Hypoxia Effects on Demersal and Benthic Fauna

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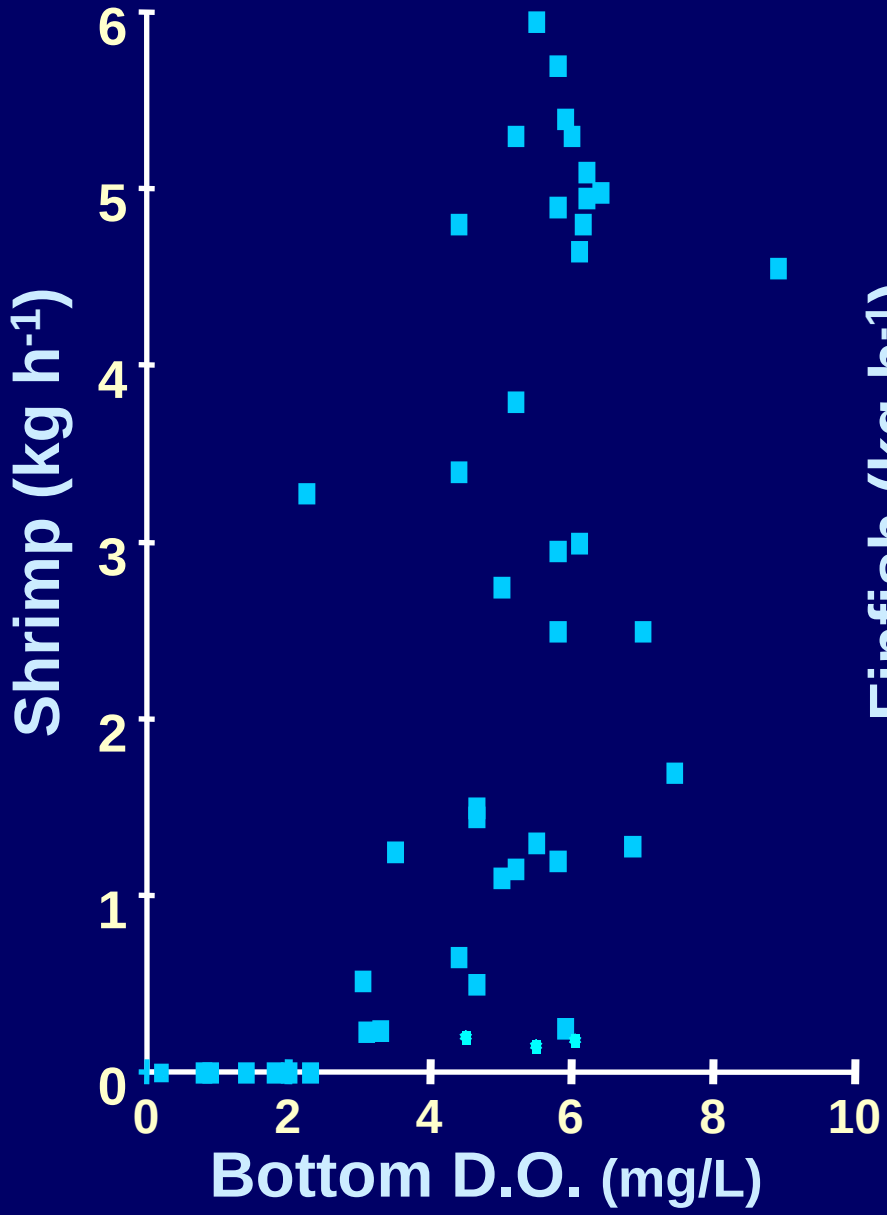
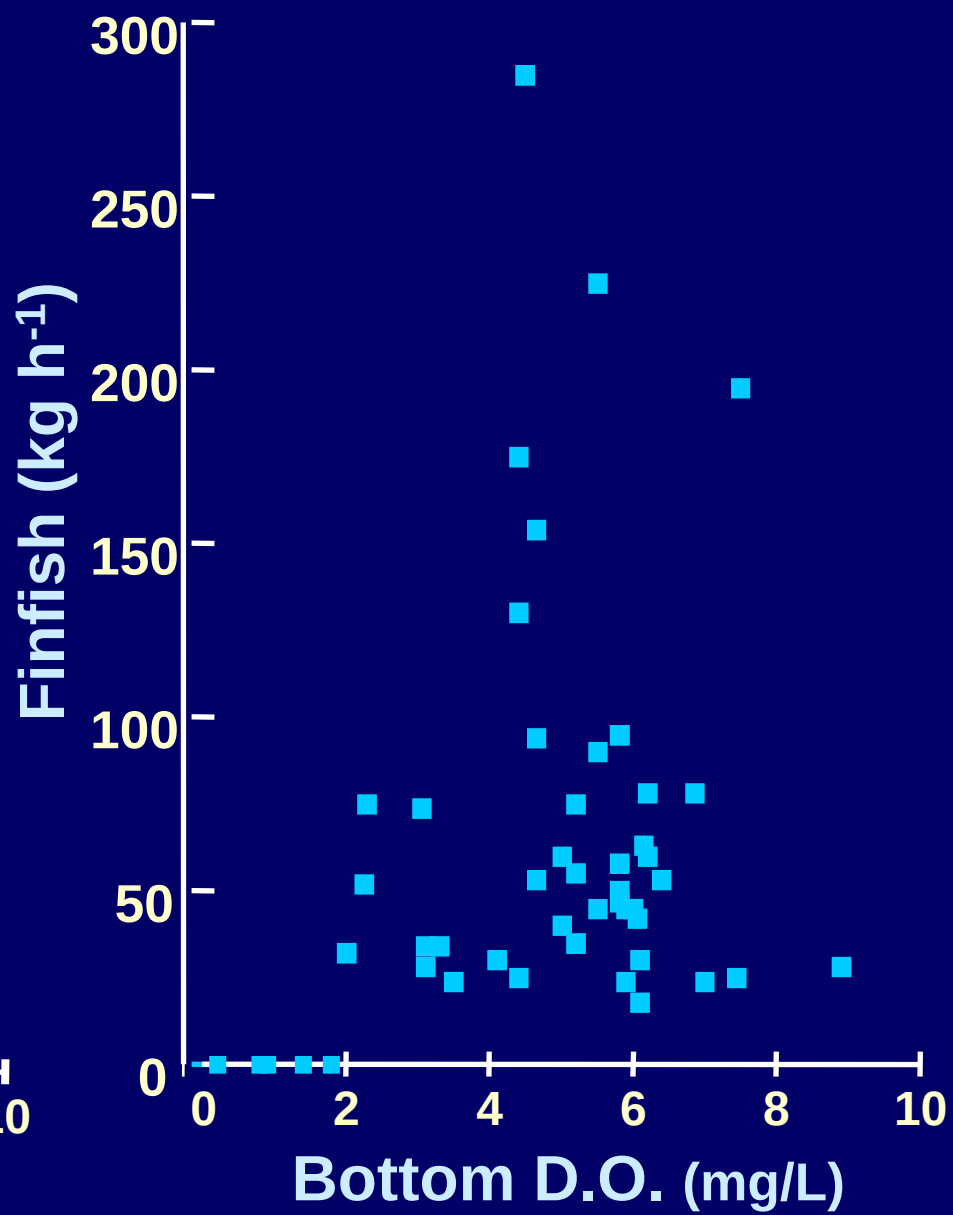
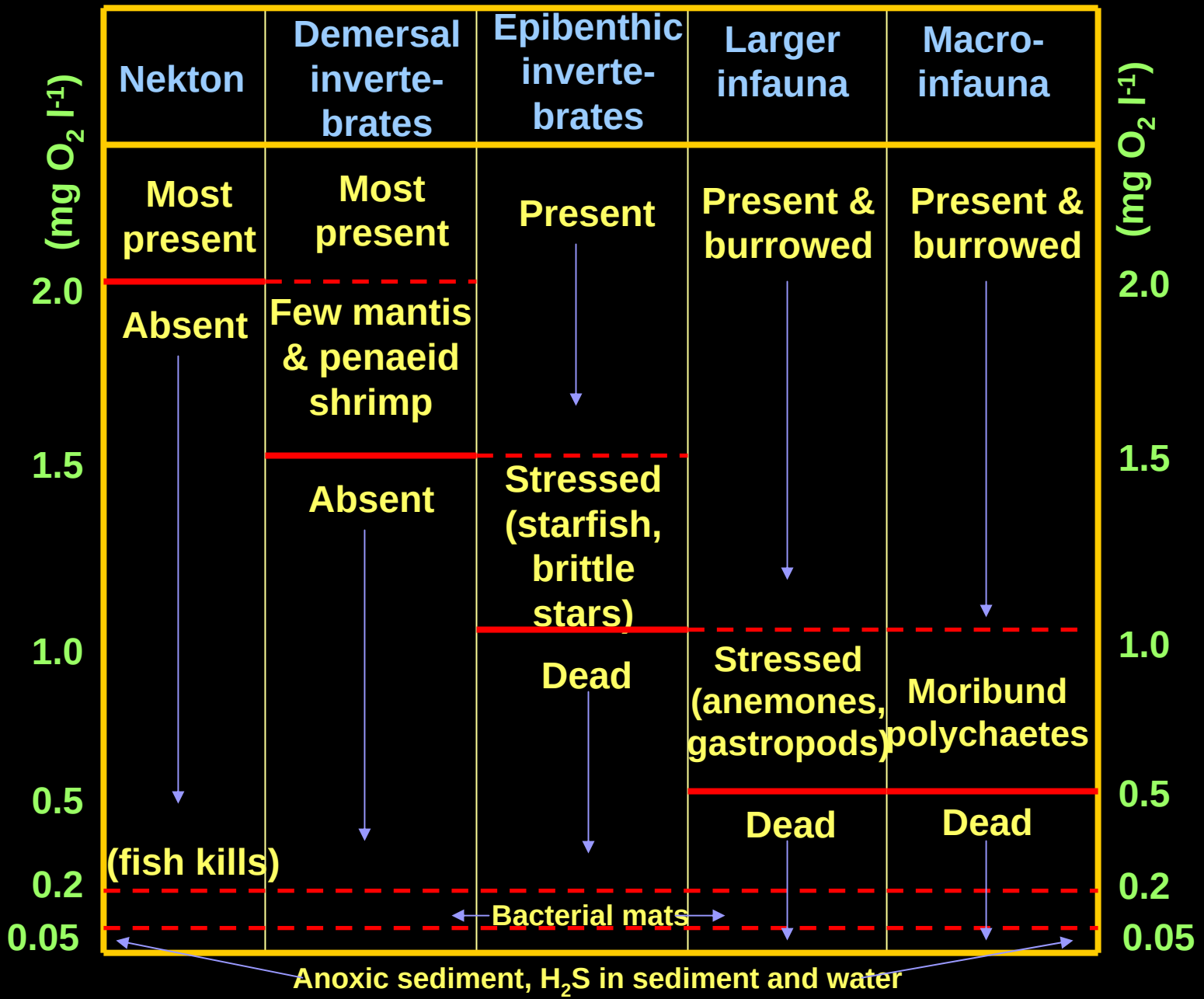
Center for Sponsored Coastal Ocean Research, Coastal Ocean Program, NGOMEX Hypoxia Studies

