The Use of Calculated Stream Metabolism in Understanding Nutrients and Algal Measures in Agricultural Streams

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National Water-Quality Monitoring Conference
May 7-11, 2006

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U.S. Department of the Interior
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Introduction

- Part of the U.S. Geological Survey's National Water-Quality Assessment (NAWQA) Program's Nutrient Enrichment Topical Study (NEET)
- Determine interrelations among nutrient conditions/algal measures and stream metabolism
- Focused on small stream sites in areas with significant agricultural influences

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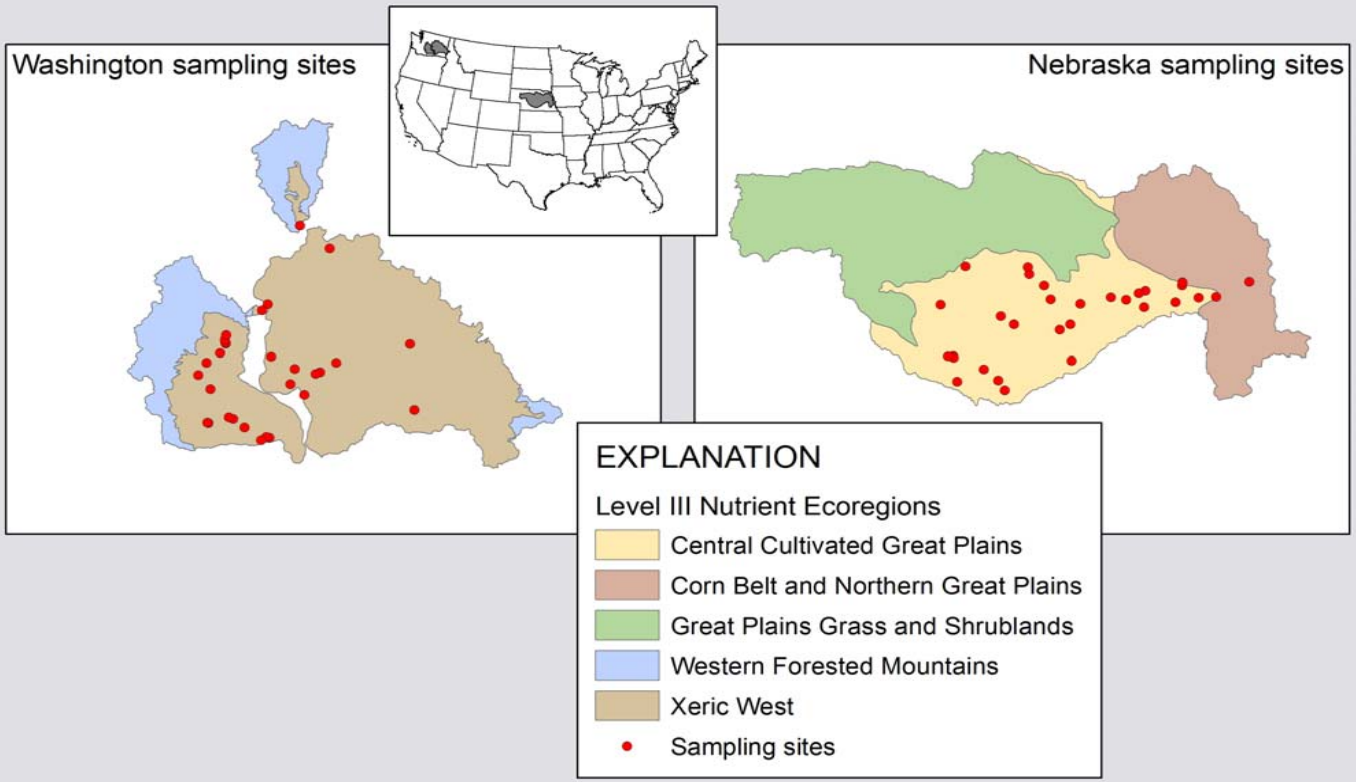
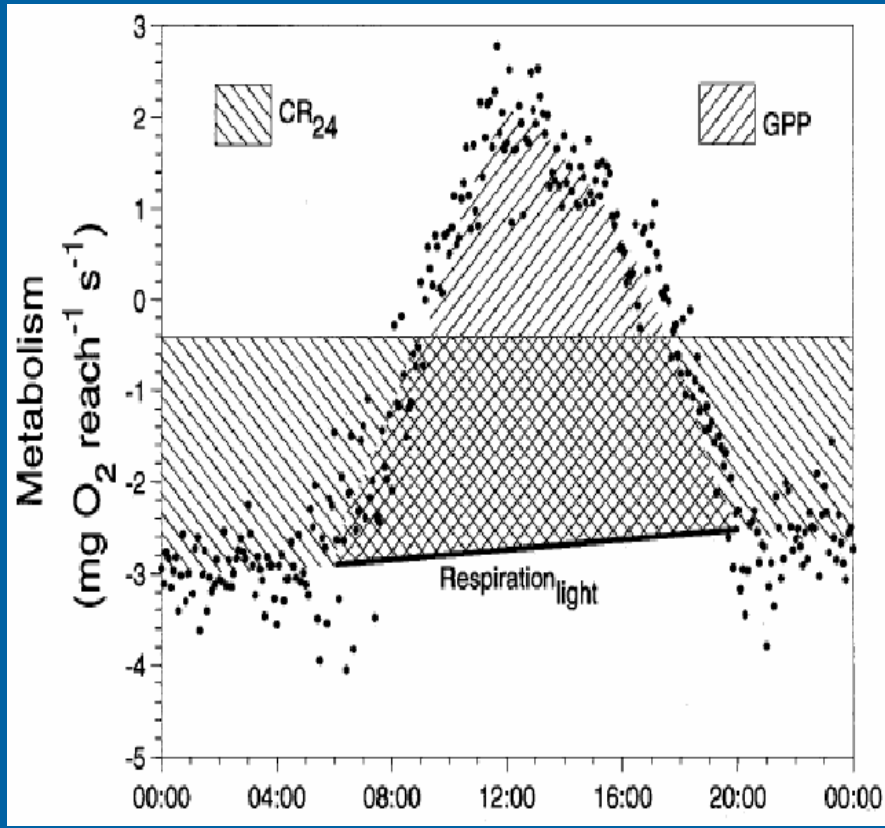
Focus on the Western Study Areas



