




<div data-bbox="235 184 766 310" data-label="Section-Header"> <h2>Benthic feeding guilds, functional groups & bioturbation</h2> </div> <div data-bbox="409 323 600 350" data-label="Text"> <p>Class 2: 9/4/08 Th</p> </div> <div data-bbox="654 512 771 539" data-label="Text"> <p>EEOS630</p> </div>	<div data-bbox="816 132 1401 210" data-label="Section-Header"> <h3>Slide 1 Benthic feeding guilds, functional groups & bioturbation</h3> </div> <div data-bbox="816 294 940 325" data-label="Text"> <p>NOTES:</p> </div>
<div data-bbox="276 688 753 724" data-label="Section-Header"> <h3>Reading assignments for Class 2-4</h3> </div> <div data-bbox="297 741 742 766" data-label="Section-Header"> <h4>Feeding guilds, bioturbation & benthic diatoms</h4> </div> <div data-bbox="228 758 670 1066" data-label="List-Group"> <ul style="list-style-type: none"> • Feeding & Feeding guilds <ul style="list-style-type: none"> ▶ Gallagher's Chapter 1 ▶ Cammen 1980 ▶ Fauchald & Jumars • Bioturbation <ul style="list-style-type: none"> ▶ Gallagher Chapter 2 ▶ Boudreau, B. P. 1998. Mean mixed depth of sediments: the wherefore and the why. <i>Limnol. Oceanogr.</i> 43: 524-526. ▶ Shull, D. H. 2001. Transition-matrix model of bioturbation and radionuclide diagenesis. <i>Limnol. Oceanogr.</i> 46: 905-916. • Microphytobenthos <ul style="list-style-type: none"> ▶ Gallagher Chapter 3: Microphytobenthic production ▶ Gould & Gallagher (1990) ▶ Glud, R. N. M. Kühl, F. Wenzhöfer, and S. Rysgaard. 2002. Benthic diatoms of a high Arctic fjord (Young Sound, NE Greenland): importance for ecosystem primary production. <i>Mar. Ecol. Prog. Ser.</i> 238: 15-29. </div> <div data-bbox="654 1037 771 1064" data-label="Text"> <p>EEOS630</p> </div>	<div data-bbox="816 659 1411 697" data-label="Section-Header"> <h3>Slide 2 Reading assignments for Class 2-4</h3> </div> <div data-bbox="816 781 940 814" data-label="Text"> <p>NOTES:</p> </div>
<div data-bbox="311 1180 716 1218" data-label="Section-Header"> <h3>Big ideas for today's class</h3> </div> <div data-bbox="233 1245 776 1551" data-label="List-Group"> <ul style="list-style-type: none"> • The diverse meanings of 'biodiversity', niche, functional groups & guild • Major benthic feeding guilds defined by where they obtain food and their motility <ul style="list-style-type: none"> ▶ Macrophages, especially carnivores ▶ Microphage <ul style="list-style-type: none"> ■ Deposit feeding (surface & subsurface) ■ Suspension feeding • Functional groups of benthos <ul style="list-style-type: none"> ▶ Major groups described by Woodin, Jackson & especially Don Rhoads ▶ Rhoads et al. Described succession & response to pollution in terms of functional groups, not species </div> <div data-bbox="654 1526 771 1551" data-label="Text"> <p>EEOS630</p> </div>	<div data-bbox="816 1148 1295 1184" data-label="Section-Header"> <h3>Slide 3 Big ideas for today's class</h3> </div> <div data-bbox="816 1268 940 1302" data-label="Text"> <p>NOTES:</p> </div>

