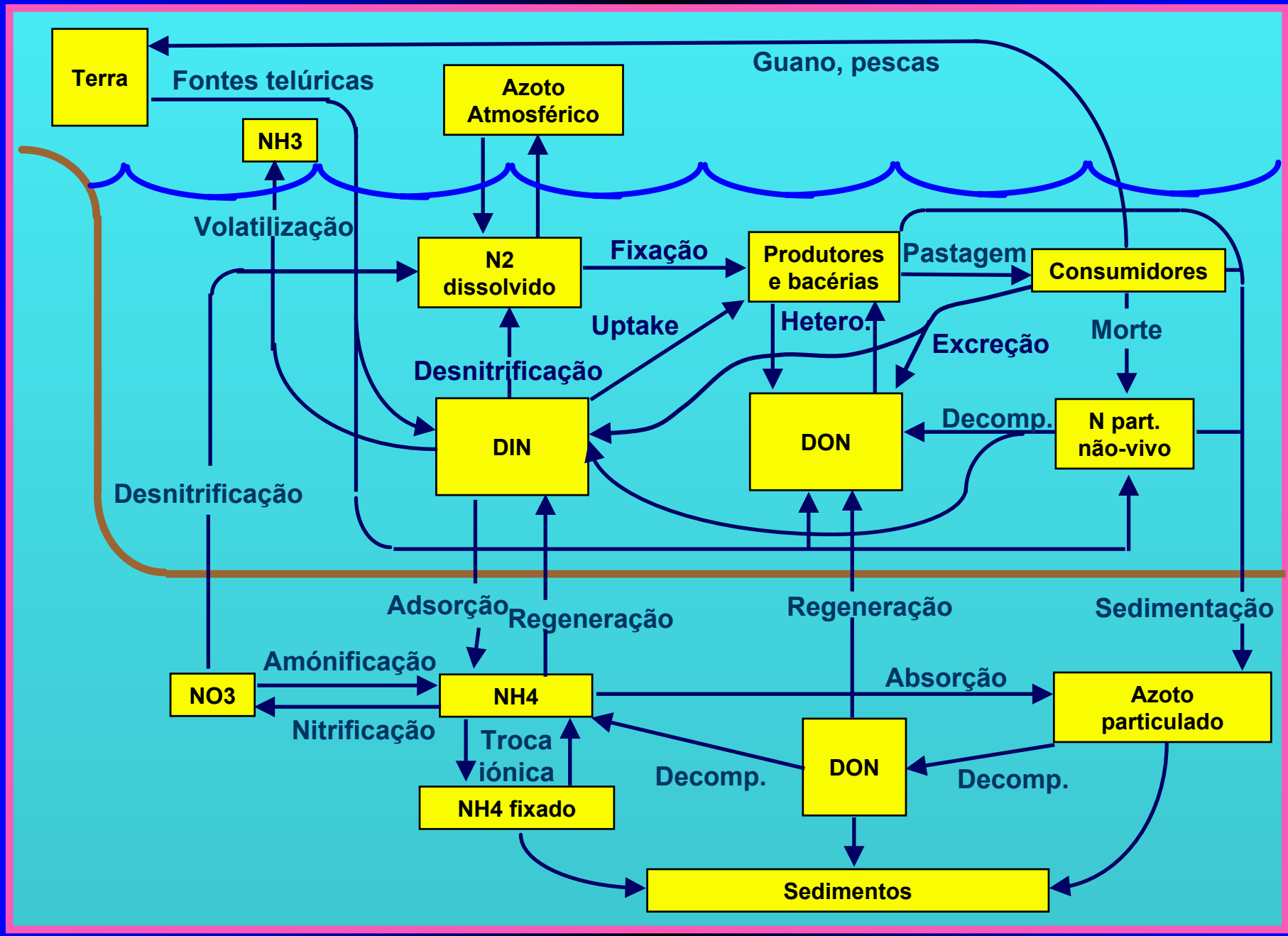
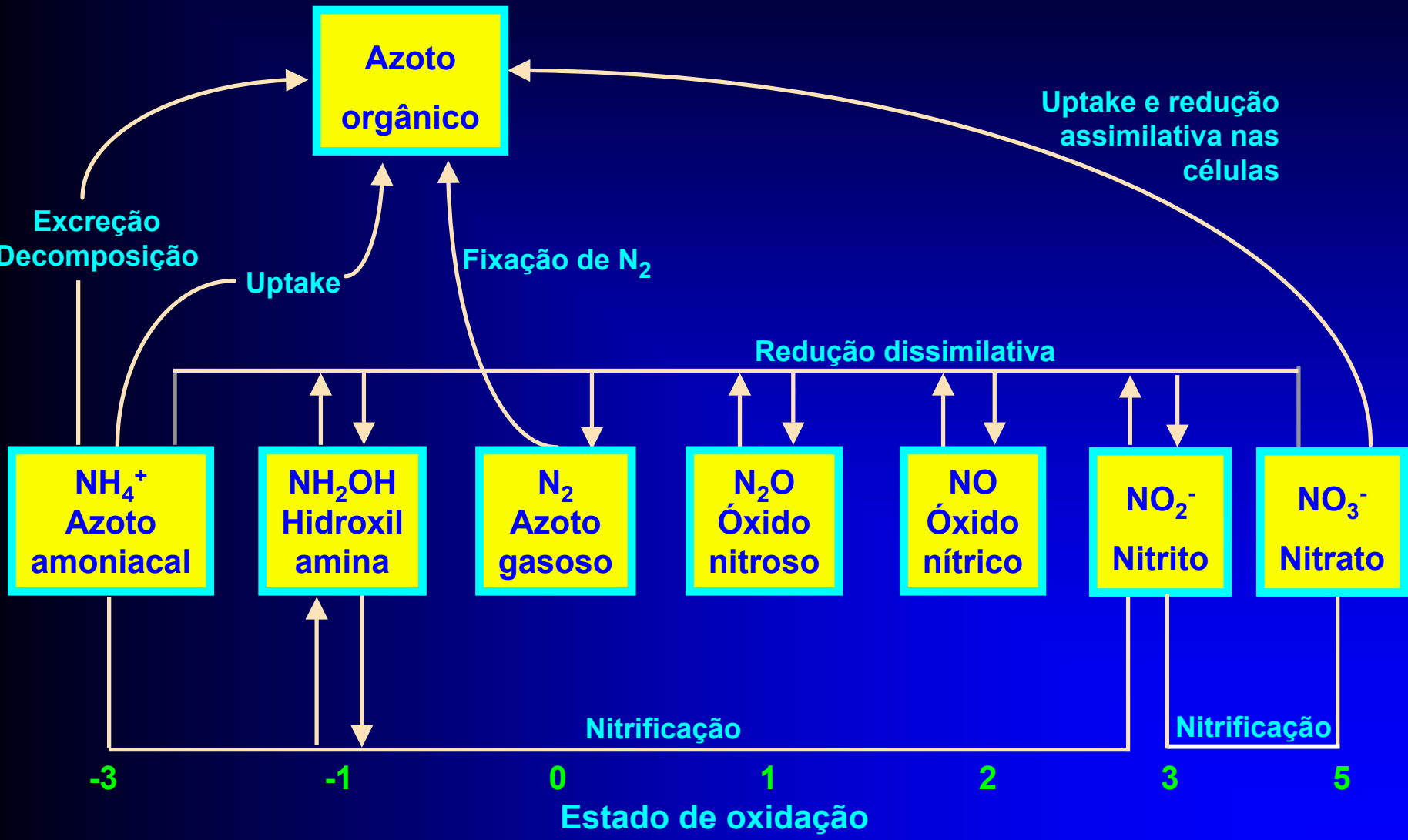
# Ciclo do azoto no ambiente marinho