What Is Stream Metabolism?

- Measure of oxygen production and uptake
- Based on photosynthesis

  CO_2 + Nutrients + Solar Energy = Biomass (organic carbon) + O_2
- Changes in dissolved oxygen
  - Gross Primary Production (GPP)
  - Community Respiration (CR_{24})
  - Ratio of GPP:CR_{24}



Why Measure Stream Metabolism/Primary Production?

- Nutrient and algal biomass relationships often not predictable in altered stream systems
- Identified as a secondary response variable for nutrient criteria
- Few large-scale estimates in disturbed/altered systems
- Indication of instream processing status
  - Ratio of $GPP/CR_{24}>1$ = net energy gain
  - Ratio of $GPP/CR_{24}<1$ = net energy loss

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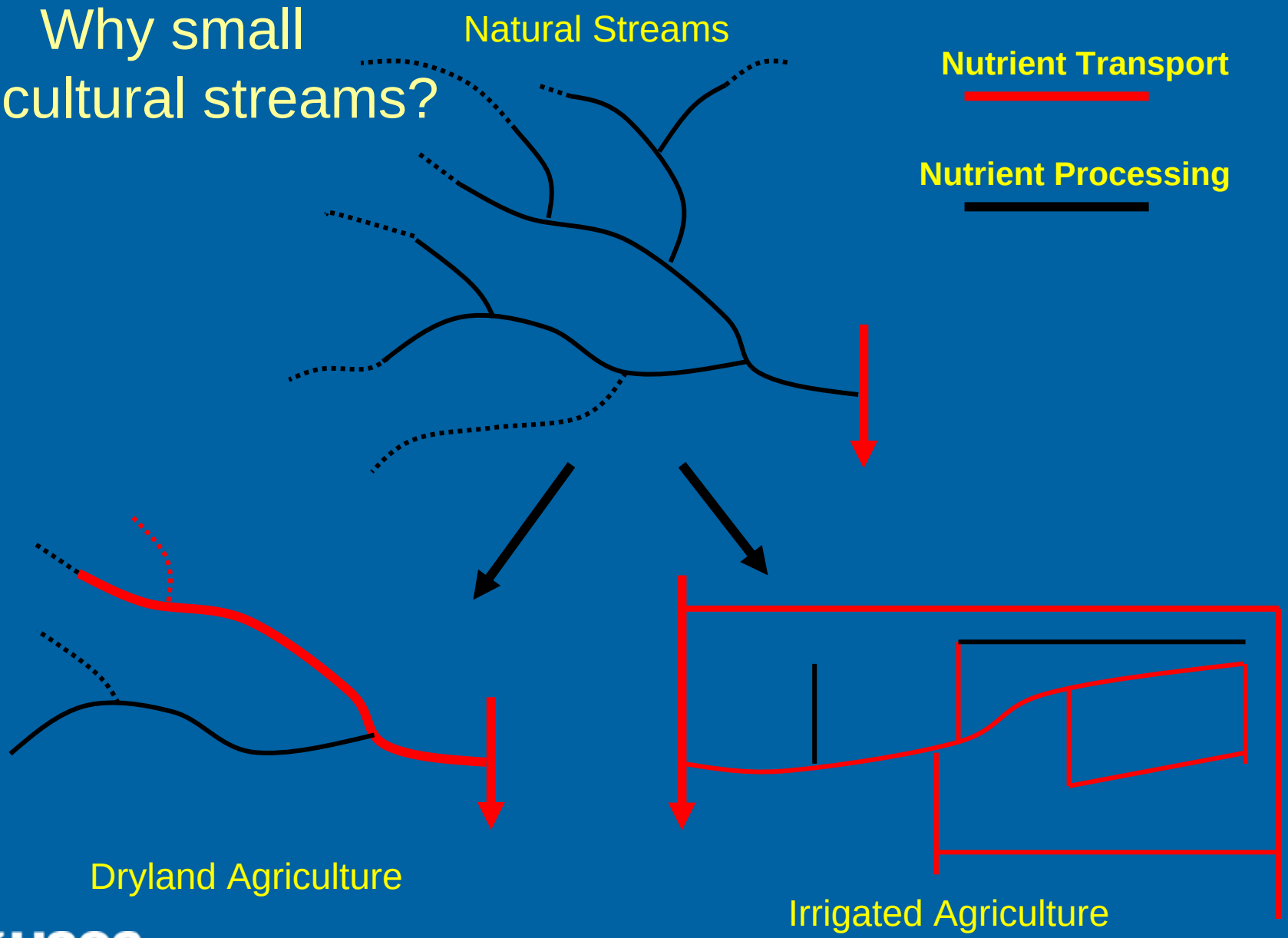
Why small agricultural streams?



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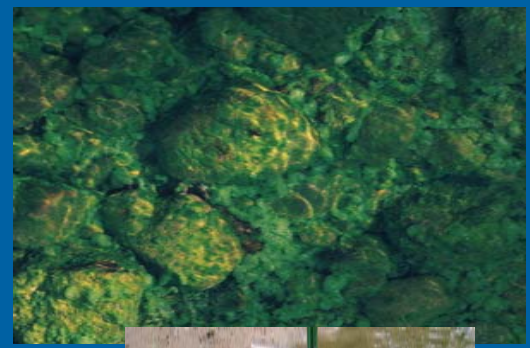
Were Production Measures Related to Nutrients or Algal Biomass?