Hypoxia = Dissolved O_2 < 2 mg/L (=2 ppm)





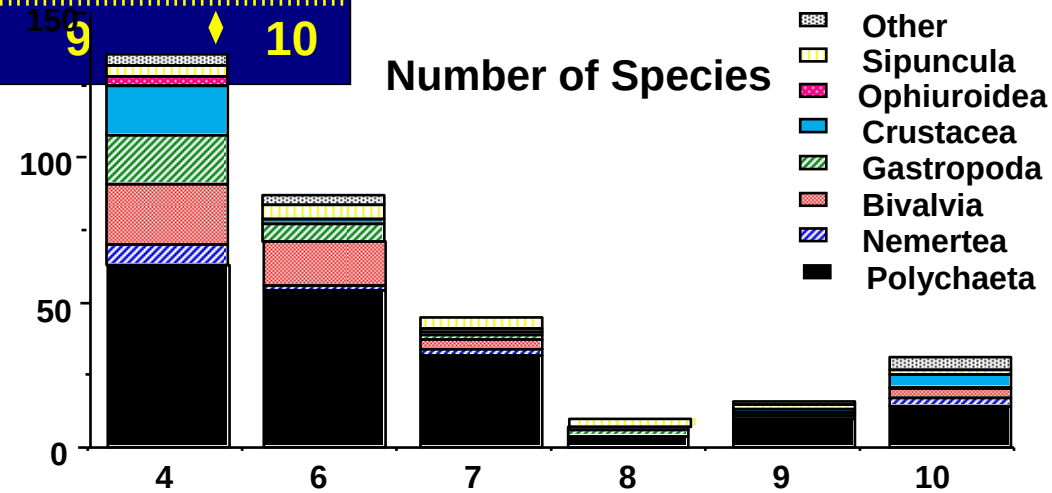
(data from Leming and Stuntz, 1984; SW Louis. Coast, June 1982)