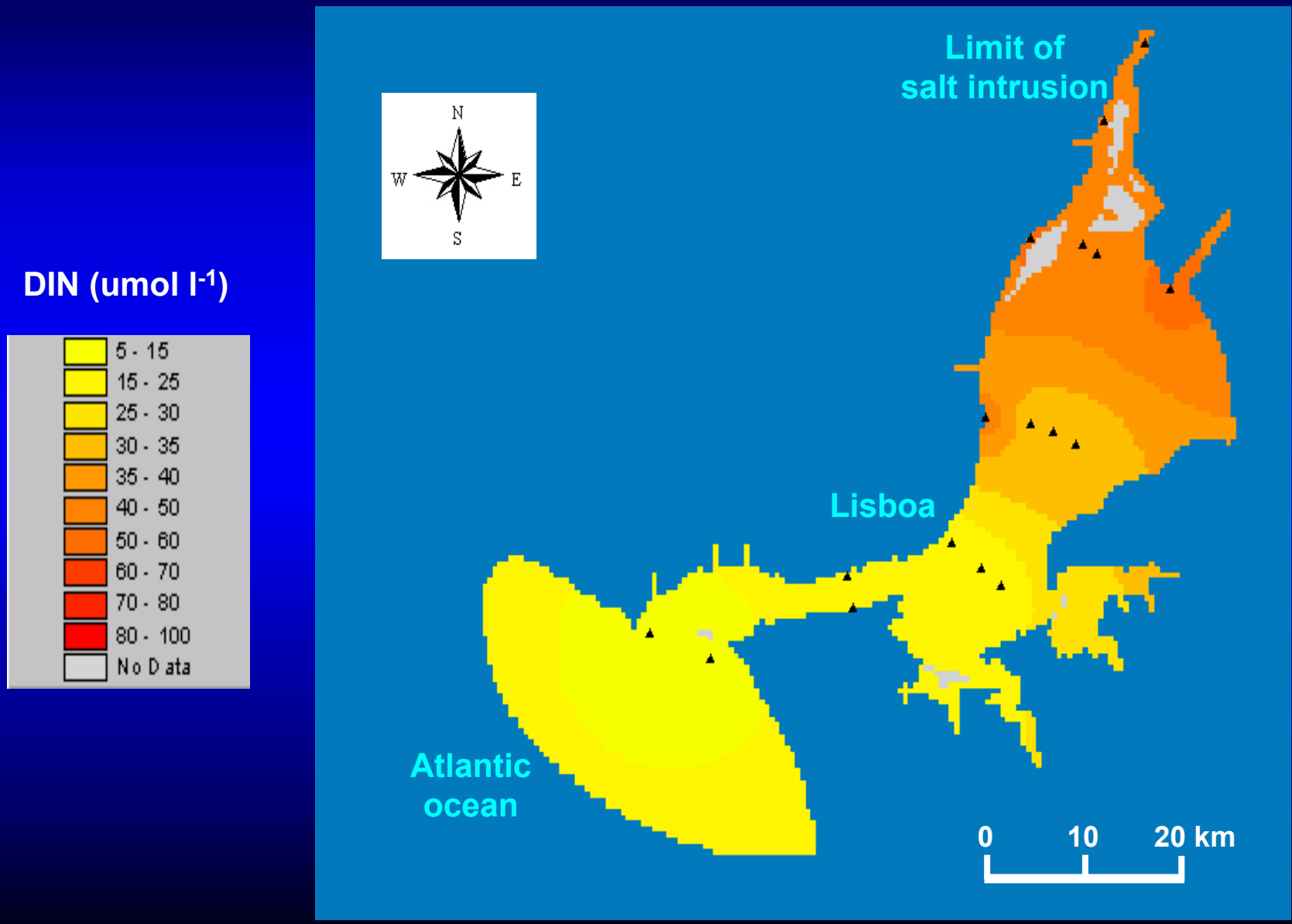


# Transformações de azoto

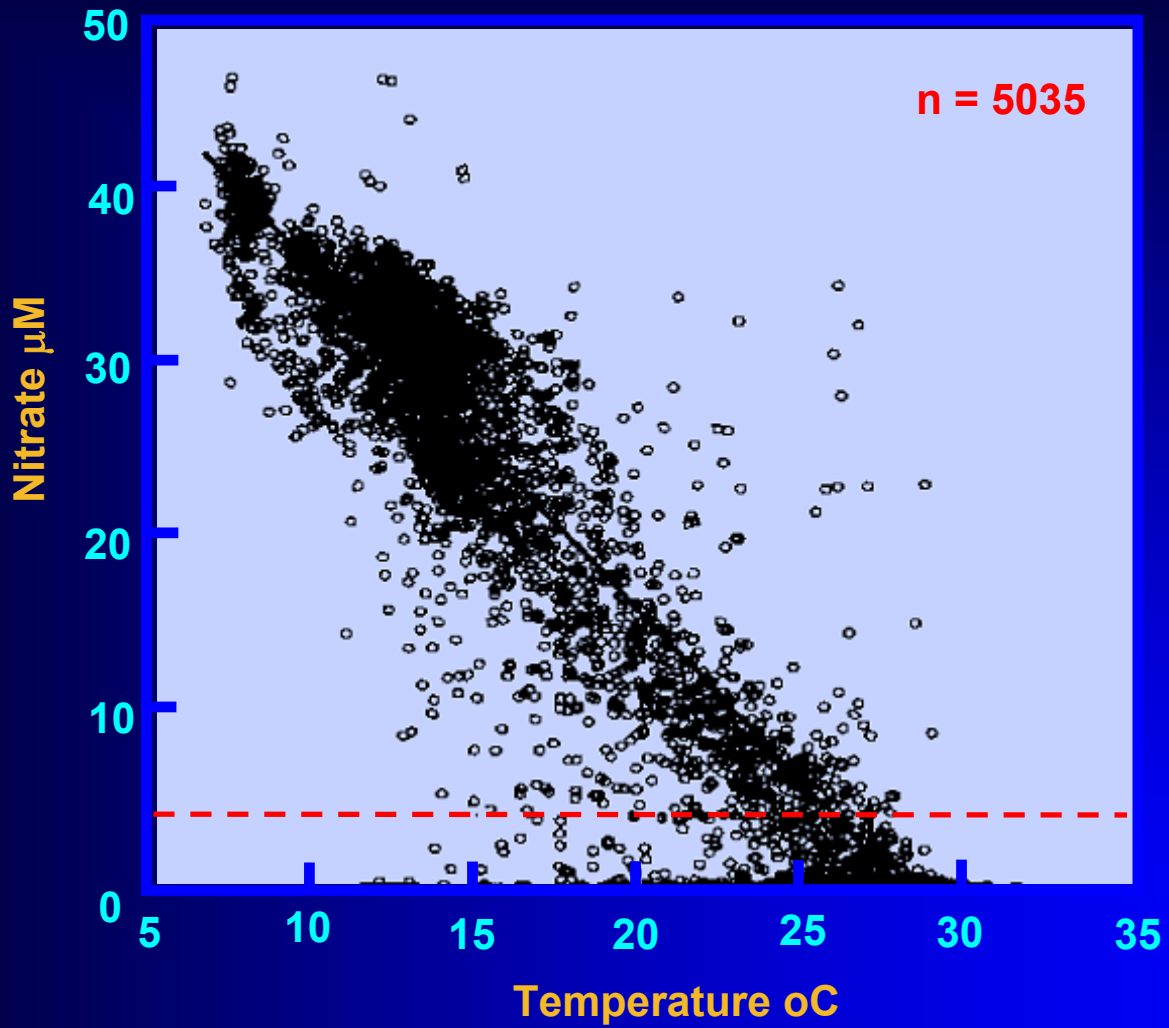



Fenchel & Blackburn, 1979. Bacteria and mineral cycling. Academic Press.

# GIS - Annual mean DIN in the Tagus estuary



# NO3-Temperature relationship for the eastern tropical Pacific (Aug.-Nov. 86-88)

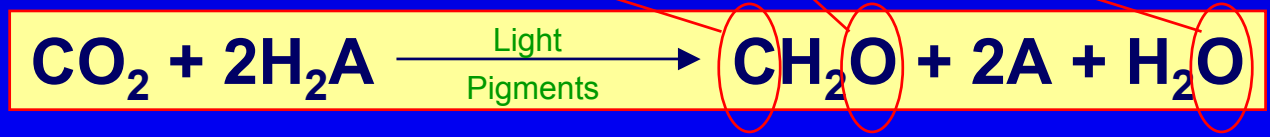



