Benthos and Water Clarity

Roberto J. Llansó [1], Daniel M. Dauer [2], Mike F. Lane [2]

1 - Versar, Inc., Columbia, Maryland 21045

2– Department of Biological Sciences, Old Dominion University, Norfolk, Virginia 23529

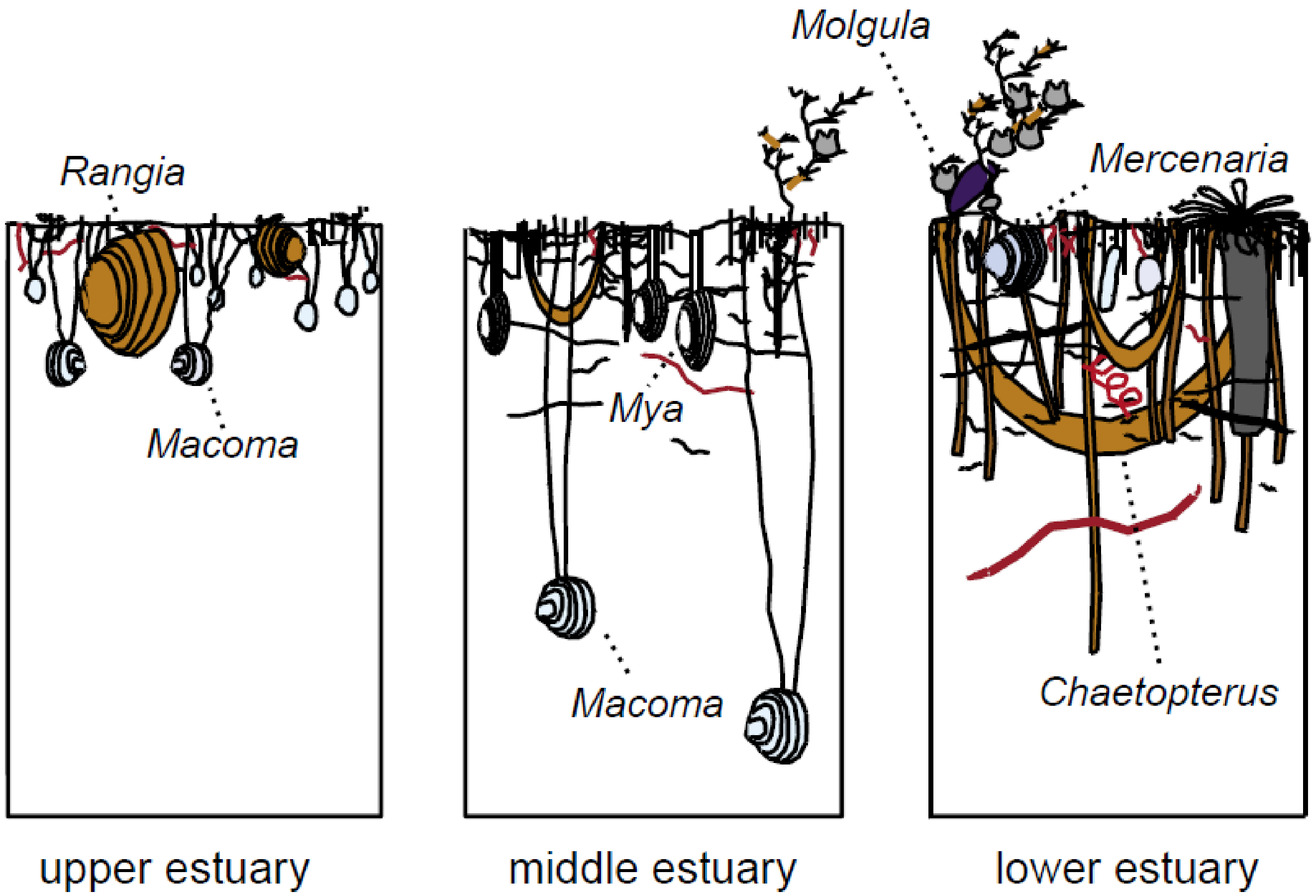
OLD DOMINION UNIVERSITY

Chesapeake Bay Benthic Monitoring Program

VERSAR

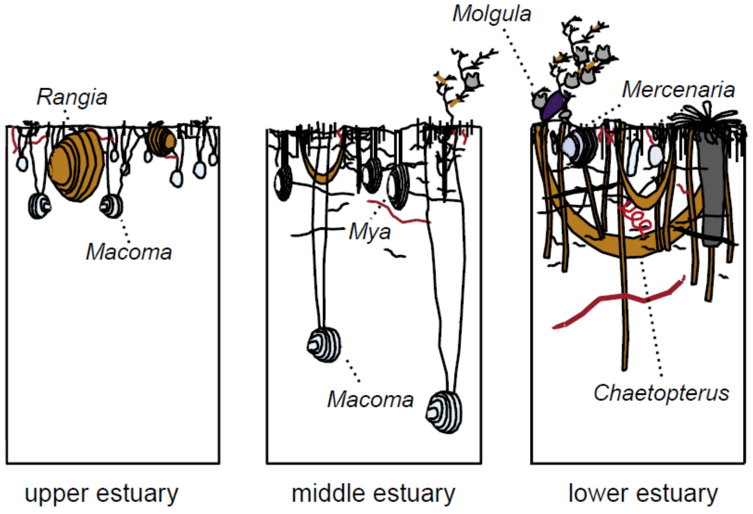
Benthic processes – water clarity

1. Role of suspension feeders (oto)
    - Epifaunal suspension feeders
    - Infaunal suspension feeders
2. For infaunal bivalves – water depth and depth in sediment
3. Sediment stabilizers versus destabilizers

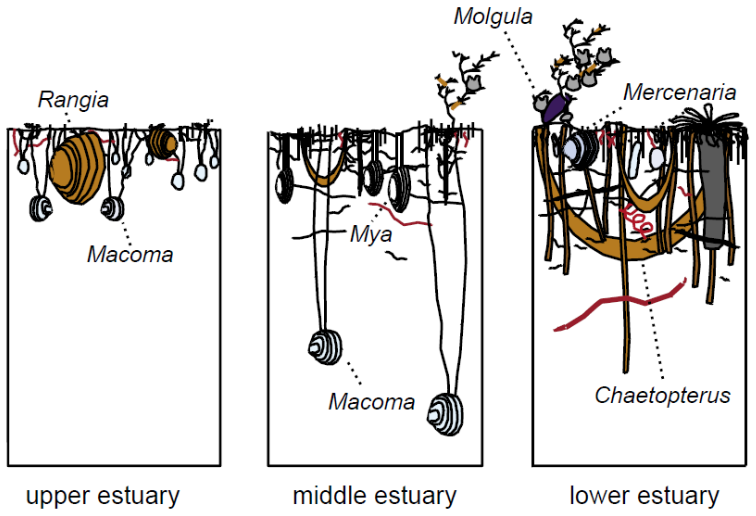


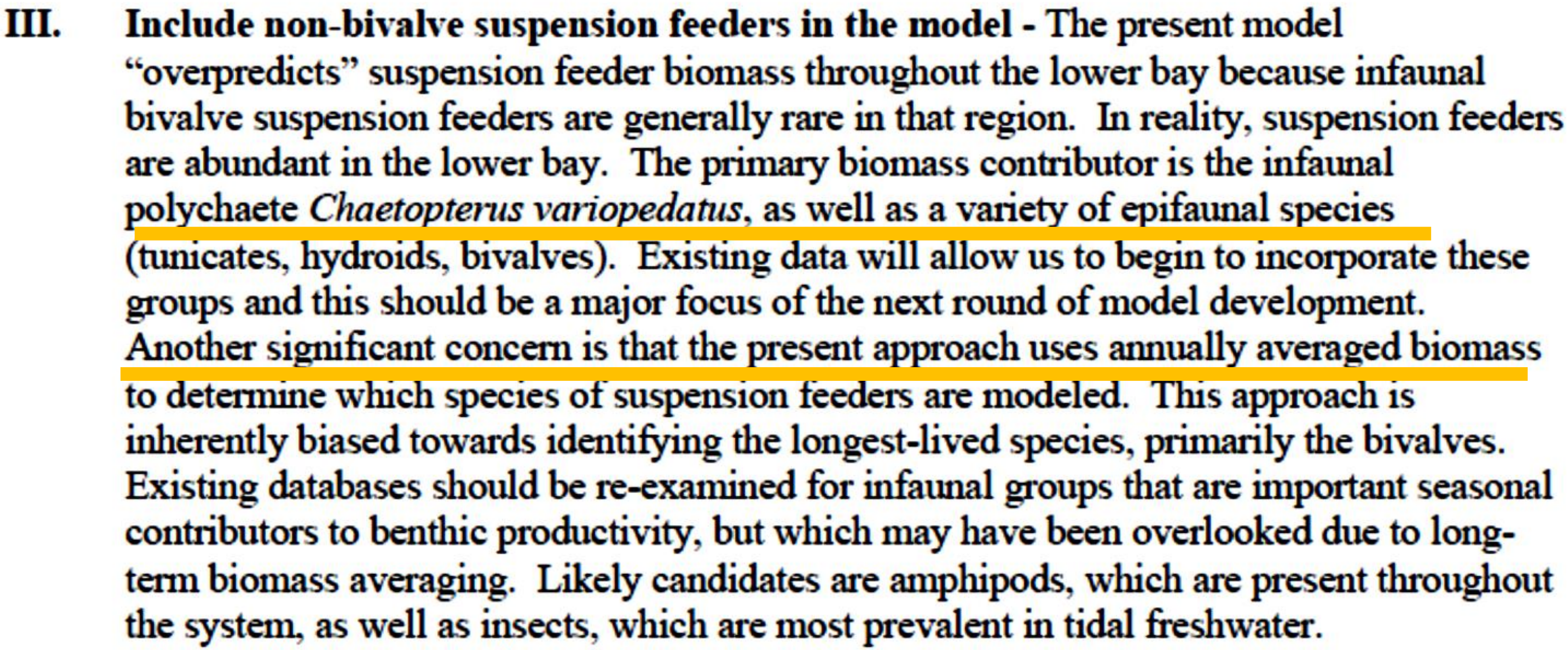
A Report from the
Benthic Process Model Review Team

Linda C. Schaffner, Carl T. Friedrichs and Dan M. Dauer

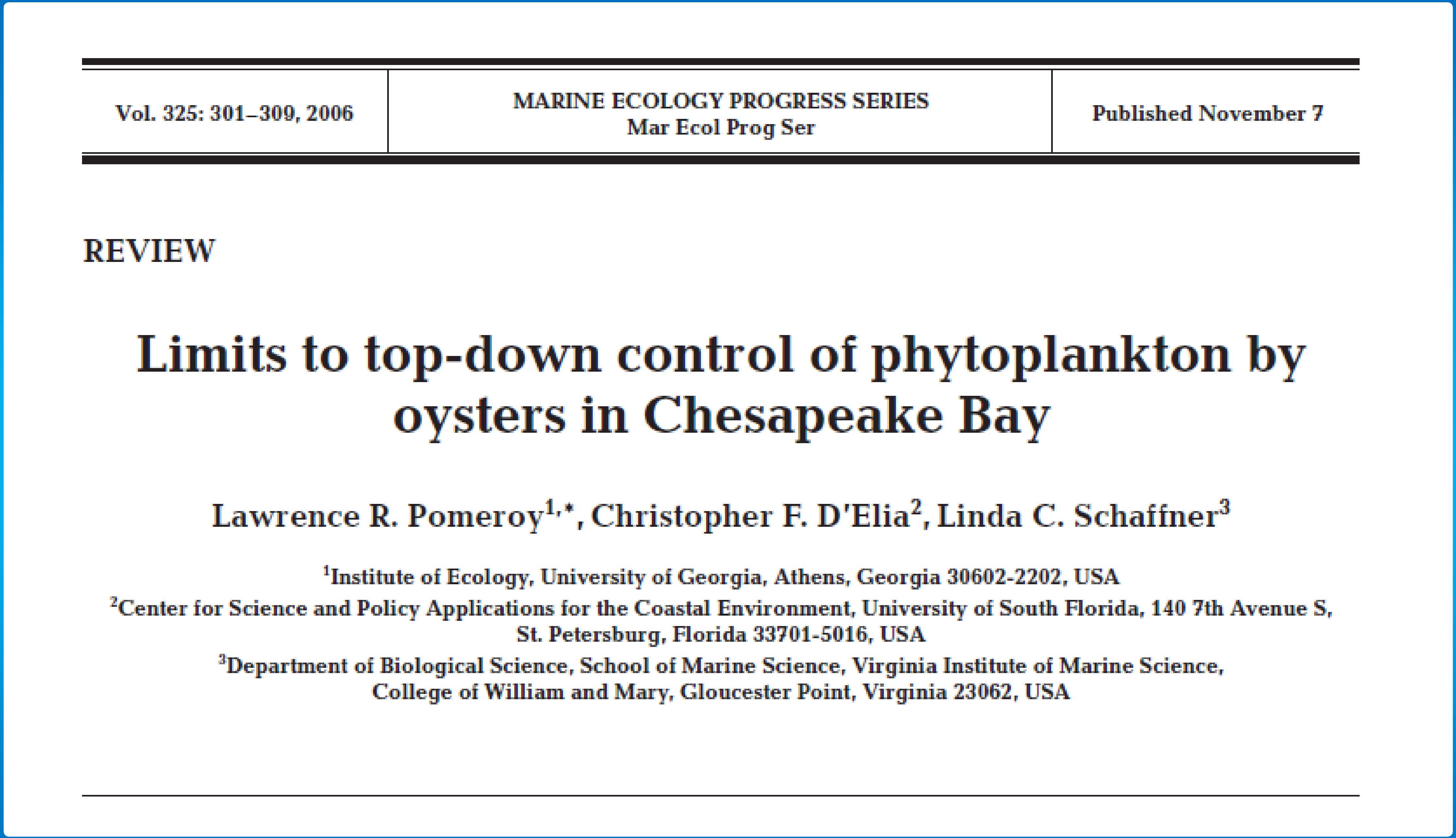


III. **Include non-bivalve suspension feeders in the model -** The present model "overpredicts" suspension feeder biomass throughout the lower bay because infaunal bivalve suspension feeders are generally rare in that region. In reality, suspension feeders are abundant in the lower bay. The primary biomass contributor is the infaunal polychaete *Chaetopterus variopedatus*, as well as a variety of epifaunal species (tunicates, hydroids, bivalves). Existing data will allow us to begin to incorporate these groups and this should be a major focus of the next round of model development. Another significant concern is that the present approach uses annually averaged biomass to determine which species of suspension feeders are modeled. This approach is inherently biased towards identifying the longest-lived species, primarily the bivalves. Existing databases should be re-examined for infaunal groups that are important seasonal contributors to benthic productivity, but which may have been overlooked due to long-term biomass averaging. Likely candidates are amphipods, which are present throughout the system, as well as insects, which are most prevalent in tidal freshwater.





