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Ambient Water Quality Criteria Recommendations

Information Supporting the Development of State and Tribal Nutrient Criteria

Rivers and Streams in Nutrient Ecoregion III

EPA 822-B-00-016

AMBIENT WATER QUALITY CRITERIA RECOMMENDATIONS

INFORMATION SUPPORTING THE DEVELOPMENT OF STATE AND TRIBAL NUTRIENT CRITERIA

FOR

RIVERS AND STREAMS IN NUTRIENT ECOREGION III

Xeric West

including all or parts of the States of

Washington, Oregon, California, Nevada, Idaho, Wyoming, Montana, Utah, Colorado, New Mexico, Arizona, Texas

and the authorized Tribes within the Ecoregion

U.S. ENVIRONMENTAL PROTECTION AGENCY

OFFICE OF WATER
OFFICE OF SCIENCE AND TECHNOLOGY
HEALTH AND ECOLOGICAL CRITERIA DIVISION
WASHINGTON, D.C.

DECEMBER 2000

FOREWORD

This document presents EPA's nutrient criteria for **Rivers and Streams in Nutrient Ecoregion III.** 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 CWA. Under section 303(c) of the CWA, States and authorized Tribes have the primary responsibility for adopting water quality standards as State or Tribal law or regulation. The standards must 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 for the criteria for their water quality standards.

The term "water quality criteria" is used in two sections of the Clean Water Act, Section 304(a)(1) and Section 303(c)(2). The term has a different impact in each section. 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. Ambient water quality criteria associated with specific waterbody uses when adopted as State or Tribal water quality standards under Section 303 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 as numeric criteria or quantified translations of narrative criteria within State or Tribal water quality standards, quantified criteria serve as a critical basis for assessing attainment of designated uses and measuring progress toward meeting the water quality goals of the Clean Water Act.

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 why as much as half of the surface waters surveyed in this country 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 fourteen 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 is publishing Technical Guidance Manuals that describe a process for assessing nutrient conditions in the four waterbody types.

EPA's section 304(a) water quality criteria for nutrients provide numeric water quality criteria, as well as procedures by which to translate narrative 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 quantified 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.

EPA will work with States and authorized Tribes as they adopt water quality criteria for nutrients into their water quality standards. EPA recognizes that States and authorized Tribes require flexibility in adopting numeric nutrient criteria into State and Tribal water quality standards. States and authorized Tribes have several options available to them. EPA recommends the following approaches, in order of preference:

(1) Wherever possible, develop nutrient criteria that fully reflect localized conditions and protect specific designated uses using 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.

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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 decision-makers retain the discretion to adopt approaches on a case-by-case basis that differ from this guidance when appropriate and scientifically defensible. While this document contains EPA's scientific recommendations regarding ambient concentrations of nutrients that 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 more localized nutrient criteria based on approaches described in the waterbody guidance manuals. This document presents EPA=s current recommended criteria for total phosphorus, total nitrogen, chlorophyll *a*, and turbidity for rivers and streams in Nutrient Ecoregion III (Xeric West) 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 are intended to address cultural eutrophication-- the adverse effects of excess nutrient inputs. The criteria are empirically derived to represent conditions of surface waters that are minimally impacted by human activities and protective of aquatic life and recreational uses. The information contained in this document represent 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 which included, to the extent they were readily available, the following elements critical to criterion derivation:

- **Historical and recent nutrient data in Nutrient Ecoregion III.**
  Data sets from Legacy STORET, NASQAN, NAWQA and EPA Region10 were used to assess nutrient conditions from 1990 to 1998.

- **Reference sites/reference conditions in Nutrient Ecoregion III.**
  Reference conditions presented are based on 25th percentiles of all nutrient data including a comparison of reference condition for the aggregate ecoregion versus the subecoregions. States and Tribes are urged to determine their own reference sites for rivers and streams within the ecoregion 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 used in the ecoregion 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 are 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: Idaho, Washington, and Oregon.

The following tables contain a summary of Aggregate and level III ecoregion values for TN, TP, water column chl *a*, and turbidity:

BASED ON 25th PERCENTILES ONLY

Nutrient Parameters	**Aggregate Nutrient Ecoregion III Reference Conditions**
Total phosphorus (µg/L)	21.88
Total nitrogen (mg/L)	0.38
Chlorophyll *a* (µg/L) (Fluorometric method)	1.78
Turbidity (FTU)	2.34

For subecoregions 6, 10, 12, 13, 14, 18, 20, 22, 24, 79, 80, and 81 the ranges of nutrient parameter reference conditions are:

BASED ON 25th PERCENTILE ONLY

Nutrient Parameters	**Range of Level III Subecoregions Reference Conditions**
Total phosphorus (µg/L)	10-55
Total nitrogen (mg/L)	0.22-0.90
Chlorophyll *a* (µg/L) (Fluorometric method)	1.78-4.85
Turbidity (FTU)	1.93-5.13

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; (513) 489-8190 or toll free (800) 490-9198. Please refer to EPA document number EPA-822-B-00-016.

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LISTS OF TABLES AND FIGURES

Figures

Tables

TABLE OF CONTENTS

1.0 INTRODUCTION

Background

Nutrients are essential to the health and diversity of our surface waters. However, in excessive amounts, nutrients cause hypereutrophication, which results in overgrowth of plant life and decline of the biological community. Excessive nutrients can also result in potential human health risks, such as the growth of harmful algal blooms - most recently manifested in the *Pfiesteria* outbreaks of the Gulf and East Coasts. Chronic nutrient overenrichment of a waterbody can lead to the following consequences: low dissolved oxygen, fish kills, algal blooms, overabundance of macrophytes, likely increased sediment accumulation rates, 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 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 establishes a national goal to achieve, wherever attainable, water quality which provides for the protection and propagation of fish, shellfish, and wildlife and recreation in and on the water. In adopting water quality standards, States and Tribes designate uses for their waters in consideration of the Clean Water Act goals, and establish water quality criteria that contain sufficient parameters to protect 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 the experts how to best deal with the national nutrient problem. The experts recommended that the Agency not develop single criteria values for phosphorus or nitrogen applicable to all water bodies and regions of the country. Rather, the experts 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 will be published in spring 2000 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 more 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* and some measure of turbidity). Other indicators such as dissolved oxygen and macrophyte growth or speciation, and other fauna and flora changes are also deemed useful. However, the first four 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, natural resources management-- especially water resource management, chemistry, and ecology. The RTAG evaluates and recommends appropriate classification techniques for criteria determination, usually physical 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 ten-twenty five years. This information gives evidence about the background and enrichment trend of the resource.

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

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

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

The last and final element of the criteria development process is the 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.

While States and authorized Tribes would 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 for nutrient management decision making is the balanced incorporation of all five elements, or at least all elements except modeling.

Because some parts of the country have naturally higher soil and parent material enrichment, and different precipitation regimes, the application of the criterion development process has to be adjusted by region. Therefore, an ecoregional approach was chosen to develop nutrient criteria appropriate to each of the different geographical and climatological areas of the country. Initially, the continental U.S. was divided into 14 separate ecoregions of similar geographical characteristics. 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 than adjacent areas in a holistic sense. Geographic phenomena such as soils, vegetation, climate, geology, land cover, and physiology that are associated with spatial differences in the quantity and quality of ecosystem components are relatively similar within each ecoregion.

The Nutrient ecoregions are aggregates of U.S. EPA's hierarchal 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 due to 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 as well as more refined scales (level III ecoregions and waterbody classes), where data were available to make such assessments, are presented for comparison purposes and completeness of analysis.

Relationship 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 an aggregation of data from sites that represent the least-impacted and 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 the basic approach to their 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 utilize 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 and holistic indicators of water quality necessary to protect uses.

States and authorized Tribes can develop and apply nutrient criteria 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 through designing and conducting a common sampling program. The traditional biological criteria variables of benthic invertebrate and fish sampling can be readily incorporated to supplement a nutrient assessment. To demonstrate the effectiveness of this tandem approach, EPA has initiated pilot projects in both freshwater and marine environments to investigate the relationship between nutrient overenrichment and apparent declines in diversity indices 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 that ultimately provide a basis for controlling discharges or releases of pollutants. The recommendations also provide guidance to EPA when promulgating Federal water quality standards under section 303(c) when such action is necessary. 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 in their standards 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 initiated efforts where possible. States and Tribes can address nutrient overenrichment through establishment of numerical criteria or through use of new or existing 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 establish procedures to quantitatively translate these statements for both assessment and source control purposes.

The intent of developing ecoregional nutrient criteria is to represent conditions of 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 judgement, and evaluation of downstream effects. To the extent allowed by the information available, EPA has used elements of this process to produce the information contained in this document. The values for both 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 in standards to protect uses.

In its water quality standards regulations, 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 in most cases. EPA has also published methods for modifying 304(a) criteria on a site-specific basis, such as the water effect ratio, where site-specific conditions warrant modification to achieve the intended level of protection. For nutrients, however, EPA expects that, in most cases, it will be necessary for States and authorized Tribes to identify with greater precision the nutrient levels that protect aquatic life and recreational uses. This can be achieved through development of criteria modified to reflect conditions at a smaller geographic scale than an ecoregion such as a subecoregion, the State or Tribe level, or specific class of waterbodies. Criteria refinement can occur by grouping data or performing data analyses at these smaller geographic scales. Refinement can also occur through further consideration of other elements of criteria development, such as published literature or models.

The values presented in this document generally represent nutrient levels that protect against the adverse effects of nutrient 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 designated uses that need to be protected. For example, more sensitive uses may require more stringent values as criteria to ensure adequate protection. On the other hand, overly stringent levels of protection against the adverse effects of cultural eutrophication may actually fall below levels that represent 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 and current reference conditions, using historical data and expert judgement. These elements of the nutrient 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 and to develop more refined criteria according to the methods described in EPA's technical guidance manuals for specific waterbody types.

To assist in the process of further refinement of nutrient criteria, EPA has established ten Regional Technical Advisory Groups (experts from EPA Regional Offices and States/Tribes). In the process of 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 the process of using the information and recommendations contained in this document, as well as additional information, 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 provide sufficient protection of uses before impairment occurs and to maintain downstream uses. Early response variables are necessary to provide warning signs 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 (i.e., how long) and frequency (i.e., how often) of occurrence in addition to magnitude (i.e., 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 measurements) is considered appropriate. However, these seasonal or annual central tendency measures should apply each season or each year, except under the most extraordinary of conditions (e.g., a 100 year flood).

3.0 AREA COVERED BY THIS DOCUMENT

The following sections provide a general description of the aggregate ecoregion and its geographical boundaries. Descriptions of the level III ecoregions contained within the aggregate ecoregion are also provided.

3.1 Description of Aggregate Ecoregion III - Xeric West

The Xeric West is composed of unforested basins, alluvial fans, plateaus, buttes, and scattered mountains. Region III is drier than surrounding regions and naturally occurring water is scarce in nearly all places. Its climate is subject to large year-to-year, seasonal, and diurnal variations. Perennial streams are rare and those that occur typically originate outside the region in the higher, wetter, more rugged Western Forested Mountains (II). Vegetation is often desertic with areas of woodland occurring only locally in wetter locations. Most of the area is uncultivated and used for range. However, irrigated agriculture occurs where water is available and soils are suitable. In parts of the region, groundwater overdraft has lowered the water table causing diminished spring flow/streamflow, salt water intrusion (in coastal areas), and ground subsidence. Rivers that are heavily used for irrigation have high concentrations of dissolved solids, nitrite plus nitrate, and salinity that can increase downstream due to the effects of irrigation return flow and evaporation. Areas of high human population density occur along with associated water quality problems including elevated levels of fecal coliform bacteria, nitrite plus nitrate, phosphorus, sulfate, and dissolved solids.

3.2 Geographical Boundaries of Aggregate Ecoregion III

Ecoregion III encompasses the areas of the western United States where dry conditions prevail (Figure 1). More specifically, the region includes central Washington, south eastern Oregon and the southern 1/3rd of Idaho. The entire state of Nevada is included in this region as well as the vast majority of Utah (excluding the central mountainous region that is part of ecoregion II). The region continues south to include the southeastern portion of California. The region also includes an u-shaped portion of California that starts up the central portion of Pacific coast turns back southward around the central part of California included in ecoregion I. From southern California, the region stretches east into Arizona, New Mexico and a small area of southwest Texas. All of Arizona and New Mexico that are included in ecoregion III with the exception of the mountainous areas that are part of ecoregion II. In addition, extreme western Colorado and central Wyoming are included in this ecoregion.

3.3 Level III Ecoregions Within Aggregate Ecoregion III

There are twelve Level III ecoregions contained within Aggregate Ecoregion III (Figure 2). The following provides brief descriptions of the climate, vegetative cover, topography, and other ecological information pertaining to these subecoregions.

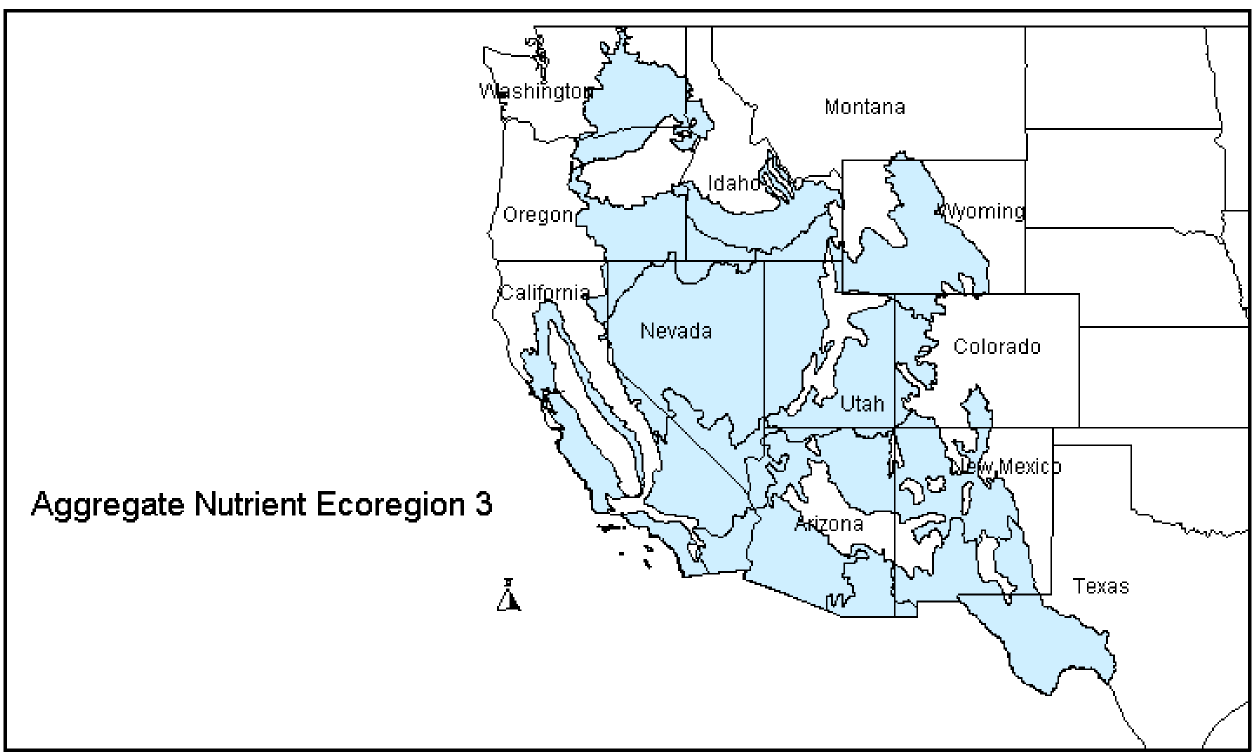

Figure 1. Aggregate Ecoregion III.

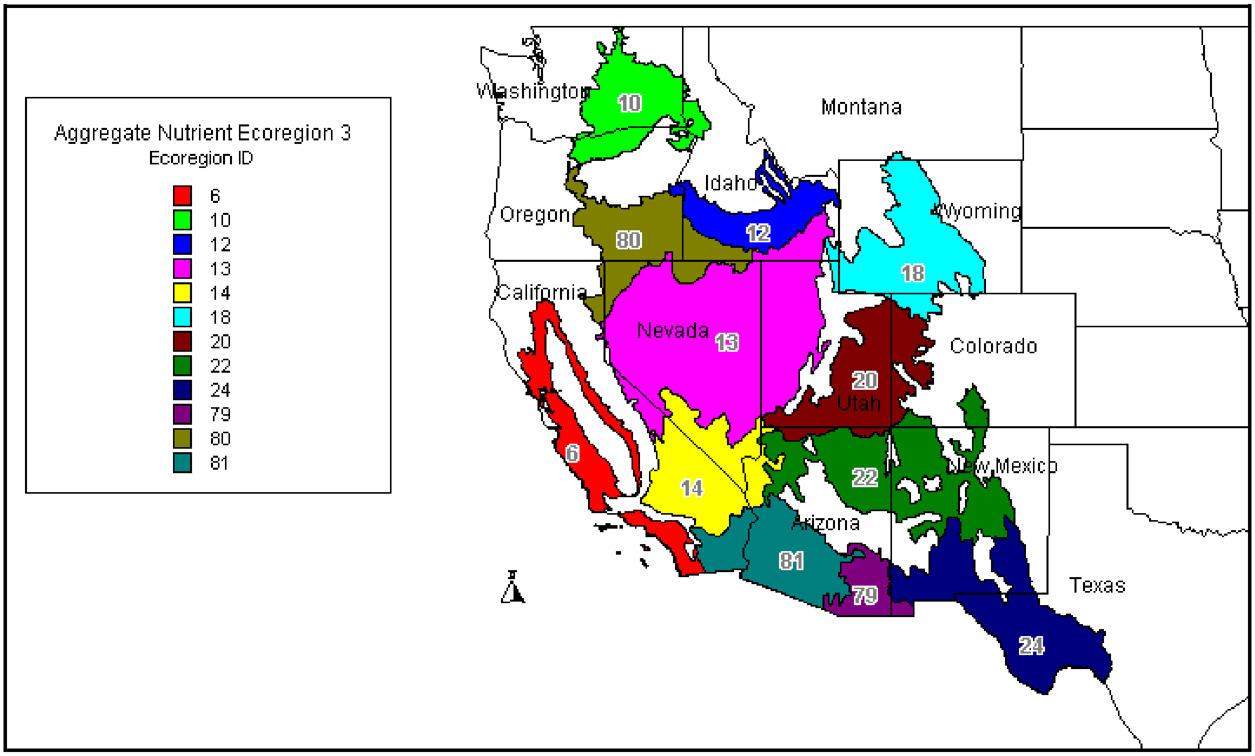

Figure 2. Aggregate Ecoregion III with level III ecoregions shown.

6. Southern and Central California Chaparral and Oak Woodlands

The primary distinguishing characteristic of this ecoregion is its Mediterranean climate of hot dry summers and cool moist winters, and associated vegetative cover comprising mainly chaparral and oak woodlands; grasslands occur in some lower elevations and patches of pine are found at higher elevations. Most of the region consists of open low mountains or foothills, but there are areas of irregular plains in the south and near the border of the adjacent Central California Valley ecoregion. Much of this region is grazed by domestic livestock; very little land has been cultivated.

10. Columbia Plateau

The Columbia Plateau is an arid sagebrush steppe and grassland surrounded on all sides by moister, predominantly forested, mountainous ecological regions. This region is underlain by lava rock up to two miles thick and is covered in some places by loess soils that have been extensively cultivated for wheat, particularly in the eastern portions of the region where precipitation amounts are greater.

12. Snake River Basin

This portion of the xeric intermontane basin and range area of the western United States is considerably lower and more gently sloping than the surrounding ecoregions. Mostly because of the available water for irrigation, a large percent of the alluvial valleys bordering the Snake River are in agriculture, with sugar beets, potatoes, and vegetables being the principal crops. Cattle feedlots and dairy operations are also common in the river plain. Except for the scattered barren lava fields, the remainder of the plains and low hills in the ecoregion have a sagebrush steppe potential natural vegetation and are now used for cattle grazing.

13. Central Basin and Range

The Central Basin and Range Ecoregion is characterized by a mosaic of xeric basins, scattered low and high mountains, and salt flats. Compared to the Snake River Basin and Northern Basin and Range regions to the north, the region is hotter and contains higher and a greater density of mountains that have perennial streams and ponderosa pine forests at higher elevations. Also, there is less grassland and more shrubland, and the soils are mostly Aridisols rather than dry Mollisols. The region is not as hot as the Mojave and Sonoran Basin and Range ecoregions and it has a greater percent of land that is grazed.

