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Marine Water Condition Index (MWCI)

YEARS 2001-2010

Overview — State wide index scores and trends of the MWCI

Regional Trends — Regional index trends and confidence levels

Trend Details — Trends for broken-out variable groups (modules)

Variables — Variability in source data relative to the MWCI baseline

Report — Formulation, baselines and communication

MWCI – YEARS 2001-2010

Yearly MWC Index Scores By Region

Region/Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Admiralty Reach	8	4	0	-5	-3	-5	4	0	-3	-2
Georgia Basin	11	1	-2	10	-2	-7	1	9	-9	7
Grays Harbor-Ocean	0	1	-2	4	2	3	5	6	-10	-2
Grays Harbor-River	14	-4	-5	-2	-8	-12	9	14	8	8
S. Hood Canal	9	3	-4	-9	-1	-11	6	10	-1	-14
Central-South Basin	12	8	-1	-6	-8	-3	4	1	-7	-10
Bellingham Bay	23	-3	1	6	-12	-8	7	2	-12	-14
Sinclair Inlet	13	1	-3	-6	-5	-11	4	1	3	-13
Oakland Bay	11	-2	-7	-9	-5	1	4	-3	1	-6
South Sound	14	-2	2	0	-4	-2	3	0	-8	-12
Elliott Bay	6	-3	-9	3	-15	-9	3	4	-8	-5
Commencement Bay	13	-3	-5	0	-3	-1	7	-5	-8	-8
Whidbey Basin	9	-5	-2	-10	-1	1	9	7	-9	-14
Willapa Bay-Ocean	14	-3	-6	10	-1	-6	7	7	-2	-4
Willapa Bay-Proper	16	5	-2	-2	-8	-7	-4	12	6	4
Willapa Bay-River	14	5	1	-2	-16	-4	10	8	-2	5
Budd Inlet	18	1	-13	-9	-7	-1	8	5	3	-8

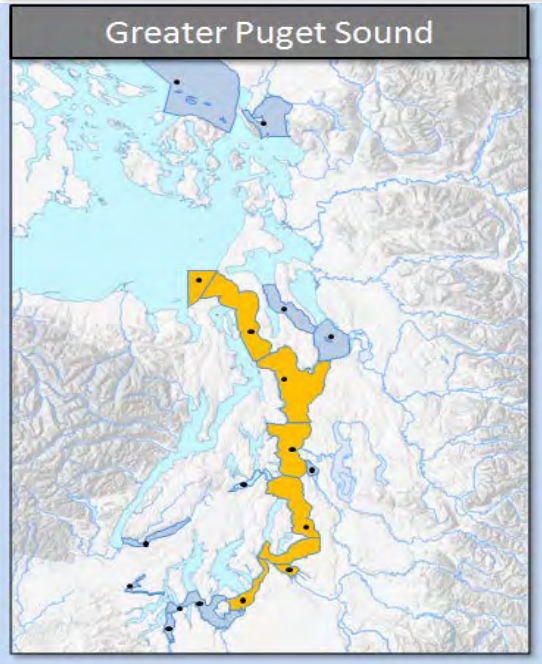
The MWC Index score ranges from -50 to +50 (100 points)

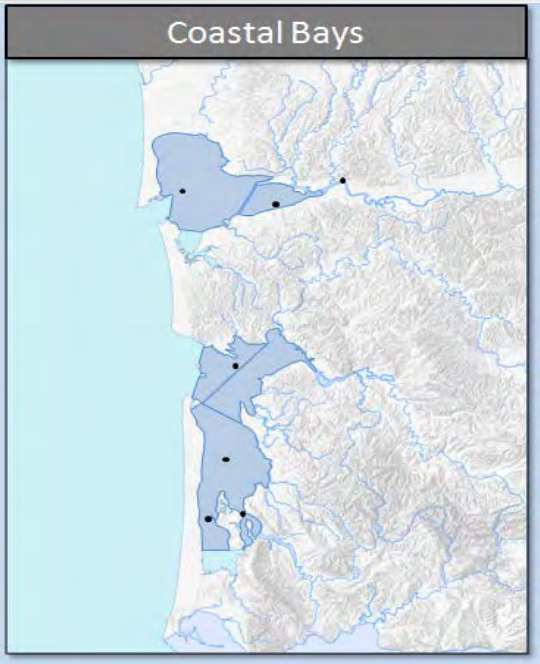
- Good change, score >0, (green)
- Unchanged, score = 0, (yellow)
- Bad change, score <0, (red)

Explain:

- ***What can change tell us?***
- ***Are change and water quality the same?***

Where Do We Find Significant 10-Year Trends?





Maps showing regions with significant negative (red) or positive (dark green) change in the MWCI score.

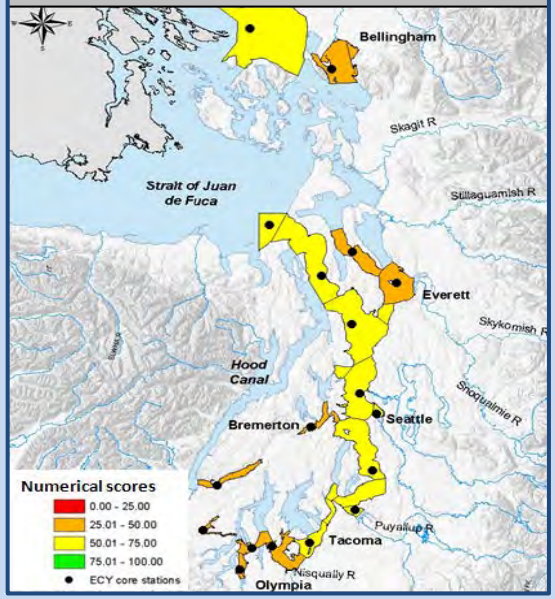
To show a significant change specific to nutrients, we use a subset of the MWC Index, the **Eutrophication Index** (negative=orange, positive=green)

Regions covered by the MWCI are in (blue), stations are indicated by dots

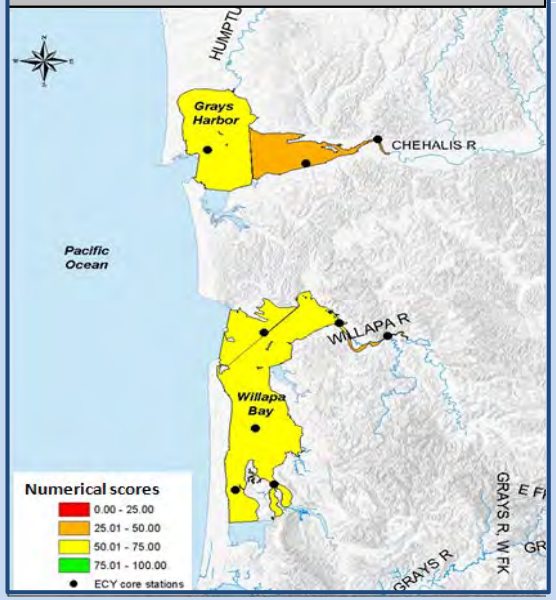
Explain:

- ***What is a significant change?***

Greater Puget Sound



Coastal Bays



Are change and water quality the same?

The MWC Index is a complementary tool for reporting water quality using national water quality standards.

The MWC Index measures change against pre-existing conditions in a complex estuarine environment. We can tell whether a change affects marine water quality positively or negatively by taking larger natural oceanic influences and climatic variability into account.

Maps show if a change in the MWC Index occurs in a region of general water quality concern. Red and orange depict regions that had persistently water quality concerns in the last decade.

What are pre-existing conditions?
From 1999-2008 we established a baseline in persistent water quality gradients that we use to sensitively track change.

Is the ranking scheme part of the MWC Index.
No, it helps place the MWCI into the context of pre-existing and persistent patterns of water quality.

Why is the MWCI not using marine water quality standards?
Standards are sparse and not sensitive enough for the estuarine complexity.

Where can I find information on marine water quality standards?

Water Quality Program Home

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What can change tell us

- **Estuaries have naturally large differences in marine water conditions and water quality**. This makes it challenging to apply one water quality criteria to a diverse system such as Puget Sound, Willapa Bay and Grays Harbor. Instead the Detailed Reports how conditions at each station have changed relative to a historic snapshot in time. The conditions between 1999-2008 are not pristine, but provide an informed baseline to measure change, because we have very good data coverage, consistent methods and information on larger oceanographic and climatic patterns.

- As a result the MWCI can sensitively detect a change at each station. The challenge to account for the large temporal and spatial variation within Washington's marine water bodies is thereby creatively omitted.

- To test if a change continues (trend) or finds a new equilibrium we use test statistics.

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Significant Change

- **Natural conditions fluctuate** from year to year, responding to **climatic and oceanographic influences**.

- To have **confidence in describing a continuing change (trend)** we statistically test if yearly index scores follow a trend over a 10-year window. To do so we use the non-parametric test statistics using the Spearman Rank Correlations (N=10, p=0.05).

- When a **significant change** in marine conditions occurs we focus the attention towards these region to focus the attention towards these trends. We present significant trends for the Marine Water Condition Index (MWCI) and the Eutrophication sub-index on maps (click here).

- You can read more about the focus of each module here.

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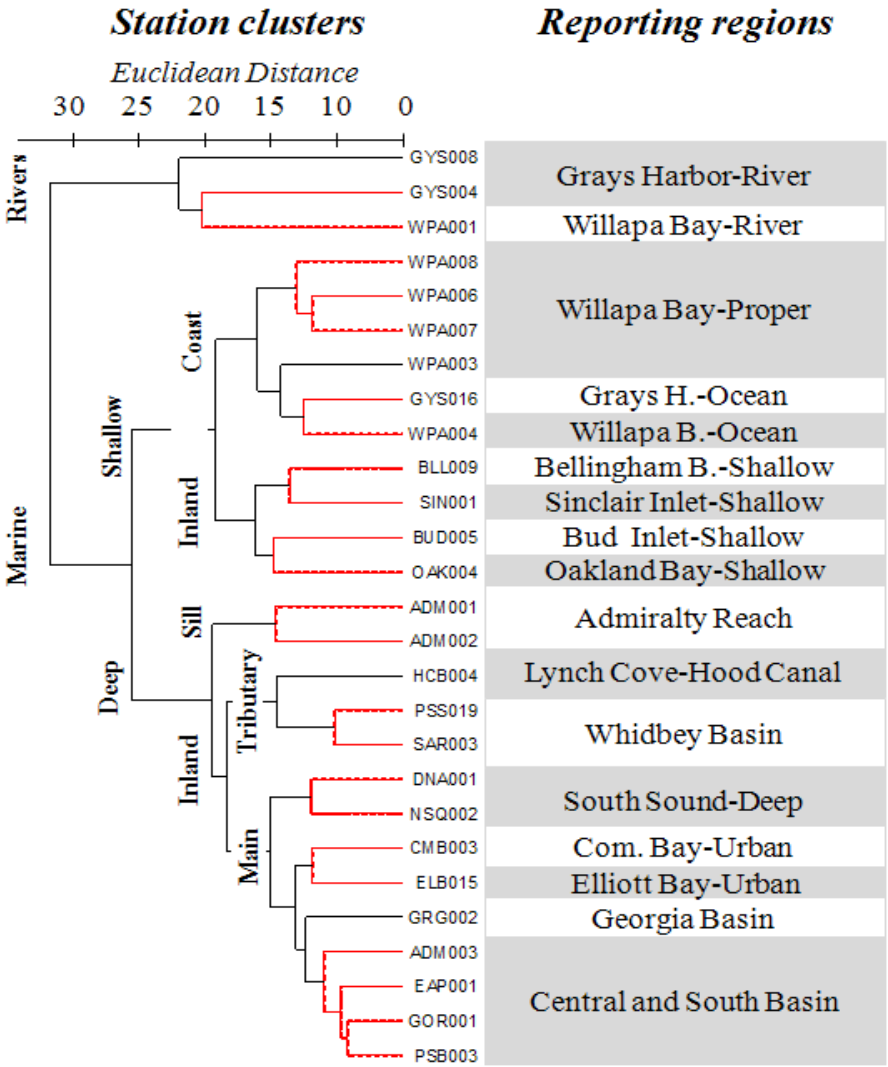
Reporting Regions

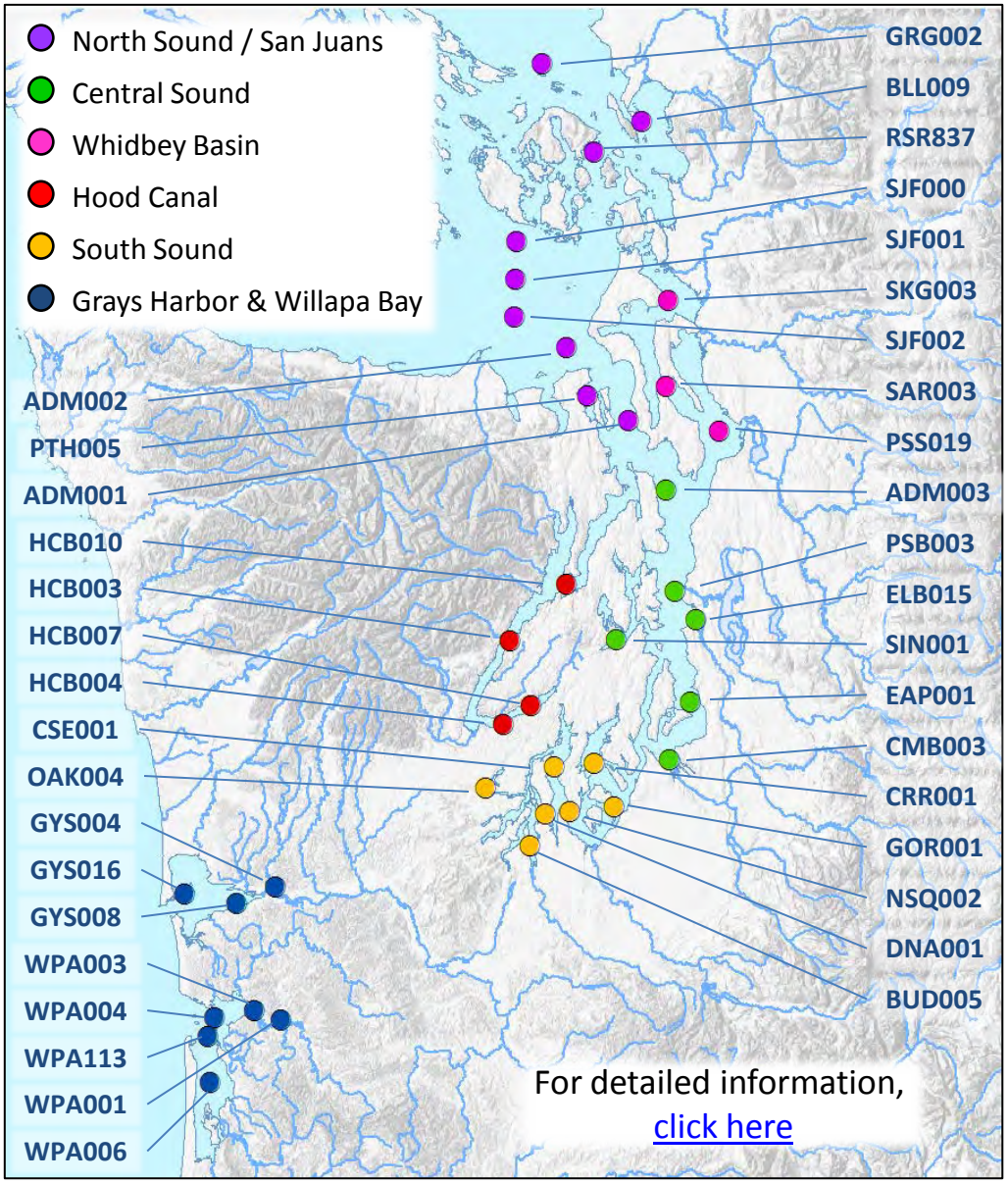
- **Reporting regions were grouped based on similarity in water conditions**

- To provide a quantitative approach to selecting reporting regions, we grouped stations into statistically pre-determined groups. We based station groups on multi-dimensional scaling criteria using 16 variables (see Detailed Report 2011). The approach employed cluster analysis (PRIMER) using 10-year monthly averages of each variable. Some shallow stations grouped closely. We therefore partial separated shallow stations to achieve a better geographically coherence.



Comm. Bay: Commencement Bay, Tacoma.
Central and South Basin: Central and South Basins of Puget Sound.

Long-Term Marine Water Quality Monitoring Program



Station Location:

Station locations were determined by integrating three existing and recommended station networks: existing Ecology sites, sites recommended in 1988by the Puget Sound Water Quality Authority – Monitoring Management Committee (MMC, 1988), and from historical stations surveyed by Collias, et al. during the 1950s and 1960s. Our sampling strategy incorporates 3 types of stations:

Core Stations

Core stations are located in the center of distinct hydrographic regions. These stations provide a long-term record of ambient water column conditions, annual variability and changing marine water quality conditions.

Rotational Stations

Rotational stations are sampled to augment information collected from core station monitoring. These additional stations allow more extensive observation of specific regions and increase geographic coverage of the station network.