<div data-bbox="414 170 602 207" data-label="Section-Header"> <h2>Biodiversity</h2> </div> <div data-bbox="397 214 618 241" data-label="Section-Header"> <h3>A variety of definitions</h3> </div> <div data-bbox="237 245 662 501" data-label="List-Group"> <ul style="list-style-type: none"> • NRC (1995): <i>'the collection of genomes, species, and ecosystems occurring in a geographically defined region.'</i> • Hubbell (2001, p. 3): species richness and relative abundance in space and time. • Biodiversity can be defined in terms of hierarchy and level of biological organization: Structure, Function & Composition </div> <div data-bbox="652 514 771 541" data-label="Text"> <p>EEOS630</p> </div>	<div data-bbox="815 134 1109 172" data-label="Section-Header"> <h2>Slide 4 Biodiversity</h2> </div> <div data-bbox="815 258 940 291" data-label="Text"> <p>NOTES:</p> </div>
<div data-bbox="337 655 693 695" data-label="Section-Header"> <h2>Biodiversity: All 4 levels</h2> </div> <div data-bbox="272 703 747 732" data-label="Text"> <p>Orians (1997) based on Norris (1990), See Chapter 5</p> </div> <div data-bbox="313 726 618 1026" data-label="Diagram"> </div> <div data-bbox="652 1001 771 1029" data-label="Text"> <p>EEOS630</p> </div>	<div data-bbox="815 623 1278 661" data-label="Section-Header"> <h2>Slide 5 Biodiversity: All 4 levels</h2> </div> <div data-bbox="815 745 940 779" data-label="Text"> <p>NOTES:</p> </div>
<div data-bbox="337 1144 693 1182" data-label="Section-Header"> <h2>Biodiversity: Landscape</h2> </div> <div data-bbox="371 1190 641 1220" data-label="Text"> <p>Amenable to remote sensing</p> </div> <div data-bbox="313 1213 618 1514" data-label="Diagram"> </div> <div data-bbox="652 1488 771 1516" data-label="Text"> <p>EEOS630</p> </div>	<div data-bbox="815 1113 1278 1150" data-label="Section-Header"> <h2>Slide 6 Biodiversity: Landscape</h2> </div> <div data-bbox="815 1234 940 1268" data-label="Text"> <p>NOTES:</p> </div>

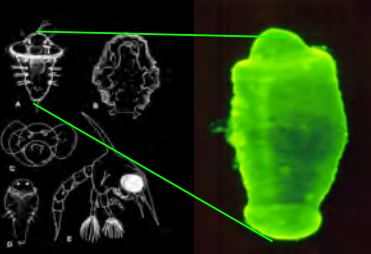

<div data-bbox="207 132 782 573"> <h3>Biodiversity: Communities & Ecosystems</h3> </div>	<div data-bbox="824 132 1403 216"> <h3>Slide 7 Biodiversity: Communities & Ecosystems</h3> </div> <div data-bbox="824 289 1403 331"> <p>NOTES:</p> </div>
<div data-bbox="207 657 782 1098"> <h3>Biodiversity: Populations</h3> </div>	<div data-bbox="824 657 1403 699"> <h3>Slide 8 Biodiversity: Populations</h3> </div> <div data-bbox="824 772 1403 814"> <p>NOTES:</p> </div>
<div data-bbox="207 1140 782 1581"> <h3>Biodiversity: Individuals</h3> </div>	<div data-bbox="824 1140 1403 1182"> <h3>Slide 9 Biodiversity: Individuals</h3> </div> <div data-bbox="824 1255 1403 1297"> <p>NOTES:</p> </div>

