregion, such as a subecoregion, the State or Tribe level, or a specific class of waterbodies. Criteria can be refined by grouping data or performing analyses at these smaller geographic scales. Refinement can also occur through further consideration of other elements such as published literature or models.

EPA expects that the values presented in this document generally represent nutrient levels that protect against the adverse effects of cultural overenrichment and are based on information available to the Agency at the time of this publication. However, States and Tribes should critically evaluate this information in light of the specific uses that need to be protected. For example, more sensitive uses may require more stringent criteria to ensure adequate protection. On the other hand, overly stringent levels of protection against cultural eutrophication may actually fall below the natural load of nutrients for certain waterbodies. In cases such as these, the level of nutrients specified may not be sufficient to support a productive fishery. In the criteria derivation process, it is important to distinguish between the natural load associated with a specific waterbody using historical data and expert judgment and current reference conditions. These elements of the criteria derivation process are best addressed by States and Tribes with access to information and local expertise. Therefore, EPA strongly encourages States and Tribes to use the information contained in this document to develop more refined criteria according to the methods described in EPA's technical guidance manuals for specific waterbody types.

To assist in further refinement of nutrient criteria, EPA has established 10 RTAGs (experts from EPA Regional Offices and States/Tribes). In refining criteria, States and authorized Tribes need to provide documentation of data and analyses, along with a defensible rationale, for any new or revised nutrient criteria they submit to EPA for review and approval. As part of EPA's review of State and Tribal standards, EPA intends to seek assurance from the RTAG that proposed criteria are sufficient to protect uses.

In using the information and recommendations in this document and elsewhere to develop numerical criteria or procedures to translate narrative criteria, EPA encourages States and Tribes to:

- Address both chemical causal variables and early indicator response variables. Causal variables are necessary to protect uses before impairment occurs and to maintain downstream uses. Early response variables are necessary to warn of possible impairment and to integrate the effects of variable and potentially unmeasured nutrient loads.

- Include variables that can be measured to determine if standards are met, and variables that can be related to the ultimate sources of excess nutrients.

- Identify appropriate periods of duration (how long) and frequency (how often) of occurrence in addition to magnitude (how much). EPA does not recommend identifying nutrient concentrations that must be met at all times; rather a seasonal or annual averaging period (e.g., based on weekly or biweekly measurements) is considered appropriate. However, these central tendency measures should apply each season or each year, except under the most extraordinary conditions (e.g., a 100-year flood).

3.0 AREA COVERED BY THIS DOCUMENT

This chapter provides a general description of the Aggregate Ecoregion and its geographical boundaries. Descriptions of the level III subecoregions contained within the Aggregate Ecoregion are also provided.

3.1 Description of Aggregate Ecoregion I

Ecoregion I is composed of broad, arable, western valleys that are drier, flatter, and much more densely populated than the neighboring Western Forested Mountains (II). This ecoregion encompasses two river valley areas, the Willamette Valley in Oregon and Washington and the Central Valley in California. Soils are typically nutrient-rich and more naturally fertile than those of the adjacent nutrient regions. They support mostly cropland agriculture. Erosion, fertilizer use, irrigation return, livestock, urbanization, and industrialization have degraded the surficial water quality of the region by increasing levels of nutrients, dissolved solids, toxic compounds, and fecal coliform bacteria.

The broad, Willamette Valley is composed of nearly level terraces and floodplains that are interlaced and surrounded by rolling hills. The meandering, low gradient Willamette River and its tributaries drain the Valley and have formed oxbow lakes. Elevations range from 10 to 1,500 feet. The mean annual precipitation varies from 37 to 60 inches and the average freeze-free season is 165-210 days. The potential natural vegetation includes Douglas-fir-hemlock-cedar forests and Oregon oakwoods; in addition, wetlands, Oregon white oak savanna, prairies, riparian forests of cottonwoods and willows were part of the pre-settlement landscape. Today, the Willamette Valley is the most important agricultural area in Oregon. Cropland agriculture is widespread and contrasts with the prevailing land use of the Western Forested Mountains (II). The Willamette Valley's climate is ocean influenced and mild. Precipitation is concentrated in the fall, winter, and spring months; summers are dry and, correspondingly, summer streamflow is relatively low. The Valley's temperate climate and its productive, nutrient-rich soils support an especially wide range of crops including grass seed vegetables, berries, wine grapes, nursery stock, Christmas trees, hay, and grain; pastureland is also common. The Valley's moderate precipitation and plentiful streamflow furnish enough water for present needs; additional supplies are available from adjoining mountain ranges. The Willamette Valley is the home to most of Oregon's rapidly growing population and industrial base. Urbanization, fertilizer use, industrialization, irrigation return, nearby logging, and livestock have affected surficial water quality. Dissolved phosphorus in some streams is rising due to human activities including agricultural use of phosphorus fertilizer, greater runoff from suburban-urban areas, and more discharge from municipal sewage treatment plants. Dissolved oxygen is decreasing in some streams within suburbanized and urbanized watersheds.

The Central Valley of California is composed of the intensively farmed Sacramento and San Joaquin valleys. Elevations range from 0 to 650 feet. The mean annual precipitation varies from 5 to 25 inches and the average freeze-free season is 230 to 350 days. The potential natural vegetation of the Central Valley includes California steppe, tule marshes, and salt bush-greasewood; oak, willow, and cottonwood naturally occurred along streams and salt bush originally grew on saline sodic soils. The land use mosaic, potential natural vegetation, and terrain are all different in the nearby Western Forested Mountains (II) and Xeric West (III). Long, hot, dry summers and cool, rainy winters are characteristic of the Central Valley. Stream flow is limited over much of the area during the summer and water for crops often comes from stream diversions, wells, canals, and reservoirs. More than 90% of the Central Valley is in farms and ranches; urban or suburban areas have been rapidly expanding but occupy less than 5% of the Central Valley. Nearly half of the region is in cropland, about three fourths of which is irrigated. Environmental concerns in the region include high concentrations of salt and toxic chemicals in drainage waters, high phosphorus and nitrogen concentrations in streams from nonpoint sources, groundwater contamination from heavy use of agricultural chemicals, lowering of the groundwater table due to over-pumping, ground subsidence from overdraft pumping, wildlife habitat loss, and urban sprawl.

The San Joaquin Valley includes some of the most extensively cultivated, irrigated, and chemically treated land in California; its water quality has been severely affected by land use and generally deteriorates downstream. Dissolved solid, nitrite plus nitrate, sulfate, and selenium concentrations have been rising in the San Joaquin Valley as a result of increasing irrigation return flow and reuse of stream water; runoff from dairies and feedlots has also affected nitrite and nitrate levels. The California State Water Resources Control Board has declared a 100 mile segment of the San Joaquin River as "Water Quality Limited."

In the Sacramento River, median concentrations of most water pollutants are lower than in the San Joaquin River system. Weathering of metavolcanic and metasedimentary bedrock containing appreciable concentrations of fixed nitrogen in the Mokelumne River basin has contributed a significant amount of nitrate to surface waters.

3.2 Geographical Boundaries of Aggregate Ecoregion I

Ecoregion I is composed of two separate segments that span along the west coast (Figure 2). The small, northern segment (Willamette Valley) begins near the southwestern border of Washington and continues south into Oregon. The second, larger segment (Central Valley) begins in north central California and continues south encompassing the middle portion of the State.

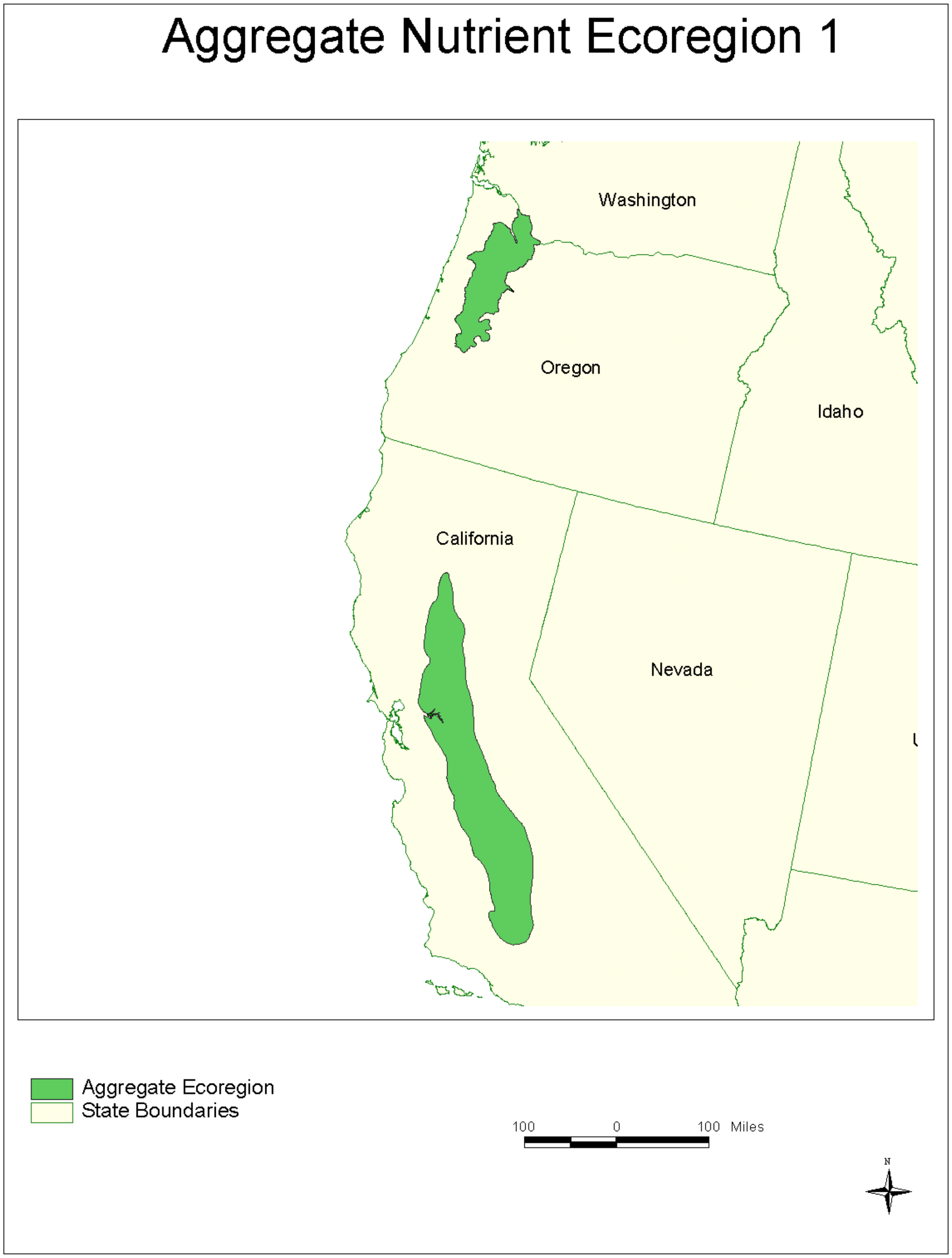


Figure 2. Aggregate Ecoregion I.

3.3 Level III Subecoregions Within Aggregate Ecoregion I

There are two level III subecoregions contained within Aggregate Ecoregion I (Figure 3). The following are brief descriptions provided by Omernik (1999) of the climate, vegetative cover, topography, and other ecological information pertaining to these subecoregions.

3. Willamette Valley

Rolling prairies, deciduous/coniferous forests, and extensive wetlands characterized the pre-19th century landscape of this broad, lowland valley. The Willamette Valley is distinguished from the adjacent Coast Range and Cascades by lower precipitation, less relief, and a different mosaic of vegetation. Landforms consist of terraces and floodplains, interlaced and surrounded by rolling hills. Productive soils and a temperate climate make it one of the most important agricultural areas in Oregon.

7. Central California Valley

Flat, intensively farmed plains with long, hot dry summers and cool wet winters distinguish the Central California Valley from its neighboring Ecoregions that are either hilly or mountainous, forest or shrub covered, and generally nonagricultural. Nearly half of the region is in cropland, about three fourths of which is irrigated. Environmental concerns in the region include salinity due to evaporation of irrigation water, groundwater contamination from heavy use of agricultural chemicals, wildlife habitat loss, and urban sprawl.

3.4 Suggested Ecoregional Subdivisions or Adjustments

EPA recommends that the RTAG evaluate the adequacy of EPA nutrient ecoregional and subecoregional boundaries and refine them as needed to reflect local conditions. See the paper by Dale Robertson (USGS, 2001b) for an alternative approach to Ecoregions entitled "An Alternative Regarding the Scheme for Defining Nutrient Criteria for Rivers and Streams."

4.0 DATA REVIEW FOR RIVERS AND STREAMS IN AGGREGATE ECOREGION I

This section describes the nutrient data EPA has collected and analyzed for this Ecoregion, including an assessment of data quantity and quality. The data tables present the data for each causal parameter (total phosphorus and total nitrogen, both reported and calculated from TKN and nitrite/nitrate), and the primary response variables (some measure of turbidity and chlorophyll *a*). EPA considers these parameters essential to nutrient assessment, because the first two are the main causative agents of enrichment and the two response variables are the early indicators of enrichment for most surface waters (see Chapter 3 of the *Rivers and Streams Nutrient Criteria Technical Guidance Manual* [U.S. EPA, 2000b] for a complete discussion on choosing causal and response variables).

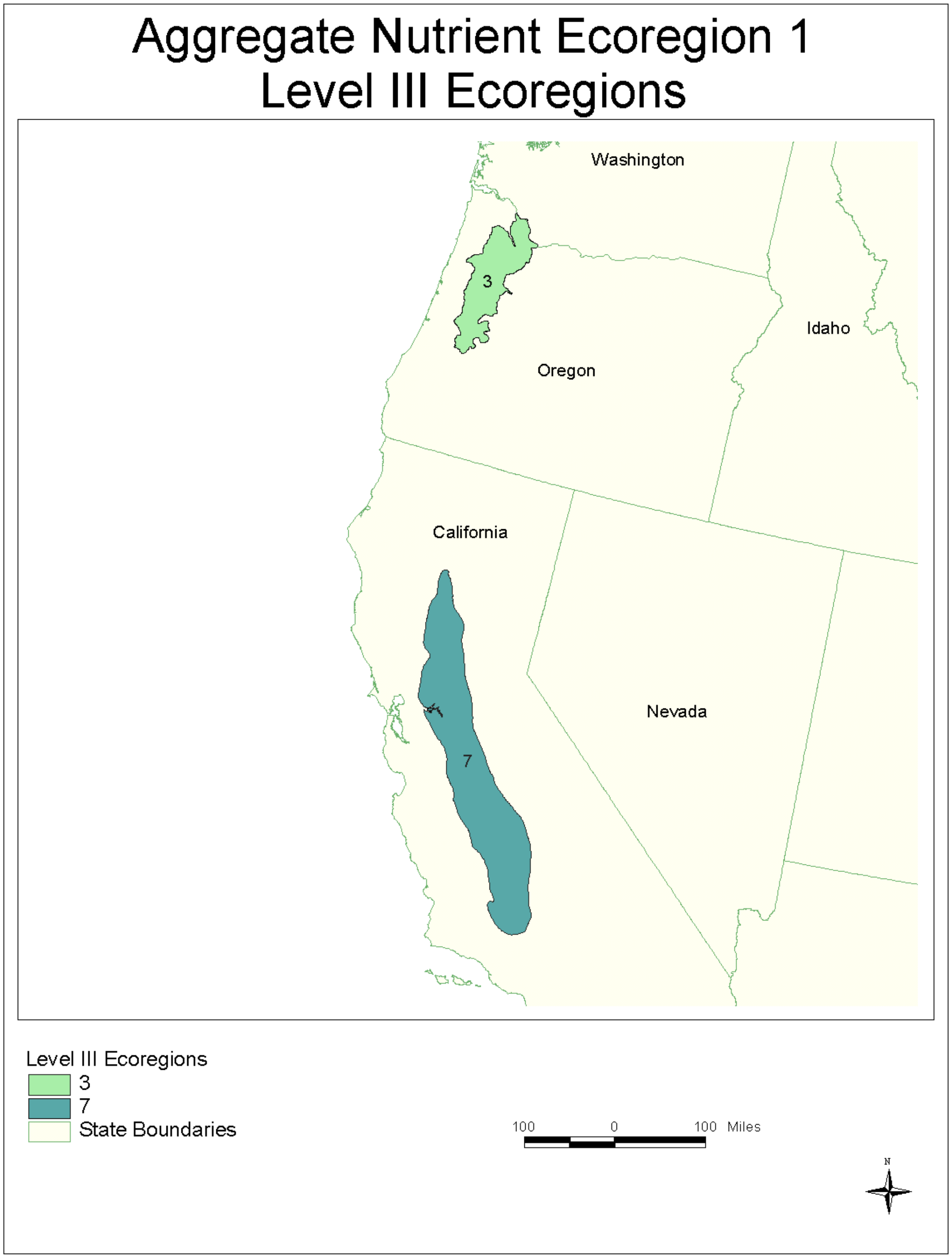


Figure 3. Aggregate Ecoregion I with level III Ecoregions shown.

4.1 Data Sources

Data sets from Legacy STORET, NASQAN, NAWQA, and EPA Region 10 were used to assess nutrient conditions from 1990 to 2000. EPA recommends that the RTAGs identify additional data sources that can be used to supplement the data sets listed above. In addition, the RTAGs may utilize published literature values to support quantitative and qualitative analyses.

4.2 Historical Data from Aggregate Ecoregion I (TP, TN, chl *a*, and turbidity)

EPA recommends that States/Tribes assess long-term trends observed over the past 50 years to assess the relative stability of the systems. This information may be obtained from scientific literature or documentation of historical trends. To gain additional perspective on more recent trends, it is recommended that States and Tribes assess nutrient trends over the past 10 years (e.g., what do seasonal variations indicate?).

4.3 QA/QC of Data Sources

An initial quality screen of data was conducted using the rules presented in Appendix C. Data remaining after screening for duplications and other QA measures (e.g., poor or unreported analytical records, sampling errors or omissions, stations associated with outfalls, stormwater sewers, hazardous waste sites) were used in the statistical analyses.

States within Ecoregion I were contacted regarding the quality of their data and information on the methods used to sample and analyze their waters. The following States indicated standard methods or approved EPA methods were used: Washington and Oregon. California indicated that standard or EPA-approved methods were used for some specific nutrient parameters.

4.4 Data for All Rivers and Streams Within Aggregate Ecoregion I

Figure 4 shows the location of the sampling stations within each subecoregion. Table 1 presents all data records for all parameters for Aggregate Ecoregion I and subecoregions within the Aggregate Ecoregion.

4.5 Statistical Analysis of Data

EPA's *Technical Guidance Manual for Developing Nutrient Criteria for Rivers and Streams* describes two ways of establishing a reference condition. One method is to choose the upper 25th percentile (75th percentile) of a reference population of streams. This is the preferred method. The 75th percentile is preferred by EPA because it is likely associated with minimally impacted conditions, will be protective of designated uses, and provides management flexibility. When reference streams are not identified, the second method is to determine the lower 25th percentile of the population of all streams within a region to attempt to approximate the preferred approach. The 25th percentile of the entire population was chosen by EPA to represent a surrogate for an actual reference population. Data analyses to date indicate that the lower 25th percentile from an entire population roughly approximates the 75th percentile for a reference

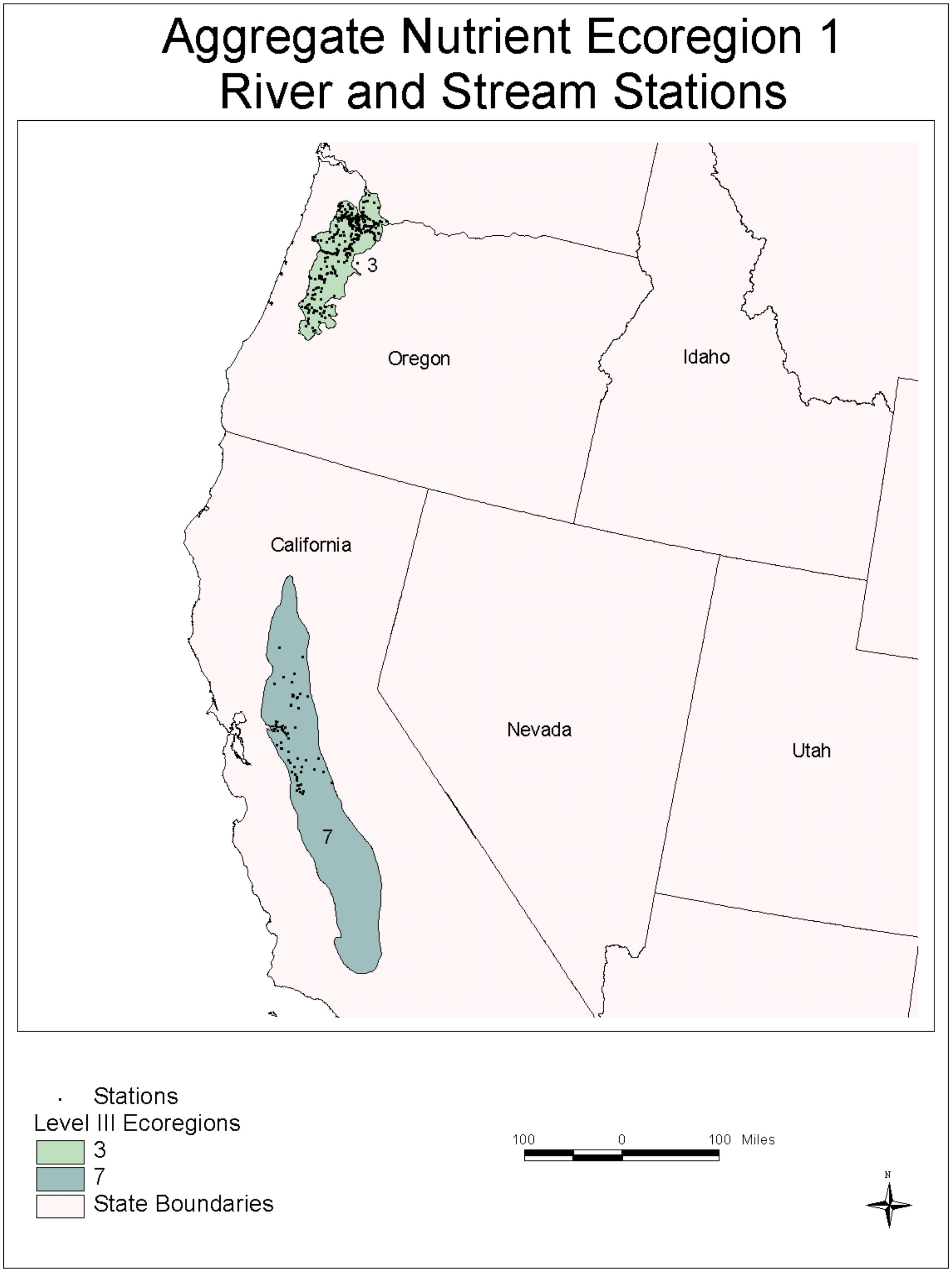


Figure 4. Sampling locations within each level III Ecoregion.

Table 1. River and stream records* for Aggregate Ecoregion I—Willamette and Central Valleys

	Aggregate Ecoregion I	Sub ecoR 3	Sub ecoR 7
# of named streams	214	171	43
# of stream stations	572	499	73
Key nutrient parameters (listed below)			
- # of records for turbidity (all methods)	12,562	11,140	1,422
- # of records for chlorophyll *a* (all methods) + periphyton	9,456	8,192	1,264
- # of records for total Kjeldhal nitrogen (TKN)	14,316	13,070	1,246
- # of records for nitrite + nitrate (NO_2+NO_3)	11,641	11,460	181
- # of records for total nitrogen (TN)	292	155	137
- # of records for total phosphorus (TP)	16,179	13,923	2,256
Total # of records for key nutrient parameters	64,446	57,940	6,506

*The number of rivers and streams presented in this table is based on the number of rivers and streams for which nutrient data were provided in the National Nutrient database. This does not imply that this is the total of rivers and streams within the Ecoregion. States and Tribes should determine the representativeness of the tabular data by comparing this information with any additional material they may have.