- **Combined data sets:**
  - **No relationships between productivity and nutrients or algal biomass**
- **Individual study areas:**
  - **No relationships between productivity and algal biomass**
  - **GPP and CR_{24} related to some nutrient measures**
  - **Primary production in these agriculturally dominated areas related more strongly to physical habitat and environmental variables**

Data Collection in Each Study Area

- **Stream metabolism (10 of the 28 Study Sites)**
  - **Utilize Data From Large-Scale Sampling Event**
    - **Water chemistry**
    - **Reach-scale habitat assessment**
  - **Continuous Water-Quality Monitors**
    - **10 two-station sites**
    - **Minimum 48-hour deployment**
    - **Dissolved oxygen, pH, water temperature, specific conductance**
  - **Continuous Light Measurements (PAR)**
  - **Reaeration (limited number of sites)**



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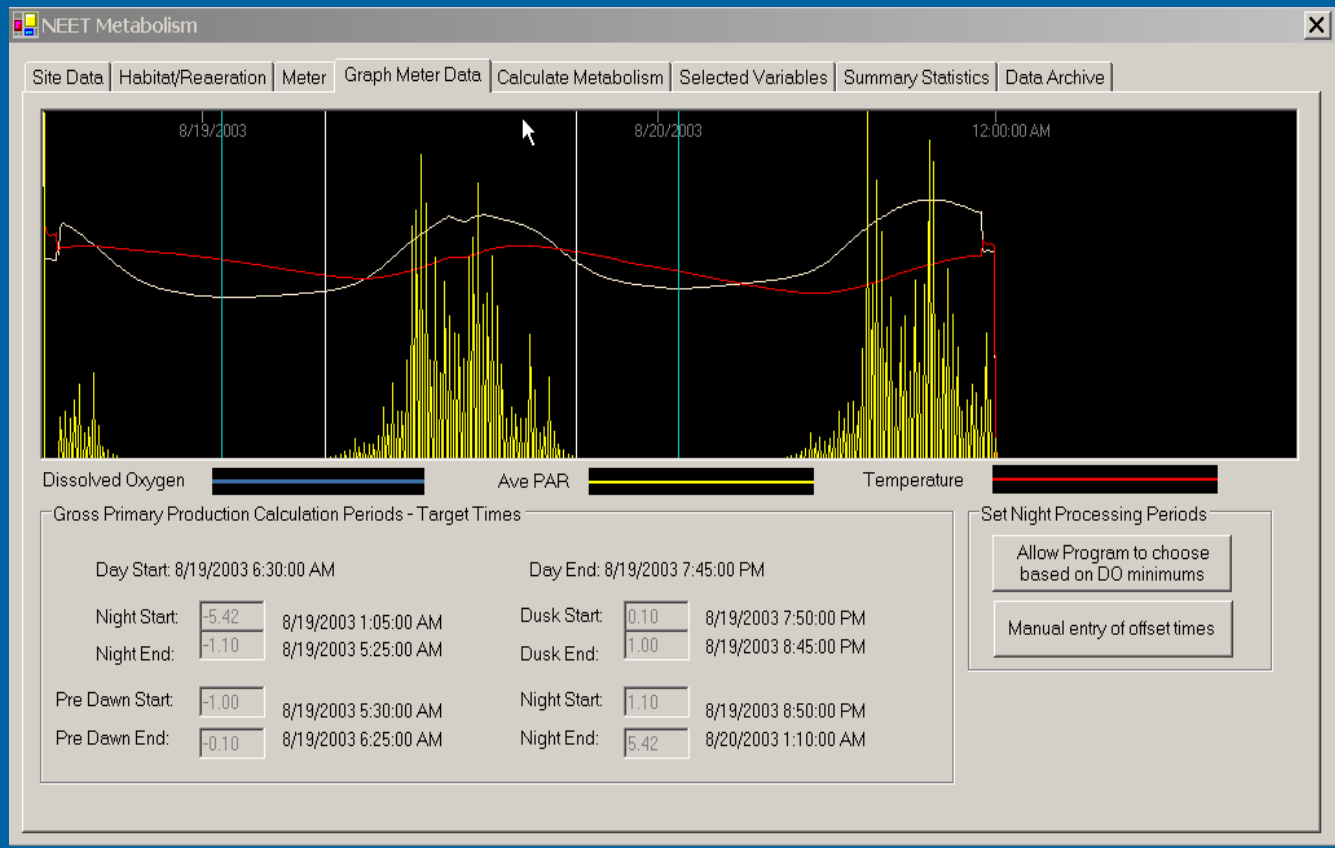
USGS Stream Metabolism Program