14. Mojave Basin and Range

This ecoregion contains scattered mountains which are generally lower than those of the Central Basin and Range. Potential natural vegetation in this region is predominantly creosote bush, as compared to the mostly saltbush-greasewood and Great Basin sagebrush of the ecoregion to the north, and creosote bush-bur sage with large patches of palo verde-cactus shrub and saguaro cactus in the Sonoran Basin and Range to the south. Most of this region is federally owned and there is relatively little grazing activity because of the lack of water and forage for livestock. Heavy use of off-road vehicles and motorcycles in some areas has caused severe wind and water erosion problems.

18. Wyoming Basin

This ecoregion is a broad intermontane basin dominated by arid grasslands and shrublands and interrupted by high hills and low mountains. Nearly surrounded by forest covered mountains, the region is somewhat drier than the Northwestern Great Plains to the northeast and does not have the extensive cover of pinyon-juniper woodland found in the Colorado Plateaus to the south. Much of the region is used for livestock grazing, although many areas lack sufficient vegetation to support this activity. The region contains major producing natural gas and petroleum fields.

20. Colorado Plateaus

Rugged tableland topography is typical of the Colorado Plateau ecoregion. Precipitous side-walls mark abrupt changes in local relief, often from 300 to 600 meters. The region is more elevated than the Wyoming Basin to the north and therefore contains a far greater extent of pinyon-juniper woodlands. However, the region also has large low lying areas containing saltbrush-greasewood (typical of hotter drier areas), which are generally not found in the higher Arizona/New Mexico Plateau to the south where grasslands are common.

22. Arizona/New Mexico Plateau

The Arizona/New Mexico Plateau represents a large transitional region between the semiarid grasslands and low relief tablelands of the Southwestern Tablelands ecoregion in the east, the drier shrublands and woodland covered higher relief tablelands of the Colorado Plateau in the north, and the lower, hotter, less vegetated Mojave Basin and Range in the west and Chihuahuan Deserts in the south. Higher, more forest covered, mountainous ecoregions border the region on the northeast and southwest. Local relief in the region varies from a few meters on plains and mesa tops to well over 300 meters along tableland side slopes.

24. Chihuahuan Deserts

This desertic ecoregion extends from the Madrean Archipelago in southeastern Arizona to the Edwards Plateau in south-central Texas. The region comprises broad basins and valleys bordered by sloping alluvial fans and terraces. Isolated mesas and mountains are located in the central and western parts of the region. Vegetative cover is predominantly arid grass and shrubland, except on the higher mountains where oak-juniper woodlands occur.

79. Madrean Archipelago

Also known as the Sky Islands in the United States, this is a region of basins and ranges with medium to high local relief, typically 1,000 to 1,500 meters. Native vegetation in the region is mostly grama-tobosa shrubsteppe in the basins and oak-juniper woodlands on the ranges, except at higher elevations where ponderosa pine is predominant. The region has ecological significance as both a barrier and bridge between two major cordilleras of North America, the Rocky Mountains and the Sierra Madre Occidental.

80. Northern Basin and Range

This ecoregion consists of arid tablelands, intermontane basins, dissected lava plains, and widely scattered low mountains. The bulk of the region is covered by sagebrush steppe vegetation. The ecoregion is drier and less suitable for agriculture than the Columbia Plateau, it is higher and cooler than the Snake River Basin the east, and contains a lower density of mountain ranges than the adjacent Central Basin and Range ecoregion to the south. Much of the region is used as rangeland.

81. Sonoran Basin and Range

Similar to the Mojave Basin and Range to the north, this ecoregion contains scattered low mountains and has large tracts of federally owned land, most of which is used for military training. However, the Sonoran Basin and Range is slightly hotter than the Mojave and contains large areas of palo verde-cactus shrub and giant saguaro cactus, whereas the potential natural vegetation in the Mojave is largely creosote bush.

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.

4.0 DATA REVIEW FOR RIVERS AND STREAMS IN AGGREGATE ECOREGION III

The following 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*. These are the parameters which EPA considers 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 system enrichment for most of the 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.)

4.1 Data Sources

Data sets from Legacy STORET, NASQAN, NAWQA, and EPA Region10 were used to assess nutrient conditions from1990 to1999. 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 III (TP, TN, Chl *a*, and Turbidity)

EPA recommends that States/Tribes assess long-term trends observed over the past 50 years. 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 last 10 years (e.g., what do seasonal trends 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, storm water sewers, hazardous waste sites) were the data used in the statistical analyses.

States within Ecoregion III were contacted regarding the quality of their data. The following States provided information on the methods used to sample and analyze their waters: Washington, Oregon, and Idaho. In all cases, States indicated a Standard method or an approved EPA method was used. California, Nevada, Utah, Colorado, Arizona, New Mexico, Texas, Wyoming, and Montana did not provide information prior to the publication of this document.

4.4 Data for All Rivers and Streams Within Aggregate Ecoregion III

Figure 3 shows the location of the sampling stations within each subecoregion. Table 1 presents all data records for all parameters for Aggregate Ecoregion III and subecoregions within the Aggregate Ecoregion.

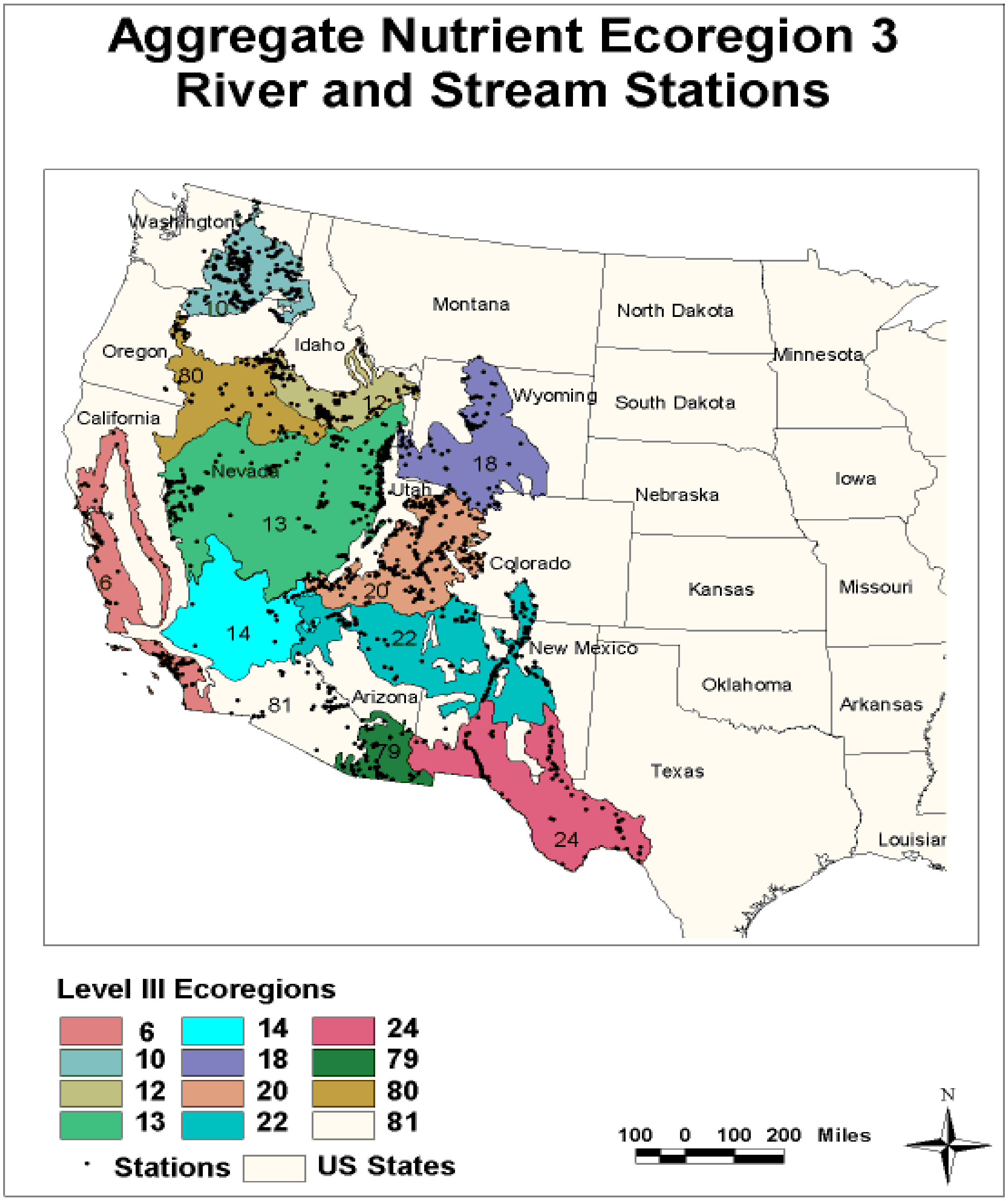

Figure 3. Sampling locations within each level III ecoregion.

Table 1. River and stream records for Aggregate Ecoregion III - Xeric West

	Aggregate Ecoregion III	Sub ecoR 6	Sub ecoR 10	Sub ecoR 12	Sub ecoR 13	Sub ecoR 14	Sub ecoR 18
# of Streams	1198	76	170	148	249	16	58
# of Stream Stations	2492	227	378	304	508	38	91
Key Nutrient Parameters (listed below)							
- # of records for Turbidity (all methods)	22,251	1185	5236	2037	6486	366	279
- # of records for Chlorophyll *a* (all methods) + Periphyton	1764	88	394	355	83	0	0
- # of records for Total Kjeldahl Nitrogen (TKN)	29,239	1652	4647	3824	8635	616	633
- # of records for Nitrate + Nitrite (NO_2 + NO_3)	14,210	290	3198	2735	836	319	612
- # of records for Total Nitrogen (TN)	6908	170	889	91	3320	242	94
- # of records for Total Phosphorus (TP)	35,660	550	6616	4218	10,474	831	1247
Total # of records for key nutrient parameters	110,032	3935	20,980	13,260	29,834	2374	2865

Table 1 (continued). **River and stream records for Aggregate Ecoregion III - Xeric West**

	Sub ecoR 20	Sub ecoR 22	Sub ecoR 24	Sub ecoR 79	Sub ecoR 80	Sub ecoR 81
# of Streams	214	119	57	27	42	49
# of Stream Stations	353	240	130	53	81	89
Key Nutrient Parameters (listed below)						
- # of records for Turbidity (all methods)	2944	1241	541	405	886	645
- # of records for Chlorophyll *a* (all methods) + Periphyton	34	0	375	0	435	0
- # of records for Total Kjeldahl Nitrogen (TKN)	3069	2347	1515	400	788	1113
- # of records for Nitrate + Nitrite (NO_2 + NO_3)	1899	1850	877	370	288	936
- # of records for Total Nitrogen (TN)	255	1001	511	18	92	225
- # of records for Total Phosphorus (TP)	5088	2526	1664	404	937	1105
Total # of records for key nutrient parameters	13,289	8965	5483	1597	3426	4024

Definitions used to complete Table 1:

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 were 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.

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 to establish a reference condition. The 75th percentile was chosen by EPA since 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. 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 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], and the letter from Tennessee Department of Environment and Conservation to Geoffrey Grubbs [TNDEC, 2000]). 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-l 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. Appendix A provides a complete presentation of all descriptive statistics for both the aggregate ecoregion and the level III subecoregion.

4.6. Classification of River/Stream Type

It is anticipated that assessing the data by stream type will 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 III, for which data existed. For example, if one stream had 300 observations for phosphorus over the decade or one 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 (Figure 4a & b).

Table 2. Reference conditions for Aggregate Ecoregion III 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)	733	0	13.05	**0.198**	
$NO_2 + NO_3$ (mg/L)	459	0	9.66	**0.025**	
TN (mg/L) - calculated	NA	0	22.71	**0.223**	
TN (mg/L) - reported	154	0.43	10.58	**0.377**	
TP (*u*g/L)	808	0	12,787.5	**21.88**	
Turbidity (NTU)	181	.288	157.8	**1.84**	
Turbidity (FTU)	407	0	160	**234**	
Turbidity (JCU)	1[z]	14.9	14.9	**14.9**	
Chlorophyll *a* (*u*g/L) -F	24	0.3	27	**1.78**	
Chlorophyll *a* (*u*g/L) -S	23	0.205	60.35	**1.43**	
Chlorophyll *a* (*u*g/L) -T	16	0.95	19.475	**5.625**	
Periphyton Chl *a* (mg/m^2)	3 z F	43.9	65	**43.9 zz**	

P25:	25th percentile of all data
P75:	75th percentile of all data
**	as determined by the Regional Technical Assistance Groups (RTAGs)
+	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*u*g/L, summer 15*u*g/L, fall 12*u*g/L, and winter 5*u*g/L, the median value of all seasons P25 will be 11*u*g/L.
++	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.
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.
NA	Not Applicable

Tables 3a-l 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-l.

Table 3a. Reference conditions for level III ecoregion 6 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)	**40**	**0.05**	**4.25**	**0.363**	
NO_2 + NO_3 (mg/L)	**17**	**0.025**	**8.275**	**0.155**	
TN (mg/L) - calculated	**NA**	**0.075**	**12.525**	**0.518**	
TN (mg/L) - reported	**10**	**0.223**	**9.95**	**0.5**	
TP (*u*g/L)	**23**	**2.5**	**3212.5**	**30**	
Turbidity (NTU)	**13[w]**	**1**	**35.875**	**1.9**	
Turbidity (FTU)	**21**	**0.775**	**47.25**	**2.65**	
Turbidity (JCU)	**-**	**-**	**-**	**-**	
Chlorophyll *a* (*u*g/L) -F	**0[z]**	**-**	**-**	**-**	
Chlorophyll *a* (*u*g/L) -S	**2[z,w]**	**2.3915**	**2.3915**	**2.3915**	
Chlorophyll *a* (*u*g/L) -T	**0[z]**	**-**	**-**	**-**	
Periphyton Chl *a* (mg/m^2)	**-**	**-**	**-**	**-**	

Table 3b. Reference conditions for level III ecoregion 10 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)	106	0.525	1.42	0.288	
$NO_2 + NO_3$ (mg/L)	71	0.003	9.604	0.072	
TN (mg/L) - calculated	NA	0.528	11.024	0.36	
TN (mg/L) - reported	24	0.082	3.083	0.221	
TP (*u*g/L)	127	2.5	2070	30	
Turbidity (NTU)	41	0.3125	87.975	1.45	
Turbidity (FTU)	69	0.375	30.25	2.031	
Turbidity (JCU)	-	-	-	-	
Chlorophyll *a* (*u*g/L) -F	16	0.8	27	1.775	
Chlorophyll *a* (*u*g/L) -S	3[z]	0.205	0.745	0.205	
Chlorophyll *a* (*u*g/L) -T	0[z]	-	-	-	
Periphyton Chl *a* (mg/m^2)	1z	44	44-	44zz	

Table 3c. Reference conditions for level III ecoregion 12 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)	82	0.05	2.025	0.272	
$NO_2 + NO_3$ (mg/L)	78	0.014	7.793	0.272	
TN (mg/L) - calculated	NA	0.064	9.818	0.544	
TN (mg/L) - reported	4	0.368	2.913	0.896	
TP (*u*g/L)	87	6.25	6341.25	42.5	
Turbidity (NTU)	3[z]	1.538	1.788	1.538[zz]	
Turbidity (FTU)	49	1.25	154.75	3.25	
Turbidity (JCU)	-	-	-	-	
Chlorophyll *a* (*u*g/L) -F	3[z]	4.85	13.8	4.85[zz]	
Chlorophyll *a* (*u*g/L) -S	0[z]	-	-	-	
Chlorophyll *a* (*u*g/L) -T	12	0.95	18.9	3.3	
Periphyton Chl *a* (mg/m^2)	1z	43.9	43.9	43.9zz	

Table 3d. Reference conditions for level III ecoregion 13 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)	168	0.025	4.465	0.228	
$NO_2 + NO_3$ (mg/L)	65[f]	0.005	3.48	0.038	
TN (mg/L) - calculated	NA	0.03	7.945	0.266	
TN (mg/L) - reported	36	0.23	5.55	0.425	
TP (*u*g/L)	193	2.5	2150	28.75	
Turbidity (NTU)	26	2	42.388	4.3	
Turbidity (FTU)	105	0.35	102	1.925	
Turbidity (JCU)	-	-	-	-	
Chlorophyll *a* (*u*g/L) -F	0[z]	-	-	-	
Chlorophyll *a* (*u*g/L) -S	6	2.1	60.35	3.265	
Chlorophyll *a* (*u*g/L) -T	0[z]	-	-	-	
Periphyton Chl *a* (mg/m^2)	1 z	8	8	8 zz	

Table 3e. Reference conditions for level III ecoregion 14 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)	12[s]	0.088	1.803	0.288	
$NO_2 + NO_3$ (mg/L)	7	0.268	2.175	0.353	
TN (mg/L) - calculated	NA	0.356	3.978	0.641	
TN (mg/L) - reported	6	0.57	1.207	0.67	
TP (*u*g/L)	12[s]	5	515	10	
Turbidity (NTU)	5	0.638	45.138	1.088	
Turbidity (FTU)	4	0.875	37.563	3.919	
Turbidity (JCU)	-	-	-	-	
Chlorophyll *a* (*u*g/L) -F	0[z]	-	-	-	
Chlorophyll *a* (*u*g/L) -S	0[z]	-	-	-	
Chlorophyll *a* (*u*g/L) -T	0[z]	-	-	-	
Periphyton Chl *a* (mg/m^2)	-	-	-	-	

Table 3f. Reference conditions for level III ecoregion 18 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)	23	0.05	0.87	0.225	
$NO_2 + NO_3$ (mg/L)	21	0	1.829	0.025	
TN (mg/L) - calculated	NA	0.05	2.699	0.25	
TN (mg/L) - reported	5[s]	0.34	1.018	0.368	
TP (*ug*/L)	46	5	395	21.875	
Turbidity (NTU)	-	-	-	-	
Turbidity (FTU)	10	1.425	53.625	4.2	
Turbidity (JCU)	1[z]	5	5	5[zz]	
Chlorophyll *a* (*ug*/L) -F	0[z]	-	-	-	
Chlorophyll *a* (*ug*/L) -S	0[z]	-	-	-	
Chlorophyll *a* (*ug*/L) -T	0[z]	-	-	-	
Periphyton Chl *a* (mg/m^2)	-	-	-	-	

Table 3g. Reference conditions for level III ecoregion 20 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)	121	0	2.74	0.15	
$NO_2 + NO_3$ (mg/L)	77[f]	0	3.48	0	
TN (mg/L) - calculated	NA	0	6.22	0.15	
TN (mg/L) - reported	8	0.399	1.4	0.553	
TP (*ug*/L)	149	0	1090	20	
Turbidity (NTU)	4[f]	3.75	52	5.5	
Turbidity (FTU)	108	0.45	147.5	2.794	
Turbidity (JCU)	-	-	-	-	
Chlorophyll *a* (*ug*/L) -F	0[z]	-	-	-	
Chlorophyll *a* (*ug*/L) -S	6	3.7	15.4	4.1	
Chlorophyll *a* (*ug*/L) -T	0[z]	-	-	-	
Periphyton Chl *a* (mg/m^2)	-	-	-	-	

Table 3h. Reference conditions for level III ecoregion 22 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)	74	0	13.05	0.075	
$NO_2 + NO_3$ (mg/L)	76	0	3.335	0.01	
TN (mg/L) - calculated	NA	0	16.385	0.085	
TN (mg/L) - reported	33	0.043	4.443	0.228	
TP (*u*g/L)	82	0	12787.5	15	
Turbidity (NTU)	46	0.425	115.25	1.425	
Turbidity (FTU)	4	3.425	25.75	5.125	
Turbidity (JCU)	-	-	-	-	
Chlorophyll *a* (*u*g/L) -F	0[z]	-	-	-	
Chlorophyll *a* (*u*g/L) -S	0[z]	-	-	-	
Chlorophyll *a* (*u*g/L) -T	0[z]	-	-	-	
Periphyton Chl *a* (mg/m^2)	-	-	-	-	

Table 3i. Reference conditions for level III ecoregion 24 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)	28[s]	0.06	3.838	0.185	
$NO_2 + NO_3$ (mg/L)	17	0.155	1.535	0.358	
TN (mg/L) - calculated	NA	0.215	5.373	0.543	
TN (mg/L) - reported	14	0.43	3.225	0.615	
TP (*u*g/L)	28[s]	2.5	1462.5	17.5	
Turbidity (NTU)	9	1.75	53.45	3.05	
Turbidity (FTU)	4	0.475	37.75	2.113	
Turbidity (JCU)	1[z,f,w]	21.2	21.2	21.2[zz]	
Chlorophyll *a* (*u*g/L) -F	0[z]	-	-	-	
Chlorophyll *a* (*u*g/L) -S	8	0.25	10.53	0.25	
Chlorophyll *a* (*u*g/L) -T	0[z]	-	-	-	
Periphyton Chl *a* (mg/m^2)	-	-	-	-	

Table 3j. Reference conditions for level III ecoregion 79 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)	21s	0.044	1.16	0.106	
$NO_2 + NO_3$ (mg/L)	21s	0.007	4.162	0.018	
TN (mg/L) - calculated	NA	0.051	5.322	0.124	
TN (mg/L) - reported	5s	0.335	0.485	0.35	
TP (*u*g/L)	21s	7.5	675	10	
Turbidity (NTU)	17s	0.45	76.725	0.8	
Turbidity (FTU)	3z	4.1	27	4.1	
Turbidity (JCU)	-	-	-	-	
Chlorophyll *a* (*u*g/L) -F	0z	-	-	-	
Chlorophyll *a* (*u*g/L) -S	0z	-	-	-	
Chlorophyll *a* (*u*g/L) -T	0z	-	-	-	
Periphyton Chl *a* (mg/m^2)	-	-	-	-	

Table 3k. Reference conditions for level III ecoregion 80 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)	21	0.069	1.285	0.23	
$NO_2 + NO_3$ (mg/L)	18s	0.013	1.347	0.025	
TN (mg/L) - calculated	NA	0.082	2.632	0.255	
TN (mg/L) - reported	6s	0.42	1.7	0.483	
TP (*u*g/L)	25	10	333.75	55	
Turbidity (NTU)	13s	2.2	22.825	2.325	
Turbidity (FTU)	24f	0	28.5	2	
Turbidity (JCU)	-	-	-	-	
Chlorophyll *a* (*u*g/L) -F	12s	0.6	4.3	2.85	
Chlorophyll *a* (*u*g/L) -S	0z	-	-	-	
Chlorophyll *a* (*u*g/L) -T	4	5.775	14.725	5.945	
Periphyton Chl *a* (mg/m^2)	-	-	-	-	

Table 3l. Reference conditions for level III ecoregion 81 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)	29	0.063	4.5	0.224	
$NO_2 + NO_3$ (mg/L)	29	0.007	7.475	0.067	
TN (mg/L) - calculated	NA	0.07	11.975	0.291	
TN (mg/L) - reported	8	0.3	10.325	0.607	
TP (*u*g/L)	27	0	1485	25	
Turbidity (NTU)	15[w]	0.45	85.5	1.913	
Turbidity (FTU)	10	1.688	116.25	2.388	
Turbidity (JCU)	-	-	-	-	
Chlorophyll *a* (*u*g/L) -F	0[z]	-	-	-	
Chlorophyll *a* (*u*g/L) -S	0[z]	-	-	-	
Chlorophyll *a* (*u*g/L) -T	0[z]	-	-	-	
Periphyton Chl *a* (mg/m^2)	-	-	-	-	

Definitions used in filling Tables 2 and 3 - Reference Condition tables

1. Number of Streams in Table 2 refers to the largest number of streams and rivers for which data existed for a given season within an aggregate nutrient ecoregion.