Seasonal Stations

Seasonal stations are selected occasionally based on recommendations and data needs, and may be moved to fill or improve data records for other sections of the monitoring program.

Click on regions for more information

Regional Summaries 2001-2010

Explain Graphic

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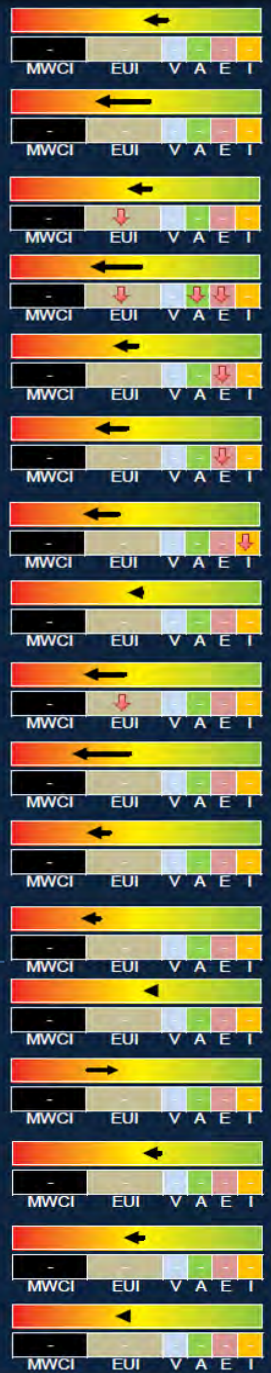
SALISH SEA

- Georgia Basin: Decreasing Tendency
- Bellingham Bay: Decreasing Tendency
- Admiralty Reach: Significantly Decreasing
- Central-South Basin: Significantly Decreasing
- Whidbey Basin: Decreasing Tendency
- S. Hood Canal: Decreasing Tendency
- Sinclair Inlet: Decreasing Tendency
- Elliott Bay-Urban: Decreasing Tendency
- Commencement Bay: Significantly Decreasing
- South Sound: Decreasing Tendency
- Budd Inlet-Shallow: Decreasing Tendency
- Oakland Bay: Decreasing Tendency

COAST

- Grays Harbor-Ocean: Decreasing Tendency
- Grays Harbor-River: Improving Tendency
- Willapa Bay-Ocean: Decreasing Tendency
- Willapa Bay-Proper: Decreasing Tendency
- Willapa Bay-River: Decreasing Tendency

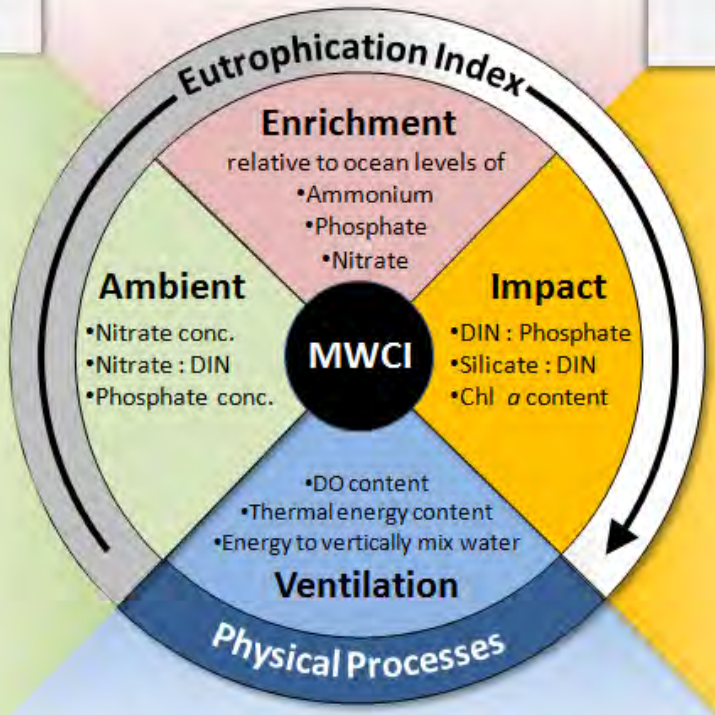


Key questions underlying the modules of the MWCI

Marine Water Condition Index (MWCI):
Are physical conditions and eutrophication jointly changing water quality?

Are changes in ambient nutrients related to oceanic processes?

Eutrophication Index:
Have conditions changed to imply a shift in eutrophication?



Are nutrients changing from historic baseline conditions?

Are the nutrient balance and algal biomass changing from historic baseline conditions?

Do physical conditions affect the availability of oxygen and renewal of water?

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Explore the trends of the MWCI modules by region

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Graphics of the time series of MWCI modules explained

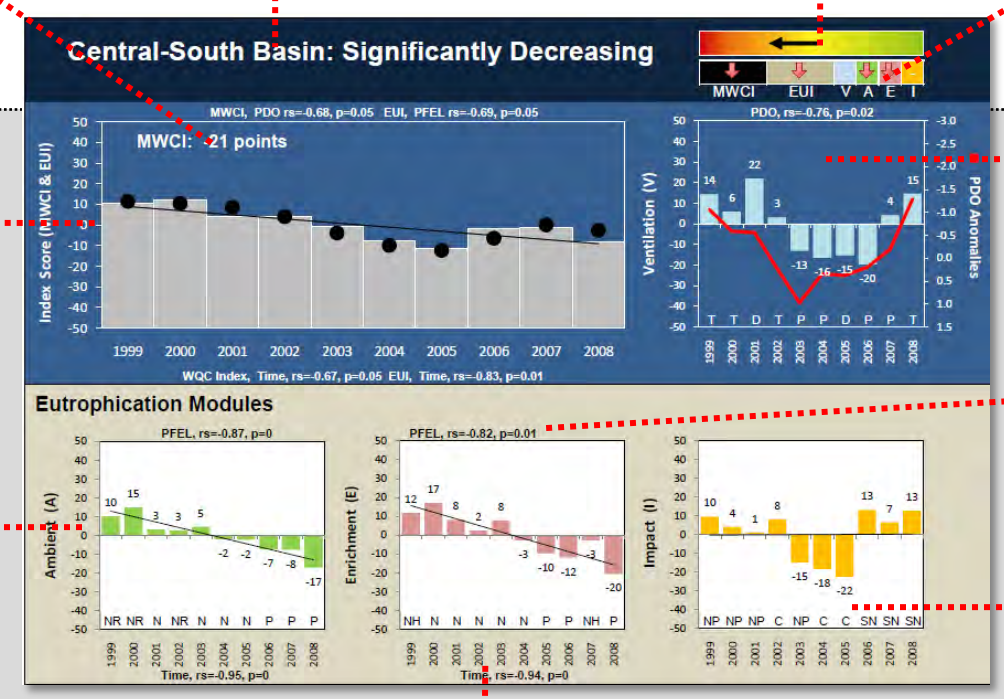
Schematic reporting layer (absolute change from baseline)

Trend line of MWCI over the last 10 years
Its change is used to scale the arrow

Describing the certainty of long-term trend

Combining trends with geographic differences in water quality

Significant changes in modules over 10 years



Trends in **MWCI** (dots)
Eutrophication Index (**EUI**, bar graph)

Eutrophication Module & Trends
- **Ambient**
- **Enrichment**
- **Impact**

Ventilation module [PDO included in red]

Correlations with climate indices PDO, Upwelling Index (PFEL, top of panels)

Variable most lowering the module score

Significant temporal trends (bottom of panels)

Temporally reporting layer (change within 10 year time frame)

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Communicating the direction, intensity and confidence of trends

Color range on a horizontal bar represents the status of historic baseline conditions in relative terms (ranks), lower 0=red, higher 100= green.

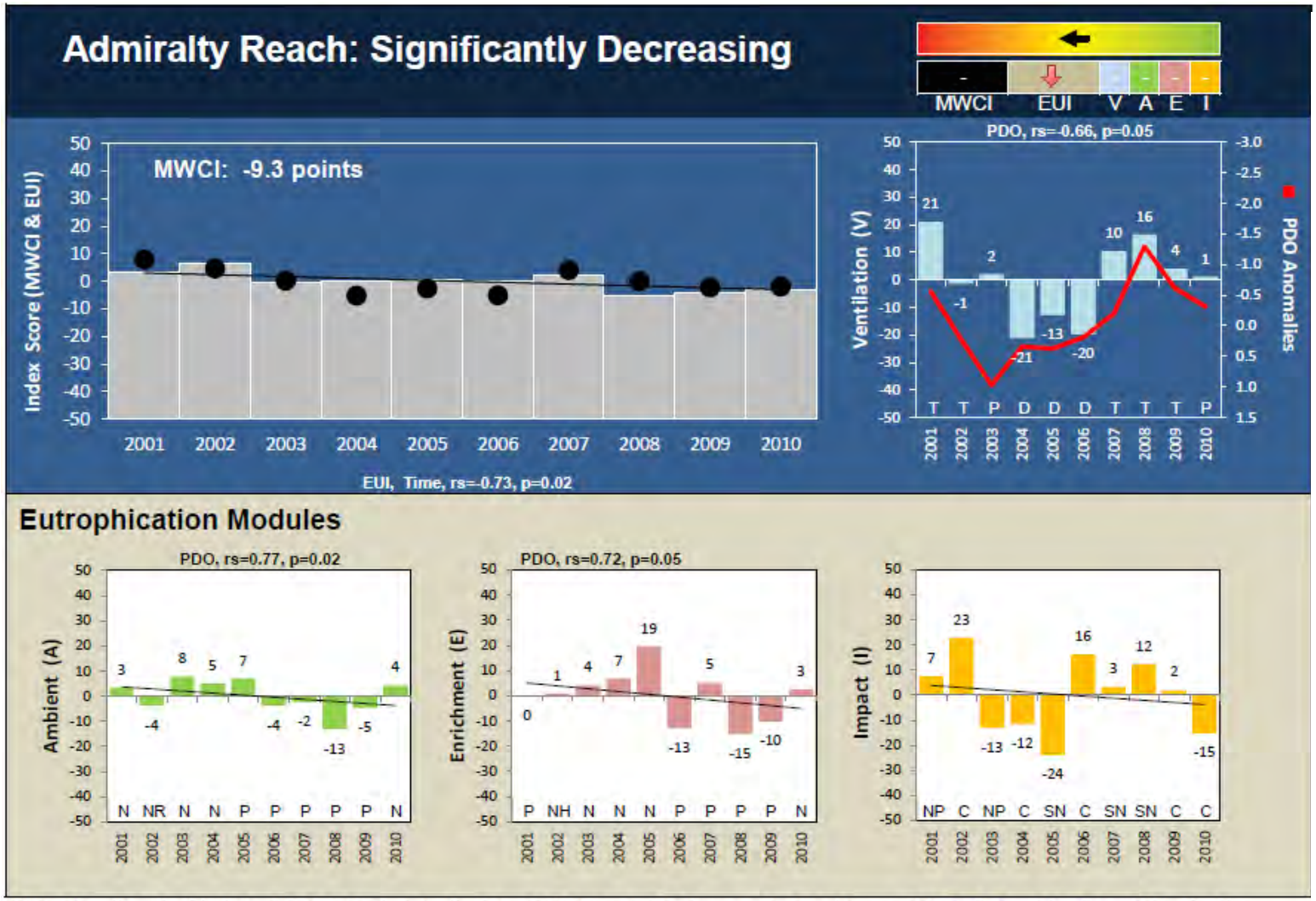
Arrow length and direction are proportional to the absolute change over the last ten years. It is calculated by a trend line through yearly MWCI scores

The arrow origin is placed into qualitative context with other stations on a horizontal color bar. Stations are ranked between 0-100

MWC Index | Eutrophication Index | Ventilation | Ambient | Enrichment | Impact

Arrows (↓ ↑) indicate significance and direction of trend, *(- not significant)*

by including statistical criteria for decision making



MWCI= Marine Water Condition Index, EUI= Eutrophication Index, Ventilation (V): T=Heat content, D= DO content, P=-Potential energy, PDO=Pacific Decadal Oscillation, PFEL= Upwelling
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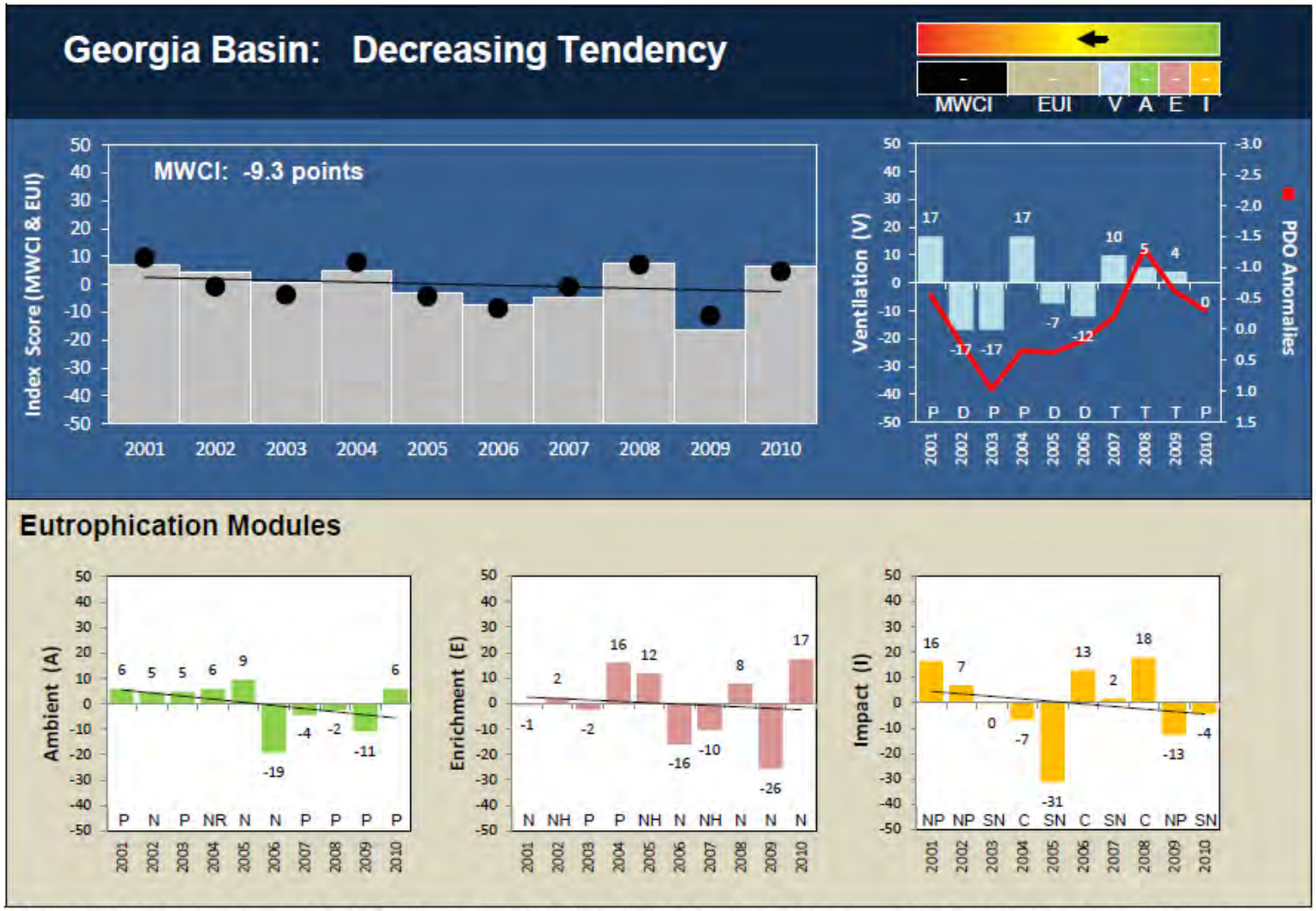
Explain graphic