III. **Include non-bivalve suspension feeders in the model -** The present model "overpredicts" suspension feeder biomass throughout the lower bay because infaunal bivalve suspension feeders are generally rare in that region. In reality, suspension feeders are abundant in the lower bay. The primary biomass contributor is the infaunal polychaete *Chaetopterus variopedatus*, as well as a variety of epifaunal species (tunicates, hydroids, bivalves). Existing data will allow us to begin to incorporate these groups and this should be a major focus of the next round of model development. Another significant concern is that the present approach uses annually averaged biomass to determine which species of suspension feeders are modeled. This approach is inherently biased towards identifying the longest-lived species, primarily the bivalves. Existing databases should be re-examined for infaunal groups that are important seasonal contributors to benthic productivity, but which may have been overlooked due to long-term biomass averaging. Likely candidates are amphipods, which are present throughout the system, as well as insects, which are most prevalent in tidal freshwater.



Vol. 325: 301–309, 2006
MARINE ECOLOGY PROGRESS SERIES
Mar Ecol Prog Ser
Published November 7

REVIEW

Limits to top-down control of phytoplankton by oysters in Chesapeake Bay

Lawrence R. Pomeroy[1,*], Christopher F. D'Elia[2], Linda C. Schaffner[3]

[1]Institute of Ecology, University of Georgia, Athens, Georgia 30602-2202, USA
[2]Center for Science and Policy Applications for the Coastal Environment, University of South Florida, 140 7th Avenue S,
St. Petersburg, Florida 33701-5016, USA
[3]Department of Biological Science, School of Marine Science, Virginia Institute of Marine Science,
College of William and Mary, Gloucester Point, Virginia 23062, USA

Limits to top-down control of phytoplankton by oysters in Chesapeake Bay

Lawrence R. Pomeroy[1,*], Christopher F. D'Elia[2], Linda C. Schaffner[3]

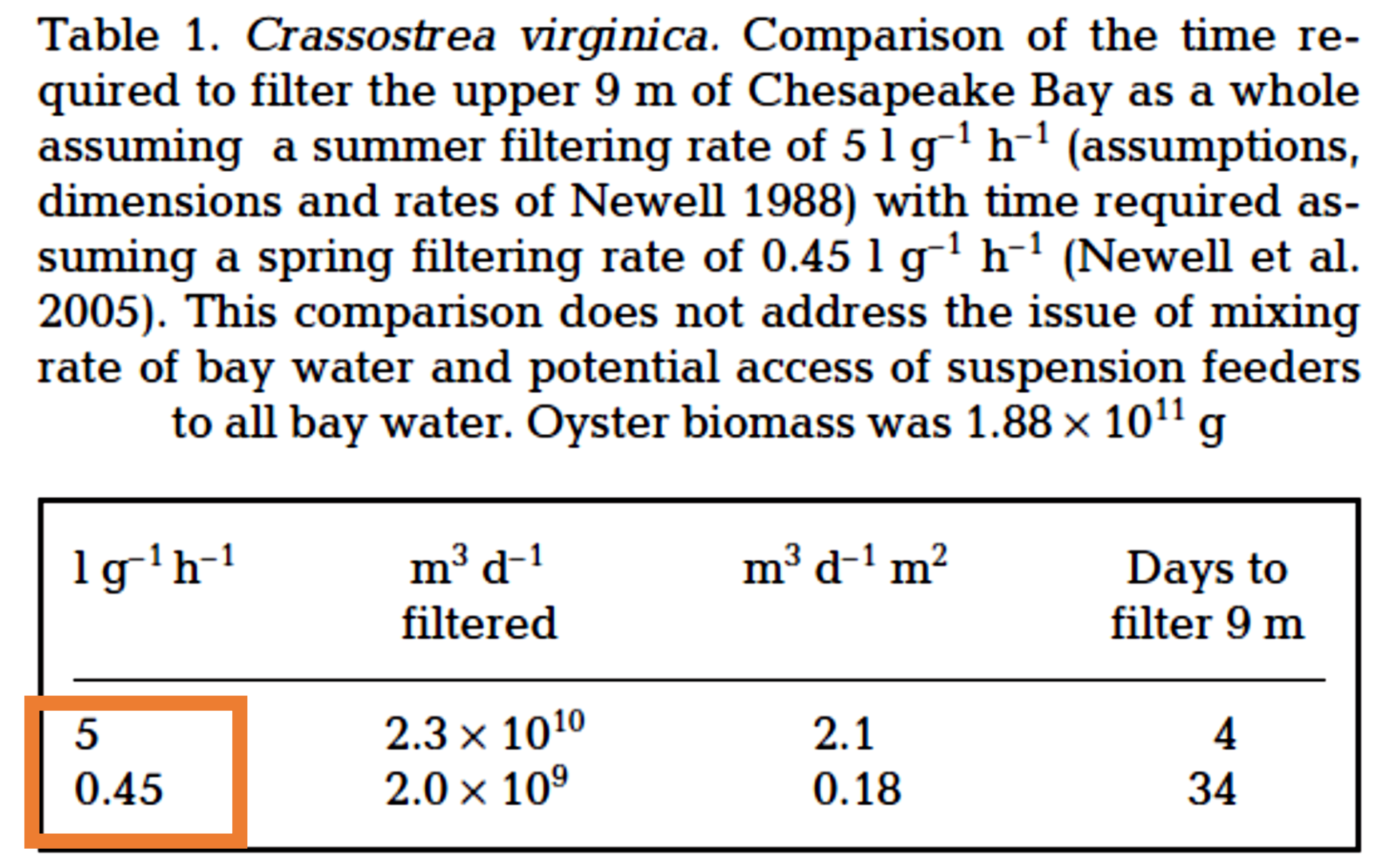
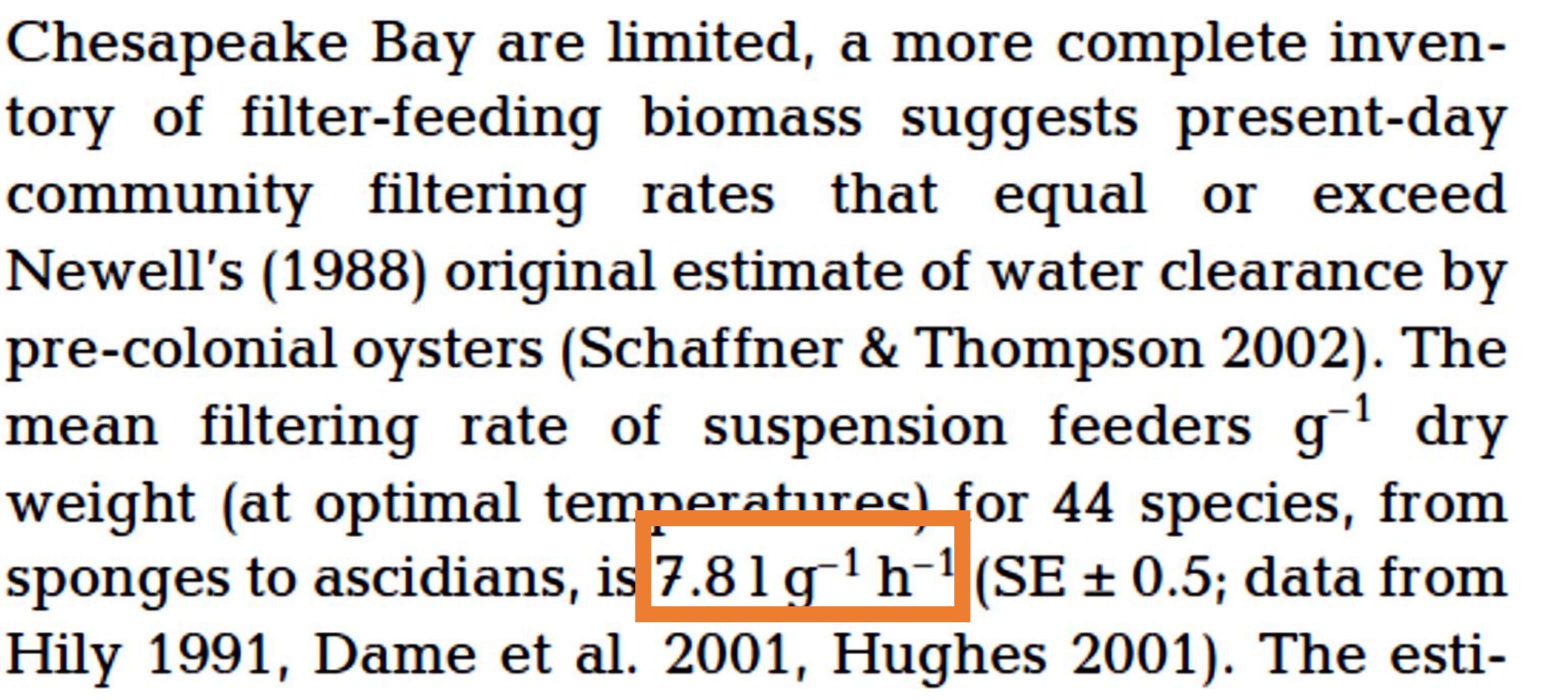


Table 1. *Crassostrea virginica*. Comparison of the time required to filter the upper 9 m of Chesapeake Bay as a whole assuming a summer filtering rate of 5 l g^{-1} h^{-1} (assumptions, dimensions and rates of Newell 1988) with time required assuming a spring filtering rate of 0.45 l g^{-1} h^{-1} (Newell et al. 2005). This comparison does not address the issue of mixing rate of bay water and potential access of suspension feeders to all bay water. Oyster biomass was 1.88×10^{11} g

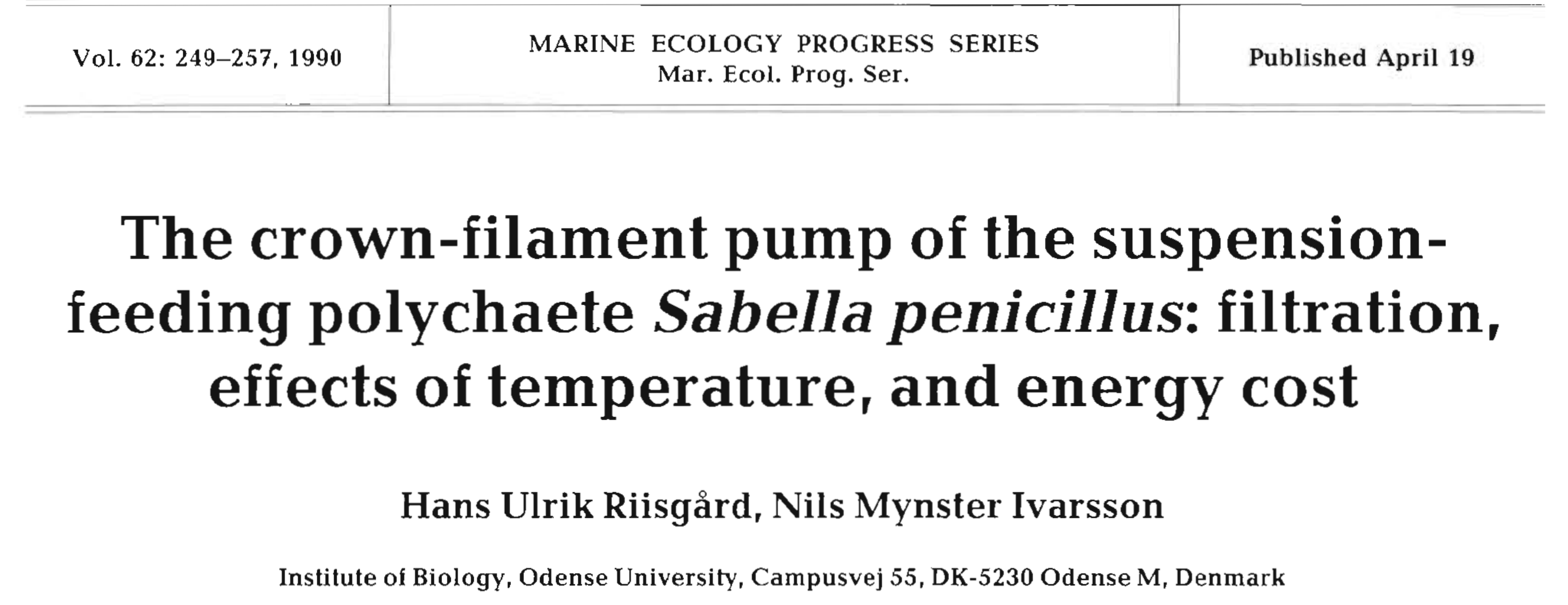
l g^{-1} h^{-1}	m^3 d^{-1} filtered	m^3 d^{-1} m^2	Days to filter 9 m
5	2.3×10^{10}	2.1	4
0.45	2.0×10^{9}	0.18	34

Limits to top-down control of phytoplankton by oysters in Chesapeake Bay

Lawrence R. Pomeroy[1,*], Christopher F. D'Elia[2], Linda C. Schaffner[3]