Input:

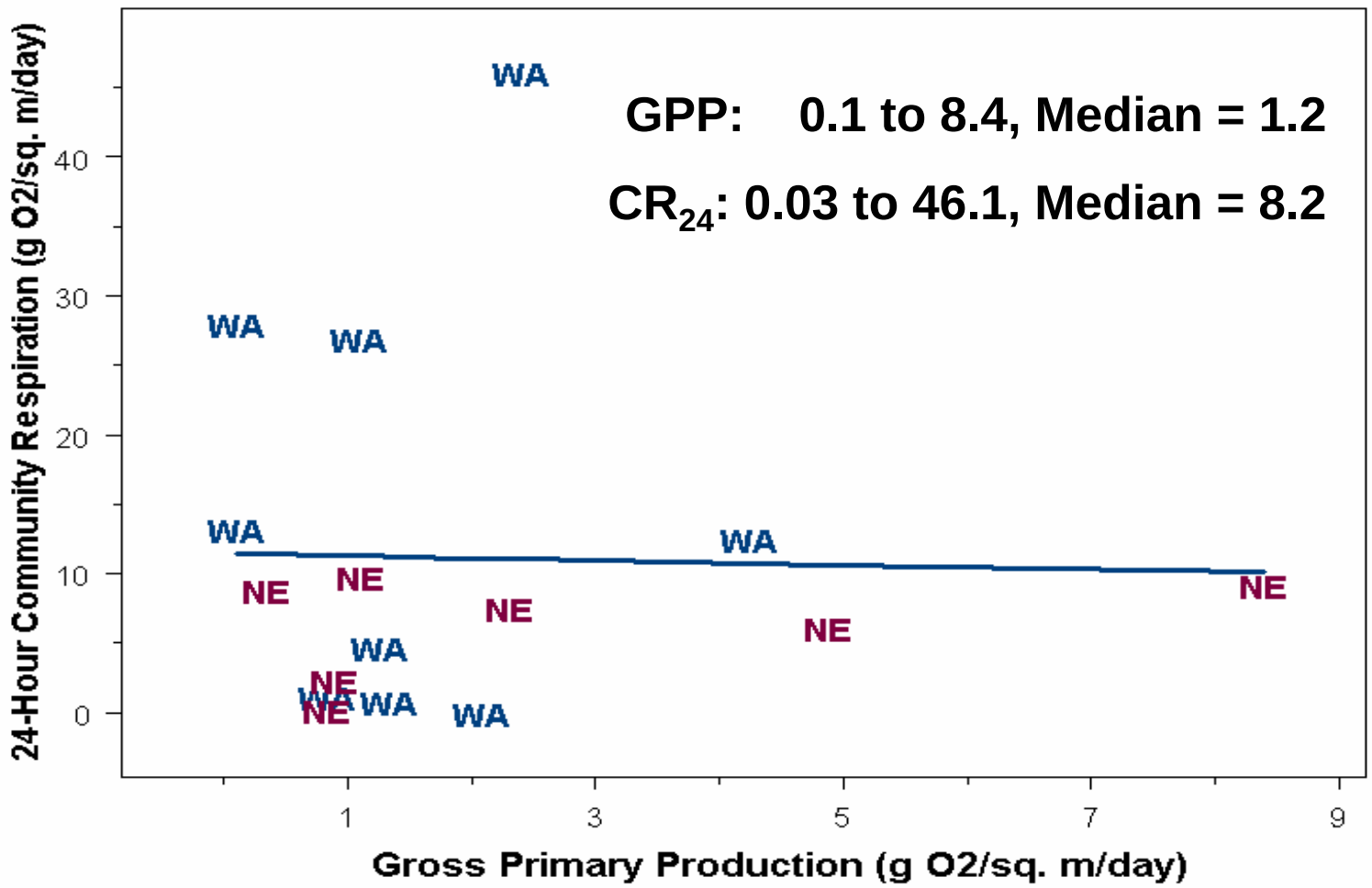
- Load text files of dissolved oxygen and light
- Enter stream-channel characteristics
- Reaeration value