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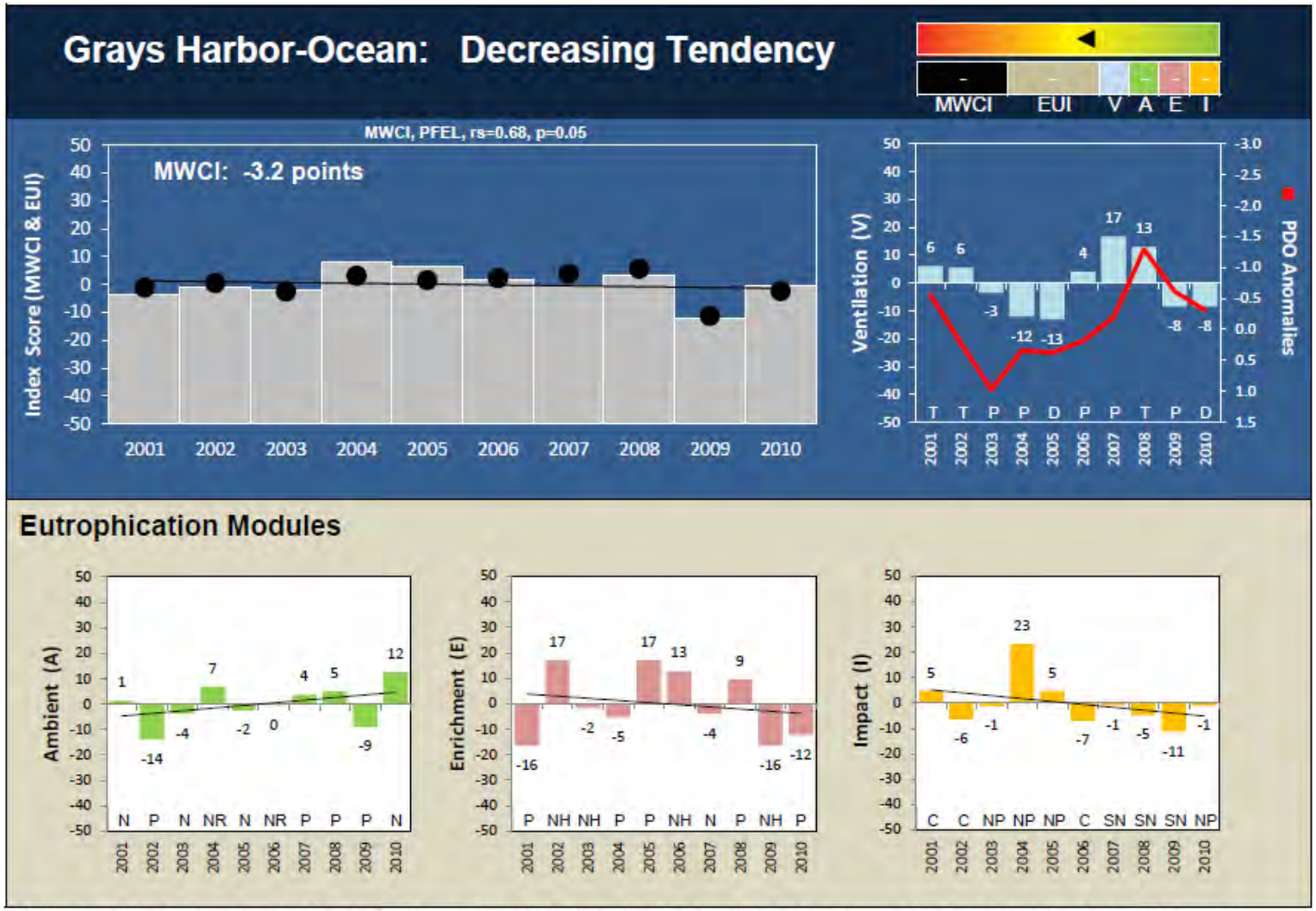

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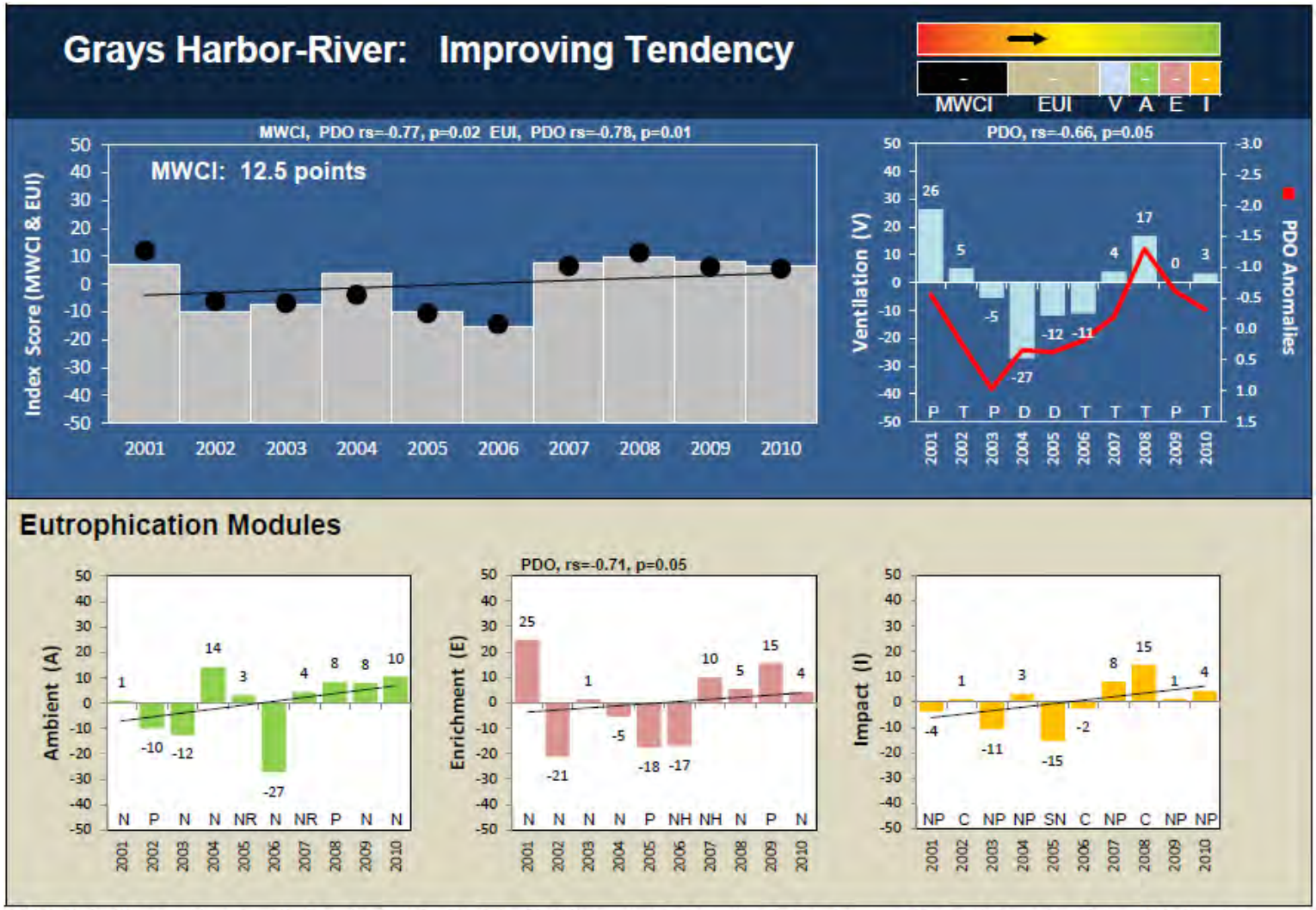

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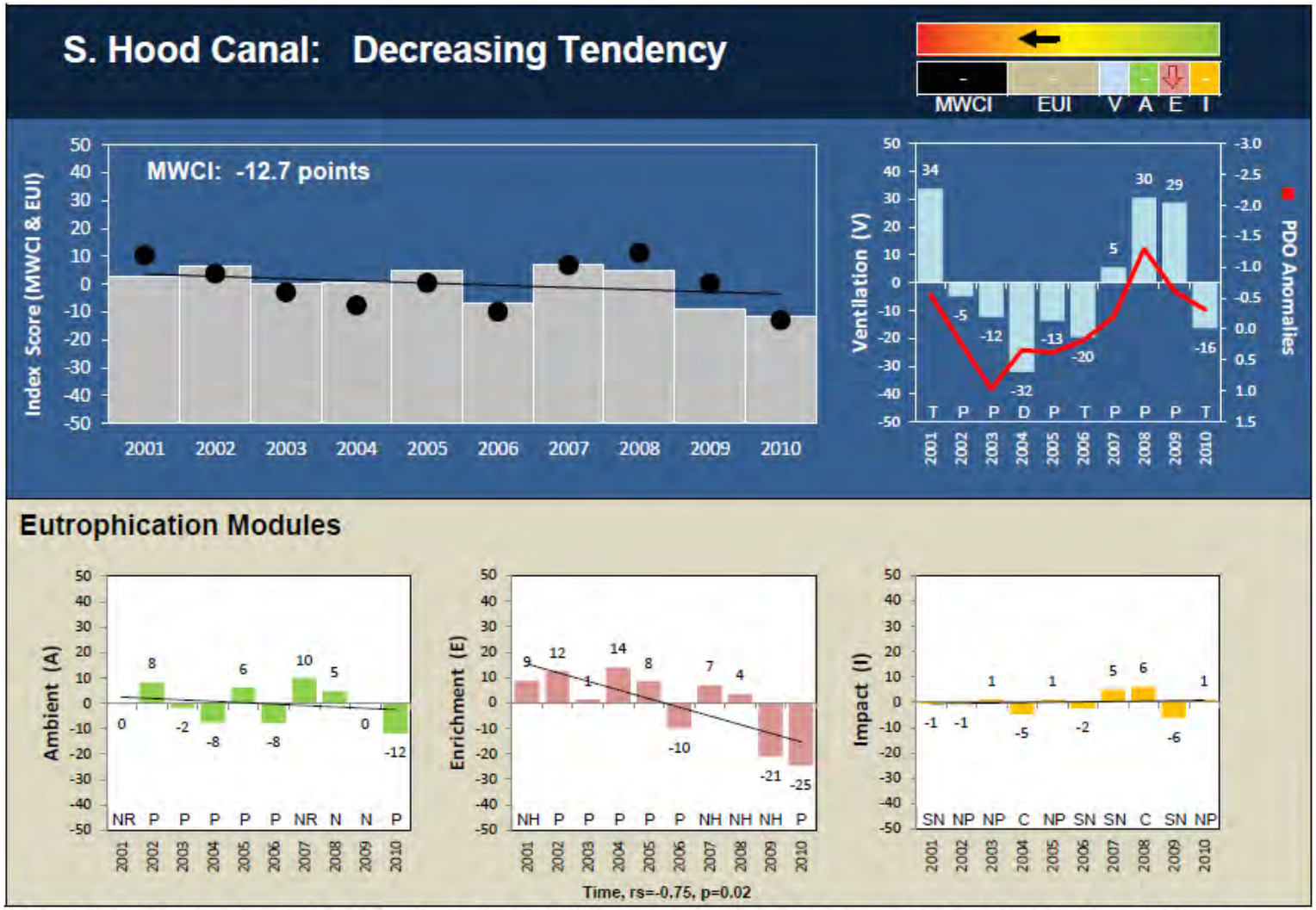

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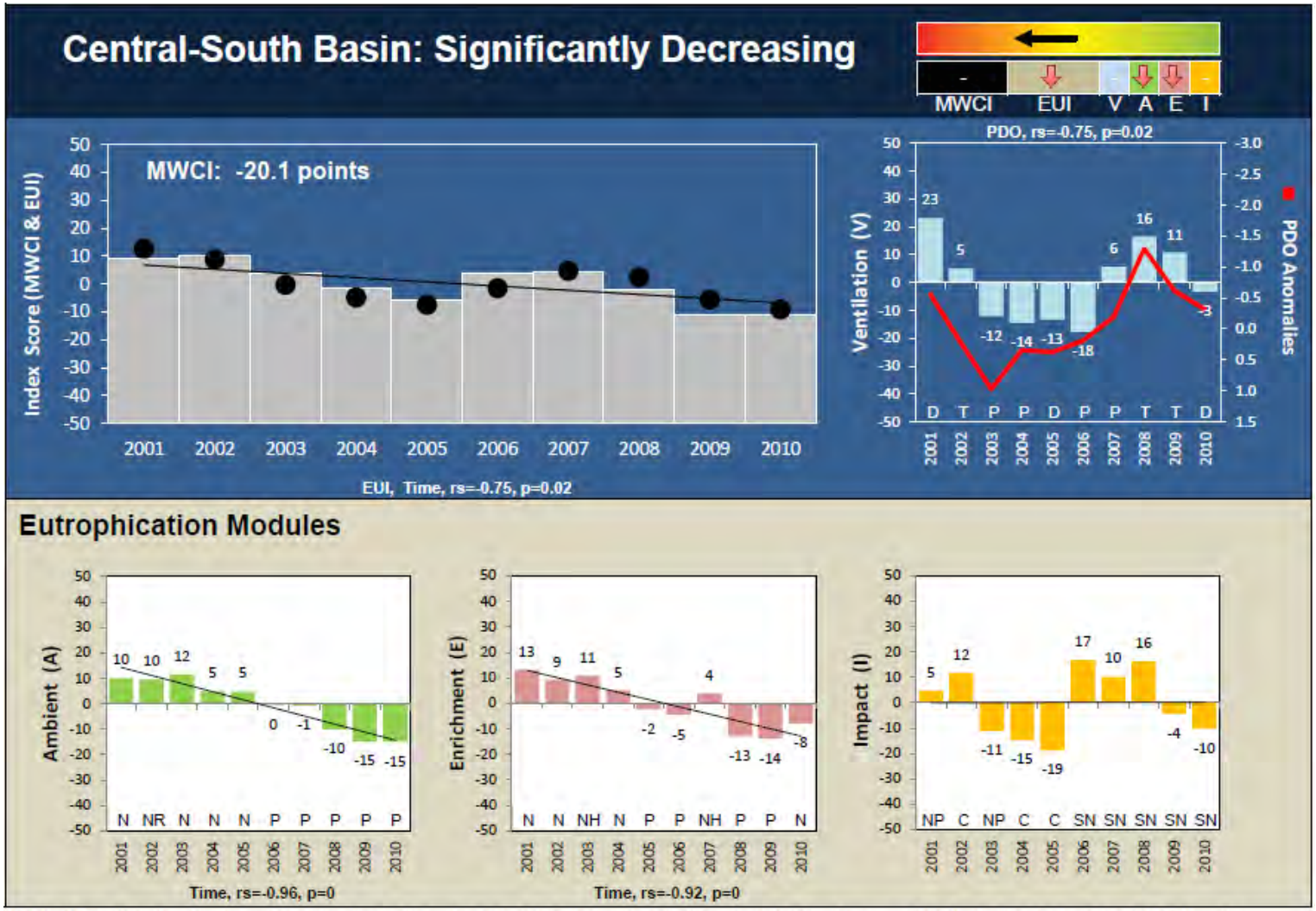

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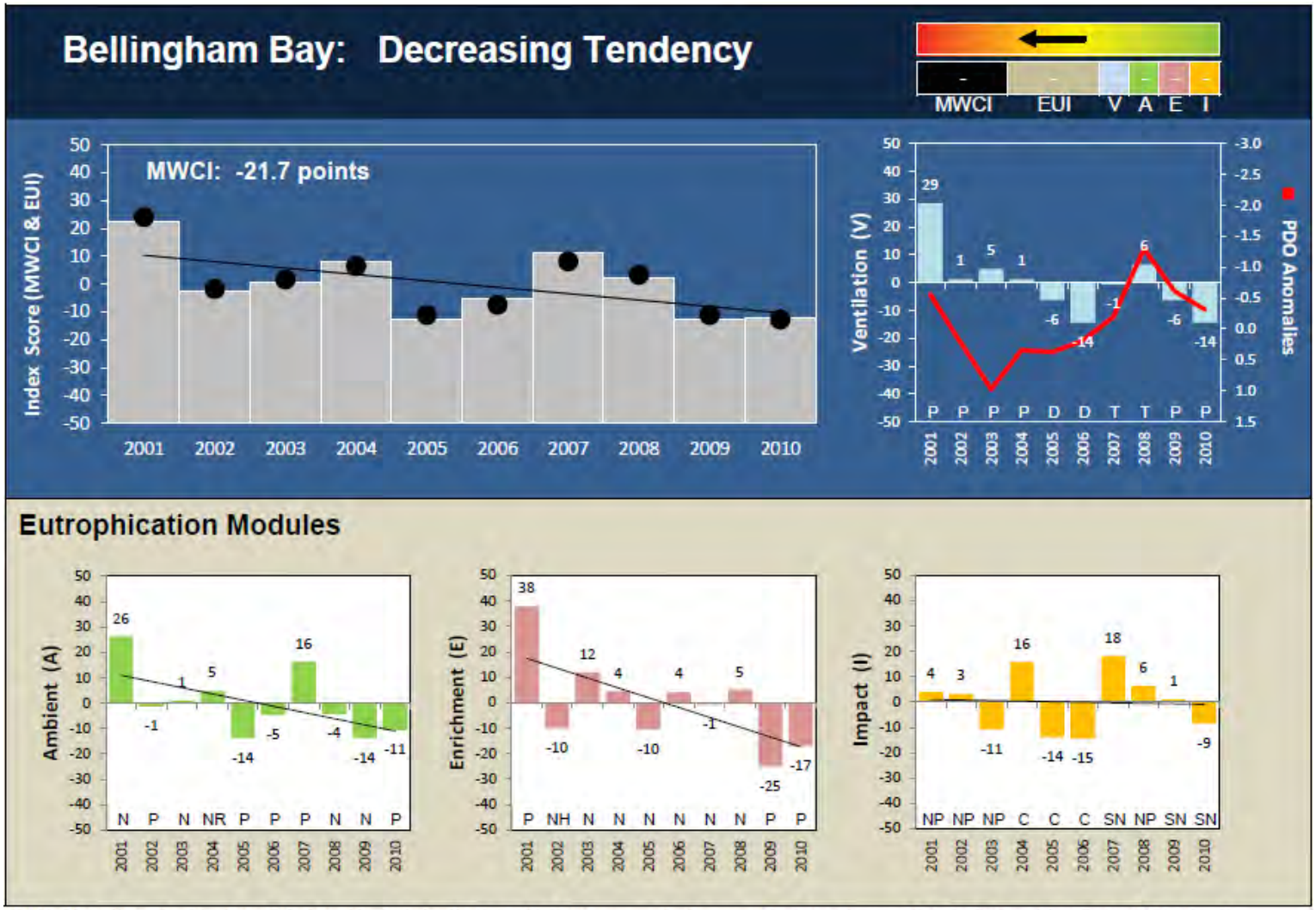