Chesapeake Bay are limited, a more complete inventory of filter-feeding biomass suggests present-day community filtering rates that equal or exceed Newell's (1988) original estimate of water clearance by pre-colonial oysters (Schaffner & Thompson 2002). The mean filtering rate of suspension feeders g^{-1} dry weight (at optimal temperatures) for 44 species, from sponges to ascidians, is 7.8 l g^{-1} h^{-1} (SE ± 0.5; data from Hily 1991, Dame et al. 2001, Hughes 2001). The esti-



Vol. 62: 249–257, 1990 | MARINE ECOLOGY PROGRESS SERIES
Mar. Ecol. Prog. Ser. | Published April 19

The crown-filament pump of the suspension-feeding polychaete *Sabella penicillus*: filtration, effects of temperature, and energy cost

Hans Ulrik Riisgård, Nils Mynster Ivarsson

Institute of Biology, Odense University, Campusvej 55, DK-5230 Odense M, Denmark

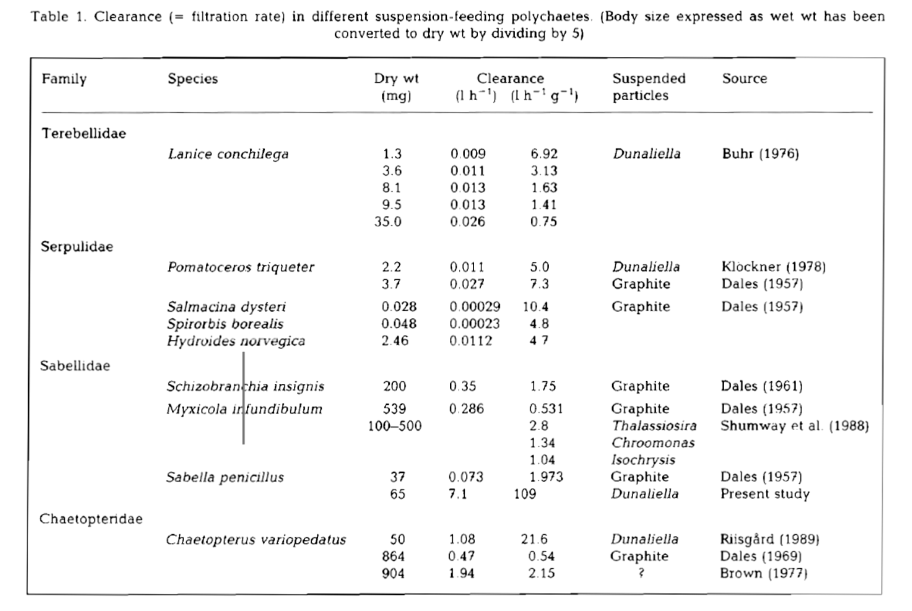


Table 1. Clearance (= filtration rate) in different suspension-feeding polychaetes. (Body size expressed as wet wt has been converted to dry wt by dividing by 5)

Family	Species	Dry wt (mg)	Clearance		Suspended particles	Source
			($l\ h^{-1}$)	($l\ h^{-1}\ g^{-1}$)		
Terebellidae						
	Lanice conchilega	1.3	0.009	6.92	*Dunaliella*	Buhr (1976)
		3.6	0.011	3.13		
		8.1	0.013	1.63		
		9.5	0.013	1.41		
		35.0	0.026	0.75		
Serpulidae						
	Pomatoceros triqueter	2.2	0.011	5.0	*Dunaliella*	Klöckner (1978)
		3.7	0.027	7.3	Graphite	Dales (1957)
	Salmacina dysteri	0.028	0.00029	10.4	Graphite	Dales (1957)
	Spirorbis borealis	0.048	0.00023	4.8		
	Hydroides norvegica	2.46	0.0112	4.7		
Sabellidae						
	Schizobranchia insignis	200	0.35	1.75	Graphite	Dales (1961)
	Myxicola infundibulum	539	0.286	0.531	Graphite	Dales (1957)
		100–500		2.8	*Thalassiosira*	Shumway et al. (1988)
				1.34	*Chroomonas*	
				1.04	*Isochrysis*	
	Sabella penicillus	37	0.073	1.973	Graphite	Dales (1957)
		65	7.1	109	*Dunaliella*	Present study
Chaetopteridae						
	Chaetopterus variopedatus	50	1.08	21.6	*Dunaliella*	Riisgård (1989)
		864	0.47	0.54	Graphite	Dales (1969)
		904	1.94	2.15	?	Brown (1977)

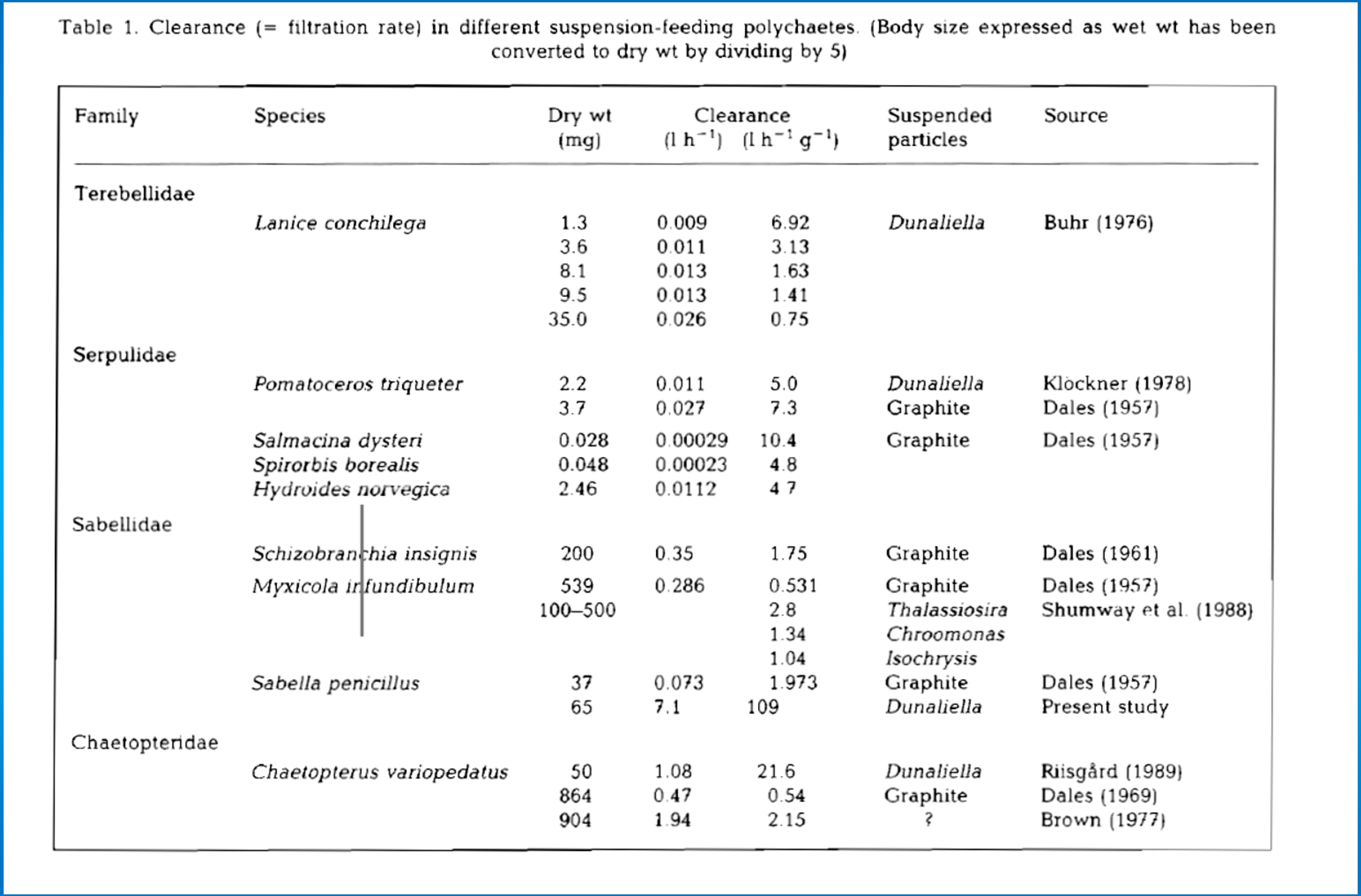


Table 1. Clearance (= filtration rate) in different suspension-feeding polychaetes. (Body size expressed as wet wt has been converted to dry wt by dividing by 5)

Family	Species	Dry wt (mg)	Clearance		Suspended particles	Source
			(l h^{-1})	(l h^{-1} g^{-1})		
Terebellidae						
	Lanice conchilega	1.3	0.009	6.92	*Dunaliella*	Buhr (1976)
		3.6	0.011	3.13		
		8.1	0.013	1.63		
		9.5	0.013	1.41		
		35.0	0.026	0.75		
Serpulidae						
	Pomatoceros triqueter	2.2	0.011	5.0	*Dunaliella*	Klöckner (1978)
		3.7	0.027	7.3	Graphite	Dales (1957)
	Salmacina dysteri	0.028	0.00029	10.4	Graphite	Dales (1957)
	Spirorbis borealis	0.048	0.00023	4.8		
	Hydroides norvegica	2.46	0.0112	4.7		
Sabellidae						
	Schizobranchia insignis	200	0.35	1.75	Graphite	Dales (1961)
	Myxicola infundibulum	539	0.286	0.531	Graphite	Dales (1957)
		100–500		2.8	*Thalassiosira*	Shumway et al. (1988)
				1.34	*Chroomonas*	
				1.04	*Isochrysis*	
	Sabella penicillus	37	0.073	1.973	Graphite	Dales (1957)
		65	7.1	109	*Dunaliella*	Present study
Chaetopteridae						
	Chaetopterus variopedatus	50	1.08	21.6	*Dunaliella*	Riisgård (1989)
		864	0.47	0.54	Graphite	Dales (1969)
		904	1.94	2.15	?	Brown (1977)

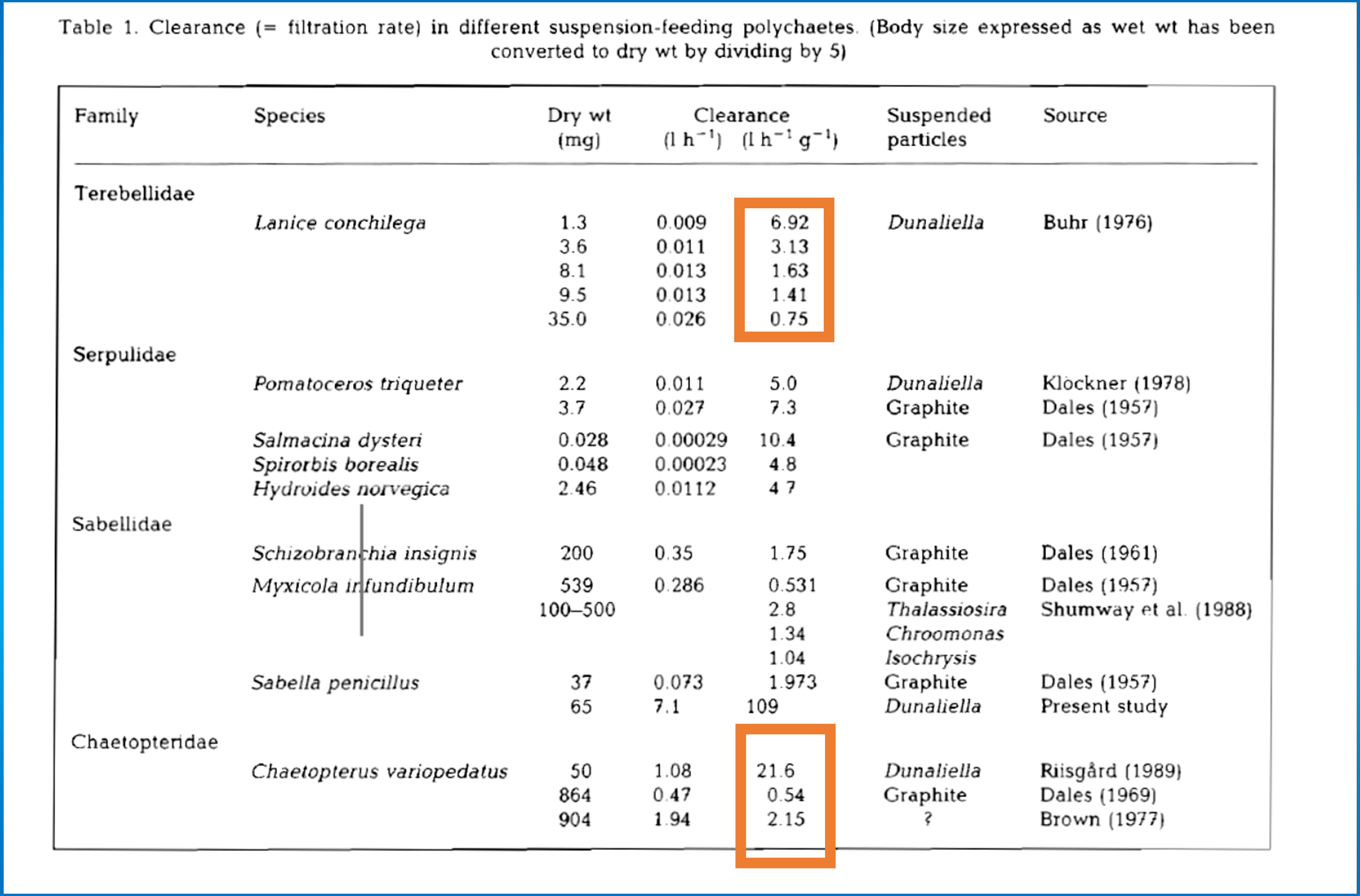
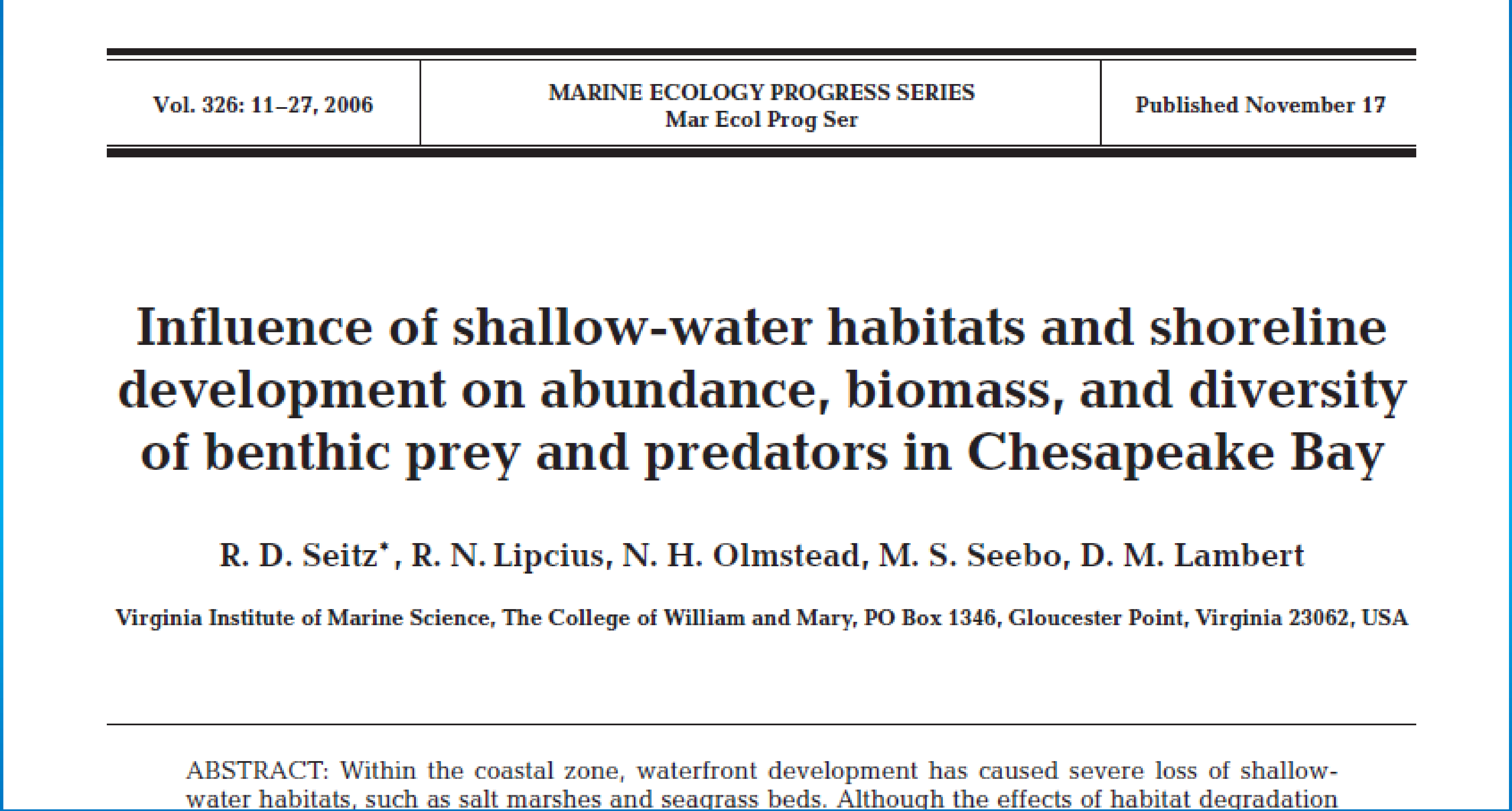


