ASLO/TOS Ocean Research 2004 Conference

The use of ASSETS and phytoplankton species composition to define type-specific reference conditions for estuarine water quality management

ASLO/TOS 2004, Honolulu
Session SS5.13
Eutrophication of Coastal Waters
February 17th 2004

http://www.eutro.org

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Topics

- Problem definition — 1
- Monotype thresholds and problems — 3
- Examples from a multitype world — 4
- Possible improvements to ASSETS — 3
- Conclusions — 1

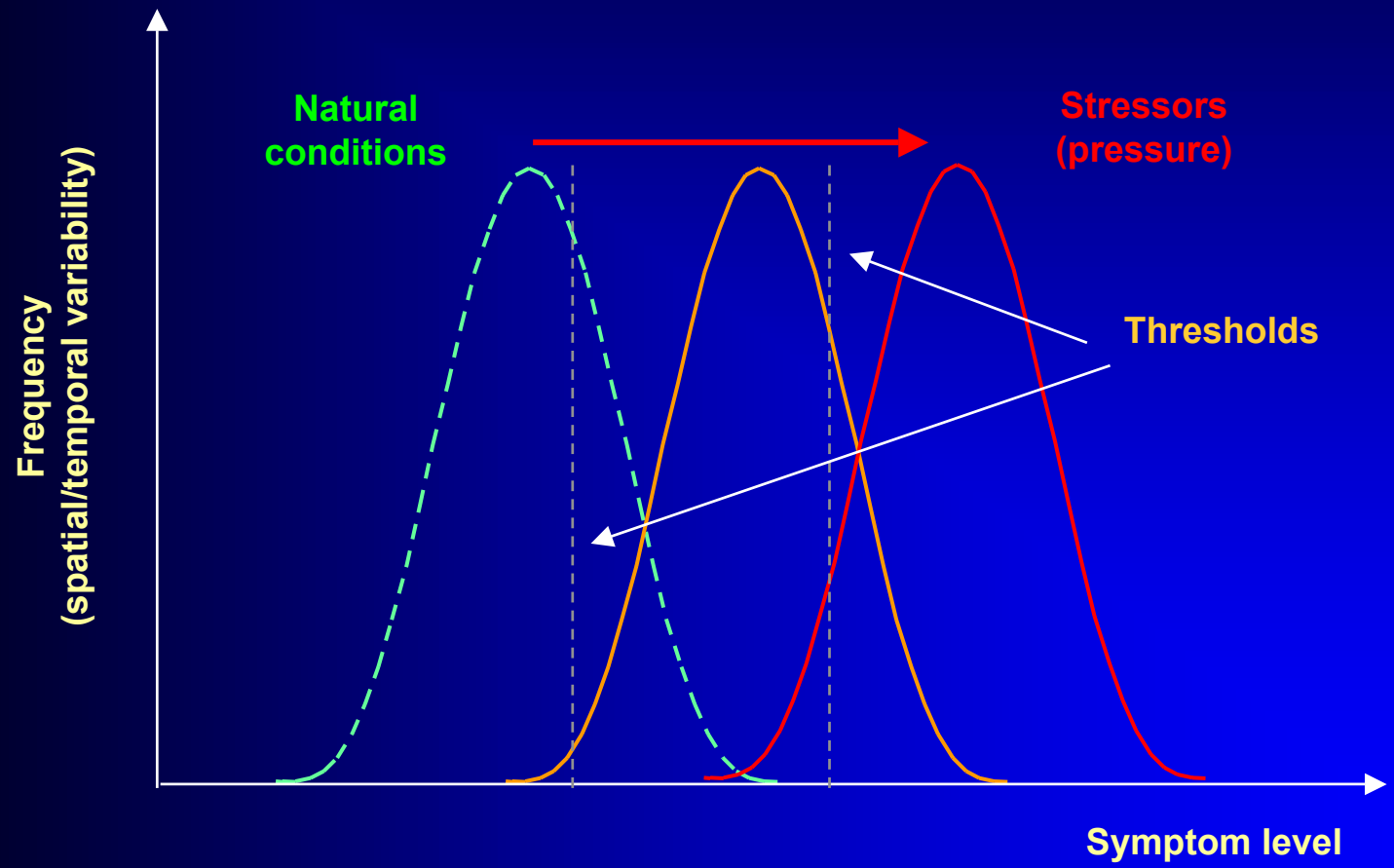
Slides: 12+2

Guadiana estuary, Portugal

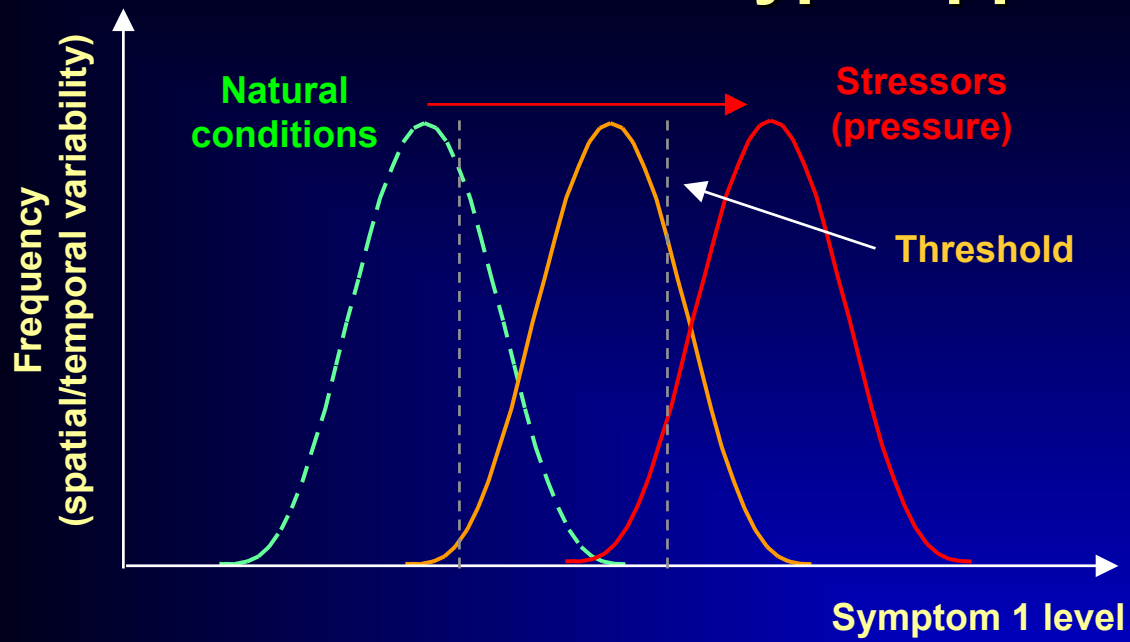
Problem definition

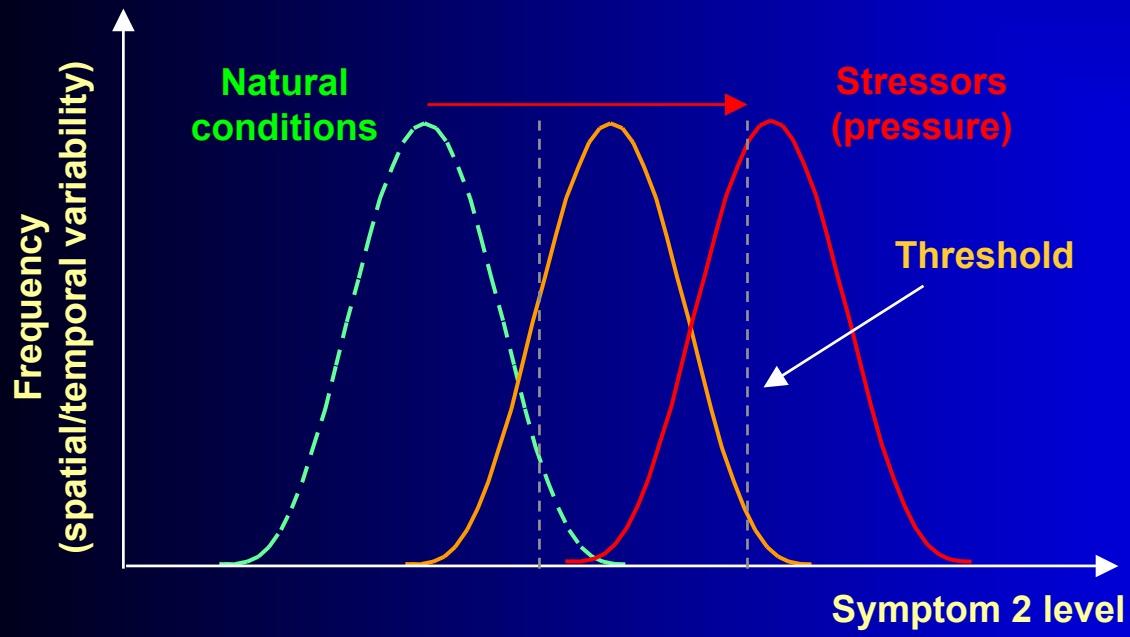
- Coastal eutrophication assessment has traditionally been based on state
- The NEEA approach developed a PSR framework, extended by ASSETS into an integrated PSR, resulting in a single index
- Overall Eutrophic Condition (OEC), the NEEA/ASSETS index for state, is based on fixed thresholds
- NOAA, EPA, OSPAR and others recognize that a fair assessment of state should consider typology
- Other regulatory instruments such as the EU WFD require the definition of type-specific reference conditions

Typology reality check
(a) regulatory reality

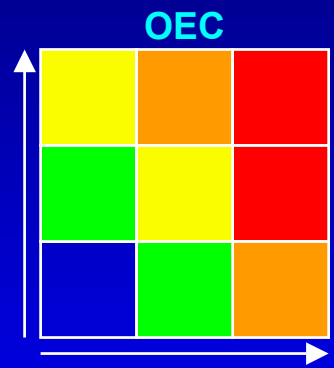


ASSETS Monotype approach for OEC





Symptom 1
Spatial weighting
Temporal weighting



Symptom 2
Spatial weighting
Temporal weighting

S.B. Bricker, J.G. Ferreira, T. Simas, 2003. An integrated methodology for assessment of estuarine trophic status. Ecological Modelling, 169(1), 39-60.