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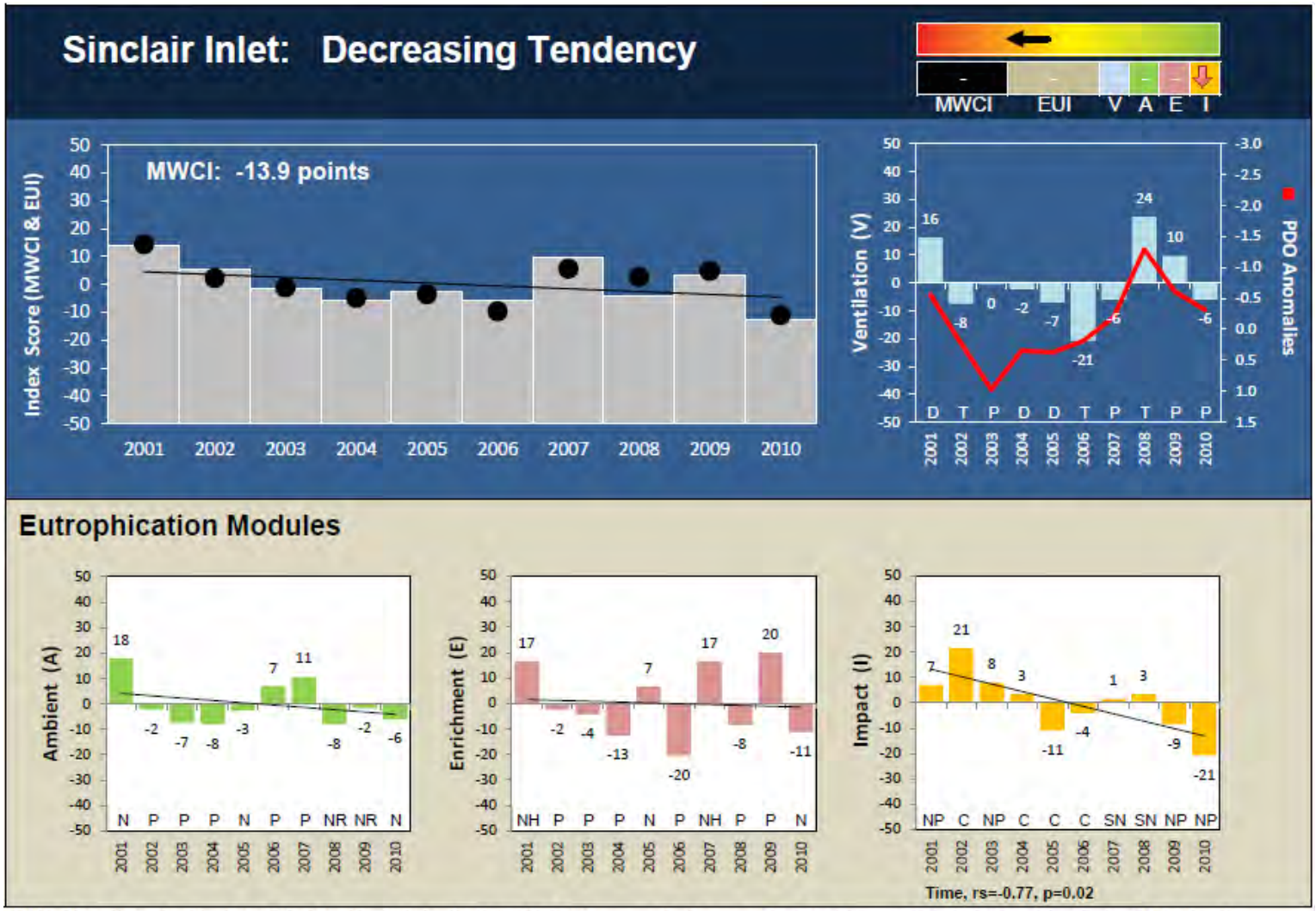

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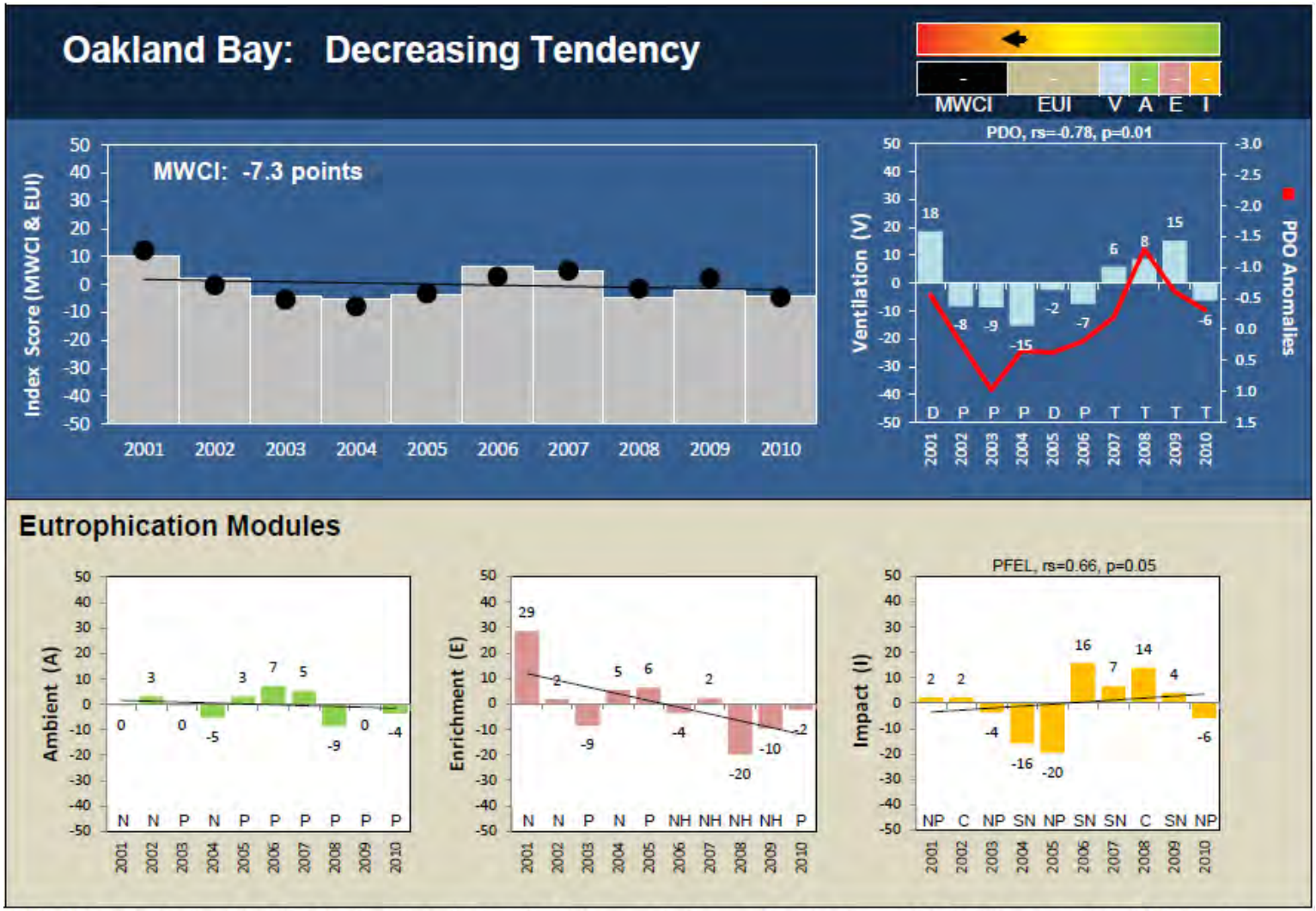

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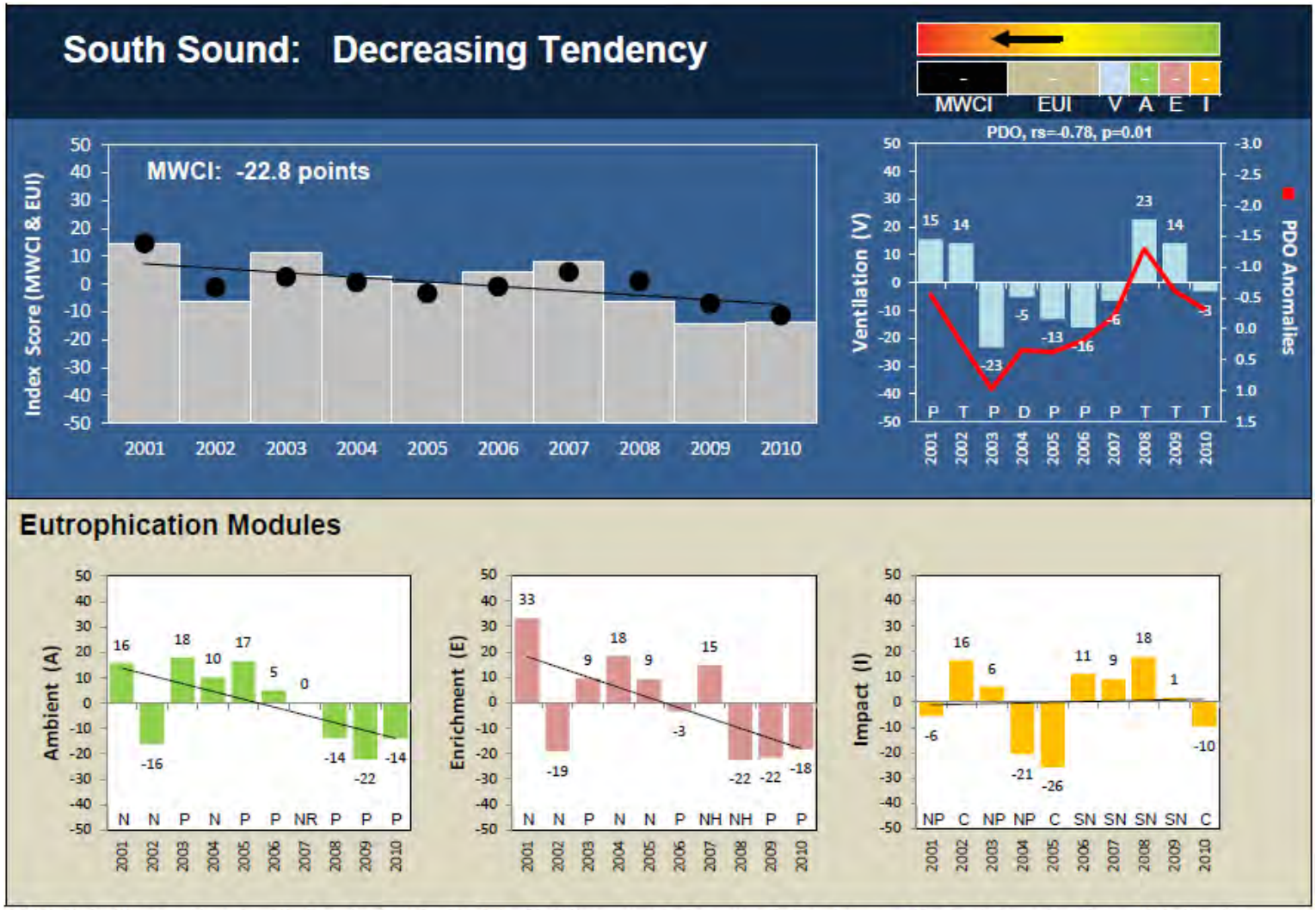

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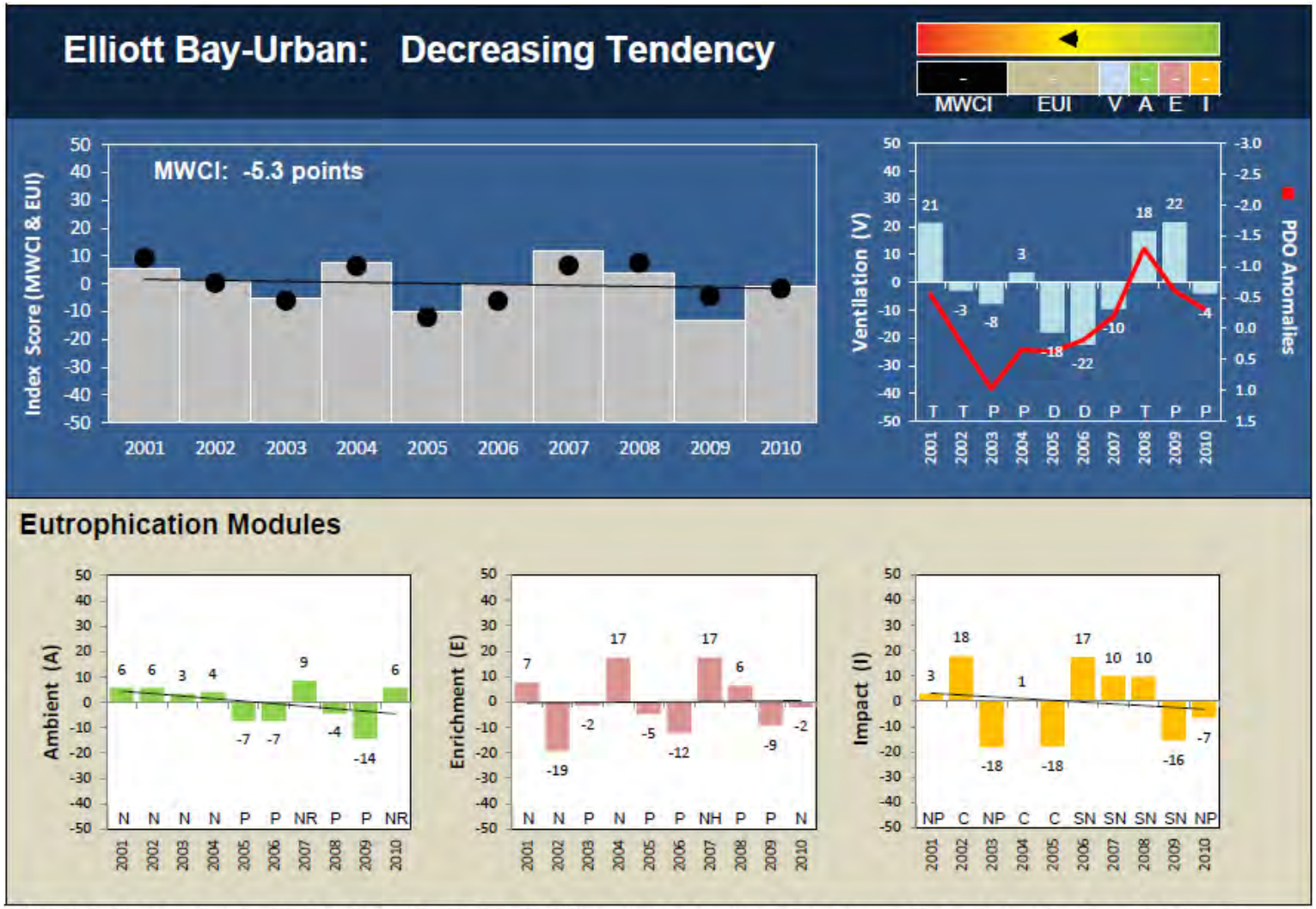