Table 1. Clearance (= filtration rate) in different suspension-feeding polychaetes. (Body size expressed as wet wt has been converted to dry wt by dividing by 5)

Family	Species	Dry wt (mg)	Clearance $(l\ h^{-1})$	Clearance $(l\ h^{-1}\ g^{-1})$	Suspended particles	Source
Terebellidae						
	Lanice conchilega	1.3	0.009	6.92	*Dunaliella*	Buhr (1976)
		3.6	0.011	3.13		
		8.1	0.013	1.63		
		9.5	0.013	1.41		
		35.0	0.026	0.75		
Serpulidae						
	Pomatoceros triqueter	2.2	0.011	5.0	*Dunaliella*	Klöckner (1978)
		3.7	0.027	7.3	Graphite	Dales (1957)
	Salmacina dysteri	0.028	0.00029	10.4	Graphite	Dales (1957)
	Spirorbis borealis	0.048	0.00023	4.8		
	Hydroides norvegica	2.46	0.0112	4.7		
Sabellidae						
	Schizobranchia insignis	200	0.35	1.75	Graphite	Dales (1961)
	Myxicola infundibulum	539	0.286	0.531	Graphite	Dales (1957)
		100–500		2.8	*Thalassiosira*	Shumway et al. (1988)
				1.34	*Chroomonas*	
				1.04	*Isochrysis*	
	Sabella penicillus	37	0.073	1.973	Graphite	Dales (1957)
		65	7.1	109	*Dunaliella*	Present study
Chaetopteridae						
	Chaetopterus variopedatus	50	1.08	21.6	*Dunaliella*	Riisgård (1989)
		864	0.47	0.54	Graphite	Dales (1969)
		904	1.94	2.15	?	Brown (1977)

Benthic processes – water clarity

1. Role of suspension feeders (oto)
    - Epifaunal suspension feeders
    - Infaunal suspension feeders
2. For infaunal bivalves – water depth and depth in sediment
3. Sediment stabilizers versus destabilizers



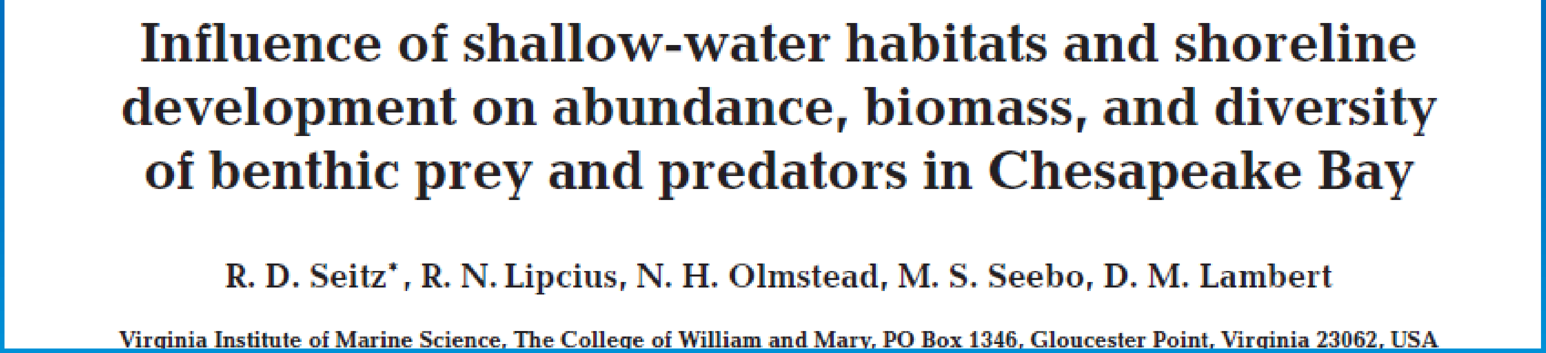
Vol. 326: 11–27, 2006
MARINE ECOLOGY PROGRESS SERIES
Mar Ecol Prog Ser
Published November 17

Influence of shallow-water habitats and shoreline development on abundance, biomass, and diversity of benthic prey and predators in Chesapeake Bay

R. D. Seitz*, R. N. Lipcius, N. H. Olmstead, M. S. Seebo, D. M. Lambert

Virginia Institute of Marine Science, The College of William and Mary, PO Box 1346, Gloucester Point, Virginia 23062, USA

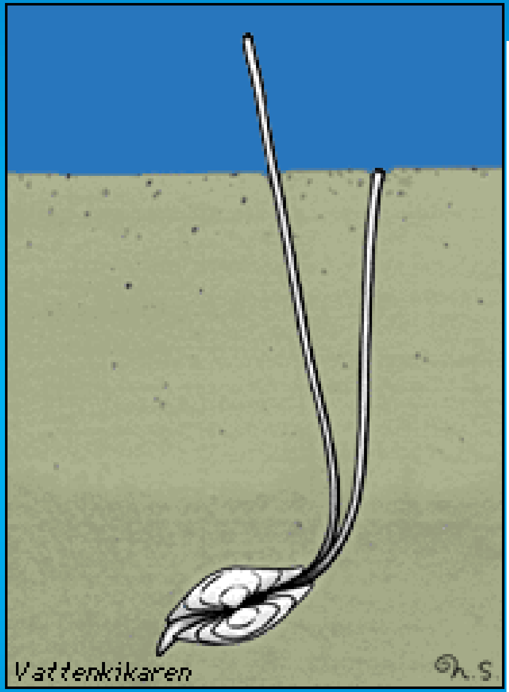
ABSTRACT: Within the coastal zone, waterfront development has caused severe loss of shallow-water habitats, such as salt marshes and seagrass beds. Although the effects of habitat degradation



Influence of shallow-water habitats and shoreline development on abundance, biomass, and diversity of benthic prey and predators in Chesapeake Bay

R. D. Seitz*, R. N. Lipcius, N. H. Olmstead, M. S. Seebo, D. M. Lambert

Virginia Institute of Marine Science, The College of William and Mary, PO Box 1346, Gloucester Point, Virginia 23062, USA



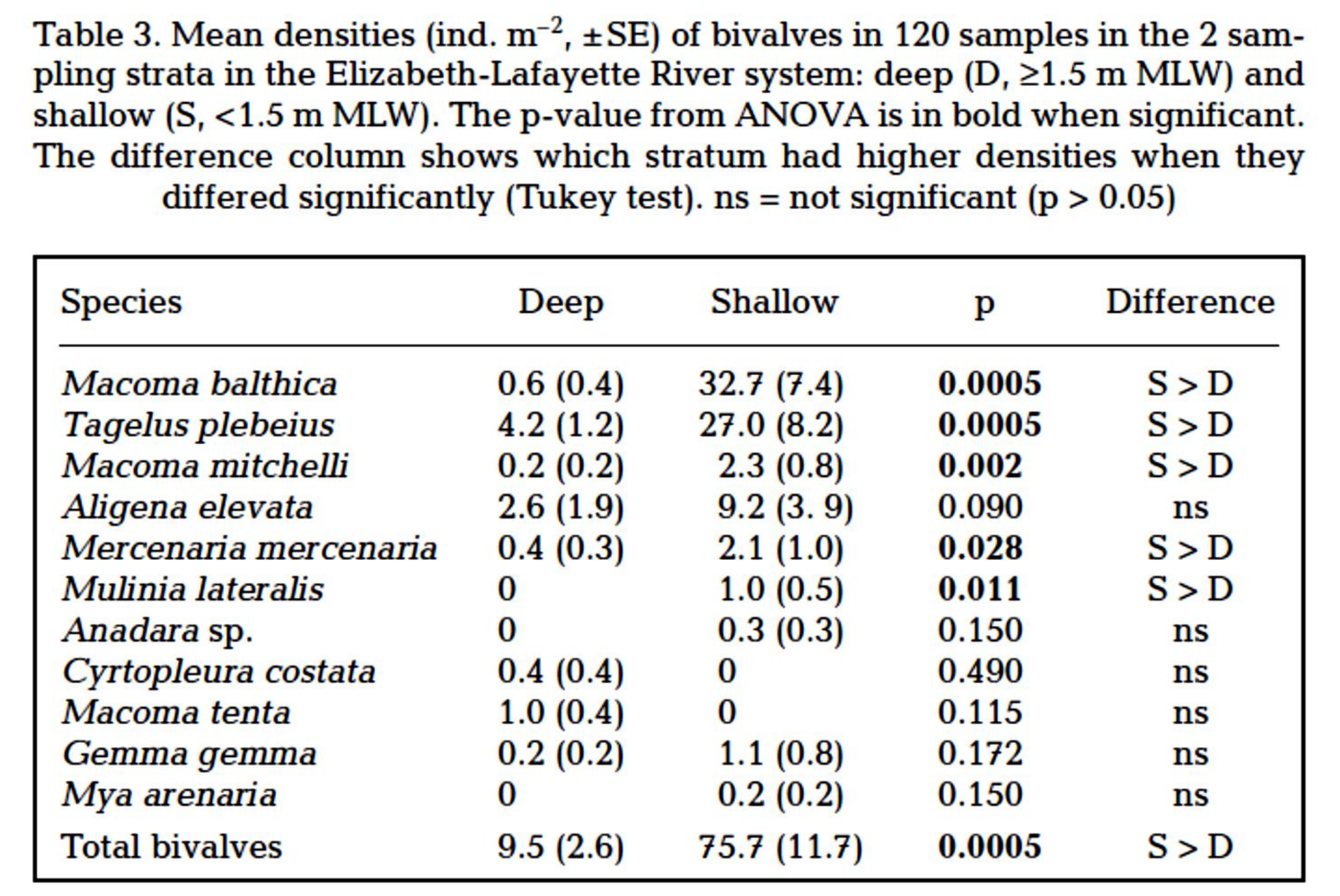
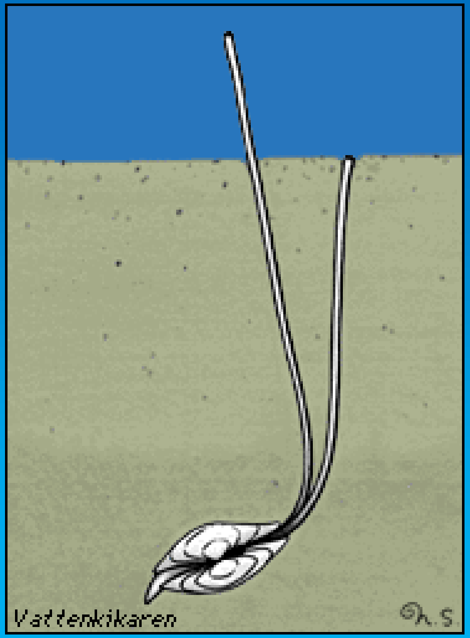
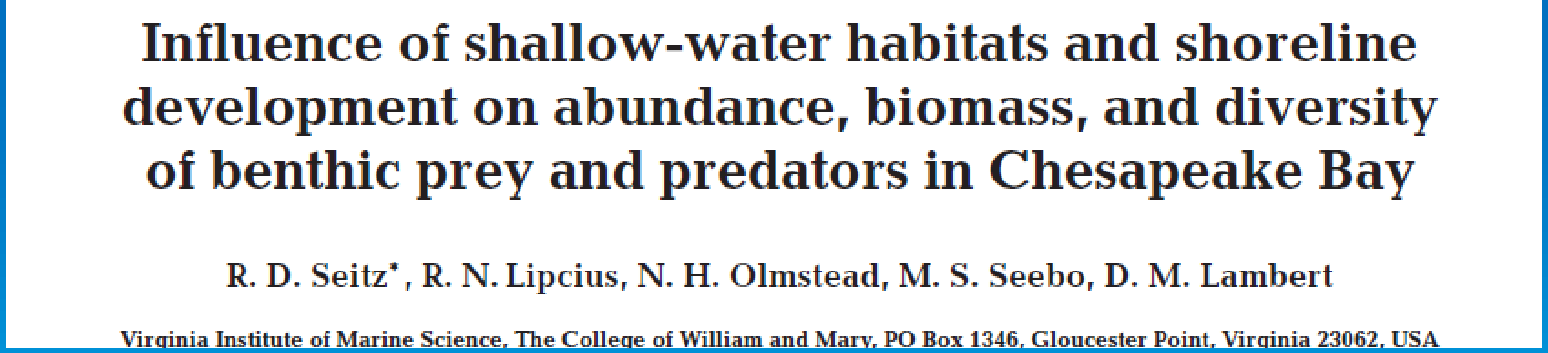


