Statewide Water Quality Trend Analyses for Inclusion in the Oklahoma Comprehensive Water Plan

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Why Look at Trends?

- Context
  - Use assessment is a binary approach (impaired vs. unimpaired)
  - Trend analysis gives context to data relationships

- Effective and Timely Water Quality Management
  - Allocation of Resources (hot-spots)
  - Are water quality criteria and implementation effective?
  - Determination of possible future costs (e.g., water treatment)

Back Story

Funded through the Oklahoma Comprehensive Water Plan (OCWP)

- Overarching goal of the OCWP is to provide safe, reliable, and quality water for the citizens of Oklahoma for the foreseeable future
- Recognized early on that a comprehensive trend analyses invaluable planning tool for not only water quality management, but water use planning activities.
- Examples:
  - Cultural eutrophication can create serious taste and odor issues in drinking water supplies.
  - Increased ground and surface water depletion concentrates minerals impairing the beneficial use of those waters for agriculture, municipalities, and industry.
  - Increased sedimentation of Oklahoma's rivers and reservoirs decreases the amount of storage and increases the costs of pretreatment.

Back Story

Formulated Ad-hoc Advisory Workgroups for Both Lakes and Streams

- Numerous staff professionals from various local, state, and federal agencies as well as state universities were invited to participate in a series of conferences calls and planning meetings.
- Addressed a broad range of topics, including which waterbodies, what parameters, available data, data reduction, analysis methods, and reporting.
- In the end, various ideas were used to create a limited approach for both waterbody types.
- A limited technical approach was necessitated by several factors
  - limited time and funding.
  - A comprehensive, statewide trend analysis of several waterbody types is relatively unique.

Resources Considered

Lakes

- Chose 65 of the 130 available lakes
- Selection Criteria Included:
  1. Regular monitoring over the past 10-15 years (BUMP Lakes) with no longer than a 5 year data gap
  2. Quarterly monitoring data at a minimum
  3. Include broad-based parametric coverage (at least nutrients, conductivity, water temperature, chlorophyll, and Secchi depth)
  4. Be representative in terms of size and use (sensitive water supplies, recreation, etc.)

Streams and Rivers

- Eventually chose 60 monitoring stations to include
- Selection Criteria Included:
  1. Stations must be part of the BUMP network (logistics decision)
  2. At least 10 years of data with no more than a 5 year data gap
  3. Continuous flow data record over period of record being used.
  4. Include broad-based parametric coverage (at least nutrient, conductivity, DO, pH and water temperature data).

Methodology

Data Solicitation

- Solicited all data through several requests from a number of federal, state, tribal, and local entities
- Majority of data from the OWRB, USGS, Army Corp, ODEQ, and OK Conservation Commission

General Data Reduction

- All data from various sources combined
- Generally common non-detect levels determined for each parameter
- Datasets screened for information collected on the same day

Methodology (cont.)

Streams Data

- Distinguishing between and combining apples/apples and apples/oranges (e.g., total nitrogen and turbidity data sets)
- Grouped data into historical and recent datasets
- Analyzed various periods of record—all data, historical (varied), and recent (typically previous 10-12 years)
- Analyzed concentrations and flow-adjusted concentrations

Lake Data

- Created common lake sites in order to group data from various agencies (based mostly on BUMP monitoring locations)
- Analyzed datasets by whole lake, lake site, and lake segment (if > 1)

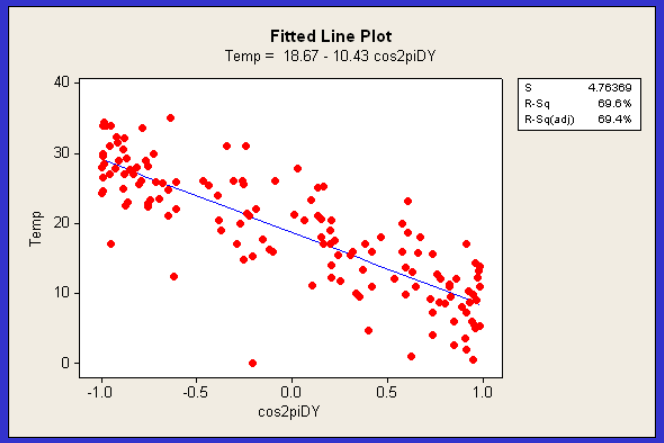
Methodology (cont.)

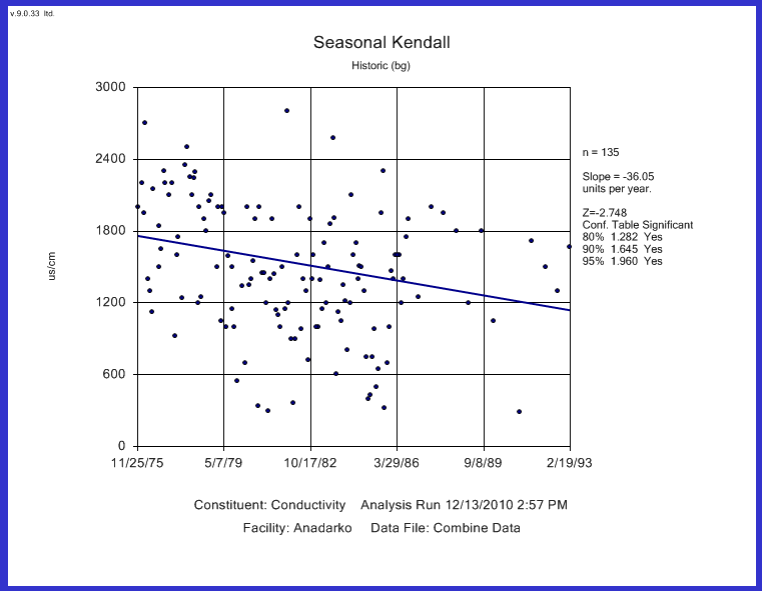
Statistical Analyses

- Multiple linear regression including both flow and seasonal terms (streams)—performed on log-transformed and raw data

(Temp = time (DD) + flow + 2piSeas + 4 piSeas)

- Mann-Kendall and Seasonal Kendall (streams and lakes) – flow adjusted and concentrations in streams
- Analyzed for significant relationships at various confidence levels (equivalent to alpha = 0.20, 0.10, and 0.05)
- Combined various analyses for each parameter at each site and made a single determination
- Scored as no trend; high, moderate, or slight upward or downward trend