Fiedler *et al.*, 1991 - Limnol. & Oceanog. 36, p. 1834-50

# Redfield ratio

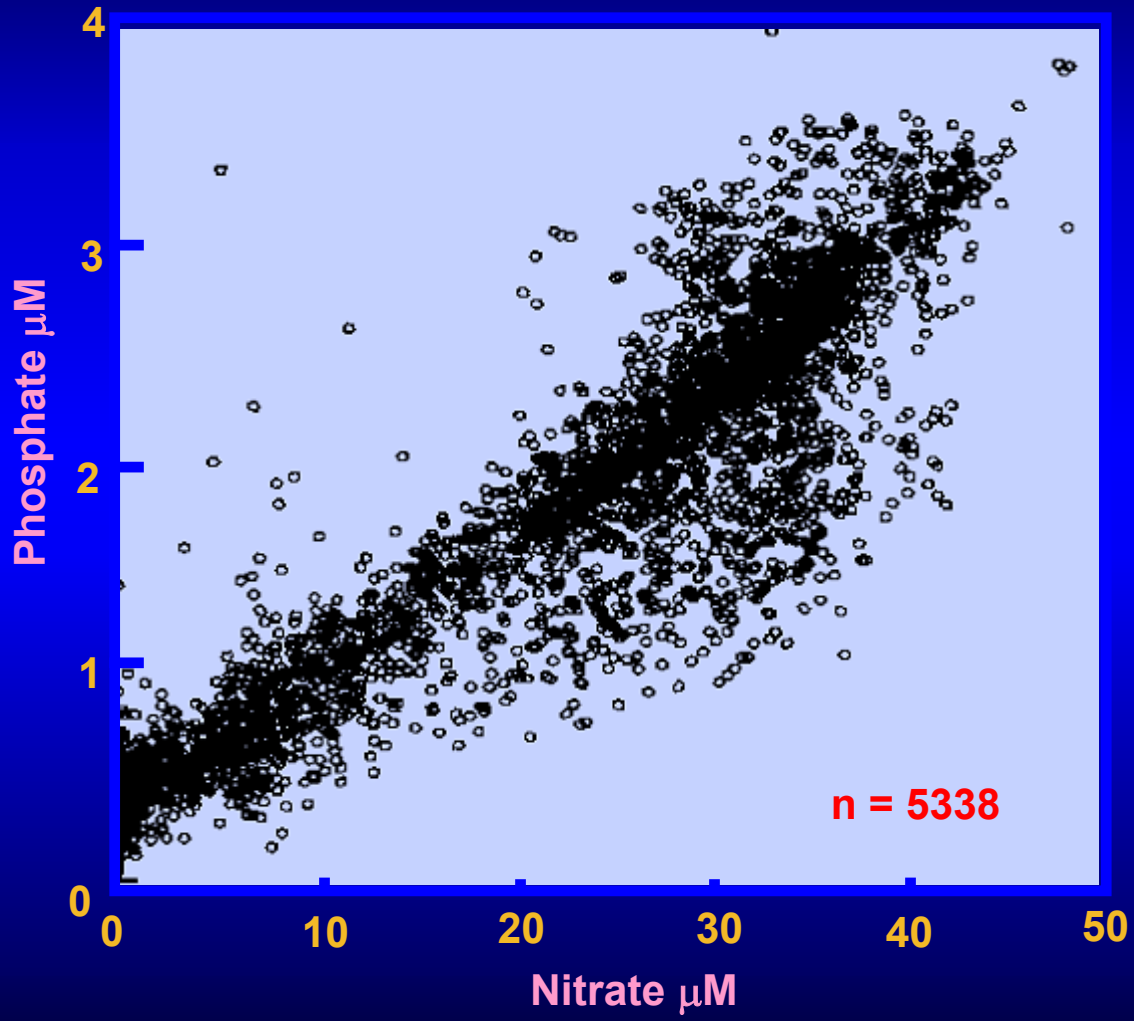
## Definitions

- "Standard" ratio of C:N:P
- May be expressed in atoms or mass
- Derives from the constancy of composition of biota
- C:N:P 106:16:1 (in atoms)
- C:N:P 45:7:1 (in mass)
- Oxygen may also be included, considering that for every carbon atom fixed two oxygen atoms are produced