Classification issues

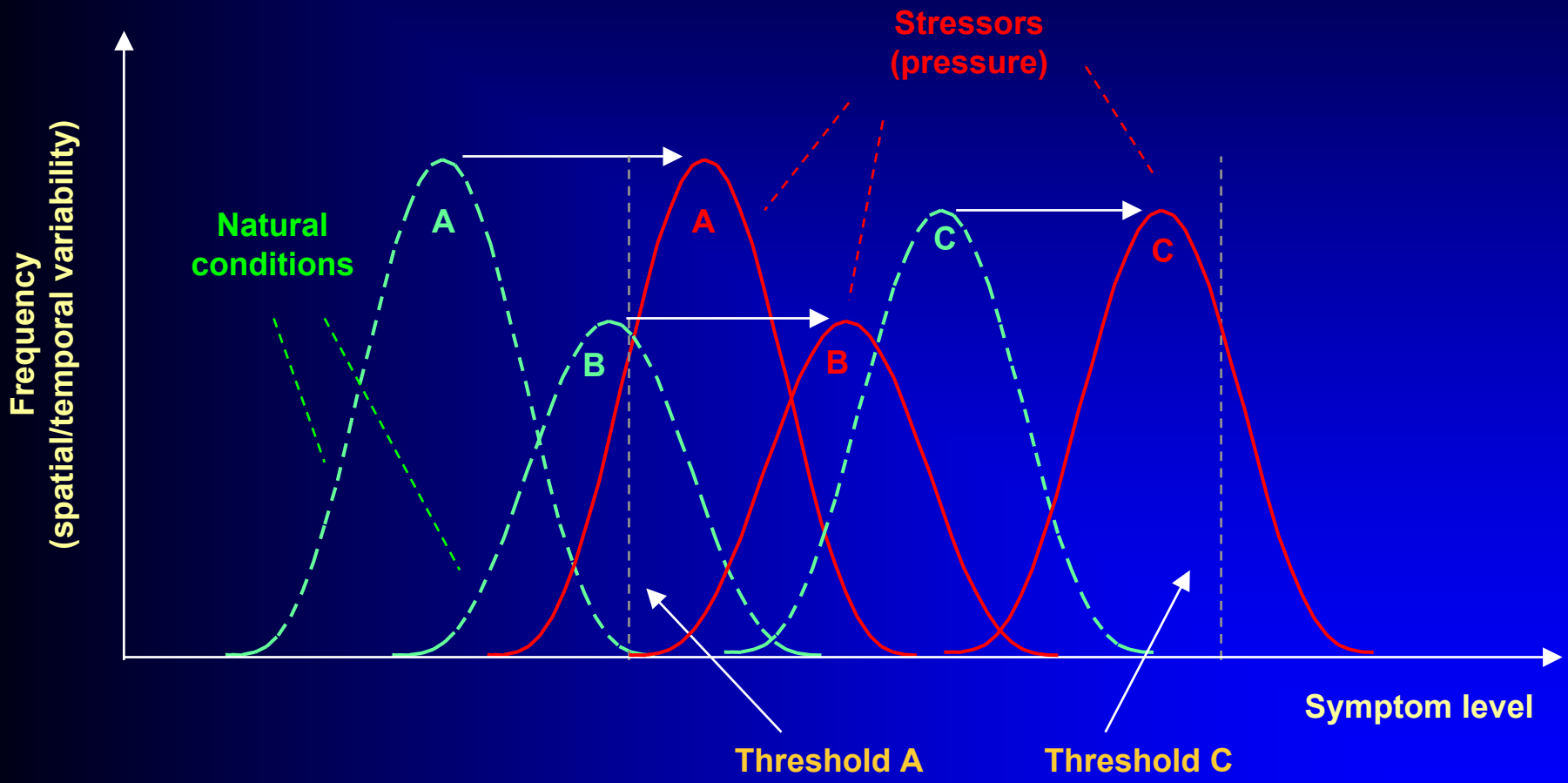
NEEA

- Florida Bay: Highly sensitive system is severely impacted when chlorophyll *a* reaches 5 μg L^{-1}, which is considered Low by the NEEA category definition
- Narraguagus Bay: Naturally occurring nuisance and toxic blooms which come into the system from the ocean
- NW coast: HAB events due to upwelling relaxation occurring offshore, transported into the coastal bays and estuaries

Others

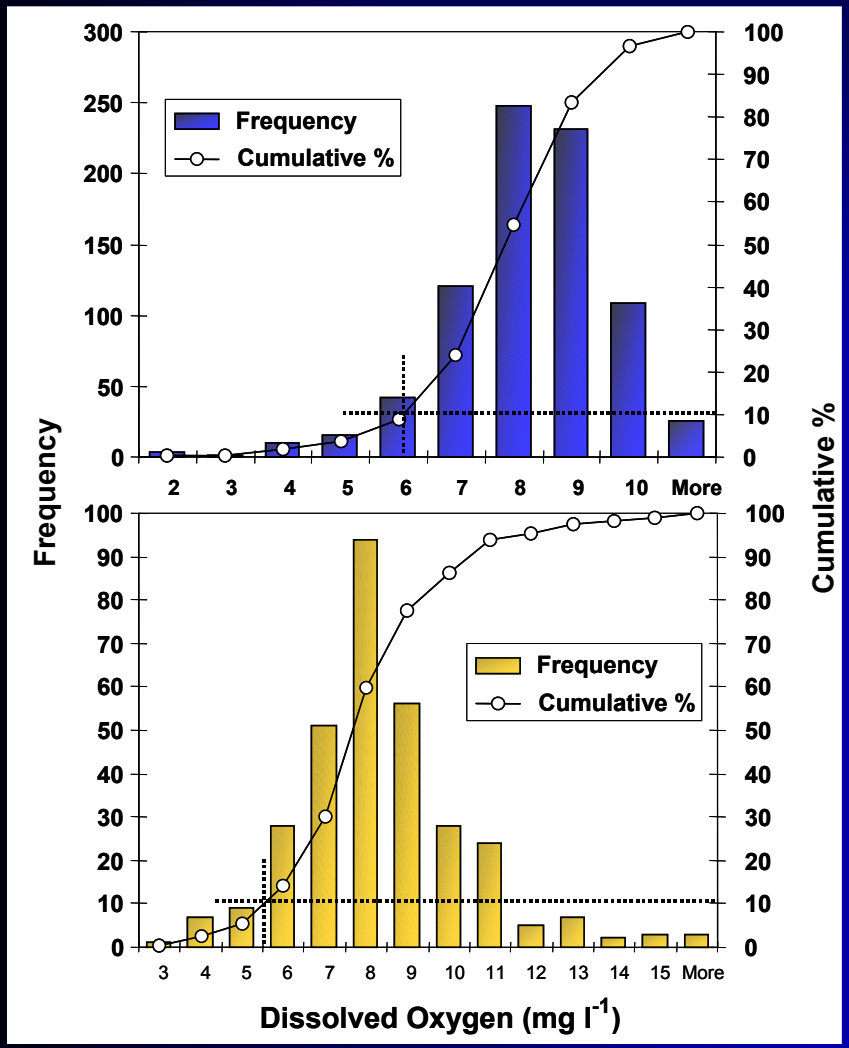
- Similar issues for HAB, e.g. in the Western Iberian Atlantic region or the Benguela upwelling
- D.O. thresholds set in absolute terms penalize water bodies with a naturally lower capacity to dissolve O_2, due to higher T and S
- Short residence times or high natural turbidity favour shifts from pelagic to benthic symptoms of eutrophication
- Use of means instead of medians or a percentile based approach may misclassify systems subject to short extreme events