Results—By the Numbers

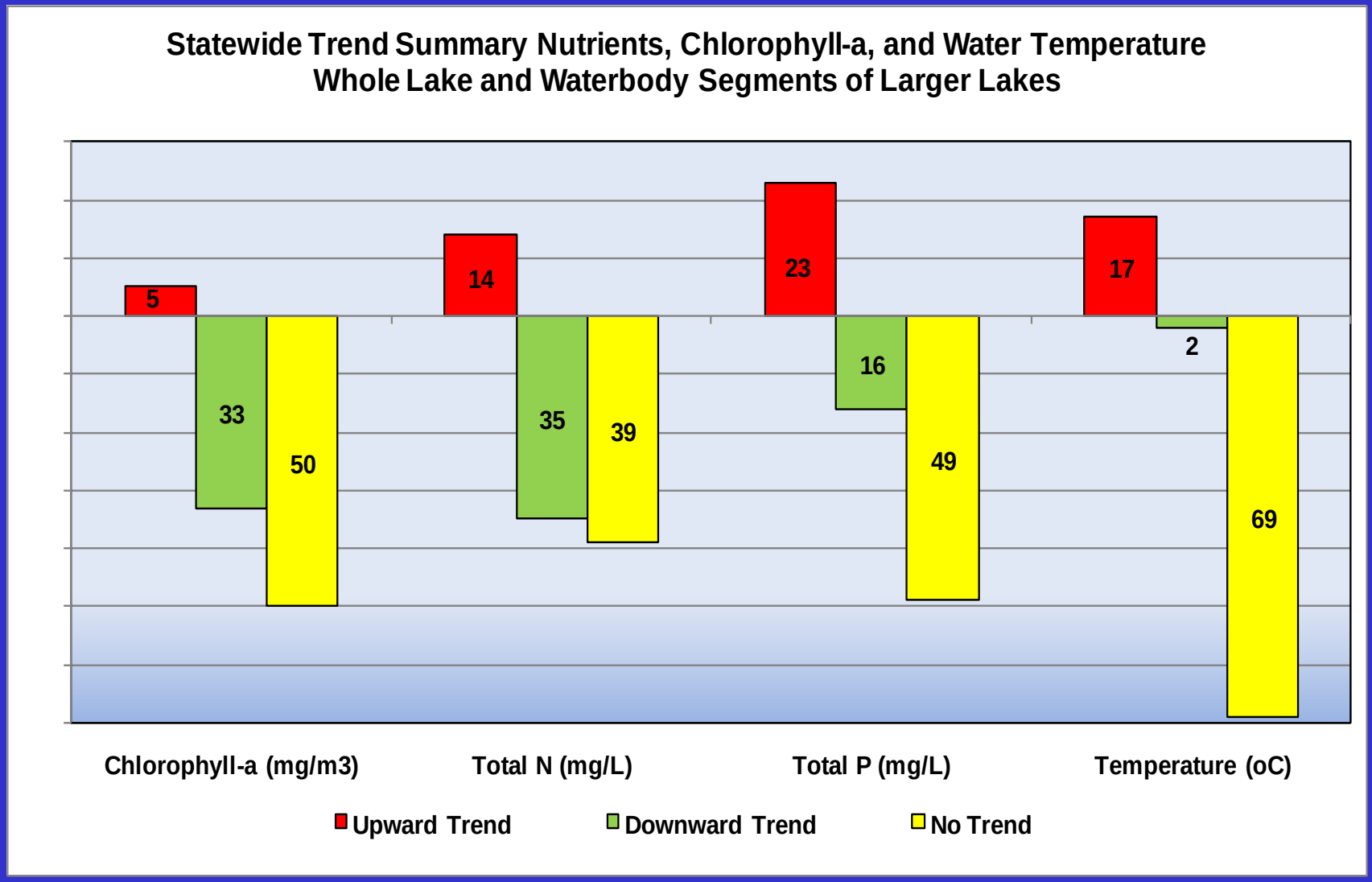
Analyses

- Lakes = ~15,000
- Streams = ~24,000

Data Points

- Lakes = ~200,000
- Streams = ~350,000

General Trend Results (Lakes)