Output

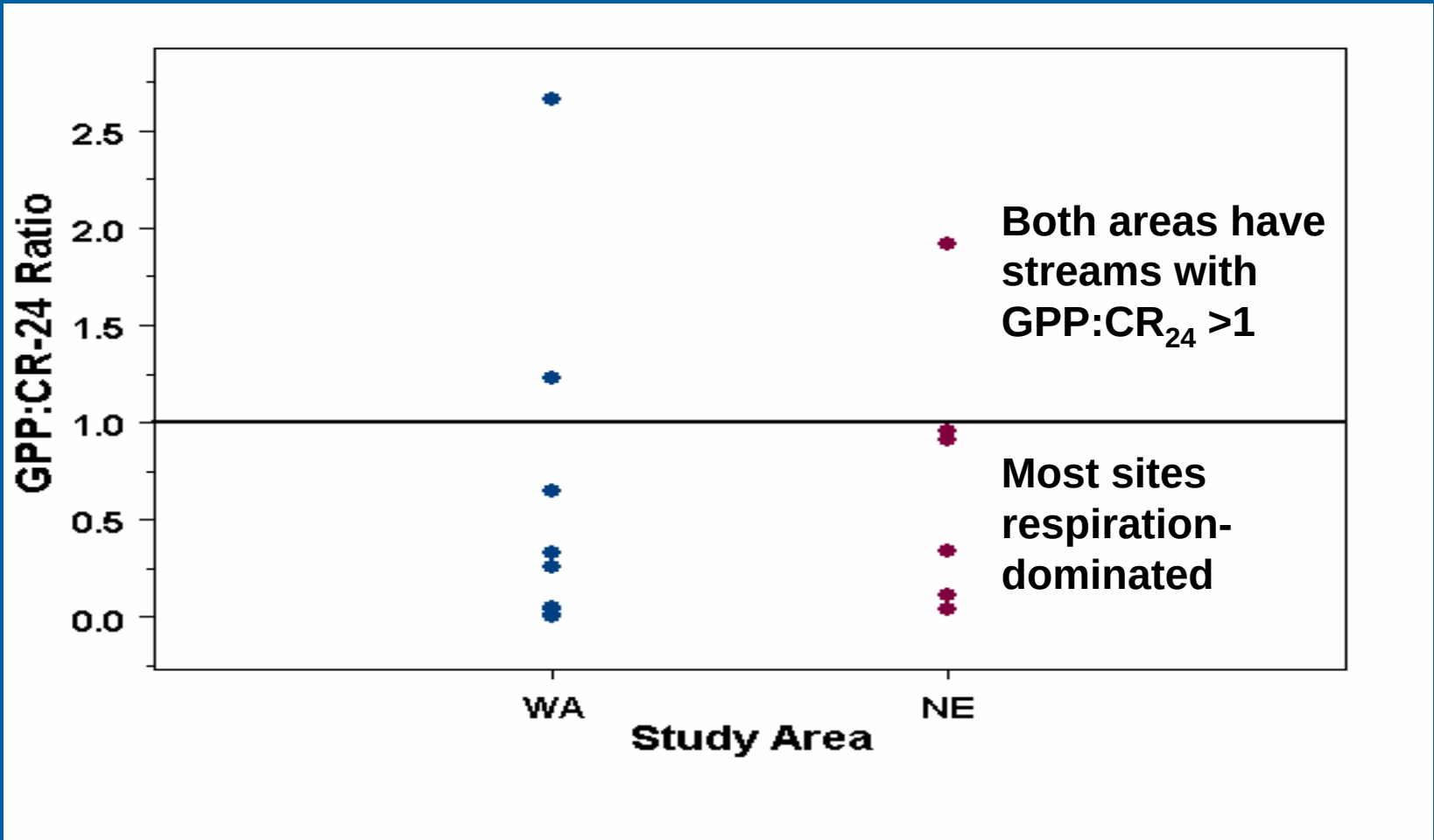
- Spreadsheet format
- GPP and CR_{24}
- GPP:CR Ratio
- NEP