Typology reality check
(b) ecosystem reality

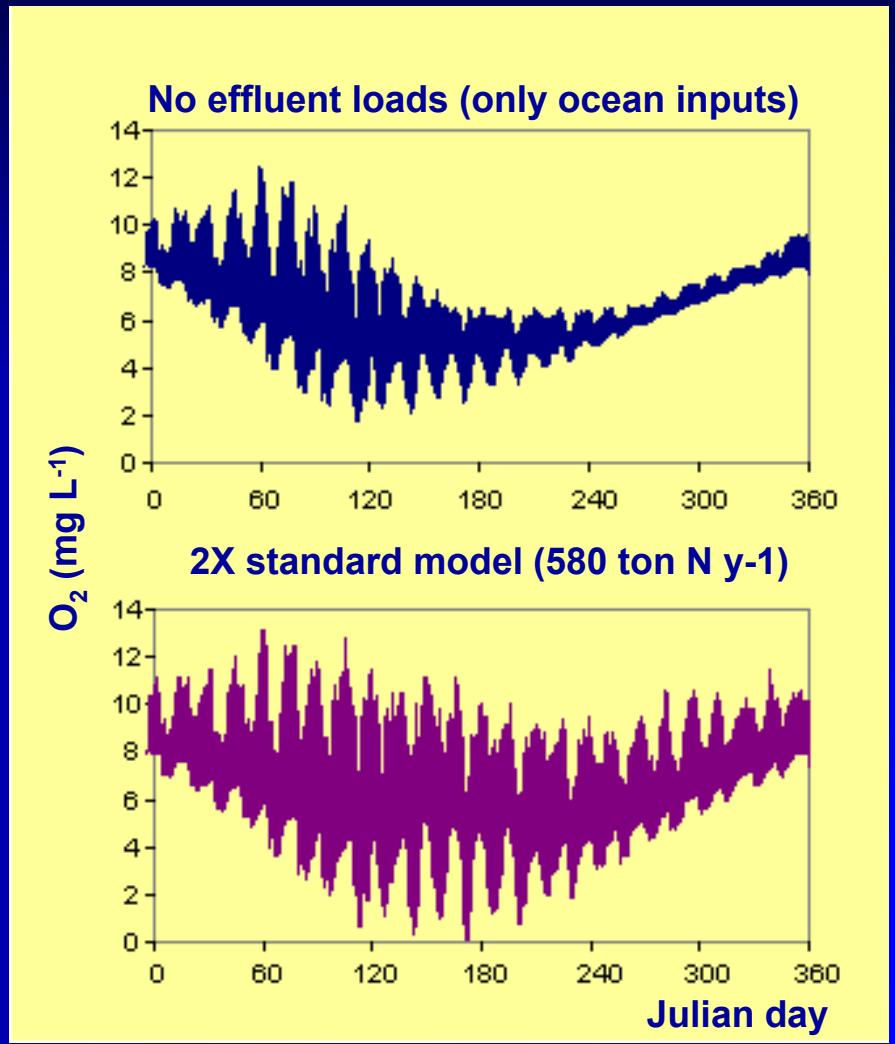


Dissolved oxygen in the Ria Formosa