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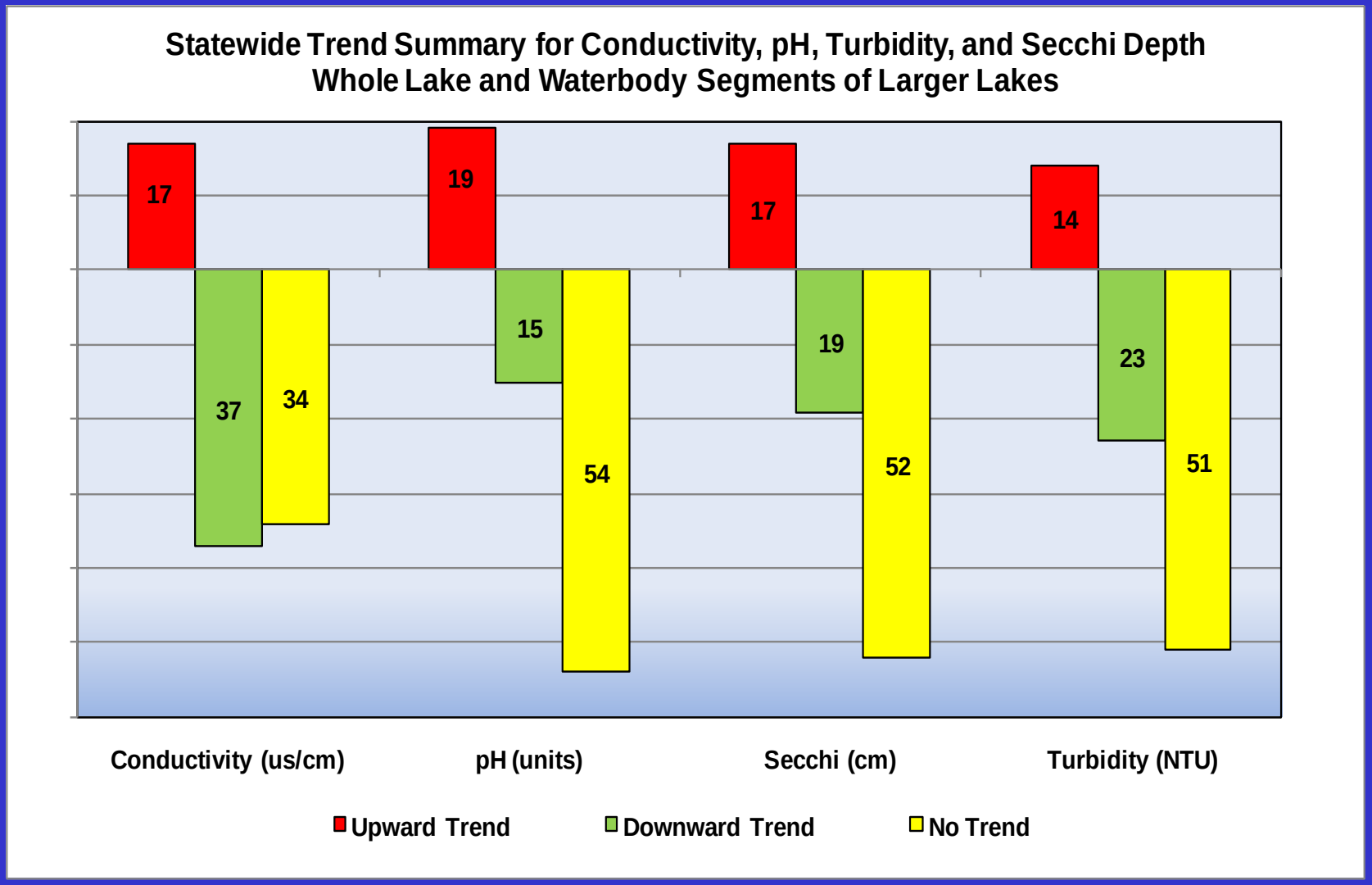
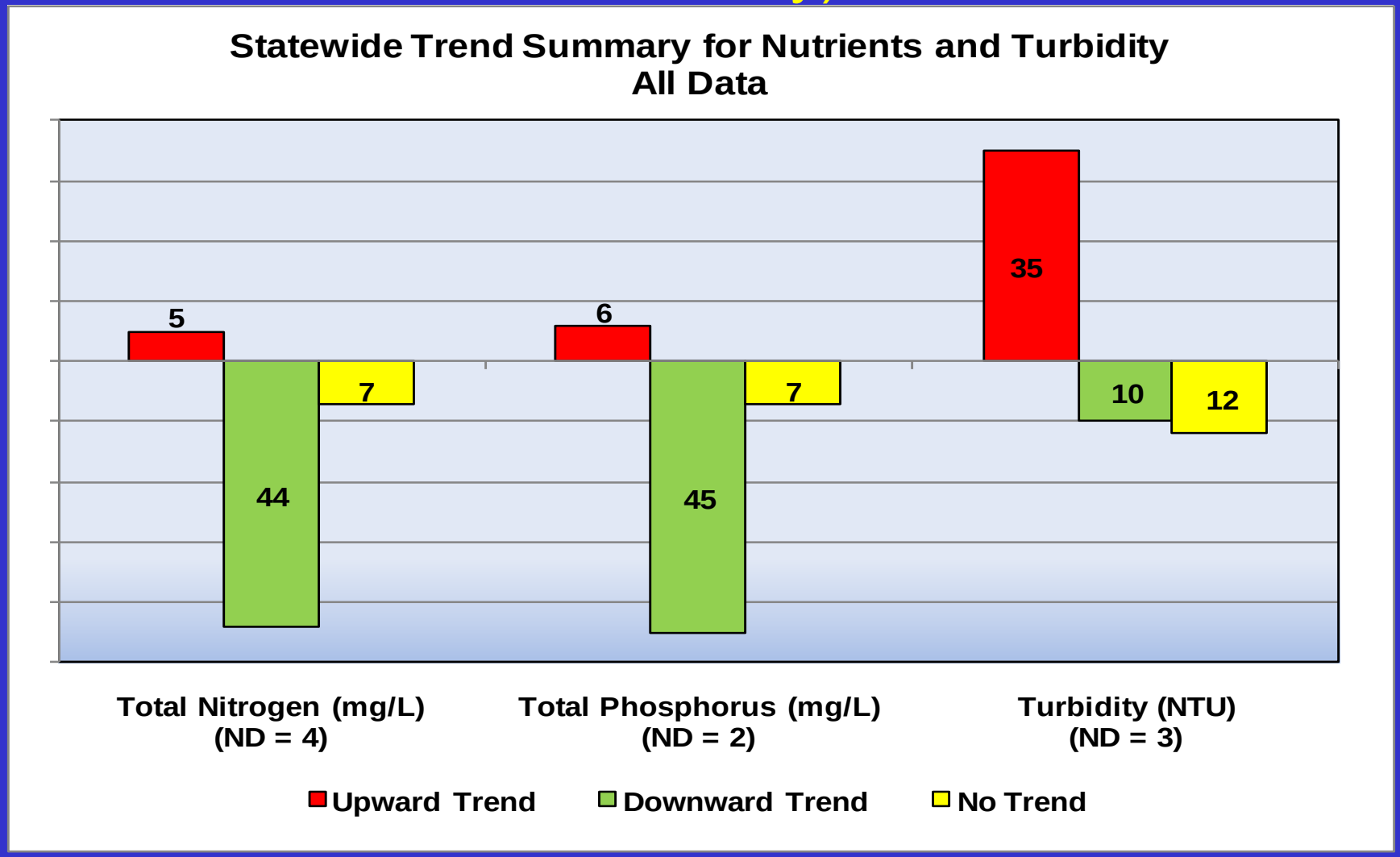


General Trend Results (Streams—Nutrients and Turbidity)