Table 3. Mean densities (ind. m^{-2}, ±SE) of bivalves in 120 samples in the 2 sampling strata in the Elizabeth-Lafayette River system: deep (D, ≥1.5 m MLW) and shallow (S, <1.5 m MLW). The p-value from ANOVA is in bold when significant. The difference column shows which stratum had higher densities when they differed significantly (Tukey test). ns = not significant ($p > 0.05$)

Species	Deep	Shallow	p	Difference
Macoma balthica	0.6 (0.4)	32.7 (7.4)	**0.0005**	S > D
Tagelus plebeius	4.2 (1.2)	27.0 (8.2)	**0.0005**	S > D
Macoma mitchelli	0.2 (0.2)	2.3 (0.8)	**0.002**	S > D
Aligena elevata	2.6 (1.9)	9.2 (3. 9)	0.090	ns
Mercenaria mercenaria	0.4 (0.3)	2.1 (1.0)	**0.028**	S > D
Mulinia lateralis	0	1.0 (0.5)	**0.011**	S > D
Anadara sp.	0	0.3 (0.3)	0.150	ns
Cyrtopleura costata	0.4 (0.4)	0	0.490	ns
Macoma tenta	1.0 (0.4)	0	0.115	ns
Gemma gemma	0.2 (0.2)	1.1 (0.8)	0.172	ns
Mya arenaria	0	0.2 (0.2)	0.150	ns
Total bivalves	9.5 (2.6)	75.7 (11.7)	**0.0005**	S > D





Influence of shallow-water habitats and shoreline development on abundance, biomass, and diversity of benthic prey and predators in Chesapeake Bay

R. D. Seitz*, R. N. Lipcius, N. H. Olmstead, M. S. Seebo, D. M. Lambert

Virginia Institute of Marine Science, The College of William and Mary, PO Box 1346, Gloucester Point, Virginia 23062, USA

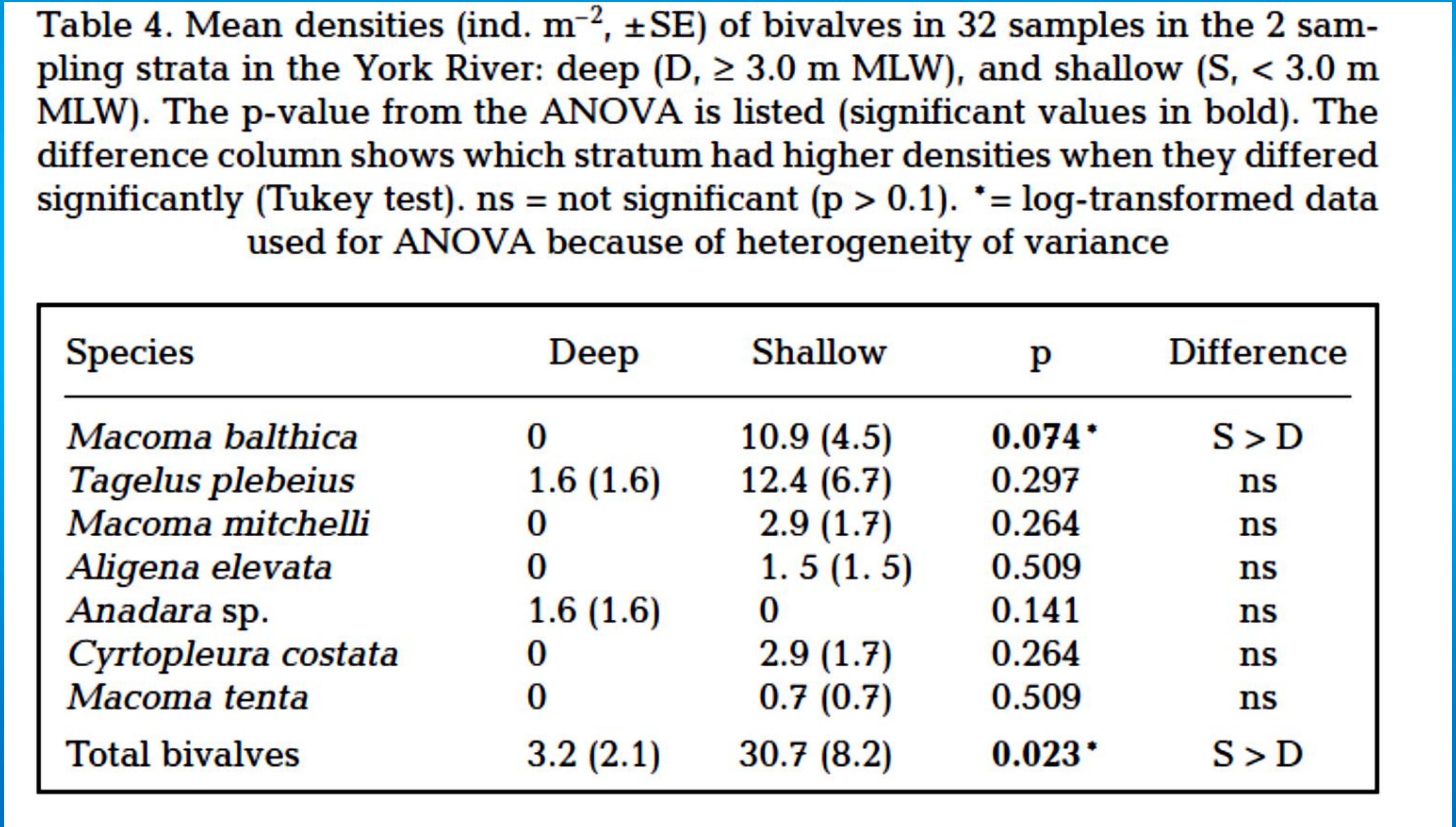
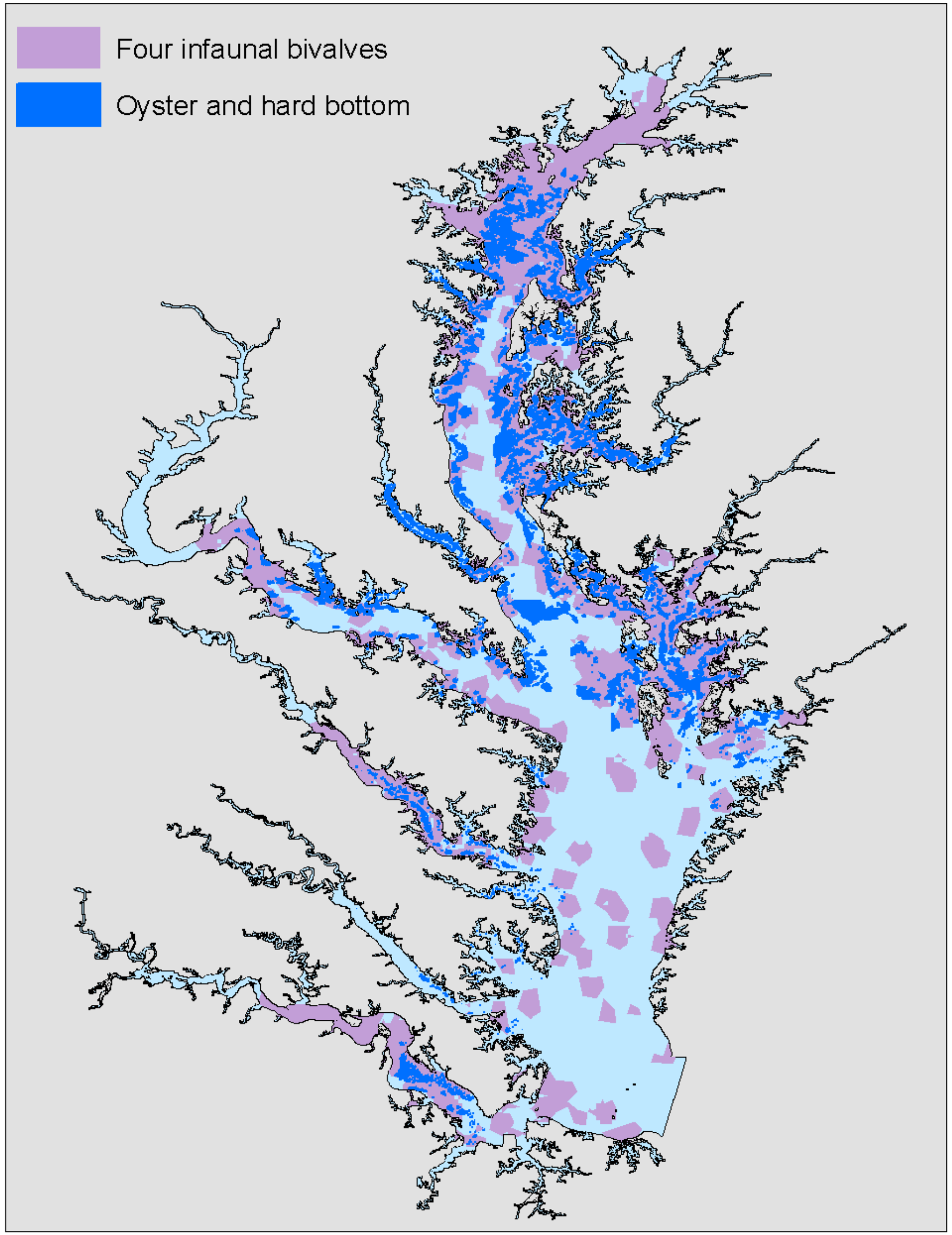
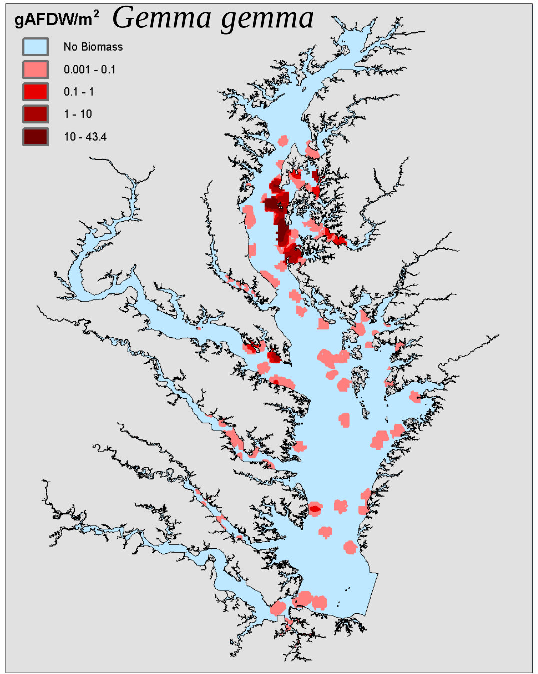


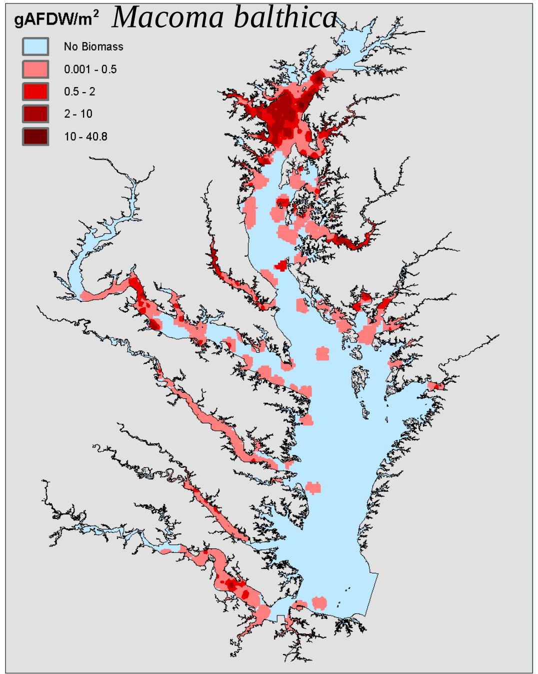
Table 4. Mean densities (ind. m^{-2}, ±SE) of bivalves in 32 samples in the 2 sampling strata in the York River: deep (D, ≥ 3.0 m MLW), and shallow (S, < 3.0 m MLW). The p-value from the ANOVA is listed (significant values in bold). The difference column shows which stratum had higher densities when they differed significantly (Tukey test). ns = not significant ($p > 0.1$). * = log-transformed data used for ANOVA because of heterogeneity of variance