Channels and intertidal areas

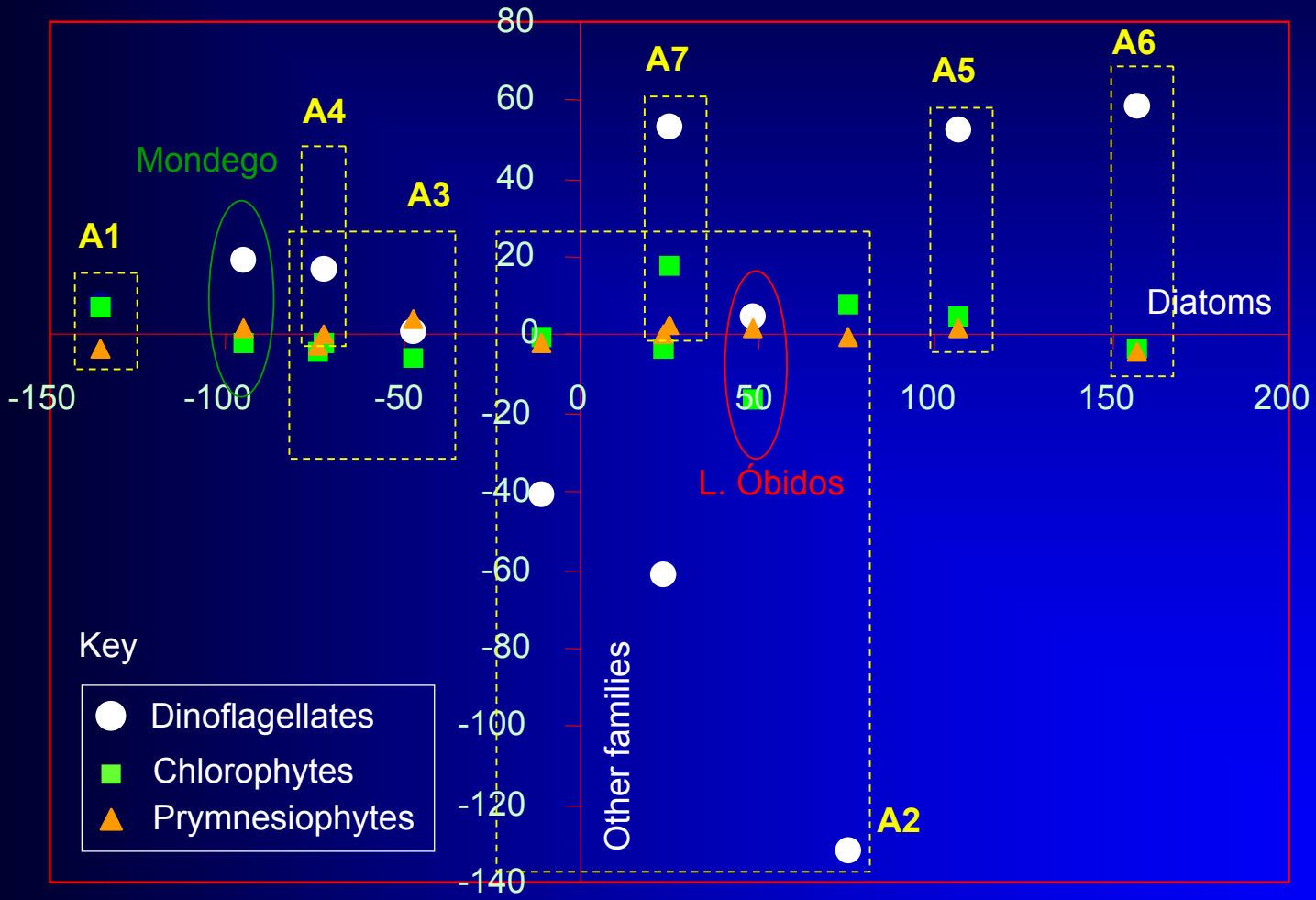
D.O in the channels



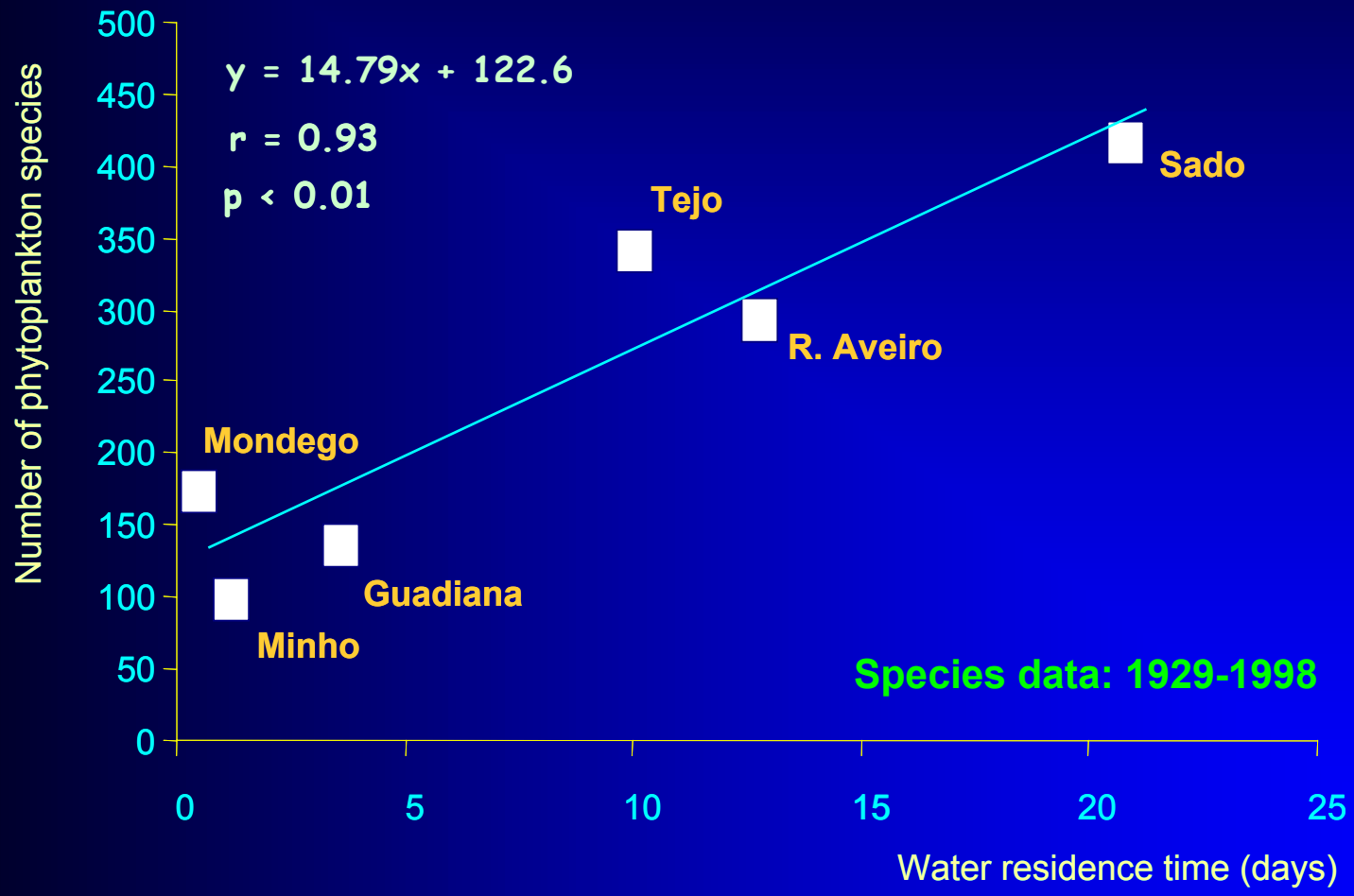