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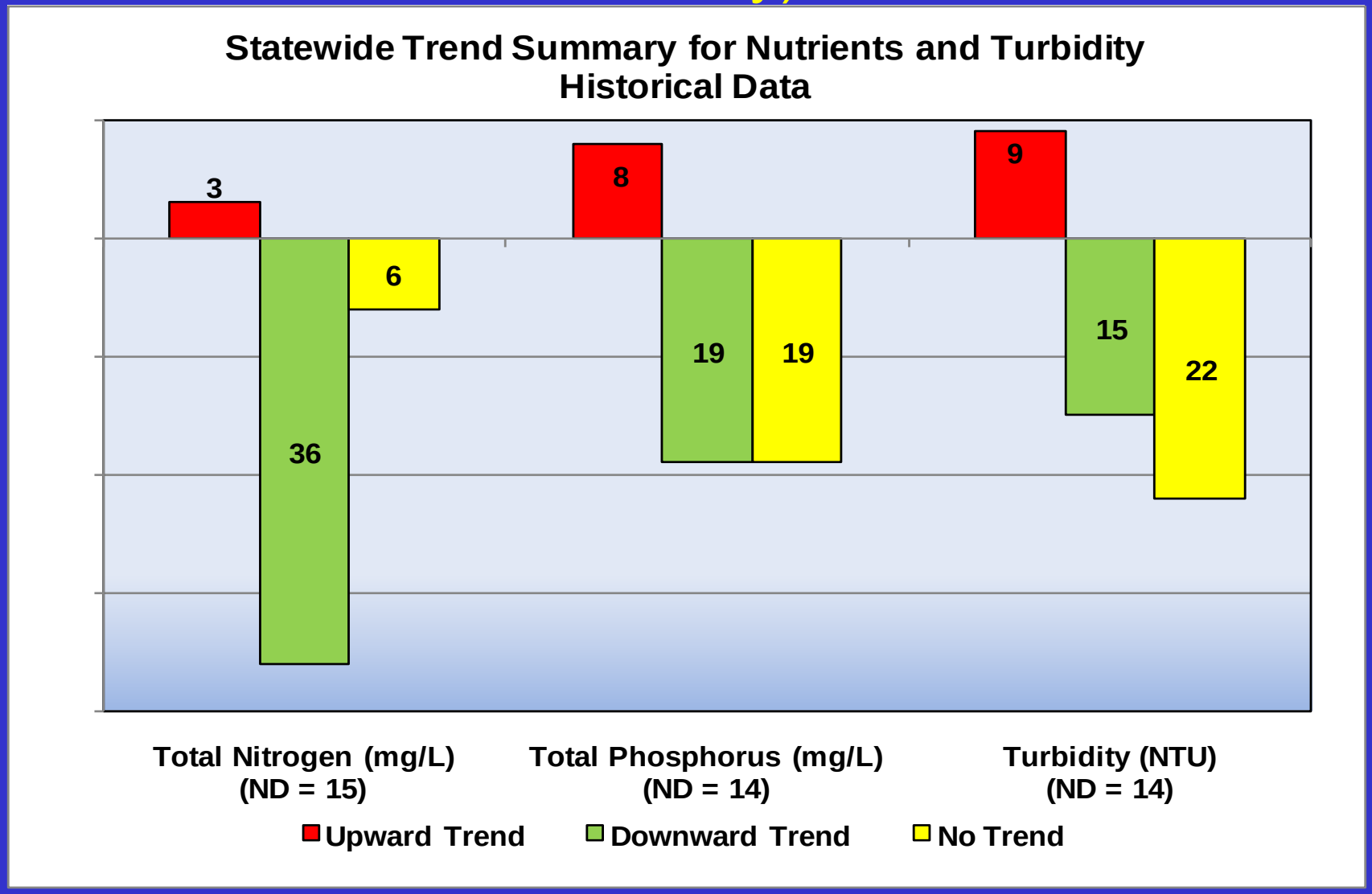