2. Number of Streams in Table 3 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).

3. 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.

4. 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 less than 3 seasons were used to derive the median, the entry is flagged **(z).**

5. 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 less than 4 streams/season in order to retain all information for all seasons. In calculating the 25th percentile for a season with less than 4 stream medians, the statistical program automatically used the minimum value within the less-than-4 population. If less than 4 streams were used in developing a seasonal quartile and or all-seasons median, the entry is flagged **(zz).**

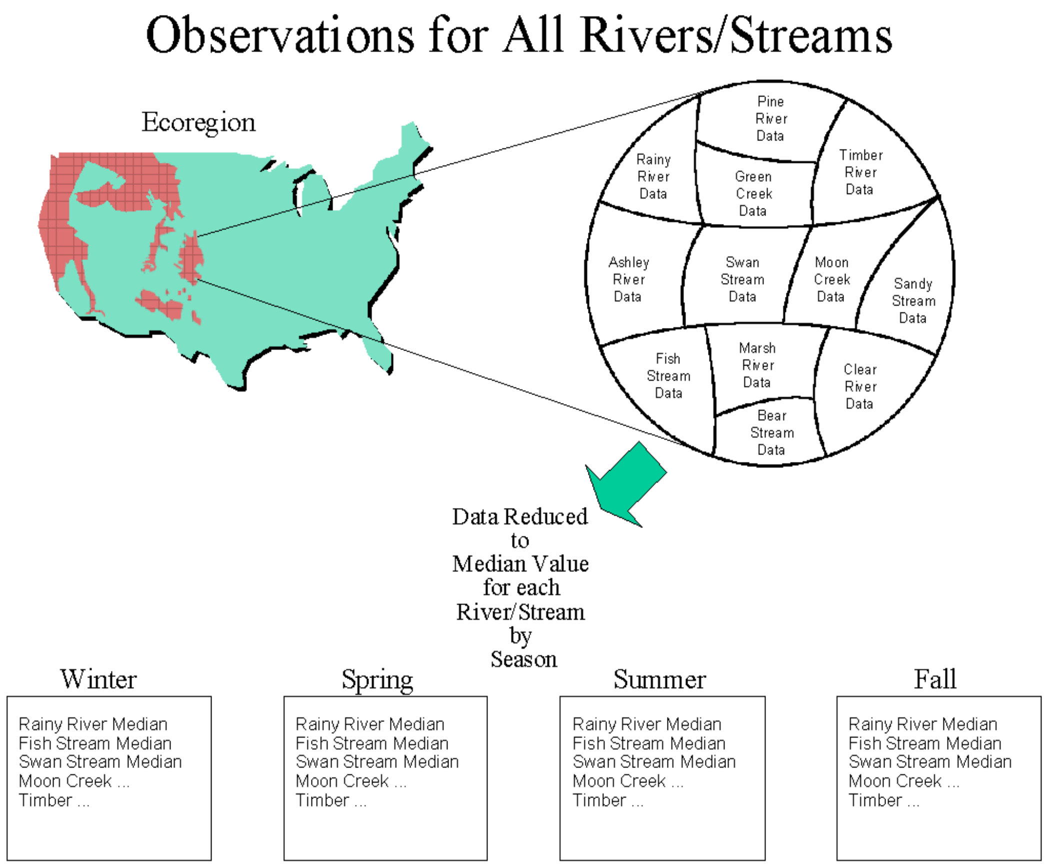

Figure 4a. Illustration of data reduction process for stream data.

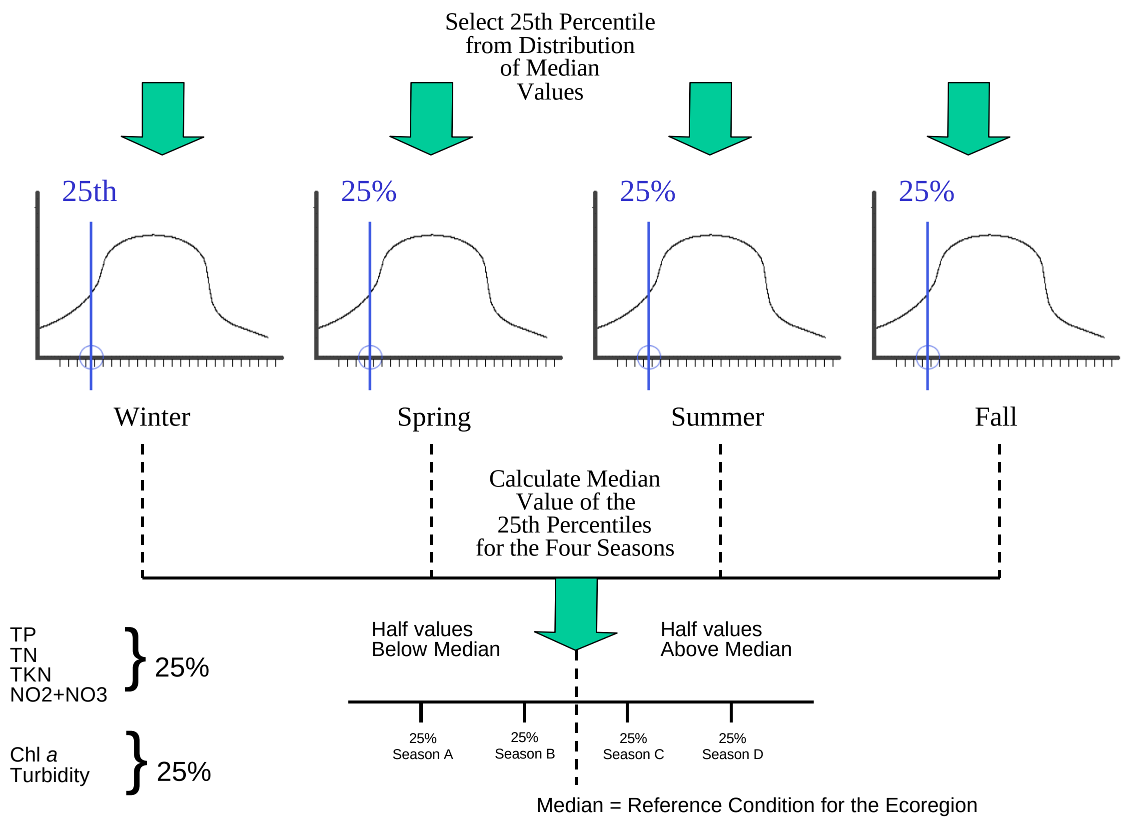

Figure 4b. Illustration of reference condition calculation.

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 can not be determined, use the the 25th percentile for the Aggregate ecoregion or consider the **lowest** 25th percentile from a subecoregion (level III) within the aggregate nutrient ecoregion. The rationale being that without data, one may assume that the subecoregion in question may be 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 were added, resulting in a calculated TN value. The number of samples (N) for calculated TN is not filled in since 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 are preferred over all other methods. However, when no data exist for Fluorometric and Spectrophotometric methods, Trichromatic values may be used. Data from the variance 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, p. 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 since this is the only variable for which the value of the parameter **increases** with greater clarity. (For lakes and reservoirs only.)

7. Turbidity units: All 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 since 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. A zero (0) is reported if the reported median for a parameter is 0 or if the component value is below detection.

5.0 REFERENCE SITES AND CONDITIONS IN AGGREGATE ECOREGION III

Reference conditions represent the natural, least impacted conditions or what is considered to be the most attainable conditions. This section 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-l in section 4.0.

RTAG discussion and rationale for selection of reference sites and conditions in Ecoregion III. 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. The following 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

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

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 our 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 work sheet (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-l and other literature and information readily available to the HQ 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 Tables of Refined Nutrient Water Quality Criteria for Aggregate Ecoregion III and Level III Subecoregions for TP, TN, Chl *a*, Turbidity (where sufficient data exist)

Aggregate Ecoregion III- Xeric West	Proposed Criterion
Total Phosphorus (µg/L)	
Total Nitrogen (mg/L)	
Chlorophyll *a* (µg/L or mg/m^2)	
Turbidity (NTU or other units)	
Other (Index; other parameter such as DO)	

- *Literature sources*

- *Historical data and trends*

- *Reference condition*

- *Models*

- *RTAG expert review and consensus*

- *Downstream effects*

Ecoregion #6--Southern and Central California Chaparral and Oak Woodlands	**Proposed Criterion**
Total Phosphorus (µg/L)	
Total Nitrogen (mg/L)	
Chlorophyll *a* (µg/L or mg/m^2)	
Turbidity (NTU or other units)	
Other (Index; other parameter such as DO)	

7.3 Setting Seasonal Criteria

The recommendations presented in this document are based in part on medians of all the 25^{th} percentile seasonal data (decadal), and as such are reflective of 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 which reflect **each** particular 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 also require increased monitoring within each season to assess compliance.

7.4 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 condition developed for the cascades); or (2) Use the 25th perecentiles 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.

7.5 Site-Specific Criteria Development

Criteria may be refined in a number of ways. The best way to refine criteria 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)
- 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

NYSDEC (New York State Department of Environment and Conservation). 2000. Memorandum from Scott Kishbaugh to Jay Bloomfield, September 26, 2000, regarding reference lakes for nutrient criteria.

TNDEC (Tennessee Department of Environment and Conservation). 2000. Letter to Geoff Grubbs, October 5, 2000, containing comments on draft nutrient criteria recommendations.

U.S. EPA. 2000a. Nutrient Criteria Technical Guidance Manual: Lakes and Reservoirs, U.S. Environmental Protection Agency, Washington, DC. EPA-822-B00-001.

U.S. EPA. 2000b. Nutrient Criteria Technical Guidance Manual: Rivers and Streams, U.S. Environmental Protection Agency, Washington, DC. EPA-822-B00-002.

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: III
Rivers and Streams
Descriptive Statistics by Decade and Season
Parameter Chla_Fluor_ug_L_Median

SEASON	N	MEAN	MIN	MAX	STDDEV	STDERR	CV	P5	P25	MEDIAN	P75	P95
FALL	11	7.23	.200	27.00	7.77	2.34	108	0.20	1.78	4.40	10.0	27.0
SPRING	19	6.13	.300	53.50	12.6	2.89	206	0.30	1.00	2.00	3.15	53.5
SUMMER	24	5.69	.600	13.80	3.78	0.77	67	0.80	2.78	4.98	8.10	12.7
WINTER	0	.	.	.	.	.	.	.	.	.	.	.

Aggregate Nutrient Ecoregion: III
Rivers and Streams
Descriptive Statistics by Decade and Season
Parameter Chla_Phyto_C_F_ug_L_Med

SEASON	N	MEAN	MIN	MAX	STDDEV	STDERR	CV	P5	P25	MEDIAN	P75	P95
FALL	1	2.70	2.70	2.70	.	.	.	2.70	2.70	2.70	2.70	2.70
SPRING	1	2.40	2.40	2.40	.	.	.	2.40	2.40	2.40	2.40	2.40
SUMMER	1	3.90	3.90	3.90	.	.	.	3.90	3.90	3.90	3.90	3.90
WINTER	0	.	.	.	.	.	.	.	.	.	.	.

Aggregate Nutrient Ecoregion: III
Rivers and Streams
Descriptive Statistics by Decade and Season
Parameter Chla_Phyto_Spec_A_ug_L_Median

SEASON	N	MEAN	MIN	MAX	STDDEV	STDERR	CV	P5	P25	MEDIAN	P75	P95
FALL	19	10.7	.240	70.90	18.0	4.13	169	0.24	1.96	3.82	10.1	70.9
SPRING	14	9.32	.120	56.50	14.9	3.97	159	0.12	1.54	3.13	12.2	56.5
SUMMER	24	7.12	.170	64.20	12.8	2.61	180	0.25	1.32	4.25	7.60	13.7
WINTER	13	1.92	.250	8.86	2.27	0.63	118	0.25	0.97	1.20	2.00	8.86

Aggregate Nutrient Ecoregion: III
Rivers and Streams
Descriptive Statistics by Decade and Season
Parameter Chla_Tric_U_ug_L_Median

SEASON	N	MEAN	MIN	MAX	STDDEV	STDERR	CV	P5	P25	MEDIAN	P75	P95
FALL	9	7.24	1.10	15.45	4.58	1.53	63	1.10	4.75	5.30	9.10	15.5
SPRING	9	16.9	.770	28.90	10.2	3.39	60	0.77	11.9	16.9	24.6	28.9
SUMMER	16	7.80	.800	23.95	6.13	1.53	79	0.80	2.34	7.85	10.1	24.0
WINTER	7	10.3	4.50	14.00	3.69	1.40	36	4.50	6.50	11.0	13.9	14.0

Aggregate Nutrient Ecoregion: III

Rivers and Streams

Descriptive Statistics by Decade and Season

Parameter Chlb_Phyto_C_F_ug_L_Med

SEASON	N	MEAN	MIN	MAX	STDDEV	STDERR	CV	P5	P25	MEDIAN	P75	P95
FALL	1	0.05	.050	0.05	.	.	.	0.05	0.05	0.05	0.05	0.05
SPRING	1	0.20	.200	0.20	.	.	.	0.20	0.20	0.20	0.20	0.20
SUMMER	1	0.20	.200	0.20	.	.	.	0.20	0.20	0.20	0.20	0.20
WINTER	0	.	.	.	.	.	.	.	.	.	.	.

Aggregate Nutrient Ecoregion: III 6

Rivers and Streams

Descriptive Statistics by Decade and Season

Parameter DIP_ug_L_Median

SEASON	N	MEAN	MIN	MAX	STDDEV	STDERR	CV	P5	P25	MEDIAN	P75	P95
FALL	118	128	.000	2575.00	414	38.1	323	5.00	7.50	21.8	55.0	670
SPRING	119	92.3	.000	1350.00	223	20.4	242	5.00	8.75	25.0	60.0	558
SUMMER	118	96.1	.000	2150.00	285	26.3	297	5.00	7.50	19.4	50.0	515
WINTER	112	147	5.00	2375.00	410	38.8	279	5.00	10.0	22.5	70.0	1055

Aggregate Nutrient Ecoregion: III 7

Rivers and Streams

Descriptive Statistics by Decade and Season

Parameter DO_mg_L_Median

SEASON	N	MEAN	MIN	MAX	STDDEV	STDERR	CV	P5	P25	MEDIAN	P75	P95
FALL	567	9.19	1.30	13.05	1.52	0.06	17	6.70	8.40	9.25	10.2	11.4
SPRING	626	9.34	3.50	33.00	1.74	0.07	19	7.00	8.40	9.25	10.2	11.7
SUMMER	644	8.37	.850	102.50	4.00	0.16	48	5.90	7.50	8.25	9.05	10.6
WINTER	476	10.8	2.20	14.50	1.72	0.08	16	7.90	9.90	10.9	12.0	13.2

Aggregate Nutrient Ecoregion: III 8

Rivers and Streams

Descriptive Statistics by Decade and Season

Parameter NO2_NO3_mg_L_Median

SEASON	N	MEAN	MIN	MAX	STDDEV	STDERR	CV	P5	P25	MEDIAN	P75	P95
FALL	459	0.72	.000	9.57	1.28	0.06	178	0.00	0.03	0.22	0.80	2.87
SPRING	443	0.71	.000	9.76	1.33	0.06	188	0.00	0.03	0.18	0.75	2.87
SUMMER	448	0.69	.000	9.95	1.32	0.06	191	0.00	0.03	0.14	0.68	3.01
WINTER	398	1.06	.000	9.45	1.60	0.08	152	0.00	0.09	0.39	1.45	4.50

Aggregate Nutrient Ecoregion: III
Rivers and Streams
Descriptive Statistics by Decade and Season
Parameter TKN_mg_L_Median

SEASON	N	MEAN	MIN	MAX	STDDEV	STDERR	CV	P5	P25	MEDIAN	P75	P95
FALL	632	0.50	.000	13.10	0.76	0.03	153	0.05	0.17	0.32	0.54	1.45
SPRING	733	0.58	.000	12.25	0.75	0.03	130	0.05	0.25	0.40	0.63	1.75
SUMMER	712	0.59	.000	28.00	1.20	0.04	203	0.05	0.22	0.40	0.65	1.60
WINTER	530	0.61	.000	13.00	0.99	0.04	162	0.05	0.18	0.38	0.66	1.83

Aggregate Nutrient Ecoregion: III 10
Rivers and Streams
Descriptive Statistics by Decade and Season
Parameter TN_mg_L_Median

SEASON	N	MEAN	MIN	MAX	STDDEV	STDERR	CV	P5	P25	MEDIAN	P75	P95
FALL	146	1.01	.050	10.15	1.57	0.13	156	0.14	0.31	0.53	1.11	2.98
SPRING	154	1.06	.040	11.00	1.55	0.12	146	0.16	0.42	0.63	1.04	2.65
SUMMER	153	0.98	.035	10.00	1.54	0.12	157	0.13	0.34	0.53	1.00	2.79
WINTER	113	1.52	.045	14.00	2.41	0.23	158	0.20	0.44	0.75	1.40	7.10

Aggregate Nutrient Ecoregion: III 11
Rivers and Streams
Descriptive Statistics by Decade and Season
Parameter TP_ug_L_Median

SEASON	N	MEAN	MIN	MAX	STDDEV	STDERR	CV	P5	P25	MEDIAN	P75	P95
FALL	720	140	.000	7975.00	411	15.3	293	2.50	20.0	50.0	110	470
SPRING	804	169	.000	8575.00	521	18.4	308	6.25	30.0	76.3	160	475
SUMMER	808	161	.000	17000.0	709	24.9	441	5.00	20.0	60.0	135	425
WINTER	589	215	.000	21000.0	975	40.2	453	5.00	23.8	60.0	148	645