Definitions: (1) # of records refers to the total count of observations for that parameter over the entire decade (1990-1999) for that particular aggregate or subecoregion. These are counts for all seasons over that decade. (2) # of stream stations refers to the total number of river and stream stations within the aggregate or subecoregion from which nutrient data was collected. Since streams and rivers can cross ecoregional boundaries, it is important to note that only those portions of a river or stream (and data associated with those stations) that exist within the Ecoregion are included within this table.

population (see case studies for Minnesota lakes in the *Lakes and Reservoirs Nutrient Criteria Technical Guidance Document* [U.S. EPA, 2000a], the case study for Tennessee streams in the *Rivers and Streams Nutrient Criteria Technical Guidance Document* [U.S. EPA, 2000b], the letter from Tennessee Department of Environment and Conservation to Geoffrey Grubbs [TNDEC, 2000], the unpublished paper entitled "Estimating the Natural Background Concentrations of Nutrients in Streams and Rivers of the Conterminous United States" [USGS, 2001], and the letter from Matthew Liebman, U.S. EPA Region 1 Nutrient Criteria Coordinator to Geoffrey Grubbs [U.S. EPA, 2000c]). New York State has also presented evidence that the 25th percentile and the 75th percentile compare well based on user perceptions of water resources (NYSDEC, 2000).

Tables 2 and 3a-b present potential reference conditions for both the Aggregate Ecoregion and the subecoregions using both methods. However, the reference stream column is left blank because EPA does not have reference data and anticipates that States/Tribes will provide information on reference streams. Tables 3a-b present potential reference conditions for rivers and streams in the level III subecoregions within the Aggregate Ecoregion. Note that the footnotes for Table 2 apply to Tables 3a-b. Appendixes A and B provides a complete presentation of all descriptive statistics for both the Aggregate Ecoregion and the level III subecoregions.

Tables 4 and 5 are presented for comparison purposes. They allow the reader to determine where, in the trophic state, the recommended reference conditions fall within traditionally viewed trophic boundaries.

4.6 Classification of River/Stream Type

Assessing the data by stream type should further reduce the variability in the data analysis. There were no readily available classification data in the national datasets used to develop these criteria. States and Tribes are strongly encouraged to classify their streams before developing a final criterion.

4.7 Summary of Data Reduction Methods

All descriptive statistics were calculated using the medians for each stream within **Ecoregion I** for which data existed. For example, if one stream had 300 observations for phosphorus over the decade or 1 year's time, one median resulted. Each median from each stream was then used in calculating the percentiles for phosphorus for the aggregate nutrient Ecoregion/subecoregion (level III Ecoregion) by season and year (Figures 5a, 5b).

Preferred Data Choices and Recommendations When Data Are Missing

1. **Where data are missing** or are very low in total records for a given parameter, use 25th percentiles for parameters within an adjacent, similar subecoregion within the same aggregate nutrient Ecoregion, **or** when a similar subecoregion cannot be determined, use the 25th percentile for the Aggregate Ecoregion or consider the **lowest** 25th percentile from

Table 2. Reference conditions for Aggregate Ecoregion I streams

Parameter	No. of streams N*	Reported values		25th percentiles based on all seasons data for the decade	Reference streams‡
		Min	Max	P25 all seasons†	P75 all seasons
TKN (mg/L)	127	0.05	3.55	0.23	
NO_2+NO_3-N (mg/L)	88	0.02	8.64	0.15	
TN (mg/L) - calculated				0.38	
TN (mg/L) - reported	16	0.00	3.05	0.31	
TP (μg/L)	178	1	1,900	47	
Turbidity (NTU)	32	0.78	34.54	4.38	
Turbidity (FTU)	80	0.55	63	4.25	
Turbidity (JCU)	1 (z)	45	45	45 (zz)	
Chlorophyll *a* (μg/L) - F	57	0.43	31.10	1.83	
Chlorophyll *a* (μg/L) - S	11	0.9	15.3	1.6	
Chlorophyll *a* (μg/L) - T	1	4.3	4.3	4.3 (zz)	
Periphyton Chl *a* (mg/m^2)	7	63.7	153.8	63.7	

* N = largest value reported for a decade/season. TN calculated is based on the sum of TKN+NO_2+NO_3. TN reported is actual TN value reported in the database for one sample.
† Median for all seasons' 25th percentiles, e.g., this value was calculated from four seasons' 25th percentiles. If the seasonal 25th percentile (P25) TP values are: spring 10 μg/L, summer 15 μg/L, fall 12 μg/L, and winter 5 μg/L, the median value of all seasons' P25 will be 11μg/L.
‡ As determined by the Regional Technical Assistance Groups (RTAGs).

Abbreviations: P25, 25th percentile of all data; P75, 75th percentile of all data; F, Chlorophyll *a* measured by Fluorometric method with acid correction; S, Chlorophyll *a* measured by Spectrophotometric method with acid correction; T, Chlorophyll *a b c* measured by Trichromatic method; —, not applicable.

Definitions: (1) Number of Streams refers to the largest number of streams and rivers for which data existed for a given season within an aggregate nutrient Ecoregion. (2) Medians. All values (min, max, and 25th percentiles) included in the table are based on waterbody medians. All data for a particular parameter within a stream for the decade were reduced to one median for that stream. This prevents over-representation of individual waterbodies with a great deal of data versus those with fewer data points within the statistical analysis. (3) 25th percentile for all seasons is calculated by taking the median of the 4 seasonal 25th percentiles. If a season is missing, the median was calculated with 3 seasons of data. If fewer than 3 seasons were used to derive the median, the entry is flagged (z). (4) A 25th percentile for a season is best derived with data from a minimum of 4 streams/season. However, this table provides 25th percentiles that were derived with fewer than 4 streams/season in order to retain all information for all seasons. In calculating the 25^{th} percentile for a season with fewer than 4 stream medians, the statistical program automatically used the minimum value within the fewer-than-4 population. If fewer than 4 streams were used in developing a seasonal quartile and or all-seasons median, the entry is flagged (zz).

Note: For seasonal values, refer to Appendix A, "Descriptive Statistics Data Tables for Aggregate Ecoregion."

Table 3a. Reference conditions for Ecoregion I streams subecoregion 3

Parameter	No. of streams N*	Reported values		25th percentiles based on all seasons data for the decade	Reference streams‡
		Min	Max	P25 all seasons†	P75 all seasons
TKN (mg/L)	96	0.05	2.75	0.21	
NO_2+NO_3-N (mg/L)	85	0.02	8.64	0.15	
TN (mg/L) - calculated				0.36	
TN (mg/L) - reported	13	0.00	2.99	0.32	
TP (µg/L)	138	2	816.25	40	
Turbidity (NTU)	31	0.78	34.54	4.66	
Turbidity (FTU)	68	0.55	63	3.94	
Turbidity (JCU)	—	—	—	—	
Chlorophyll *a* (µg/L) - F	57	0.4	31.1	1.8	
Chlorophyll *a* (µg/L) - S	—	—	—	—	
Chlorophyll *a* (µg/L) - T	1	4.3	4.3	4.3 (zz)	
Periphyton Chl *a* (mg/m^2)	7	63.7	153.8	63.7	

Table 3b. Reference conditions for Ecoregion I streams subecoregion 7

Parameter	No. of streams N*	Reported values		25th percentiles based on all seasons data for the decade	Reference streams‡
		Min	Max	P25 all seasons†	P75 all seasons
TKN (mg/L)	31	0.05	3.55	0.19	
NO_2+NO_3-N (mg/L)	5	0.11	1.48	0.12	
TN (mg/L) - calculated				0.31	
TN (mg/L) - reported	3	0.35	2.26	0.35 (zz)	
TP (µg/L)	40	11	1,900	77	
Turbidity (NTU)	2 (z)	5.20	6.80	5.20 (zz)	
Turbidity (FTU)	13	3.23	21	7.13	
Turbidity (JCU)	1 (z)	45	45	45 (zz)	
Chlorophyll *a* (µg/L) - F	—	—	—	—	
Chlorophyll *a* (µg/L) - S	11	0.9	15.3	1.6	
Chlorophyll *a* (µg/L) - T	—	—	—	—	
Periphyton Chl *a* (mg/m^2)	—	—	—	—	

* N = largest value reported for a decade/season. TN calculated is based on the sum of TKN+NO_2+NO_3. TN reported is actual TN value reported in the database for one sample.
† Median for all seasons' 25th percentiles, e.g., this value was calculated from four seasons' 25th percentiles. If the seasonal 25th percentile (P25) TP values are: spring 10 µg/L, summer 15 µg/L, fall 12 µg/L, and winter 5 µg/L, the median value of all seasons' P25 will be 11µg/L.
‡ As determined by the Regional Technical Assistance Groups (RTAGs).

Abbreviations: P25, 25th percentile of all data; P75, 75th percentile of all data; F, Chlorophyll *a* measured by Fluorometric method with acid correction; S, Chlorophyll *a* measured by Spectrophotometric method with acid correction; T, Chlorophyll *a b c* measured by Trichromatic method; —, not applicable.

Definitions: (1) Number of Streams refers to the number of streams and rivers for which data existed for the summer months since summer is generally when the greatest amount of nutrient sampling is conducted. If another season greatly predominates, notification is made (s=spring, f=fall, w=winter). (2) Medians. All values (min, max, and 25th percentiles) included in the table are based on waterbody medians. All data for a particular parameter within a stream for the decade were reduced to one median for that stream. This prevents over-representation of individual waterbodies with a great deal of data versus those with fewer data points within the statistical analysis. (3) 25th percentile for all seasons is calculated by taking the median of the 4 seasonal 25th percentiles. If a season is missing, the median was calculated with 3 seasons of data. If fewer than 3 seasons were used to derive the median, the entry is flagged (z). (4) A 25th percentile for a season is best derived with data from a minimum of 4 streams/season. However, this table provides 25th percentiles that were derived with fewer than 4 streams/season in order to retain all information for all seasons. In calculating the 25th percentile for a season with fewer than 4 stream medians, the statistical program automatically used the minimum value within the fewer-than-4 population. If fewer than 4 streams were used in developing a seasonal quartile and or all-seasons median, the entry is flagged (zz).

Note: For seasonal and yearly values, refer to Appendix B, "Descriptive Statistics Data Tables for Level III Subecoregions Within Aggregate Ecoregion."

Table 4. Suggested boundaries for trophic classification of streams from cumulative frequency distributions. The boundary between oligotrophic and mesotrophic systems represents the lowest third of the distribution and the boundary between mesotrophic and eutrophic marks the top third of the distribution.

Variable (units)	Oligotrophic-mesotrophic boundary	Mesotrophic-eutrophic boundary	Sample size (N)
mean benthic chlorophyll (mg m^{-2})[a]	20	70	286
maximum benthic chlorophyll (mg m^{-2})[a]	60	200	176
sestonic chlorophyll (µg L^{-1})[b]	10	30	292
TN (µg L^{-1})[a,c]	700	1,500	1,070
TP (µg L^{-1})[a,b,c]	25	75	1,366

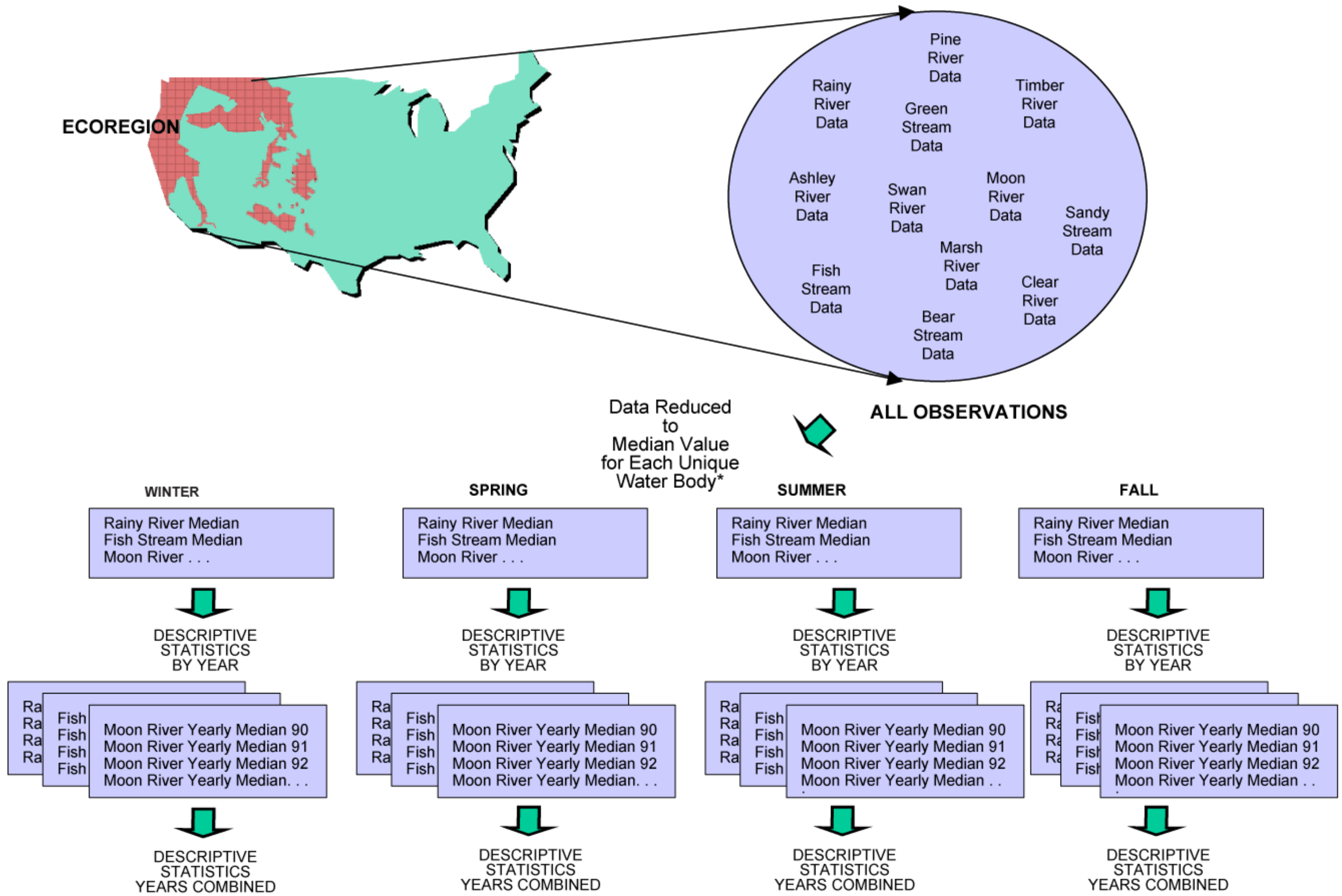
Note: This table is provided to allow the reader to make comparisons between the ecoregional criteria provided in this document and traditional nutrient and biological endpoints.

[a]Data from Dodds et al. (1998); [b]data from Van Nieuwenhuyse and Jones (1996); [c]data from Omernik (1977).

Table 5. Nutrient (µg/L) and algal biomass criteria limits recommended to prevent nuisance conditions and water quality degradation in streams based either on nutrient-chlorophyll *a* relationships or preventing risks to stream impairment as indicated.

TN	TP	DIN	SRP	Chlorophyll *a*	Impairment Risk	Source
Periphyton Maximum in mg/m²						
				100-200	nuisance growth	Welch et al. 1988, 1989
275-650	38-90			100-200	nuisance growth	Dodds et al. 1997
1,500	75			200	eutrophy	Dodds et al. 1998
300	20			150	nuisance growth	Clark Fork River Tri-State Council, MT
	20				*Cladophora* nuisance growth	Chetelat et al. 1999
	10-20				*Cladophora* nuisance growth	Stevenson unpubl. data
		430	60		eutrophy	UK Environ. Agency 1988
		100[a]	10[a]	200	nuisance growth	Biggs 2000
		25	3	100	reduced invertebrate diversity	Nordin 1985
			15	100	nuisance growth	Quinn 1991
		1,000	10[b]	~100	eutrophy	Sosiak pers. comm.
Plankton Mean in µg/L						
TN	**TP**	**DIN**	**SRP**	**Chlorophyll *a***	**Impairment Risk**	**Source**
300[c]	42			8	eutrophy	Van Nieuwenhuyse and Jones 1996
	70			15	chlorophyll action level	OAR 2000
250[c]	35			8	eutrophy	OECD 1992 (for lakes)

[a]30-day biomass accrual time.
[b]Total dissolved P.
[c]Based on Redfield ratio of 7.2N:1P (Smith et al. 1997).



**Unique Water Body - is a water body that is unique to a state, a subecoregion, a county, the year, and the season.*

Figure 5a. Illustration of data reduction process for stream data.

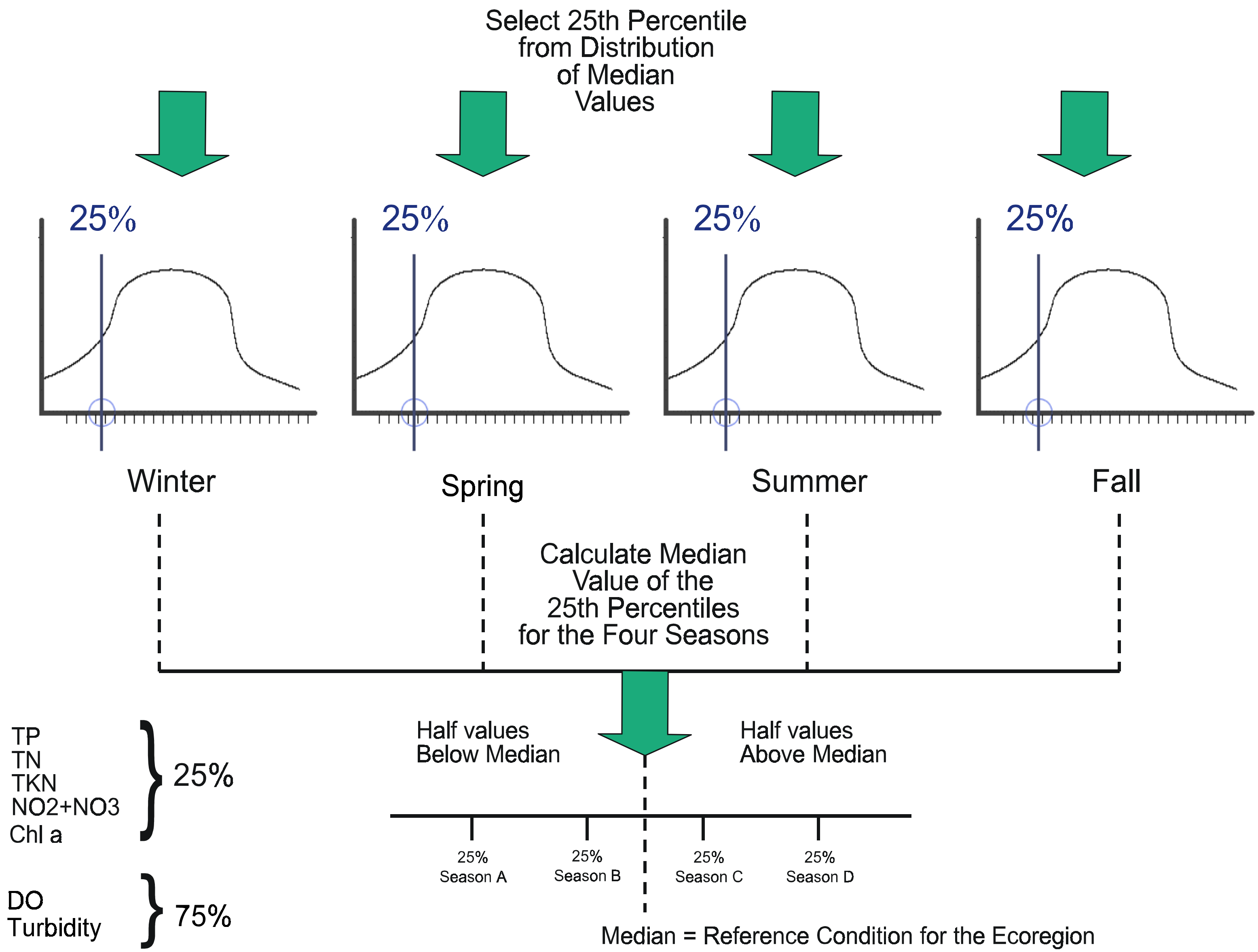


Figure 5b. Illustration of reference condition calculation.

a subecoregion (level III) within the aggregate nutrient Ecoregion. Without data, one may assume that the subecoregion in question is as sensitive as the most sensitive subecoregion within the aggregate.

2. **TN calculated:** When reported total nitrogen (TN) median values are lacking or very low in comparison to TKN and Nitrate/Nitrite-N values, the medians for TKN and nitrite/nitrate-N are added, resulting in a calculated TN value. The number of samples (N) for calculated TN is not filled in because it is represented by two subsamples of data: TKN and nitrite/nitrate-N. Therefore, N/A is placed in this box.

3. **TN reported:** This is the median based on reported values for TN from the database.

4. **Chlorophyll *a*:** Medians based on all methods are reported; however, the acid-corrected medians are preferred to the uncorrected medians. In developing a reference condition from a particular method, it is recommended that the method with the most observations be used. Fluorometric and spectrophotometric observations are preferred over all other methods. However, when no data exist for fluorometric and spectrophotometric methods, trichromatic values may be used. Data from the various techniques are not interchangeable.

5. **Periphyton:** Where periphyton data exist, record them separately. For periphyton-dominated streams, a measure of periphyton chlorophyll is a more appropriate response variable than planktonic chlorophyll *a*. See Table 4, page 101, of the *Rivers and Streams Nutrient Technical Guidance Manual* (U.S. EPA, 2000b) for values of periphyton and planktonic chlorophyll *a* related to eutrophy in streams.

6. **Secchi depth:** The 75th percentile is reported for Secchi depth because this is the only variable for which the value of the parameter **increases** with greater clarity (for lakes and reservoirs only).

7. **Turbidity units:** Turbidity units from all methods are reported. FTUs and NTUs are preferred over JCUs. If FTUs and NTUs do not exist, use JCUs. These units are not interchangeable. Turbidity is chosen as a response variable in streams because it can be an indicator of increasing algal biomass due to nutrient enrichment. See pages 32-33 of the *Rivers and Streams Nutrient Technical Guidance Manual* for a discussion of turbidity and correlations with algal growth.

8. **Lack of data:** A dash (—) represents missing, inadequate, or inconclusive data. According to EPA statistical analyses, 5% or fewer of the reported observations are "below detection." Because of this low incidence, these data were retained and factored into the statistical analysis as reported according to the protocols described in Appendix C, "Quality Control/Quality Assurance Rules."

5.0 REFERENCE SITES AND CONDITIONS IN AGGREGATE ECOREGION I

Reference conditions represent the natural, least impacted conditions, or what is considered to be the most attainable conditions. This chapter compares the different reference conditions determined from the two methods and establishes which reference condition is most appropriate.

- *A priori* determination of reference sites. The preferred method for establishing reference condition is to choose the upper percentile of an a priori population of reference streams. States and Tribes are encouraged to identify reference conditions based on this method.

- Statistical determination of reference conditions (25th percentile of entire database). See Tables 2 and 3a-b in Section 4.0.

- RTAG discussion and rationale for selection of reference sites and conditions in Ecoregion I. The RTAG should compare the results derived from the two methods described above and present a rationale for the final selection of reference sites.

6.0 MODELS USED TO PREDICT OR VERIFY RESPONSE PARAMETERS

The RTAG is encouraged to identify and apply relevant models to support nutrient criteria development. There are three scenarios under which models may be used to derive criteria or support criteria development:

- Models for predicting correlations between causal and response variables

- Models used to verify reference conditions based on percentiles

- Regression models used to predict reference conditions in impacted areas

Appendix C of the Rivers and Streams Technical Guidance Manual (U.S. EPA, 2000b), and Chapter 9 of the Lakes and Reservoirs Technical Guidance Manual (U.S. EPA, 2000a) should be consulted for further details.

7.0 FRAMEWORK FOR REFINING RECOMMENDED NUTRIENT CRITERIA FOR RIVERS AND STREAMS IN AGGREGATE ECOREGION I

Information on each of the following six weight-of-evidence factors is important to refine the criteria presented in this document. All elements should be addressed in developing criteria, as is expressed in EPA's nutrient criteria technical guidance manuals. It is our expectation that EPA Regions, States, and Tribes (as RTAGs) will consider these elements as States/Tribes develop their criteria. This section should be viewed as a worksheet (sections are left blank for this purpose) to assist in the refinement of nutrient criteria. If many of these elements are ultimately unaddressed, EPA may rely on the proposed reference conditions presented in Tables

3a-b and other literature and information readily available to the EPA Headquarters nutrient team to develop nutrient water quality recommendations for this Ecoregion.