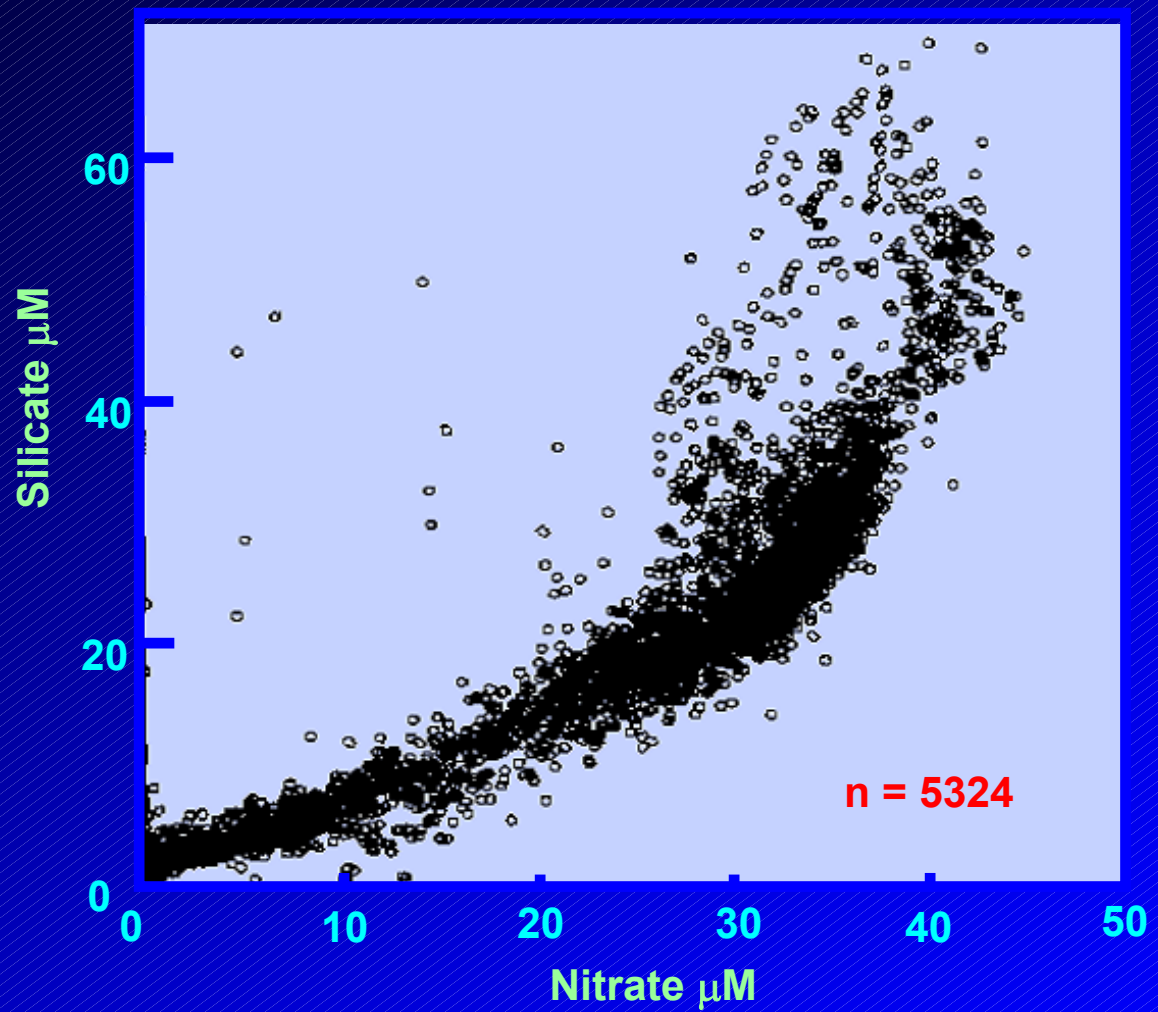

O:C:N:P 212:106:16:1

# PO4 - NO3 relationship for the eastern tropical Pacific (Aug.-Nov. 1986-88)



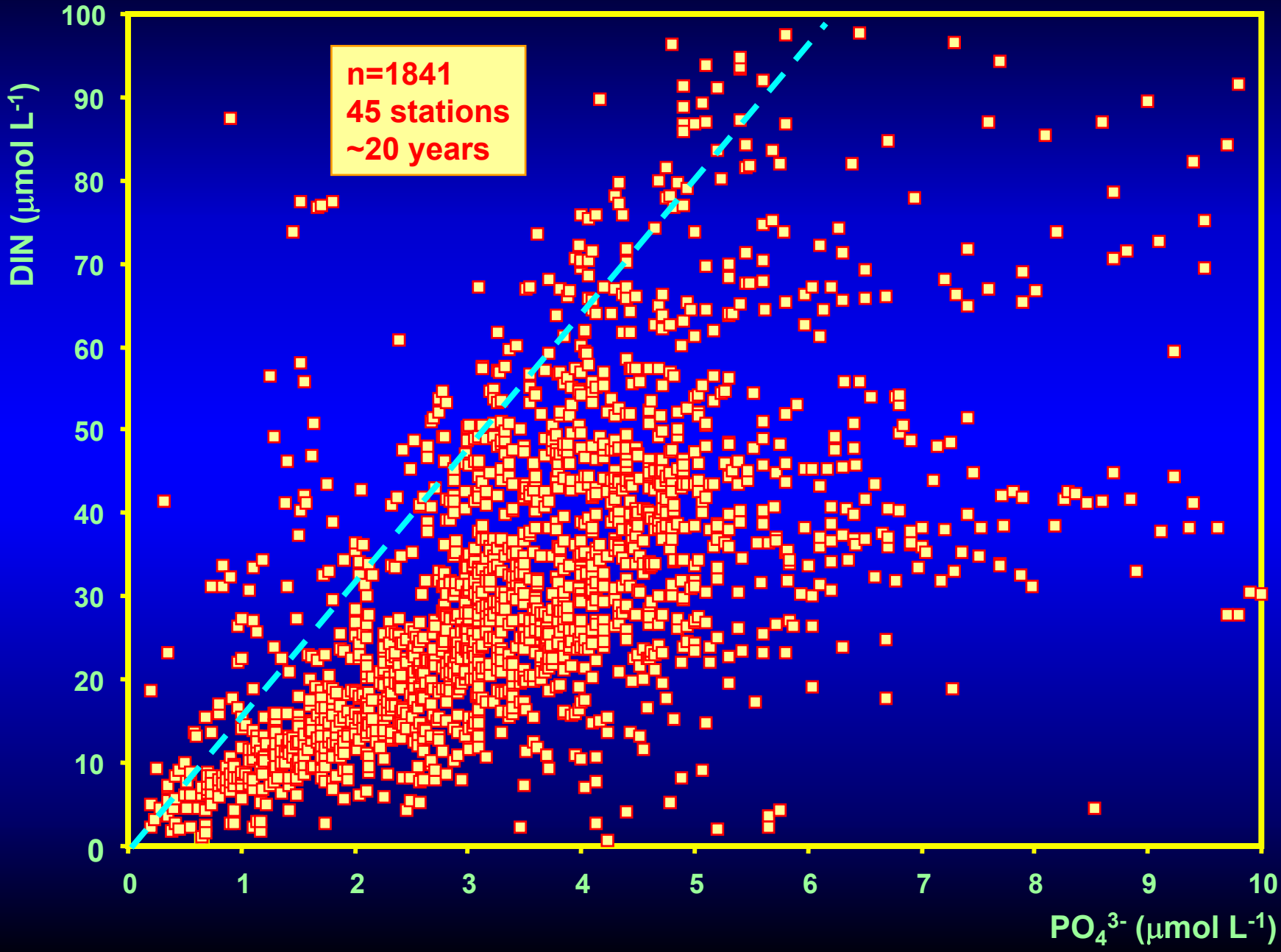

Fiedler *et al.*, 1991 - Limnol. & Oceanog. 36, p. 1834-50

# SiO4 - NO3 relationship for the eastern tropical Pacific (Aug.-Nov. 1986-88)

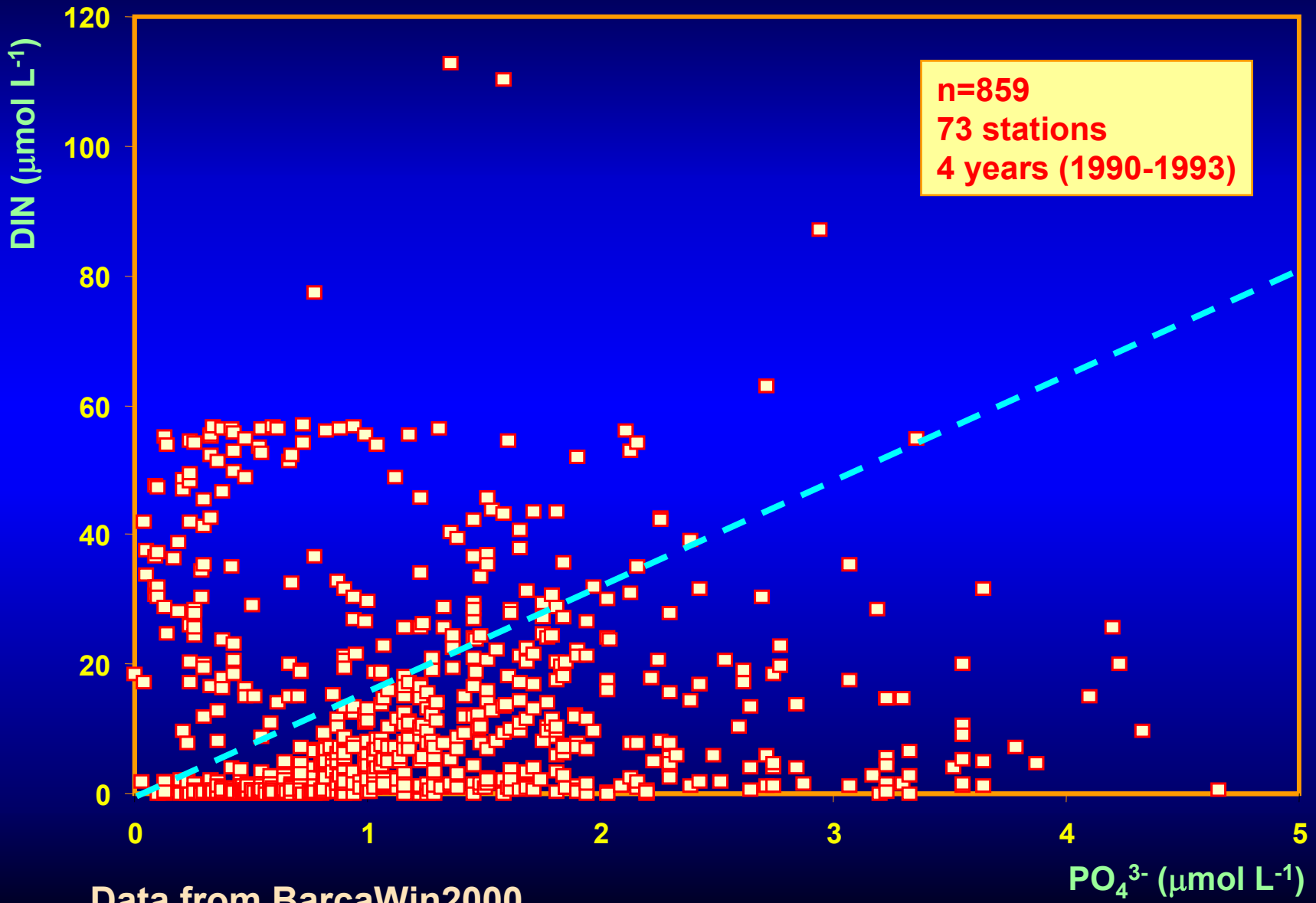



Fiedler *et al.*, 1991 - Limnol. & Oceanog. 36, p. 1834-50