Production/Respiration Values



Gross Primary Productivity to 24-Hour Community Respiration Ratio



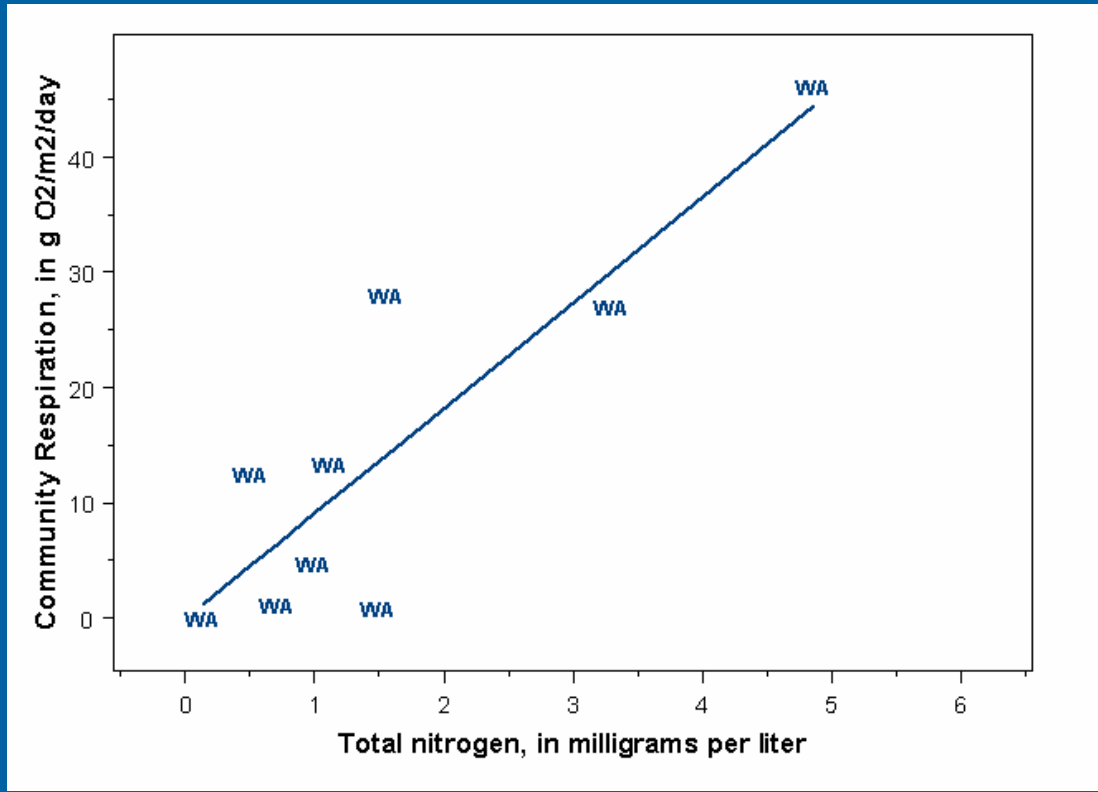
Results of Productivity Comparisons --Combined Dataset