7.1 Example Worksheet for Developing Aggregate Ecoregion and Subecoregion Nutrient Criteria

*Literature sources:*____

*Historical data and trends:*____

*Reference condition:*____

*Models:*____

*RTAG expert review and consensus:*____

*Downstream effects:*____

____

____

____

____

____

7.2 Setting Seasonal Criteria

The recommendations presented in this document are based in part on medians of all the 25th percentile seasonal data (decadal), and as such reflect all seasons and not one particular season or year. It is recommended that States and Tribes monitor in all seasons to best assess compliance with the resulting criterion. States/Tribes may choose to develop criteria that reflect **each** particular season or **given season** or a **given year** when there is significant variability between seasons/years or designated uses that are specifically tied to one or more seasons of the year (e.g., recreation, fishing). Using the tables in Appendix A and B, one can set reference conditions based on a particular season or year and then develop a criterion based on each individual season. Obviously, this option is season-specific and would require increased monitoring within each season to assess compliance. If a case can be made that one season is more appropriate than another season, or more appropriate than the annual median, criteria should be season specific. For example, in most parts of the country, spring and summer are the most common growth periods, so criteria for chlorophyll *a* and Secchi may be set for spring and summer only. However, caution should be used when developing criteria for TN and TP because the peak loading of these nutrients may take place in seasons other than summer, such as winter and spring. For these reasons, EPA developed annual criteria and provided additional seasonal information in appendices.

7.3 When Data/Reference Conditions Are Lacking

When data are unavailable to develop a reference condition for a particular parameter(s) within a subecoregion, EPA recommends one of three options: (1) use data from a similar neighboring subecoregion (e.g., if data are few or nonexistent for the Northern Cascades, consider using the data and reference conditions developed for the Cascades); (2) use the 25th percentiles for the Aggregate Ecoregion; or (3) consider using the lowest of the yearly medians for that parameter calculated for all the subecoregions within the Aggregate Ecoregion.

7.4 Site-Specific Criteria Development

Criteria may be refined in a number of ways. The best way is to follow the critical elements of criteria development as well as to refer to the *Rivers and Streams Nutrient Criteria Technical Guidance Manual* (U.S. EPA, 2000b). The Technical Guidance Manual presents sections on each of the following factors to consider in setting criteria:

- Refinements to Ecoregions (Section 2.3). See paper by Dale Robertson (USGS, 2001b), an alternative approach to ecoregions entitled “An Alternative Regarding the Scheme for Defining Nutrient Criteria for Rivers and Streams.”
- Classification of waterbodies (Chapter 2)
- Setting seasonal criteria to reflect major seasonal climate differences and accounting for significant or cyclical precipitation events (high-flow/low-flow conditions) (Chapter 4)

8.0 LITERATURE CITED

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9.0 APPENDICES

A. Descriptive Statistics Data Tables for Aggregate Ecoregion
B. Descriptive Statistics Data Tables for Level III Subecoregions Within Aggregate Ecoregion
C. Quality Control/Quality Assurance Rules

APPENDIX A

Descriptive Statistics Data Tables for Aggregate Ecoregion

Aggregate Nutrient Ecoregion: I
Rivers and Streams
Descriptive Statistics by Decade and Season
from 1990 to 1998
Chloro_A_Fluor_cor_ug_L

season	N	MEAN	MIN	MAX	STDDEV	STDERR	CV	P5	P25	MEDIAN	P75	P95
FALL	52	4.65	.40000	51.00	7.12	0.99	153	0.90	1.85	3.10	4.73	13.35
SPRING	50	4.81	.40000	23.20	4.93	0.70	103	1.08	1.80	3.35	5.40	17.00
SUMMER	57	5.64	.50000	39.00	7.30	0.97	129	0.90	1.89	3.35	5.95	24.00
WINTER	17	2.92	.45000	21.30	4.86	1.18	166	0.45	1.20	1.35	2.60	21.30

Data were not always available for all years.

Aggregate Nutrient Ecoregion: I
Rivers and Streams
Descriptive Statistics by Decade and Season
from 1998 to 1998
Chloro_A_Peri_Spe_unc_mg_sqm

season	N	MEAN	MIN	MAX	STDDEV	STDERR	CV	P5	P25	MEDIAN	P75	P95
FALL	1	153.85	153.85	153.85	.	.	.	153.85	153.85	153.85	153.85	153.85
SPRING	1	63.70	63.700	63.70	.	.	.	63.70	63.70	63.70	63.70	63.70
SUMMER	7	203.74	50.600	370.60	131.62	49.75	65	50.60	62.00	194.10	370.60	370.60

Data were not always available for all years.

Aggregate Nutrient Ecoregion: I
Rivers and Streams
Descriptive Statistics by Decade and Season
from 1990 to 1995
Chloro_A_Phyto_Spec_A_ug_L

season	N	MEAN	MIN	MAX	STDDEV	STDERR	CV	P5	P25	MEDIAN	P75	P95
FALL	11	3.49	.76000	12.47	3.54	1.07	101	0.76	1.39	1.69	5.59	12.47
SPRING	11	4.73	1.1650	18.11	5.34	1.61	113	1.17	1.83	2.34	4.83	18.11
SUMMER	11	6.48	.99000	26.42	8.94	2.70	138	0.99	2.22	2.51	5.24	26.42
WINTER	11	2.07	.32500	9.28	2.61	0.79	126	0.33	0.70	0.99	2.44	9.28

Data were not always available for all years.

Aggregate Nutrient Ecoregion: I
Rivers and Streams
Descriptive Statistics by Decade and Season
from 1994 to 1995
Chloro_A_Trich_unco_ug_L

season	N	MEAN	MIN	MAX	STDDEV	STDERR	CV	P5	P25	MEDIAN	P75	P95
FALL	1	4.95	4.9500	4.95	.	.	.	4.95	4.95	4.95	4.95	4.95
SPRING	1	3.70	3.7000	3.70	.	.	.	3.70	3.70	3.70	3.70	3.70
SUMMER	1	7.98	7.9750	7.98	.	.	.	7.98	7.98	7.98	7.98	7.98
WINTER	1	0.30	.30000	0.30	.	.	.	0.30	0.30	0.30	0.30	0.30

Data were not always available for all years.

Aggregate Nutrient Ecoregion: I
Rivers and Streams
Descriptive Statistics by Decade and Season
from 1990 to 1998
DIP_ug_L

season	N	MEAN	MIN	MAX	STDDEV	STDERR	CV	P5	P25	MEDIAN	P75	P95
FALL	17	156.00	9.5000	1350.00	314.35	76.24	202	9.50	32.50	77.50	107.50	1350.0
SPRING	17	177.12	6.0000	1650.00	384.18	93.18	217	6.00	35.00	95.00	140.00	1650.0
SUMMER	23	126.80	4.0000	995.00	206.56	43.07	163	8.50	27.00	60.00	135.00	355.00
WINTER	16	405.00	16.250	5250.00	1293.3	323.33	319	16.25	40.00	66.25	132.50	5250.0

Data were not always available for all years.

Aggregate Nutrient Ecoregion: I
Rivers and Streams
Descriptive Statistics by Decade and Season
from 1990 to 1998
Dissolved_Oxygen_mg_L

season	N	MEAN	MIN	MAX	STDDEV	STDERR	CV	P5	P25	MEDIAN	P75	P95
FALL	110	9.05	1.8000	12.30	1.70	0.16	19	6.75	8.35	9.25	10.10	11.20
SPRING	129	9.74	4.5500	13.20	1.66	0.15	17	6.90	8.78	10.00	10.80	12.20
SUMMER	127	8.21	.70000	11.20	1.75	0.16	21	5.20	7.20	8.28	9.40	10.60
WINTER	91	10.99	6.6000	13.40	1.38	0.15	13	8.45	10.05	10.95	12.20	12.85

Data were not always available for all years.

Aggregate Nutrient Ecoregion: I
Rivers and Streams
Descriptive Statistics by Decade and Season
from 1990 to 1998
Nitrite_Nitrate_NO2_NO3_mg_L

season	N	MEAN	MIN	MAX	STDDEV	STDERR	CV	P5	P25	MEDIAN	P75	P95
FALL	82	0.60	.01000	7.90	1.21	0.13	201	0.02	0.06	0.24	0.50	2.13
SPRING	76	0.82	.02000	8.63	1.22	0.14	150	0.06	0.23	0.50	1.06	3.10
SUMMER	88	0.62	.01750	8.65	1.30	0.14	211	0.03	0.07	0.24	0.50	1.98
WINTER	61	1.44	.02000	9.60	1.65	0.21	114	0.13	0.38	0.83	1.89	4.30

Data were not always available for all years.

Aggregate Nutrient Ecoregion: I
Rivers and Streams
Descriptive Statistics by Decade and Season
from 1990 to 1998
Nitrogen_Tot_Kjeldhal_mg_L

season	N	MEAN	MIN	MAX	STDDEV	STDERR	CV	P5	P25	MEDIAN	P75	P95
FALL	105	0.48	.05000	3.60	0.56	0.05	116	0.05	0.18	0.36	0.57	1.40
SPRING	110	0.50	.05000	3.40	0.49	0.05	98	0.05	0.25	0.38	0.58	1.35
SUMMER	127	0.50	.05000	3.50	0.59	0.05	118	0.05	0.20	0.34	0.55	1.55
WINTER	83	0.77	.05000	24.00	2.60	0.29	337	0.05	0.25	0.40	0.63	1.30

Data were not always available for all years.

Aggregate Nutrient Ecoregion: I
Rivers and Streams
Descriptive Statistics by Decade and Season
from 1990 to 1992
Phosph_Ortho_Tot_as_P_ug_L

season	N	MEAN	MIN	MAX	STDDEV	STDERR	CV	P5	P25	MEDIAN	P75	P95
FALL	5	59.00	5.0000	140.00	55.05	24.62	93	5.00	30.00	30.00	90.00	140.00
SPRING	5	86.50	17.500	160.00	60.87	27.22	70	17.50	50.00	65.00	140.00	160.00
SUMMER	5	55.00	12.500	120.00	42.24	18.89	77	12.50	35.00	35.00	72.50	120.00
WINTER	4	66.25	20.000	145.00	54.98	27.49	83	20.00	30.00	50.00	102.50	145.00

Data were not always available for all years.

Aggregate Nutrient Ecoregion: I
Rivers and Streams
Descriptive Statistics by Decade and Season
from 1990 to 1998
Total_Nitrogen_mg_L

season	N	MEAN	MIN	MAX	STDDEV	STDERR	CV	P5	P25	MEDIAN	P75	P95
FALL	10	0.89	.00000	3.13	0.91	0.29	103	0.00	0.34	0.63	1.28	3.13
SPRING	10	0.94	.00000	2.55	0.87	0.27	92	0.00	0.29	0.61	1.61	2.55
SUMMER	16	0.63	.00000	2.98	0.86	0.21	137	0.00	0.13	0.30	0.69	2.98
WINTER	9	1.39	.32500	3.13	1.07	0.36	77	0.33	0.56	1.14	1.93	3.13

Data were not always available for all years.

Aggregate Nutrient Ecoregion: I
Rivers and Streams
Descriptive Statistics by Decade and Season
from 1990 to 1998
Total_Phosphorus_ug_L

season	N	MEAN	MIN	MAX	STDDEV	STDERR	CV	P5	P25	MEDIAN	P75	P95
FALL	137	129.16	.00000	1450.00	170.24	14.54	132	10.00	45.00	90.00	157.50	320.00
SPRING	154	143.61	.00000	2350.00	228.51	18.41	159	20.00	50.00	85.00	152.50	380.00
SUMMER	178	140.36	2.5000	1100.00	174.45	13.08	124	15.00	45.00	90.00	170.00	380.00
WINTER	111	201.63	2.5000	8350.00	786.19	74.62	390	10.63	50.00	110.00	150.00	340.00

Data were not always available for all years.

Aggregate Nutrient Ecoregion: I
Rivers and Streams
Descriptive Statistics by Decade and Season
from 1990 to 1998
Turbidity_FTU

season	N	MEAN	MIN	MAX	STDDEV	STDERR	CV	P5	P25	MEDIAN	P75	P95
FALL	80	6.86	.30000	95.00	10.87	1.22	159	0.81	2.78	5.00	7.60	16.00
SPRING	72	8.41	.60000	19.00	4.33	0.51	51	2.00	5.50	8.00	11.00	17.50
SUMMER	80	7.02	.50000	31.00	6.15	0.69	88	1.00	3.00	5.00	8.35	21.88
WINTER	61	18.01	1.4000	142.00	20.44	2.62	113	3.00	6.50	13.60	21.00	46.00

Data were not always available for all years.

Aggregate Nutrient Ecoregion: I
Rivers and Streams
Descriptive Statistics by Decade and Season
from 1995 to 1995
Turbidity_JCU

season	N	MEAN	MIN	MAX	STDDEV	STDERR	CV	P5	P25	MEDIAN	P75	P95
SPRING	1	12.00	12.000	12.00	.	.	.	12.00	12.00	12.00	12.00	12.00
WINTER	1	78.00	78.000	78.00	.	.	.	78.00	78.00	78.00	78.00	78.00

Data were not always available for all years.

Aggregate Nutrient Ecoregion: I
Rivers and Streams
Descriptive Statistics by Decade and Season
from 1990 to 1998
Turbidity_NTU

season	N	MEAN	MIN	MAX	STDDEV	STDERR	CV	P5	P25	MEDIAN	P75	P95
FALL	20	12.73	1.4000	39.33	9.63	2.15	76	1.65	5.45	11.00	18.03	33.45
SPRING	17	11.65	.60000	29.75	9.29	2.25	80	0.60	3.30	11.50	15.00	29.75
SUMMER	14	8.18	.60000	23.15	6.89	1.84	84	0.60	1.20	7.32	12.80	23.15
WINTER	32	18.11	.95000	54.00	15.22	2.69	84	1.93	7.00	10.93	29.00	52.13

Data were not always available for all years.

Aggregate Nutrient Ecoregion: I
Rivers and Streams
Descriptive Statistics by Decade and Season
from 1992 to 1998
pH_S_U

season	N	MEAN	MIN	MAX	STDDEV	STDERR	CV	P5	P25	MEDIAN	P75	P95
FALL	22	7.47	6.9000	7.95	0.27	0.06	4	7.15	7.28	7.46	7.60	7.88
SPRING	22	7.49	7.0000	8.15	0.31	0.07	4	7.08	7.20	7.48	7.73	7.98
SUMMER	27	7.68	7.1500	8.50	0.33	0.06	4	7.33	7.40	7.63	7.90	8.40
WINTER	21	7.37	6.7500	8.03	0.33	0.07	4	6.86	7.20	7.35	7.60	7.83

Data were not always available for all years.

APPENDIX B

Descriptive Statistics Data Tables for Level III Subecoregions Within Aggregate Ecoregion

Aggregate Nutrient Ecoregion: I
Rivers and Streams
Descriptive Statistics by Subecoregion, Decade and Season
from 1990 to 1998
Chloro_A_Fluor_cor_ug_L

subecoregion	season	N	MEAN	MIN	MAX	STDDEV	STDERR	CV	P5	P25	MEDIAN	P75	P95
3	FALL	52	4.65	.40000	51.00	7.12	0.99	153	0.90	1.85	3.10	4.73	13.4
3	SPRING	50	4.81	.40000	23.20	4.93	0.70	103	1.08	1.80	3.35	5.40	17.0
3	SUMMER	57	5.64	.50000	39.00	7.30	0.97	129	0.90	1.89	3.35	5.95	24.0
3	WINTER	17	2.92	.45000	21.30	4.86	1.18	166	0.45	1.20	1.35	2.60	21.3

Data were not always available for all years.

Aggregate Nutrient Ecoregion: I
Rivers and Streams
Descriptive Statistics by Subecoregion, Decade and Season
from 1998 to 1998
Chloro_A_Peri_Spe_unc_mg_sqm

subecoregion	season	N	MEAN	MIN	MAX	STDDEV	STDERR	CV	P5	P25	MEDIAN	P75	P95
3	FALL	1	153.85	153.85	153.85	.	.	.	154	154	154	154	154
3	SPRING	1	63.70	63.700	63.70	.	.	.	63.7	63.7	63.7	63.7	63.7
3	SUMMER	7	203.74	50.600	370.60	132	49.7	65	50.6	62.0	194	371	371

Data were not always available for all years.

Aggregate Nutrient Ecoregion: I
Rivers and Streams
Descriptive Statistics by Subecoregion, Decade and Season
from 1990 to 1995
Chloro_A_Phyto_Spec_A_ug_L

subecoregion	season	N	MEAN	MIN	MAX	STDDEV	STDERR	CV	P5	P25	MEDIAN	P75	P95
7	FALL	11	3.49	.76000	12.47	3.54	1.07	101	0.76	1.39	1.69	5.59	12.5
7	SPRING	11	4.73	1.1650	18.11	5.34	1.61	113	1.17	1.83	2.34	4.83	18.1
7	SUMMER	11	6.48	.99000	26.42	8.94	2.70	138	0.99	2.22	2.51	5.24	26.4
7	WINTER	11	2.07	.32500	9.28	2.61	0.79	126	0.33	0.70	0.99	2.44	9.28

Data were not always available for all years.

Aggregate Nutrient Ecoregion: I
Rivers and Streams
Descriptive Statistics by Subecoregion, Decade and Season
from 1994 to 1995
Chloro_A_Trich_unco_ug_L

subecoregion	season	N	MEAN	MIN	MAX	STDDEV	STDERR	CV	P5	P25	MEDIAN	P75	P95
3	FALL	1	4.95	4.9500	4.95	.	.	.	4.95	4.95	4.95	4.95	4.95
3	SPRING	1	3.70	3.7000	3.70	.	.	.	3.70	3.70	3.70	3.70	3.70
3	SUMMER	1	7.98	7.9750	7.98	.	.	.	7.98	7.98	7.98	7.98	7.98
3	WINTER	1	0.30	.30000	0.30	.	.	.	0.30	0.30	0.30	0.30	0.30

Data were not always available for all years.

Aggregate Nutrient Ecoregion: I
Rivers and Streams
Descriptive Statistics by Subecoregion, Decade and Season
from 1990 to 1998
DIP_ug_L

subecoregion	season	N	MEAN	MIN	MAX	STDDEV	STDERR	CV	P5	P25	MEDIAN	P75	P95
3	FALL	6	95.33	9.5000	245.00	80.7	32.9	85	9.50	52.5	78.8	108	245
3	SPRING	6	62.67	6.0000	150.00	51.6	21.1	82	6.00	35.0	45.0	95.0	150
3	SUMMER	12	77.63	4.0000	355.00	95.6	27.6	123	4.00	19.0	55.8	95.0	355
3	WINTER	5	71.50	35.000	125.00	37.6	16.8	53	35.0	40.0	65.0	92.5	125
7	FALL	11	189.09	12.500	1350.00	389	117	206	12.5	30.0	77.5	145	1350
7	SPRING	11	239.55	12.500	1650.00	472	142	197	12.5	32.5	123	175	1650
7	SUMMER	11	180.45	10.000	995.00	279	84.1	155	10.0	27.5	108	193	995
7	WINTER	11	556.59	16.250	5250.00	1558	470	280	16.3	40.0	67.5	148	5250

Data were not always available for all years.

Aggregate Nutrient Ecoregion: I
Rivers and Streams
Descriptive Statistics by Subecoregion, Decade and Season
from 1990 to 1998
Dissolved_Oxygen_mg_L

subecoregion	season	N	MEAN	MIN	MAX	STDDEV	STDERR	CV	P5	P25	MEDIAN	P75	P95
3	FALL	71	9.31	1.8000	12.30	1.95	0.23	21	3.60	8.53	9.80	10.4	11.3
3	SPRING	89	10.04	4.5500	13.20	1.75	0.19	17	6.40	9.33	10.4	11.1	12.2
3	SUMMER	89	8.37	.70000	11.20	1.95	0.21	23	4.20	7.30	8.70	9.70	10.6
3	WINTER	55	11.75	8.6000	13.40	0.97	0.13	8	10.3	11.3	11.9	12.5	13.0
7	FALL	39	8.57	5.8000	10.30	0.96	0.15	11	7.20	7.90	8.60	9.15	10.2
7	SPRING	40	9.07	6.9000	12.20	1.20	0.19	13	7.19	8.58	9.05	9.54	11.6
7	SUMMER	38	7.86	5.9000	10.70	1.09	0.18	14	6.00	7.08	7.99	8.55	9.80
7	WINTER	36	9.82	6.6000	11.60	1.09	0.18	11	7.10	9.30	9.98	10.7	11.2

Data were not always available for all years.

Aggregate Nutrient Ecoregion: I
Rivers and Streams
Descriptive Statistics by Subecoregion, Decade and Season
from 1990 to 1998
Nitrite_Nitrate_NO2_NO3_mg_L

subecoregion	season	N	MEAN	MIN	MAX	STDDEV	STDERR	CV	P5	P25	MEDIAN	P75	P95
3	FALL	79	0.61	.01000	7.90	1.23	0.14	202	0.02	0.05	0.24	0.50	3.25
3	SPRING	73	0.82	.02000	8.63	1.24	0.14	150	0.06	0.23	0.51	1.05	3.10
3	SUMMER	85	0.62	.01750	8.65	1.32	0.14	213	0.03	0.07	0.24	0.49	1.98
3	WINTER	56	1.35	.02000	9.60	1.54	0.21	114	0.13	0.42	0.83	1.86	3.70
7	FALL	3	0.43	.06900	1.15	0.62	0.36	143	0.07	0.07	0.08	1.15	1.15
7	SPRING	3	0.64	.14500	1.55	0.79	0.46	123	0.15	0.15	0.23	1.55	1.55
7	SUMMER	3	0.55	.08750	1.40	0.74	0.43	136	0.09	0.09	0.15	1.40	1.40
7	WINTER	5	2.49	.13000	6.00	2.58	1.15	104	0.13	0.27	1.73	4.30	6.00

Data were not always available for all years.

Aggregate Nutrient Ecoregion: I
Rivers and Streams
Descriptive Statistics by Subecoregion, Decade and Season
from 1990 to 1998
Nitrogen_Tot_Kjeldhal_mg_L

subecoregion	season	N	MEAN	MIN	MAX	STDDEV	STDERR	CV	P5	P25	MEDIAN	P75	P95
3	FALL	75	0.44	.05000	2.48	0.42	0.05	95	0.05	0.20	0.31	0.50	1.40
3	SPRING	79	0.42	.05000	3.40	0.43	0.05	103	0.05	0.21	0.35	0.46	1.10
3	SUMMER	96	0.39	.05000	3.02	0.41	0.04	104	0.05	0.20	0.30	0.47	0.95
3	WINTER	56	0.43	.05000	1.38	0.29	0.04	68	0.05	0.23	0.40	0.51	1.08
7	FALL	30	0.59	.05000	3.60	0.82	0.15	139	0.05	0.10	0.40	0.75	3.03
7	SPRING	31	0.72	.05000	2.50	0.58	0.10	80	0.05	0.25	0.60	1.03	2.10
7	SUMMER	31	0.83	.05000	3.50	0.88	0.16	106	0.05	0.13	0.65	1.15	3.50
7	WINTER	27	1.47	.05000	24.00	4.52	0.87	307	0.05	0.30	0.45	1.23	1.35

Data were not always available for all years.

Aggregate Nutrient Ecoregion: I
Rivers and Streams
Descriptive Statistics by Subecoregion, Decade and Season
from 1990 to 1992
Phosph_Ortho_Tot_as_P_ug_L

subecoregion	season	N	MEAN	MIN	MAX	STDDEV	STDERR	CV	P5	P25	MEDIAN	P75	P95
3	FALL	2	85.00	30.000	140.00	77.8	55.0	92	30.0	30.0	85.0	140	140
3	SPRING	2	95.00	50.000	140.00	63.6	45.0	67	50.0	50.0	95.0	140	140
3	SUMMER	2	53.75	35.000	72.50	26.5	18.8	49	35.0	35.0	53.8	72.5	72.5
3	WINTER	1	40.00	40.000	40.00	.	.	.	40.0	40.0	40.0	40.0	40.0
7	FALL	3	41.67	5.0000	90.00	43.7	25.2	105	5.00	5.00	30.0	90.0	90.0
7	SPRING	3	80.83	17.500	160.00	72.6	41.9	90	17.5	17.5	65.0	160	160
7	SUMMER	3	55.83	12.500	120.00	56.7	32.7	102	12.5	12.5	35.0	120	120
7	WINTER	3	75.00	20.000	145.00	63.8	36.9	85	20.0	20.0	60.0	145	145

Data were not always available for all years.