Aggregate Nutrient Ecoregion: III 12
Rivers and Streams
Descriptive Statistics by Decade and Season
Parameter Turb_FTU_Median

SEASON	N	MEAN	MIN	MAX	STDDEV	STDERR	CV	P5	P25	MEDIAN	P75	P95
FALL	359	11.2	.000	149.50	19.4	1.02	174	0.65	2.00	4.00	10.0	49.0
SPRING	399	18.6	.000	167.00	26.8	1.34	144	1.00	3.30	8.40	19.9	91.0
SUMMER	407	14.4	.000	160.00	22.3	1.10	155	0.70	2.18	5.25	15.0	59.0
WINTER	269	13.1	.000	160.00	20.7	1.26	159	0.85	2.50	5.38	13.0	46.0

Aggregate Nutrient Ecoregion: III

Rivers and Streams

Descriptive Statistics by Decade and Season

Parameter Turb_JCU_Median

SEASON	N	MEAN	MIN	MAX	STDDEV	STDERR	CV	P5	P25	MEDIAN	P75	P95
FALL	1	14.9	14.9	14.90	.	.	.	14.9	14.9	14.9	14.9	14.9
SPRING	0	.	.	.	.	.	.	.	.	.	.	.
SUMMER	1	5.00	5.00	5.00	.	.	.	5.00	5.00	5.00	5.00	5.00
WINTER	1	27.5	27.5	27.50	.	.	.	27.5	27.5	27.5	27.5	27.5

Aggregate Nutrient Ecoregion: III

Rivers and Streams

Descriptive Statistics by Decade and Season

Parameter Turb_NTU_Median

SEASON	N	MEAN	MIN	MAX	STDDEV	STDERR	CV	P5	P25	MEDIAN	P75	P95
FALL	161	11.8	.275	144.00	24.1	1.90	204	0.55	1.65	3.00	10.0	64.8
SPRING	181	19.9	.400	139.00	26.4	1.97	133	1.00	3.70	12.0	25.0	60.4
SUMMER	168	11.9	.250	171.80	23.3	1.80	196	0.50	1.68	4.00	9.88	58.1
WINTER	132	21.4	.300	171.00	34.1	2.97	159	0.50	2.00	6.23	25.1	96.0

APPENDIX B

Descriptive Statistics Data Tables for Level III Subecoregions within Aggregate Ecoregion

Aggregate Nutrient Ecoregion: III
Rivers and Streams
Descriptive Statistics by Decade and Season
Parameter Chla_Fluor_ug_L_Median

Eco_ Level_ III	SEASON	N	MEAN	MIN	MAX	STDDEV	STDERR	CV	P5	P25	MEDIAN	P75	P95
6	FALL	0	.	.	.	.	.	.	.	.	.	.	.
6	SPRING	0	.	.	.	.	.	.	.	.	.	.	.
6	SUMMER	0	.	.	.	.	.	.	.	.	.	.	.
6	WINTER	0	.	.	.	.	.	.	.	.	.	.	.
10	FALL	9	8.02	.200	27.00	8.46	2.82	105	0.20	1.78	5.00	10.0	27.0
10	SPRING	7	13.8	1.00	53.50	19.1	7.23	139	1.00	1.20	2.48	18.0	53.5
10	SUMMER	16	5.36	.800	12.70	3.50	0.87	65	0.80	2.38	4.65	8.10	12.7
10	WINTER	0	.	.	.	.	.	.	.	.	.	.	.
12	FALL	0	.	.	.	.	.	.	.	.	.	.	.
12	SPRING	0	.	.	.	.	.	.	.	.	.	.	.
12	SUMMER	3	10.1	4.85	13.80	4.66	2.69	46	4.85	4.85	11.6	13.8	13.8
12	WINTER	0	.	.	.	.	.	.	.	.	.	.	.
13	FALL	0	.	.	.	.	.	.	.	.	.	.	.
13	SPRING	0	.	.	.	.	.	.	.	.	.	.	.
13	SUMMER	0	.	.	.	.	.	.	.	.	.	.	.
13	WINTER	0	.	.	.	.	.	.	.	.	.	.	.
14	FALL	0	.	.	.	.	.	.	.	.	.	.	.
14	SPRING	0	.	.	.	.	.	.	.	.	.	.	.
14	SUMMER	0	.	.	.	.	.	.	.	.	.	.	.
14	WINTER	0	.	.	.	.	.	.	.	.	.	.	.
18	FALL	0	.	.	.	.	.	.	.	.	.	.	.
18	SPRING	0	.	.	.	.	.	.	.	.	.	.	.
18	SUMMER	0	.	.	.	.	.	.	.	.	.	.	.
18	WINTER	0	.	.	.	.	.	.	.	.	.	.	.
20	FALL	0	.	.	.	.	.	.	.	.	.	.	.
20	SPRING	0	.	.	.	.	.	.	.	.	.	.	.
20	SUMMER	0	.	.	.	.	.	.	.	.	.	.	.
20	WINTER	0	.	.	.	.	.	.	.	.	.	.	.
22	FALL	0	.	.	.	.	.	.	.	.	.	.	.
22	SPRING	0	.	.	.	.	.	.	.	.	.	.	.
22	SUMMER	0	.	.	.	.	.	.	.	.	.	.	.

Aggregate Nutrient Ecoregion: III
Rivers and Streams
Descriptive Statistics by Decade and Season
Parameter Chla_Fluor_ug_L_Median

Eco_ Level_ III	SEASON	N	MEAN	MIN	MAX	STDDEV	STDERR	CV	P5	P25	MEDIAN	P75	P95
22	WINTER	0	.	.	.	.	.	.	.	.	.	.	.
24	FALL	0	.	.	.	.	.	.	.	.	.	.	.
24	SPRING	0	.	.	.	.	.	.	.	.	.	.	.
24	SUMMER	0	.	.	.	.	.	.	.	.	.	.	.
24	WINTER	0	.	.	.	.	.	.	.	.	.	.	.
79	FALL	0	.	.	.	.	.	.	.	.	.	.	.

79	SPRING	0	.	.	.	.	.	.	.	.	.	.	.
79	SUMMER	0	.	.	.	.	.	.	.	.	.	.	.
79	WINTER	0	.	.	.	.	.	.	.	.	.	.	.
80	FALL	2	3.68	3.05	4.30	0.88	0.63	24	3.05	3.05	3.68	4.30	4.30
80	SPRING	12	1.67	.300	3.60	1.13	0.33	68	0.30	0.85	1.13	2.75	3.60
80	SUMMER	5	4.11	.600	7.30	2.76	1.23	67	0.60	2.85	3.30	6.50	7.30
80	WINTER	0	.	.	.	.	.	.	.	.	.	.	.
81	FALL	0	.	.	.	.	.	.	.	.	.	.	.
81	SPRING	0	.	.	.	.	.	.	.	.	.	.	.
81	SUMMER	0	.	.	.	.	.	.	.	.	.	.	.
81	WINTER	0	.	.	.	.	.	.	.	.	.	.	.

Aggregate Nutrient Ecoregion: III
Rivers and Streams
Descriptive Statistics by Decade and Season
Parameter Chla_Phyto_C_F_ug_L_Med

Eco_ Level_ III	SEASON	N	MEAN	MIN	MAX	STDDEV	STDERR	CV	P5	P25	MEDIAN	P75	P95
6	FALL	0	.	.	.	.	.	.	.	.	.	.	.
6	SPRING	0	.	.	.	.	.	.	.	.	.	.	.
6	SUMMER	0	.	.	.	.	.	.	.	.	.	.	.
6	WINTER	0	.	.	.	.	.	.	.	.	.	.	.
10	FALL	1	2.70	2.70	2.70	.	.	.	2.70	2.70	2.70	2.70	2.70
10	SPRING	1	2.40	2.40	2.40	.	.	.	2.40	2.40	2.40	2.40	2.40
10	SUMMER	1	3.90	3.90	3.90	.	.	.	3.90	3.90	3.90	3.90	3.90
10	WINTER	0	.	.	.	.	.	.	.	.	.	.	.
12	FALL	0	.	.	.	.	.	.	.	.	.	.	.
12	SPRING	0	.	.	.	.	.	.	.	.	.	.	.
12	SUMMER	0	.	.	.	.	.	.	.	.	.	.	.
12	WINTER	0	.	.	.	.	.	.	.	.	.	.	.
13	FALL	0	.	.	.	.	.	.	.	.	.	.	.
13	SPRING	0	.	.	.	.	.	.	.	.	.	.	.
13	SUMMER	0	.	.	.	.	.	.	.	.	.	.	.
13	WINTER	0	.	.	.	.	.	.	.	.	.	.	.
14	FALL	0	.	.	.	.	.	.	.	.	.	.	.
14	SPRING	0	.	.	.	.	.	.	.	.	.	.	.
14	SUMMER	0	.	.	.	.	.	.	.	.	.	.	.
14	WINTER	0	.	.	.	.	.	.	.	.	.	.	.
18	FALL	0	.	.	.	.	.	.	.	.	.	.	.
18	SPRING	0	.	.	.	.	.	.	.	.	.	.	.
18	SUMMER	0	.	.	.	.	.	.	.	.	.	.	.
18	WINTER	0	.	.	.	.	.	.	.	.	.	.	.
20	FALL	0	.	.	.	.	.	.	.	.	.	.	.
20	SPRING	0	.	.	.	.	.	.	.	.	.	.	.
20	SUMMER	0	.	.	.	.	.	.	.	.	.	.	.
20	WINTER	0	.	.	.	.	.	.	.	.	.	.	.
22	FALL	0	.	.	.	.	.	.	.	.	.	.	.
22	SPRING	0	.	.	.	.	.	.	.	.	.	.	.
22	SUMMER	0	.	.	.	.	.	.	.	.	.	.	.

Aggregate Nutrient Ecoregion: III

Rivers and Streams

Descriptive Statistics by Decade and Season

Parameter Chla_Phyto_C_F_ug_L_Med

Eco_ Level_ III	SEASON	N	MEAN	MIN	MAX	STDDEV	STDERR	CV	P5	P25	MEDIAN	P75	P95
22	WINTER	0	.	.	.	.	.	.	.	.	.	.	.
24	FALL	0	.	.	.	.	.	.	.	.	.	.	.
24	SPRING	0	.	.	.	.	.	.	.	.	.	.	.
24	SUMMER	0	.	.	.	.	.	.	.	.	.	.	.
24	WINTER	0	.	.	.	.	.	.	.	.	.	.	.
79	FALL	0	.	.	.	.	.	.	.	.	.	.	.
79	SPRING	0	.	.	.	.	.	.	.	.	.	.	.
79	SUMMER	0	.	.	.	.	.	.	.	.	.	.	.
79	WINTER	0	.	.	.	.	.	.	.	.	.	.	.
80	FALL	0	.	.	.	.	.	.	.	.	.	.	.
80	SPRING	0	.	.	.	.	.	.	.	.	.	.	.
80	SUMMER	0	.	.	.	.	.	.	.	.	.	.	.
80	WINTER	0	.	.	.	.	.	.	.	.	.	.	.
81	FALL	0	.	.	.	.	.	.	.	.	.	.	.
81	SPRING	0	.	.	.	.	.	.	.	.	.	.	.
81	SUMMER	0	.	.	.	.	.	.	.	.	.	.	.
81	WINTER	0	.	.	.	.	.	.	.	.	.	.	.

Aggregate Nutrient Ecoregion: III

Rivers and Streams

Descriptive Statistics by Decade and Season

Parameter Chla_Phyto_Spec_A_ug_L_Median

Eco_ Level_ III	SEASON	N	MEAN	MIN	MAX	STDDEV	STDERR	CV	P5	P25	MEDIAN	P75	P95
6	FALL	1	2.24	2.24	2.24	.	.	.	2.24	2.24	2.24	2.24	2.24
6	SPRING	1	2.55	2.55	2.55	.	.	.	2.55	2.55	2.55	2.55	2.55
6	SUMMER	1	3.24	3.24	3.24	.	.	.	3.24	3.24	3.24	3.24	3.24
6	WINTER	2	1.08	.970	1.19	0.16	0.11	14	0.97	0.97	1.08	1.19	1.19
10	FALL	1	0.24	.240	0.24	.	.	.	0.24	0.24	0.24	0.24	0.24
10	SPRING	1	0.12	.120	0.12	.	.	.	0.12	0.12	0.12	0.12	0.12
10	SUMMER	3	1.89	.170	3.80	1.82	1.05	96	0.17	0.17	1.70	3.80	3.80
10	WINTER	1	1.25	1.25	1.25	.	.	.	1.25	1.25	1.25	1.25	1.25
12	FALL	0	.	.	.	.	.	.	.	.	.	.	.
12	SPRING	0	.	.	.	.	.	.	.	.	.	.	.
12	SUMMER	0	.	.	.	.	.	.	.	.	.	.	.
12	WINTER	0	.	.	.	.	.	.	.	.	.	.	.
13	FALL	6	24.6	1.96	70.90	27.5	11.2	112	1.96	3.22	13.3	44.7	70.9
13	SPRING	5	18.2	2.95	56.50	22.4	10.0	124	2.95	3.31	8.75	19.3	56.5
13	SUMMER	6	16.0	2.24	64.20	23.9	9.75	149	2.24	4.70	5.96	13.1	64.2
13	WINTER	3	1.23	1.20	1.30	0.06	0.03	5	1.20	1.20	1.20	1.30	1.30
14	FALL	0	.	.	.	.	.	.	.	.	.	.	.
14	SPRING	0	.	.	.	.	.	.	.	.	.	.	.
14	SUMMER	0	.	.	.	.	.	.	.	.	.	.	.

14	WINTER	0	.	.	.	.	.	.	.	.	.	.	.
18	FALL	0	.	.	.	.	.	.	.	.	.	.	.
18	SPRING	0	.	.	.	.	.	.	.	.	.	.	.
18	SUMMER	0	.	.	.	.	.	.	.	.	.	.	.
18	WINTER	0	.	.	.	.	.	.	.	.	.	.	.
20	FALL	4	8.34	3.70	20.30	7.99	3.99	96	3.70	4.10	4.68	12.6	20.3
20	SPRING	1	15.4	15.4	15.40	.	.	.	15.4	15.4	15.4	15.4	15.4
20	SUMMER	6	6.14	1.60	10.45	3.64	1.49	59	1.60	1.90	7.05	8.80	10.5
20	WINTER	0	.	.	.	.	.	.	.	.	.	.	.
22	FALL	0	.	.	.	.	.	.	.	.	.	.	.
22	SPRING	0	.	.	.	.	.	.	.	.	.	.	.
22	SUMMER	0	.	.	.	.	.	.	.	.	.	.	.

Rivers and Streams

Descriptive Statistics by Decade and Season

Parameter Chla_Phyto_Spec_A_ug_L_Median

Eco_ Level_ III	SEASON	N	MEAN	MIN	MAX	STDDEV	STDERR	CV	P5	P25	MEDIAN	P75	P95
22	WINTER	0	.	.	.	.	.	.	.	.	.	.	.
24	FALL	7	2.77	.250	8.24	2.93	1.11	106	0.25	0.25	2.62	3.96	8.24
24	SPRING	6	3.61	.250	12.20	4.51	1.84	125	0.25	0.25	2.24	4.50	12.2
24	SUMMER	8	3.60	.250	13.70	4.92	1.74	137	0.25	0.31	0.77	6.35	13.7
24	WINTER	7	2.55	.250	8.86	3.04	1.15	119	0.25	0.25	2.00	3.31	8.86
79	FALL	0	.	.	.	.	.	.	.	.	.	.	.
79	SPRING	0	.	.	.	.	.	.	.	.	.	.	.
79	SUMMER	0	.	.	.	.	.	.	.	.	.	.	.
79	WINTER	0	.	.	.	.	.	.	.	.	.	.	.
80	FALL	0	.	.	.	.	.	.	.	.	.	.	.
80	SPRING	0	.	.	.	.	.	.	.	.	.	.	.
80	SUMMER	0	.	.	.	.	.	.	.	.	.	.	.
80	WINTER	0	.	.	.	.	.	.	.	.	.	.	.
81	FALL	0	.	.	.	.	.	.	.	.	.	.	.
81	SPRING	0	.	.	.	.	.	.	.	.	.	.	.
81	SUMMER	0	.	.	.	.	.	.	.	.	.	.	.
81	WINTER	0	.	.	.	.	.	.	.	.	.	.	.

Rivers and Streams

Descriptive Statistics by Decade and Season

Parameter Chla_Tric_U_ug_L_Median

Eco_ Level_ III	SEASON	N	MEAN	MIN	MAX	STDDEV	STDERR	CV	P5	P25	MEDIAN	P75	P95
6	FALL	0	.	.	.	.	.	.	.	.	.	.	.
6	SPRING	0	.	.	.	.	.	.	.	.	.	.	.
6	SUMMER	0	.	.	.	.	.	.	.	.	.	.	.
6	WINTER	0	.	.	.	.	.	.	.	.	.	.	.
10	FALL	0	.	.	.	.	.	.	.	.	.	.	.
10	SPRING	0	.	.	.	.	.	.	.	.	.	.	.
10	SUMMER	0	.	.	.	.	.	.	.	.	.	.	.

10	WINTER	0	.	.	.	.	.	.	.	.	.	.	.
12	FALL	6	5.98	1.10	12.70	4.02	1.64	67	1.10	3.70	5.08	8.20	12.7
12	SPRING	6	17.8	.770	28.90	12.6	5.15	71	0.77	2.90	23.1	27.9	28.9
12	SUMMER	12	7.84	.800	23.95	7.01	2.02	89	0.80	1.68	7.85	11.6	24.0
12	WINTER	4	10.2	4.50	13.85	4.21	2.11	41	4.50	7.03	11.2	13.4	13.9
13	FALL	0	.	.	.	.	.	.	.	.	.	.	.
13	SPRING	0	.	.	.	.	.	.	.	.	.	.	.
13	SUMMER	0	.	.	.	.	.	.	.	.	.	.	.
13	WINTER	0	.	.	.	.	.	.	.	.	.	.	.
14	FALL	0	.	.	.	.	.	.	.	.	.	.	.
14	SPRING	0	.	.	.	.	.	.	.	.	.	.	.
14	SUMMER	0	.	.	.	.	.	.	.	.	.	.	.
14	WINTER	0	.	.	.	.	.	.	.	.	.	.	.
18	FALL	0	.	.	.	.	.	.	.	.	.	.	.
18	SPRING	0	.	.	.	.	.	.	.	.	.	.	.
18	SUMMER	0	.	.	.	.	.	.	.	.	.	.	.
18	WINTER	0	.	.	.	.	.	.	.	.	.	.	.
20	FALL	0	.	.	.	.	.	.	.	.	.	.	.
20	SPRING	0	.	.	.	.	.	.	.	.	.	.	.
20	SUMMER	0	.	.	.	.	.	.	.	.	.	.	.
20	WINTER	0	.	.	.	.	.	.	.	.	.	.	.
22	FALL	0	.	.	.	.	.	.	.	.	.	.	.
22	SPRING	0	.	.	.	.	.	.	.	.	.	.	.
22	SUMMER	0	.	.	.	.	.	.	.	.	.	.	.

Rivers and Streams

Descriptive Statistics by Decade and Season

Parameter Chla_Tric_U_ug_L_Median

Eco_ Level_ III	SEASON	N	MEAN	MIN	MAX	STDDEV	STDERR	CV	P5	P25	MEDIAN	P75	P95
22	WINTER	0	.	.	.	.	.	.	.	.	.	.	.
24	FALL	0	.	.	.	.	.	.	.	.	.	.	.
24	SPRING	0	.	.	.	.	.	.	.	.	.	.	.
24	SUMMER	0	.	.	.	.	.	.	.	.	.	.	.
24	WINTER	0	.	.	.	.	.	.	.	.	.	.	.
79	FALL	0	.	.	.	.	.	.	.	.	.	.	.
79	SPRING	0	.	.	.	.	.	.	.	.	.	.	.
79	SUMMER	0	.	.	.	.	.	.	.	.	.	.	.
79	WINTER	0	.	.	.	.	.	.	.	.	.	.	.
80	FALL	3	9.77	4.75	15.45	5.38	3.11	55	4.75	4.75	9.10	15.5	15.5
80	SPRING	3	15.1	11.9	16.85	2.82	1.63	19	11.9	11.9	16.6	16.9	16.9
80	SUMMER	4	7.67	5.05	11.10	2.81	1.40	37	5.05	5.39	7.27	9.95	11.1
80	WINTER	3	10.5	6.50	14.00	3.77	2.18	36	6.50	6.50	11.0	14.0	14.0
81	FALL	0	.	.	.	.	.	.	.	.	.	.	.
81	SPRING	0	.	.	.	.	.	.	.	.	.	.	.
81	SUMMER	0	.	.	.	.	.	.	.	.	.	.	.
81	WINTER	0	.	.	.	.	.	.	.	.	.	.	.