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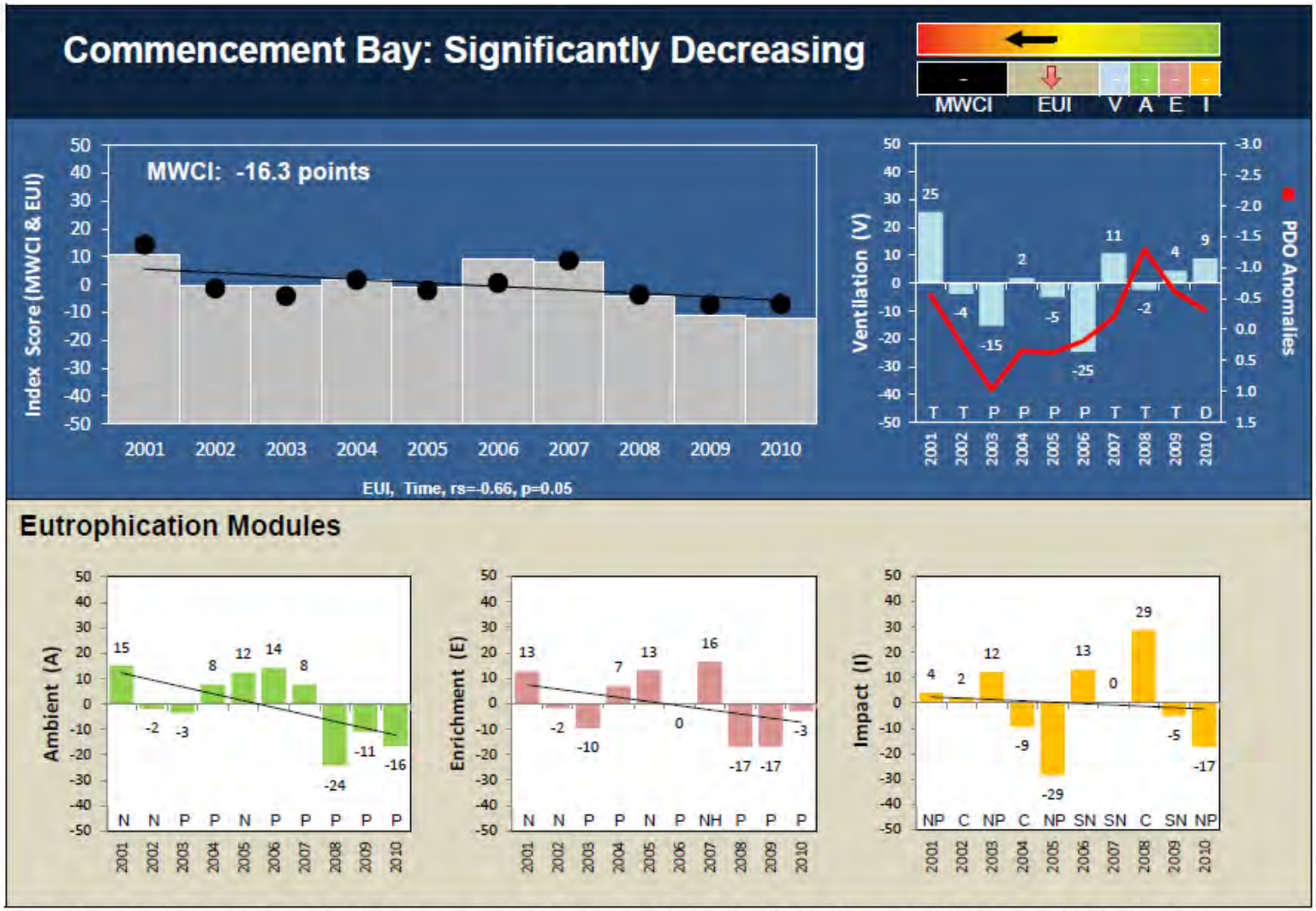

MWCI= Marine Water Condition Index, EUI= Eutrophication Index, Ventilation (V): T=Heat content, D= DO content, P=-Potential energy, PDO=Pacific Decadal Oscillation, PFEL= Upwelling
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Commencem. Bay
South Sound (deep)
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Oakland Bay
Grays Harbor Ocean
Grays Harbor River
Willapa Bay Ocean
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Willapa Bay River

DEPARTMENT OF ECOLOGY State of Washington

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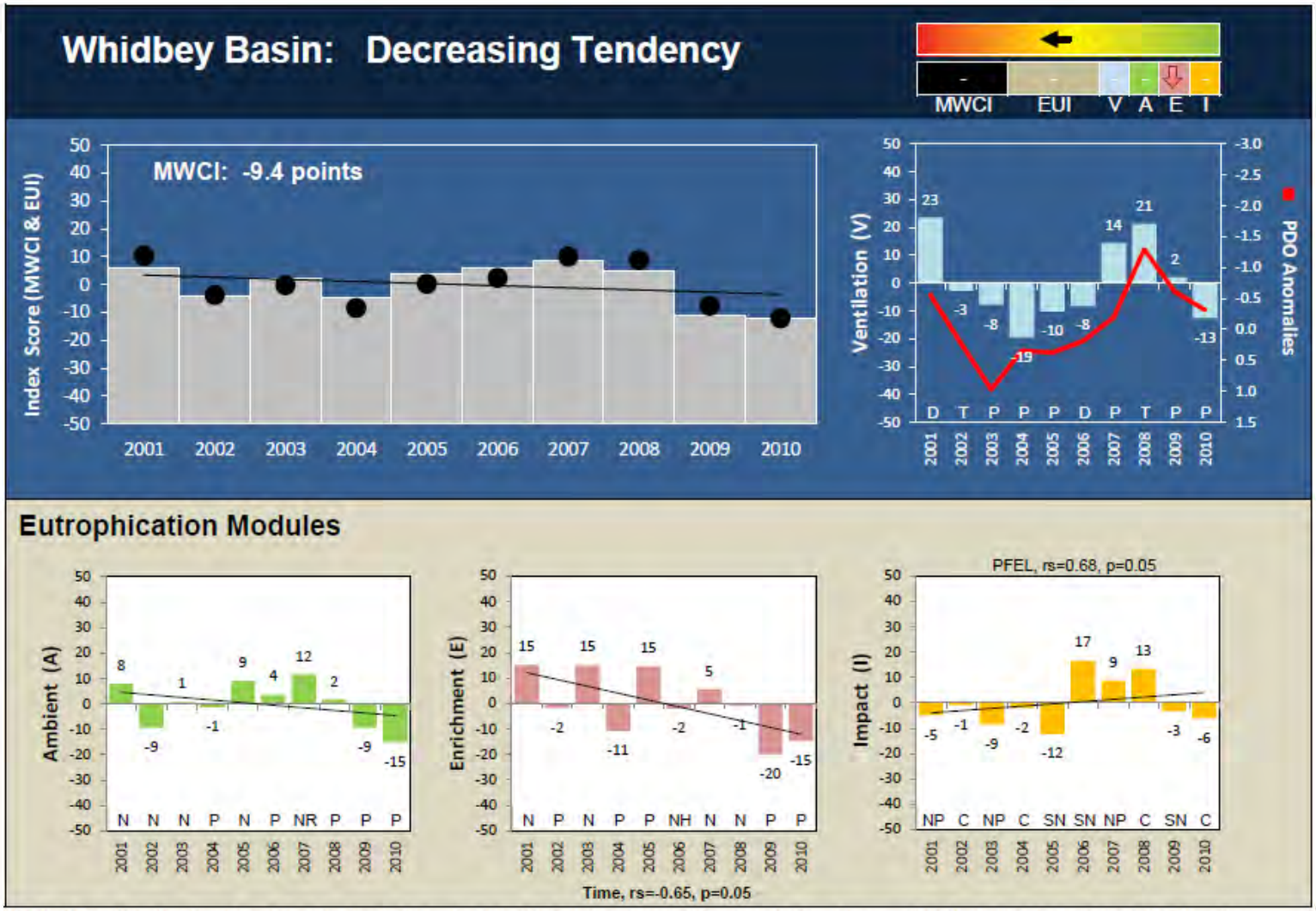

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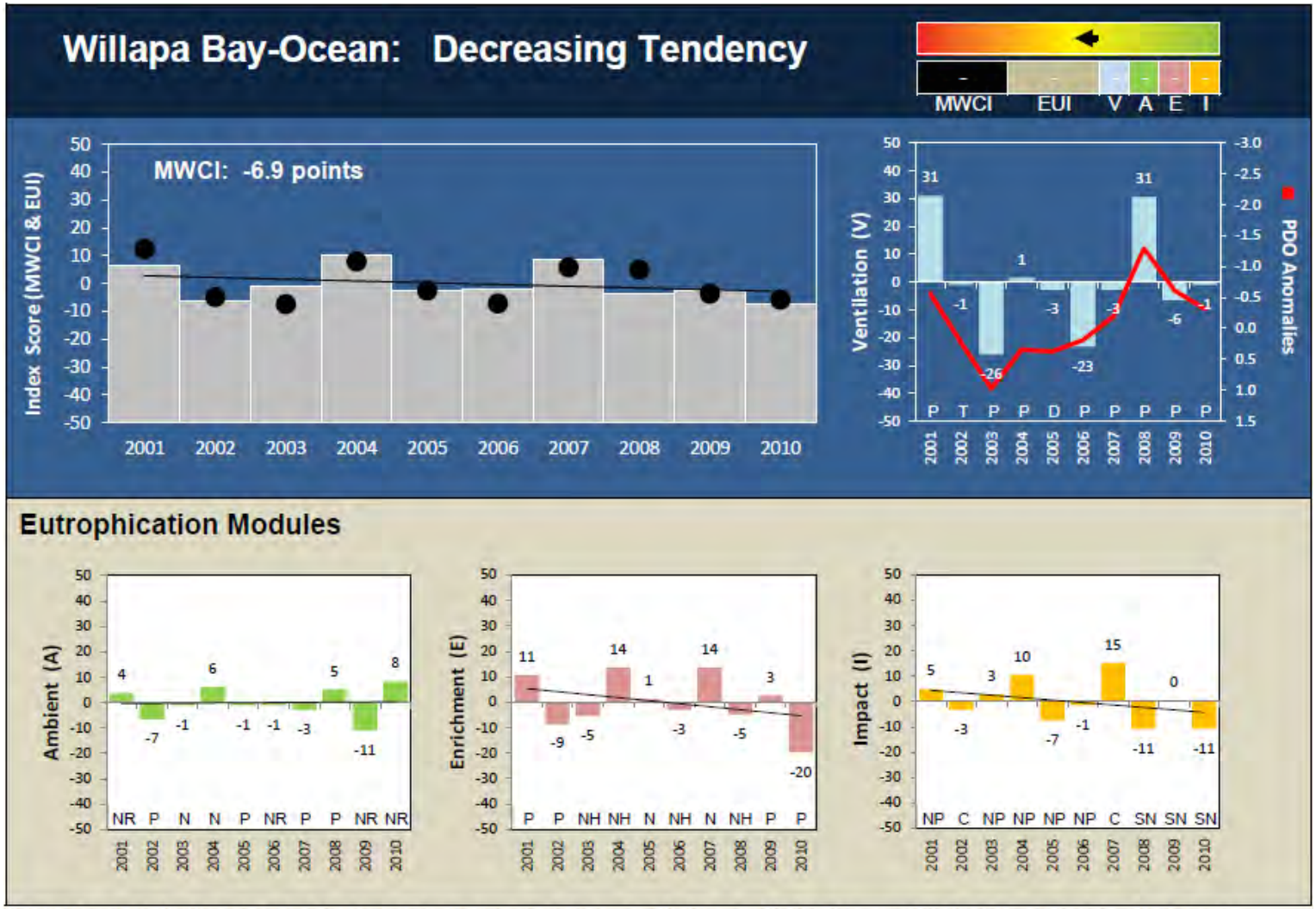

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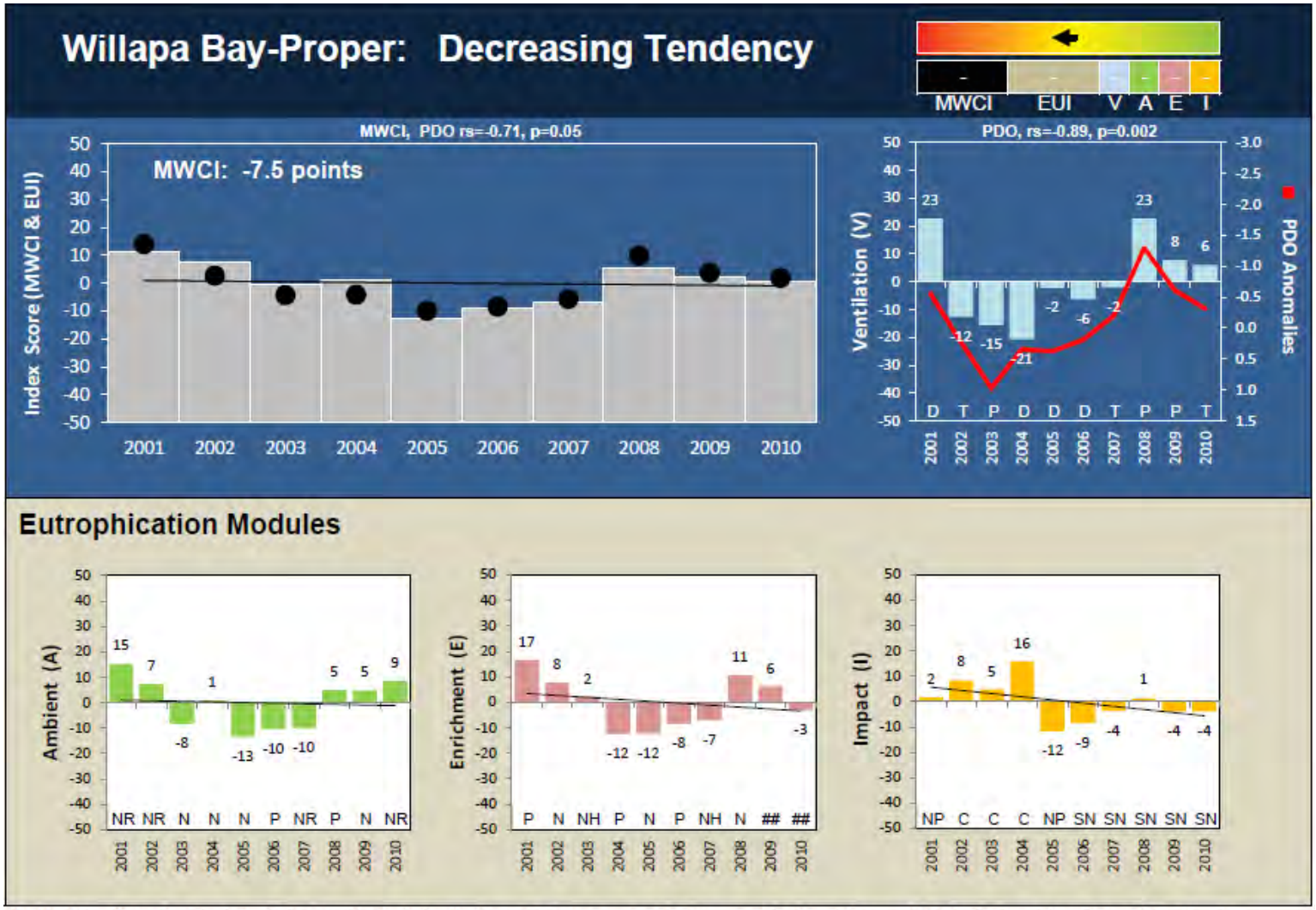

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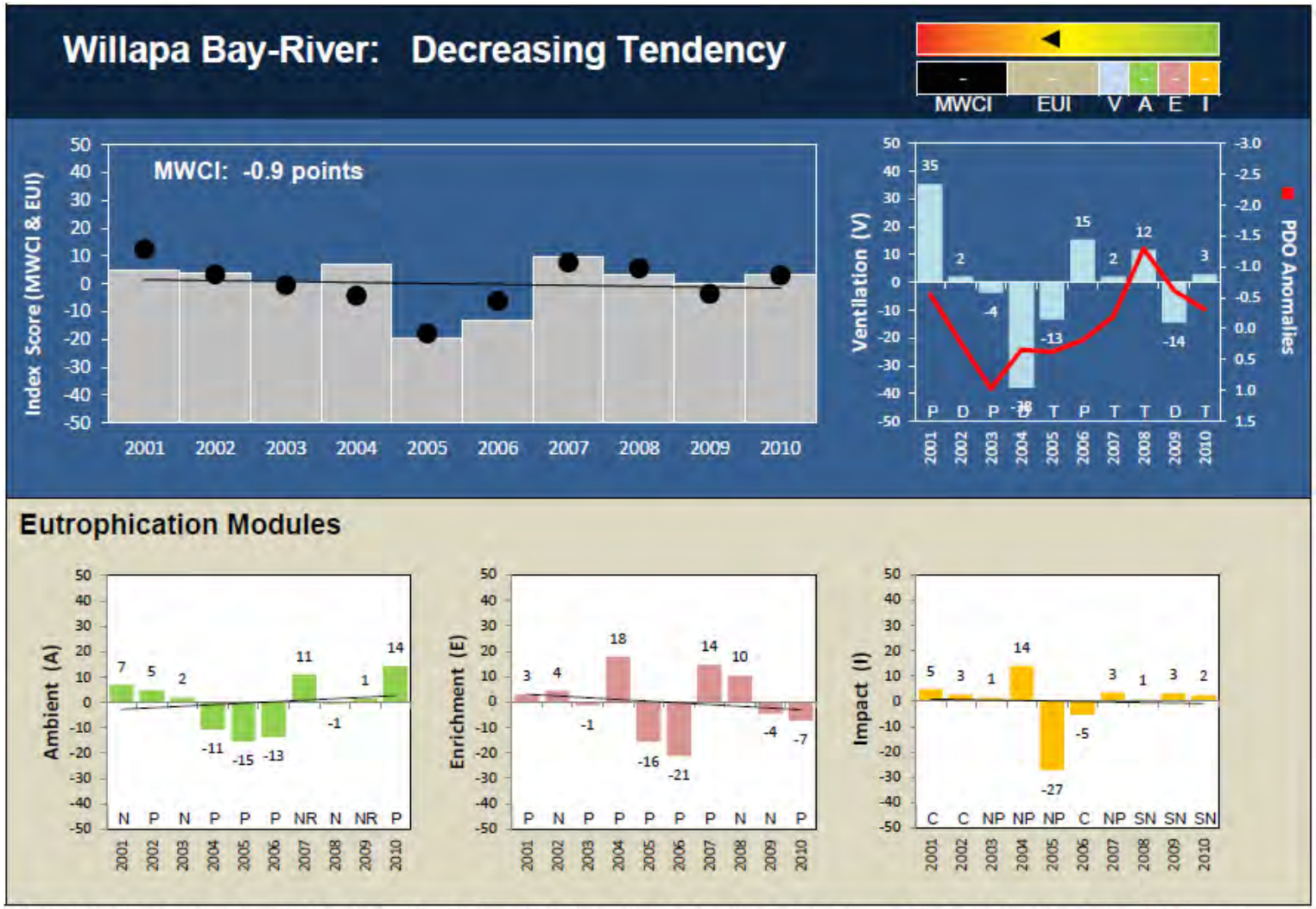