Aggregate Nutrient Ecoregion: I
Rivers and Streams
Descriptive Statistics by Subecoregion, Decade and Season
from 1990 to 1998
Total_Nitrogen_mg_L

subecoregion	season	N	MEAN	MIN	MAX	STDDEV	STDERR	CV	P5	P25	MEDIAN	P75	P95
3	FALL	7	0.96	.00000	3.13	1.03	0.39	107	0.00	0.38	0.64	1.28	3.13
3	SPRING	7	0.91	.00000	2.55	0.90	0.34	100	0.00	0.26	0.67	1.61	2.55
3	SUMMER	13	0.52	.00000	2.98	0.80	0.22	153	0.00	0.08	0.24	0.68	2.98
3	WINTER	6	1.38	.32500	3.00	0.98	0.40	71	0.33	0.56	1.22	1.93	3.00
7	FALL	3	0.73	.29000	1.58	0.73	0.42	99	0.29	0.29	0.34	1.58	1.58
7	SPRING	3	1.02	.39000	2.13	0.96	0.55	94	0.39	0.39	0.56	2.13	2.13
7	SUMMER	3	1.08	.30000	2.40	1.15	0.66	106	0.30	0.30	0.55	2.40	2.40
7	WINTER	3	1.41	.50000	3.13	1.48	0.86	105	0.50	0.50	0.62	3.13	3.13

Data were not always available for all years.

Aggregate Nutrient Ecoregion: I
Rivers and Streams
Descriptive Statistics by Subecoregion, Decade and Season
from 1990 to 1998
Total_Phosphorus_ug_L

subecoregion	season	N	MEAN	MIN	MAX	STDDEV	STDERR	CV	P5	P25	MEDIAN	P75	P95
3	FALL	97	109.85	2.5000	842.50	110	11.1	100	16.3	40.0	82.5	150	310
3	SPRING	114	111.44	.00000	790.00	130	12.1	116	10.0	50.0	75.0	130	260
3	SUMMER	138	118.51	2.5000	1050.00	144	12.3	122	11.0	40.0	80.0	150	315
3	WINTER	73	109.19	2.5000	420.00	83.3	9.74	76	10.6	40.0	100	130	315
7	FALL	40	176.00	.00000	1450.00	261	41.3	149	4.38	47.5	113	206	641
7	SPRING	40	235.31	20.000	2350.00	380	60.1	162	20.0	77.5	146	228	775
7	SUMMER	40	215.75	20.000	1100.00	239	37.9	111	20.0	77.5	138	283	835
7	WINTER	38	379.21	2.5000	8350.00	1332	216	351	10.0	90.0	140	265	375

Data were not always available for all years.

Aggregate Nutrient Ecoregion: I
Rivers and Streams
Descriptive Statistics by Subecoregion, Decade and Season
from 1990 to 1998
Turbidity_FTU

subecoregion	season	N	MEAN	MIN	MAX	STDDEV	STDERR	CV	P5	P25	MEDIAN	P75	P95
3	FALL	68	6.71	.30000	95.00	11.7	1.42	174	0.63	2.48	4.64	6.80	17.0
3	SPRING	60	7.75	.60000	18.50	4.07	0.53	53	1.50	5.13	7.31	10.0	16.3
3	SUMMER	67	6.07	.50000	31.00	5.66	0.69	93	1.00	2.75	4.50	7.40	16.0
3	WINTER	49	19.98	1.4000	142.00	22.3	3.18	111	3.00	8.00	16.8	22.5	56.0
7	FALL	12	7.67	1.6500	15.00	3.80	1.10	50	1.65	5.19	6.88	9.38	15.0
7	SPRING	12	11.74	3.9000	19.00	4.19	1.21	36	3.90	8.75	12.4	14.4	19.0
7	SUMMER	13	11.90	2.6000	27.25	6.48	1.80	54	2.60	8.00	11.5	13.8	27.3
7	WINTER	12	10.00	3.8500	23.00	5.27	1.52	53	3.85	6.25	9.38	12.8	23.0

Data were not always available for all years.

Aggregate Nutrient Ecoregion: I
Rivers and Streams
Descriptive Statistics by Subecoregion, Decade and Season
from 1995 to 1995
Turbidity_JCU

subecoregion	season	N	MEAN	MIN	MAX	STDDEV	STDERR	CV	P5	P25	MEDIAN	P75	P95
7	SPRING	1	12.00	12.000	12.00	.	.	.	12.0	12.0	12.0	12.0	12.0
7	WINTER	1	78.00	78.000	78.00	.	.	.	78.0	78.0	78.0	78.0	78.0

Data were not always available for all years.

Aggregate Nutrient Ecoregion: I
Rivers and Streams
Descriptive Statistics by Subecoregion, Decade and Season
from 1990 to 1998
Turbidity_NTU

subecoregion	season	N	MEAN	MIN	MAX	STDDEV	STDERR	CV	P5	P25	MEDIAN	P75	P95
3	FALL	18	13.66	1.4000	39.33	9.70	2.29	71	1.40	6.03	12.8	18.1	39.3
3	SPRING	17	11.65	.60000	29.75	9.29	2.25	80	0.60	3.30	11.5	15.0	29.8
3	SUMMER	14	8.18	.60000	23.15	6.89	1.84	84	0.60	1.20	7.32	12.8	23.2
3	WINTER	31	18.45	.95000	54.00	15.3	2.76	83	1.93	7.00	11.9	29.0	52.1
7	FALL	2	4.30	2.7000	5.90	2.26	1.60	53	2.70	2.70	4.30	5.90	5.90
7	WINTER	1	7.70	7.7000	7.70	.	.	.	7.70	7.70	7.70	7.70	7.70

Data were not always available for all years.

Aggregate Nutrient Ecoregion: I
Rivers and Streams
Descriptive Statistics by Subecoregion, Decade and Season
from 1992 to 1998
pH_S_U

subecoregion	season	N	MEAN	MIN	MAX	STDDEV	STDERR	CV	P5	P25	MEDIAN	P75	P95
3	FALL	13	7.32	6.9000	7.60	0.20	0.05	3	6.90	7.20	7.31	7.46	7.60
3	SPRING	13	7.34	7.0000	7.71	0.22	0.06	3	7.00	7.20	7.29	7.50	7.71
3	SUMMER	18	7.60	7.1500	8.50	0.36	0.08	5	7.15	7.35	7.49	7.64	8.50
3	WINTER	12	7.19	6.7500	7.50	0.22	0.06	3	6.75	7.13	7.20	7.36	7.50
7	FALL	9	7.69	7.4000	7.95	0.20	0.07	3	7.40	7.55	7.78	7.83	7.95
7	SPRING	9	7.70	7.2000	8.15	0.32	0.11	4	7.20	7.43	7.80	7.88	8.15
7	SUMMER	9	7.85	7.4000	8.10	0.22	0.07	3	7.40	7.75	7.88	8.00	8.10
7	WINTER	9	7.61	7.1000	8.03	0.29	0.10	4	7.10	7.43	7.65	7.83	8.03

Data were not always available for all years.

Rivers and Streams
Descriptive Statistics by Subecoregion, Year and Season
from 1990 to 1998
Chloro_A_Fluor_cor_ug_L

subecoregion	year	season	N	MEAN	MIN	MAX	STDDEV	STDERR	CV	P5	P25	MEDIAN	P75	P95
3	1990	FALL	29	3.80	.60000	13.40	3.44	0.64	90	0.80	1.40	3.00	4.40	12.5
3	1990	SPRING	25	3.21	.50000	12.60	2.94	0.59	92	0.50	1.20	2.15	3.85	9.70
3	1990	SUMMER	36	4.19	.30000	25.00	4.48	0.75	107	0.50	1.35	3.00	5.30	11.3
3	1990	WINTER	7	1.43	.70000	2.80	0.67	0.25	47	0.70	1.00	1.30	1.60	2.80
3	1991	FALL	38	4.01	.30000	28.40	5.16	0.84	129	0.50	1.60	2.05	4.90	18.0
3	1991	SPRING	12	3.66	.90000	7.75	2.07	0.60	57	0.90	2.15	3.10	5.00	7.75
3	1991	SUMMER	39	4.30	.50000	16.30	3.32	0.53	77	0.90	1.80	3.20	6.30	10.0
3	1991	WINTER	6	1.73	1.1500	2.40	0.44	0.18	25	1.15	1.35	1.80	1.90	2.40
3	1992	FALL	20	4.70	.50000	14.20	4.62	1.03	98	0.68	1.38	2.35	9.28	14.1
3	1992	SPRING	19	7.22	.40000	30.50	8.35	1.91	116	0.40	1.25	3.90	15.7	30.5
3	1992	SUMMER	40	7.55	.60000	48.75	10.6	1.68	141	0.90	1.83	3.53	7.75	35.0
3	1992	WINTER	6	2.04	1.2000	4.20	1.08	0.44	53	1.20	1.60	1.68	1.90	4.20
3	1993	FALL	24	3.62	.65000	14.90	3.63	0.74	100	0.80	1.60	2.10	4.55	13.7
3	1993	SPRING	15	3.05	1.6000	5.55	1.51	0.39	49	1.60	1.70	2.00	4.30	5.55
3	1993	SUMMER	32	7.26	1.1000	74.00	13.9	2.46	192	1.20	1.33	2.60	5.43	30.5
3	1994	FALL	37	8.19	.40000	110.00	18.1	2.97	221	0.80	2.30	3.70	5.90	30.8
3	1994	SPRING	23	6.02	.60000	23.20	5.24	1.09	87	0.70	2.50	4.00	8.60	14.1
3	1994	SUMMER	37	10.05	1.7000	108.00	19.0	3.12	189	1.75	2.80	4.85	7.30	44.7
3	1994	WINTER	15	9.58	1.2000	40.10	12.7	3.28	132	1.20	1.90	3.05	17.4	40.1
3	1995	FALL	33	6.37	.60000	32.00	6.31	1.10	99	1.20	3.00	4.80	6.00	22.0
3	1995	SPRING	16	4.76	1.2000	15.00	3.10	0.77	65	1.20	3.05	4.45	5.53	15.0
3	1995	SUMMER	36	5.84	.70000	34.70	7.46	1.24	128	0.80	2.20	3.13	6.00	24.0
3	1995	WINTER	12	0.82	.30000	2.50	0.61	0.18	74	0.30	0.45	0.60	1.00	2.50
3	1996	FALL	34	4.20	.40000	12.00	2.74	0.47	65	0.90	2.15	3.93	5.60	11.3
3	1996	SPRING	26	5.30	.45000	16.00	4.24	0.83	80	0.95	2.00	3.95	8.05	14.6
3	1996	SUMMER	38	7.01	.75000	45.00	9.07	1.47	129	1.00	2.00	3.90	7.70	32.5
3	1996	WINTER	7	0.63	.40000	0.80	0.13	0.05	20	0.40	0.60	0.60	0.70	0.80
3	1997	FALL	35	6.17	1.0000	70.00	11.4	1.92	184	1.20	2.70	4.20	5.60	14.0
3	1997	SPRING	23	6.43	1.2500	24.60	5.56	1.16	86	1.50	2.25	4.90	8.30	16.0
3	1997	SUMMER	35	7.18	.60000	39.60	9.57	1.62	133	0.80	1.80	3.00	7.05	34.0
3	1998	SPRING	10	4.01	2.0000	7.40	1.40	0.44	35	2.00	3.40	3.90	4.30	7.40
3	1998	SUMMER	2	3.25	2.6000	3.90	0.92	0.65	28	2.60	2.60	3.25	3.90	3.90

Aggregate Nutrient Ecoregion: I
Rivers and Streams
Descriptive Statistics by Subecoregion, Year and Season
from 1998 to 1998
Chloro_A_Peri_Spe_unc_mg_sqm

subecoregion	year	season	N	MEAN	MIN	MAX	STDDEV	STDERR	CV	P5	P25	MEDIAN	P75	P95
3	1998	FALL	1	153.85	153.85	153.85	.	.	.	154	154	154	154	154
3	1998	SPRING	1	63.70	63.700	63.70	.	.	.	63.7	63.7	63.7	63.7	63.7
3	1998	SUMMER	7	203.74	50.600	370.60	132	49.7	65	50.6	62.0	194	371	371

Aggregate Nutrient Ecoregion: I
Rivers and Streams
Descriptive Statistics by Subecoregion, Year and Season
from 1990 to 1995
Chloro_A_Phyto_Spec_A_ug_L

subecoregion	year	season	N	MEAN	MIN	MAX	STDDEV	STDERR	CV	P5	P25	MEDIAN	P75	P95
7	1990	FALL	11	5.46	.86000	28.55	8.03	2.42	147	0.86	1.72	2.10	7.75	28.5
7	1990	SPRING	11	6.64	1.3900	18.83	7.16	2.16	108	1.39	2.01	2.62	16.8	18.8
7	1990	SUMMER	11	8.49	.93000	36.43	13.0	3.91	153	0.93	2.40	3.00	4.08	36.4
7	1990	WINTER	11	3.94	.77000	15.75	4.94	1.49	125	0.77	1.20	1.68	3.55	15.8
7	1991	FALL	11	5.17	.66000	24.95	7.11	2.14	137	0.66	1.74	1.95	5.39	25.0
7	1991	SPRING	11	5.91	.68000	34.35	9.98	3.01	169	0.68	1.51	2.35	3.41	34.3
7	1991	SUMMER	11	11.96	.91000	69.15	22.4	6.75	187	0.91	1.85	2.37	4.55	69.1
7	1991	WINTER	11	6.49	1.0200	38.64	11.1	3.34	170	1.02	1.25	2.27	6.08	38.6
7	1992	FALL	11	4.20	.31000	15.84	4.80	1.45	114	0.31	1.64	2.01	5.74	15.8
7	1992	SPRING	11	7.06	1.4200	27.68	8.78	2.65	124	1.42	1.83	4.17	5.18	27.7
7	1992	SUMMER	11	5.82	.95500	32.87	9.06	2.73	156	0.96	2.32	2.97	4.74	32.9
7	1992	WINTER	11	2.05	.26000	8.34	2.52	0.76	123	0.26	0.39	1.05	2.41	8.34
7	1993	FALL	11	3.16	.74000	10.58	3.20	0.96	101	0.74	0.99	1.31	5.91	10.6
7	1993	SPRING	11	7.12	.54000	23.18	7.67	2.31	108	0.54	2.41	2.92	10.9	23.2
7	1993	SUMMER	11	9.28	.51000	24.64	7.97	2.40	86	0.51	2.08	6.16	15.5	24.6
7	1993	WINTER	11	2.07	.32000	10.22	2.96	0.89	143	0.32	0.45	0.68	2.47	10.2
7	1994	FALL	11	3.14	.52500	14.37	4.02	1.21	128	0.53	0.85	1.55	4.33	14.4
7	1994	SPRING	11	3.95	1.2700	11.04	3.66	1.10	93	1.27	1.40	2.02	4.89	11.0
7	1994	SUMMER	11	4.74	.82000	19.86	6.74	2.03	142	0.82	1.59	2.07	2.52	19.9
7	1994	WINTER	11	1.49	.14000	7.88	2.21	0.67	148	0.14	0.38	0.59	1.83	7.88
7	1995	FALL	11	1.78	.96000	3.20	0.75	0.22	42	0.96	1.34	1.49	2.10	3.20
7	1995	SPRING	11	2.50	.82000	4.39	1.43	0.43	57	0.82	0.94	3.01	3.94	4.39
7	1995	SUMMER	11	2.95	1.0500	7.24	1.96	0.59	66	1.05	1.56	2.32	3.58	7.24
7	1995	WINTER	11	0.95	.33000	2.47	0.60	0.18	64	0.33	0.53	0.90	1.00	2.47

Rivers and Streams
Descriptive Statistics by Subecoregion, Year and Season
from 1994 to 1995
Chloro_A_Trich_unco_ug_L

subecoregion	year	season	N	MEAN	MIN	MAX	STDDEV	STDERR	CV	P5	P25	MEDIAN	P75	P95
3	1994	FALL	1	4.90	4.9000	4.90	.	.	.	4.90	4.90	4.90	4.90	4.90
3	1994	SUMMER	1	11.90	11.900	11.90	.	.	.	11.9	11.9	11.9	11.9	11.9
3	1995	FALL	1	5.00	5.0000	5.00	.	.	.	5.00	5.00	5.00	5.00	5.00
3	1995	SPRING	1	3.70	3.7000	3.70	.	.	.	3.70	3.70	3.70	3.70	3.70
3	1995	SUMMER	1	4.05	4.0500	4.05	.	.	.	4.05	4.05	4.05	4.05	4.05
3	1995	WINTER	1	0.30	.30000	0.30	.	.	.	0.30	0.30	0.30	0.30	0.30

Aggregate Nutrient Ecoregion: I
Rivers and Streams
Descriptive Statistics by Subecoregion, Year and Season
from 1990 to 1998
DIP_ug_L

subecoregion	year	season	N	MEAN	MIN	MAX	STDDEV	STDERR	CV	P5	P25	MEDIAN	P75	P95
3	1990	FALL	2	92.50	55.000	130.00	53.0	37.5	57	55.0	55.0	92.5	130	130
3	1990	SPRING	2	75.00	40.000	110.00	49.5	35.0	66	40.0	40.0	75.0	110	110
3	1990	SUMMER	2	117.50	65.000	170.00	74.2	52.5	63	65.0	65.0	118	170	170
3	1990	WINTER	2	67.50	40.000	95.00	38.9	27.5	58	40.0	40.0	67.5	95.0	95.0
3	1991	FALL	2	70.00	30.000	110.00	56.6	40.0	81	30.0	30.0	70.0	110	110
3	1991	SPRING	2	67.50	25.000	110.00	60.1	42.5	89	25.0	25.0	67.5	110	110
3	1991	SUMMER	2	60.00	50.000	70.00	14.1	10.0	24	50.0	50.0	60.0	70.0	70.0
3	1991	WINTER	1	25.00	25.000	25.00	.	.	.	25.0	25.0	25.0	25.0	25.0
3	1992	FALL	2	112.50	55.000	170.00	81.3	57.5	72	55.0	55.0	113	170	170
3	1992	SPRING	2	95.00	55.000	135.00	56.6	40.0	60	55.0	55.0	95.0	135	135
3	1992	SUMMER	2	49.50	24.000	75.00	36.1	25.5	73	24.0	24.0	49.5	75.0	75.0
3	1992	WINTER	1	50.00	50.000	50.00	.	.	.	50.0	50.0	50.0	50.0	50.0
3	1993	FALL	5	89.00	50.000	155.00	53.7	24.0	60	50.0	50.0	50.0	140	155
3	1993	SPRING	5	64.00	30.000	140.00	46.3	20.7	72	30.0	30.0	45.0	75.0	140
3	1993	SUMMER	5	105.00	50.000	240.00	77.0	34.4	73	50.0	65.0	80.0	90.0	240
3	1993	WINTER	5	103.00	45.000	190.00	70.9	31.7	69	45.0	50.0	60.0	170	190
3	1994	FALL	5	108.00	60.000	250.00	79.9	35.7	74	60.0	70.0	75.0	85.0	250
3	1994	SPRING	5	70.00	35.000	185.00	64.5	28.9	92	35.0	40.0	40.0	50.0	185
3	1994	SUMMER	5	133.00	5.0000	370.00	143	64.0	108	5.00	55.0	80.0	155	370
3	1994	WINTER	5	70.00	30.000	125.00	38.6	17.2	55	30.0	40.0	65.0	90.0	125
3	1995	FALL	2	42.50	35.000	50.00	10.6	7.50	25	35.0	35.0	42.5	50.0	50.0
3	1995	SPRING	5	71.00	35.000	150.00	47.5	21.2	67	35.0	40.0	50.0	80.0	150
3	1995	SUMMER	5	123.00	25.000	355.00	135	60.2	109	25.0	35.0	90.0	110	355
3	1995	WINTER	5	57.00	25.000	110.00	35.1	15.7	62	25.0	35.0	40.0	75.0	110
3	1996	FALL	1	245.00	245.00	245.00	.	.	.	245	245	245	245	245
3	1998	FALL	1	9.50	9.5000	9.50	.	.	.	9.50	9.50	9.50	9.50	9.50
3	1998	SPRING	1	6.00	6.0000	6.00	.	.	.	6.00	6.00	6.00	6.00	6.00
3	1998	SUMMER	7	41.29	4.0000	127.00	43.5	16.4	105	4.00	8.50	27.0	57.5	127
7	1990	FALL	3	23.33	5.0000	40.00	17.6	10.1	75	5.00	5.00	25.0	40.0	40.0
7	1990	SPRING	3	44.17	7.5000	105.00	53.1	30.6	120	7.50	7.50	20.0	105	105
7	1990	SUMMER	3	50.00	10.000	110.00	52.9	30.6	106	10.0	10.0	30.0	110	110
7	1990	WINTER	3	68.33	20.000	145.00	67.1	38.8	98	20.0	20.0	40.0	145	145

Rivers and Streams
Descriptive Statistics by Subecoregion, Year and Season
from 1990 to 1998
DIP_ug_L

subecoregion	year	season	N	MEAN	MIN	MAX	STDDEV	STDERR	CV	P5	P25	MEDIAN	P75	P95
7	1991	FALL	3	54.17	12.500	120.00	57.7	33.3	106	12.5	12.5	30.0	120	120
7	1991	SPRING	3	65.00	25.000	115.00	45.8	26.5	71	25.0	25.0	55.0	115	115
7	1991	SUMMER	3	42.50	12.500	90.00	41.6	24.0	98	12.5	12.5	25.0	90.0	90.0
7	1991	WINTER	3	42.50	12.500	80.00	34.4	19.8	81	12.5	12.5	35.0	80.0	80.0
7	1992	FALL	3	50.83	12.500	90.00	38.8	22.4	76	12.5	12.5	50.0	90.0	90.0
7	1992	SPRING	5	1275.00	5.0000	6100.00	2698	1206	212	5.00	40.0	90.0	140	6100
7	1992	SUMMER	5	364.50	5.0000	1600.00	693	310	190	5.00	12.5	70.0	135	1600
7	1992	WINTER	5	1740.00	30.000	8400.00	3723	1665	214	30.0	65.0	70.0	135	8400
7	1993	FALL	11	168.41	12.500	1100.00	315	94.9	187	12.5	20.0	85.0	175	1100
7	1993	SPRING	11	116.59	12.500	260.00	93.1	28.1	80	12.5	30.0	115	210	260
7	1993	SUMMER	11	138.18	10.000	635.00	177	53.4	128	10.0	35.0	110	150	635
7	1993	WINTER	11	549.09	7.5000	5050.00	1495	451	272	7.50	25.0	95.0	210	5050
7	1994	FALL	10	227.00	5.0000	1600.00	486	154	214	5.00	40.0	65.0	115	1600
7	1994	SPRING	11	217.05	12.500	1650.00	478	144	220	12.5	25.0	100	140	1650
7	1994	SUMMER	11	191.82	5.0000	995.00	284	85.6	148	5.00	20.0	100	190	995
7	1994	WINTER	10	613.50	20.000	5250.00	1631	516	266	20.0	35.0	95.0	150	5250
7	1995	FALL	2	65.00	35.000	95.00	42.4	30.0	65	35.0	35.0	65.0	95.0	95.0
7	1995	SPRING	4	313.75	20.000	1070.00	507	254	162	20.0	22.5	82.5	605	1070
7	1995	SUMMER	1	7.50	7.5000	7.50	.	.	.	7.50	7.50	7.50	7.50	7.50
7	1995	WINTER	3	163.33	20.000	410.00	215	124	131	20.0	20.0	60.0	410	410