Aggregate Nutrient Ecoregion: III
Rivers and Streams
Descriptive Statistics by Decade and Season
Parameter Chlb_Phyto_C_F_ug_L_Med

Eco_ Level_ III	SEASON	N	MEAN	MIN	MAX	STDDEV	STDERR	CV	P5	P25	MEDIAN	P75	P95
6	FALL	0	.	.	.	.	.	.	.	.	.	.	.
6	SPRING	0	.	.	.	.	.	.	.	.	.	.	.
6	SUMMER	0	.	.	.	.	.	.	.	.	.	.	.
6	WINTER	0	.	.	.	.	.	.	.	.	.	.	.
10	FALL	1	0.05	.050	0.05	.	.	.	0.05	0.05	0.05	0.05	0.05
10	SPRING	1	0.20	.200	0.20	.	.	.	0.20	0.20	0.20	0.20	0.20
10	SUMMER	1	0.20	.200	0.20	.	.	.	0.20	0.20	0.20	0.20	0.20
10	WINTER	0	.	.	.	.	.	.	.	.	.	.	.
12	FALL	0	.	.	.	.	.	.	.	.	.	.	.
12	SPRING	0	.	.	.	.	.	.	.	.	.	.	.
12	SUMMER	0	.	.	.	.	.	.	.	.	.	.	.
12	WINTER	0	.	.	.	.	.	.	.	.	.	.	.
13	FALL	0	.	.	.	.	.	.	.	.	.	.	.
13	SPRING	0	.	.	.	.	.	.	.	.	.	.	.
13	SUMMER	0	.	.	.	.	.	.	.	.	.	.	.
13	WINTER	0	.	.	.	.	.	.	.	.	.	.	.
14	FALL	0	.	.	.	.	.	.	.	.	.	.	.
14	SPRING	0	.	.	.	.	.	.	.	.	.	.	.
14	SUMMER	0	.	.	.	.	.	.	.	.	.	.	.
14	WINTER	0	.	.	.	.	.	.	.	.	.	.	.
18	FALL	0	.	.	.	.	.	.	.	.	.	.	.
18	SPRING	0	.	.	.	.	.	.	.	.	.	.	.
18	SUMMER	0	.	.	.	.	.	.	.	.	.	.	.
18	WINTER	0	.	.	.	.	.	.	.	.	.	.	.
20	FALL	0	.	.	.	.	.	.	.	.	.	.	.
20	SPRING	0	.	.	.	.	.	.	.	.	.	.	.
20	SUMMER	0	.	.	.	.	.	.	.	.	.	.	.
20	WINTER	0	.	.	.	.	.	.	.	.	.	.	.
22	FALL	0	.	.	.	.	.	.	.	.	.	.	.
22	SPRING	0	.	.	.	.	.	.	.	.	.	.	.
22	SUMMER	0	.	.	.	.	.	.	.	.	.	.	.

Aggregate Nutrient Ecoregion: III
Rivers and Streams
Descriptive Statistics by Decade and Season
Parameter Chlb_Phyto_C_F_ug_L_Med

Eco_ Level_ III	SEASON	N	MEAN	MIN	MAX	STDDEV	STDERR	CV	P5	P25	MEDIAN	P75	P95
22	WINTER	0	.	.	.	.	.	.	.	.	.	.	.
24	FALL	0	.	.	.	.	.	.	.	.	.	.	.
24	SPRING	0	.	.	.	.	.	.	.	.	.	.	.
24	SUMMER	0	.	.	.	.	.	.	.	.	.	.	.
24	WINTER	0	.	.	.	.	.	.	.	.	.	.	.

79	FALL	0	.	.	.	.	.	.	.	.	.	.	.
79	SPRING	0	.	.	.	.	.	.	.	.	.	.	.
79	SUMMER	0	.	.	.	.	.	.	.	.	.	.	.
79	WINTER	0	.	.	.	.	.	.	.	.	.	.	.
80	FALL	0	.	.	.	.	.	.	.	.	.	.	.
80	SPRING	0	.	.	.	.	.	.	.	.	.	.	.
80	SUMMER	0	.	.	.	.	.	.	.	.	.	.	.
80	WINTER	0	.	.	.	.	.	.	.	.	.	.	.
81	FALL	0	.	.	.	.	.	.	.	.	.	.	.
81	SPRING	0	.	.	.	.	.	.	.	.	.	.	.
81	SUMMER	0	.	.	.	.	.	.	.	.	.	.	.
81	WINTER	0	.	.	.	.	.	.	.	.	.	.	.

Aggregate Nutrient Ecoregion: III
Rivers and Streams
Descriptive Statistics by Decade and Season
Parameter DIP_ug_L_Median

Eco_ Level_ III	SEASON	N	MEAN	MIN	MAX	STDDEV	STDERR	CV	P5	P25	MEDIAN	P75	P95
6	FALL	7	441	5.00	2575.00	944	357	214	5.00	15.0	55.0	193	2575
6	SPRING	8	415	6.25	1350.00	562	199	135	6.25	35.0	115	833	1350
6	SUMMER	7	434	5.00	2150.00	783	296	181	5.00	10.0	47.5	555	2150
6	WINTER	7	706	10.0	2375.00	1115	422	158	10.0	20.0	67.5	2300	2375
10	FALL	26	113	.000	2050.00	397	77.8	351	0.00	6.25	29.5	47.5	160
10	SPRING	26	48.9	.000	480.00	94.0	18.4	192	0.00	7.50	25.0	47.5	125
10	SUMMER	26	86.5	.000	1500.00	290	57.0	336	0.00	5.00	12.5	60.0	140
10	WINTER	22	93.9	5.00	730.00	155	33.1	165	7.50	11.3	45.0	105	240
12	FALL	18	58.5	5.00	340.00	74.8	17.6	128	5.00	25.0	47.5	60.0	340
12	SPRING	18	61.3	5.00	280.00	63.3	14.9	103	5.00	20.0	46.9	80.0	280
12	SUMMER	18	65.3	5.00	292.50	66.7	15.7	102	5.00	20.0	50.0	90.0	293
12	WINTER	18	69.5	5.00	430.00	96.4	22.7	139	5.00	10.0	50.0	80.0	430
13	FALL	20	120	5.00	1550.00	346	77.5	289	5.63	7.50	18.0	56.3	964
13	SPRING	20	107	5.00	1100.00	263	58.8	246	5.63	11.3	20.0	50.5	829
13	SUMMER	20	94.1	5.00	1187.50	262	58.5	278	5.00	10.0	21.0	42.5	693
13	WINTER	19	194	5.00	2000.00	520	119	268	5.00	9.00	20.0	50.0	2000
14	FALL	4	42.2	6.25	75.00	29.6	14.8	70	6.25	19.4	43.8	65.0	75.0
14	SPRING	4	41.3	5.00	80.00	33.0	16.5	80	5.00	15.0	40.0	67.5	80.0
14	SUMMER	4	27.2	5.00	47.50	19.0	9.50	70	5.00	11.9	28.1	42.5	47.5
14	WINTER	4	67.2	6.25	125.00	48.5	24.3	72	6.25	36.9	68.8	97.5	125
18	FALL	7	8.04	5.00	13.75	3.90	1.47	49	5.00	5.00	5.00	12.0	13.8
18	SPRING	7	16.2	5.00	30.00	9.78	3.70	60	5.00	11.0	12.5	30.0	30.0
18	SUMMER	7	12.0	5.00	20.00	5.42	2.05	45	5.00	7.50	13.8	16.0	20.0
18	WINTER	7	12.3	5.00	16.00	3.75	1.42	30	5.00	10.0	13.8	15.0	16.0
20	FALL	7	7.86	5.00	22.50	6.52	2.47	83	5.00	5.00	5.00	7.50	22.5
20	SPRING	7	12.5	5.00	22.50	7.00	2.64	56	5.00	6.25	13.8	20.0	22.5
20	SUMMER	7	10.4	5.00	17.50	5.34	2.02	52	5.00	5.00	11.3	15.0	17.5
20	WINTER	7	11.1	5.00	20.00	7.05	2.66	64	5.00	5.00	7.50	20.0	20.0
22	FALL	11	196	5.00	2000.00	598	180	305	5.00	7.50	15.0	25.0	2000
22	SPRING	11	86.5	5.00	745.00	219	66.0	253	5.00	8.75	25.0	40.0	745
22	SUMMER	11	120	6.25	1100.00	325	98.1	271	6.25	12.5	20.0	35.0	1100

Rivers and Streams
Descriptive Statistics by Decade and Season
Parameter DIP_ug_L_Median

Eco_ Level_ III	SEASON	N	MEAN	MIN	MAX	STDDEV	STDERR	CV	P5	P25	MEDIAN	P75	P95
22	WINTER	11	88.2	5.00	760.00	223	67.3	253	5.00	13.8	20.0	37.5	760
24	FALL	9	101	5.00	670.00	216	72.0	213	5.00	7.50	11.3	80.0	670
24	SPRING	9	47.4	5.00	235.00	75.0	25.0	158	5.00	5.00	8.75	42.5	235
24	SUMMER	9	40.0	5.00	152.50	48.6	16.2	122	5.00	7.50	15.0	52.5	153
24	WINTER	9	152	5.00	1055.00	342	114	225	5.00	5.00	7.50	110	1055
79	FALL	1	13.8	13.8	13.75	.	.	.	13.8	13.8	13.8	13.8	13.8
79	SPRING	1	5.00	5.00	5.00	.	.	.	5.00	5.00	5.00	5.00	5.00
79	SUMMER	1	18.8	18.8	18.75	.	.	.	18.8	18.8	18.8	18.8	18.8
79	WINTER	1	12.5	12.5	12.50	.	.	.	12.5	12.5	12.5	12.5	12.5
80	FALL	2	40.0	30.0	50.00	14.1	10.0	35	30.0	30.0	40.0	50.0	50.0
80	SPRING	2	60.6	51.3	70.00	13.3	9.38	22	51.3	51.3	60.6	70.0	70.0
80	SUMMER	2	37.5	5.00	70.00	46.0	32.5	123	5.00	5.00	37.5	70.0	70.0
80	WINTER	1	65.0	65.0	65.00	.	.	.	65.0	65.0	65.0	65.0	65.0
81	FALL	6	372	5.00	1950.00	776	317	209	5.00	20.0	37.5	180	1950
81	SPRING	6	214	5.00	640.00	288	117	135	5.00	16.3	48.8	523	640
81	SUMMER	6	160	5.00	515.00	230	93.9	144	5.00	10.0	20.0	390	515
81	WINTER	6	280	12.5	1350.00	529	216	189	12.5	16.3	53.8	193	1350

Rivers and Streams
Descriptive Statistics by Decade and Season
Parameter DO_mg_L_Median

Eco_ Level_ III	SEASON	N	MEAN	MIN	MAX	STDDEV	STDERR	CV	P5	P25	MEDIAN	P75	P95
6	FALL	13	9.08	2.70	12.10	2.28	0.63	25	2.70	8.40	9.20	10.4	12.1
6	SPRING	22	10.3	5.85	13.70	1.63	0.35	16	7.60	9.73	10.3	11.2	12.4
6	SUMMER	20	8.72	.850	12.90	2.43	0.54	28	3.60	7.75	9.05	10.2	11.9
6	WINTER	22	10.2	6.30	12.40	1.31	0.28	13	8.20	9.65	10.2	10.8	12.2
10	FALL	97	10.5	5.68	13.05	1.04	0.11	10	9.05	9.80	10.6	11.1	12.2
10	SPRING	101	10.5	5.85	13.95	1.40	0.14	13	8.10	9.65	10.5	11.4	12.5
10	SUMMER	104	9.34	5.35	12.80	1.08	0.11	12	7.65	8.88	9.30	10.0	10.8
10	WINTER	80	12.4	7.40	14.05	1.13	0.13	9	9.94	12.1	12.6	13.0	13.8
12	FALL	65	9.37	5.10	12.10	1.26	0.16	13	7.40	8.70	9.40	10.1	11.6
12	SPRING	68	10.1	3.90	33.00	3.08	0.37	30	8.20	9.30	9.81	10.5	11.7
12	SUMMER	76	9.70	4.20	102.50	10.9	1.25	112	6.10	7.74	8.50	9.03	11.6
12	WINTER	45	11.2	4.10	14.50	1.86	0.28	17	7.98	10.6	11.5	12.3	13.2
13	FALL	120	8.79	4.40	11.85	1.33	0.12	15	6.51	8.00	8.90	9.65	10.9
13	SPRING	161	8.84	3.50	12.30	1.34	0.11	15	6.35	8.10	9.03	9.70	10.7
13	SUMMER	160	8.13	2.25	12.60	1.32	0.10	16	5.86	7.48	8.20	8.98	10.0
13	WINTER	115	10.1	2.20	13.10	1.72	0.16	17	6.98	9.33	10.4	11.2	12.2
14	FALL	5	8.70	6.70	11.10	1.57	0.70	18	6.70	8.50	8.53	8.65	11.1
14	SPRING	8	8.35	7.10	9.80	0.92	0.32	11	7.10	7.63	8.40	8.93	9.80
14	SUMMER	5	7.86	7.30	8.90	0.64	0.29	8	7.30	7.50	7.55	8.05	8.90

14	WINTER	5	10.1	7.80	11.00	1.31	0.59	13	7.80	10.4	10.7	10.7	11.0
18	FALL	22	9.73	7.40	12.30	1.33	0.28	14	8.08	8.80	9.63	10.6	12.0
18	SPRING	25	9.77	6.98	11.50	1.09	0.22	11	8.30	9.15	9.70	10.6	11.3
18	SUMMER	25	8.59	4.80	12.30	1.57	0.31	18	6.60	7.80	8.28	9.20	12.0
18	WINTER	19	11.0	9.65	12.68	0.89	0.20	8	9.65	10.3	11.2	11.6	12.7
20	FALL	128	8.90	1.30	11.70	1.57	0.14	18	6.20	8.08	9.10	9.88	11.0
20	SPRING	112	8.83	3.95	11.35	1.14	0.11	13	7.03	8.23	8.88	9.50	10.6
20	SUMMER	130	7.75	2.70	10.60	1.21	0.11	16	5.40	7.40	8.00	8.45	9.15
20	WINTER	83	10.9	7.70	14.00	1.19	0.13	11	9.20	10.1	10.9	11.7	13.0
22	FALL	49	9.10	5.50	11.35	1.03	0.15	11	7.60	8.55	9.05	9.60	10.7
22	SPRING	52	9.30	7.55	13.35	1.06	0.15	11	8.10	8.55	9.15	9.90	10.6
22	SUMMER	53	7.75	4.80	12.70	1.31	0.18	17	5.95	7.20	7.70	8.20	10.0

Rivers and Streams

Descriptive Statistics by Decade and Season

Parameter DO_mg_L_Median

Eco_ Level_ III	SEASON	N	MEAN	MIN	MAX	STDDEV	STDERR	CV	P5	P25	MEDIAN	P75	P95
22	WINTER	39	11.1	8.90	12.65	0.85	0.14	8	9.65	10.6	11.0	11.9	12.6
24	FALL	12	8.52	6.40	9.70	0.90	0.26	11	6.40	8.34	8.53	9.05	9.70
24	SPRING	21	8.20	6.20	10.30	1.10	0.24	13	6.20	7.60	8.40	8.90	9.60
24	SUMMER	14	7.46	5.00	9.95	1.10	0.29	15	5.00	6.90	7.50	7.70	9.95
24	WINTER	18	8.75	4.00	11.15	1.94	0.46	22	4.00	8.00	9.50	10.1	11.2
79	FALL	13	7.52	4.90	10.40	1.64	0.46	22	4.90	6.45	8.10	8.25	10.4
79	SPRING	18	8.09	6.10	11.00	1.07	0.25	13	6.10	7.65	8.18	8.60	11.0
79	SUMMER	14	6.63	2.20	8.60	1.71	0.46	26	2.20	6.20	7.10	7.85	8.60
79	WINTER	15	9.37	5.70	10.95	1.26	0.33	13	5.70	8.50	9.83	10.1	11.0
80	FALL	23	9.29	7.10	12.90	1.48	0.31	16	7.30	7.95	9.25	10.1	11.9
80	SPRING	18	10.1	8.25	12.10	1.22	0.29	12	8.25	9.20	10.2	10.6	12.1
80	SUMMER	19	9.02	6.60	11.40	1.17	0.27	13	6.60	8.40	8.83	9.53	11.4
80	WINTER	13	11.8	9.70	13.60	1.15	0.32	10	9.70	11.2	11.7	12.5	13.6
81	FALL	20	7.80	4.65	10.55	1.41	0.32	18	4.85	7.28	8.09	8.60	10.0
81	SPRING	20	8.41	4.35	11.20	1.53	0.34	18	5.11	8.10	8.68	9.28	10.7
81	SUMMER	24	6.91	2.90	8.70	1.48	0.30	21	4.30	6.25	7.30	7.95	8.58
81	WINTER	22	9.23	5.60	13.00	1.57	0.34	17	6.00	8.40	9.28	10.2	10.9

Rivers and Streams

Descriptive Statistics by Decade and Season

Parameter NO2_NO3_mg_L_Median

Eco_ Level_ III	SEASON	N	MEAN	MIN	MAX	STDDEV	STDERR	CV	P5	P25	MEDIAN	P75	P95
6	FALL	11	1.98	.025	8.15	3.07	0.92	155	0.03	0.07	0.27	2.20	8.15
6	SPRING	20	1.97	.050	7.00	2.07	0.46	105	0.06	0.48	0.94	3.45	6.18
6	SUMMER	17	1.56	.018	8.40	2.78	0.67	179	0.02	0.11	0.16	1.33	8.40
6	WINTER	19	1.88	.025	9.10	2.54	0.58	135	0.03	0.20	0.90	1.60	9.10
10	FALL	66	0.81	.003	7.80	1.50	0.18	184	0.01	0.06	0.24	0.95	3.66
10	SPRING	70	1.22	.002	9.76	2.15	0.26	176	0.00	0.08	0.26	1.30	7.00
10	SUMMER	71	0.93	.000	9.95	1.87	0.22	201	0.00	0.05	0.17	0.95	5.49

10	WINTER	59	1.46	.015	9.45	1.91	0.25	131	0.04	0.18	0.45	2.32	6.00
12	FALL	71	1.68	.025	9.57	1.53	0.18	92	0.03	0.33	1.84	2.38	3.89
12	SPRING	78	1.27	.002	6.45	1.18	0.13	93	0.01	0.21	0.97	2.13	3.27
12	SUMMER	78	1.38	.002	4.51	1.15	0.13	83	0.02	0.20	1.47	2.28	3.50
12	WINTER	63	2.26	.040	9.14	1.76	0.22	78	0.17	0.90	2.03	3.05	5.41
13	FALL	65	0.56	.003	3.95	0.74	0.09	133	0.01	0.05	0.31	0.75	1.89
13	SPRING	38	0.39	.005	2.70	0.53	0.09	138	0.01	0.04	0.16	0.56	1.49
13	SUMMER	43	0.38	.005	3.01	0.72	0.11	189	0.01	0.03	0.13	0.35	2.70
13	WINTER	60	0.69	.010	5.77	1.06	0.14	155	0.02	0.04	0.20	0.99	2.70
14	FALL	7	0.84	.300	2.25	0.71	0.27	84	0.30	0.35	0.57	1.31	2.25
14	SPRING	7	0.63	.235	2.10	0.65	0.25	104	0.24	0.38	0.41	0.44	2.10
14	SUMMER	7	0.75	.160	2.35	0.76	0.29	101	0.16	0.26	0.45	1.01	2.35
14	WINTER	7	0.69	.326	1.60	0.47	0.18	68	0.33	0.36	0.41	0.93	1.60
18	FALL	20	0.15	.000	1.38	0.32	0.07	213	0.00	0.01	0.03	0.13	0.99
18	SPRING	22	0.22	.000	1.03	0.31	0.07	142	0.01	0.03	0.04	0.35	0.90
18	SUMMER	21	0.27	.000	2.28	0.58	0.13	213	0.01	0.03	0.07	0.15	1.60
18	WINTER	23	0.53	.000	5.70	1.19	0.25	225	0.01	0.05	0.18	0.36	1.50
20	FALL	77	0.26	.000	2.90	0.46	0.05	175	0.00	0.00	0.09	0.39	1.03
20	SPRING	53	0.23	.000	3.33	0.50	0.07	219	0.00	0.00	0.02	0.32	0.94
20	SUMMER	63	0.30	.000	3.63	0.65	0.08	220	0.00	0.00	0.01	0.35	1.34
20	WINTER	47	0.42	.000	4.81	0.76	0.11	180	0.00	0.00	0.20	0.58	1.12
22	FALL	71	0.23	.000	4.88	0.62	0.07	271	0.00	0.01	0.03	0.21	0.82
22	SPRING	74	0.13	.000	1.79	0.27	0.03	213	0.00	0.01	0.03	0.12	0.69
22	SUMMER	76	0.29	.000	7.20	0.96	0.11	325	0.00	0.01	0.03	0.20	0.95