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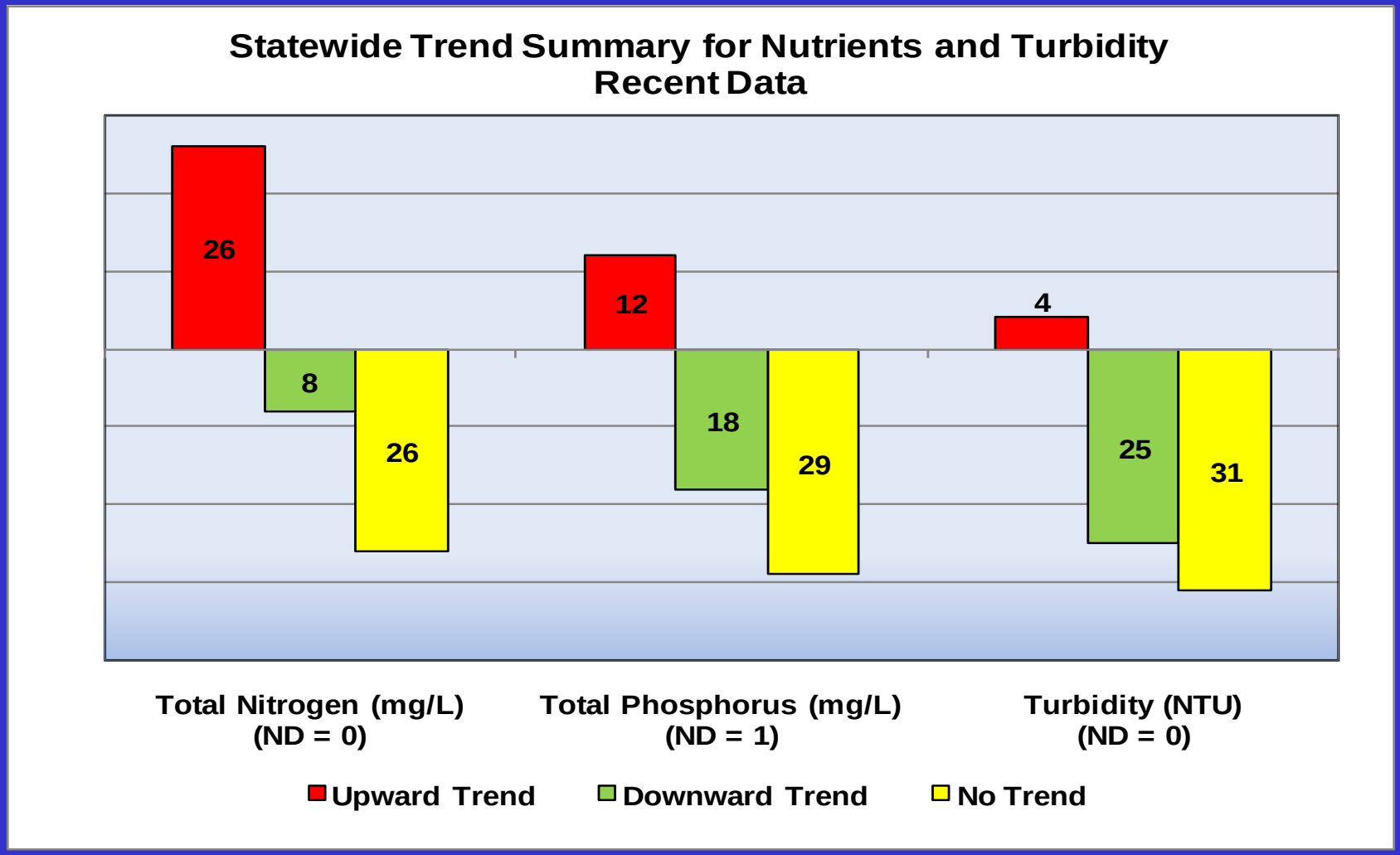
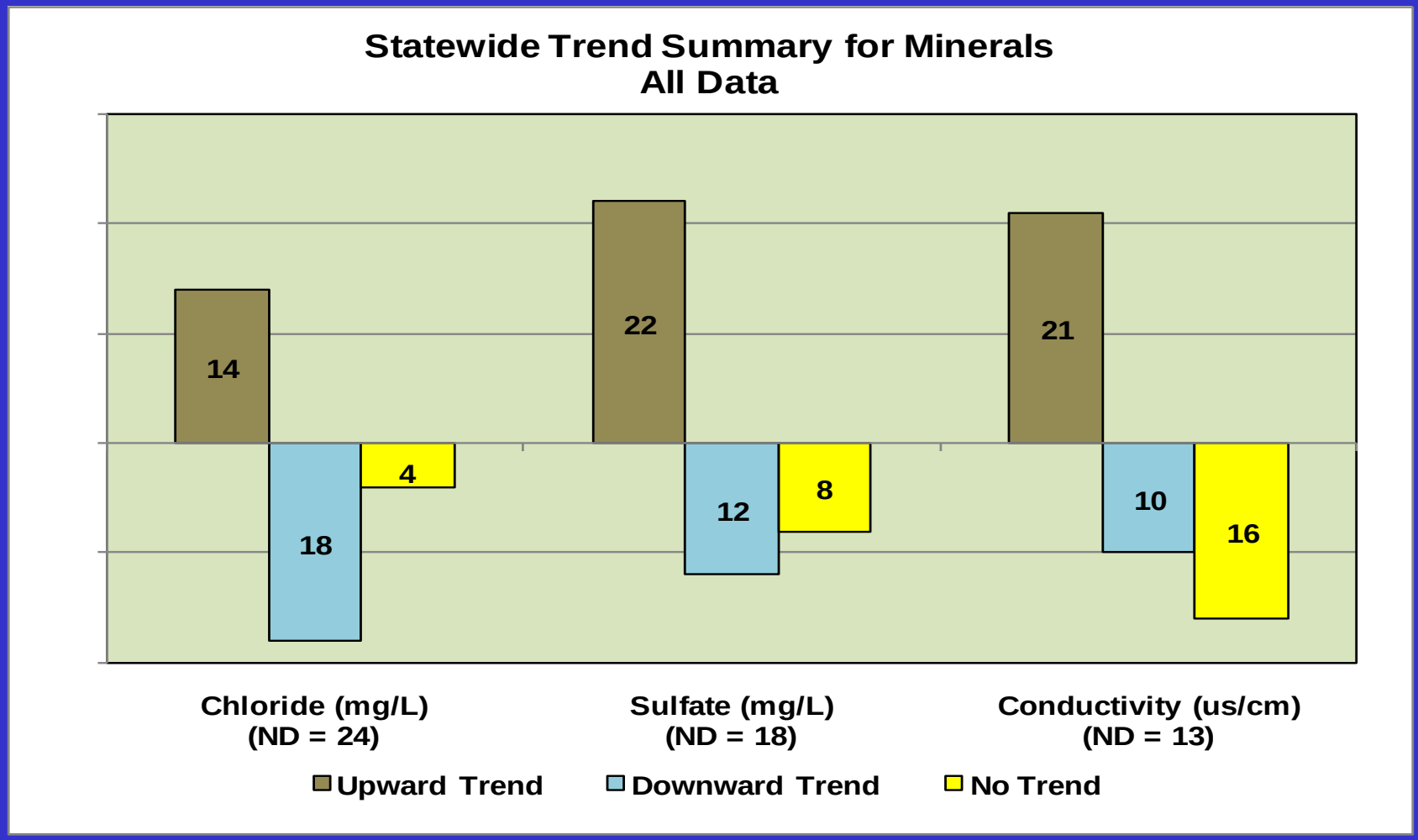


General Trend Results (Streams—Minerals)