Species	Deep	Shallow	p	Difference
Macoma balthica	0	10.9 (4.5)	**0.074***	S > D
Tagelus plebeius	1.6 (1.6)	12.4 (6.7)	0.297	ns
Macoma mitchelli	0	2.9 (1.7)	0.264	ns
Aligena elevata	0	1. 5 (1. 5)	0.509	ns
Anadara sp.	1.6 (1.6)	0	0.141	ns
Cyrtopleura costata	0	2.9 (1.7)	0.264	ns
Macoma tenta	0	0.7 (0.7)	0.509	ns
Total bivalves	3.2 (2.1)	30.7 (8.2)	**0.023***	S > D

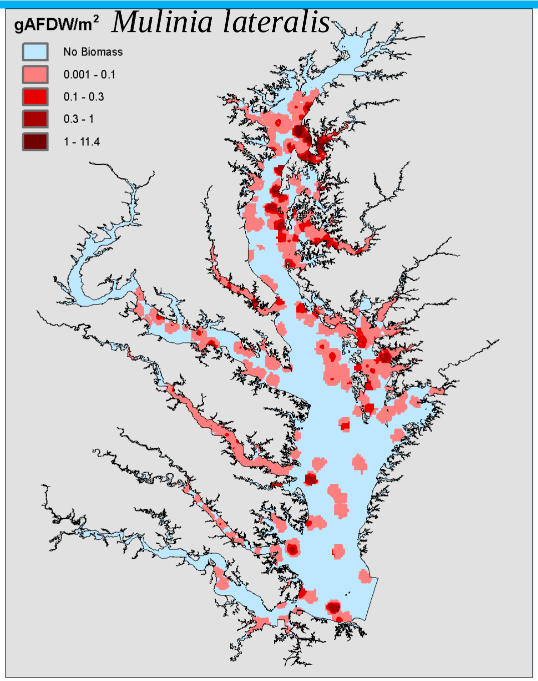

Four infaunal bivalves
Oyster and hard bottom



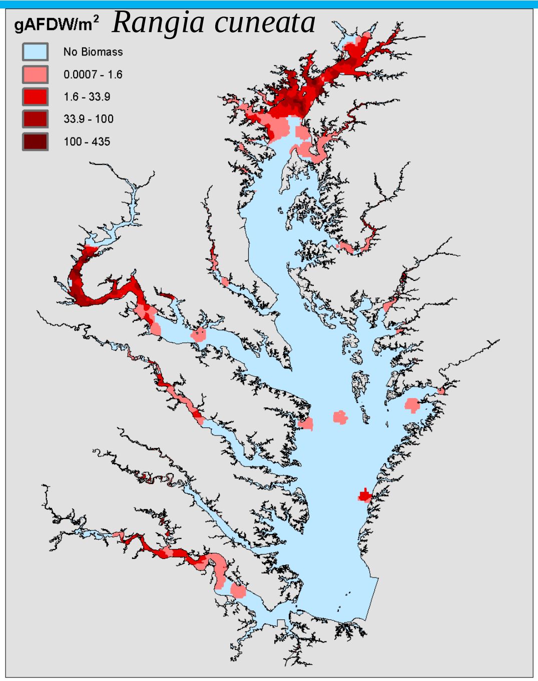
Gemma gemma



Macoma balthica

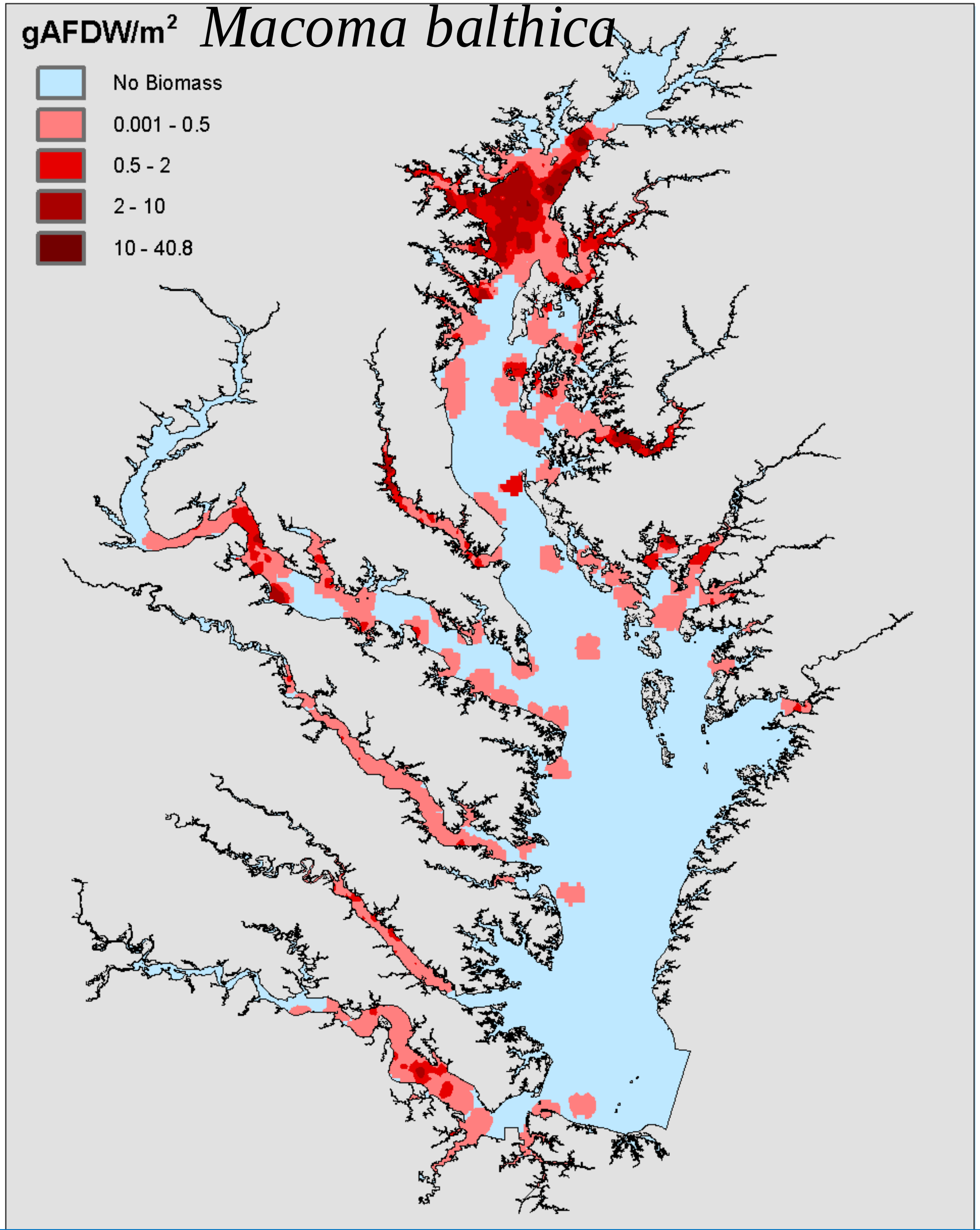


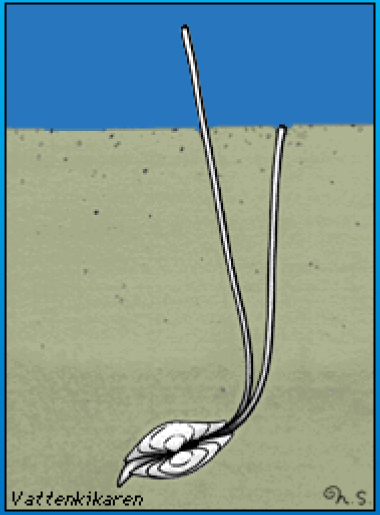
Mulinia lateralis

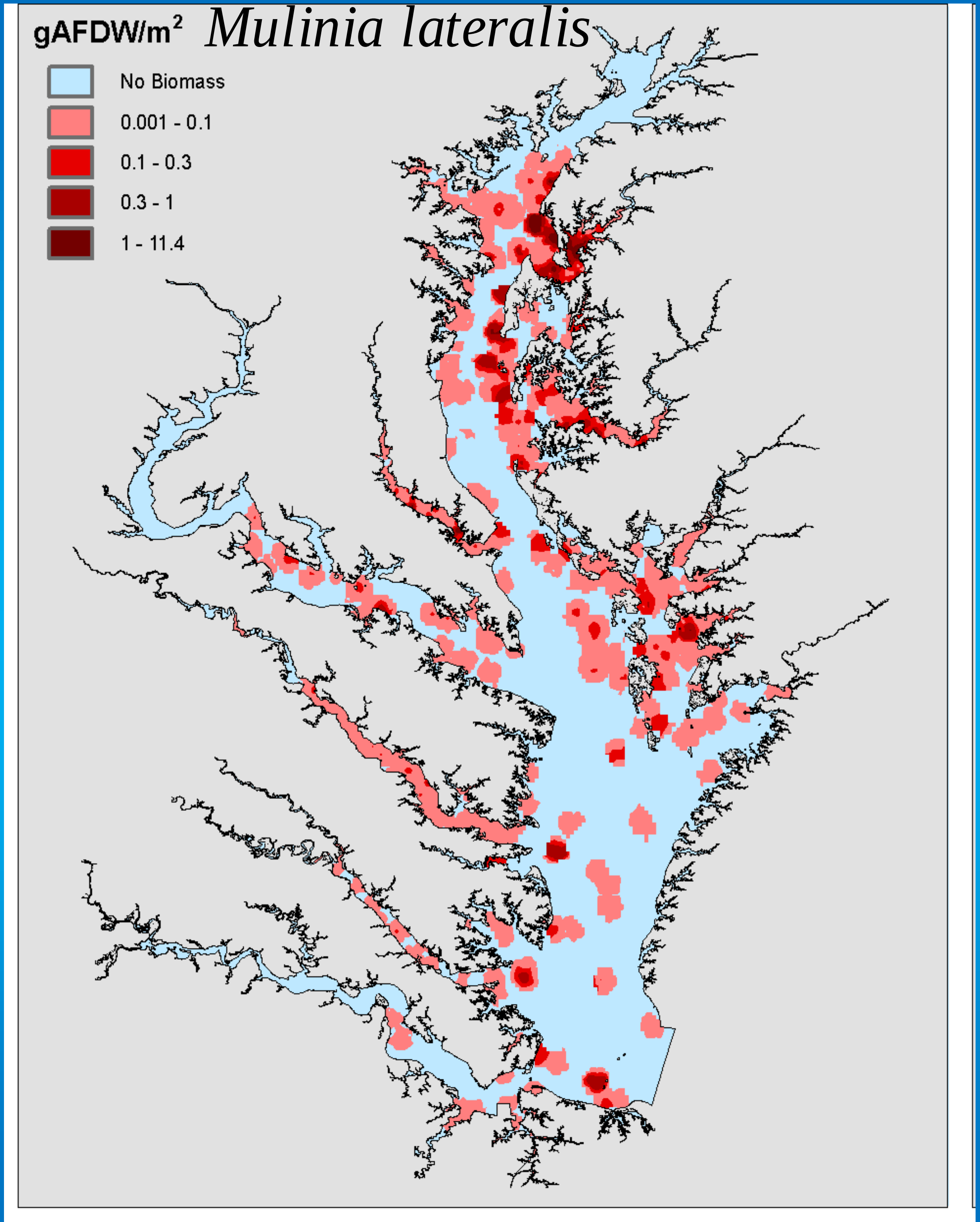


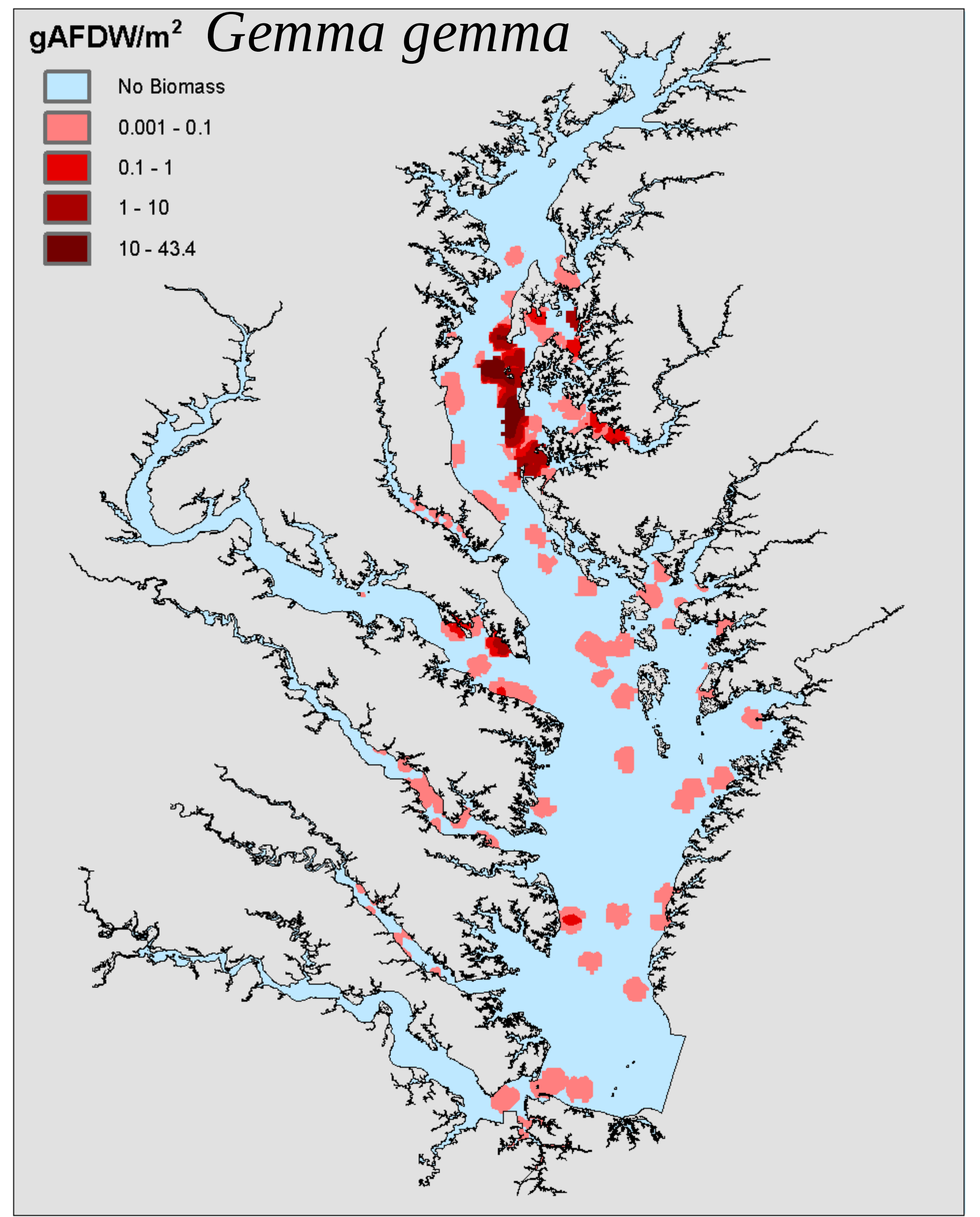
Rangia cuneata

Macoma balthica



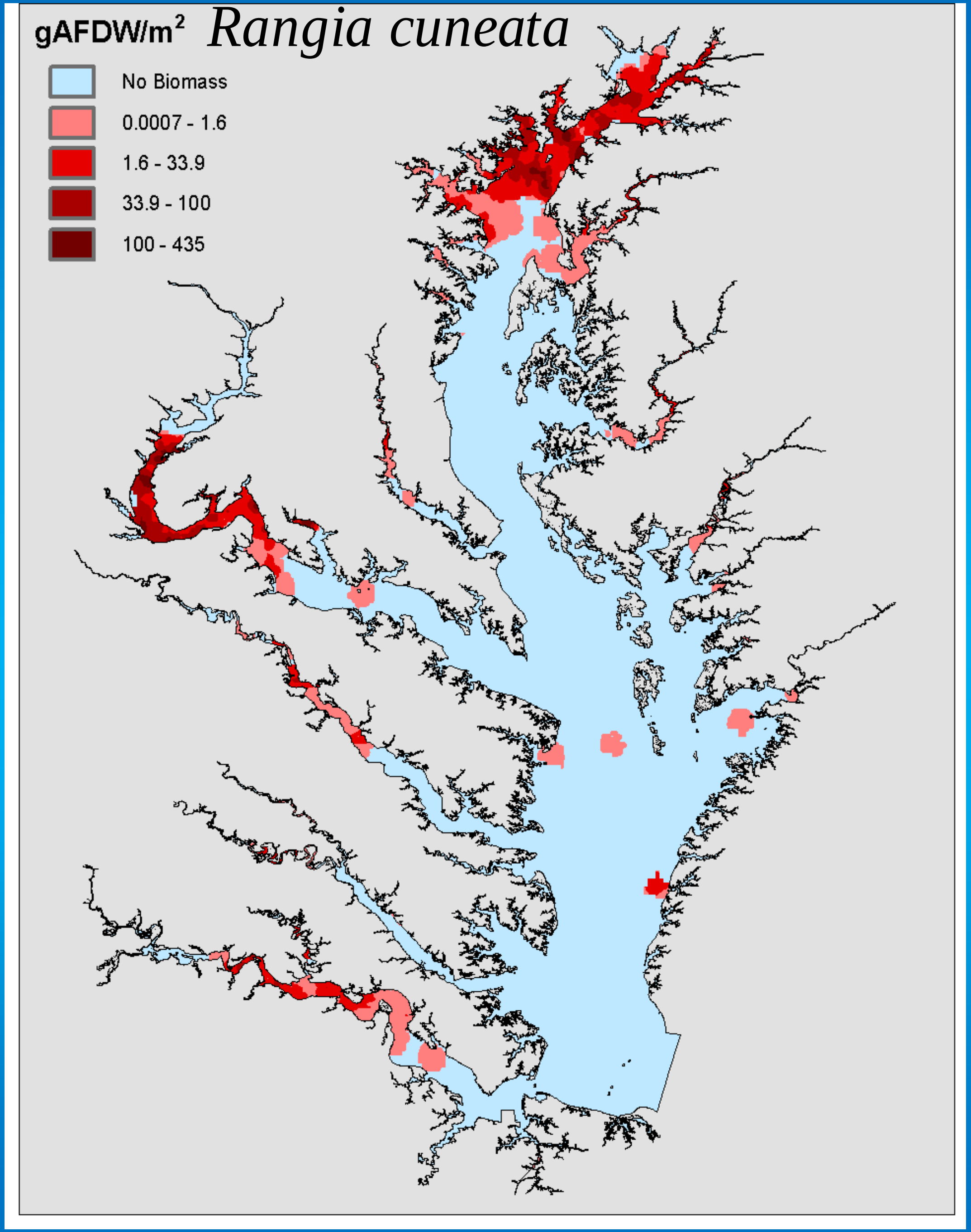



gAFDW/m²
Mulinia lateralis
No Biomass
0.001 - 0.1
0.1 - 0.3
0.3 - 1
1 - 11.4



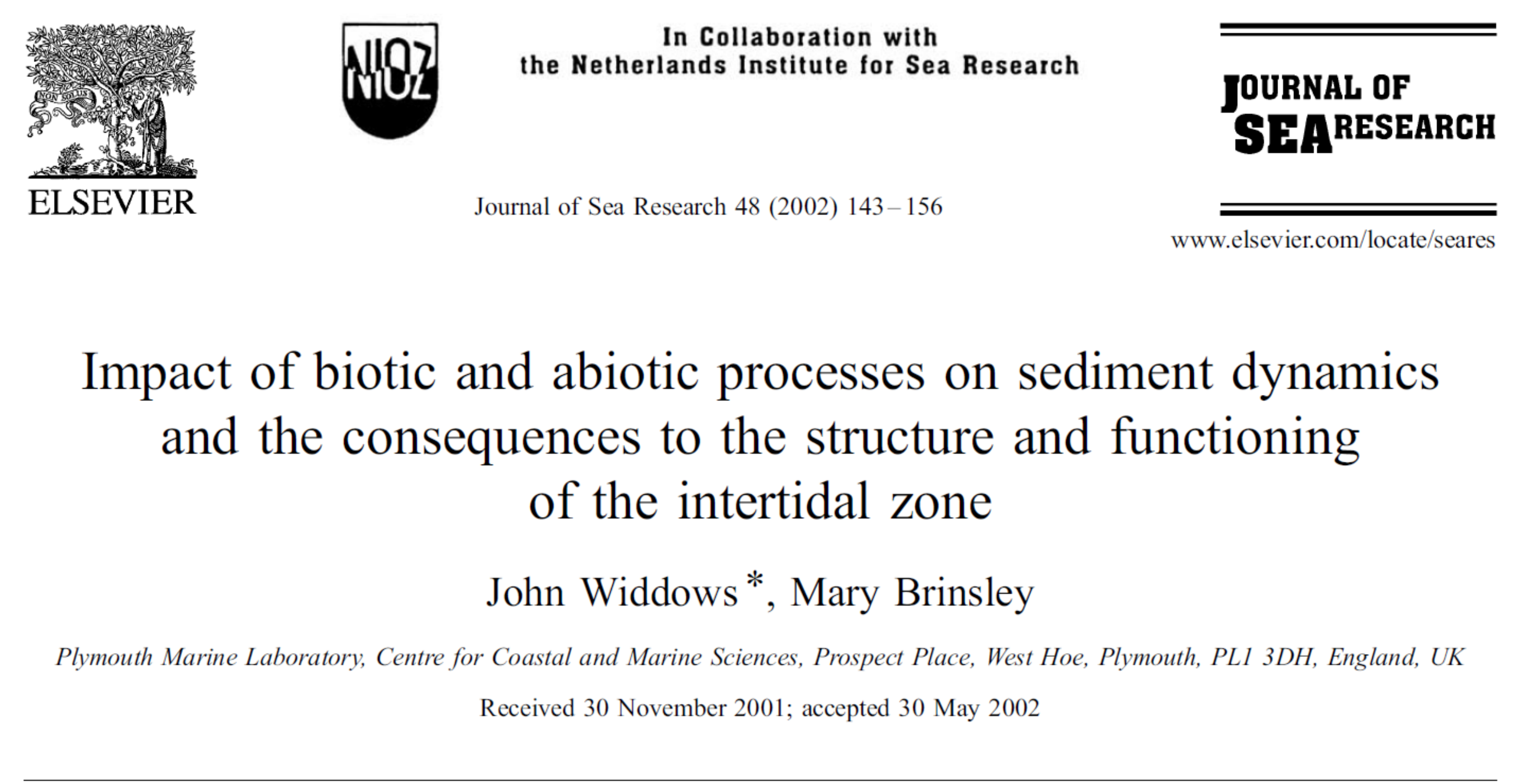
Gemma gemma
United States, Connecticut, Guilford
NMR 17484. Actual size 4 mm

Rangia cuneata



Benthic processes – water clarity

1. Role of suspension feeders (oto)
    - Epifaunal suspension feeders
    - Infaunal suspension feeders
2. For infaunal bivalves – water depth and depth in sediment
3. Sediment stabilizers versus destabilizers



ELSEVIER

In Collaboration with