<div data-bbox="233 163 769 205" data-label="Section-Header"> <h2>Biodiversity: Genes</h2> </div> <div data-bbox="315 228 615 525" data-label="Diagram"> </div> <div data-bbox="656 512 769 539" data-label="Text"> <p>EEOS630</p> </div>	<div data-bbox="818 132 1227 170" data-label="Section-Header"> <h2>Slide 10 Biodiversity: Genes</h2> </div> <div data-bbox="818 254 941 289" data-label="Text"> <p>NOTES:</p> </div>
<div data-bbox="233 655 769 697" data-label="Section-Header"> <h2>Biodiversity: All 4 levels</h2> </div> <div data-bbox="272 701 747 728" data-label="Text"> <p>Orians (1997) based on Norris (1990), See Chapter 5</p> </div> <div data-bbox="315 722 615 1020" data-label="Diagram"> </div> <div data-bbox="656 1001 769 1029" data-label="Text"> <p>EEOS630</p> </div>	<div data-bbox="818 623 1292 661" data-label="Section-Header"> <h2>Slide 11 Biodiversity: All 4 levels</h2> </div> <div data-bbox="818 743 941 779" data-label="Text"> <p>NOTES:</p> </div>
<div data-bbox="233 1148 769 1190" data-label="Section-Header"> <h2>Biodiversity: too broadly defined?</h2> </div> <div data-bbox="305 1188 721 1215" data-label="Text"> <p>Broad definition criticized by Hubbell (2001)</p> </div> <div data-bbox="233 1218 659 1480" data-label="Text"> <p>"... the term biodiversity has been coopted by the policy community, where the term has become too inclusive. In policy discussions, biodiversity covers an enormous and heterogeneous array of subjects, scales and questions. "Biodiversity" in policy parlance is the sum total of all biological variation from the gene level to single-species populations of microbes to elephants, and multispecies communities and ecosystems to landscape and global levels of biotic organization. In some usages, it also includes all ecological interactions within and among scales of biological organization."</p> </div> <div data-bbox="667 1323 774 1488" data-label="Image"> </div> <div data-bbox="656 1488 769 1516" data-label="Text"> <p>EEOS630</p> </div>	<div data-bbox="818 1113 1300 1182" data-label="Section-Header"> <h2>Slide 12 Biodiversity: too broadly defined?</h2> </div> <div data-bbox="818 1268 941 1304" data-label="Text"> <p>NOTES:</p> </div>

<p>Species: the fundamental units of biodiversity</p> <p>Harvard's EO Wilson (1992, p 35-38)</p> <ul style="list-style-type: none"> The species concept is crucial to the study of biodiversity. It is the foundation of systematic biology. Not to have a natural unit such as the species would be to abandon a large part of biology into a free fall, all the way from the ecosystem down to the organism. Without natural species, ecosystems could only be analyzed in the broadest terms, using crude and shifting descriptions of the organisms that compose them. Biologists would find it difficult to compare results from one study to the next. 	<p>Slide 13 Species: the fundamental units of biodiversity</p> <p>NOTES:</p>
<p>Mayr's biological species concept</p> <p>Mayr 1982, p. 273 The growth of biological thought</p> <p><i>"A species is a reproductive community of populations (reproductively isolated from others) that occupies a specific niche in nature."</i></p> <p>Mayr argues that the 'niche occupation' clause is necessary to apply the biological species concept to asexual clones, <i>"It is thus customary to combine into species those asexual individuals and clones that fill the same ecological niche or that play the same role in the ecosystem."</i></p>	<p>Slide 14 Mayr's biological species concept</p> <p>NOTES:</p>
<p>What is an organism's niche?</p> <p>GE Hutchinson's Fundamental Niche (1978, p. 160)</p> <ul style="list-style-type: none"> "Each niche can be regarded as a set of points, each one of which defines a possible set of environmental values permitting the species to live." <ul style="list-style-type: none"> The fundamental niche is the hypervolume defined only by abiotic environmental variables and food The realized niche includes the effects of negative interactions with other organisms <ul style="list-style-type: none"> Canonical correspondence analysis & WA-PLS are relatively new methods for analyzing this species-environment relationship Used for inferring paleoclimate Elton (1927) described the niche as the function performed by the species in the community Both senses are used in ecology <p>EEOS630</p>	<p>Slide 15 What is an organism's niche?</p> <p>NOTES:</p>