Aggregate Nutrient Ecoregion: III
Rivers and Streams
Descriptive Statistics by Decade and Season
Parameter NO2_NO3_mg_L_Median

Eco_ Level_ III	SEASON	N	MEAN	MIN	MAX	STDDEV	STDERR	CV	P5	P25	MEDIAN	P75	P95
22	WINTER	47	0.21	.000	1.70	0.35	0.05	167	0.00	0.00	0.08	0.24	1.10
24	FALL	16	0.97	.200	3.59	0.86	0.22	89	0.20	0.46	0.61	1.55	3.59
24	SPRING	16	0.46	.110	1.37	0.37	0.09	79	0.11	0.20	0.33	0.67	1.37
24	SUMMER	17	0.47	.070	1.20	0.36	0.09	76	0.07	0.26	0.38	0.68	1.20
24	WINTER	14	0.85	.470	1.70	0.46	0.12	54	0.47	0.52	0.66	1.02	1.70
79	FALL	14	0.46	.000	3.80	1.01	0.27	219	0.00	0.02	0.03	0.47	3.80
79	SPRING	21	0.33	.000	4.72	1.02	0.22	308	0.00	0.01	0.03	0.11	0.57
79	SUMMER	17	0.27	.015	2.68	0.64	0.15	234	0.02	0.02	0.05	0.16	2.68
79	WINTER	17	0.69	.013	4.52	1.38	0.34	200	0.01	0.03	0.19	0.49	4.52
80	FALL	16	0.20	.005	1.20	0.36	0.09	182	0.01	0.01	0.04	0.17	1.20
80	SPRING	18	0.17	.005	1.00	0.30	0.07	174	0.01	0.02	0.05	0.17	1.00
80	SUMMER	9	0.27	.020	1.49	0.47	0.16	175	0.02	0.03	0.07	0.20	1.49
80	WINTER	10	0.92	.040	3.40	1.11	0.35	121	0.04	0.14	0.32	1.80	3.40
81	FALL	25	1.12	.000	7.45	2.03	0.41	181	0.01	0.09	0.37	0.94	7.30
81	SPRING	26	1.08	.018	7.50	1.88	0.37	174	0.03	0.12	0.34	0.99	6.15
81	SUMMER	29	0.94	.000	7.25	1.72	0.32	184	0.01	0.03	0.23	1.00	5.60
81	WINTER	32	1.11	.013	9.30	2.13	0.38	192	0.02	0.04	0.30	1.00	7.20

Aggregate Nutrient Ecoregion: III
Rivers and Streams
Descriptive Statistics by Decade and Season
Parameter TKN_mg_L_Median

Eco_ Level_ III	SEASON	N	MEAN	MIN	MAX	STDDEV	STDERR	CV	P5	P25	MEDIAN	P75	P95
6	FALL	35	1.30	.050	3.50	1.01	0.17	78	0.05	0.60	1.01	2.05	3.50
6	SPRING	44	1.12	.050	3.50	0.97	0.15	87	0.10	0.35	0.87	1.45	3.30
6	SUMMER	40	1.19	.050	5.00	1.24	0.20	104	0.05	0.38	0.80	1.48	4.10
6	WINTER	47	1.26	.050	8.45	1.38	0.20	109	0.05	0.33	1.05	1.45	3.30
10	FALL	103	0.32	.035	1.10	0.21	0.02	65	0.05	0.19	0.30	0.40	0.77
10	SPRING	107	0.49	.070	2.90	0.35	0.03	70	0.15	0.30	0.43	0.60	0.99
10	SUMMER	106	0.44	.000	1.28	0.25	0.02	57	0.08	0.28	0.40	0.62	0.86
10	WINTER	79	0.50	.100	1.56	0.32	0.04	64	0.13	0.30	0.43	0.60	1.24
12	FALL	72	0.38	.050	1.41	0.23	0.03	60	0.09	0.25	0.36	0.52	0.71
12	SPRING	80	0.47	.010	1.69	0.29	0.03	62	0.10	0.27	0.42	0.60	0.90
12	SUMMER	82	0.51	.120	2.62	0.37	0.04	72	0.14	0.30	0.44	0.60	1.18
12	WINTER	50	0.43	.050	2.36	0.34	0.05	80	0.10	0.27	0.39	0.50	0.80
13	FALL	122	0.51	.025	2.36	0.42	0.04	84	0.05	0.24	0.41	0.63	1.38
13	SPRING	169	0.63	.025	4.23	0.71	0.05	113	0.03	0.21	0.45	0.65	2.21
13	SUMMER	168	0.60	.025	4.76	0.60	0.05	101	0.07	0.29	0.50	0.68	1.70
13	WINTER	124	0.63	.025	4.70	0.72	0.06	115	0.08	0.22	0.40	0.79	2.50
14	FALL	10	0.63	.050	2.00	0.60	0.19	94	0.05	0.30	0.51	0.63	2.00
14	SPRING	12	0.74	.050	2.60	0.80	0.23	108	0.05	0.22	0.45	1.02	2.60
14	SUMMER	10	0.59	.125	1.43	0.45	0.14	76	0.13	0.28	0.43	0.87	1.43
14	WINTER	10	0.76	.150	1.61	0.59	0.19	78	0.15	0.35	0.52	1.55	1.61
18	FALL	22	0.26	.050	0.65	0.18	0.04	68	0.05	0.15	0.25	0.30	0.60
18	SPRING	26	0.51	.000	2.30	0.41	0.08	81	0.05	0.33	0.50	0.58	0.73
18	SUMMER	23	0.42	.050	1.09	0.27	0.06	63	0.05	0.28	0.40	0.53	0.90
18	WINTER	19	0.25	.050	0.50	0.13	0.03	53	0.05	0.18	0.23	0.30	0.50
20	FALL	116	0.40	.000	3.90	0.46	0.04	117	0.00	0.13	0.30	0.50	1.05
20	SPRING	123	0.47	.000	2.84	0.47	0.04	102	0.03	0.20	0.34	0.54	1.61
20	SUMMER	121	0.47	.000	2.26	0.46	0.04	96	0.00	0.17	0.35	0.65	1.57
20	WINTER	64	0.44	.000	2.64	0.53	0.07	121	0.00	0.08	0.31	0.61	1.23
22	FALL	70	0.56	.000	13.10	1.59	0.19	285	0.03	0.05	0.20	0.62	1.40
22	SPRING	73	0.61	.000	12.25	1.48	0.17	243	0.03	0.10	0.33	0.60	1.25
22	SUMMER	74	0.80	.000	28.00	3.26	0.38	407	0.00	0.10	0.23	0.60	1.55

Aggregate Nutrient Ecoregion: III
Rivers and Streams
Descriptive Statistics by Decade and Season
Parameter TKN_mg_L_Median

Eco_ Level_ III	SEASON	N	MEAN	MIN	MAX	STDDEV	STDERR	CV	P5	P25	MEDIAN	P75	P95
22	WINTER	52	0.65	.000	13.00	2.17	0.30	335	0.00	0.05	0.09	0.40	1.15
24	FALL	18	0.50	.050	2.98	0.66	0.16	133	0.05	0.16	0.35	0.55	2.98
24	SPRING	28	0.60	.080	5.40	0.97	0.18	161	0.10	0.26	0.45	0.53	1.00
24	SUMMER	21	0.44	.070	1.30	0.31	0.07	69	0.10	0.21	0.40	0.58	0.95
24	WINTER	22	0.55	.050	4.70	0.96	0.20	175	0.05	0.10	0.34	0.60	0.83

79	FALL	14	0.15	.038	0.54	0.15	0.04	99	0.04	0.05	0.08	0.24	0.54
79	SPRING	21	0.26	.050	0.57	0.14	0.03	53	0.08	0.18	0.23	0.35	0.55
79	SUMMER	17	0.34	.050	1.75	0.42	0.10	121	0.05	0.13	0.20	0.30	1.75
79	WINTER	17	0.45	.013	2.20	0.61	0.15	136	0.01	0.08	0.17	0.50	2.20
80	FALL	24	0.37	.088	0.80	0.15	0.03	41	0.18	0.25	0.38	0.47	0.53
80	SPRING	24	0.50	.200	1.40	0.30	0.06	60	0.23	0.30	0.38	0.66	1.10
80	SUMMER	21	0.44	.050	1.60	0.38	0.08	86	0.05	0.21	0.32	0.50	1.25
80	WINTER	14	0.36	.050	1.17	0.28	0.07	77	0.05	0.14	0.34	0.44	1.17
81	FALL	26	1.11	.000	4.60	1.35	0.26	122	0.00	0.17	0.43	1.50	3.70
81	SPRING	26	0.73	.050	3.48	0.94	0.18	129	0.05	0.25	0.33	0.61	3.30
81	SUMMER	29	0.93	.075	5.40	1.22	0.23	131	0.18	0.30	0.39	0.70	3.40
81	WINTER	32	0.79	.075	4.40	1.04	0.18	132	0.10	0.20	0.33	0.92	3.63

Rivers and Streams

Descriptive Statistics by Decade and Season

Parameter TN_mg_L_Median

Eco_ Level_ III	SEASON	N	MEAN	MIN	MAX	STDDEV	STDERR	CV	P5	P25	MEDIAN	P75	P95
6	FALL	9	2.30	.245	9.45	3.47	1.16	151	0.25	0.50	0.51	1.11	9.45
6	SPRING	10	2.67	.200	9.90	3.33	1.05	124	0.20	0.50	1.60	2.45	9.90
6	SUMMER	10	2.39	.380	10.00	3.66	1.16	153	0.38	0.50	0.74	1.00	10.0
6	WINTER	10	3.41	.200	12.50	4.36	1.38	128	0.20	0.75	1.44	4.50	12.5
10	FALL	23	0.72	.073	3.27	0.83	0.17	116	0.09	0.21	0.40	0.87	2.74
10	SPRING	24	0.75	.090	2.65	0.72	0.15	96	0.13	0.23	0.52	0.96	2.33
10	SUMMER	24	0.70	.060	3.30	0.86	0.18	122	0.09	0.13	0.33	1.01	2.79
10	WINTER	24	0.83	.090	2.90	0.77	0.16	93	0.10	0.26	0.63	1.09	2.62
12	FALL	4	1.65	.300	2.98	1.11	0.56	67	0.30	0.85	1.66	2.45	2.98
12	SPRING	4	1.53	.435	2.85	1.00	0.50	65	0.44	0.89	1.41	2.16	2.85
12	SUMMER	4	1.59	.300	2.60	0.97	0.48	61	0.30	0.90	1.73	2.28	2.60
12	WINTER	4	2.31	.670	4.50	1.60	0.80	69	0.67	1.34	2.03	3.28	4.50
13	FALL	34	0.91	.200	6.00	1.03	0.18	113	0.22	0.42	0.53	1.19	2.13
13	SPRING	34	1.00	.240	5.10	0.95	0.16	95	0.26	0.51	0.66	1.08	2.60
13	SUMMER	36	0.80	.273	4.35	0.74	0.12	93	0.30	0.39	0.57	0.91	2.20
13	WINTER	30	1.17	.220	7.10	1.51	0.28	128	0.26	0.44	0.59	1.17	5.35
14	FALL	6	0.98	.530	1.37	0.37	0.15	38	0.53	0.67	1.02	1.30	1.37
14	SPRING	6	0.83	.625	1.19	0.22	0.09	26	0.63	0.68	0.76	0.99	1.19
14	SUMMER	6	0.76	.448	1.08	0.25	0.10	33	0.45	0.58	0.73	1.03	1.08
14	WINTER	6	0.96	.610	1.22	0.27	0.11	28	0.61	0.75	0.99	1.20	1.22
18	FALL	5	0.37	.250	0.65	0.16	0.07	43	0.25	0.30	0.30	0.35	0.65
18	SPRING	5	0.67	.500	1.06	0.22	0.10	33	0.50	0.55	0.59	0.64	1.06
18	SUMMER	4	0.59	.400	0.98	0.26	0.13	44	0.40	0.44	0.50	0.75	0.98
18	WINTER	5	0.62	.280	1.45	0.48	0.21	77	0.28	0.30	0.49	0.60	1.45
20	FALL	8	0.77	.100	1.60	0.46	0.16	59	0.10	0.51	0.70	1.03	1.60
20	SPRING	8	0.90	.770	1.06	0.12	0.04	13	0.77	0.81	0.87	1.03	1.06
20	SUMMER	8	0.91	.200	2.00	0.62	0.22	67	0.20	0.45	0.73	1.38	2.00
20	WINTER	3	0.97	.598	1.20	0.32	0.19	33	0.60	0.60	1.10	1.20	1.20
22	FALL	31	0.47	.050	1.80	0.42	0.08	90	0.08	0.17	0.31	0.68	1.26
22	SPRING	33	0.67	.040	4.39	0.82	0.14	122	0.05	0.24	0.46	0.61	2.50
22	SUMMER	33	0.62	.035	4.50	0.84	0.15	136	0.10	0.22	0.35	0.64	2.23

Aggregate Nutrient Ecoregion: III
Rivers and Streams
Descriptive Statistics by Decade and Season
Parameter TN_mg_L_Median

Eco_ Level_ III	SEASON	N	MEAN	MIN	MAX	STDDEV	STDERR	CV	P5	P25	MEDIAN	P75	P95
22	WINTER	13	1.49	.045	14.00	3.76	1.04	252	0.05	0.36	0.47	0.65	14.0
24	FALL	11	1.35	.340	4.75	1.23	0.37	91	0.34	0.57	1.19	1.70	4.75
24	SPRING	11	0.93	.390	1.70	0.42	0.13	45	0.39	0.50	0.85	1.35	1.70
24	SUMMER	14	0.97	.470	1.60	0.38	0.10	39	0.47	0.66	0.88	1.21	1.60
24	WINTER	8	1.87	.800	5.50	1.50	0.53	80	0.80	1.17	1.53	1.61	5.50
79	FALL	1	0.20	.200	0.20	.	.	.	0.20	0.20	0.20	0.20	0.20
79	SPRING	5	0.33	.190	0.61	0.17	0.08	51	0.19	0.23	0.26	0.35	0.61
79	SUMMER	1	0.50	.500	0.50	.	.	.	0.50	0.50	0.50	0.50	0.50
79	WINTER	1	0.47	.470	0.47	.	.	.	0.47	0.47	0.47	0.47	0.47
80	FALL	6	0.66	.390	1.60	0.47	0.19	71	0.39	0.42	0.50	0.56	1.60
80	SPRING	6	0.85	.450	1.80	0.51	0.21	60	0.45	0.54	0.63	1.04	1.80
80	SUMMER	5	0.68	.335	1.60	0.52	0.23	76	0.34	0.43	0.52	0.53	1.60
80	WINTER	1	2.15	2.15	2.15	.	.	.	2.15	2.15	2.15	2.15	2.15
81	FALL	8	3.07	.395	10.15	4.09	1.45	133	0.40	0.74	1.01	5.27	10.2
81	SPRING	8	2.97	.300	11.00	4.28	1.51	144	0.30	0.57	0.71	4.95	11.0
81	SUMMER	8	2.81	.300	10.00	4.09	1.44	145	0.30	0.48	0.71	4.90	10.0
81	WINTER	8	3.08	.295	10.50	4.18	1.48	136	0.30	0.64	1.03	5.25	10.5

Aggregate Nutrient Ecoregion: III
Rivers and Streams
Descriptive Statistics by Decade and Season
Parameter TP_ug_L_Median

Eco_ Level_ III	SEASON	N	MEAN	MIN	MAX	STDDEV	STDERR	CV	P5	P25	MEDIAN	P75	P95
6	FALL	17	424	2.50	2825.00	746	181	176	2.50	20.0	138	205	2825
6	SPRING	27	273	2.50	2200.00	491	94.5	180	8.13	40.0	105	193	1275
6	SUMMER	23	411	2.50	3600.00	869	181	211	10.0	20.0	50.0	105	1600
6	WINTER	24	579	10.0	4250.00	1111	227	192	10.0	42.5	153	255	3000
10	FALL	123	103	2.50	2350.00	251	22.6	244	6.25	30.0	55.0	105	180
10	SPRING	129	114	2.50	1985.00	188	16.6	165	15.0	40.0	80.0	130	280
10	SUMMER	127	109	2.50	1650.00	200	17.8	184	5.00	30.0	65.0	110	250
10	WINTER	103	157	.000	2155.00	252	24.8	161	6.25	30.0	90.0	178	510
12	FALL	76	123	2.50	745.00	124	14.2	100	5.00	35.0	97.5	168	375
12	SPRING	84	265	10.0	8410.00	921	101	348	10.0	50.0	95.0	203	600
12	SUMMER	87	271	10.0	8440.00	908	97.3	335	20.0	57.5	130	220	530
12	WINTER	51	209	2.50	4272.50	597	83.5	285	10.0	30.0	75.0	183	510
13	FALL	149	172	2.50	2300.00	359	29.4	208	6.88	27.5	70.0	130	780
13	SPRING	188	156	2.50	1880.00	277	20.2	177	5.00	30.0	70.0	155	600
13	SUMMER	193	145	2.50	2200.00	266	19.1	183	10.0	25.0	67.5	142	450
13	WINTER	139	172	2.50	2100.00	333	28.3	194	4.38	30.0	70.0	149	700
14	FALL	10	170	5.00	495.00	161	50.8	95	5.00	10.0	164	275	495
14	SPRING	12	153	2.50	535.00	166	48.0	109	2.50	10.0	113	216	535
14	SUMMER	10	127	5.00	425.00	130	41.1	103	5.00	10.0	101	145	425

14	WINTER	10	221	10.0	550.00	203	64.2	92	10.0	15.0	180	400	550
18	FALL	37	41.3	5.00	480.00	76.9	12.6	186	5.00	15.6	30.0	36.3	100
18	SPRING	36	73.1	5.00	310.00	67.1	11.2	92	5.00	30.0	62.5	81.3	300
18	SUMMER	46	60.8	5.00	510.00	82.8	12.2	136	5.00	20.0	42.5	70.0	178
18	WINTER	29	42.4	4.38	250.00	44.7	8.29	105	10.0	23.8	35.0	45.0	110
20	FALL	143	57.0	.000	605.00	78.7	6.58	138	2.50	16.3	35.0	60.6	170
20	SPRING	142	103	.000	960.00	135	11.3	131	2.50	20.0	55.0	128	353
20	SUMMER	149	79.0	.000	1250.00	134	11.0	170	2.50	20.0	40.0	95.0	240
20	WINTER	88	91.2	.000	1220.00	170	18.1	187	2.50	20.0	45.0	70.0	370
22	FALL	78	248	.000	7975.00	958	108	387	2.50	10.0	31.3	100	1180
22	SPRING	83	300	.000	8575.00	1141	125	380	2.50	20.0	80.0	150	655
22	SUMMER	82	337	.000	17000.0	1881	208	558	2.50	20.0	50.0	135	635

Aggregate Nutrient Ecoregion: III
Rivers and Streams
Descriptive Statistics by Decade and Season
Parameter TP_ug_L_Median

Eco_ Level_ III	SEASON	N	MEAN	MIN	MAX	STDDEV	STDERR	CV	P5	P25	MEDIAN	P75	P95
22	WINTER	58	593	.000	21000.0	2852	374	481	0.00	10.0	32.5	75.0	2000
24	FALL	19	156	4.38	1325.00	295	67.6	189	4.38	15.0	55.0	195	1325
24	SPRING	28	168	2.50	2300.00	431	81.4	256	2.50	20.0	67.5	113	460
24	SUMMER	22	91.4	2.50	365.00	108	23.0	118	2.50	10.0	55.0	95.0	270
24	WINTER	25	191	2.50	1600.00	391	78.3	205	2.50	20.0	60.0	120	1300
79	FALL	14	96.8	.000	540.00	142	38.1	147	0.00	10.0	48.8	110	540
79	SPRING	21	123	5.00	415.00	124	27.0	101	5.00	10.0	90.0	180	330
79	SUMMER	17	147	10.0	975.00	239	58.1	163	10.0	10.0	57.5	165	975
79	WINTER	16	122	10.0	810.00	204	50.9	168	10.0	10.0	28.8	134	810
80	FALL	29	95.4	10.0	260.00	77.7	14.4	81	10.0	35.0	70.0	130	258
80	SPRING	28	141	20.0	330.00	77.5	14.6	55	40.0	72.5	120	200	270
80	SUMMER	25	112	10.0	352.50	83.5	16.7	75	10.0	50.0	100	160	243
80	WINTER	15	135	10.0	337.50	97.5	25.2	72	10.0	60.0	105	240	338
81	FALL	25	327	.000	1770.00	487	97.4	149	0.00	30.0	95.0	350	1650
81	SPRING	26	271	.000	1200.00	356	69.8	132	0.00	20.0	143	330	1035
81	SUMMER	27	166	.000	805.00	253	48.7	152	2.50	25.0	50.0	180	800
81	WINTER	31	249	8.13	2400.00	445	79.9	179	10.0	25.0	100	385	753