# N:P ratio for the Tagus Estuary – Data from B2K

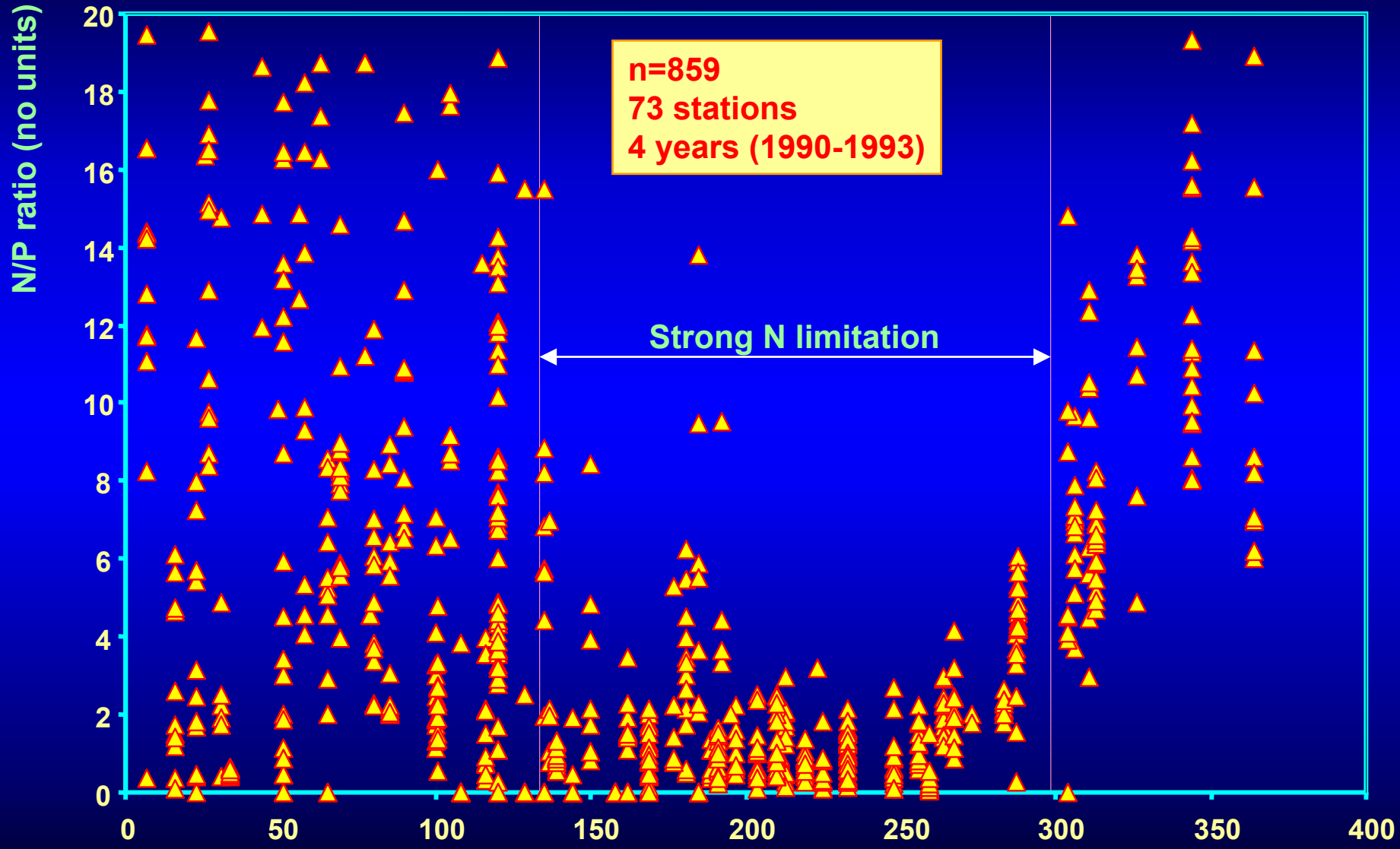


# N:P ratio for Carlingford Lough



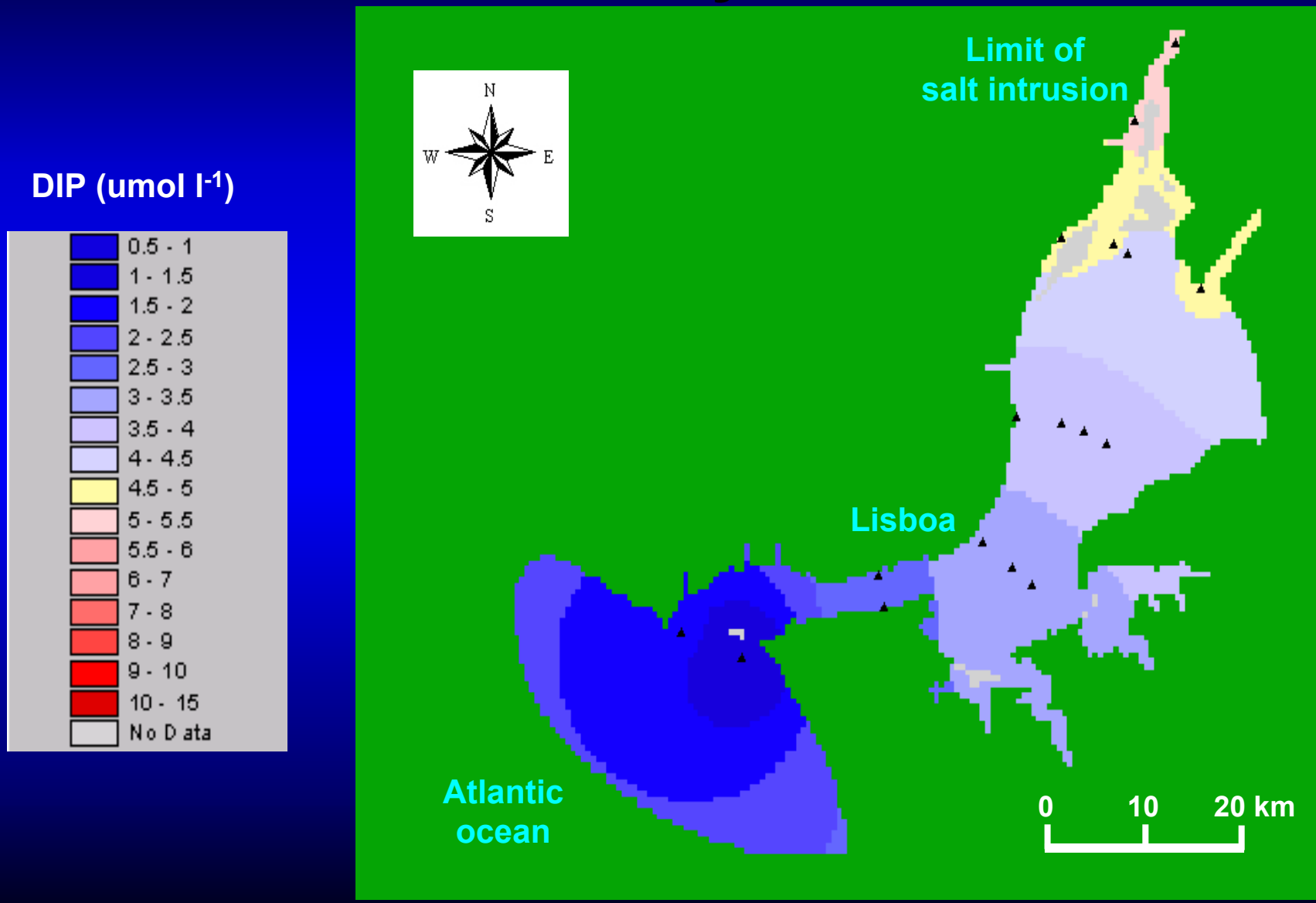

Data from BarcaWin2000

# N:P ratio for Carlingford Lough
# Seasonal breakdown

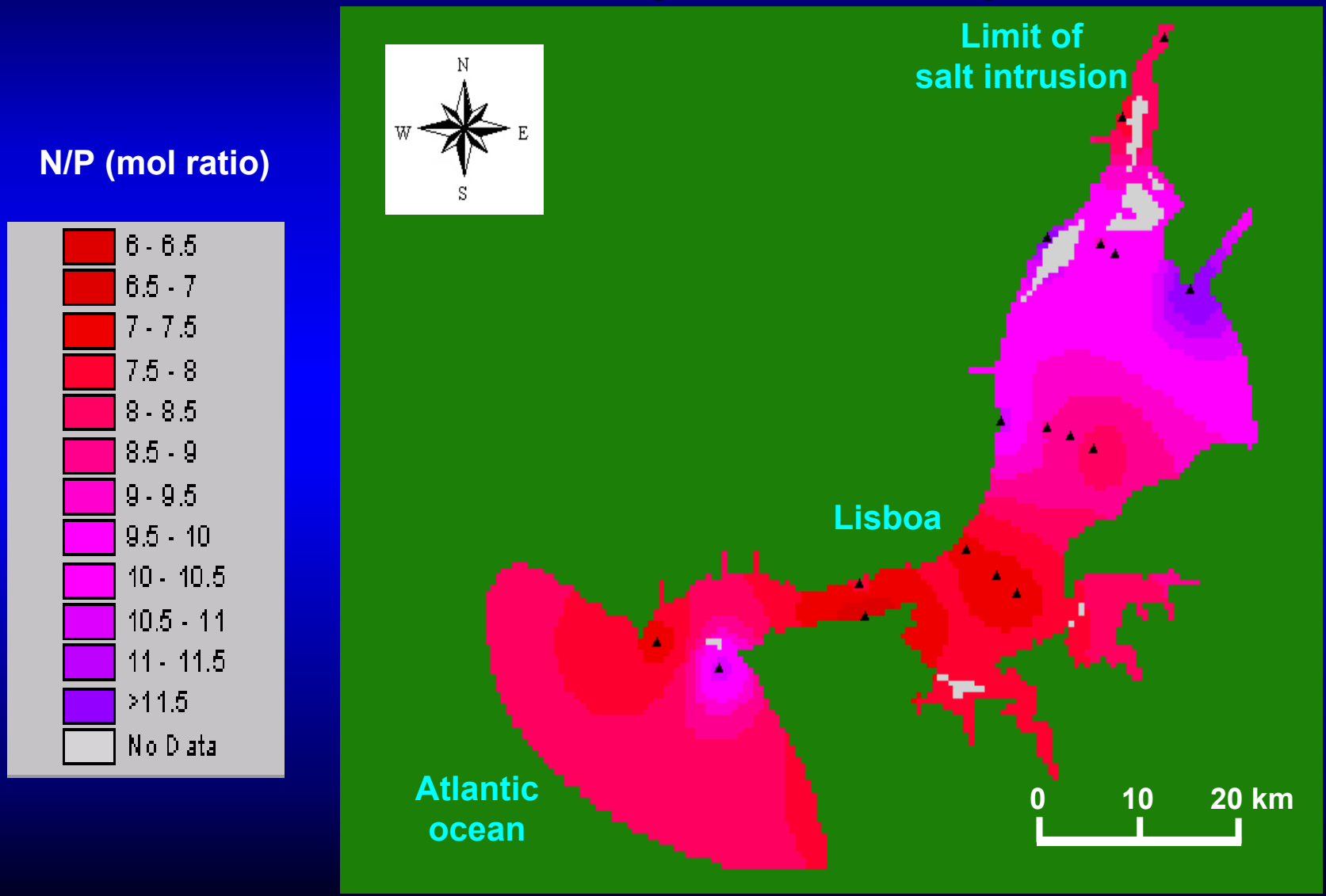



Data from BarcaWin2000

# GIS - Annual mean DIP in the Tagus estuary



# GIS - Annual