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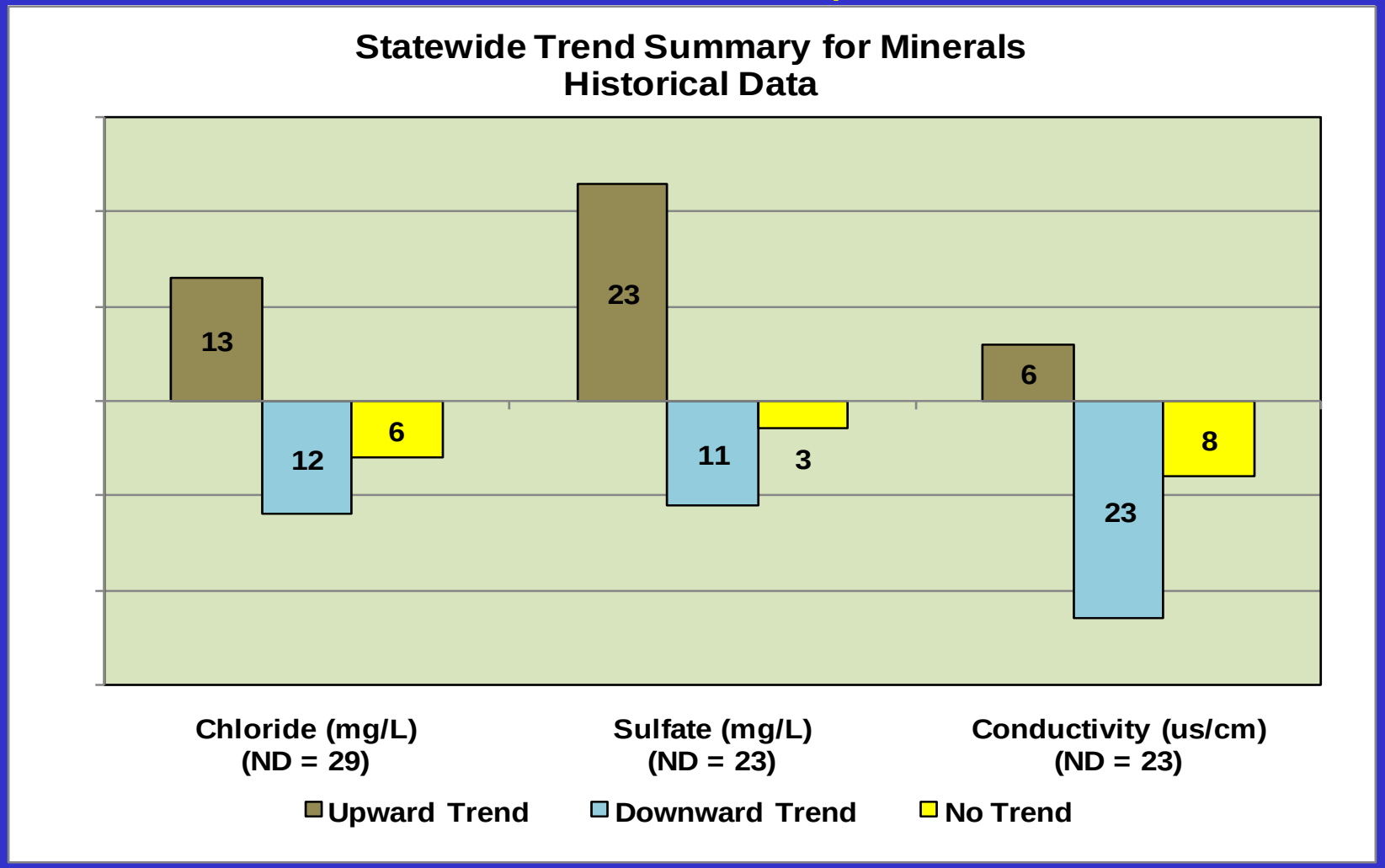