D.O in the tide pools



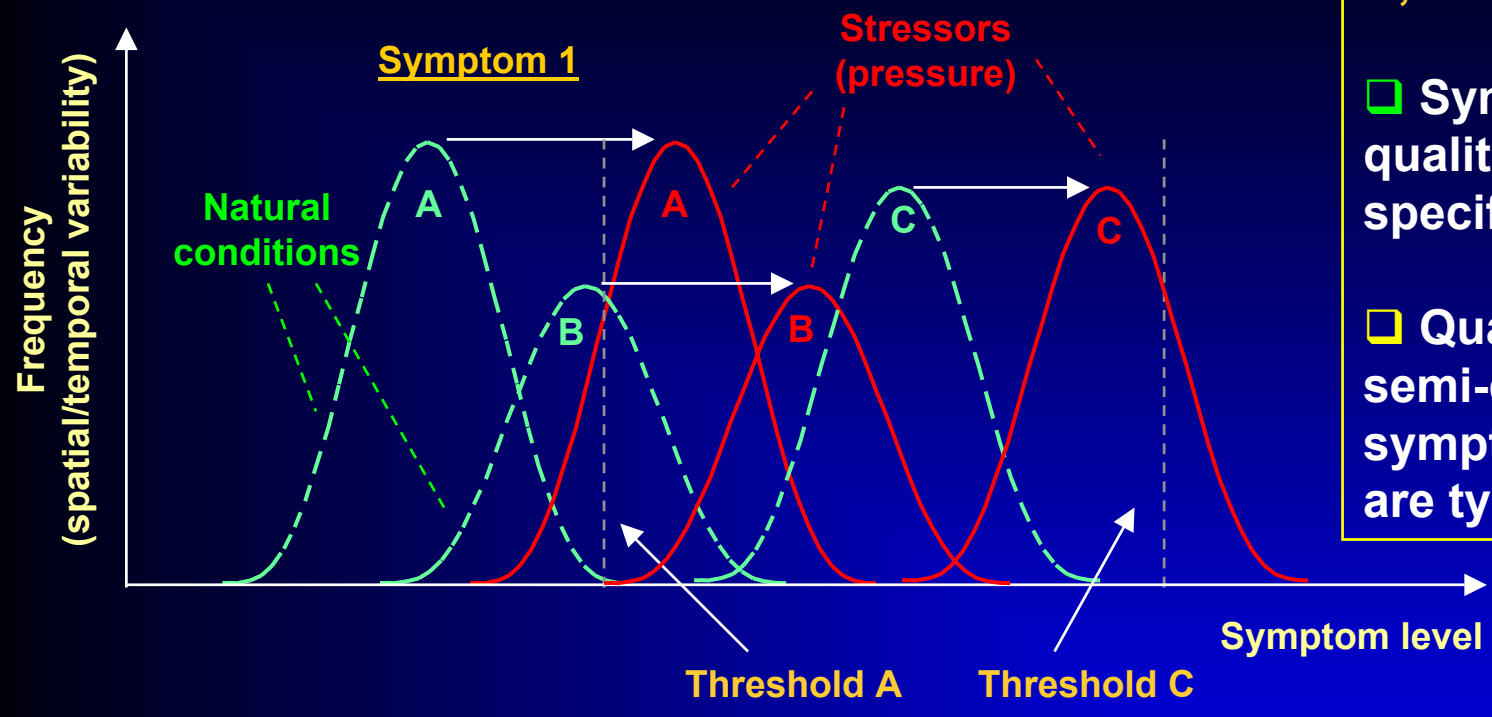
Long-term (~70 years) series of phytoplankton species