Aggregate Nutrient Ecoregion: I
Rivers and Streams
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Dissolved_Oxygen_mg_L

subecoregion	year	season	N	MEAN	MIN	MAX	STDDEV	STDERR	CV	P5	P25	MEDIAN	P75	P95
3	1990	FALL	27	9.65	1.0000	12.40	2.29	0.44	24	6.20	8.25	10.2	11.0	11.7
3	1990	SPRING	23	10.54	6.5000	12.30	1.46	0.30	14	7.90	10.1	10.8	11.5	12.2
3	1990	SUMMER	30	8.90	4.1000	11.35	1.68	0.31	19	6.50	7.90	9.23	10.4	11.1
3	1990	WINTER	27	12.05	10.450	13.40	0.74	0.14	6	10.5	11.6	12.2	12.5	13.2
3	1991	FALL	38	9.61	1.9000	13.40	2.58	0.42	27	2.60	8.60	9.80	11.4	13.2
3	1991	SPRING	29	11.42	8.9500	13.00	0.99	0.18	9	9.45	11.1	11.3	12.1	12.8
3	1991	SUMMER	37	8.93	2.4500	11.65	2.18	0.36	24	3.10	8.20	9.35	10.4	11.5
3	1991	WINTER	32	11.68	6.8000	13.85	1.26	0.22	11	9.45	11.3	11.7	12.5	13.5
3	1992	FALL	38	9.13	3.5000	11.65	1.79	0.29	20	3.80	8.30	9.65	10.2	11.5
3	1992	SPRING	38	10.03	4.5500	12.80	1.67	0.27	17	4.80	9.55	10.3	11.0	12.3
3	1992	SUMMER	38	8.72	3.4000	11.60	1.95	0.32	22	3.70	8.00	8.95	10.1	11.0
3	1992	WINTER	32	11.51	8.3000	12.80	0.89	0.16	8	10.5	11.1	11.7	12.1	12.7
3	1993	FALL	28	9.79	7.7000	11.70	1.09	0.21	11	8.00	9.20	9.60	10.9	11.3
3	1993	SPRING	35	11.02	8.5500	13.80	1.18	0.20	11	9.20	10.2	10.9	11.9	12.7
3	1993	SUMMER	34	9.40	6.7000	13.00	1.37	0.23	15	7.45	8.50	9.63	10.4	11.2
3	1993	WINTER	32	11.88	9.7000	13.20	0.90	0.16	8	9.70	11.5	12.0	12.6	13.0
3	1994	FALL	44	9.74	7.0000	12.20	1.28	0.19	13	7.60	8.93	9.70	10.8	11.7
3	1994	SPRING	46	10.02	5.4000	14.20	1.70	0.25	17	7.30	8.90	10.2	11.3	12.3
3	1994	SUMMER	50	8.41	.70000	12.90	1.95	0.28	23	5.80	7.80	8.70	9.50	10.4
3	1994	WINTER	38	11.54	8.6000	13.30	1.16	0.19	10	9.20	10.7	11.7	12.5	13.1
3	1995	FALL	34	9.75	4.6000	11.80	1.34	0.23	14	7.85	9.50	10.0	10.4	11.7
3	1995	SPRING	33	10.76	9.3000	12.60	0.98	0.17	9	9.40	10.0	10.4	11.5	12.6
3	1995	SUMMER	35	8.70	4.2000	10.90	1.51	0.25	17	6.70	7.50	9.10	9.90	10.4
3	1995	WINTER	34	11.16	7.9000	13.75	1.17	0.20	11	9.20	10.5	11.2	12.2	12.9
3	1996	FALL	39	9.38	3.6000	11.90	1.50	0.24	16	7.23	8.86	9.25	10.2	11.8
3	1996	SPRING	50	10.26	5.0000	13.20	1.44	0.20	14	7.60	9.50	10.5	11.1	12.5
3	1996	SUMMER	37	8.73	6.3000	14.45	1.53	0.25	18	6.89	7.70	8.45	9.60	11.0
3	1996	WINTER	33	11.82	8.9000	13.65	1.03	0.18	9	9.90	11.3	11.9	12.5	13.5
3	1997	FALL	33	9.44	5.5500	11.80	1.60	0.28	17	6.58	8.45	10.1	10.4	11.3
3	1997	SPRING	35	10.43	6.4000	13.80	1.37	0.23	13	8.20	9.40	10.6	11.2	12.4
3	1997	SUMMER	35	8.36	4.8950	11.20	1.62	0.27	19	5.20	7.30	8.50	9.50	10.8
3	1997	WINTER	33	12.09	10.300	13.70	0.85	0.15	7	10.4	11.5	12.1	12.7	13.4

Rivers and Streams
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Dissolved_Oxygen_mg_L

subecoregion	year	season	N	MEAN	MIN	MAX	STDDEV	STDERR	CV	P5	P25	MEDIAN	P75	P95
3	1998	FALL	1	10.40	10.400	10.40	.	.	.	10.4	10.4	10.4	10.4	10.4
3	1998	SPRING	1	11.00	11.000	11.00	.	.	.	11.0	11.0	11.0	11.0	11.0
3	1998	SUMMER	6	9.78	9.3000	10.60	0.53	0.22	5	9.30	9.30	9.65	10.2	10.6
3	1998	WINTER	23	11.39	9.6000	13.70	0.93	0.19	8	9.65	11.0	11.5	12.0	12.3
7	1990	FALL	12	8.37	7.6000	9.25	0.44	0.13	5	7.60	8.13	8.23	8.68	9.25
7	1990	SPRING	12	8.93	8.5000	9.80	0.34	0.10	4	8.50	8.70	8.90	9.00	9.80
7	1990	SUMMER	12	7.76	6.2500	9.20	0.81	0.23	10	6.25	7.18	7.88	8.18	9.20
7	1990	WINTER	12	10.25	9.1000	11.05	0.62	0.18	6	9.10	9.85	10.1	10.9	11.1
7	1991	FALL	12	8.02	7.0000	9.30	0.69	0.20	9	7.00	7.55	8.00	8.45	9.30
7	1991	SPRING	12	8.88	7.9000	10.30	0.65	0.19	7	7.90	8.40	8.93	9.15	10.3
7	1991	SUMMER	12	7.84	6.6000	9.80	0.82	0.24	10	6.60	7.28	7.90	8.25	9.80
7	1991	WINTER	12	10.50	9.3000	11.00	0.43	0.13	4	9.30	10.4	10.6	10.8	11.0
7	1992	FALL	11	7.92	6.4000	8.75	0.72	0.22	9	6.40	7.40	7.90	8.50	8.75
7	1992	SPRING	16	8.47	5.9500	10.00	0.92	0.23	11	5.95	8.10	8.65	8.85	10.0
7	1992	SUMMER	16	7.83	6.2000	13.90	1.77	0.44	23	6.20	6.85	7.78	8.10	13.9
7	1992	WINTER	15	9.76	5.4000	11.20	1.41	0.37	14	5.40	9.80	10.0	10.3	11.2
7	1993	FALL	29	8.63	6.5000	10.75	0.99	0.18	12	6.90	8.30	8.60	8.90	10.8
7	1993	SPRING	32	8.70	6.4000	10.85	1.08	0.19	12	6.50	8.00	8.70	9.50	10.1
7	1993	SUMMER	30	7.96	5.8500	9.60	0.97	0.18	12	6.10	7.40	8.10	8.80	9.50
7	1993	WINTER	28	9.54	6.6000	11.40	1.03	0.19	11	7.90	8.90	9.73	10.1	11.4
7	1994	FALL	31	8.47	6.1000	10.00	0.97	0.17	11	6.20	7.70	8.60	9.20	10.0
7	1994	SPRING	29	9.08	7.8000	10.90	0.72	0.13	8	7.95	8.60	9.25	9.40	10.2
7	1994	SUMMER	29	7.76	6.4000	9.80	0.94	0.17	12	6.40	6.80	7.90	8.30	8.95
7	1994	WINTER	27	10.10	7.7000	11.90	1.04	0.20	10	8.00	9.80	10.0	10.8	11.9
7	1995	FALL	11	8.41	7.7000	9.00	0.49	0.15	6	7.70	7.95	8.50	8.90	9.00
7	1995	SPRING	15	9.20	7.1000	10.85	1.16	0.30	13	7.10	8.25	9.80	10.2	10.9
7	1995	SUMMER	11	7.78	4.6000	9.05	1.27	0.38	16	4.60	7.00	8.30	8.50	9.05
7	1995	WINTER	15	9.14	7.1000	10.50	1.07	0.28	12	7.10	8.40	9.30	10.0	10.5
7	1996	FALL	9	9.01	5.8000	10.30	1.30	0.43	14	5.80	9.00	9.00	9.80	10.3
7	1996	SPRING	9	10.24	6.9000	12.20	1.58	0.53	15	6.90	10.1	10.2	11.1	12.2
7	1996	SUMMER	9	8.48	5.9000	10.70	1.70	0.57	20	5.90	7.20	9.10	9.40	10.7
7	1996	WINTER	9	9.94	7.1000	11.60	1.54	0.51	16	7.10	8.50	10.6	10.8	11.6

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from 1990 to 1998
Nitrite_Nitrate_NO2_NO3_mg_L

subecoregion	year	season	N	MEAN	MIN	MAX	STDDEV	STDERR	CV	P5	P25	MEDIAN	P75	P95
3	1990	FALL	43	0.73	.00500	5.95	1.33	0.20	182	0.03	0.13	0.25	0.59	4.90
3	1990	SPRING	41	0.74	.03000	7.30	1.35	0.21	184	0.04	0.18	0.36	0.54	1.46
3	1990	SUMMER	50	0.72	.03000	8.64	1.46	0.21	202	0.03	0.13	0.25	0.48	3.75
3	1990	WINTER	30	1.17	.11000	5.60	1.17	0.21	100	0.13	0.48	0.78	1.52	3.20
3	1991	FALL	53	0.78	.00500	6.00	1.36	0.19	175	0.02	0.10	0.23	0.56	4.10
3	1991	SPRING	45	0.98	.09000	5.50	1.03	0.15	105	0.13	0.30	0.71	1.05	2.80
3	1991	SUMMER	47	0.79	.02000	8.95	1.48	0.22	186	0.04	0.19	0.35	0.59	3.20
3	1991	WINTER	39	1.21	.10500	5.40	1.07	0.17	88	0.14	0.44	0.87	1.89	3.18
3	1992	FALL	55	0.63	.00500	5.65	1.18	0.16	187	0.01	0.05	0.24	0.37	3.36
3	1992	SPRING	52	0.84	.02000	9.95	1.49	0.21	179	0.05	0.22	0.46	0.79	3.20
3	1992	SUMMER	51	0.68	.02000	8.65	1.43	0.20	209	0.03	0.10	0.26	0.50	3.26
3	1992	WINTER	37	1.47	.08000	9.60	1.70	0.28	115	0.14	0.40	1.00	1.99	3.70
3	1993	FALL	33	0.90	.02000	7.90	1.69	0.29	188	0.02	0.16	0.23	0.84	5.20
3	1993	SPRING	41	0.84	.07000	2.90	0.67	0.10	80	0.13	0.41	0.61	1.10	2.40
3	1993	SUMMER	41	0.58	.03000	4.80	0.87	0.14	149	0.03	0.15	0.33	0.53	1.57
3	1993	WINTER	34	1.21	.17000	4.00	0.92	0.16	75	0.18	0.66	0.95	1.40	3.20
3	1994	FALL	50	0.54	.02000	5.90	0.99	0.14	185	0.02	0.09	0.21	0.43	1.90
3	1994	SPRING	41	0.75	.04000	4.30	0.79	0.12	106	0.06	0.28	0.55	0.94	1.82
3	1994	SUMMER	48	0.48	.02000	4.95	0.86	0.12	180	0.03	0.10	0.24	0.41	1.90
3	1994	WINTER	39	1.18	.02000	3.50	0.93	0.15	79	0.06	0.41	0.91	1.92	3.10
3	1995	FALL	40	0.48	.00500	3.40	0.64	0.10	133	0.05	0.19	0.30	0.45	1.83
3	1995	SPRING	43	0.73	.03000	3.40	0.72	0.11	99	0.04	0.24	0.58	1.01	1.75
3	1995	SUMMER	40	0.51	.02000	5.10	0.84	0.13	162	0.02	0.17	0.36	0.49	1.72
3	1995	WINTER	39	1.15	.10500	3.60	0.87	0.14	76	0.11	0.39	0.86	1.74	3.10
3	1996	FALL	32	0.57	.02000	6.10	1.27	0.23	223	0.02	0.06	0.17	0.30	4.00
3	1996	SPRING	36	0.71	.02500	3.90	0.80	0.13	114	0.04	0.25	0.42	0.98	3.20
3	1996	SUMMER	30	0.53	.00500	5.30	1.08	0.20	203	0.01	0.05	0.15	0.45	2.90
3	1996	WINTER	36	0.91	.11000	3.05	0.74	0.12	81	0.12	0.38	0.58	1.31	2.60
3	1997	FALL	34	0.61	.00500	4.50	0.90	0.15	147	0.01	0.12	0.28	0.74	2.90
3	1997	SPRING	36	0.49	.00500	3.10	0.65	0.11	132	0.02	0.15	0.35	0.53	2.70
3	1997	SUMMER	36	0.53	.00500	4.40	0.84	0.14	158	0.01	0.11	0.25	0.56	2.30
3	1997	WINTER	26	0.69	.04000	3.80	0.80	0.16	116	0.08	0.17	0.40	0.87	1.90

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from 1990 to 1998
Nitrite_Nitrate_NO2_NO3_mg_L

subecoregion	year	season	N	MEAN	MIN	MAX	STDDEV	STDERR	CV	P5	P25	MEDIAN	P75	P95
3	1998	FALL	1	0.00	.00000	0.00	.	.	.	0.00	0.00	0.00	0.00	0.00
3	1998	SPRING	1	0.03	.02800	0.03	.	.	.	0.03	0.03	0.03	0.03	0.03
3	1998	SUMMER	9	1.25	.01600	7.08	2.22	0.74	177	0.02	0.24	0.74	0.88	7.08
3	1998	WINTER	23	0.70	.08000	3.10	0.73	0.15	105	0.09	0.19	0.49	1.00	2.30
7	1990	FALL	1	0.05	.05000	0.05	.	.	.	0.05	0.05	0.05	0.05	0.05
7	1990	SPRING	2	0.95	.20000	1.70	1.06	0.75	112	0.20	0.20	0.95	1.70	1.70
7	1990	SUMMER	1	2.00	2.0000	2.00	.	.	.	2.00	2.00	2.00	2.00	2.00
7	1990	WINTER	5	2.24	.10000	4.40	1.97	0.88	88	0.10	0.20	3.00	3.50	4.40
7	1991	FALL	3	0.32	.02350	0.78	0.40	0.23	124	0.02	0.02	0.17	0.78	0.78
7	1991	SPRING	3	0.84	.18000	1.85	0.89	0.51	106	0.18	0.18	0.48	1.85	1.85
7	1991	SUMMER	3	0.37	.10500	0.86	0.42	0.24	114	0.11	0.11	0.15	0.86	0.86
7	1991	WINTER	5	3.18	.13000	7.60	3.20	1.43	101	0.13	0.30	2.75	5.10	7.60
7	1992	FALL	3	0.43	.02500	1.20	0.66	0.38	153	0.03	0.03	0.08	1.20	1.20
7	1992	SPRING	3	0.39	.09850	0.83	0.38	0.22	97	0.10	0.10	0.26	0.83	0.83
7	1992	SUMMER	3	0.40	.08000	0.96	0.48	0.28	121	0.08	0.08	0.16	0.96	0.96
7	1992	WINTER	3	0.74	.13000	1.60	0.77	0.44	104	0.13	0.13	0.48	1.60	1.60
7	1993	FALL	3	0.47	.06900	1.20	0.63	0.37	135	0.07	0.07	0.14	1.20	1.20
7	1993	SPRING	3	0.60	.14500	1.40	0.70	0.40	116	0.15	0.15	0.25	1.40	1.40
7	1993	SUMMER	3	0.52	.07150	1.40	0.76	0.44	146	0.07	0.07	0.10	1.40	1.40
7	1993	WINTER	2	0.74	.27000	1.20	0.66	0.47	89	0.27	0.27	0.74	1.20	1.20
7	1994	FALL	1	1.60	1.6000	1.60	.	.	.	1.60	1.60	1.60	1.60	1.60
7	1994	SPRING	2	0.94	.17000	1.70	1.08	0.77	116	0.17	0.17	0.94	1.70	1.70
7	1994	SUMMER	1	1.80	1.8000	1.80	.	.	.	1.80	1.80	1.80	1.80	1.80
7	1994	WINTER	2	1.09	.33000	1.85	1.07	0.76	99	0.33	0.33	1.09	1.85	1.85
7	1995	FALL	2	0.60	.09000	1.10	0.71	0.51	120	0.09	0.09	0.60	1.10	1.10
7	1995	SPRING	2	0.36	.11000	0.61	0.35	0.25	98	0.11	0.11	0.36	0.61	0.61
7	1995	SUMMER	1	0.08	.08000	0.08	.	.	.	0.08	0.08	0.08	0.08	0.08
7	1995	WINTER	1	1.50	1.5000	1.50	.	.	.	1.50	1.50	1.50	1.50	1.50

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from 1990 to 1998
Nitrogen_Tot_Kjeldhal_mg_L

subecoregion	year	season	N	MEAN	MIN	MAX	STDDEV	STDERR	CV	P5	P25	MEDIAN	P75	P95
3	1990	FALL	42	0.47	.05000	1.21	0.26	0.04	54	0.20	0.30	0.45	0.63	0.88
3	1990	SPRING	40	0.38	.05000	0.91	0.21	0.03	56	0.05	0.22	0.40	0.50	0.83
3	1990	SUMMER	48	0.47	.05000	2.85	0.42	0.06	90	0.13	0.20	0.40	0.56	0.99
3	1990	WINTER	33	0.44	.05000	1.05	0.27	0.05	63	0.05	0.20	0.40	0.60	0.91
3	1991	FALL	50	0.50	.05000	5.10	0.74	0.10	146	0.05	0.20	0.30	0.55	1.40
3	1991	SPRING	45	0.43	.05000	1.54	0.31	0.05	72	0.05	0.27	0.40	0.50	1.10
3	1991	SUMMER	48	0.52	.05000	3.19	0.54	0.08	104	0.18	0.27	0.36	0.56	1.60
3	1991	WINTER	35	0.53	.05000	1.38	0.32	0.05	61	0.05	0.30	0.46	0.70	1.30
3	1992	FALL	47	0.50	.05000	2.50	0.51	0.08	102	0.05	0.25	0.40	0.60	1.80
3	1992	SPRING	47	0.45	.05000	2.00	0.39	0.06	85	0.05	0.20	0.38	0.60	1.10
3	1992	SUMMER	47	0.56	.06000	3.26	0.62	0.09	110	0.13	0.20	0.40	0.60	2.10
3	1992	WINTER	33	0.55	.05000	1.80	0.45	0.08	82	0.05	0.26	0.40	0.74	1.60
3	1993	FALL	38	0.37	.05000	1.40	0.24	0.04	65	0.05	0.20	0.30	0.46	0.80
3	1993	SPRING	44	0.38	.05000	1.40	0.24	0.04	62	0.05	0.22	0.35	0.50	0.70
3	1993	SUMMER	46	0.37	.05000	1.80	0.29	0.04	77	0.05	0.20	0.30	0.47	0.79
3	1993	WINTER	37	0.43	.05000	1.30	0.30	0.05	70	0.05	0.20	0.35	0.50	1.30
3	1994	FALL	49	0.44	.05000	2.00	0.40	0.06	92	0.05	0.20	0.40	0.52	1.40
3	1994	SPRING	54	0.44	.05000	3.60	0.63	0.09	145	0.05	0.20	0.30	0.41	0.90
3	1994	SUMMER	65	0.35	.05000	1.90	0.27	0.03	78	0.05	0.20	0.30	0.45	0.65
3	1994	WINTER	40	0.44	.05000	1.20	0.24	0.04	56	0.05	0.30	0.41	0.57	0.90
3	1995	FALL	40	0.43	.05000	1.50	0.25	0.04	57	0.15	0.30	0.40	0.54	0.77
3	1995	SPRING	38	0.40	.05000	1.90	0.36	0.06	90	0.05	0.20	0.33	0.40	1.30
3	1995	SUMMER	43	0.35	.05000	1.30	0.21	0.03	59	0.05	0.20	0.30	0.48	0.60
3	1995	WINTER	38	0.35	.05000	1.20	0.26	0.04	75	0.05	0.18	0.30	0.40	0.90
3	1996	FALL	41	0.32	.05000	1.60	0.33	0.05	102	0.05	0.13	0.21	0.44	0.60
3	1996	SPRING	37	0.34	.05000	1.10	0.21	0.04	63	0.05	0.20	0.30	0.43	0.80
3	1996	SUMMER	40	0.33	.05000	1.40	0.25	0.04	75	0.05	0.20	0.30	0.44	0.70
3	1996	WINTER	36	0.34	.05000	0.80	0.17	0.03	51	0.05	0.21	0.38	0.45	0.58
3	1997	FALL	36	0.23	.05000	0.90	0.19	0.03	83	0.05	0.05	0.23	0.37	0.52
3	1997	SPRING	39	0.26	.05000	1.05	0.19	0.03	73	0.05	0.13	0.21	0.35	0.58
3	1997	SUMMER	38	0.32	.05000	1.20	0.22	0.04	70	0.05	0.20	0.29	0.46	0.65
3	1997	WINTER	36	0.32	.05000	0.95	0.21	0.03	64	0.05	0.20	0.29	0.43	0.70

Aggregate Nutrient Ecoregion: I
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from 1990 to 1998
Nitrogen_Tot_Kjeldhal_mg_L

subecoregion	year	season	N	MEAN	MIN	MAX	STDDEV	STDERR	CV	P5	P25	MEDIAN	P75	P95
3	1998	SPRING	12	0.32	.09000	0.54	0.12	0.03	38	0.09	0.24	0.32	0.40	0.54
3	1998	SUMMER	6	0.39	.13000	0.52	0.14	0.06	36	0.13	0.33	0.44	0.48	0.52
3	1998	WINTER	32	0.27	.05000	0.50	0.15	0.03	56	0.05	0.10	0.30	0.38	0.50
7	1990	FALL	3	0.26	.07500	0.40	0.17	0.10	64	0.08	0.08	0.30	0.40	0.40
7	1990	SPRING	3	0.38	.30000	0.55	0.14	0.08	38	0.30	0.30	0.30	0.55	0.55
7	1990	SUMMER	3	0.67	.30000	1.00	0.35	0.20	53	0.30	0.30	0.70	1.00	1.00
7	1990	WINTER	3	0.67	.40000	1.20	0.46	0.27	69	0.40	0.40	0.40	1.20	1.20
7	1991	FALL	3	0.48	.12500	1.00	0.46	0.27	97	0.13	0.13	0.30	1.00	1.00
7	1991	SPRING	3	0.65	.30000	0.95	0.33	0.19	50	0.30	0.30	0.70	0.95	0.95
7	1991	SUMMER	3	0.83	.40000	1.50	0.59	0.34	70	0.40	0.40	0.60	1.50	1.50
7	1991	WINTER	3	0.32	.05000	0.70	0.34	0.20	107	0.05	0.05	0.20	0.70	0.70
7	1992	FALL	3	0.23	.10000	0.40	0.15	0.09	65	0.10	0.10	0.20	0.40	0.40
7	1992	SPRING	7	1.04	.07500	2.50	1.02	0.39	98	0.08	0.30	0.70	2.50	2.50
7	1992	SUMMER	7	0.99	.05000	2.20	0.88	0.33	89	0.05	0.08	0.80	2.10	2.20
7	1992	WINTER	6	4.32	.12500	24.00	9.64	3.94	223	0.13	0.40	0.40	0.60	24.0
7	1993	FALL	20	0.62	.05000	2.40	0.69	0.15	111	0.05	0.10	0.38	0.80	2.40
7	1993	SPRING	23	0.94	.07500	2.10	0.60	0.12	64	0.30	0.40	0.85	1.45	2.10
7	1993	SUMMER	23	0.92	.05000	3.50	0.96	0.20	104	0.08	0.20	0.70	1.05	3.50
7	1993	WINTER	19	2.31	.10000	28.50	6.36	1.46	275	0.10	0.60	0.90	1.40	28.5
7	1994	FALL	22	0.81	.05000	4.80	1.18	0.25	146	0.05	0.18	0.45	0.80	3.65
7	1994	SPRING	20	0.99	.07500	7.55	1.60	0.36	162	0.09	0.25	0.80	0.95	4.53
7	1994	SUMMER	20	1.10	.05000	3.50	1.01	0.23	91	0.08	0.30	0.85	1.50	3.50
7	1994	WINTER	18	1.66	.12500	19.00	4.35	1.03	263	0.13	0.20	0.53	1.05	19.0
7	1995	FALL	2	0.35	.20000	0.50	0.21	0.15	61	0.20	0.20	0.35	0.50	0.50
7	1995	SPRING	6	1.04	.10000	5.05	1.97	0.80	190	0.10	0.13	0.23	0.50	5.05
7	1995	SUMMER	2	0.14	.07500	0.20	0.09	0.06	64	0.08	0.08	0.14	0.20	0.20
7	1995	WINTER	5	0.72	.20000	2.20	0.84	0.38	117	0.20	0.20	0.50	0.50	2.20
7	1996	FALL	9	0.21	.05000	0.60	0.25	0.08	118	0.05	0.05	0.05	0.40	0.60
7	1996	SPRING	9	0.30	.05000	0.90	0.28	0.09	93	0.05	0.20	0.20	0.28	0.90
7	1996	SUMMER	9	0.30	.05000	0.90	0.36	0.12	121	0.05	0.05	0.05	0.60	0.90
7	1996	WINTER	9	0.40	.05000	1.30	0.46	0.15	114	0.05	0.05	0.30	0.40	1.30