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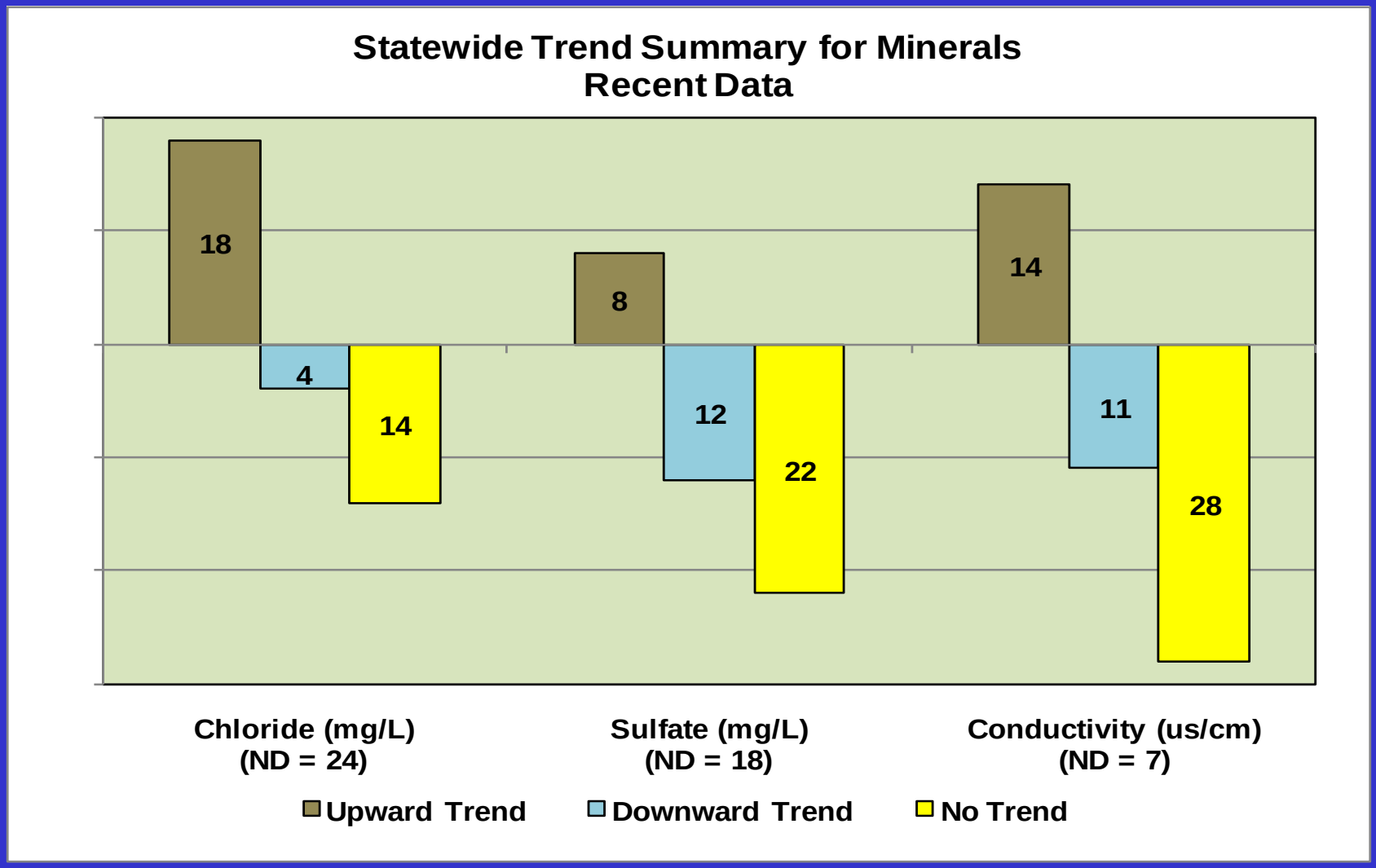
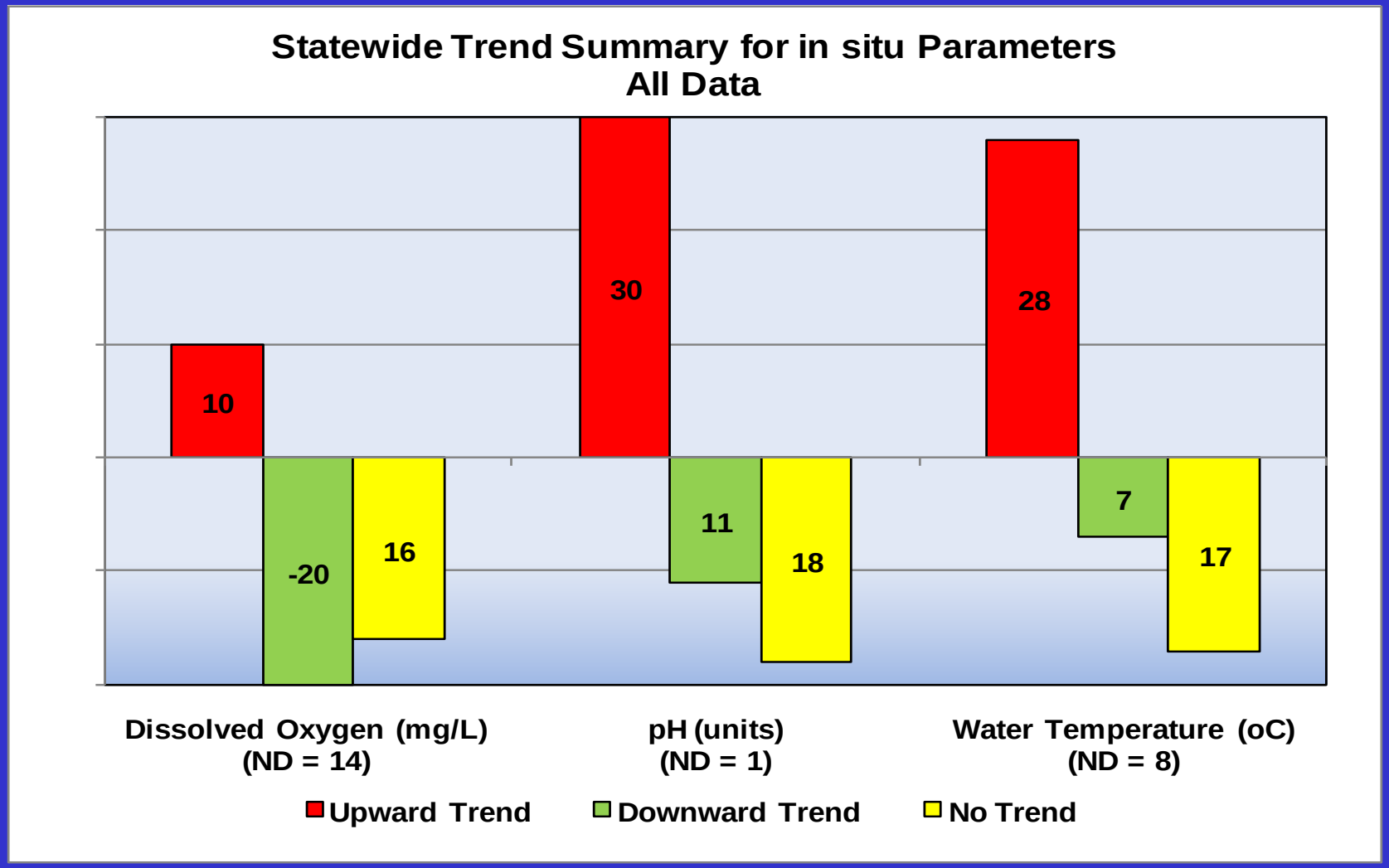


General Trend Results (Streams—*in situ*)



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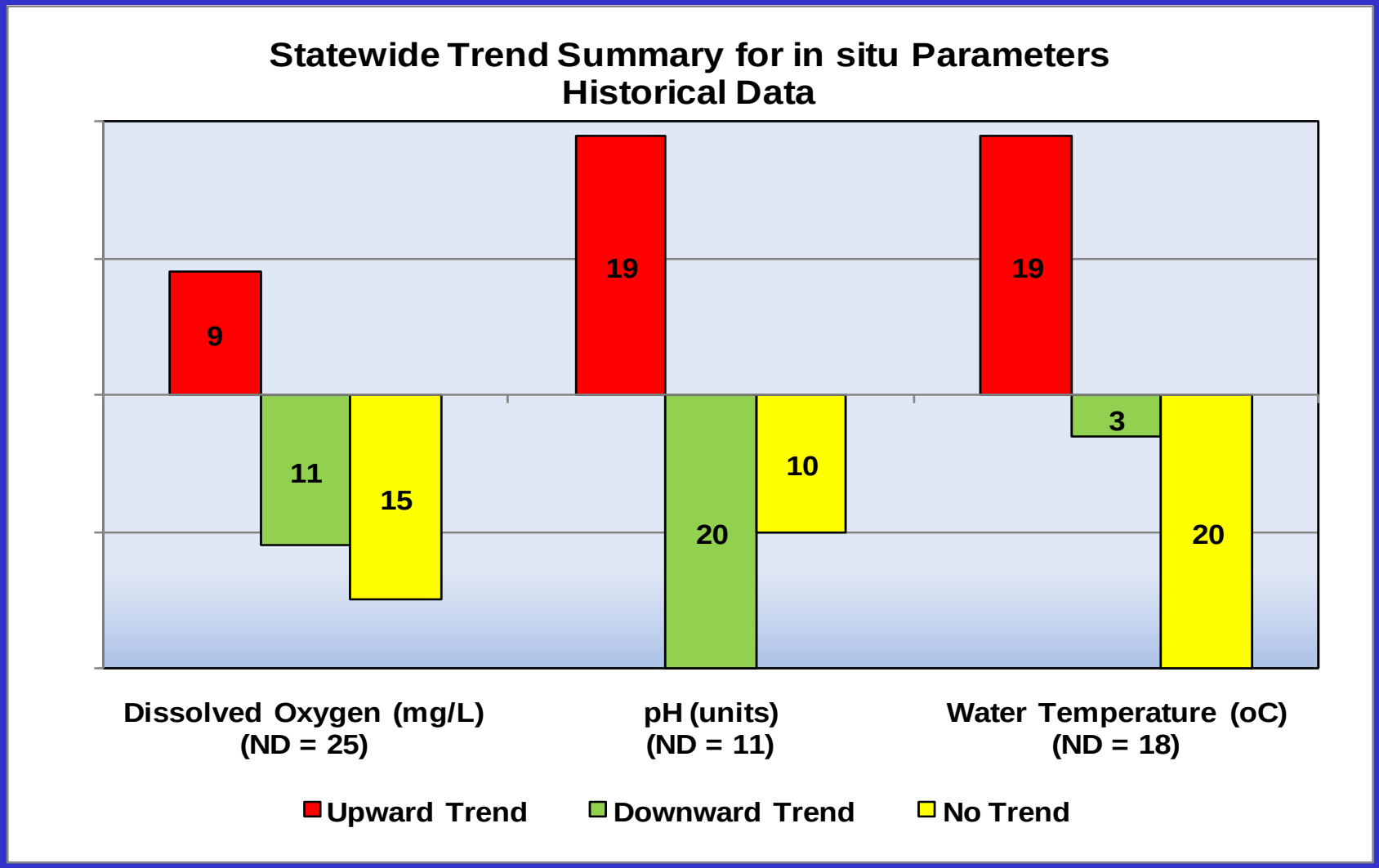