Aggregate Nutrient Ecoregion: III
Rivers and Streams
Descriptive Statistics by Decade and Season
Parameter Turb_FTU_Median

Eco_ Level_ III	SEASON	N	MEAN	MIN	MAX	STDDEV	STDERR	CV	P5	P25	MEDIAN	P75	P95
6	FALL	15	5.69	.475	22.35	6.30	1.63	111	0.48	1.28	3.40	8.05	22.4
6	SPRING	24	21.2	1.13	100.00	22.8	4.66	108	1.85	3.18	13.8	32.5	51.0
6	SUMMER	21	7.50	.750	29.50	7.13	1.55	95	0.80	2.80	4.90	10.9	17.2
6	WINTER	22	15.2	.800	65.00	17.3	3.68	113	1.25	2.50	7.28	30.0	45.0
10	FALL	61	3.76	.000	30.00	5.10	0.65	135	0.95	1.30	2.50	3.50	13.5
10	SPRING	63	7.01	1.00	30.50	5.88	0.74	84	1.00	2.38	5.00	10.0	17.0
10	SUMMER	69	8.97	.250	97.00	15.6	1.88	174	0.60	2.06	4.00	7.00	41.0

10	WINTER	46	5.07	.500	24.00	4.46	0.66	88	1.50	2.00	4.00	7.00	12.0
12	FALL	51	10.0	.400	149.50	21.1	2.96	211	1.00	3.00	5.00	8.85	34.5
12	SPRING	58	21.1	1.00	167.00	33.8	4.43	160	1.00	4.50	9.38	16.2	107
12	SUMMER	49	16.5	1.50	160.00	25.2	3.60	152	2.00	3.50	10.0	17.5	55.0
12	WINTER	20	9.61	2.30	42.00	10.3	2.31	107	2.40	3.00	5.31	10.8	35.5
13	FALL	73	8.89	.400	73.00	12.4	1.45	139	0.53	1.30	3.80	10.9	35.5
13	SPRING	97	13.6	.800	142.50	20.4	2.07	149	1.55	3.30	6.70	15.0	53.0
13	SUMMER	105	12.7	.300	125.00	21.2	2.07	166	0.70	1.70	4.30	13.0	58.3
13	WINTER	79	8.44	.300	79.00	13.5	1.51	159	0.60	2.15	3.70	8.50	38.0
14	FALL	3	49.1	.400	121.00	63.5	36.7	129	0.40	0.40	26.0	121	121
14	SPRING	3	13.7	.975	22.00	11.2	6.45	82	0.98	0.98	18.0	22.0	22.0
14	SUMMER	4	17.2	.775	32.13	13.5	6.73	78	0.78	6.86	18.0	27.6	32.1
14	WINTER	4	32.0	1.05	43.00	20.6	10.3	64	1.05	21.5	42.0	42.5	43.0
18	FALL	10	15.1	1.20	93.50	27.7	8.76	183	1.20	4.10	7.03	8.93	93.5
18	SPRING	10	28.6	1.40	72.50	21.8	6.90	76	1.40	15.6	22.8	37.5	72.5
18	SUMMER	10	10.4	2.03	19.00	6.18	1.95	60	2.03	4.30	10.0	14.7	19.0
18	WINTER	9	6.54	1.45	34.75	10.7	3.57	164	1.45	1.93	2.75	3.65	34.8
20	FALL	104	17.2	.300	97.00	23.0	2.26	134	0.90	2.60	7.40	24.3	76.0
20	SPRING	104	27.1	.500	145.00	33.6	3.30	124	1.00	2.99	11.5	40.9	98.5
20	SUMMER	108	21.6	.400	150.00	27.7	2.67	129	0.70	2.60	8.88	32.2	82.6
20	WINTER	56	25.4	.650	160.00	31.2	4.17	123	1.40	6.10	13.2	36.3	98.7
22	FALL	4	5.79	3.10	9.10	2.77	1.39	48	3.10	3.53	5.48	8.05	9.10
22	SPRING	4	39.2	19.0	50.25	14.0	6.98	36	19.0	30.1	43.7	48.3	50.3
22	SUMMER	4	12.1	3.75	18.50	6.74	3.37	56	3.75	6.73	13.1	17.5	18.5

Rivers and Streams

Descriptive Statistics by Decade and Season

Parameter Turb_FTU_Median

Eco_ Level_ III	SEASON	N	MEAN	MIN	MAX	STDDEV	STDERR	CV	P5	P25	MEDIAN	P75	P95
22	WINTER	4	13.8	.600	33.00	14.8	7.39	107	0.60	2.25	10.7	25.3	33.0
24	FALL	4	10.0	.500	26.25	11.3	5.66	113	0.50	2.56	6.71	17.5	26.3
24	SPRING	4	16.4	.500	49.25	22.5	11.3	137	0.50	1.75	8.00	31.1	49.3
24	SUMMER	4	25.6	.450	79.00	36.4	18.2	142	0.45	2.48	11.5	48.8	79.0
24	WINTER	4	5.67	.300	13.10	6.14	3.07	108	0.30	0.64	4.64	10.7	13.1
79	FALL	3	10.7	3.20	24.00	11.5	6.67	108	3.20	3.20	4.90	24.0	24.0
79	SPRING	3	26.1	4.30	53.25	24.9	14.4	95	4.30	4.30	20.8	53.3	53.3
79	SUMMER	3	12.1	3.90	21.50	8.85	5.11	73	3.90	3.90	11.0	21.5	21.5
79	WINTER	3	18.2	8.10	30.00	11.0	6.37	61	8.10	8.10	16.6	30.0	30.0
80	FALL	24	6.22	.000	67.00	13.2	2.68	211	1.00	2.00	3.50	4.75	10.8
80	SPRING	23	11.1	.000	34.50	9.80	2.04	88	1.00	4.00	8.00	15.5	33.5
80	SUMMER	20	5.10	.000	22.50	6.79	1.52	133	0.00	1.00	2.00	6.25	22.5
80	WINTER	13	5.56	.000	15.50	4.87	1.35	87	0.00	2.00	4.00	7.00	15.5
81	FALL	7	28.1	1.93	110.00	40.2	15.2	143	1.93	2.38	9.05	52.0	110
81	SPRING	6	34.8	3.00	145.00	55.9	22.8	160	3.00	3.88	8.00	41.0	145
81	SUMMER	10	14.5	.800	88.00	27.0	8.53	187	0.80	1.00	3.40	14.1	88.0
81	WINTER	9	30.3	1.45	122.50	44.5	14.8	146	1.45	2.40	6.10	39.0	123

Aggregate Nutrient Ecoregion: III
Rivers and Streams
Descriptive Statistics by Decade and Season
Parameter Turb_JCU_Median

Eco_ Level_ III	SEASON	N	MEAN	MIN	MAX	STDDEV	STDERR	CV	P5	P25	MEDIAN	P75	P95
6	FALL	0	.	.	.	.	.	.	.	.	.	.	.
6	SPRING	0	.	.	.	.	.	.	.	.	.	.	.
6	SUMMER	0	.	.	.	.	.	.	.	.	.	.	.
6	WINTER	0	.	.	.	.	.	.	.	.	.	.	.
10	FALL	0	.	.	.	.	.	.	.	.	.	.	.
10	SPRING	0	.	.	.	.	.	.	.	.	.	.	.
10	SUMMER	0	.	.	.	.	.	.	.	.	.	.	.
10	WINTER	0	.	.	.	.	.	.	.	.	.	.	.
12	FALL	0	.	.	.	.	.	.	.	.	.	.	.
12	SPRING	0	.	.	.	.	.	.	.	.	.	.	.
12	SUMMER	0	.	.	.	.	.	.	.	.	.	.	.
12	WINTER	0	.	.	.	.	.	.	.	.	.	.	.
13	FALL	0	.	.	.	.	.	.	.	.	.	.	.
13	SPRING	0	.	.	.	.	.	.	.	.	.	.	.
13	SUMMER	0	.	.	.	.	.	.	.	.	.	.	.
13	WINTER	0	.	.	.	.	.	.	.	.	.	.	.
14	FALL	0	.	.	.	.	.	.	.	.	.	.	.
14	SPRING	0	.	.	.	.	.	.	.	.	.	.	.
14	SUMMER	0	.	.	.	.	.	.	.	.	.	.	.
14	WINTER	0	.	.	.	.	.	.	.	.	.	.	.
18	FALL	0	.	.	.	.	.	.	.	.	.	.	.
18	SPRING	0	.	.	.	.	.	.	.	.	.	.	.
18	SUMMER	1	5.00	5.00	5.00	.	.	.	5.00	5.00	5.00	5.00	5.00
18	WINTER	0	.	.	.	.	.	.	.	.	.	.	.
20	FALL	0	.	.	.	.	.	.	.	.	.	.	.
20	SPRING	0	.	.	.	.	.	.	.	.	.	.	.
20	SUMMER	0	.	.	.	.	.	.	.	.	.	.	.
20	WINTER	0	.	.	.	.	.	.	.	.	.	.	.
22	FALL	0	.	.	.	.	.	.	.	.	.	.	.
22	SPRING	0	.	.	.	.	.	.	.	.	.	.	.
22	SUMMER	0	.	.	.	.	.	.	.	.	.	.	.

Aggregate Nutrient Ecoregion: III
Rivers and Streams
Descriptive Statistics by Decade and Season
Parameter Turb_JCU_Median

Eco_ Level_ III	SEASON	N	MEAN	MIN	MAX	STDDEV	STDERR	CV	P5	P25	MEDIAN	P75	P95
22	WINTER	0	.	.	.	.	.	.	.	.	.	.	.
24	FALL	1	14.9	14.9	14.90	.	.	.	14.9	14.9	14.9	14.9	14.9
24	SPRING	0	.	.	.	.	.	.	.	.	.	.	.
24	SUMMER	0	.	.	.	.	.	.	.	.	.	.	.
24	WINTER	1	27.5	27.5	27.50	.	.	.	27.5	27.5	27.5	27.5	27.5

79	FALL	0	.	.	.	.	.	.	.	.	.	.	.
79	SPRING	0	.	.	.	.	.	.	.	.	.	.	.
79	SUMMER	0	.	.	.	.	.	.	.	.	.	.	.
79	WINTER	0	.	.	.	.	.	.	.	.	.	.	.
80	FALL	0	.	.	.	.	.	.	.	.	.	.	.
80	SPRING	0	.	.	.	.	.	.	.	.	.	.	.
80	SUMMER	0	.	.	.	.	.	.	.	.	.	.	.
80	WINTER	0	.	.	.	.	.	.	.	.	.	.	.
81	FALL	0	.	.	.	.	.	.	.	.	.	.	.
81	SPRING	0	.	.	.	.	.	.	.	.	.	.	.
81	SUMMER	0	.	.	.	.	.	.	.	.	.	.	.
81	WINTER	0	.	.	.	.	.	.	.	.	.	.	.

Aggregate Nutrient Ecoregion: III
Rivers and Streams
Descriptive Statistics by Decade and Season
Parameter Turb_NTU_Median

Eco_ Level_ III	SEASON	N	MEAN	MIN	MAX	STDDEV	STDERR	CV	P5	P25	MEDIAN	P75	P95
6	FALL	7	12.2	.500	23.75	10.7	4.03	87	0.50	1.90	11.0	22.7	23.8
6	SPRING	11	11.8	1.00	48.00	16.6	5.01	141	1.00	1.90	3.20	27.5	48.0
6	SUMMER	7	7.53	1.00	15.00	5.68	2.15	75	1.00	1.40	7.20	13.5	15.0
6	WINTER	13	57.2	1.50	141.00	43.3	12.0	76	1.50	29.0	47.0	88.0	141
10	FALL	39	5.59	.275	64.80	10.6	1.70	190	0.40	1.10	2.70	5.80	21.0
10	SPRING	40	12.3	.800	53.50	12.9	2.04	105	1.15	3.30	7.60	17.1	41.0
10	SUMMER	41	6.86	.250	111.15	17.3	2.70	252	0.95	1.60	2.50	5.20	15.5
10	WINTER	38	20.8	.350	168.20	37.2	6.03	178	0.48	1.30	4.71	16.3	123
12	FALL	3	1.58	1.33	1.78	0.23	0.13	15	1.33	1.33	1.65	1.78	1.78
12	SPRING	0	.	.	.	.	.	.	.	.	.	.	.
12	SUMMER	3	1.78	1.75	1.80	0.03	0.01	1	1.75	1.75	1.78	1.80	1.80
12	WINTER	0	.	.	.	.	.	.	.	.	.	.	.
13	FALL	26	6.14	1.40	19.00	4.96	0.97	81	1.90	2.95	4.08	6.60	16.5
13	SPRING	26	18.3	2.80	58.78	14.0	2.74	76	3.20	5.35	15.3	26.7	41.0
13	SUMMER	26	8.64	2.00	26.00	6.02	1.18	70	2.75	4.25	6.54	11.7	18.8
13	WINTER	24	15.0	2.00	86.25	17.9	3.66	120	2.10	4.35	7.60	21.5	30.0
14	FALL	5	36.2	.875	107.50	43.5	19.5	120	0.88	0.98	35.0	36.5	108
14	SPRING	5	19.8	.400	45.25	19.1	8.53	96	0.40	1.13	24.6	27.5	45.3
14	SUMMER	5	22.5	.400	41.00	20.4	9.12	91	0.40	1.05	29.8	40.4	41.0
14	WINTER	4	29.9	1.40	45.03	20.3	10.2	68	1.40	15.3	36.6	44.5	45.0
18	FALL	0	.	.	.	.	.	.	.	.	.	.	.
18	SPRING	0	.	.	.	.	.	.	.	.	.	.	.
18	SUMMER	0	.	.	.	.	.	.	.	.	.	.	.
18	WINTER	0	.	.	.	.	.	.	.	.	.	.	.
20	FALL	4	33.8	2.50	107.30	49.2	24.6	146	2.50	7.00	12.8	60.7	107
20	SPRING	3	37.5	10.5	52.00	23.4	13.5	62	10.5	10.5	50.0	52.0	52.0
20	SUMMER	3	29.8	4.00	52.00	24.2	14.0	81	4.00	4.00	33.5	52.0	52.0
20	WINTER	1	3.50	3.50	3.50	.	.	.	3.50	3.50	3.50	3.50	3.50
22	FALL	47	18.2	.500	144.00	35.5	5.17	195	0.55	1.45	2.70	11.8	97.1
22	SPRING	48	22.5	.400	120.50	29.3	4.23	130	0.60	3.60	14.0	26.6	99.0
22	SUMMER	46	14.9	.400	110.00	27.1	4.00	182	0.60	1.30	3.15	10.4	87.0

Aggregate Nutrient Ecoregion: III
Rivers and Streams
Descriptive Statistics by Decade and Season
Parameter Turb_NTU_Median

Eco_ Level_ III	SEASON	N	MEAN	MIN	MAX	STDDEV	STDERR	CV	P5	P25	MEDIAN	P75	P95
22	WINTER	21	10.5	.450	93.95	21.0	4.58	200	0.50	1.40	3.20	7.40	37.8
24	FALL	4	18.5	2.70	54.80	24.4	12.2	132	2.70	4.35	8.30	32.7	54.8
24	SPRING	4	17.4	.800	52.10	23.9	11.9	137	0.80	1.75	8.35	33.1	52.1
24	SUMMER	9	39.4	.300	171.80	57.3	19.1	146	0.30	1.70	22.5	33.8	172
24	WINTER	1	39.3	39.3	39.25	.	.	.	39.3	39.3	39.3	39.3	39.3
79	FALL	9	5.97	.500	15.45	5.86	1.95	98	0.50	0.80	3.60	11.0	15.5
79	SPRING	17	14.5	.500	138.00	32.3	7.84	222	0.50	2.20	5.40	13.0	138
79	SUMMER	13	3.42	.400	11.55	3.75	1.04	110	0.40	0.60	1.20	6.80	11.6
79	WINTER	14	18.5	.300	171.00	44.6	11.9	241	0.30	0.80	4.46	14.0	171
80	FALL	6	8.60	1.40	40.00	15.4	6.29	179	1.40	1.50	2.63	3.45	40.0
80	SPRING	13	33.3	4.50	116.00	36.1	10.0	108	4.50	12.0	17.0	33.3	116
80	SUMMER	4	3.48	2.40	5.65	1.47	0.74	42	2.40	2.65	2.93	4.30	5.65
80	WINTER	1	2.00	2.00	2.00	.	.	.	2.00	2.00	2.00	2.00	2.00
81	FALL	11	7.45	.400	40.00	11.8	3.57	159	0.40	0.65	2.85	12.0	40.0
81	SPRING	14	32.4	.500	139.00	44.2	11.8	136	0.50	6.50	14.6	38.0	139
81	SUMMER	11	12.3	.700	60.00	18.9	5.71	154	0.70	2.40	4.20	13.6	60.0
81	WINTER	15	19.4	.300	111.00	31.6	8.16	163	0.30	1.43	5.20	14.8	111

APPENDIX C

Quality Control/Quality Assurance Rules

Support for the Compilation and Analysis of National Nutrient Data

15 Nutrient Ecoregion/Waterbody Type Summary Chapters

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CONTENTS

1.0 BACKGROUND

The Nutrient Criteria Program has initiated development of a national Nutrient Criteria Database application that will be used to store and analyze nutrient data. The ultimate use of these data will be to derive ecoregion- and waterbody-specific nutrient criteria ranges. 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 will be used to develop national nutrient criteria ranges.

1.1 Purpose

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

- Lakes and Reservoirs
  - Aggregate Nutrient ecoregions: 2, 6, 7, 8, 9, 11, 12, 13

- Rivers and Streams
  - Aggregate Nutrient ecoregions: 2, 3, 6, 7, 9, 11, 12, 14

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 Manual: 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
- Region 1
- Region 2 - Lake Champlain Monitoring Project
- Region 2 - NYSDEC Finger Lakes Monitoring Program
- Region 2 - NY Citizens Lake Assessment Program
- Region 2 - Lake Classification and Inventory Survey
- Region 2 - NYCDEP (1990-1998)
- Region 2 - NYCDEP (Storm Event data)
- Region 2 - New Jersey Nutrient Data (Tidal Waters)
- Region 5
- Region 3
- Region 3 - Nitrite Data
- Region 3 - Choptank River files
- Region 4 - Tennessee Valley Authority
- Region 7 - Central Plains Center for BioAssessment (CPCB)
- Region 7 - REMAP
- Region 2 - Delaware River Basin Commission (1990-1998)
- Region 3 - PA Lake Data
- Region 3 - University of Delaware
- Region 10
- University of Auburn

As part of the conversion process, INDUS performed a number of Quality Assurance/Quality Control (QA/QC) steps to ensure that the data was properly converted into the Nutrient Criteria Database. Section 2 explains 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. 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. INDUS also contacted each agency to determine which laboratory methods were used for each parameter.

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.

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 was 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. If a station was lacking latitude and longitude coordinates or 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 was 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 listed in the station table. The county information was assumed to be correct; therefore, the county centroid was used.

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, 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 by 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 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 lake 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 lake 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 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, 5th, 25th , 75th , 95th 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. When there was little or no data for chlorophyll, then pH or dissolved oxygen was substituted for chlorophyll. 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. Regressions were also run for total nitrogen and total phosphorus for ecoregions where both these variables were measured.

Note: At the time of creation of this document only regressions for aggregate nutrient ecoregion 7 for lakes and reservoirs were delivered to the EPA. Regressions for the remaining aggregate nutrient ecoregions will be delivered in August 2000.