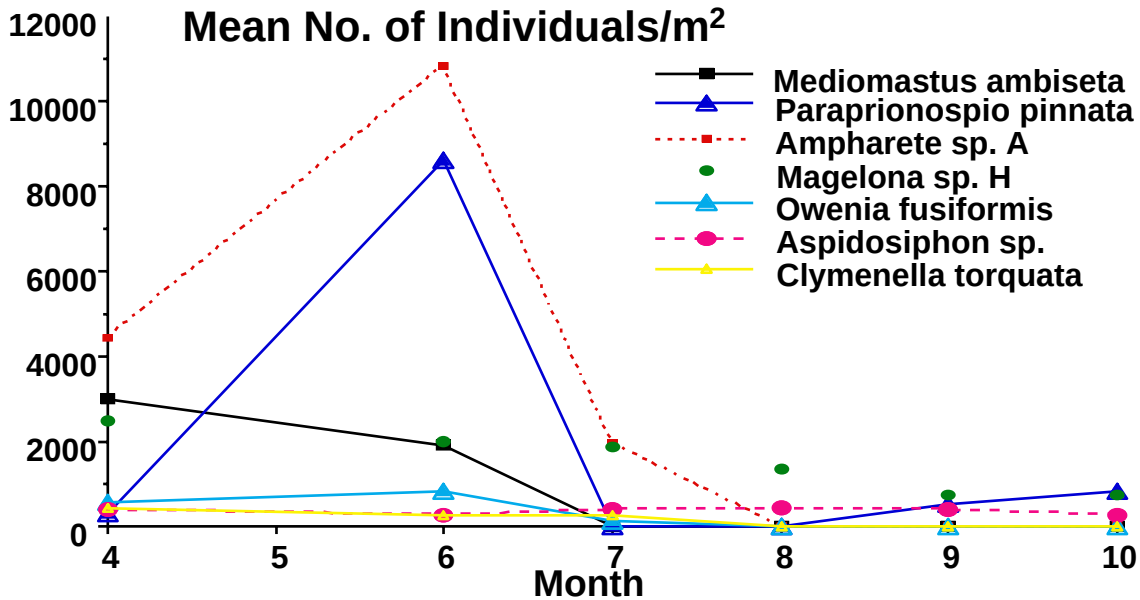


(Rabalais, Harper & Turner, 2001)

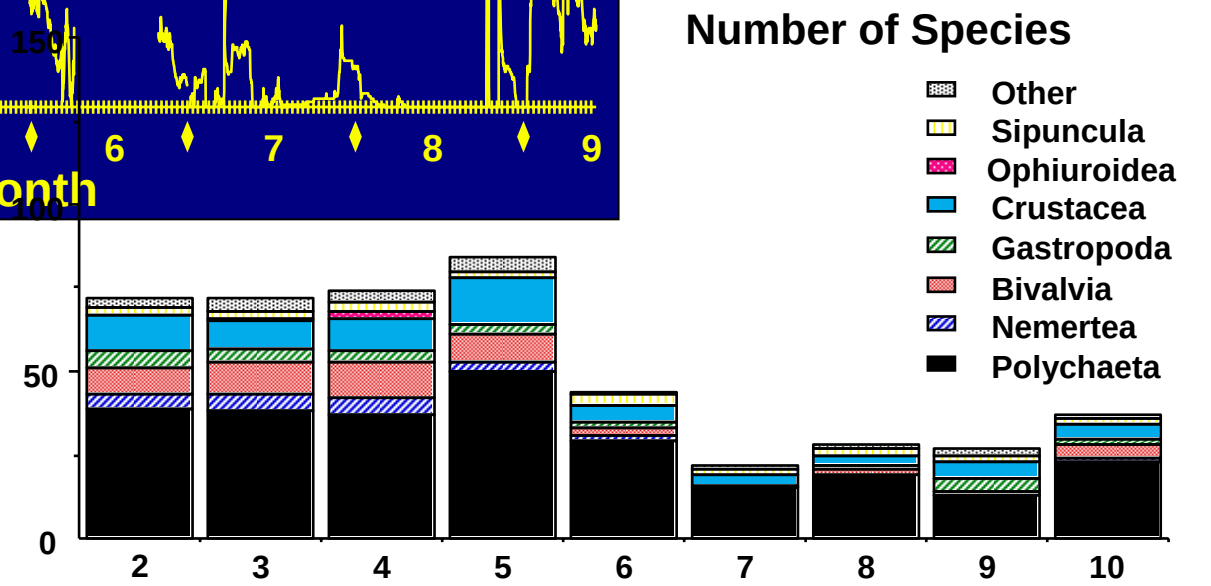
“Charismatically Stressed or Dead Organisms”
(Downing 2002)