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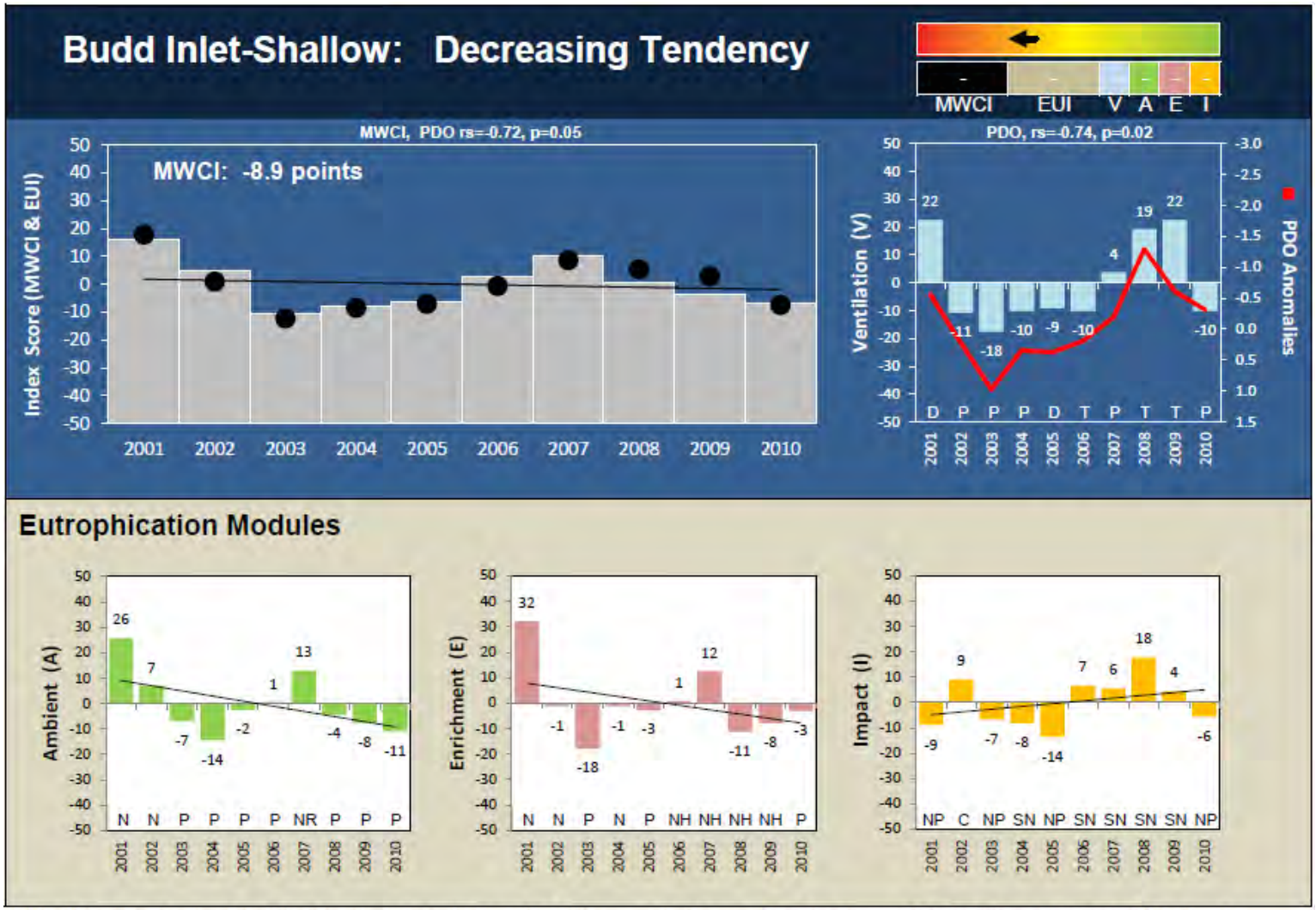

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Explain graphic

Navigate through our clickable document in PDF format

All tabs are clickable

4 Modules
3 Variables

Ambient	Enrichment	Impact	Ventilation
Nitrate	Phosphate	NO_3 : DIN	Baseline

Active tabs are in bold black

Link to 10-year baseline

In this section you find heat maps that show the monthly variability of twelve water variables of the MWCI. We subtracted a time averaged (median) 10-year seasonal cycle (=site specific baseline) from the data. This step effectively removes the seasonal cycle. The resulting de-seasonalized data highlights the variability and trends around the baseline. Colors red and green emphasize the anomalies. Download data and heat maps in Excel.

Should the link not work type in:

http://www.ecy.wa.gov/programs/eap/mar_wat/pdf/data.zip

Ambient: Are nutrient concentrations different from baseline conditions?

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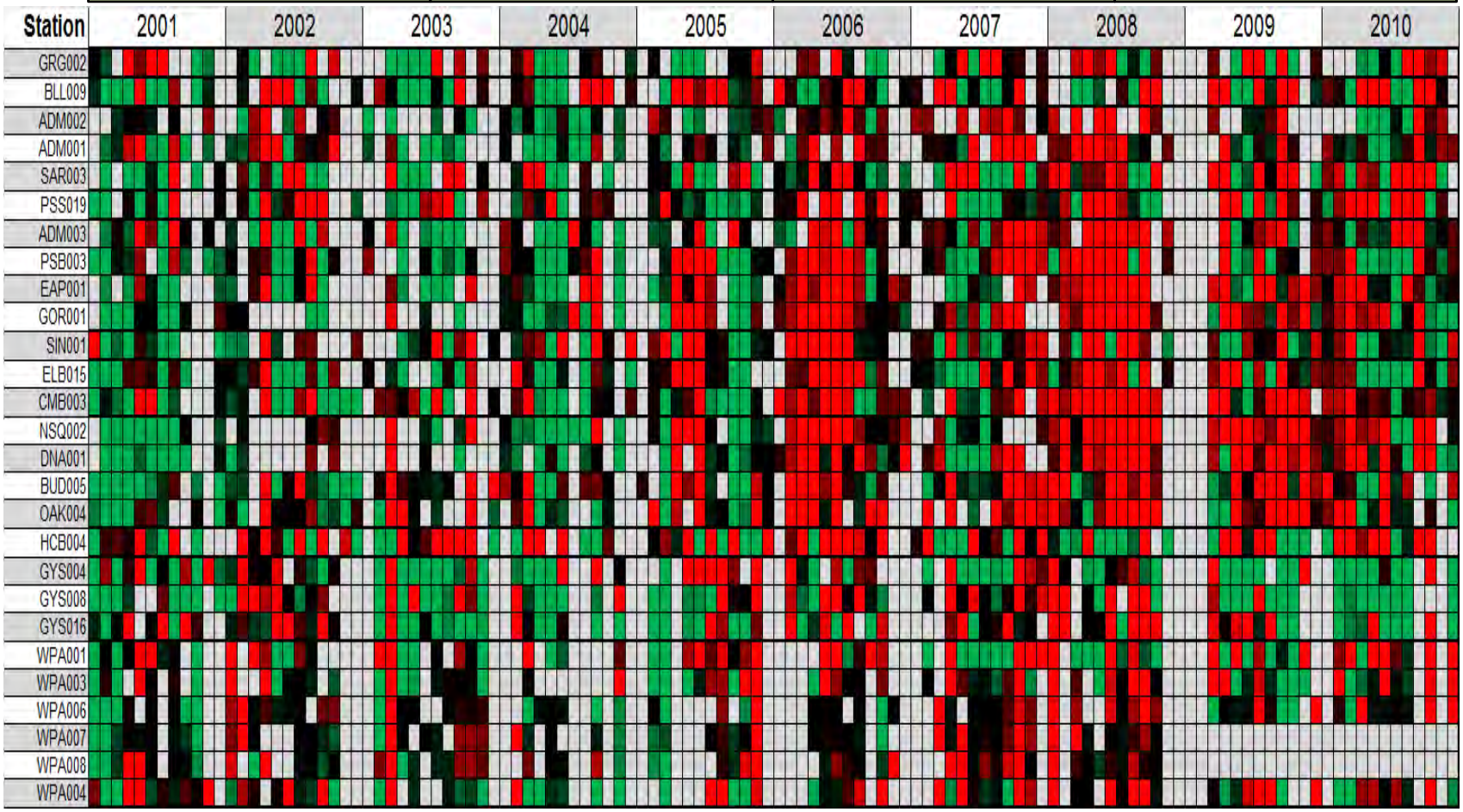
Ambient	Enrichment	Impact	Ventilation
Nitrate	Phosphate	NO_3 : DIN	Baseline

SHOW STATION ON MAP



DATA RESOURCE

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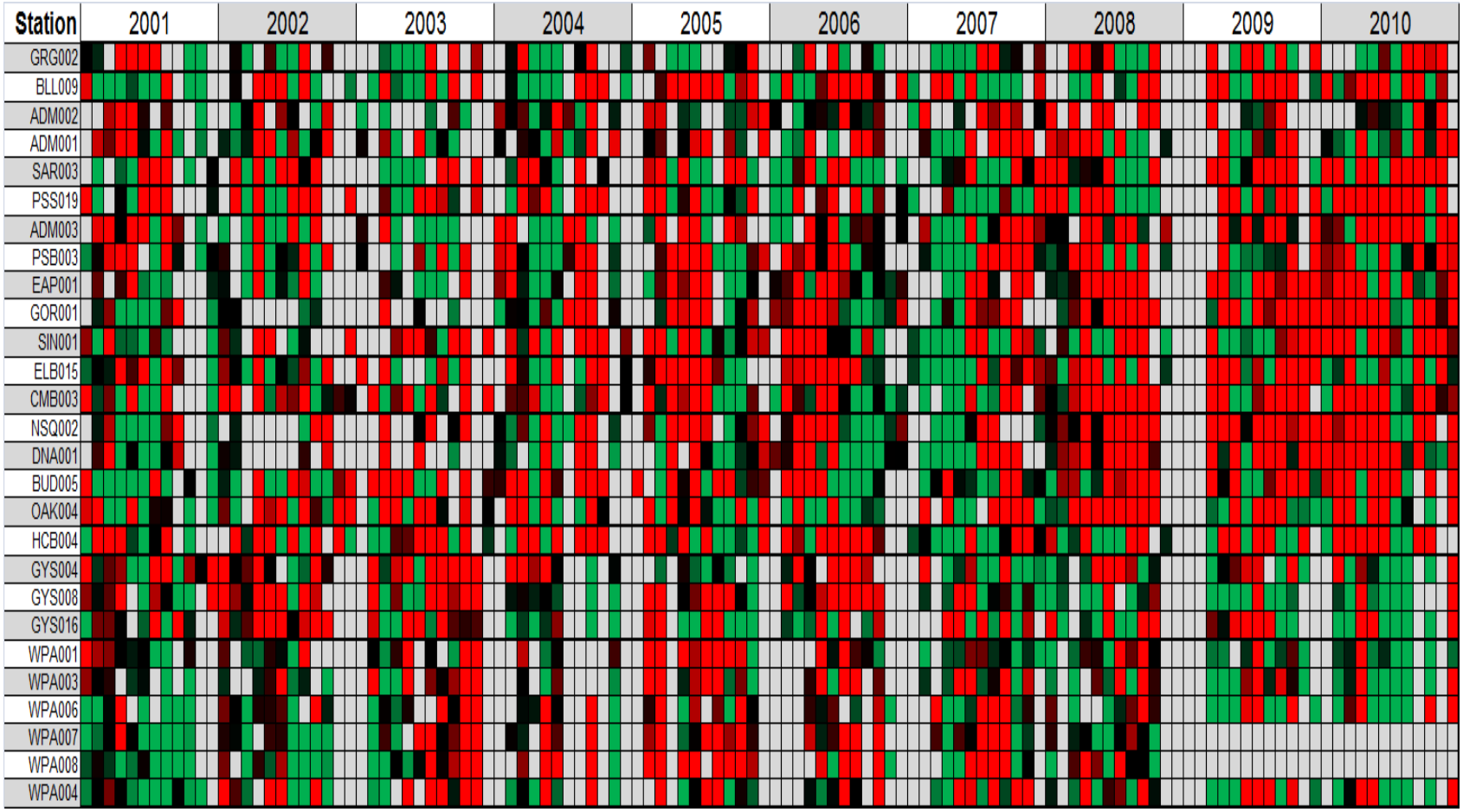
Ambient: Are nutrient concentrations different from baseline conditions?

DEPARTMENT OF ECOLOGY State of Washington

Ambient	Enrichment	Impact	Ventilation
Nitrate	**Phosphate**	NO_3 : DIN	Baseline

SHOW STATION ON MAP



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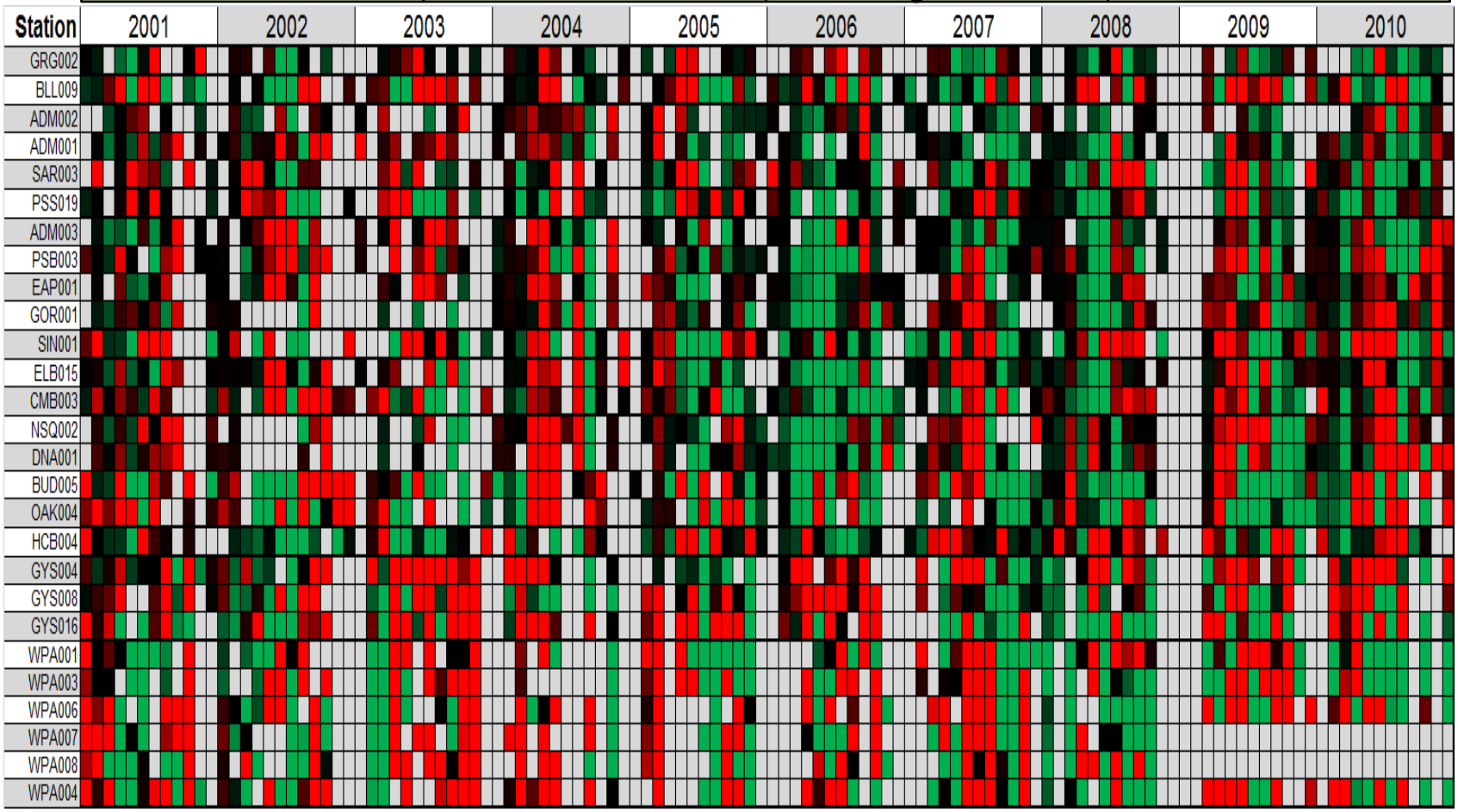
Nitrate	Phosphate	NO_3 : DIN	Baseline