<div data-bbox="235 163 771 541"> <h2>Ways of classifying the benthos</h2> <h3>Species, functional groups, and guilds</h3> <ul style="list-style-type: none"> • Old but still accepted dichotomies <ul style="list-style-type: none"> ▀ Meiofauna vs. Macrofauna <ul style="list-style-type: none"> ▀ permanent meiofauna ▀ Temporary meiofauna ▀ Infauna vs. epifauna • Feeding types <ul style="list-style-type: none"> ▀ Predators, scavengers, deposit feeders, suspension feeders, interface feeders ▀ Deposit feeders <ul style="list-style-type: none"> ▀ Surface deposit feeders ▀ Subsurface deposit feeders <ul style="list-style-type: none"> ▀ Rhoads' conveyor belt species ▀ Reverse conveyor belt species • Woodin's functional groups: tube builders, burrowers or suspension feeders • Jumars & Fauchald's Polychaete Feeding Guilds <p>EEOS630</p> </div>	<div data-bbox="824 132 1385 174"> <h2>Slide 16 Ways of classifying the benthos</h2> </div> <div data-bbox="824 258 938 300"> <p>NOTES:</p> </div>
<div data-bbox="235 653 771 1031"> <h2>Sampling the benthos</h2> <h3>0.25-m² Box corer shown</h3> <ul style="list-style-type: none"> • What question is being asked? <ul style="list-style-type: none"> ▀ Questions dictate sampling designs <ul style="list-style-type: none"> ▀ Monitoring designs ▀ Biodiversity assessment ▀ Assessing an impact after it may have occurred: Green's BACI: Before-after comparison ▀ Should be statistically valid • Sampling devices <ul style="list-style-type: none"> ▀ Petersen, Van Veen or Ted Young grab ▀ Box core ▀ HAPS multicorer ▀ Profile Camera (e.g., REMOTS™)  </div>	<div data-bbox="824 617 1252 659"> <h2>Slide 17 Sampling the benthos</h2> </div> <div data-bbox="824 743 938 785"> <p>NOTES:</p> </div>
<div data-bbox="235 1138 771 1516"> <h2>Sampling the benthos</h2> <h3>HAPS Multicorer shown</h3> <ul style="list-style-type: none"> • Mesh sizes <ul style="list-style-type: none"> ▀ 0.3, 0.5, or 1.0-mm mesh ▀ Meiofauna: use 63-µm mesh • Sample size: 0.25-, 0.1-, 0.043-m² or smaller (drinking straws) <ul style="list-style-type: none"> ▀ Large enough to sample the largest organism of interest ▀ Trade-off between sample area & statistical power  </div>	<div data-bbox="824 1102 1252 1144"> <h2>Slide 18 Sampling the benthos</h2> </div> <div data-bbox="824 1228 938 1270"> <p>NOTES:</p> </div>

<div data-bbox="349 165 675 203" data-label="Section-Header"> <h3>Sampling the benthos</h3> </div> <div data-bbox="282 214 748 239" data-label="Text"> <p>Peterson grab, box core & Sanders' anchor dredge</p> </div> <div data-bbox="269 239 748 569" data-label="Image"> </div>	<div data-bbox="816 132 1255 170" data-label="Section-Header"> <h3>Slide 19 Sampling the benthos</h3> </div> <div data-bbox="816 315 940 348" data-label="Text"> <p>NOTES:</p> </div>
<div data-bbox="355 653 672 693" data-label="Section-Header"> <h3>Valid “pigeon holes”</h3> </div> <div data-bbox="334 699 688 726" data-label="Text"> <p>Based on organism location and size</p> </div> <div data-bbox="235 722 654 1026" data-label="List-Group"> <ul style="list-style-type: none"> • Epifauna vs. Infauna: Live within or on the sediment • Classifications based on size <ul style="list-style-type: none"> • Megafauna • Macrofauna (retained on a 300-μm, 500-μm, or 1-mm sieve) <ul style="list-style-type: none"> ■ Most benthic organisms start life with planktonic larvae (meroplankton vs. holoplankton) <ul style="list-style-type: none"> ○ Leontotrophic ○ Planktotrophic • Meiofauna (63 μm to 500 μm) <ul style="list-style-type: none"> ■ Permanent (entire life spent within the meiofaunal size category) ■ Temporary (juvenile macrofauna) ■ Mesopsammon (organisms that live among sand grains) • Microfauna (<63 μm): Ciliates, Dinoflagellates & heterotrophic flagellates </div> <div data-bbox="656 1001 771 1026" data-label="Text"> <p>EEOS630</p> </div>	<div data-bbox="816 619 1242 657" data-label="Section-Header"> <h3>Slide 20 Valid “pigeon holes”</h3> </div> <div data-bbox="816 741 940 774" data-label="Text"> <p>NOTES:</p> </div>
<div data-bbox="277 1142 743 1180" data-label="Section-Header"> <h3>Meiofauna (63- to 500-μm sieve)</h3> </div> <div data-bbox="323 1188 701 1215" data-label="Text"> <p><i>Huntemannia jadensis</i> (Bob Feller photo)</p> </div> <div data-bbox="240 1213 579 1528" data-label="Image"> </div>	<div data-bbox="816 1108 1398 1146" data-label="Section-Header"> <h3>Slide 21 Meiofauna (63- to 500-μm sieve)</h3> </div> <div data-bbox="816 1230 940 1264" data-label="Text"> <p>NOTES:</p> </div>