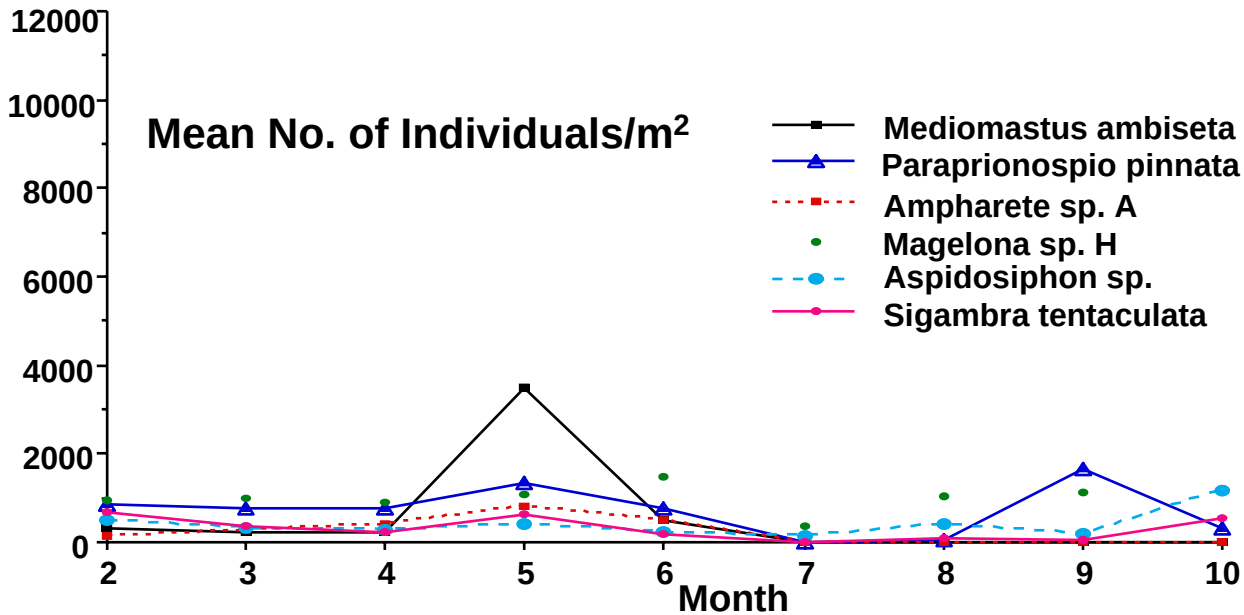
Photos Removed





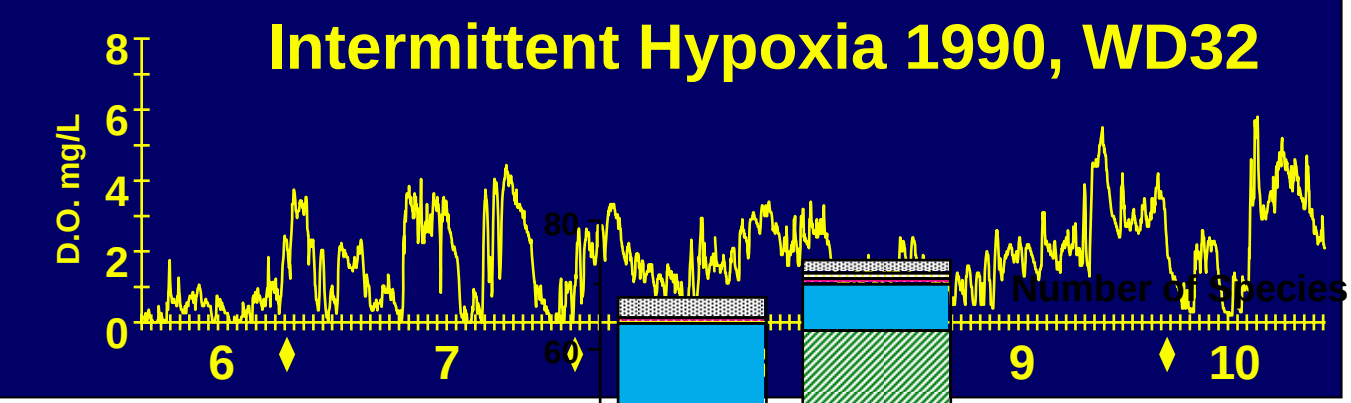
(Rabalais et al., 2001)