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from 1990 to 1992
Phosph_Ortho_Tot_as_P_ug_L

subecoregion	year	season	N	MEAN	MIN	MAX	STDDEV	STDERR	CV	P5	P25	MEDIAN	P75	P95
3	1990	FALL	2	85.00	30.000	140.00	77.8	55.0	92	30.0	30.0	85.0	140	140
3	1991	FALL	2	70.00	20.000	120.00	70.7	50.0	101	20.0	20.0	70.0	120	120
3	1991	SPRING	2	80.00	40.000	120.00	56.6	40.0	71	40.0	40.0	80.0	120	120
3	1991	SUMMER	2	50.00	35.000	65.00	21.2	15.0	42	35.0	35.0	50.0	65.0	65.0
3	1991	WINTER	1	30.00	30.000	30.00	.	.	.	30.0	30.0	30.0	30.0	30.0
3	1992	FALL	2	115.00	50.000	180.00	91.9	65.0	80	50.0	50.0	115	180	180
3	1992	SPRING	2	110.00	60.000	160.00	70.7	50.0	64	60.0	60.0	110	160	160
3	1992	SUMMER	2	57.50	35.000	80.00	31.8	22.5	55	35.0	35.0	57.5	80.0	80.0
3	1992	WINTER	1	50.00	50.000	50.00	.	.	.	50.0	50.0	50.0	50.0	50.0
7	1990	FALL	1	5.00	5.0000	5.00	.	.	.	5.00	5.00	5.00	5.00	5.00
7	1990	WINTER	2	40.00	20.000	60.00	28.3	20.0	71	20.0	20.0	40.0	60.0	60.0
7	1991	FALL	3	48.33	5.0000	120.00	62.5	36.1	129	5.00	5.00	20.0	120	120
7	1991	SPRING	3	73.33	30.000	130.00	51.3	29.6	70	30.0	30.0	60.0	130	130
7	1991	SUMMER	3	65.00	5.0000	160.00	83.2	48.0	128	5.00	5.00	30.0	160	160
7	1991	WINTER	3	60.00	20.000	120.00	52.9	30.6	88	20.0	20.0	40.0	120	120
7	1992	FALL	3	45.00	5.0000	90.00	42.7	24.7	95	5.00	5.00	40.0	90.0	90.0
7	1992	SPRING	3	88.33	5.0000	190.00	93.9	54.2	106	5.00	5.00	70.0	190	190
7	1992	SUMMER	3	46.67	20.000	80.00	30.6	17.6	65	20.0	20.0	40.0	80.0	80.0
7	1992	WINTER	3	83.33	10.000	170.00	80.8	46.7	97	10.0	10.0	70.0	170	170

Aggregate Nutrient Ecoregion: I
Rivers and Streams
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from 1990 to 1998
Total_Nitrogen_mg_L

subecoregion	year	season	N	MEAN	MIN	MAX	STDDEV	STDERR	CV	P5	P25	MEDIAN	P75	P95
3	1990	FALL	2	1.20	.70000	1.70	0.71	0.50	59	0.70	0.70	1.20	1.70	1.70
3	1990	SPRING	2	1.58	.45000	2.70	1.59	1.13	101	0.45	0.45	1.58	2.70	2.70
3	1990	SUMMER	2	2.00	.60000	3.40	1.98	1.40	99	0.60	0.60	2.00	3.40	3.40
3	1990	WINTER	2	1.85	1.5000	2.20	0.49	0.35	27	1.50	1.50	1.85	2.20	2.20
3	1991	FALL	1	4.20	4.2000	4.20	.	.	.	4.20	4.20	4.20	4.20	4.20
3	1991	SPRING	2	1.96	1.2100	2.70	1.05	0.75	54	1.21	1.21	1.96	2.70	2.70
3	1991	SUMMER	2	1.92	.79500	3.05	1.59	1.13	83	0.80	0.80	1.92	3.05	3.05
3	1992	FALL	2	2.39	.57000	4.20	2.57	1.82	108	0.57	0.57	2.39	4.20	4.20
3	1992	SPRING	1	2.70	2.7000	2.70	.	.	.	2.70	2.70	2.70	2.70	2.70
3	1992	SUMMER	2	1.97	.74000	3.20	1.74	1.23	88	0.74	0.74	1.97	3.20	3.20
3	1992	WINTER	1	1.20	1.2000	1.20	.	.	.	1.20	1.20	1.20	1.20	1.20
3	1993	FALL	2	2.03	.50000	3.55	2.16	1.53	107	0.50	0.50	2.03	3.55	3.55
3	1993	SPRING	2	1.31	.92000	1.70	0.55	0.39	42	0.92	0.92	1.31	1.70	1.70
3	1993	SUMMER	2	1.67	.73000	2.60	1.32	0.94	79	0.73	0.73	1.67	2.60	2.60
3	1993	WINTER	2	2.06	1.1250	3.00	1.33	0.94	64	1.13	1.13	2.06	3.00	3.00
3	1994	FALL	6	1.14	.46000	1.90	0.63	0.26	55	0.46	0.54	1.08	1.77	1.90
3	1994	SPRING	2	1.69	.97000	2.40	1.01	0.72	60	0.97	0.97	1.69	2.40	2.40
3	1994	SUMMER	2	1.17	.63000	1.70	0.76	0.54	65	0.63	0.63	1.17	1.70	1.70
3	1994	WINTER	6	1.61	.32000	3.50	1.20	0.49	74	0.32	0.59	1.38	2.49	3.50
3	1995	FALL	5	1.04	.38000	2.70	0.94	0.42	90	0.38	0.55	0.78	0.80	2.70
3	1995	SPRING	6	1.00	.26000	2.00	0.72	0.29	72	0.26	0.28	0.94	1.61	2.00
3	1995	SUMMER	6	0.93	.26000	2.90	1.00	0.41	107	0.26	0.30	0.59	0.92	2.90
3	1995	WINTER	4	0.77	.33000	1.36	0.47	0.23	61	0.33	0.40	0.69	1.14	1.36
3	1996	FALL	1	0.22	.22000	0.22	.	.	.	0.22	0.22	0.22	0.22	0.22
3	1996	SPRING	1	0.29	.29000	0.29	.	.	.	0.29	0.29	0.29	0.29	0.29
3	1996	SUMMER	1	0.21	.21000	0.21	.	.	.	0.21	0.21	0.21	0.21	0.21
3	1996	WINTER	1	0.56	.56000	0.56	.	.	.	0.56	0.56	0.56	0.56	0.56
3	1998	FALL	1	0.00	.00000	0.00	.	.	.	0.00	0.00	0.00	0.00	0.00
3	1998	SPRING	1	0.00	.00000	0.00	.	.	.	0.00	0.00	0.00	0.00	0.00
3	1998	SUMMER	7	0.16	.00000	0.68	0.24	0.09	152	0.00	0.00	0.08	0.18	0.68
7	1990	FALL	2	0.63	.40000	0.85	0.32	0.23	51	0.40	0.40	0.63	0.85	0.85
7	1990	SPRING	3	1.02	.30000	2.25	1.07	0.62	106	0.30	0.30	0.50	2.25	2.25

Rivers and Streams
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Total_Nitrogen_mg_L

subecoregion	year	season	N	MEAN	MIN	MAX	STDDEV	STDERR	CV	P5	P25	MEDIAN	P75	P95
7	1990	SUMMER	3	1.33	.30000	3.00	1.46	0.84	109	0.30	0.30	0.70	3.00	3.00
7	1990	WINTER	3	1.77	.50000	4.20	2.11	1.22	119	0.50	0.50	0.60	4.20	4.20
7	1991	FALL	3	0.83	.27000	1.75	0.80	0.46	97	0.27	0.27	0.47	1.75	1.75
7	1991	SPRING	3	1.48	.48000	2.75	1.16	0.67	79	0.48	0.48	1.20	2.75	2.75
7	1991	SUMMER	3	1.22	.55000	2.40	1.03	0.59	84	0.55	0.55	0.71	2.40	2.40
7	1991	WINTER	2	2.00	.50000	3.50	2.12	1.50	106	0.50	0.50	2.00	3.50	3.50
7	1992	FALL	2	0.83	.20000	1.45	0.88	0.63	107	0.20	0.20	0.83	1.45	1.45
7	1992	SPRING	2	0.93	.56000	1.30	0.52	0.37	56	0.56	0.56	0.93	1.30	1.30
7	1992	SUMMER	1	1.75	1.7500	1.75	.	.	.	1.75	1.75	1.75	1.75	1.75
7	1992	WINTER	3	1.24	.53000	2.30	0.94	0.54	75	0.53	0.53	0.89	2.30	2.30
7	1993	FALL	1	1.55	1.5500	1.55	.	.	.	1.55	1.55	1.55	1.55	1.55
7	1993	SPRING	2	1.28	.55000	2.00	1.03	0.73	80	0.55	0.55	1.28	2.00	2.00
7	1993	SUMMER	1	1.70	1.7000	1.70	.	.	.	1.70	1.70	1.70	1.70	1.70
7	1993	WINTER	2	1.66	.57000	2.75	1.54	1.09	93	0.57	0.57	1.66	2.75	2.75
7	1994	FALL	1	2.00	2.0000	2.00	.	.	.	2.00	2.00	2.00	2.00	2.00
7	1994	SPRING	1	2.60	2.6000	2.60	.	.	.	2.60	2.60	2.60	2.60	2.60
7	1994	SUMMER	3	1.03	.20000	2.60	1.36	0.78	131	0.20	0.20	0.30	2.60	2.60
7	1994	WINTER	2	1.57	.63000	2.50	1.32	0.94	84	0.63	0.63	1.57	2.50	2.50
7	1995	FALL	2	0.95	.29000	1.60	0.93	0.66	98	0.29	0.29	0.95	1.60	1.60
7	1995	SPRING	1	1.40	1.4000	1.40	.	.	.	1.40	1.40	1.40	1.40	1.40
7	1995	WINTER	1	3.50	3.5000	3.50	.	.	.	3.50	3.50	3.50	3.50	3.50

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from 1990 to 1998
Total_Phosphorus_ug_L

subecoregion	year	season	N	MEAN	MIN	MAX	STDDEV	STDERR	CV	P5	P25	MEDIAN	P75	P95
3	1990	FALL	43	135.87	7.5000	460.00	95.4	14.5	70	30.0	60.0	110	190	320
3	1990	SPRING	41	108.96	2.5000	340.00	75.5	11.8	69	20.0	50.0	100	140	270
3	1990	SUMMER	46	120.22	10.000	385.00	85.9	12.7	71	20.0	50.0	110	170	240
3	1990	WINTER	34	125.29	10.000	420.00	100	17.2	80	30.0	50.0	87.5	200	350
3	1991	FALL	56	133.39	10.000	685.00	143	19.1	107	20.0	40.0	82.5	165	480
3	1991	SPRING	48	118.59	2.5000	610.00	100	14.5	85	20.0	50.0	100	145	295
3	1991	SUMMER	78	155.16	2.5000	950.00	186	21.1	120	20.0	50.0	85.0	180	630
3	1991	WINTER	40	144.13	10.000	455.00	105	16.6	73	17.5	60.0	130	208	360
3	1992	FALL	56	130.00	2.5000	1000.00	161	21.5	124	20.0	40.0	87.5	135	400
3	1992	SPRING	54	138.89	10.000	1300.00	201	27.4	145	20.0	50.0	82.5	145	555
3	1992	SUMMER	54	138.66	2.5000	1400.00	198	27.0	143	20.0	50.0	90.0	140	290
3	1992	WINTER	39	126.22	11.250	600.00	133	21.2	105	11.3	40.0	85.0	150	480
3	1993	FALL	38	104.87	20.000	300.00	65.3	10.6	62	20.0	50.0	90.0	150	200
3	1993	SPRING	48	86.35	20.000	340.00	67.7	9.77	78	20.0	45.0	70.0	100	240
3	1993	SUMMER	46	98.48	10.000	300.00	75.6	11.1	77	20.0	40.0	80.0	130	260
3	1993	WINTER	40	103.63	10.000	370.00	86.0	13.6	83	20.0	40.0	80.0	133	310
3	1994	FALL	61	103.93	5.0000	400.00	85.3	10.9	82	10.0	50.0	90.0	135	230
3	1994	SPRING	59	86.17	2.5000	460.00	85.8	11.2	100	10.0	30.0	60.0	100	260
3	1994	SUMMER	70	105.68	2.5000	670.00	106	12.7	100	20.0	40.0	80.0	130	260
3	1994	WINTER	46	101.09	.00000	240.00	60.8	8.97	60	10.0	40.0	103	135	200
3	1995	FALL	48	86.82	2.5000	210.00	56.6	8.17	65	10.0	45.0	72.5	118	200
3	1995	SPRING	46	83.70	.00000	360.00	81.4	12.0	97	0.00	40.0	60.0	100	240
3	1995	SUMMER	51	95.93	.00000	380.00	85.7	12.0	89	5.00	40.0	80.0	130	250
3	1995	WINTER	43	97.79	.00000	300.00	63.0	9.61	64	5.00	55.0	90.0	130	210
3	1996	FALL	48	103.49	.00000	760.00	115	16.7	111	20.0	42.5	75.0	125	280
3	1996	SPRING	62	118.71	.00000	790.00	142	18.1	120	30.0	50.0	77.5	125	380
3	1996	SUMMER	47	75.32	10.000	200.00	51.3	7.49	68	15.0	40.0	65.0	100	180
3	1996	WINTER	43	116.16	5.0000	265.00	65.0	9.91	56	25.0	50.0	120	170	200
3	1997	FALL	41	76.71	5.0000	195.00	50.4	7.88	66	10.0	40.0	60.0	110	165
3	1997	SPRING	46	75.00	5.0000	165.00	43.4	6.39	58	20.0	40.0	72.5	110	150
3	1997	SUMMER	45	82.22	5.0000	220.00	57.6	8.59	70	15.0	40.0	60.0	120	190
3	1997	WINTER	42	93.48	6.2500	220.00	49.9	7.70	53	25.0	60.0	95.0	120	205

Aggregate Nutrient Ecoregion: I
Rivers and Streams
Descriptive Statistics by Subecoregion, Year and Season
from 1990 to 1998
Total_Phosphorus_ug_L

subecoregion	year	season	N	MEAN	MIN	MAX	STDDEV	STDERR	CV	P5	P25	MEDIAN	P75	P95
3	1998	FALL	1	16.00	16.000	16.00	.	.	.	16.0	16.0	16.0	16.0	16.0
3	1998	SPRING	13	79.08	5.0000	120.00	35.5	9.86	45	5.00	70.0	80.0	110	120
3	1998	SUMMER	13	77.04	5.0000	150.00	57.4	15.9	75	5.00	17.0	75.0	140	150
3	1998	WINTER	32	92.50	10.000	195.00	45.9	8.11	50	20.0	57.5	100	130	150
7	1990	FALL	12	131.25	50.000	250.00	52.5	15.2	40	50.0	103	123	155	250
7	1990	SPRING	12	128.75	30.000	265.00	60.9	17.6	47	30.0	100	115	140	265
7	1990	SUMMER	12	145.83	30.000	340.00	83.5	24.1	57	30.0	105	120	145	340
7	1990	WINTER	14	158.21	50.000	290.00	66.9	17.9	42	50.0	120	140	205	290
7	1991	FALL	13	142.31	.00000	370.00	102	28.2	71	0.00	110	140	150	370
7	1991	SPRING	12	170.83	40.000	270.00	62.3	18.0	36	40.0	150	160	195	270
7	1991	SUMMER	12	185.83	40.000	480.00	108	31.2	58	40.0	150	160	175	480
7	1991	WINTER	14	190.71	20.000	470.00	120	32.2	63	20.0	140	145	230	470
7	1992	FALL	12	131.25	10.000	250.00	56.3	16.2	43	10.0	110	135	148	250
7	1992	SPRING	16	578.36	3.7500	5050.00	1280	320	221	3.75	120	155	198	5050
7	1992	SUMMER	16	368.28	20.000	1900.00	551	138	150	20.0	125	143	318	1900
7	1992	WINTER	15	716.33	50.000	8850.00	2251	581	314	50.0	120	140	160	8850
7	1993	FALL	29	192.20	3.7500	1200.00	257	47.8	134	30.0	50.0	80.0	280	860
7	1993	SPRING	32	247.19	20.000	890.00	215	38.1	87	50.0	105	180	305	890
7	1993	SUMMER	32	193.44	15.000	750.00	188	33.3	97	50.0	75.0	100	265	750
7	1993	WINTER	28	527.50	40.000	8350.00	1538	291	292	60.0	150	185	360	570
7	1994	FALL	31	207.54	3.7500	1700.00	335	60.2	162	30.0	70.0	100	180	1050
7	1994	SPRING	29	245.52	20.000	2350.00	430	79.8	175	55.0	75.0	120	235	780
7	1994	SUMMER	29	263.28	30.000	1100.00	267	49.5	101	30.0	80.0	150	340	1100
7	1994	WINTER	27	341.85	35.000	5800.00	1095	211	320	35.0	65.0	90.0	205	390
7	1995	FALL	11	103.64	70.000	180.00	39.6	11.9	38	70.0	80.0	80.0	130	180
7	1995	SPRING	15	207.00	40.000	1490.00	360	93.0	174	40.0	70.0	100	180	1490
7	1995	SUMMER	11	106.36	50.000	230.00	56.4	17.0	53	50.0	60.0	80.0	130	230
7	1995	WINTER	15	190.67	70.000	510.00	114	29.5	60	70.0	110	160	270	510
7	1996	FALL	9	68.33	2.5000	210.00	72.8	24.3	107	2.50	11.3	40.0	110	210
7	1996	SPRING	9	76.67	20.000	190.00	62.8	20.9	82	20.0	30.0	70.0	80.0	190
7	1996	SUMMER	9	82.22	20.000	230.00	86.3	28.8	105	20.0	20.0	30.0	150	230
7	1996	WINTER	9	104.72	2.5000	320.00	120	40.2	115	2.50	30.0	50.0	140	320

Aggregate Nutrient Ecoregion: I
Rivers and Streams
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from 1990 to 1998
Turbidity_FTU

subecoregion	year	season	N	MEAN	MIN	MAX	STDDEV	STDERR	CV	P5	P25	MEDIAN	P75	P95
3	1990	FALL	29	6.02	.90000	34.00	5.71	1.06	95	2.50	4.00	5.00	7.00	9.00
3	1990	SPRING	26	6.23	1.5000	17.00	4.04	0.79	65	2.00	4.00	5.00	7.50	16.0
3	1990	SUMMER	29	4.84	1.0000	31.00	5.89	1.09	122	1.00	2.50	3.00	5.00	18.0
3	1990	WINTER	31	20.63	1.0000	150.00	35.0	6.28	170	2.00	6.50	9.00	19.0	142
3	1991	FALL	48	5.31	.25000	26.00	4.89	0.71	92	0.80	2.48	4.00	6.18	17.0
3	1991	SPRING	35	13.07	.25000	52.00	10.4	1.76	80	0.95	5.35	12.0	18.0	33.0
3	1991	SUMMER	35	4.07	.62500	16.00	3.23	0.55	79	0.80	2.00	3.00	5.00	14.0
3	1991	WINTER	32	22.39	2.0000	60.50	16.6	2.93	74	2.70	10.3	19.5	26.8	56.5
3	1992	FALL	51	4.73	.25000	22.00	4.58	0.64	97	0.30	2.00	3.50	6.10	17.0
3	1992	SPRING	48	7.31	.25000	25.00	5.24	0.76	72	0.60	3.38	6.83	9.98	18.5
3	1992	SUMMER	47	4.76	.35000	27.00	4.91	0.72	103	1.00	2.00	3.00	5.40	14.0
3	1992	WINTER	35	19.87	.25000	100.00	22.8	3.86	115	1.50	6.00	12.0	23.0	76.0
3	1993	FALL	33	4.22	1.0000	16.00	3.45	0.60	82	1.00	2.00	3.00	5.50	12.0
3	1993	SPRING	44	7.58	.60000	18.00	4.29	0.65	57	2.00	4.08	7.45	9.75	17.0
3	1993	SUMMER	40	4.71	.25000	24.00	4.10	0.65	87	1.00	2.00	3.73	6.05	11.0
3	1993	WINTER	36	11.73	1.0000	39.00	8.90	1.48	76	1.30	5.00	11.3	16.5	34.0
3	1994	FALL	42	5.56	.25000	24.50	5.67	0.88	102	1.00	2.00	4.00	6.30	17.0
3	1994	SPRING	37	5.79	1.0000	40.00	6.89	1.13	119	1.00	2.00	4.00	6.00	19.0
3	1994	SUMMER	44	5.32	.62500	27.00	4.56	0.69	86	1.00	3.00	4.00	6.45	12.0
3	1994	WINTER	34	14.49	.40000	37.50	9.93	1.70	69	1.50	6.00	13.4	20.0	33.0
3	1995	FALL	39	13.88	2.0000	178.00	28.7	4.60	207	2.00	4.00	6.00	10.5	43.5
3	1995	SPRING	34	6.94	1.0000	30.00	5.20	0.89	75	2.00	4.00	6.00	8.00	15.0
3	1995	SUMMER	36	4.69	.25000	18.00	3.67	0.61	78	0.25	3.00	4.00	5.75	16.0
3	1995	WINTER	35	25.11	3.0000	104.00	19.9	3.36	79	3.50	11.0	21.0	32.0	62.0
3	1996	FALL	40	8.90	1.0000	43.00	7.31	1.16	82	2.85	4.00	6.45	11.5	19.0
3	1996	SPRING	37	15.63	1.0000	71.00	11.4	1.88	73	5.00	9.40	13.7	18.0	33.0
3	1996	SUMMER	40	7.35	1.0000	38.00	8.30	1.31	113	1.00	2.85	5.25	7.40	31.8
3	1996	WINTER	34	39.03	3.0000	145.00	29.1	4.99	75	6.00	18.0	35.5	49.5	105
3	1997	FALL	36	7.92	1.0000	21.00	4.72	0.79	60	1.00	5.18	7.28	10.0	19.0
3	1997	SPRING	38	10.82	2.0000	52.00	8.30	1.35	77	2.00	6.75	9.00	13.5	21.0
3	1997	SUMMER	37	6.67	1.0000	22.50	4.79	0.79	72	2.00	4.00	5.80	7.50	20.0
3	1997	WINTER	36	22.33	1.5000	77.50	13.2	2.21	59	5.00	15.0	22.8	26.0	46.5

Rivers and Streams
Descriptive Statistics by Subecoregion, Year and Season
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Turbidity_FTU

subecoregion	year	season	N	MEAN	MIN	MAX	STDDEV	STDERR	CV	P5	P25	MEDIAN	P75	P95
3	1998	SPRING	12	10.38	4.0000	21.00	4.49	1.30	43	4.00	7.63	9.25	12.4	21.0
3	1998	SUMMER	6	9.54	3.8500	21.50	6.13	2.50	64	3.85	6.90	8.13	8.75	21.5
3	1998	WINTER	16	21.67	2.0000	50.00	10.5	2.63	49	2.00	17.0	20.3	26.5	50.0
7	1990	FALL	12	7.04	2.0000	14.00	3.17	0.91	45	2.00	5.00	6.25	8.50	14.0
7	1990	SPRING	12	9.23	2.3000	18.00	4.83	1.39	52	2.30	6.00	8.50	12.0	18.0
7	1990	SUMMER	12	11.88	2.6000	26.00	6.91	1.99	58	2.60	8.00	10.5	14.3	26.0
7	1990	WINTER	12	12.02	5.0000	36.00	8.66	2.50	72	5.00	6.00	9.80	15.0	36.0
7	1991	FALL	12	8.96	1.3000	16.00	4.10	1.18	46	1.30	6.50	8.50	11.3	16.0
7	1991	SPRING	12	14.83	5.5000	22.50	5.47	1.58	37	5.50	10.5	14.5	19.8	22.5
7	1991	SUMMER	12	12.73	3.8000	29.00	7.05	2.03	55	3.80	7.50	10.8	16.5	29.0
7	1991	WINTER	12	6.83	3.5000	16.00	3.37	0.97	49	3.50	5.00	6.00	7.50	16.0
7	1992	FALL	11	7.91	5.0000	14.00	2.98	0.90	38	5.00	5.00	8.00	10.0	14.0
7	1992	SPRING	12	12.53	4.9000	18.50	4.48	1.29	36	4.90	9.25	11.3	16.8	18.5
7	1992	SUMMER	13	10.74	5.0000	19.00	4.46	1.24	42	5.00	7.00	10.5	12.0	19.0
7	1992	WINTER	12	7.10	3.0000	10.00	2.26	0.65	32	3.00	5.50	7.50	9.00	10.0
7	1993	FALL	12	11.21	5.0000	32.00	8.02	2.32	72	5.00	6.00	8.75	11.5	32.0
7	1993	SPRING	12	11.78	3.9000	18.00	4.27	1.23	36	3.90	8.00	12.8	15.0	18.0
7	1993	SUMMER	12	12.37	.60000	28.50	7.47	2.16	60	0.60	7.75	11.5	14.8	28.5
7	1993	WINTER	12	29.33	2.0000	54.00	16.4	4.73	56	2.00	18.0	26.0	43.5	54.0
7	1994	FALL	12	7.31	1.2000	19.50	5.07	1.46	69	1.20	4.25	6.25	7.50	19.5
7	1994	SPRING	12	9.11	.80000	20.00	5.36	1.55	59	0.80	4.75	9.25	12.3	20.0
7	1994	SUMMER	12	11.65	.30000	28.50	8.05	2.32	69	0.30	6.50	9.00	16.5	28.5
7	1994	WINTER	11	7.36	5.0000	10.00	1.78	0.54	24	5.00	5.00	7.50	9.00	10.0
7	1995	FALL	11	7.77	5.0000	14.50	2.98	0.90	38	5.00	5.00	7.00	10.0	14.5
7	1995	SPRING	11	15.59	7.0000	26.50	5.88	1.77	38	7.00	10.0	15.0	21.0	26.5
7	1995	SUMMER	11	12.05	7.0000	20.00	4.37	1.32	36	7.00	9.00	11.0	15.5	20.0
7	1995	WINTER	11	29.05	11.500	62.00	19.3	5.82	66	11.5	13.5	20.5	53.5	62.0