the Netherlands Institute for Sea Research

JOURNAL OF
SEA RESEARCH

Journal of Sea Research 48 (2002) 143–156

www.elsevier.com/locate/seares

Impact of biotic and abiotic processes on sediment dynamics and the consequences to the structure and functioning of the intertidal zone

John Widdows*, Mary Brinsley

Plymouth Marine Laboratory, Centre for Coastal and Marine Sciences, Prospect Place, West Hoe, Plymouth, PL1 3DH, England, UK

Received 30 November 2001; accepted 30 May 2002

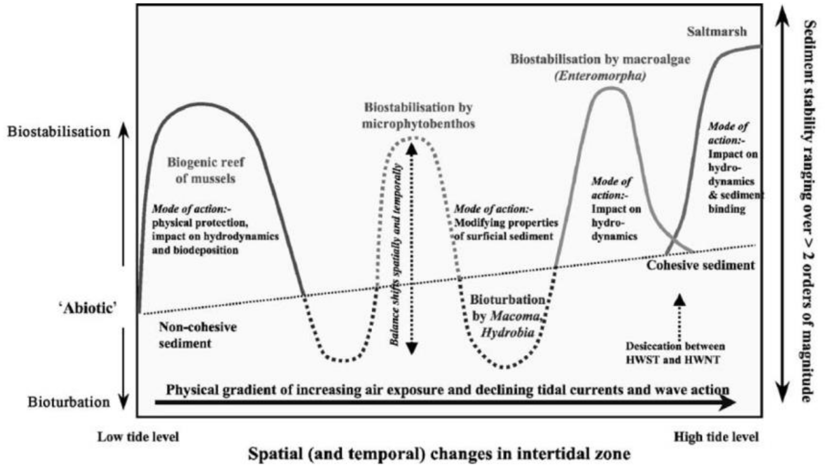


Fig. 1. Schematic diagram summarising some of the major biological and physical factors influencing sediment stability in the intertidal zone. The dotted line represents the general shoreward increase in sediment stability with increasing cohesiveness and consolidation due to increasing air exposure and declining currents/wave action. The solid lines represent the long-term increase in sediment stability as a result of biota that persist for many years to >100 years (e.g. mussel beds and salt marsh). The dashed oscillating line represents the spatial (and temporal) changes in sediment erodability due to short-term shifts (0.1 to >1 year) in the balance between the biostabilisers (microphytobenthos) and bio-destabilisers (*Macoma balthica Hydrobia ulvae*).