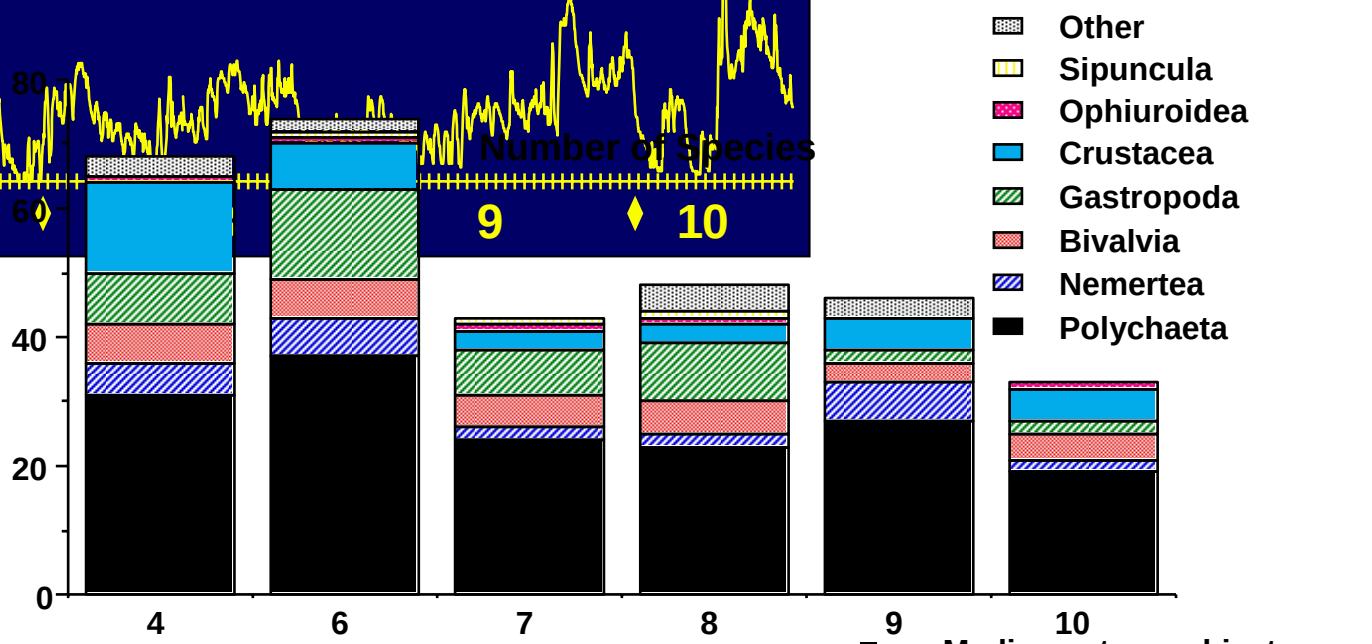


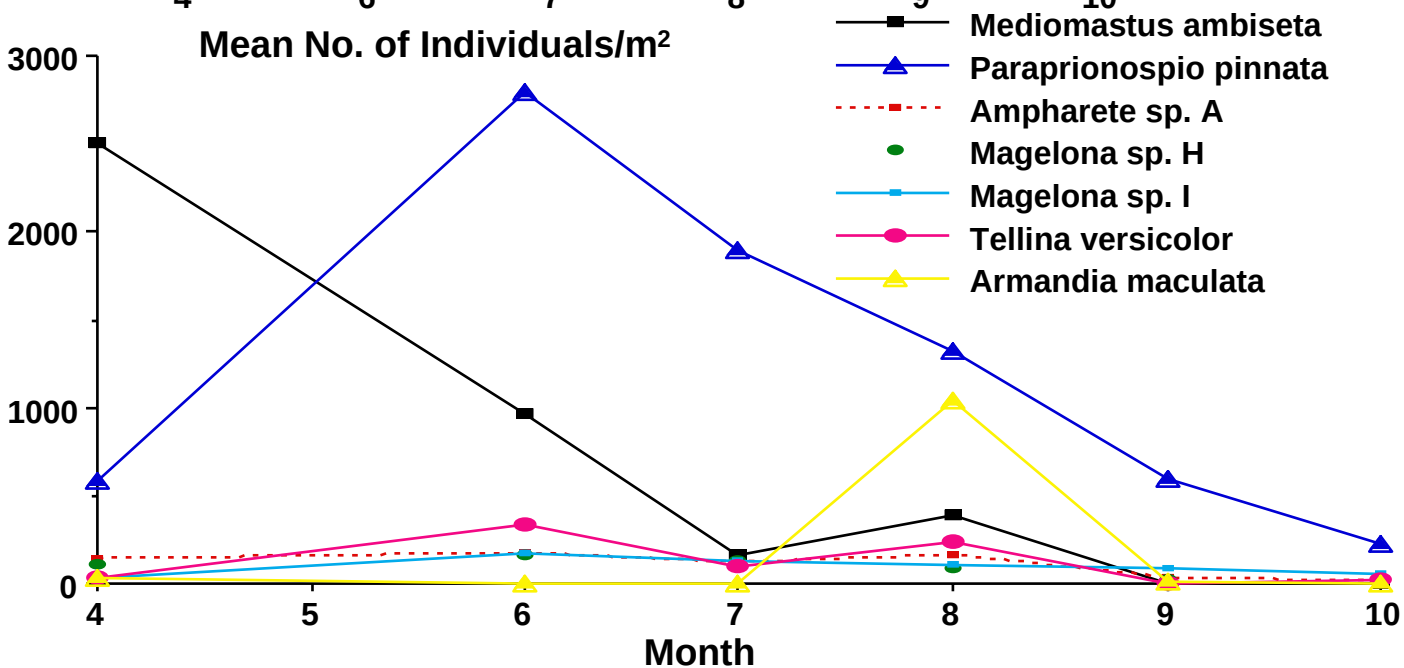


(Rabalais et al., 2001)