SHOW STATION ON MAP



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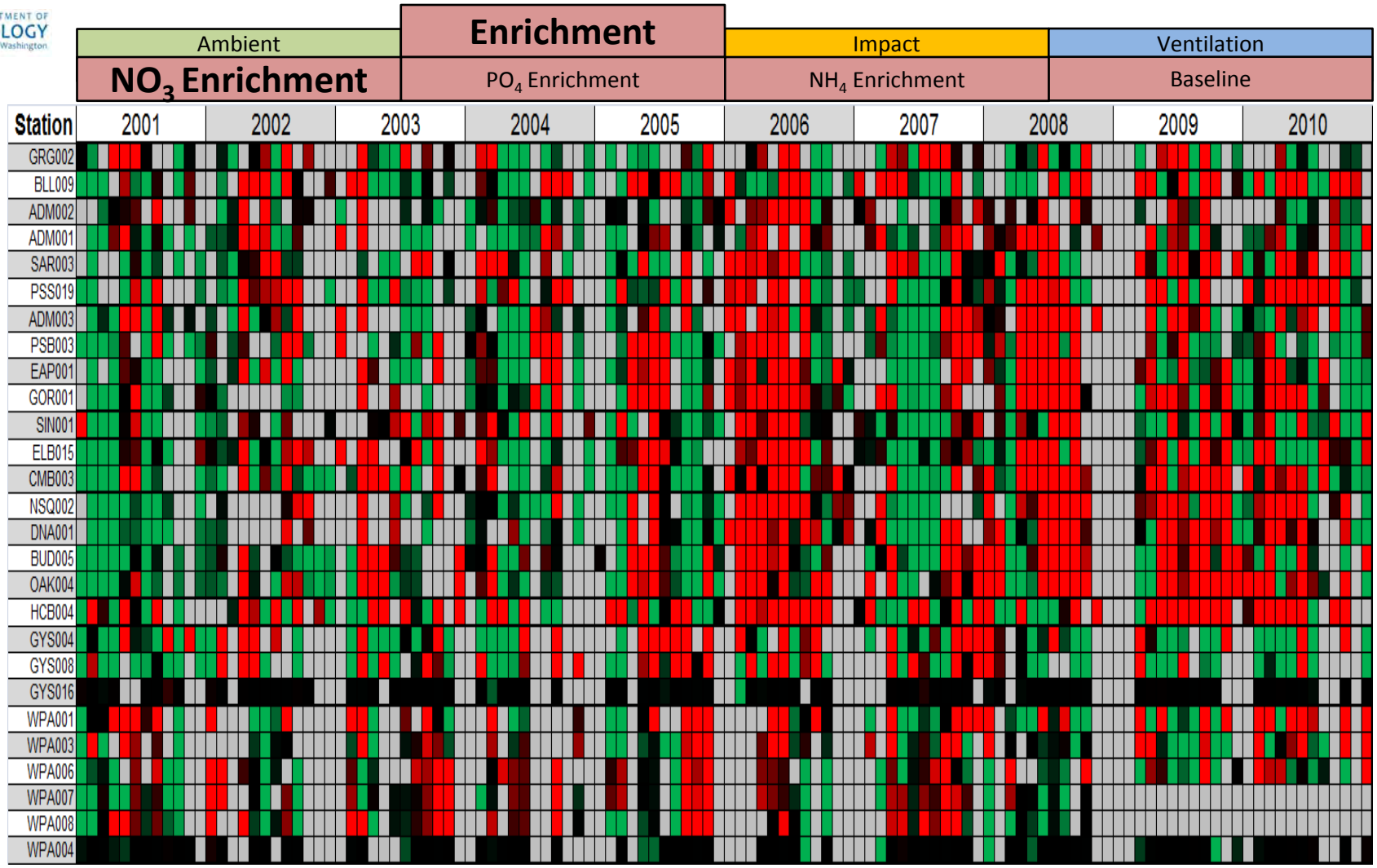
Enrichment: Are changes in nutrient concentrations related to the ocean?



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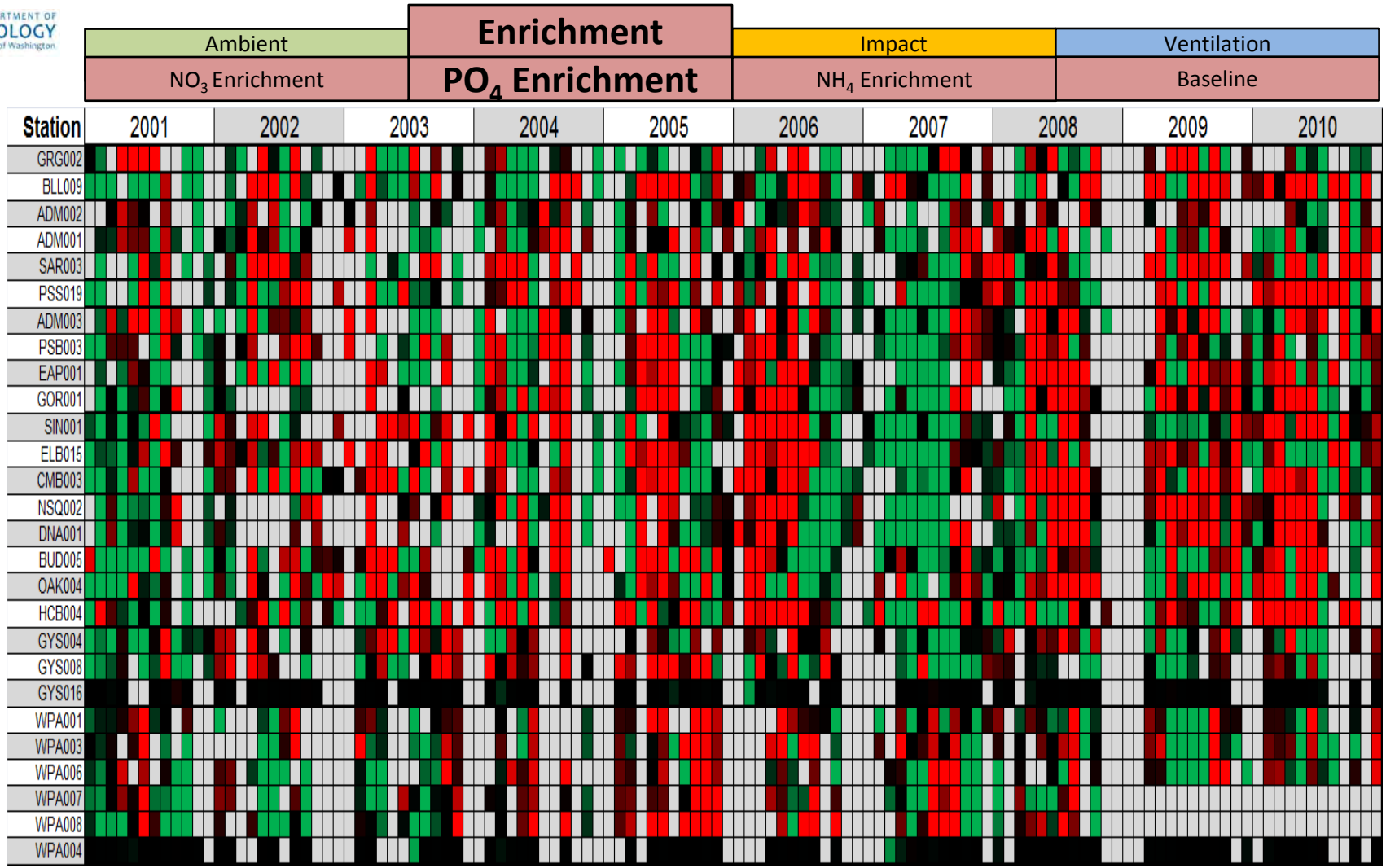

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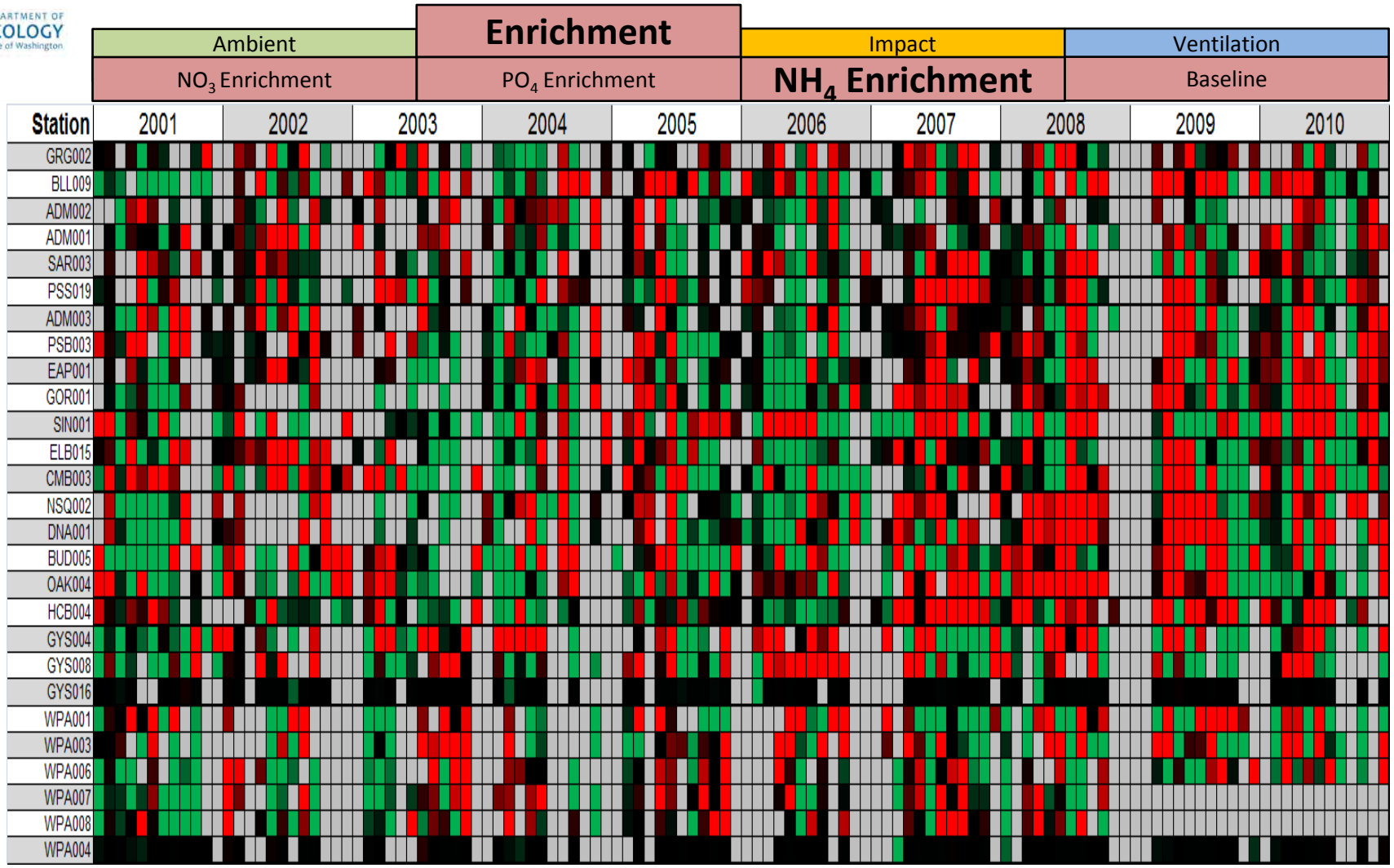

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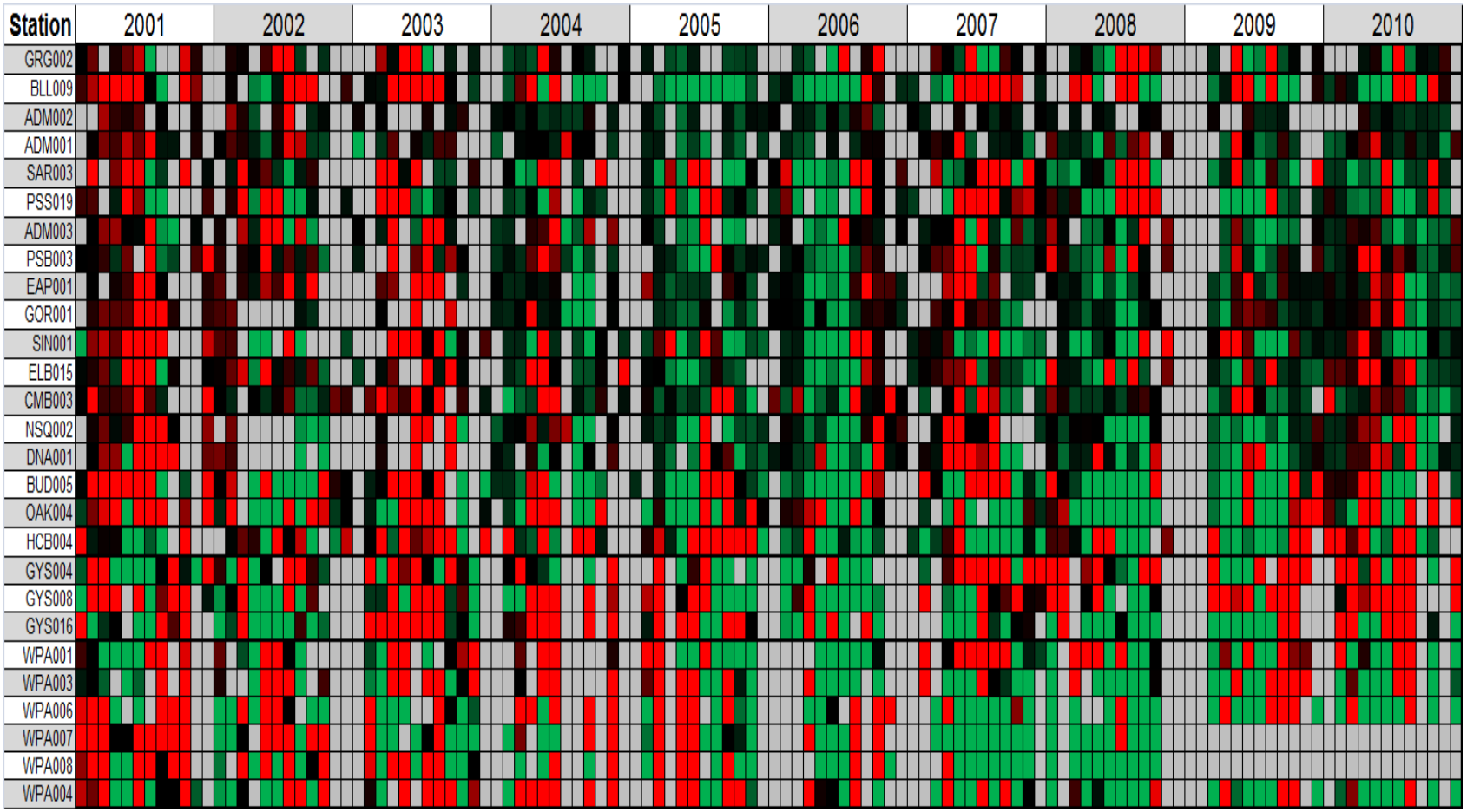
Impact: Is the nutrient balance and algal biomass leaving the baseline?