mean Redfield ratio (N/P) for the Tagus estuary



# Balanço de massa de cargas e regeneração de nutrientes em Narragansett Bay, E.U.A.

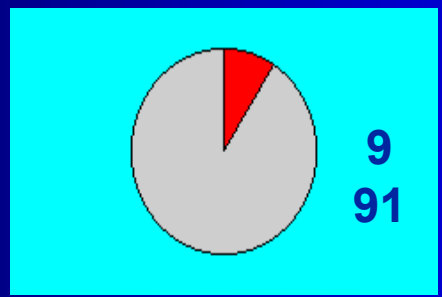
| | Entradas anuais ($10^6$ at-g $ano^{-1}$) | |
|---|---|---|
| | **Azoto** | **Fósforo** |
| **Entradas** | | |
| Fixação | 0.2 | - |
| Precipitação | 2.8 | 0.19 |
| Runoff | 16.2 | 0.8 |
| Rios | 235 | 17.3 |
| Efluentes | 278 | 21.7 |
| • **Total** | **532** | **39.9** |
| **Regeneração** | | |
| Menhaden | 0.8 | 0.1 |
| Ctenóforos | 8.1 | 0.8 |
| Zooplâncton | 98.5 | - |
| Bentos | 264 | 41.1 |
| • **Total** | **371** | **42** |

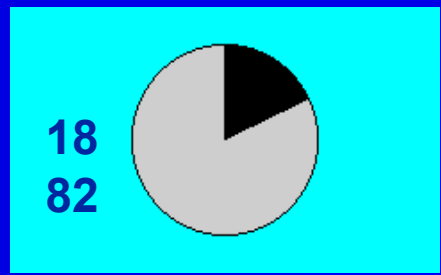
Nixon, 1981. Remineralization and nutrient cycling in coastal marine ecosystems. *In* Neilson & Cronin (Eds.) , Estuaries and Nutrients, Humana, p. 111-138.