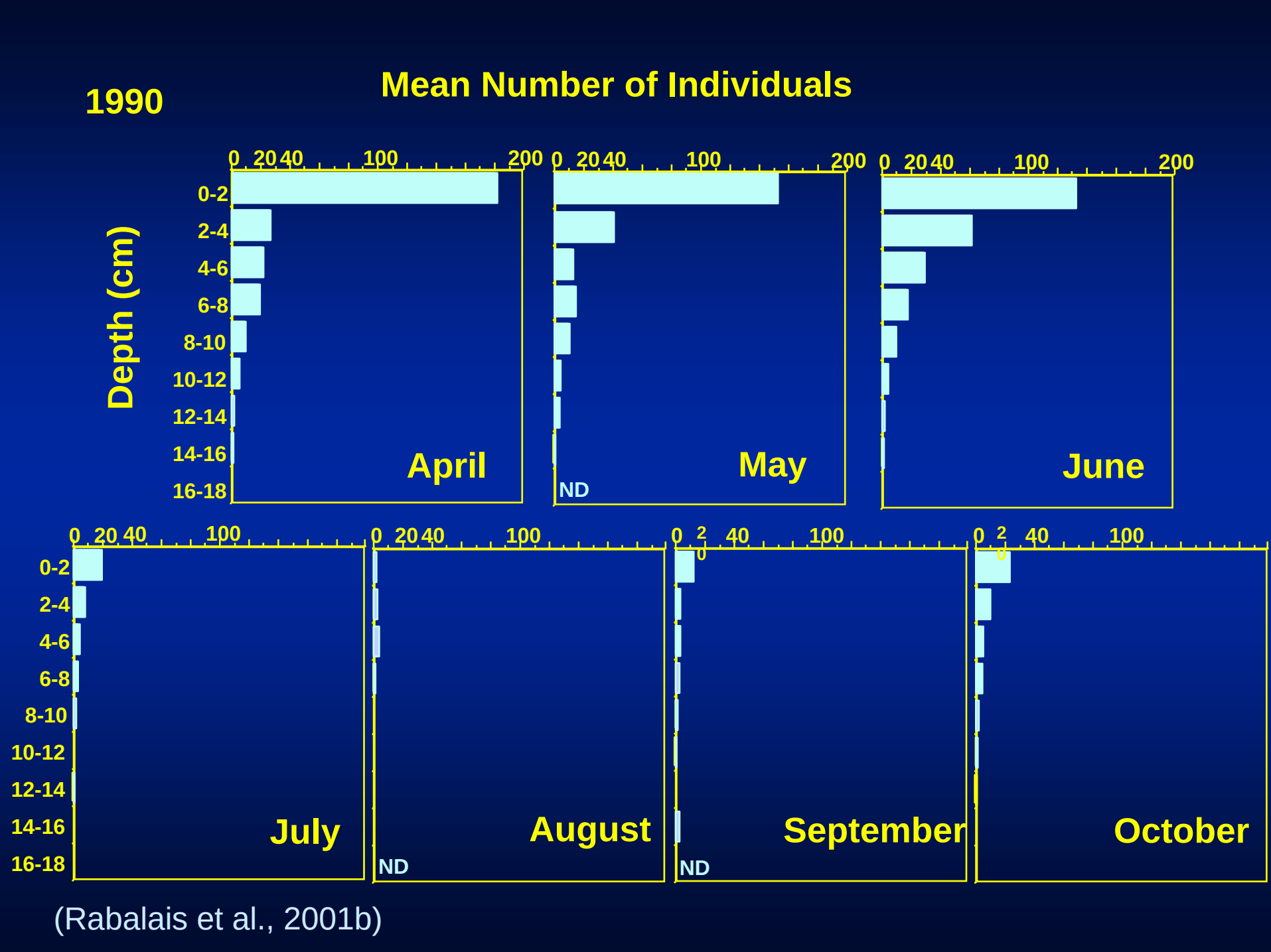
Intermittent Hypoxia 1990, WD32





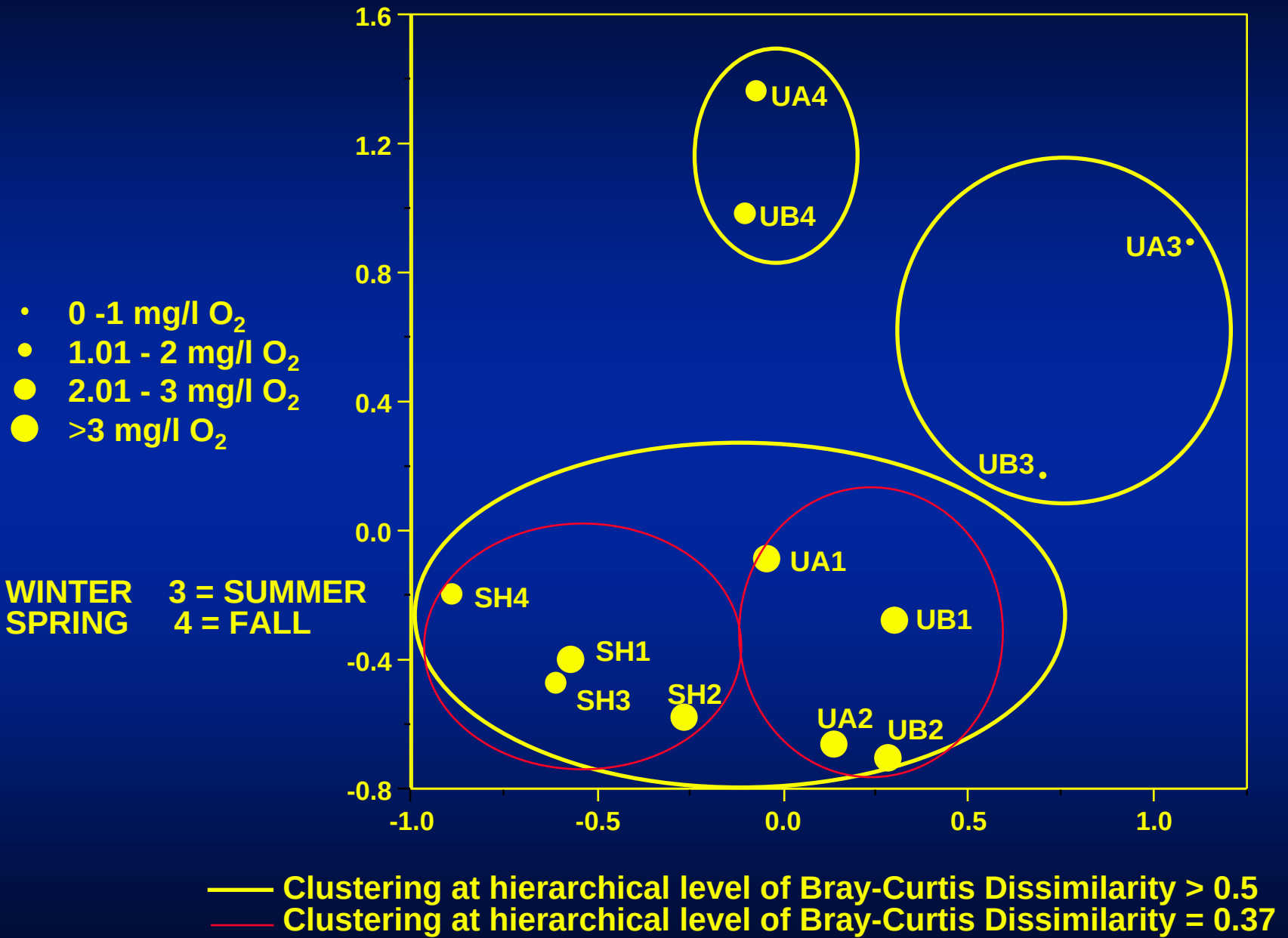


(Rabalais et al., 2001b)



(Rabalais et al., 2001b)

Results of the nonlinear multidimensional scaling analysis on matrix 'SEASON' with superimposed bottom dissolved oxygen (mg/l).



(Rabalais et al., 2001b)

Comparison of benthic communities from hypoxia-affected environments

Dauer et al. (1992)	Chesapeake Mainstem		Tributaries	
	Polyhaline	Hypoxic	Mesohaline	Hypoxic
Density (no. m^{-2})	1,978	1,723	3,065	902
Biomass (g AFDW m^{-2})	9.9	1.7	2.5	1.1
Species (no. $sample^{-1}$)	10.3	6.0	8.8	4.3

Rabalais et al. (1993)	Louisiana Shelf Periodic Hypoxia	Louisiana Shelf Seasonally Severe Hypoxia	
	Spring	Spring	Hypoxic
	April 1990	April 1990	Jul-Aug 1990
Density (no. m^{-2})	8,637	18,437	730
Biomass (g AFDW m^{-2})	2.59	2.92	0.23
Biomass (g C m^{-2})	1.30	1.46	0.10
Species (no. $sample^{-1}$)	22.1	51.4	3.6
	Feb-May 1991	Feb-May 1991	Jul-Aug 1991
Density (no. m^{-2})	2,873	6,486	1,346
Biomass (g AFDW m^{-2})	0.93	1.55	0.46
Biomass (g C m^{-2})	0.46	0.77	0.23
Species (no. $sample^{-1}$)	16.2	21.5	8.1

(Rabalais et al., 2001b)

Effects of Hypoxic/Anoxic Events on Meiofaunal Communities
Mean Density (Ind. 10 cm^{-2})

						Prior hypoxia	During hypoxia
Devils Hole (Bermuda)[a]	27	mud	0.0 – 0.6	3 mo	Total	1,500 – 2,680	0
Gulf of Mexico (USA)[b]	8-13	mud	< 2	5 mo	Total	~ 800 – 3,800	~ 500 – 1,100
					Nematoda	~ 600 – 3,100	~ 500 – 1,100
					Copepoda	~ 100 – 410	~ 0 – 20
					Kinorhyncha	~ 150 – 220	~ 10 – 110
Gullmar Fjord (Sweden)[c]	10	mud	0.3	2 mo	Nematoda	8,900 – 10,200	1,300 – 1,700
						After hypoxia	During hypoxia
Gulf of Mexico (USA)[d]	18	mud	0.0	> 3 mo	Nematoda	392	50 – 117
					Copepoda	26	0