- No significant relationships between productivity and nutrients/algal biomass
- Gross production (GPP) values were not strongly related to any environmental or physical variables
- Respiration and net ecosystem values related to local habitat measures:

  -Bank vegetative cover, canopy closure, velocity

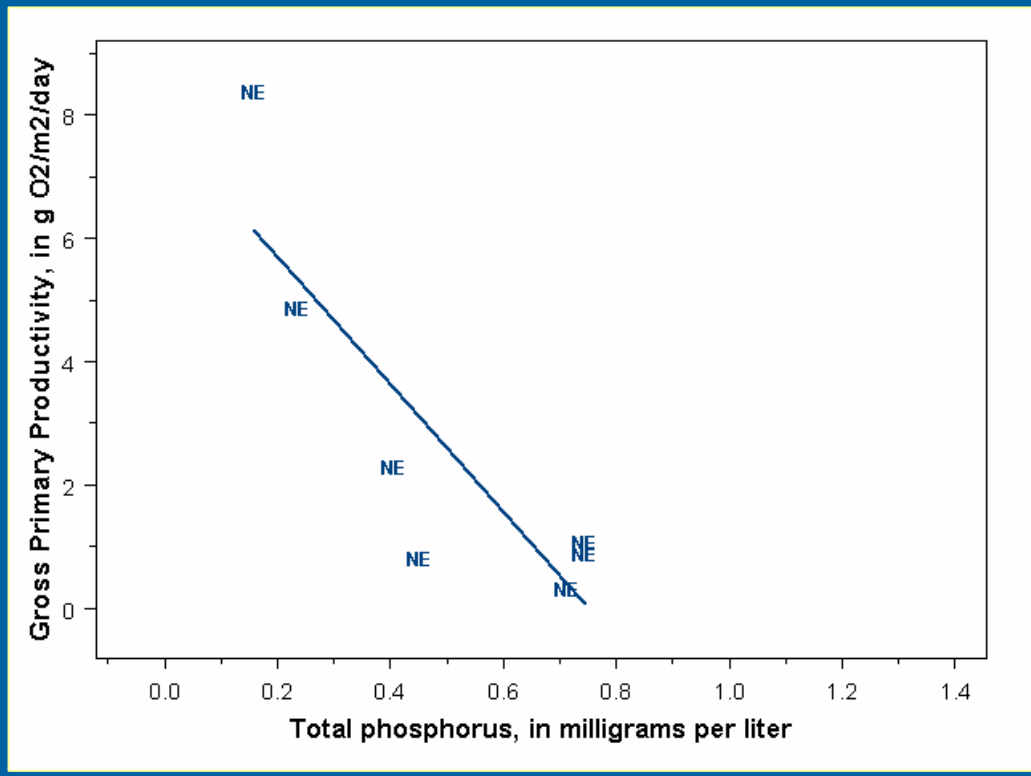
Results of Productivity Comparisons --Washington Dataset

- CR_{24}: Total and dissolved inorganic nitrogen
- Environmental Variables
  - GPP: Reach surface area
  - CR_{24}:Canopy, bank vegetative cover



Results of Productivity Comparisons -- Nebraska Dataset

- GPP: Total phosphorus, Kjeldahl nitrogen
- Environmental Variables
  - GPP: Suspended sediment, organic carbon in suspended sediment, precipitation
  - CR_{24}: Discharge, grassland



Implications

- The relationship of production and selected nutrient values at regional level supports the use of regional or subregional criteria
- Physical and environmental factors more strongly related to production values
  - Influence of channel/system alterations
    - -Altered hydrology
    - -Channel modifications
- Small streams with limited oxygen production/nutrient uptake capability

QUESTIONS?

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