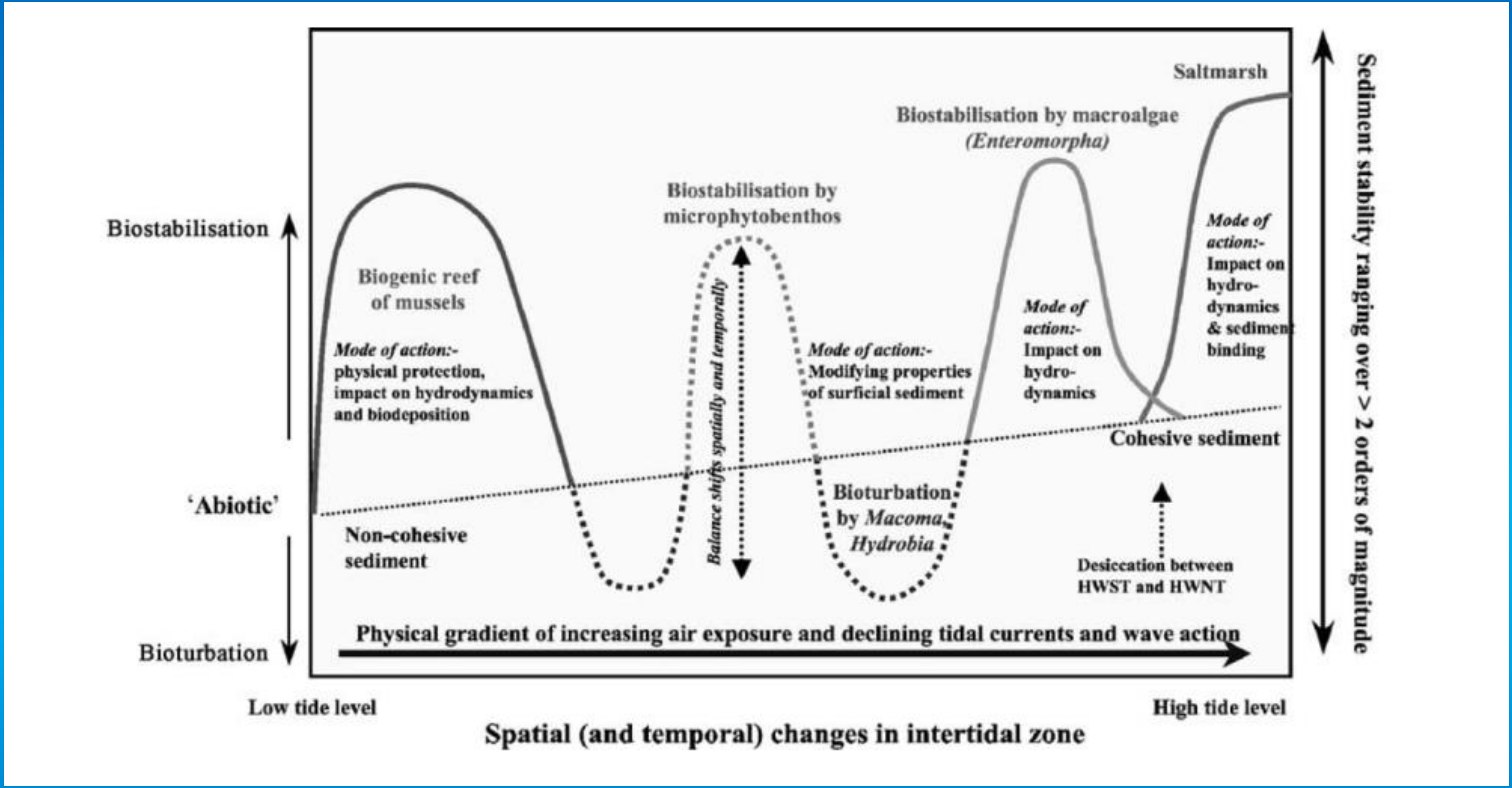
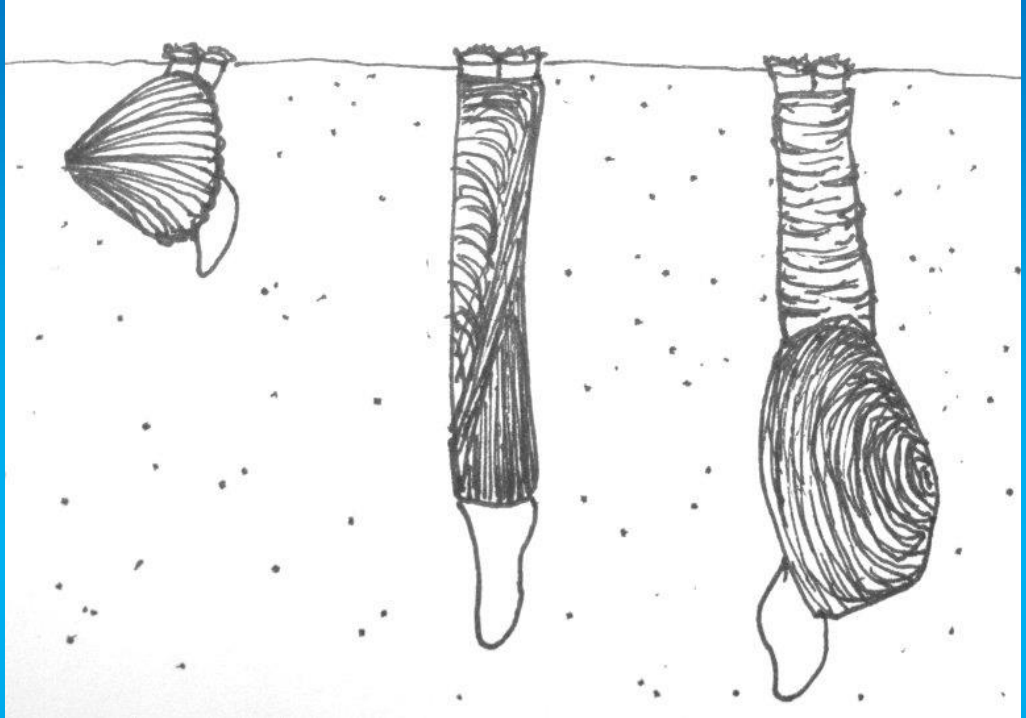
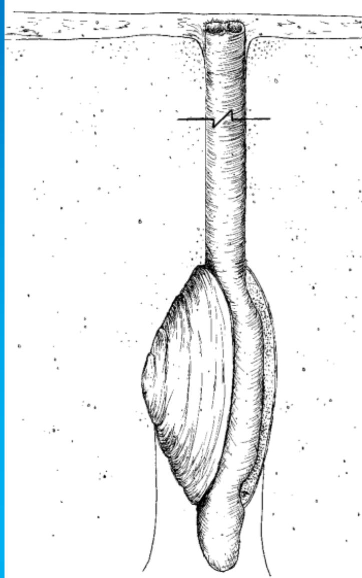
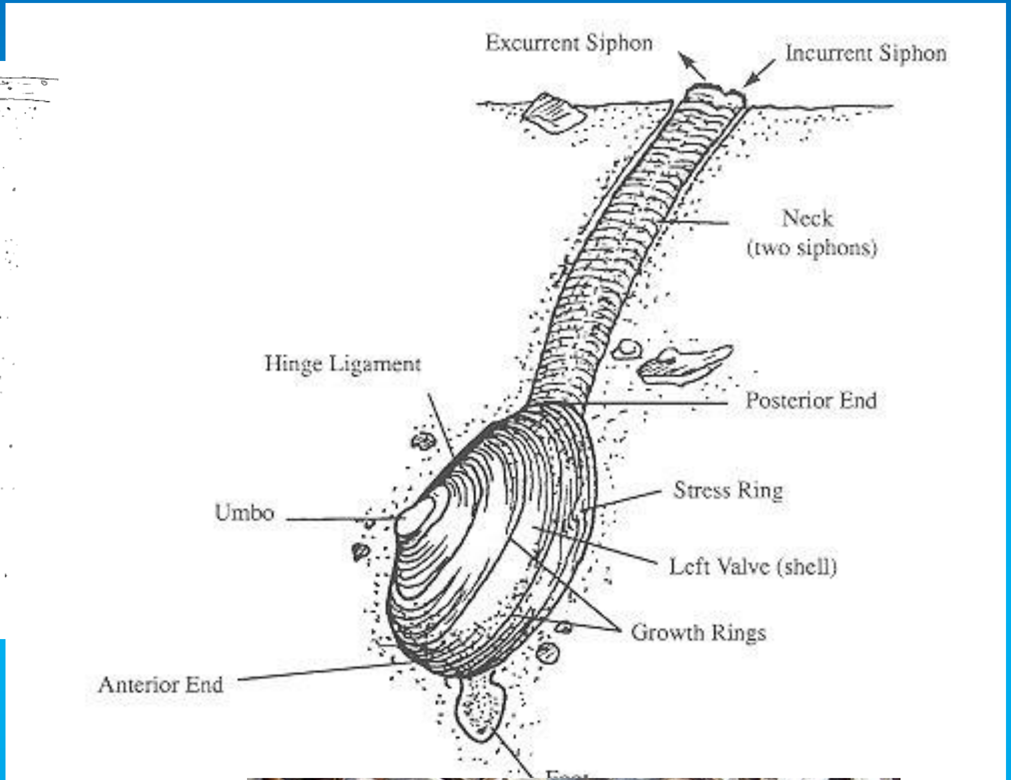
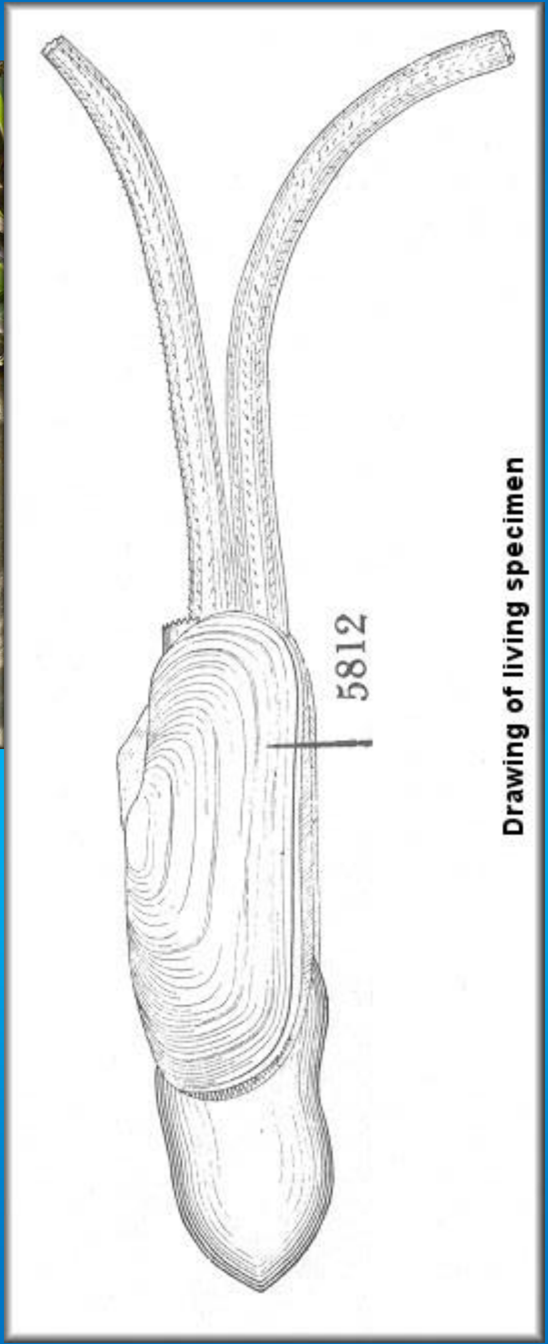


Fig. 1. Schematic diagram summarising some of the major biological and physical factors influencing sediment stability in the intertidal zone. The dotted line represents the general shoreward increase in sediment stability with increasing cohesiveness and consolidation due to increasing air exposure and declining currents/wave action. The solid lines represent the long-term increase in sediment stability as a result of biota that persist for many years to >100 years (e.g. mussel beds and salt marsh). The dashed oscillating line represents the spatial (and temporal) changes in sediment erodability due to short-term shifts (0.1 to >1 year) in the balance between the biostabilisers (microphytobenthos) and bio-destabilisers (*Macoma balthica Hydrobia ulvae*).





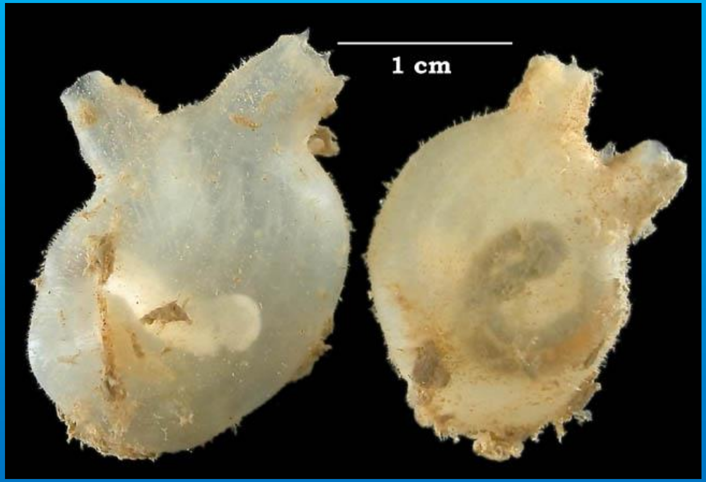

Excurrent Siphon
Incurrent Siphon
Neck
(two siphons)
Hinge Ligament
Posterior End
Stress Ring
Umbo
Left Valve (shell)
Growth Rings
Anterior End



Drawing of living specimen


Lingula


ETI ● World Biodiversity Database
N. A. Meinkoth


1 cm

Reprint from Journal of Marine Research, Volume 39, 2, 1981.

Sediment destabilization by animal tubes

by James E. Eckman[1], Arthur R. M. Nowell[1] and Peter A. Jumars[1]

ABSTRACT

Laboratory flume experiments were conducted in order to test the influence on sediment erodibility of varying densities of the tube-building polychaete worm *Owenia fusiformis*. Experiments were performed on isolated individuals, in order to measure approximate spatial limits of isolated tube effects, and on arrays of individuals at densities reported previously to be associated with stable beds. The bed was destabilized at all densities of tubes tested, and this destabilization was more pronounced at the higher densities. In the field, stable beds persist despite the frequently destabilizing influence of animal tubes. We suggest that mucous binding of sediments by animals, diatoms and/or omnipresent bacteria explains this contradiction.

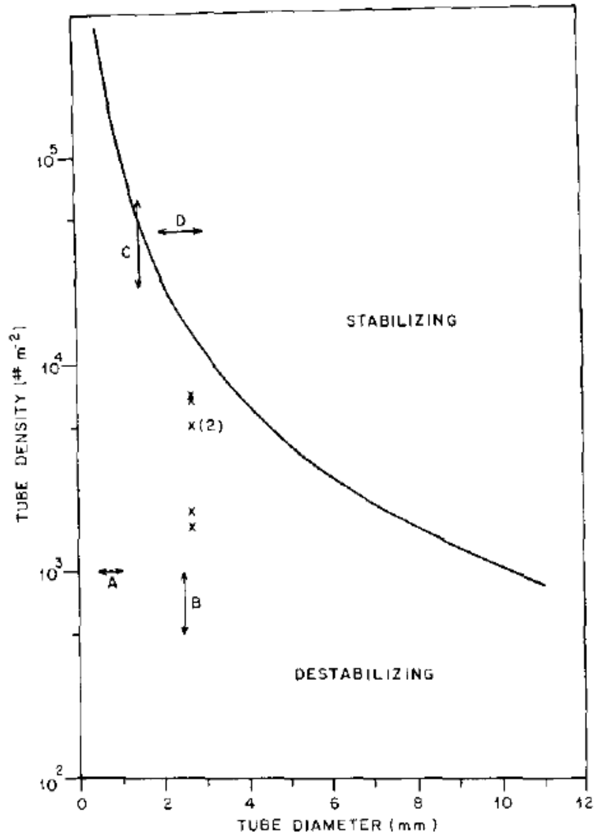


Figure 1. Minimum tube density required to stabilize sediments as a function of tube diameter, estimated from the results of Nowell and Church (1979). Also plotted are actual values from our experiments (x's) and from the following references: (A) McCall and Fisher (1980); (B) Fager (1964)—mean densities; (C) Bailey-Brock (1979)—chaetopterid mounds; (D) Mills (1967). Tube diameters are estimated for (A) through (D).