4.0 TIME PERIOD

Data collected from January 1990 to December 1999 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, 9, 10, 11, 12, and 13
  - 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, the following parameters were combined to form 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 2

Data Sources:

Legacy STORET
EPA Region 10

Parameter:

Chlorophyll A, Fluorometric, Corrected	(ug/L)
Chlorophyll A, Phytoplankton, Spectrophotometric Acid	(ug/L)
Chlorophyll A, Trichromatic, Uncorrected	(ug/L)
Phosphorous, Dissolved Inorganic (DIP)	(ug/L)
Dissolved Oxygen (DO)	(mg/L)
Nitrite and Nitrate, (NO2+NO3)	(mg/L)
Nitrogen, Total (TN)	(mg/L)
Nitrogen, Total Kjeldahl (TKN)	(mg/L)
Phosphorus, Total (TP)	(ug/L)
Phosphorus, Total Reactive	(ug/L)
SECCHI	(m)
pH	

Level III ecoregions:

1, 2, 4, 5, 9, 11, 15, 16, 17, 19, 21, 23, 41, 77, 78

5.1.2 Aggregate Nutrient Ecoregion 6

Data Sources:

Legacy STORET

Parameters:

Chlorophyll A, Fluorometric, Corrected	(ug/L)
Chlorophyll A, Phytoplankton, Spectrophotometric Acid	(ug/L)
Chlorophyll A, Trichromatic, Uncorrected	(ug/L)
Dissolved Oxygen (DO)	(mg/L)
Nitrite and Nitrate, (NO2+NO3)	(mg/L)
Nitrogen, Total (TN)	(mg/L)
Nitrogen, Total Kjeldahl (TKN)	(mg/L)
Phosphorus, Total (TP)	(ug/L)
SECCHI	(m)

Level III ecoregions:

46, 47, 48, 54, 55, 57

5.1.3 Aggregate Nutrient Ecoregion 7

Data Sources:

LCMPD
Legacy STORET
NYCDEP
EPA Region 1

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)
Phosphorous, Dissolved Inorganic (DIP)	(ug/L)
Dissolved Oxygen (DO)	(mg/L)

Nitrite and Nitrate, (NO2+NO3)	(mg/L)
Nitrogen, Total (TN)	(mg/L)
Nitrogen, Total Kjeldahl (TKN)	(mg/L)
Phosphorus, Orthophosphate, Total as P	(ug/L)
Phosphorus, Total (TP)	(ug/L)
SECCHI	(m)

<u>Level III ecoregions:</u>

51, 52, 53, 56, 60, 61, 83

5.1.4 Aggregate Nutrient Ecoregion 8

<u>Data Sources:</u>

LCMPD
Legacy STORET
NYCDEP
NYCDEC
EPA Region 1
EPA Region 3

<u>Parameters:</u>

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)
Chlorophyll B	(ug/L)
Chlorophyll C	(ug/L)
Phosphorous, Dissolved Inorganic (DIP)	(ug/L)
Dissolved Oxygen (DO)	(mg/L)
Nitrite and Nitrate, (NO2+NO3)	(mg/L)
Nitrogen, Total (TN)	(mg/L)
Nitrogen, Total Kjeldahl (TKN)	(mg/L)
Phosphorus, Total (TP)	(ug/L)
SECCHI	(m)

<u>Level III ecoregions:</u>

49, 50, 58, 62, 82

5.1.5 Aggregate Nutrient Ecoregion 9

Data Sources:

Auburn University
Legacy STORET
EPA Region 4

Parameters:

Chlorophyll A, Fluorometric, Corrected	(ug/L)
Chlorophyll A, Pheophytin	(ug/L)
Chlorophyll A, Phytoplankton, Spectrophotometric Acid	(ug/L)
Chlorophyll A, Phytoplankton, Spectrophotometric, Uncorrected	(ug/L)
Chlorophyll A, Trichromatic, Uncorrected	(ug/L)
Phosphorous, Dissolved Inorganic (DIP)	(ug/L)
Dissolved Oxygen (DO)	(mg/L)
Nitrite and Nitrate, (NO2+NO3)	(mg/L)
Nitrogen, Total (TN)	(mg/L)
Nitrogen, Total Kjeldahl (TKN)	(mg/L)
Phosphorus, Total (TP)	(ug/L)
SECCHI	(m)

Level III ecoregions:

29, 33, 35, 37, 40, 45, 64, 65, 71, 72, 74

5.1.6 Aggregate Nutrient Ecoregion 11

Data Sources:

Auburn University
Legacy STORET
NYSDEC
EPA Region 3
EPA Region 4

Parameters:

Chlorophyll A, Fluorometric, Corrected	(ug/L)
Chlorophyll A, Pheophytin	(ug/L)
Chlorophyll A, Phytoplankton, Spectrophotometric Acid	(ug/L)
Chlorophyll A, Phytoplankton, Spectrophotometric, Uncorrected	(ug/L)

Chlorophyll A, Trichromatic, Uncorrected	(ug/L)
Phosphorous, Dissolved Inorganic (DIP)	(ug/L)
Dissolved Oxygen (DO)	(mg/L)
Nitrite and Nitrate, (NO2+NO3)	(mg/L)
Nitrogen, Total (TN)	(mg/L)
Nitrogen, Total Kjeldahl (TKN)	(mg/L)
Phosphorus, Total (TP)	(ug/L)
SECCHI	(m)

Level III ecoregions:

36, 38, 39, 66, 67, 68, 69, 70

5.1.7 Aggregate Nutrient Ecoregion 12

Data Sources:

Legacy STORET

Parameters:

Chlorophyll A, Phytoplankton, Spectrophotometric Acid	(ug/L)
Chlorophyll A, Trichromatic, Uncorrected	(ug/L)
Dissolved Oxygen (DO)	(mg/L)
Nitrite and Nitrate, (NO2+NO3)	(mg/L)
Nitrogen, Total (TN)	(mg/L)
Nitrogen, Total Kjeldahl (TKN)	(mg/L)
Phosphorus, Total (TP)	(ug/L)
SECCHI	(m)

Level III ecoregions:

75

5.1.8 Aggregate Nutrient Ecoregion 13

Data Sources:

Legacy STORET

Parameters:

Chlorophyll A, Fluorometric, Corrected	(ug/L)
Chlorophyll A, Phytoplankton, Spectrophotometric Acid	(ug/L)
Chlorophyll A, Trichromatic, Uncorrected	(ug/L)
Dissolved Oxygen (DO)	(mg/L)
Nitrite and Nitrate, (NO2+NO3)	(mg/L)
Nitrogen, Total (TN)	(mg/L)
Nitrogen, Total Kjeldahl (TKN)	(mg/L)
Phosphorus, Total (TP)	(ug/L)
SECCHI	(m)

Level III ecoregions:

76

5.2 Rivers and Streams

5.2.1 Aggregate Nutrient Ecoregion 2

Data Sources:

Legacy STORET
NASQAN
NAWQA
EPA Region 10

Parameters:

Chlorophyll A, Fluorometric, Corrected	(ug/L)
Chlorophyll A, Phytoplankton, Spectrophotometric Acid	(ug/L)
Chlorophyll A, Phytoplankton, chromotographic- fluorometric	(ug/L)
Chlorophyll A, Trichromatic, Uncorrected	(ug/L)
Chlorophyll B, Phytoplankton, chromotographic- fluorometric	(ug/L)
Phosphorous, Dissolved Inorganic (DIP)	(ug/L)
Dissolved Oxygen (DO)	(mg/L)
Nitrite and Nitrate, (NO2+NO3)	(mg/L)
Phosphorus, Orthophosphate, Total as P	(ug/L)
Phosphorus, Total (TP) Reactive	(ug/L)
Nitrogen, Total (TN)	(mg/L)
Nitrogen, Total Kjeldahl (TKN)	(mg/L)
Phosphorus, Total (TP)	(ug/L)
Turbidity	(FTU)

Turbidity	(JCU)
Turbidity	(NTU)

Level III ecoregions:

1, 2, 4, 5, 8, 9, 11, 15, 16, 17, 19, 21, 23, 41, 77, 78

5.2.2 Aggregate Nutrient Ecoregion 3

Data Sources:

Legacy STORET
NASQAN
NAWQA
EPA Region 10

Parameters:

Chlorophyll A, Fluorometric, Corrected	(ug/L)
Chlorophyll A, Phytoplankton, Spectrophotometric Acid	(ug/L)
Chlorophyll A, Phytoplankton, chromotographic- fluorometric	(ug/L)
Chlorophyll A, Trichromatic, Uncorrected	(ug/L)
Chlorophyll B, Phytoplankton, chromotographic- fluorometric	(ug/L)
Phosphorous, Dissolved Inorganic (DIP)	(ug/L)
Dissolved Oxygen (DO)	(mg/L)
Nitrite and Nitrate, (NO2+NO3)	(mg/L)
Nitrogen, Total (TN)	(mg/L)
Nitrogen, Total Kjeldahl (TKN)	(mg/L)
Phosphorus, Total (TP)	(ug/L)
Turbidity	(FTU)
Turbidity	(JCU)
Turbidity	(NTU)

Level III ecoregions:

6, 10, 12, 13, 14, 18, 20, 22, 24, 79, 80, 81

5.2.3 Aggregate Nutrient Ecoregion 6

Data Sources:

Legacy STORET
NASQAN
NAWQA
EPA Region 5
EPA Region 7

Parameters:

Chlorophyll A, Fluorometric, Corrected	(ug/L)
Chlorophyll A, Phytoplankton, Spectrophotometric Acid	(ug/L)
Chlorophyll A, Phytoplankton, chromotographic- fluorometric	(ug/L)
Chlorophyll A, Trichromatic, Uncorrected	(ug/L)
Chlorophyll B, Phytoplankton, chromotographic- fluorometric	(ug/L)
Phosphorous, Dissolved Inorganic (DIP)	(ug/L)
Dissolved Oxygen (DO)	(mg/L)
Nitrite and Nitrate, (NO2+NO3)	(mg/L)
Nitrogen, Total (TN)	(mg/L)
Nitrogen, Total Kjeldahl (TKN)	(mg/L)
Organic, Phosphorus	(ug/L)
Phosphorus, Total (TP)	(ug/L)
Phosphorus, Orthophosphate, Total as P	(ug/L)
Turbidity	(FTU)
Turbidity	(JCU)
Turbidity	(NTU)

Level III ecoregions:

46, 47, 48, 54, 55, 57

5.2.4 Aggregate Nutrient Ecoregion 7

Data Sources:

LCMPD
Legacy STORET
NASQAN
NAWQA
NYCDEP

Parameters:

Chlorophyll A, Fluorometric, Corrected	(ug/L)
Chlorophyll A, Phytoplankton, Spectrophotometric Acid	(ug/L)
Chlorophyll A, Phytoplankton, Spectrophotometric, Uncorrected	(ug/L)
Chlorophyll A, Phytoplankton, chromotographic- fluorometric	(ug/L)
Chlorophyll A, Trichromatic, Uncorrected	(ug/L)
Chlorophyll B, Phytoplankton, chromotographic- fluorometric	(ug/L)
Phosphorous, Dissolved Inorganic (DIP)	(ug/L)
Dissolved Oxygen (DO)	(mg/L)
Nitrite and Nitrate, (NO2+NO3)	(mg/L)
Nitrogen, Total (TN)	(mg/L)
Nitrogen, Total Kjeldahl (TKN)	(mg/L)
Organic, Phosphorus	(ug/L)
Phosphorus, Orthophosphate, Total as P	(ug/L)
Phosphorus, Total (TP)	(ug/L)
Turbidity	(FTU)
Turbidity	(JCU)
Turbidity	(NTU)

Level III ecoregions:

51, 52, 53, 56, 60, 61, 83

5.2.5 Aggregate Nutrient Ecoregion 9

Data Sources:

Auburn University
Legacy STORET
NASQAN
NAWQA
EPA Region 3
EPA Region 5
EPA Region 7

Parameters:

Chlorophyll A, Fluorometric, Corrected	(ug/L)
Chlorophyll A, Phytoplankton, chromotographic- fluorometric	(ug/L)
Chlorophyll A, Phytoplankton, Spectrophotometric Acid	(ug/L)
Chlorophyll A, Phytoplankton, Spectrophotometric, Uncorrected	(ug/L)

Chlorophyll A, Trichromatic, Uncorrected	(ug/L)
Chlorophyll B, Phytoplankton, chromotographic- fluorometric	(ug/L)
Chlorophyll B, Phytoplankton, Spectrophotometric	(ug/L)
Phosphorous, Dissolved Inorganic (DIP)	(ug/L)
Dissolved Oxygen (DO)	(mg/L)
Organic, Phosphorus	(ug/L)
Phosphorus, Orthophosphate, Total as P	(ug/L)
Nitrite and Nitrate, (NO2+NO3)	(mg/L)
Nitrogen, Total (TN)	(mg/L)
Nitrogen, Total Kjeldahl (TKN)	(mg/L)
Phosphorus, Total (TP)	(ug/L)
Turbidity	(FTU)
Turbidity	(JCU)
Turbidity	(NTU)

Level III ecoregions:

29, 33, 35, 37, 40, 45, 64, 65, 71, 72, 74

5.2.6 Aggregate Nutrient Ecoregion 11

Data Sources:

Auburn University
Legacy STORET
NASQAN
NAWQA
EPA Region 3
EPA Region 5
EPA Region 7

Parameters:

Chlorophyll A, Fluorometric, Corrected	(ug/L)
Chlorophyll A, Phytoplankton, chromotographic- fluorometric	(ug/L)
Chlorophyll A, Phytoplankton, Spectrophotometric Acid	(ug/L)
Chlorophyll A, Phytoplankton, Spectrophotometric, Uncorrected	(ug/L)
Chlorophyll A, Trichromatic, Uncorrected	(ug/L)
Chlorophyll B, Phytoplankton, chromotographic- fluorometric	(ug/L)
Phosphorous, Dissolved Inorganic (DIP)	(ug/L)
Dissolved Oxygen (DO)	(mg/L)
Organic, Phosphorus	(ug/L)

Phosphorus, Orthophosphate, Total as P	(ug/L)
Nitrite and Nitrate, (NO2+NO3)	(mg/L)
Nitrogen, Total (TN)	(mg/L)
Nitrogen, Total Kjeldahl (TKN)	(mg/L)
Phosphorus, Total (TP)	(ug/L)
Turbidity	(FTU)
Turbidity	(JCU)
Turbidity	(NTU)

Level III ecoregions:

36, 38, 39, 66, 67, 68, 69, 70

5.2.7 Aggregate Nutrient Ecoregion 12

Data Sources:

Legacy STORET
NASQAN
NAWQA

Parameters:

Chlorophyll A, Phytoplankton, Spectrophotometric Acid	(ug/L)
Chlorophyll A, Phytoplankton, Spectrophotometric, Uncorrected	(ug/L)
Chlorophyll A, Trichromatic, Uncorrected	(ug/L)
Chlorophyll B, Phytoplankton, Spectrophotometric	(ug/L)
Phosphorous, Dissolved Inorganic (DIP)	(ug/L)
Dissolved Oxygen (DO)	(mg/L)
Nitrite and Nitrate, (NO2+NO3)	(mg/L)
Nitrogen, Total (TN)	(mg/L)
Nitrogen, Total Kjeldahl (TKN)	(mg/L)
Phosphorus, Orthophosphate, Total as P	(ug/L)
Phosphorus, Total (TP)	(ug/L)
Turbidity	(FTU)
Turbidity	(NTU)

Level III ecoregions:

75

5.2.8 Aggregate Nutrient Ecoregion 14

Data Sources:

Legacy STORET
NASQAN
NAWQA
NYCDEP
EPA Region 1
EPA Region 3

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)
Phosphorous, Dissolved Inorganic (DIP)	(ug/L)
Dissolved Oxygen (DO)	(mg/L)
Nitrite and Nitrate, (NO2+NO3)	(mg/L)
Phosphorus, Orthophosphate, Total as P	(ug/L)
Nitrogen, Total Kjeldahl (TKN)	(mg/L)
Nitrogen, Total (TN)	(mg/L)
Phosphorus, Total (TP)	(ug/L)
Turbidity	(FTU)
Turbidity	(JCU)
Turbidity	(NTU)

Level III ecoregions:

59, 63, 84

APPENDIX A

Process Used to QA/QA 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
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

   - <u>Identification of exactly matching records</u>
     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.

   - <u>Identification of matching records with the exception of station identification number</u>
     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

Steps for assigning Level III ecoregions and aggregate nutrient ecoregion codes and names to the Nutrient Criteria Database (performed using ESRI's ARCView v 3.2 and its GeoProcessing Wizard). This process is performed twice; once for the Level III ecoregions and once for the aggregate nutrient ecoregions:

- Add the station .dbf data table, with latitude and longitude data, to project by 'Add Event Theme'
- Convert to the shapefile format
- Create 'stcojoin' field, populate the 'stcojoin' field with the following formula: 'County.LCase+State.LCase'
- Add field 'stco_flag' to the station shapefile
- Spatially join the station data with the county shapefile (cntys_jned.shp)
- Select 'stcojoin' (station shapefile) field = 'stco_join2' (county shapefile) field
- Calculate stco_flag = 0 for selected features
- Step through all blank stco_flag records, assign the appropriate stco_flags, see list on the following page
- Select all stco_flags = 4 or 7, switch selection
- Calculate ctyfips (station) to cntyfips (county)
- Stop editing and save edits, remove all joins
- Add in 2 new fields 'x-coord1' and 'y-coord1' into station table
- Select all stco_flags = 1, 2, and 6
- Link county coverage with station coverage
- Populate 'x-coord1' and 'y-coord1' with 'x-coord' and 'y-coord' from county coverage
- Select all stco_flags = 1, 2, and 6, export to new .dbf file
- Add new .dbf file as event theme
- Convert to shapefile format
- Add the following fields to both tables (original station and station126 shapefiles): 'eco_omer', 'name_omer', 'dis_aggr', 'code_aggr', 'name_aggr'
- Spatially join station126 and eco-omer coverage
- Populate the 'eco_omer' field with the 'eco' value
- Repeat the previous step using the nearest method (line coverage) to determine ecoregion assignment for the line coverage, if some records are blank
- Spatially join the ecoregion line coverage to station coverage, link the LPoly# (from the spatially joined table) to Poly# (of the ecoregion polygon coverage)
- Populate the Eco fields with the appropriate information.
- Follow the same steps to the Rpoly#
- Remove all table joins
- Link the useco-om table with station126 table and populate 'name-omer' field
- Spatially join station aggr coverage and populate the rest of the fields. Follow the same procedures as outlined above
- Remove all joins
- Make sure the new Eco field added into the station126 shapefile are different than

the ones in the original station shapefile

- Join station126 and station coverage by station-id
- Populate all the Eco fields in the original station coverage
- Remove all joins
- Save table
- Make sure that all ctyfips records are populated; the county shapefile may have to be joined to populate the records, if the stco_flag = 4
- Create 2 new fields, 'NewCounty' and 'NewState'
- Populate these new fields with a spatial join to the county coverage
- Select by feature (ecoregion shapefile) all of the records in the station shapefile
- Switch selection (to get records outside of the ecoregion shapefile)
- If any of the selected records have stco_flag = 0 (they are outside the ecoregion shapefile boundary), calculate them to stco_flag = 3

stco_flags (state/county flags in order of importance)

0 The state and county values from the data set matched the state and county values from the spatial join.
(Ecoregions were assigned based on the latitude/longitude coordinates.)

1 The state and county values from the data set did not match the state and county values from the spatial join, but the point was inside the county coverage boundary.
(Ecoregions were assigned based on the county centroid.)

2 The state and county values from the data set did not match the state and county values from the spatial join because the point was outside the county coverage boundary; therefore, there was nothing to compare to the point (i.e., the point falls in the ocean/Canada/Mexico). This occurred for some coastal samples.
(Ecoregions were assigned based on the county centroid.)

3 The state and county values from the data set matched the state and county from the spatial join, but the point was outside the ecoregion boundary.
(Ecoregions were assigned to the closest ecoregion to the point.)
(No ecoregions were assigned to AK, HI, PR, BC, and GU.)

4 Latitude/longitude coordinates were provided, but there was no county information.
(Ecoregions were assigned based on the latitude/longitude coordinates.)

5 The state and county values from the data set did not match the state and county values from the spatial join due to spelling or naming convention errors.
The matches were performed manually.
(Ecoregions were assigned based on the latitude/longitude coordinates.)

6 No latitude/longitude coordinates were provided, only state and county information was available.
(Ecoregions were assigned based on the county centroid.)

7 No latitude/longitude coordinates were provided, only state information was available; therefore, no matches were possible.
(Ecoregions were not assigned. Data is not included in the analysis.)

APPENDIX C

Glossary

Coefficient of Variation- Equal to the standard deviation divided by the mean multiplied by 100.

Maximum- The highest value.

Mean- The arithmetic average.

Median- The 50th percentile or middle value. Half of the values are above the median, and half of the values are below the median.

Minimum- The lowest value.

Standard Deviation- Equal to 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- Standard error of the mean is equal to the standard deviation divided by the square root of the sample size.