[a]Coull [1969]

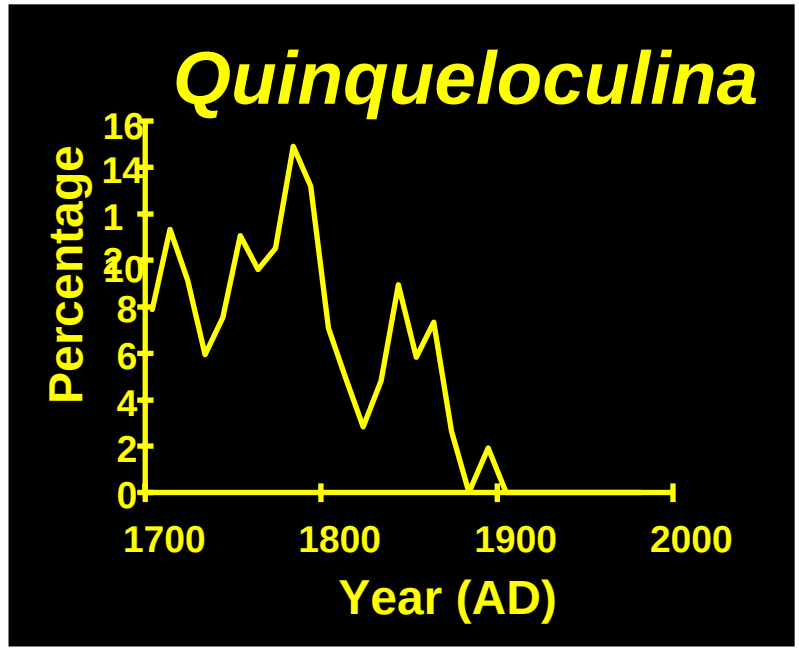
[b]Murrell and Fleeger [1989]

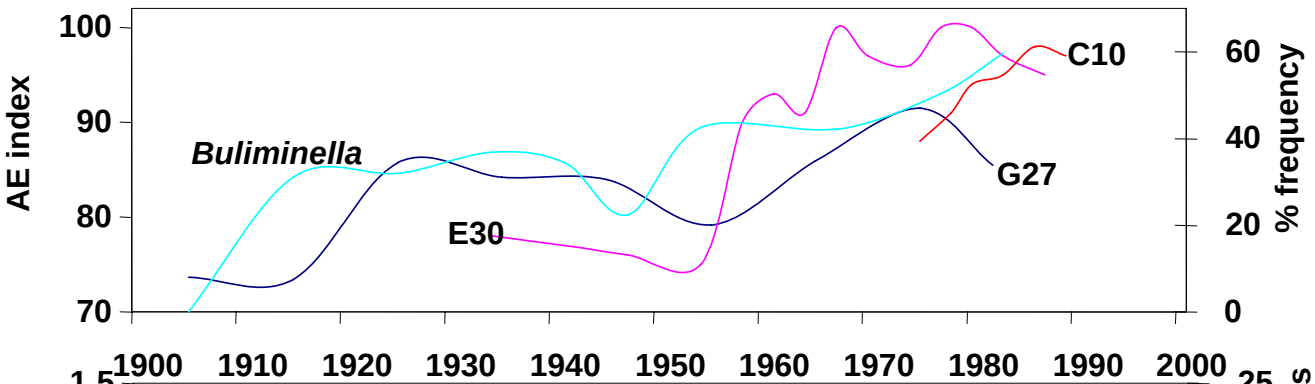
[c]Hendelberg and Jensen [1993]

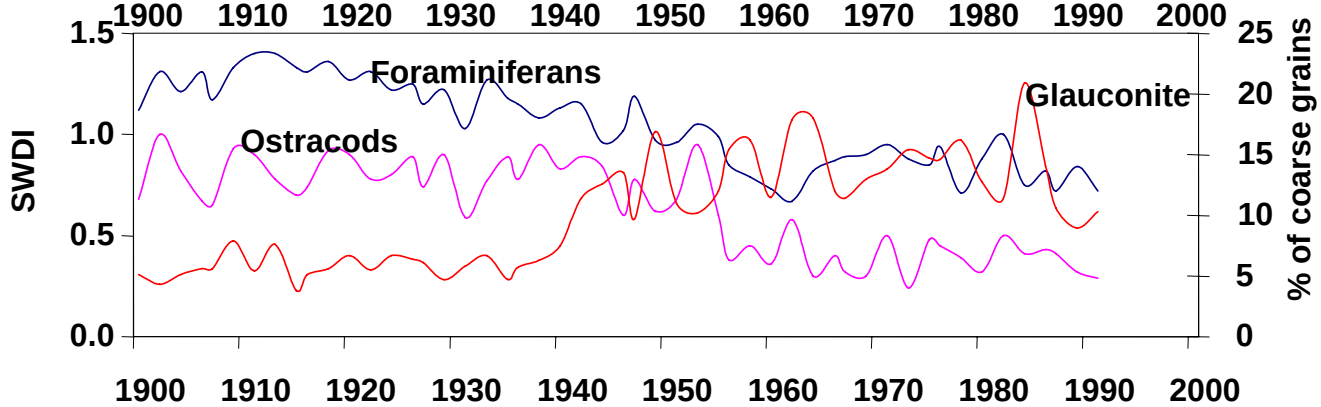
[d]Wetzel et al. [2001]

(Modified from Wetzel et al. 2001)