# Balanço de massa de azoto. Todos os valores em kg N $ano^{-1}$ Sippewissett marsh, E.U.A.

| | Entradas | Saídas | Trocas líquidas |
|---|---|---|---|
| Precipitação | 380 | | 380 |
| Águas subterrâneas | 6120 | | 6120 |
| Fixação de N2 | 3280 | | 3280 |
| Trocas pela maré | 26200 | 31600 | -5350 |
| Desnitrificação | | 6940 | -6940 |
| Sedimentação | | 1295 | -1295 |
| Outras | 9 | 26 | -17 |
| • Total | 35990 | 39860 | -3870 |

| | | |
|---|---|---|
| % de troca biótica | 9 | 18 |
| % de troca física | 91 | 82 |





Valiela & Teal (1979). The nitrogen budget of a salt marsh ecosystem, Nature 280, 652-656.
Sinais menos indicam exportação do sapal.

# DIN mass balance for Cala do Norte (kg N $y^{-1}$)

## Advection-dispersion

| Inputs | |
|---|---|
| Upstream | 817642 |
| Effluents | 3109278 |
| Sub-total | 3926920 |

| Outputs | |
|---|---|
| Downstream | -3607087 |
| Sub-total | -3607087 |

## Internal processes

| Sources | |
|---|---|
| Phyto mortality | 29740 |
| Zoo sloppy grazing | 2819 |
| Zoo metabolism | 9632 |
| Zoo excretion | 321 |
| Zoo mortality | 1527 |
| Sub-total | 44039 |

| Sinks | |
|---|---|
| Gross primary prod. | -363834 |
| Sub-total | -363834 |

| | | | |
|---|---|---|---|
| *Total* | *319833* | *Total* | *-319795* |

Total 38 kg y-1 (approx. zero) $\Delta N$ -0.113 $\mu$at g DIN $l^{-1}$ $y^{-1}$

# Phytoplankton N mass balance for Cala do Norte (gN $m^{-2}$ $y^{-1}$)

| Advection-dispersion | | Internal processes | |
|---|---|---|---|
| **Inputs** | | **Sources** | |
| Upstream | 11.88 | Net primary prod. | 20.53 |
| Sub-total | 11.88 | Sub-total | 20.53 |
| **Outputs** | | **Sinks** | |
| Downstream | - 28.24 | Natural mortality | - 2.73 |
| Sub-total | - 28.24 | Grazing | - 1.44 |
| | | Sub-total | - 4.17 |
| *Total* | - 16.36 | *Total* | *16.36* |

**Total** 0 g $m^{-2}$ $y^{-1}$ **Stock** 0.150 gN $m^{-2}$

# Redfield ratio

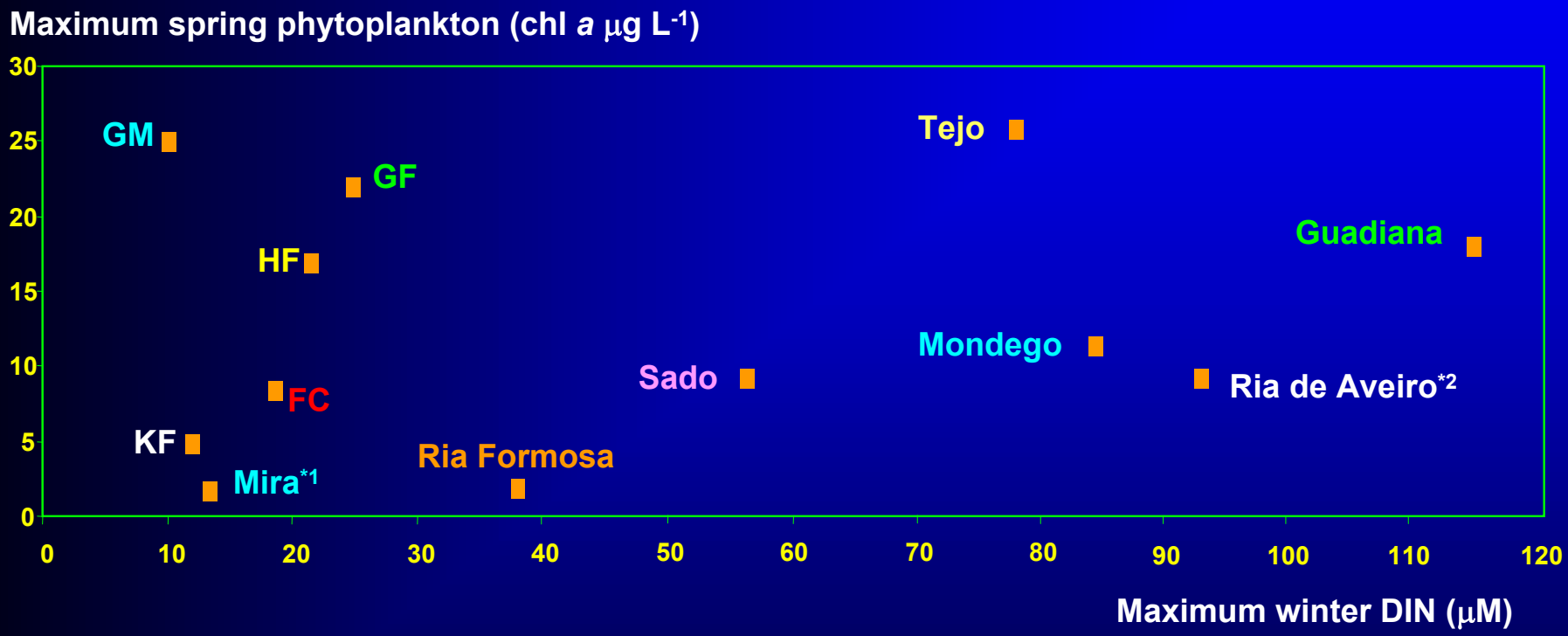
## Caveat

This is a mean ratio, in some cases the variance will be large!

## Applications

- Analysing the food chain (planktonic or detrital)
- Determining nutrient limitation
- Performing mass balances, i.e. Understanding stocks and fluxes
- Management of input and uptake
- Understanding the role of autochtonous production, external inputs and export (outwelling)
- Ecological modelling (currency tables)

# OAERRE data + TICOR data
# Chlorophyll *a* and nutrients




Tett, P., Gilpin, L., Svendsen, H., Erlandsson, C.P., Larsson, U., Kratzer, S., Fouilland, E., Janzen, C., Lee, J., Grenz, C., Newton, A., Ferreira, J.G., Fernandes, T., Scory, S., 2002. Eutrophication and some European waters of restricted exchange. Submitted to Coastal and Nearshore Oceanography, NEEA, and unpublished work from TICOR.

*1 – Chlorophyll determined from graphical data
*2 – Nitrate, not DIN