Aggregate Nutrient Ecoregion: I
Rivers and Streams
Descriptive Statistics by Subecoregion, Year and Season
from 1995 to 1995
Turbidity_JCU

subecoregion	year	season	N	MEAN	MIN	MAX	STDDEV	STDERR	CV	P5	P25	MEDIAN	P75	P95
7	1995	SPRING	1	12.00	12.000	12.00	.	.	.	12.0	12.0	12.0	12.0	12.0
7	1995	WINTER	1	78.00	78.000	78.00	.	.	.	78.0	78.0	78.0	78.0	78.0

Aggregate Nutrient Ecoregion: I
Rivers and Streams
Descriptive Statistics by Subecoregion, Year and Season
from 1990 to 1998
Turbidity_NTU

subecoregion	year	season	N	MEAN	MIN	MAX	STDDEV	STDERR	CV	P5	P25	MEDIAN	P75	P95
3	1990	FALL	1	1.50	1.5000	1.50	.	.	.	1.50	1.50	1.50	1.50	1.50
3	1990	SPRING	1	1.10	1.1000	1.10	.	.	.	1.10	1.10	1.10	1.10	1.10
3	1990	SUMMER	1	0.25	.25000	0.25	.	.	.	0.25	0.25	0.25	0.25	0.25
3	1990	WINTER	1	2.10	2.1000	2.10	.	.	.	2.10	2.10	2.10	2.10	2.10
3	1991	FALL	4	4.94	1.0000	11.75	4.87	2.44	99	1.00	1.45	3.50	8.43	11.8
3	1991	SPRING	1	1.50	1.5000	1.50	.	.	.	1.50	1.50	1.50	1.50	1.50
3	1991	SUMMER	1	1.20	1.2000	1.20	.	.	.	1.20	1.20	1.20	1.20	1.20
3	1991	WINTER	4	3.00	1.0000	6.00	2.45	1.22	82	1.00	1.00	2.50	5.00	6.00
3	1992	FALL	3	7.10	1.3000	17.00	8.62	4.97	121	1.30	1.30	3.00	17.0	17.0
3	1992	SPRING	4	3.71	.60000	9.90	4.29	2.15	116	0.60	0.83	2.18	6.60	9.90
3	1992	SUMMER	4	5.44	.60000	16.00	7.16	3.58	132	0.60	1.03	2.58	9.85	16.0
3	1992	WINTER	4	7.20	2.3000	13.00	5.43	2.72	75	2.30	2.58	6.75	11.8	13.0
3	1994	FALL	4	4.67	1.5125	7.50	2.93	1.47	63	1.51	2.18	4.83	7.15	7.50
3	1994	WINTER	4	5.38	1.2000	12.00	4.63	2.32	86	1.20	2.60	4.15	8.15	12.0
3	1995	FALL	4	9.43	2.5000	16.00	5.52	2.76	59	2.50	5.85	9.60	13.0	16.0
3	1995	SPRING	4	2.10	.60000	4.70	1.83	0.91	87	0.60	0.85	1.55	3.35	4.70
3	1995	SUMMER	4	1.68	.60000	4.40	1.82	0.91	109	0.60	0.65	0.85	2.70	4.40
3	1995	WINTER	4	2.63	.70000	6.30	2.51	1.25	96	0.70	1.10	1.75	4.15	6.30
3	1996	FALL	7	20.82	.60000	44.15	15.7	5.94	75	0.60	5.50	18.2	36.7	44.2
3	1996	SPRING	1	2.10	2.1000	2.10	.	.	.	2.10	2.10	2.10	2.10	2.10
3	1996	SUMMER	1	1.40	1.4000	1.40	.	.	.	1.40	1.40	1.40	1.40	1.40
3	1996	WINTER	8	21.75	2.5500	41.60	14.1	4.99	65	2.55	12.7	16.8	35.4	41.6
3	1997	FALL	11	17.54	10.000	34.50	7.07	2.13	40	10.0	12.0	16.9	18.5	34.5
3	1997	SPRING	10	17.59	8.4000	29.75	7.13	2.25	41	8.40	11.8	14.8	24.4	29.8
3	1997	SUMMER	7	12.42	6.0300	23.15	5.52	2.09	44	6.03	8.60	12.7	14.2	23.2
3	1997	WINTER	19	18.72	2.5000	89.20	19.5	4.48	104	2.50	7.00	13.0	23.6	89.2
3	1998	WINTER	14	28.68	4.5000	69.00	19.9	5.32	69	4.50	7.50	34.3	40.0	69.0
7	1991	FALL	2	4.30	2.7000	5.90	2.26	1.60	53	2.70	2.70	4.30	5.90	5.90
7	1992	WINTER	1	7.70	7.7000	7.70	.	.	.	7.70	7.70	7.70	7.70	7.70

Rivers and Streams
Descriptive Statistics by Subecoregion, Year and Season
from 1992 to 1998
pH_S_U

subecoregion	year	season	N	MEAN	MIN	MAX	STDDEV	STDERR	CV	P5	P25	MEDIAN	P75	P95
3	1993	FALL	5	7.49	7.4000	7.55	0.05	0.02	1	7.40	7.50	7.50	7.50	7.55
3	1993	SPRING	5	7.12	6.9000	7.40	0.19	0.09	3	6.90	7.00	7.10	7.20	7.40
3	1993	SUMMER	5	7.50	7.3500	7.70	0.15	0.07	2	7.35	7.40	7.45	7.60	7.70
3	1993	WINTER	5	7.28	7.1500	7.40	0.09	0.04	1	7.15	7.25	7.30	7.30	7.40
3	1994	FALL	5	6.95	6.8000	7.15	0.13	0.06	2	6.80	6.90	6.90	7.00	7.15
3	1994	SPRING	5	7.27	7.1500	7.50	0.14	0.06	2	7.15	7.20	7.20	7.30	7.50
3	1994	SUMMER	5	7.27	7.2000	7.35	0.06	0.03	1	7.20	7.25	7.25	7.30	7.35
3	1994	WINTER	5	7.17	6.9000	7.35	0.16	0.07	2	6.90	7.20	7.20	7.20	7.35
3	1995	FALL	2	7.20	7.2000	7.20	0.00	0.00	0	7.20	7.20	7.20	7.20	7.20
3	1995	SPRING	5	7.26	7.0000	7.70	0.26	0.12	4	7.00	7.20	7.20	7.20	7.70
3	1995	SUMMER	5	7.35	7.1000	7.50	0.15	0.07	2	7.10	7.35	7.40	7.40	7.50
3	1995	WINTER	5	7.16	7.0000	7.20	0.09	0.04	1	7.00	7.20	7.20	7.20	7.20
3	1996	FALL	9	7.09	6.8000	7.40	0.20	0.07	3	6.80	6.94	7.11	7.21	7.40
3	1996	SPRING	7	7.39	6.9500	7.67	0.25	0.09	3	6.95	7.19	7.42	7.57	7.67
3	1996	SUMMER	8	7.40	6.8000	7.69	0.29	0.10	4	6.80	7.30	7.50	7.58	7.69
3	1996	WINTER	7	7.16	6.6000	7.50	0.30	0.11	4	6.60	7.01	7.25	7.40	7.50
3	1997	FALL	7	7.69	7.5000	8.20	0.27	0.10	3	7.50	7.50	7.50	7.80	8.20
3	1997	SPRING	7	7.41	7.0000	7.75	0.28	0.11	4	7.00	7.20	7.55	7.60	7.75
3	1997	SUMMER	7	7.56	7.4000	7.80	0.13	0.05	2	7.40	7.50	7.50	7.60	7.80
3	1997	WINTER	7	7.21	6.7000	7.50	0.32	0.12	4	6.70	6.90	7.35	7.50	7.50
3	1998	FALL	1	8.05	8.0500	8.05	.	.	.	8.05	8.05	8.05	8.05	8.05
3	1998	SPRING	1	7.50	7.5000	7.50	.	.	.	7.50	7.50	7.50	7.50	7.50
3	1998	SUMMER	6	7.96	7.5000	8.50	0.41	0.17	5	7.50	7.65	7.85	8.40	8.50
7	1992	SPRING	3	8.12	7.8000	8.35	0.28	0.16	4	7.80	7.80	8.20	8.35	8.35
7	1992	SUMMER	3	8.47	7.8000	9.40	0.83	0.48	10	7.80	7.80	8.20	9.40	9.40
7	1992	WINTER	3	7.68	7.6000	7.75	0.08	0.04	1	7.60	7.60	7.70	7.75	7.75
7	1993	FALL	9	7.61	7.3000	7.95	0.22	0.07	3	7.30	7.40	7.65	7.80	7.95
7	1993	SPRING	9	7.68	7.2000	8.30	0.34	0.11	4	7.20	7.50	7.60	7.80	8.30
7	1993	SUMMER	9	7.81	7.4000	8.10	0.23	0.08	3	7.40	7.60	7.85	8.00	8.10
7	1993	WINTER	9	7.62	7.1000	8.00	0.28	0.09	4	7.10	7.50	7.60	7.80	8.00
7	1994	FALL	9	7.77	7.4000	8.10	0.22	0.07	3	7.40	7.60	7.85	7.90	8.10
7	1994	SPRING	9	7.74	7.3500	8.10	0.27	0.09	4	7.35	7.50	7.80	7.95	8.10

Aggregate Nutrient Ecoregion: I
Rivers and Streams
Descriptive Statistics by Subecoregion, Year and Season
from 1992 to 1998
pH_S_U

subecoregion	year	season	N	MEAN	MIN	MAX	STDDEV	STDERR	CV	P5	P25	MEDIAN	P75	P95
7	1994	SUMMER	9	7.84	7.4000	8.10	0.22	0.07	3	7.40	7.80	7.90	8.00	8.10
7	1994	WINTER	9	7.64	7.2000	8.15	0.34	0.11	4	7.20	7.30	7.70	7.85	8.15
7	1995	SPRING	3	7.40	7.0000	8.00	0.53	0.31	7	7.00	7.00	7.20	8.00	8.00
7	1995	WINTER	3	7.13	6.3000	7.70	0.74	0.43	10	6.30	6.30	7.40	7.70	7.70

APPENDIX C

Quality Control/Quality Assurance Rules

Continued Support for the Compilation and Analysis of National Nutrient Data

9 Nutrient Ecoregion/Waterbody Type Summary Chapters

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1.0 BACKGROUND

The Nutrient Criteria Program initiated the development of a national Nutrient Criteria Database application that is used to store and analyze nutrient data. The ultimate use of these data is to derive ecoregion specific nutrient criteria. EPA converted STOrage and RETrieval (STORET) legacy data, National Stream Quality Accounting Network (NASQAN) data, National Water-Quality Assessment (NAWQA) data, and other relevant nutrient data from universities and States/Tribes into the database. The data imported into the Nutrient Criteria Database are used to develop national nutrient criteria recommendations.

1.1 Purpose

The purpose of this deliverable is to provide EPA with information regarding the database used to create the statistical reports which will be used to derive ecoregion-specific nutrient criteria for Level III ecoregions. There are fourteen aggregate nutrient ecoregions. Each aggregate nutrient ecoregion is divided into smaller ecoregions (subecoregions) referred to as Level III ecoregions. EPA will determine criteria for the waterbody types and Level III ecoregions within the following aggregate nutrient ecoregions:

- Lakes and Reservoirs
  - Aggregate Nutrient ecoregions: 3, 4, 5, and 14

- Rivers and Streams
  - Aggregate Nutrient ecoregions: 1, 4, 5, 8, and 10

1.2 References

This section lists documents that contain baselines, standards, guidelines, policies, and references that apply to the data analysis. Listed editions were valid at the time of publication. All documents are subject to revision, but these specific editions govern the concepts described in this document.

Nutrient Criteria Technical Guidance Document: Lakes and Reservoirs (Draft). EPA, Office of Water, EPA 822-D-99-001, April 1999.

Nutrient Criteria Technical Guidance Manual: Rivers and Streams (Draft). EPA, Office of Water, EPA 822-D-99-003, September 1999.

Guidance for Data Quality Assessment: Practical Methods for Data Analysis. EPA, Office of Research and Development, EPA QA/G-9, January 1998.

2.0 QA/QC PROCEDURES

In order to develop nutrient criteria, EPA needed to obtain nutrient data from the states. EPA requested nutrient data from the states and forwarded the data sets to INDUS via e-mail and/or US mail. In addition, EPA tasked INDUS to convert data from three national data sets. EPA provided INDUS with a Legacy STORET extraction to convert into the database. The United States Geologic Survey (USGS) sent INDUS a CD-ROM with NASQAN data to convert. INDUS downloaded NAWQA files from the USGS Web site to convert the data. In total, INDUS converted and imported the following national and state data sets into the Nutrient Criteria Database:

- Legacy STORET
- NAWQA
- NASQAN
- EPA Region 1
- EPA Region 2 - Lake Champlain Monitoring Project
- EPA Region 2 - NYSDEC Finger Lakes Monitoring Program
- EPA Region 2 - NY Citizens Lake Assessment Program
- EPA Region 2 - Lake Classification and Inventory Survey
- EPA Region 2 - NYCDEP (1990-1998)
- EPA Region 2 - NYCDEP (Storm Event data)
- EPA Region 2 - New Jersey Nutrient Data (Tidal Waters)
- EPA Region 5
- EPA Region 3
- EPA Region 3 - Nitrite Data
- EPA Region 3 - Choptank River files
- EPA Region 4 - Tennessee Valley Authority
- EPA Region 7 - Central Plains Center for BioAssessment (CPCB)
- EPA Region 7 - REMAP
- EPA Region 2 - Delaware River Basin Commission (1990-1998)
- EPA Region 3 - PA Lake Data
- EPA Region 3 - University of Delaware
- EPA Region 10
- University of Auburn
- EPA Region 8 - MT and WY
- EPA Region 9
- Suffolk County
- NYCDEC
- NY Lakes Morphometry
- EPA Region 8 - South Dakota
- EPA Region 8 - Colorado Reservoir
- EPA Region 4
- EPA Region 10 - Lake Data
- EPA Region 7 - Central Plains Center for BioAssessment (CPCB) 2
- EPA Region 8 - North Dakota
- EPA Region 8 - Eagle River
- EPA Region 8 - Utah
- Florida

As part of the conversion process, INDUS performed a number of Quality Assurance/Quality Control (QA/QC) steps to ensure that the data were properly converted into the Nutrient Criteria Database. Sections 2.1 and 2.2 explain the steps performed by INDUS to convert the data.

2.1 National Data Sets

INDUS converted three national data sets into the Nutrient Criteria Database: Legacy STORET data, NASQAN data, and NAWQA data. A previous EPA contractor performed the extraction of Legacy STORET data and documented the QA/QC procedures used on the data. This documentation is included in Appendix A. INDUS performed minimal QA/QC on the Legacy STORET data set because the previous contractor completed the steps outlined in Appendix A. INDUS and EPA also agreed to convert the NAWQA and NASQAN data sets with minimal QA/QC on the assumption that the source agency, the USGS, QA/QC'd the data.

For each of the three national data sets, INDUS ran queries to determine if 1) samples existed without results and 2) if stations existed without samples. Per Task Order Project Officer (TOPO) direction, these records were deleted from the system. For analysis purposes, EPA determined that there was no need to keep station records with no samples and sample records with no results. INDUS also confirmed that each data set contained no duplicate records.

In addition, INDUS deleted all composite results from the Legacy STORET data. Per TOPO direction, it was decided that composite sample results would not be used in the statistical analysis.

2.2 State Data

Each state data set was delivered in a unique format. Many of the data sets were delivered to INDUS without corresponding documentation. INDUS analyzed each state data set in order to determine which parameters should be converted for analysis. INDUS obtained a master parameter table from EPA and converted the parameters in the state data sets according to those that were present in the EPA parameter table. INDUS converted all of the data elements in the state data sets that mapped directly to the Nutrient Criteria Database; data elements that did not map to the Nutrient Criteria Database were not converted. In some cases, state data elements that did not directly map into the Oracle database were inserted into a comment field within the database. Also, INDUS maintained an internal record of which state data elements were inserted into the comment field.

As part of the data clean-up efforts, INDUS determined whether or not there were any duplicate records in the state data sets and deleted the duplicate records. INDUS checked the waterbody, station, and sample entities for duplicate records. However, if there was not enough information provided to determine duplicates such as sampling date, there was no way for INDUS to locate duplicate records. In addition, INDUS deleted station records with no samples and sample records with no results. INDUS also deleted waterbody records that were not associated with a station. In each case, INDUS maintained an internal record of how many records were deleted.

If INDUS encountered referential integrity errors, such as samples that referred to stations that did not exist, or if INDUS was unsure of whether a record was a duplicate, INDUS contacted the agency directly via e-mail or phone to resolve any issues that arose. INDUS saved an electronic copy of each e-mail correspondence with the states to ensure that a record of the decision was maintained.

Finally, INDUS examined the remark codes of each result record in the state data sets. INDUS mapped the remark codes to the STORET remark codes listed in Table 2 of Appendix A. If any of the state result records were associated with remark codes marked as “Delete” in Table 2 of Appendix A, the result records were not converted into the database.

2.3 Laboratory Methods

Many of the state data sets did not contain laboratory method information. In addition, laboratory method information was not available for the three national data sets. In order to determine missing laboratory method information, EPA tasked another contractor to contact the data owners to obtain the laboratory method. In some cases, the data owners responded and the laboratory methods were added to the database. In other cases, the methods are unknown.

2.4 Waterbody Name and Class Information

A large percentage of the data did not have waterbody-specific information. The only waterbody information contained in the three national data sets was the waterbody name, which was embedded in the station ‘location description’ field. Most of the state data sets contained waterbody name information; however, much of the data were duplicated throughout the data sets. Therefore, the waterbody information was cleaned manually. For the three national data sets, the ‘location description’ field was extracted from the station table and moved to a temporary table. The ‘location description’ field was sorted alphabetically. Unique waterbodies were grouped together based on name similarity and whether or not the waterbodies fell within the same county, state, and waterbody type. Finally, the ‘location description’ field was edited to include only waterbody name information, not descriptive information. For example, 110 MILE CREEK AT POMONA DAM OUTFLOW, KS PO-2 was edited to 110 MILE CREEK. Also, if 100 MILE CREEK was listed ten times in New York, but in four different counties, four 100 MILE CREEK waterbody records were created.

Similar steps were taken to eliminate duplicate waterbody records in the state data sets. If a number of records had similar waterbody names and fell within the same state, county, and waterbody type, the records were grouped to create a unique waterbody record.

Most of the waterbody data did not contain depth, surface area, and volume measurements. EPA needed this information to classify waterbody types. EPA attempted to obtain waterbody class information from the states. EPA sent waterbody files to the regional coordinators and requested that certain class information be completed by each state. The state response was poor; therefore, EPA was not able to perform statistical analysis for the waterbody types by class.

2.5 Ecoregion Data

Aggregate nutrient ecoregions and Level III ecoregions were added to the database using the station latitude and longitude coordinates, the county centroid, or HUC (Hydrological Unit Code) centroid. If a station was lacking latitude and longitude coordinates and county information, the data were not included in the statistical analysis. Appendix B lists the steps taken to add the two ecoregion types (aggregate and Level III) to the Nutrient Criteria Database. The ecoregion names were pulled from aggregate nutrient ecoregion and Level III ecoregion Geographical Information System (GIS) coverages. In summary, the station latitude and longitude coordinates were used to determine the ecoregion under the following circumstances:

- The latitude and longitude coordinates fell within the county/state listed in the station table.
- The county data were missing.

The county centroid was used to determine the ecoregions under the following circumstances:

- The latitude and longitude coordinates were missing, but the state/county information was available.
- The latitude and longitude coordinates fell outside the county/state/HUC listed in the station table. The county information was assumed to be correct; therefore, the county centroid was used.

The HUC centroid was used to determine the ecoregions under the following circumstances:

- The latitude and longitude coordinates and county were missing, but the HUC information was available.

If the latitude and longitude coordinates fell outside the continental US county coverage file (i.e., the point fell in the ocean or Mexico/Canada), the nearest ecoregion was assigned to the station.

3.0 STATISTICAL ANALYSIS REPORTS

Aggregate nutrient ecoregion tables were created by extracting all observations for a specific aggregate nutrient ecoregion from the Nutrient Criteria Database. Then, the data were reduced to create tables containing only the yearly median values. To create these tables, the median value for each waterbody was calculated using all observations for each waterbody by Level III ecoregion, state, county, year, and season. Tables of decade median values were created from the yearly median tables by calculating the median for each waterbody by Level III ecoregion, state, county, decade and season.

The Data Source and the Remark Code reports were created using all observations (all reported values). All the other reports were created from either the yearly median tables or the decade median tables. In other words, the descriptive statistics and regressions were run using the median values for each waterbody and not the individual reported values.

Statistical analyses were performed under the assumption that this data set is a random sample. If this assumption cannot be verified, the observations may or may not be valid. Values below the 1st and 99th percentile were removed from the Legacy STORET database prior to the creation of the national database. Also, data were treated according to the Legacy STORET remark codes in Appendix A.

The following contains a list of each report and the purpose for creating each report:

- Data Source—Created to provide a count of the amount of data and to identify the source(s).
- Remark Codes—Created to provide a description of the data.
- Median of Each Waterbody by Year—This was an intermediate step performed to obtain a median value for each waterbody to be used in the yearly descriptive statistics reports and the regression models.
- Median of Each Waterbody by Decade—This was an intermediate step performed to obtain a median value for each waterbody to be used in the decade descriptive statistics.
- Descriptive Statistics—Created to provide EPA with the desired statistics for setting criteria levels.
- Regression Models—Created to examine the relationships between biological and nutrient variables.

Note: Separate reports were created for each season.

3.1 Data Source Reports

Data source reports were presented in the following formats:

- The number and percentage of data from each data source were summarized in tables for each aggregate nutrient ecoregion by season and waterbody type.

- The number and percentage of data from each data source were summarized in tables for each aggregate nutrient ecoregion for all seasons and waterbody type.

- The number and percentage of data from each data source were summarized in tables for each Level III ecoregion by season and waterbody type.

The 'Frequency' represents the number of data values from a specific data source for each parameter by data source. The 'Row Pct' represents the percentage of data from a specific data source for each parameter.

3.2 Remark Code Reports

Remark code reports were presented in the following formats:

- The number and percentage of data associated with a particular remark code for each parameter were summarized in tables by Level III ecoregion by decade and season.

- The number and percentage of data associated with a particular remark code for each parameter were summarized in tables by Level III ecoregion by year and season.

The 'Frequency' represents the number of data values corresponding to the remark code in the column. The 'Row Pct' represents the percentage of data that was associated with the remark code in that row.

In the database, remark codes that were entered by the states were mapped to Legacy STORET remark codes. Prior to the analysis, the data were treated according to these remark codes. For example, if the remark code was 'K,' then the reported value was divided by two. Appendix A contains a complete list of Legacy STORET remark codes.

Note: For the reports, a remark code of 'Z' indicates that no remark codes were recorded. It does not correspond to Legacy STORET code 'Z.'

3.3 Median of Each Waterbody

To reduce the data and to ensure heavily sampled waterbodies or years were not over represented in the analysis, median value tables (described above) were created. The yearly median tables and decade median tables were delivered to the EPA in electronic format as csv (comma separated value or comma delimited) files.