Benthic Foraminiferans







Hypoxia Index ↑

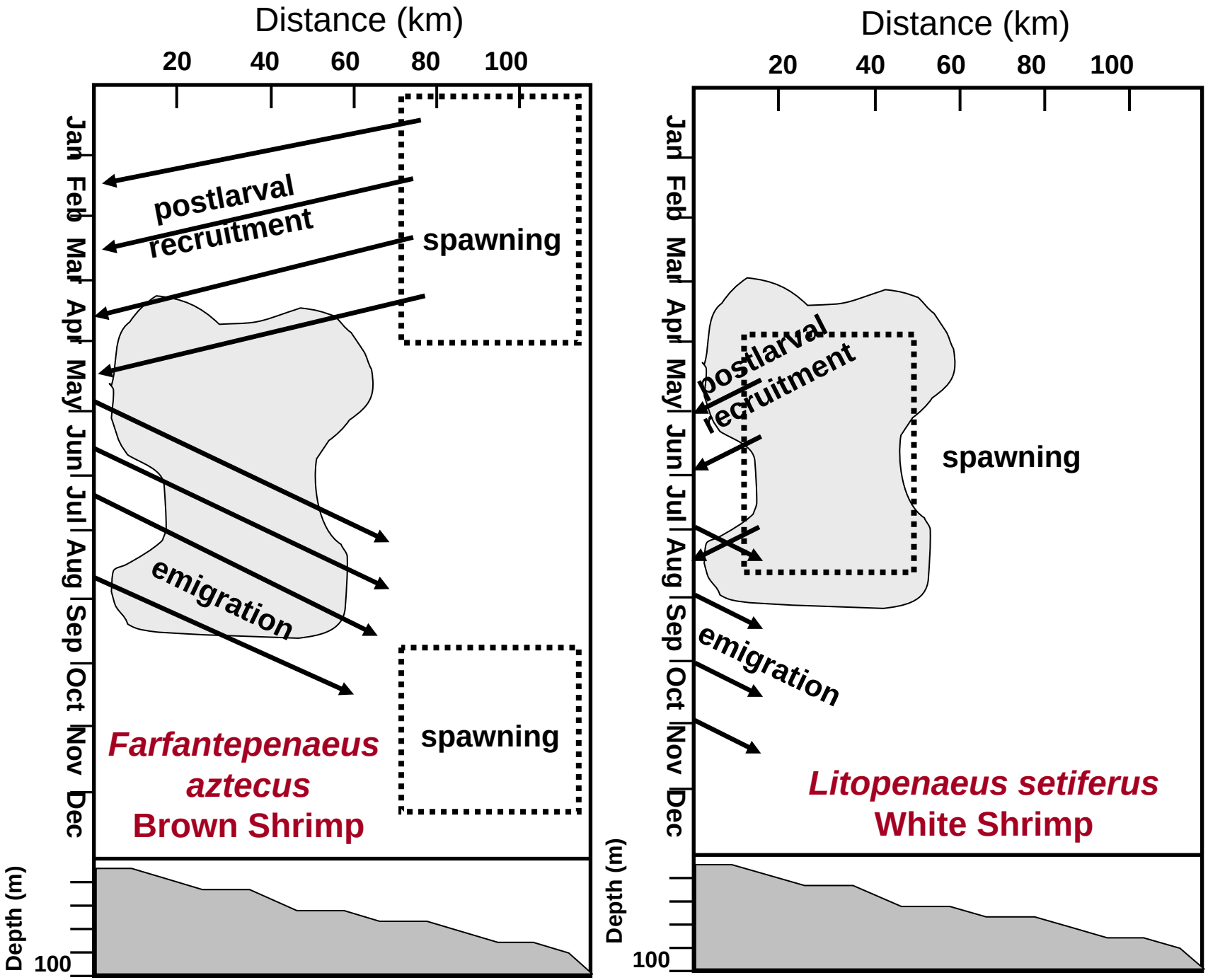
Reducing Envt. ↑
Benthic Diversity ↓

(Sen Gupta et al. 1996,
Rabalais et al. 1996, 2002)

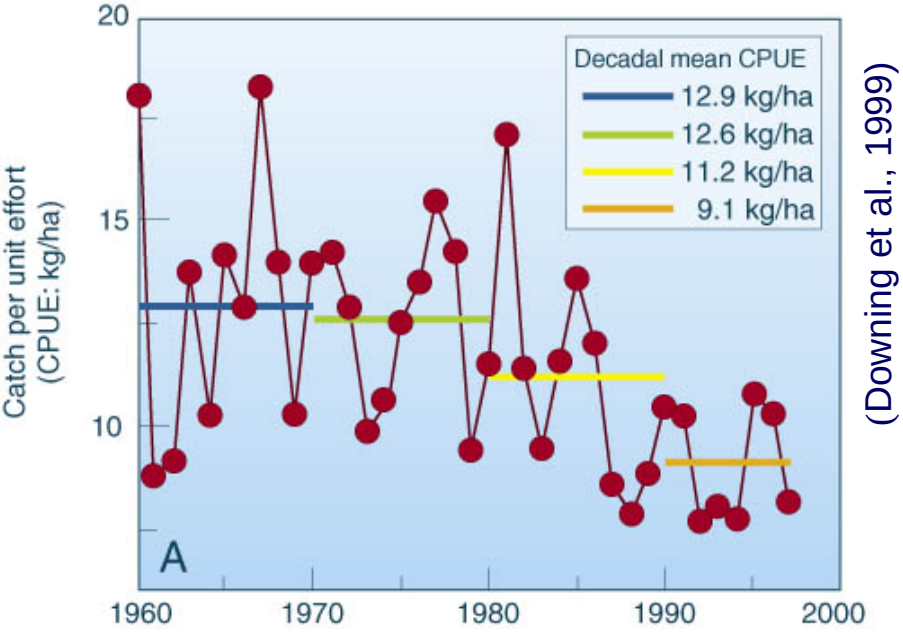
Characteristics of Louisiana Shelf Benthos Subjected to Seasonally Severe Hypoxia

- Reduced species richness
- Severely reduced abundances (but never azoic)
- Low biomass
- Limited taxa (none with direct development)
- Characteristic resistant infauna (e.g., a few polychaetes and sipunculans)
- Limited recovery following abatement of oxygen stress

(Rabalais et al., 2001b)



(source: N. Rabalais, LUMCON)



(Downing et al., 1999)

River discharge ↑
Salinity in nursery area ↓
Preferable nursery habitat for brown shrimp ↓
More hypoxia ↑
Suitable habitat for brown shrimp offshore ↓

…and the ultimate predator

River discharge ↓
Salinity in nursery area ↑
Preferable nursery habitat for brown shrimp ↑
Less hypoxia ↓
Suitable habitat for brown shrimp offshore ↑

Source: N. N. Rabalais, LUMCON

2º Production in Benthos Implications for Fisheries

- **Temporally & spatially enhanced**
- **Enhanced predation**
  - **Marginally**
  - **As stress increases**
- **High post-hypoxia recruitment**
- **High turnover rates & ultimately higher production**
- **Higher yield**

- **Prolonged, severe faunal depression, large areas**
- **Predators excluded**
  - **Stressed fauna intact**
  - **Suitable habitat absent**
- **Low post-hypoxia recruitment**
- **Turnover rates similar, biomass less, overall production lower**
- **Lower yield**

(potential dichotomy, N. N. Rabalais)

(Modified from Caddy, 1993)