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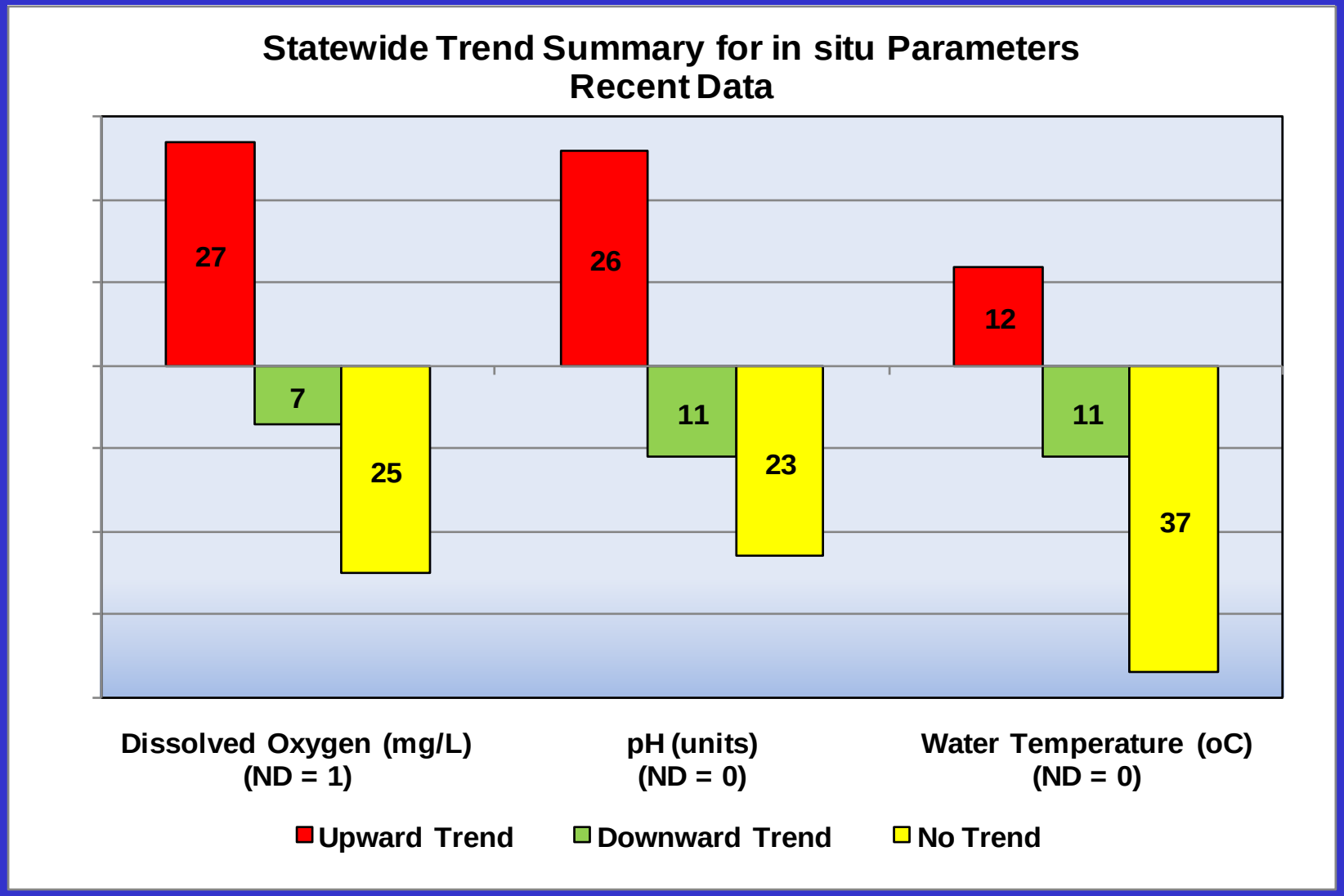

Reporting

- Executive summary write-up included on the OCWP webpage for review
- Inclusion with BUMP pages on OWRB website
- Regional Write-ups eventually on the OWRB website

Future Needs and Opportunities

- Need commitment, planning, and funding

- Analytical Opportunities
  - Calculate and analyze trends for annual loadings
  - Create water quality based water use index
  - Analyze trends in the context of regulatory and water use endpoints
  - Watershed and planning basin trends
  - Develop indicator-stressor relationships (use-based)

- Logistical Opportunities
  - Consolidate statistical methodologies
  - Broaden geographic scope to include other waterbodies (e.g., smaller streams)
  - Reporting of Information