Number of phytoplankton species as a function of water residence time

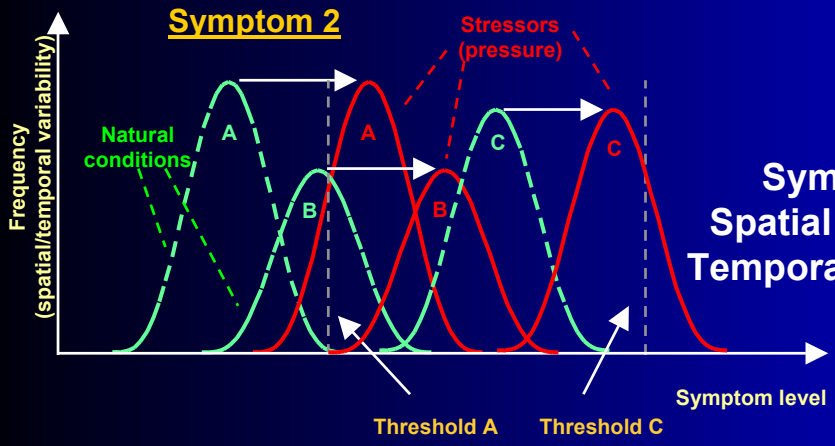


ASSETS multitype approach for OEC



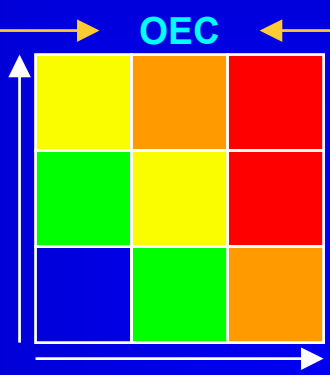
A, B and C are types

- Symptoms may be qualitatively type-specific
- Quantitative or semi-quantitative symptom thresholds are type-specific



Symptom 2
Spatial weighting
Temporal weighting

Symptom 1
Spatial weighting
Temporal weighting



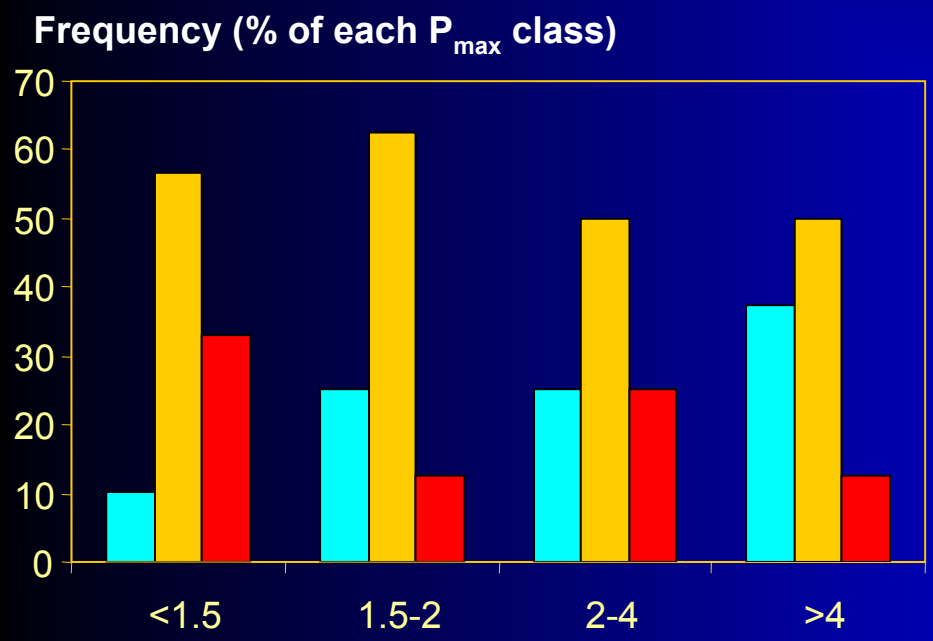
Normalized scores are as before, but related to type-specific thresholds

NEEA/ASSETS chlorophyll *a* and HAB

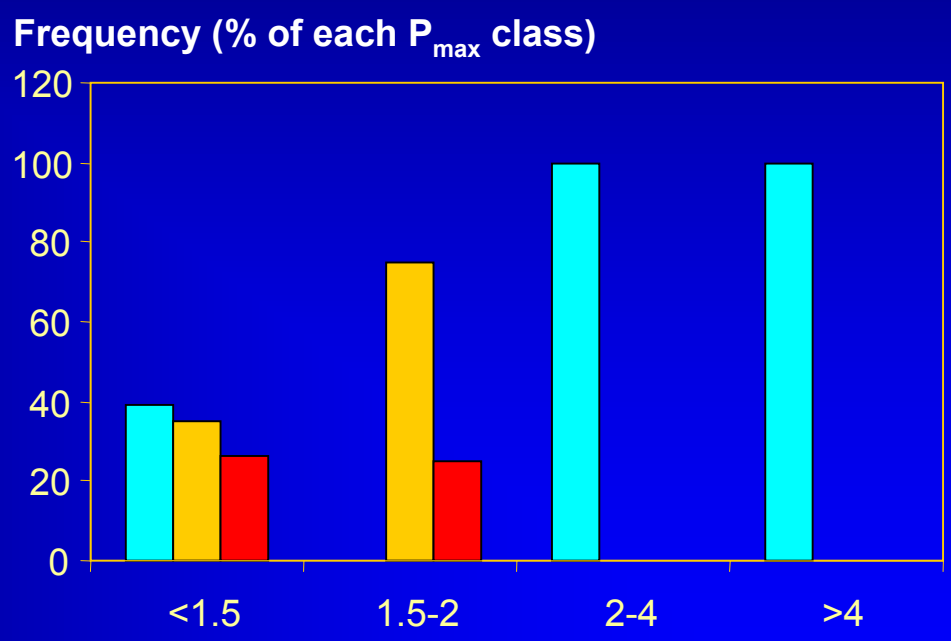
Frequency distribution according to required P_{max}

$$\ln\left(\frac{b_{max}}{b_{ini}}\right) = \left[P - \rho\left(1 + \frac{S_e}{\Delta S}\right)\right]t$$