3.4 Descriptive Statistic Reports

The number of waterbodies, median, mean, minimum, maximum, 5^{th}, 25^{th} , 75^{th} , 95^{th} percentiles, standard deviation, standard error, and coefficient of variation were calculated. The tables (described above) containing the decade median values for each waterbody for each parameter were used to create descriptive statistics reports for:

- Level III ecoregions by decade and season
- Aggregate nutrient ecoregions by decade and season

In addition, the tables containing the yearly median values for each waterbody for each parameter were used to create descriptive statistics reports for:

- Level III ecoregions by year and season

3.5 Regression Models

Simple linear regressions using the least squares method were performed to examine the relationships between biological and nutrient variables in lakes and reservoirs, and rivers and streams. Regressions were performed using the yearly median tables. Chlorophyll(s) in micrograms per liter (ug/L), Secchi in meters (m), Dissolved Oxygen in milligrams per liter (mg/L), Turbidity, and pH were the biological variables in these models. Secchi data were used in the lake and reservoir models, and Turbidity data were used in the river and stream models.

The nutrient variables in these models include: Total Phosphorus in ug/L, Total Nitrogen in mg/L, Total Kjeldahl Nitrogen in mg/L, and Nitrate and Nitrite in mg/L.

4.0 TIME PERIOD

Data collected from January 1990 to December 2000 were used in the statistical analysis reports. To capture seasonal differences, the data were classified as follows:

- Aggregate nutrient ecoregions: 6, 7, and 8
  - Spring: April to May
  - Summer: June to August
  - Fall: September to October
  - Winter: November to March
- Aggregate nutrient ecoregions: 1, 2, 3, 4, 5, 9, 10, 11, 12, 13, and 14
  - Spring: March to May
  - Summer: June to August
  - Fall: September to November
  - Winter: December to February

5.0 DATA SOURCES AND PARAMETERS FOR THE AGGREGATE NUTRIENT ECOREGIONS

This section provides information for the nutrient aggregate ecoregions that were analyzed by waterbody type. Each section lists the data sources for the aggregate nutrient ecoregion including: 1) the data sources, 2) the parameters included in the analysis, and 3) the Level III ecoregions within the aggregate nutrient ecoregions.

Note: For analysis purposes, data for the following parameters were grouped together and reported under Phosphorous, Dissolved Inorganic (DIP):

Phosphorus, Dissolved Inorganic (DIP)
Phosphorus, Dissolved (DP)
Phosphorus, Dissolved Reactive (DRP)
Orthophosphate, dissolved, mg/L as P
Orthophosphate (OPO4_PO4)

5.1 Lakes and Reservoirs

5.1.1 Aggregate Nutrient Ecoregion 3

Data Sources:

Legacy STORET
EPA Region 10
EPA Region 8 - Colorado Reservoir

Parameters:

Chlorophyll A, Fluorometric, corrected (ug/L)
Chlorophyll A, Phytoplankton, spectrophotometric Acid (ug/L)
Chlorophyll A, Trichromatic, uncorrected (ug/L)
Dissolved Inorganic Phosphorus (DIP) (ug/L)
Dissolved Oxygen (DO) (mg/L)
Nitrite and Nitrate, (NO2+NO3) (mg/L)
Nitrogen, Total (TN) (mg/L)
Nitrogen, Total Kjeldhal (TKN) (mg/L)
Phosphorus, Total (TP) (ug/L)
SECCHI (m)
pH

Level III ecoregions:

6, 10, 12, 13, 18, 20, 22, 24, 80, 81

5.1.2 Aggregate Nutrient Ecoregion 4

Data Sources:

Legacy STORET
EPA Region 8 - MT and WY
EPA Region 8 - South Dakota
EPA Region 8 - North Dakota

Parameters:

Chlorophyll A, Phytoplankton, spectrophotometric Acid (ug/L)
Chlorophyll A, Trichromatic, uncorrected (ug/L)
Dissolved Inorganic Phosphorus (DIP) (ug/L)
Dissolved Oxygen (DO) (% Saturated)
Dissolved Oxygen (DO) (mg/L)
Nitrite and Nitrate, (NO2+NO3) (mg/L)
Nitrogen, Total (TN) (mg/L)

Nitrogen, Total Kjeldhal (TKN) (mg/L)
Phosphorus, Total (TP) (ug/L)
SECCHI (m)
pH

Level III ecoregions:

26, 28, 30, 31, 43, 44

5.1.3 Aggregate Nutrient Ecoregion 5

Data sources:

Legacy STORET
EPA Region 8 - MT and WY
EPA Region 8 - South Dakota
EPA Region 8 - North Dakota

Parameters:

Chlorophyll A, Phytoplankton, spectrophotometric Acid (ug/L)
Chlorophyll A, Trichromatic, uncorrected (ug/L)
Dissolved Inorganic Phosphorus (DIP) (ug/L)
Dissolved Oxygen (DO) (% Saturated)
Dissolved Oxygen (DO) (mg/L)
Nitrite and Nitrate, (NO2+NO3) (mg/L)
Nitrogen, Total (TN) (mg/L)
Nitrogen, Total Kjeldhal (TKN) (mg/L)
Phosphorus, Total (TP) (ug/L)
SECCHI (m)
pH

Level III ecoregions:

25, 27, 32, 42

5.1.4 Aggregate Nutrient Ecoregion 14

Data sources:

Legacy STORET
Region 2 - NY Citizens Lake Assessment Program
Region 2 - NYCDEP (1990-1998)
EPA Region 1

Parameters:

CHLB (ug/L)
CHLC (ug/L)
Chlorophyll A, Fluorometric, corrected (ug/L)
Chlorophyll A, Phytoplankton, spectrophotometric Acid (ug/L)
Chlorophyll A, Phytoplankton, spectrophotometric, uncorrected (ug/L)
Chlorophyll A, Trichromatic, uncorrected (ug/L)
Dissolved Inorganic Phosphorus (DIP) (ug/L)
Dissolved Oxygen (DO) (mg/L)
Nitrite and Nitrate, (NO2+NO3) (mg/L)
Nitrogen, Total (TN) (mg/L)
Nitrogen, Total Kjeldhal (TKN) (mg/L)
Phosphorus, Total (TP) (ug/L)
SECCHI (m)
pH

Level III ecoregions:

59, 63, 84

5.2 Rivers and Streams

5.2.1 Aggregate Nutrient Ecoregion 1

Data sources:

Legacy STORET
NASQAN
NAWQA
EPA Region 10

Parameters:

Chlorophyll A, Fluorometric, corrected (ug/L)
Chlorophyll A, Periphyton, spectrophotometric, uncorrected (mg/sqm)
Chlorophyll A, Phytoplankton, spectrophotometric Acid (ug/L)
Chlorophyll A, Trichromatic, uncorrected (ug/L)
Dissolved Inorganic Phosphorus (DIP) (ug/L)
Dissolved Oxygen (DO) (mg/L)
Nitrite and Nitrate, (NO2+NO3) (mg/L)
Nitrogen, Total (TN) (mg/L)
Nitrogen, Total Kjeldhal (TKN) (mg/L)
Phosphorus, Total (TP) (ug/L)
Phosphorus, orthophosphate, total, as P(ug/L)
Turbidity (FTU)

Turbidity (NTU)
Turbidity (JCU)
pH

Level III ecoregions:

3, 7

5.2.2 Aggregate Nutrient Ecoregion 4

Data sources:

Legacy STORET
NASQAN
NAWQA
EPA Region 7 - Central Plains Center for BioAssessment (CPCB)
EPA Region 7 - Central Plains Center for BioAssessment (CPCB) 2
EPA Region 7 - REMAP
EPA Region 8 - MT and WY
EPA Region 8 - South Dakota
EPA Region 8 - North Dakota

Parameters:

Chlorophyll A, Fluorometric, corrected (ug/L)
Chlorophyll A, Pheophytin, corrected (ug/L)
Chlorophyll A, Phytoplankton, spectrophotometric Acid (ug/L)
Dissolved Inorganic Phosphorus (DIP) (ug/L)
Dissolved Oxygen (DO) (% Saturated)
Dissolved Oxygen (DO) (mg/L)
Nitrite and Nitrate, (NO2+NO3) (mg/L)
Nitrogen, Total (TN) (mg/L)
Nitrogen, Total Kjeldhal (TKN) (mg/L)
Organic_P (ug/L)
Phosphorus, Total (TP) (ug/L)
Phosphorus, orthophosphate, total, as P(ug/L)
Turbidity (FTU)
Turbidity (NTU)
Turbidity (JCU)
pH

Level III ecoregions:

26, 28, 30, 31, 43, 44

5.2.3 Aggregate Nutrient Ecoregion 5

Data sources:

Legacy STORET
NASQAN
NAWQA
EPA Region 7 - Central Plains Center for BioAssessment (CPCB)
EPA Region 7 - Central Plains Center for BioAssessment (CPCB) 2
EPA Region 7 - REMAP
EPA Region 8 - MT and WY
EPA Region 8 - South Dakota
EPA Region 8 - North Dakota

Parameters:

Chlorophyll A, Fluorometric, corrected (ug/L)
Chlorophyll A, Pheophytin, corrected (ug/L)
Chlorophyll A, Phytoplankton, spectrophotometric Acid (ug/L)
Dissolved Inorganic Phosphorus (DIP) (ug/L)
Dissolved Oxygen (DO) (% Saturated)
Dissolved Oxygen (DO) (mg/L)
Nitrite and Nitrate, (NO2+NO3) (mg/L)
Nitrogen, Total (TN) (mg/L)
Nitrogen, Total Kjeldhal (TKN) (mg/L)
Organic_P (ug/L)
Phosphorus, Total (TP) (ug/L)
Phosphorus, orthophosphate, total, as P (ug/L)
Turbidity (FTU)
Turbidity (NTU)
Turbidity (JCU)
pH

Level III ecoregions:

25, 27, 32, 42

5.2.4 Aggregate Nutrient Ecoregion 8

Data sources:

Legacy STORET
NASQAN
NAWQA
EPA Region 2 - NYCDEP (1990-1998)
EPA Region 1

EPA Region 3
EPA Region 5

Parameters:

Chlorophyll A, Fluorometric, corrected (ug/L)
Chlorophyll A, Phytoplankton, spectrophotometric Acid (ug/L)
Chlorophyll A, Phytoplankton, spectrophotometric, uncorrected (ug/L)
Chlorophyll A, Trichromatic, uncorrected (ug/L)
Dissolved Inorganic Phosphorus (DIP) (ug/L)
Dissolved Oxygen (DO) (% Saturated)
Dissolved Oxygen (DO) (mg/L)
Nitrite and Nitrate, (NO2+NO3) (mg/L)
Nitrogen, Total (TN) (mg/L)
Nitrogen, Total Kjeldhal (TKN) (mg/L)
Phosphorus, Total (TP) (ug/L)
Phosphorus, orthophosphate, total, as P (ug/L)
Turbidity (FTU)
Turbidity (NTU)
pH

Level III ecoregions:

49, 50, 58, 62, 82

5.2.5 Aggregate Nutrient Ecoregion 10

Data sources:

Legacy STORET
NASQAN
EPA Region 7 - Central Plains Center for BioAssessment (CPCB)
EPA Region 7 - Central Plains Center for BioAssessment (CPCB) 2
EPA Region 7 - REMAP

Parameters:
Chlorophyll A, Fluorometric, corrected (ug/L)
Chlorophyll A, Pheophytin, corrected (ug/L)
Chlorophyll A, Phytoplankton, chromotographic- fluorometric (ug/L)
Chlorophyll A, Phytoplankton, spectrophotometric Acid (ug/L)
Chlorophyll A, Trichromatic, uncorrected (ug/L)
Chlorophyll B, Phytoplankton, chromotographic- fluorometric (ug/L)
Dissolved Inorganic Phosphorus (DIP) (ug/L)
Dissolved Oxygen (DO) (mg/L)
Nitrite and Nitrate, (NO2+NO3) (mg/L)
Nitrogen, Total (TN) (mg/L)

Nitrogen, Total Kjeldhal (TKN) (mg/L)
Organic_P (ug/L)
Phosphorus, Total (TP) (ug/L)
Phosphorus, orthophosphate, total, as P(ug/L)
Turbidity (FTU)
Turbidity (NTU)
Turbidity (JCU)
pH

Level III ecoregions:

34, 73

APPENDIX A. Process Used to QA/QC the Legacy STORET Nutrient Data Set

1. STORET water quality parameters and Station and Sample data items were retrieved from USEPA's mainframe computer. Table 1 lists all retrieved parameters and data items.

TABLE 1: PARAMETERS AND DATA ITEMS RETRIEVED FROM STORET

Parameters Retrieved (STORET Parameter Code)	Station Data Items Included (STORET Item Name)	Sample Data Items Included (STORET Item Name)
TN - mg/l (600) TKN - mg/l (625) Total Ammonia (NH3+NH4) - mg/l (610) Total NO2+NO3 - mg/l (630) Total Nitrite - mg/l (615) Total Nitrate - mg/l (620) Organic N - mg/L (605) TP - mg/l (665) Chlor *a* - ug/L (spectrophotometric method, 32211) Chlor *a* - ug/L (fluorometric method corrected, 32209) Chlor *a* - ug/L (trichromatic method corrected, 32210) Secchi Transp. - inches (77) Secchi Transp. - meters (78) +Turbidity JCUs (70) +Turbidity FTUs (76) +Turbidity NTUs field (82078) +Turbidity NTUs lab (82079) +DO - mg/L (300) +Water Temperature (degrees C, 10/degrees F, 11)	Station Type (TYPE) Agency Code (AGENCY) Station No. (STATION) Latitude - std. decimal degrees (LATSTD) Longitude - std. decimal degrees (LONGSTD) Station Location (LOCNAME) County Name (CONAME) State Name (STNAME) Ecoregion Name - Level III (ECONAME) Ecoregion Code -Level III (ECOREG) Station Elevation (ELEV) Hydrologic Unit Code (CATUNIT) RF1 Segment and Mile (RCHMIL) RF1ON/OFF tag (ONOFF)	Sample Date (DATE) Sample Time (TIME) Sample Depth (DEPTH) Composite Sample Code (SAMPMETH)
+ If data record available at a station included data only for this or other such marked parameters, data record was deleted from data set.		

The following set of retrieval rules were applied to the retrieval process:

- Data were retrieved for waterbodies specified only as **'lake', 'stream', 'reservoir', or 'estuary'** under "Station Type" parameter**.** Any stations specified as 'well,' 'spring,' or 'outfall' were eliminated from the retrieved data set.

- Data were retrieved for station types described as 'ambient' (e.g., no pipe or facility discharge data) under the "Station Type" parameter.

- Data were retrieved that were designated as 'water' samples only. This includes 'bottom' and 'vertically integrated' water samples.

- Data were retrieved that were designated as either 'grab' samples and 'composite' samples (mean result only).

- No limits were specified for sample depths.
- Data were retrieved for all fifty states, Puerto Rico, and the District of Columbia.
- The time period specified for data retrieval was January 1990 to September 1998.
- No data marked as "Retired Data" (i.e., data from a generally unknown source) were retrieved.
- Data marked as "National Urban Runoff data" (i.e., data associated with sampling conducted after storm events to assess nonpoint source pollutants) were included in the retrieval. Such data are part of STORET's 'Archived' data.
- Intensive survey data (i.e., data collected as part of specific studies) were retrieved.

2. Any values falling below the 1st percentile and any values falling above the 99th percentile were transformed into 'missing' values (i.e., values were effectively removed from the data set, but were not permanently eliminated).

3. Based on the STORET 'Remark Code' associated with each retrieved data point, the following rules were applied (Table 2):

TABLE 2: STORET REMARK CODE RULES

STORET Remark Code	**Keep or Delete Data Point**
blank - Data not remarked.	Keep
A - Value reported is the mean of two or more determinations.	Keep
B - Results based upon colony counts outside the acceptable ranges.	Delete
C -Calculated. Value stored was not measured directly, but was calculated from other data available.	Keep
D - Field measurement.	Keep
E - Extra sample taken in compositing process.	Delete
F - In the case of species, F indicates female sex.	Delete
G - Value reported is the maximum of two or more determinations.	Delete
H - Value based on field kit determination; results may not be accurate.	Delete
I - The value reported is less than the practical quantification limit and greater than or equal to the method detection limit.	Keep, but used one-half the reported value as the new value.
J - Estimated. Value shown is not a result of analytical measurement.	Delete

TABLE 2: STORET REMARK CODE RULES	
K - Off-scale low. Actual value not known, but known to be less than value shown.	Keep, but used one-half the reported value as the new value.
L - Off-scale high. Actual value not known, but known to be greater than value shown.	Keep
M -Presence of material verified, but not quantified. Indicates a positive detection, at a level too low to permit accurate quantification.	Keep, but used one half the reported value as the new value.
N -Presumptive evidence of presence of material.	Delete
O -Sample for, but analysis lost. Accompanying value is not meaningful for analysis.	Delete
P -Too numerous to count.	Delete
Q -Sample held beyond normal holding time.	Delete
R -Significant rain in the past 48 hours.	Delete
S -Laboratory test.	Keep
T -Value reported is less than the criteria of detection.	Keep, but replaced reported value with 0.
U -Material was analyzed for, but not detected. Value stored is the limit of detection for the process in use.	Keep, but replaced reported value with 0.
V -Indicates the analyte was detected in both the sample and associated method blank.	Delete
W -Value observed is less than the lowest value reportable under remark "T."	Keep, but replaced reported value with 0.
X -Value is quasi vertically-integrated sample.	No data point with this remark code in data set.
Y -Laboratory analysis from unpreserved sample. Data may not be accurate.	Delete
Z -Too many colonies were present to count.	Delete
If a parameter (excluding water temperature) value was less than or equal to zero and no remark code was present, the value was transformed into a missing value. Rationale - Parameter concentrations should never be zero without a proper explanation. A method detection limit should at least be listed	

4. Station records were eliminated from the data set if any of the following descriptors were present within the "Station Type" parameter:

- **MONITR -** Source monitoring site, which monitors a known problem or to detect a specific problem.
- **HAZARD -** Site of hazardous or toxic wastes or substances.
- **ANPOOL -** Anchialine pool, underground pools with subsurface connections to watertable and ocean.
- **DOWN -** Downstream (i.e., within a potentially polluted area) from a facility which has a potential to pollute.
- **IMPDMT -** Impoundment. Includes waste pits, treatment lagoons, and settling and evaporation ponds.
- **STMSWR -** Storm water sewer.
- **LNDFL** - Landfill.
- **CMBMI -** Combined municipal and industrial facilities.
- **CMBSRC -** Combined source (intake and outfall).

Rationale - these descriptors potentially indicate a station location that at which an ambient water sample would not be obtained (i.e., such sampling locations are potentially biased) or the sample location is not located within one of the designated water body types (i.e, ANPOOL).

5. Station records were eliminated from data set if the station location did not fall within any established cataloging unit boundaries based on their latitude and longitude.

6. Using nutrient ecoregion GIS coverage provided by USEPA, all station locations with latitude and longitude coordinates were tagged with a nutrient ecoregion identifier (nutrient region identifiers are values 1 - 14) and the associated nutrient ecoregion name. Because no nutrient ecoregions exist for Alaska, Hawaii, and Puerto Rico, stations located in these states were tagged with "dummy" nutrient ecoregion numbers (20 = Alaska, 21 = Hawaii, 22 = Puerto Rico).

7. Using information provided by TVA, 59 station locations that were marked as 'stream' locations under the "Station Type" parameter were changed to 'reservoir' locations.

8. The nutrient data retrieved from STORET were assessed for the presence of duplicate data records. The duplicate data identification process consisted of three steps: 1) identification of records that matched exactly in terms of each variable retrieved; 2) identification of records that matched exactly in terms of each variable retrieved except for their station identification numbers; and 3) identification of records that matched exactly in terms of each variable retrieved except for their collecting agency codes. The data duplication assessment procedures were conducted using SAS programs.

Prior to initiating the data duplication assessment process, the STORET nutrient data set contained:

41,210 station records
924,420 sample records

- Identification of exactly matching records
  All data records were sorted to identify those records that matched exactly. For two records to match exactly, all variables retrieved had to be the same. For example, they had to have the same water quality parameters, parameter results and associated remark codes, and have the same station data item and sample data item information. Exactly matching records were considered to be exact duplicates, and one duplicate record of each identified matching set were eliminated from the nutrient data set. A total of 924 sample records identified as duplicates by this process were eliminated from the data set.

- Identification of matching records with the exception of station identification number
  All data records were sorted to identify those records that matched exactly except for their station identification number (i.e., they had the same water quality parameters, parameter results and associated remark codes, and the same station and sample data item information with the exception of station identification number). Although the station identification numbers were different, the latitude and longitude for the stations were the same indicating a duplication of station data due to the existence of two station identification numbers for the same station. For each set of matching records, one of the station identification numbers was randomly selected and its associated data were eliminated from the data set. A total of 686 sample records were eliminated from the data set through this process.

- Identification of matching records with the exception of collecting agency codes
  All data records were sorted to identify those records that matched exactly except for their collecting agency codes (i.e., they had the same water quality parameters, parameter results and associated remark codes, and the same station and sample data item information with the exception of agency code). The presence of two matching data records each with a different agency code attached to it suggested that one agency had utilized data collected by the other agency and had entered the data into STORET without realizing that it already had been placed in STORET by the other agency. No matching records with greater than two different agency codes were identified. For determining which record to delete from the data set, the following rules were developed:

  - If one of the matching records had a USGS agency code, the USGS record was retained and the other record was deleted.
  - Higher level agency monitoring program data were retained. For example, federal program data (indicated by a “1" at the beginning of the STORET agency code) were retained against state (indicated by a “2") and local (indicated by values higher than 2) program data.
  - If two matching records had the same level agency code, the record from the agency with the greater number of overall observations (potentially indicating the data set as the source data set) was retained.

  A total of 2,915 sample records were eliminated through this process.

As a result of the duplicate data identification process, a total of 4,525 sample records and 36 individual station records were removed from the STORET nutrient data set. The resulting nutrient data set contains the following:

41,174 station records
919,895 sample records

APPENDIX B. Process for Adding Aggregate Nutrient Ecoregions and Level III Ecoregions

The flag_id tracks the type of changes that were made to the data. There are a total of eight flags that are used to describe the changes made to the data. The flags are defined as follows:

1—The latitude and longitude coordinates match the county that was provided. If the HUC was null, it was updated based on the latitude and longitude coordinates. The ecoregions were determined by using the latitude and longitude coordinates.

2—The county and HUC are available, but the latitude and/or longitude coordinates are missing. Therefore, the centroid of the intersection of the county and HUC was used to determine the ecoregions and the latitude and longitude coordinates. If the HUC and county did not intersect, the county centroid was used to determine the ecoregions and the latitude and longitude coordinates.

3—The county is available, but the HUC and the latitude and/or longitude coordinates are missing. Therefore, the county centroid was used to determine the ecoregions, HUC, and the latitude and longitude coordinates.

4—The HUC is available, but the county is not and the latitude and/or longitude coordinates are missing. Therefore, the HUC centroid was used to determine the ecoregions, county, and the latitude and longitude coordinates.

5—The county is missing, but the latitude and longitude coordinates are available. Note: A county is considered missing if it is invalid. In other words, if the county entered did not exist in the state, it was considered null. Therefore, the latitude and longitude coordinates were used to determine the ecoregions, county, and HUC (if it was missing).

6—The latitude and longitude coordinates did not match the county that was provided, but they did match the HUC. Therefore, the county centroid was used to determine ecoregion values.

7—The latitude and longitude coordinates did not match the county or the HUC that was provided (including null HUCs). Therefore, the county centroid was used to determine ecoregion values.

8—The latitude and longitude coordinates were missing, but the ecoregions were provided by the state.
The ecoregions provided by the states were used as the ecoregion values.

APPENDIX C. Glossary

Coefficient of Variation - A measure of variability. The standard deviation divided by the mean multiplied by 100.

Maximum - The highest value.

Mean – A measure of central tendency. The arithmetic average.

Median – A measure of central tendency. The value which cuts the distribution in half, such that half of the values are above the median, and half of the values are below the median. Also called the 50th percentile or middle value.

Minimum - The lowest value.

Standard Deviation – A measure of variability. The square root of the variance with the variance defined as the sum of the squared deviations divided by the sample size minus one.

Standard Error - A measure of variability. The standard deviation divided by the square root of the sample size.

5^{th} % - the 5^{th} percentile

25^{th} % - the 25^{th} percentile, the first quartile.

75^{th} % - the 75^{th} percentile, the third quartile.

95^{th} % - the 95^{th} percentile