Ambient	Enrichment	Impact	Ventilation
Baseline	$Si(OH)_4$: DIN	DIN : PO_4	Chl a



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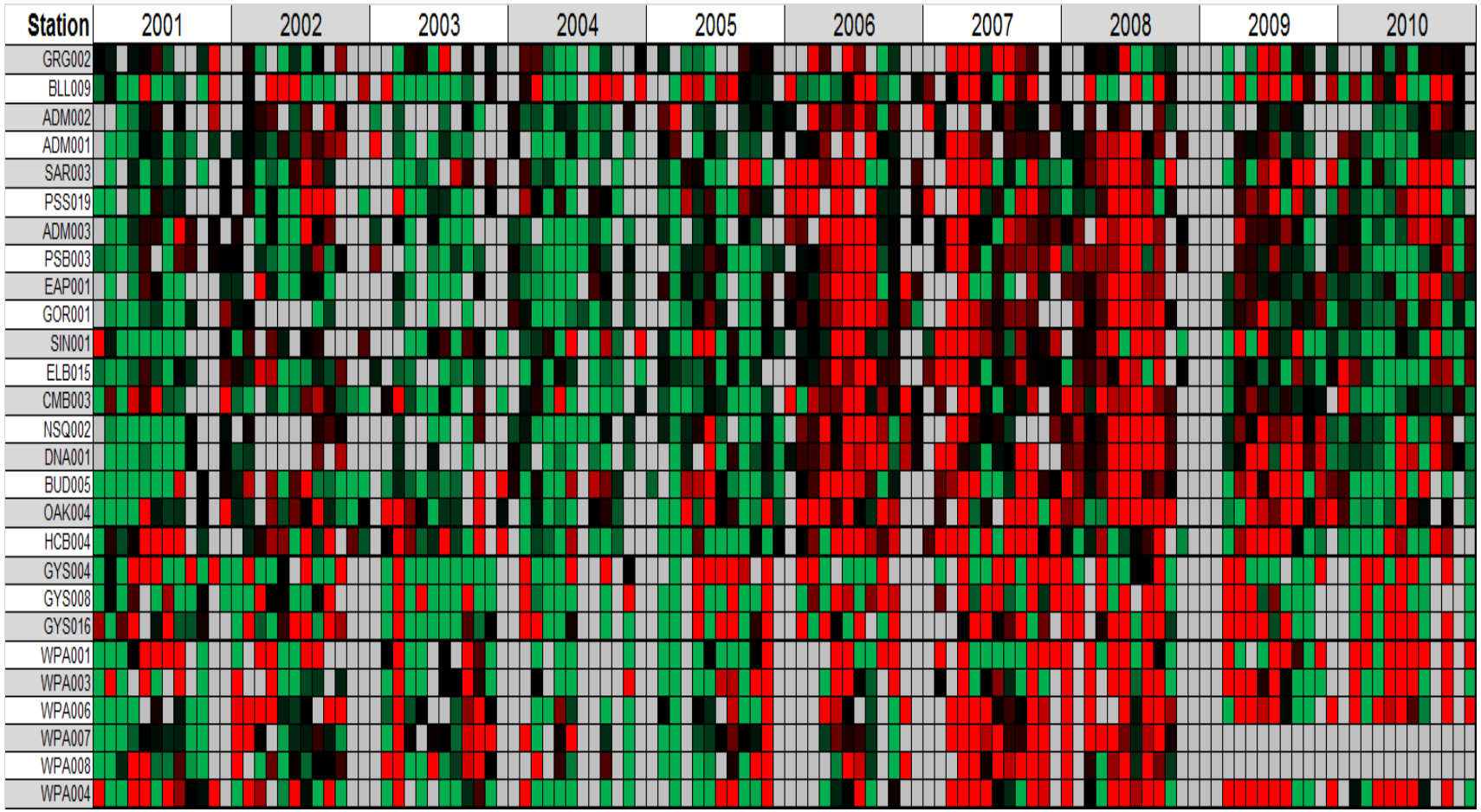

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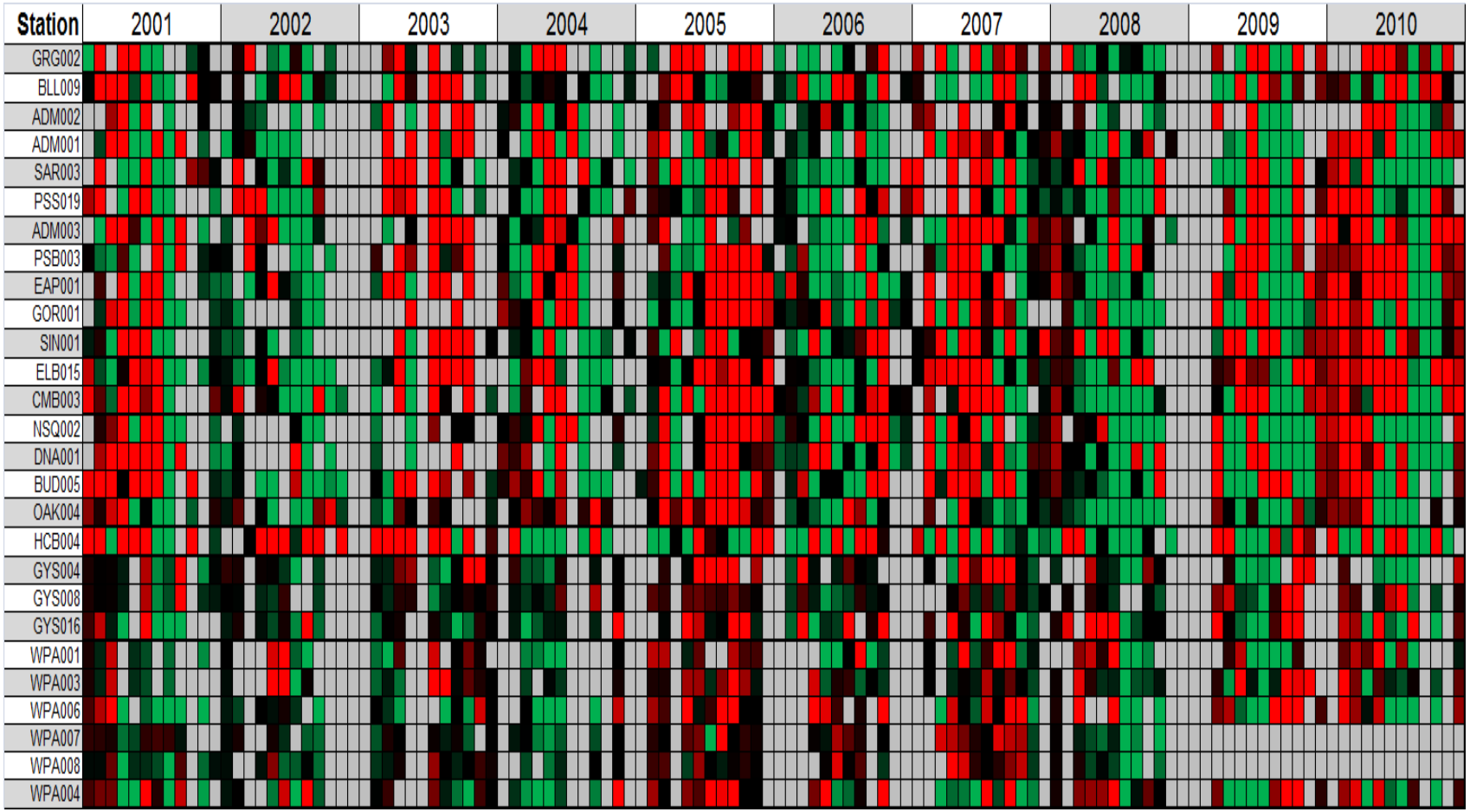

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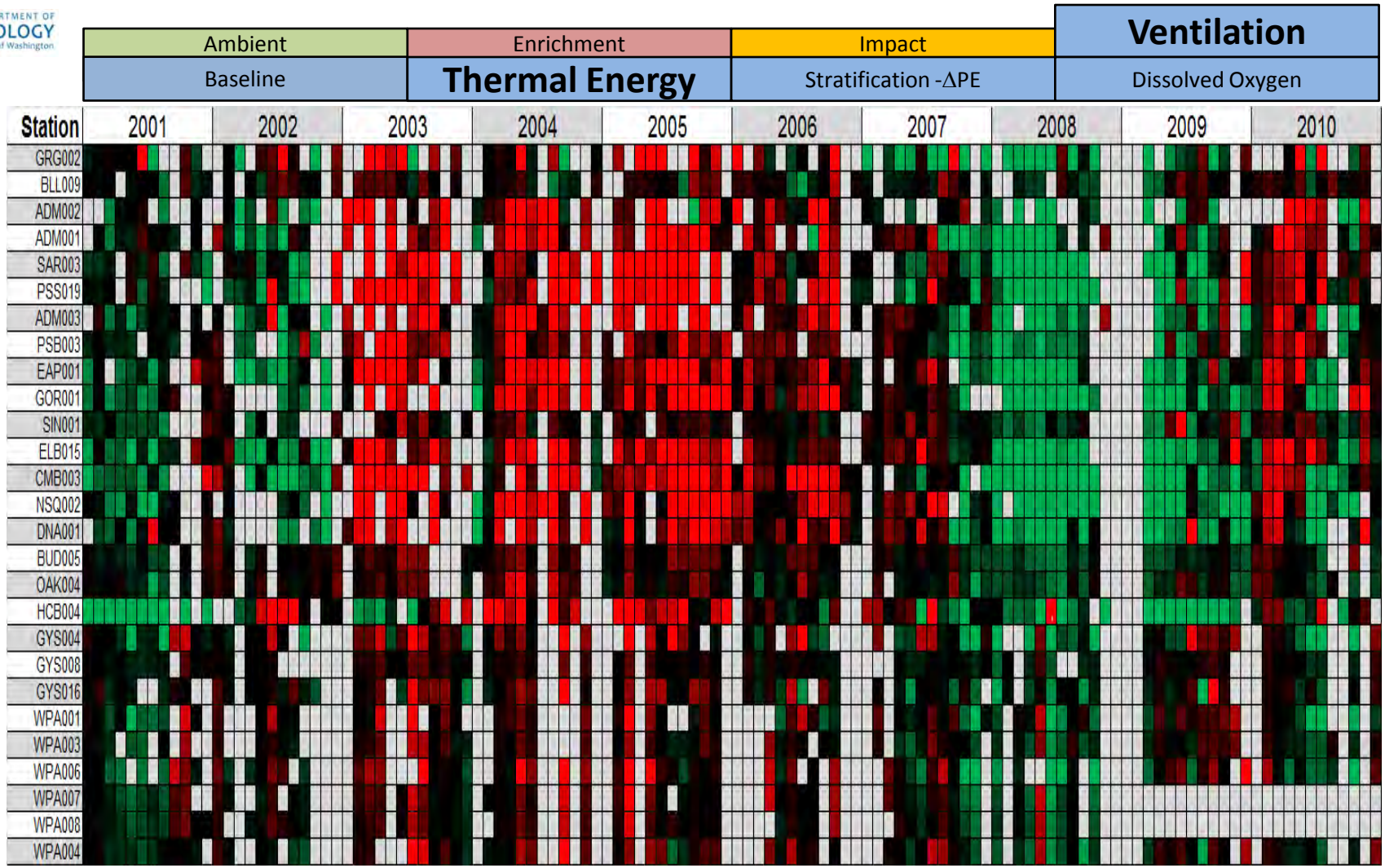
Ventilation: Are physical conditions affecting the availability of oxygen?



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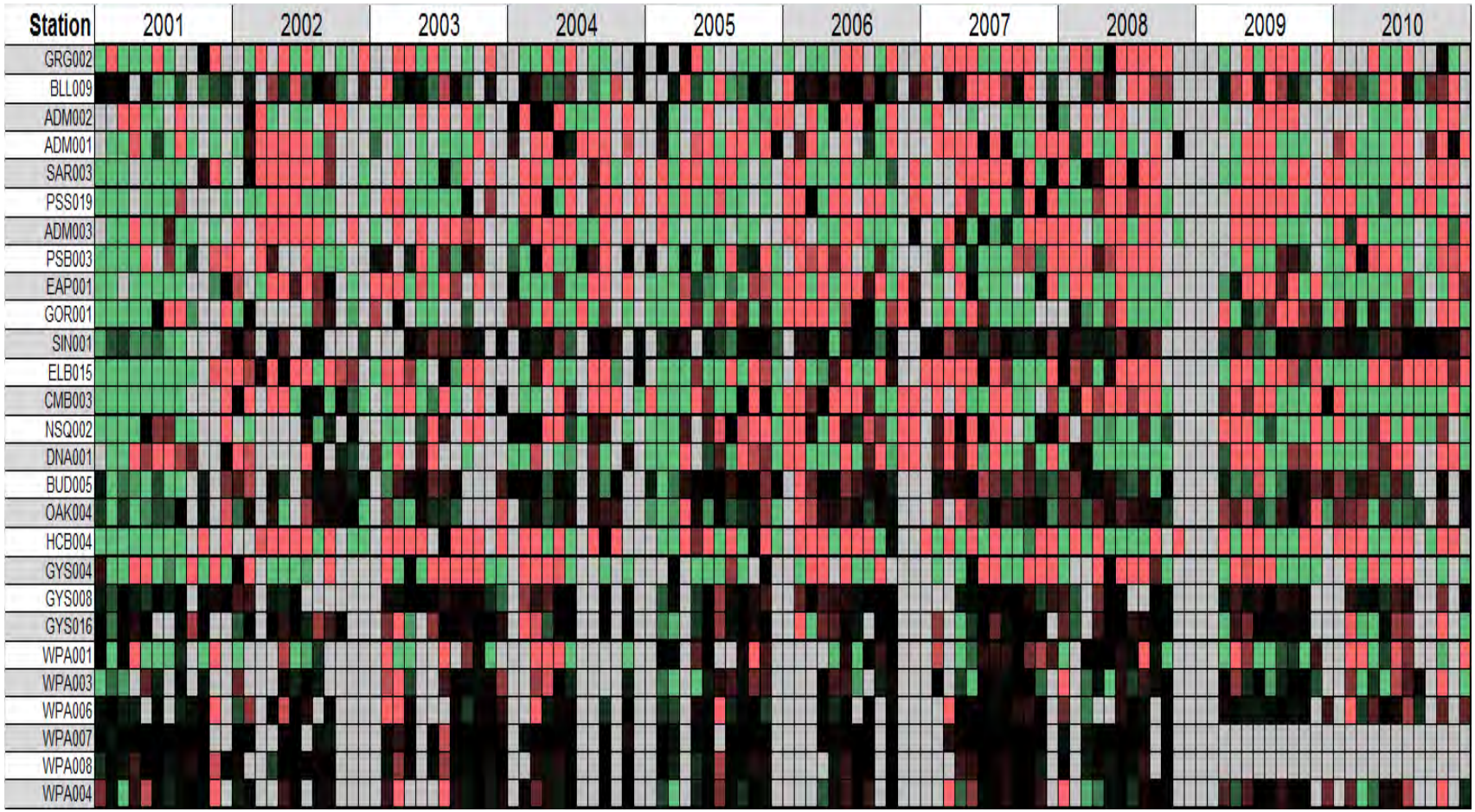
Ventilation: Are physical conditions affecting the availability of oxygen?

Ambient	Enrichment	Impact	Ventilation
Baseline	Thermal Energy	**Stratification -ΔPE**	Dissolved Oxygen



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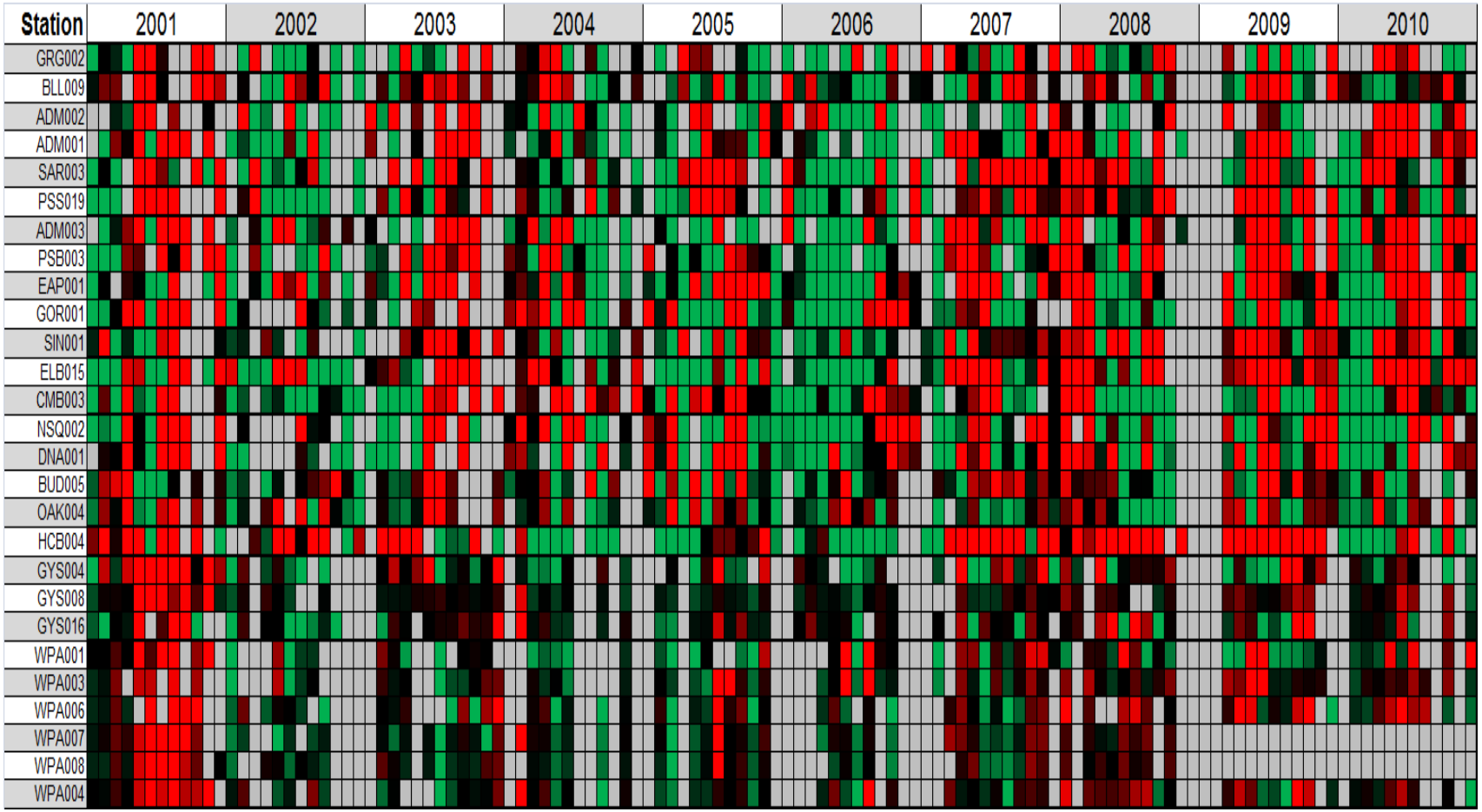

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