OEC Chlorophyll *a*



OEC Nuisance and toxic blooms

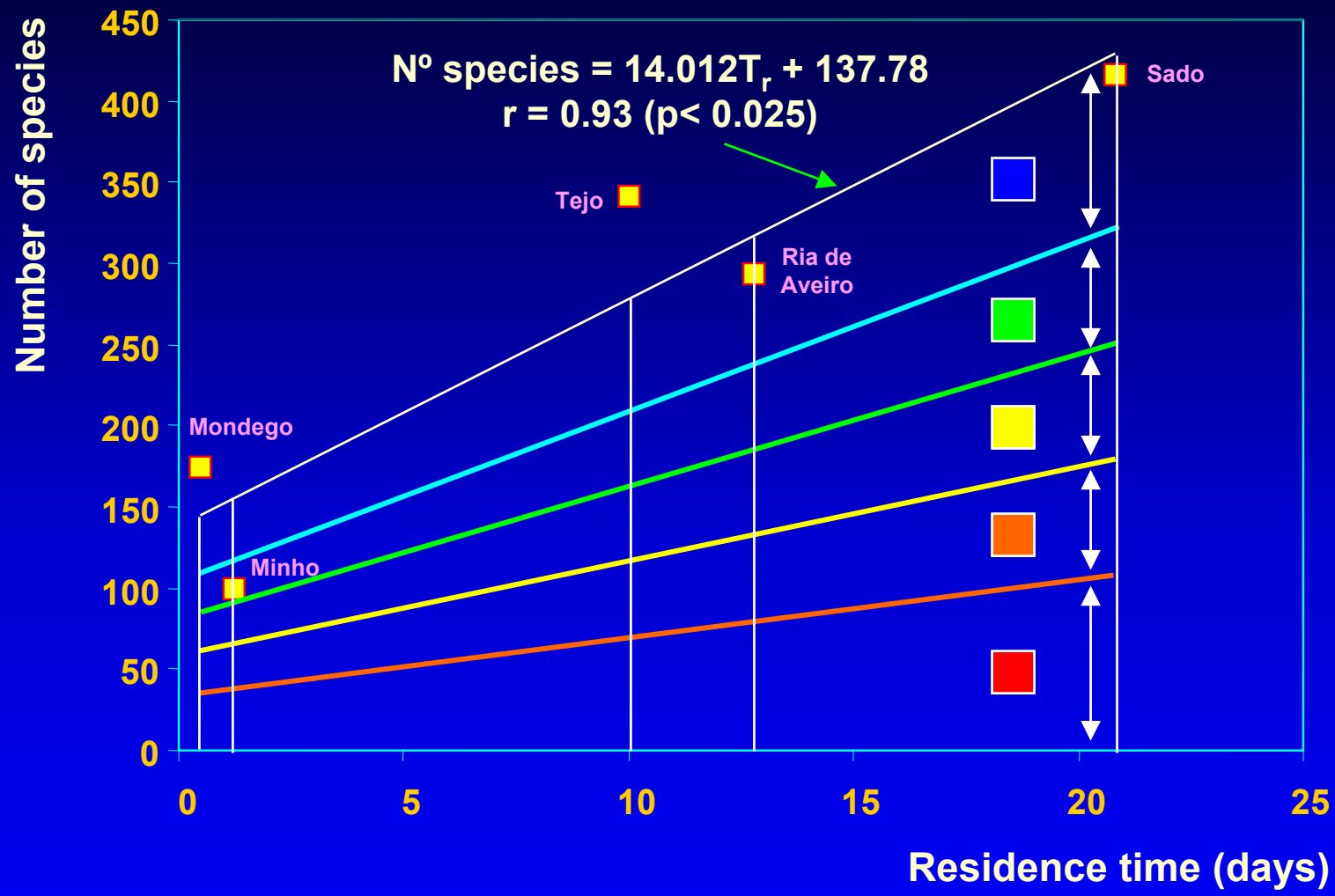


Pmax required for phytoplankton to bloom in the estuary

NEEA Grade 1 | NEEA Grade 2 | NEEA Grade 3

Residence time and species number

Correlation and ranges



Species data: 1929-1998

Final comments

- Natural conditions are widely variable, due to abiotic and biotic factors. This puts into question the use of absolute thresholds for eutrophication symptoms;
- Eutrophication assessment currently relies on a PSR approach, therefore the distinction between natural and anthropogenic causes is critical, in order to define responses (measures);
- Natural variability may be translated into types, which will determine the reference conditions for eutrophication symptoms. Deviations from a type-specific pristine situation will determine response;
- Assessment methods such as NEEA and ASSETS do already accommodate natural variability, by accounting for vulnerability and susceptibility, which are indirectly related to typology (e.g. more vulnerable systems naturally have higher symptom expression);
- Type-specific reference conditions may be defined using (a) Pristine systems (b) Historical data (c) Heuristics (d) Modeling;
- Research models may be used to explore changes in state (impacts) due to various pressure scenarios for different types, to help define meaningful thresholds.