<p>Brian Marcotte's argonauts</p> <p><i>"Truth is always sufficient but seldom necessary...Science is honorable, a virtuous endeavor, its own reward. What follows is an account of the ecology of bottom-dwelling, marine harpacticoid copepods (Crustacea: Copepoda) in Nova Scotia. The world of these ancient argonauts is a thousand micron sea. it is a world of flake and stone, of crystalline herbs and truffled gardens, of thimble mountains and ever-shifting sand. It is not the pickled muds museums house, just as human society is not a city morgue. Rather, their world can only be understood as they would live in it: sense it, explore it, eat, rest, reproduce. Meiobenthic harpacticoids are not distributed in space and time: they are space and time. Their physiology, morphology and behavior define the dimensional space in which they live and of which their evolutionary history can only hinge. Meiofauna adapt not in time but embody it: size and community structure are the sensible beat of their clock. In short, their physics exists only in so far as they live, and our understanding of them exists only in so far as we can take on their life. For this end, the present thesis begins ..."</i></p>	<p>Slide 22 Brian Marcotte's argonauts</p> <p>NOTES:</p>
<p>Benthic larvae: temporary meiofauna</p> <p><i>Capitella trochophore larva (immunofluorescence)</i></p> 	<p>Slide 23 Benthic larvae: temporary meiofauna</p> <p>NOTES:</p>
<p>Streblospio benedicti (spionid) larvae</p> <p><i>Lecithotrophic (l) & planktotrophic (r)</i></p>  <p>Most abundant animal in Boston Harbor intertidal, reproductive modes determined by Lisa Levin</p>	<p>Slide 24 Streblospio benedicti (spionid) larvae</p> <p>NOTES:</p>

<div data-bbox="370 168 649 207" data-label="Section-Header"> <h2>Functional groups</h2> </div> <div data-bbox="254 214 776 262" data-label="Section-Header"> <h3>Peter Calow's (1981) Invertebrate Biology: A Functional Approach</h3> </div> <div data-bbox="233 254 662 359" data-label="Text"> <p>"This book is about how invertebrate animals function -not just about how they work but also about why they work in the way they do. The term function means 'the work a system is designed to do', but in a biological context design is not quite the correct word, for organisms are not intelligently conceived nor are they intelligently selected.</p> </div> <div data-bbox="233 359 659 497" data-label="Text"> <p>By functional biology, then, I mean the search for explanations of the success of particular traits in given ecological circumstances; or why, in other words, those traits which have turned up by chance have then been naturally selected. There is also a very important predictive side to the programme. What traits would be expected to evolve in particular ecological conditions?" (Calow, page 11)</p> </div> <div data-bbox="233 495 656 535" data-label="Text"> <p>Functional groups are a supplement not a substitute for species identification</p> </div>	<div data-bbox="815 132 1209 172" data-label="Section-Header"> <h2>Slide 25 Functional groups</h2> </div> <div data-bbox="815 258 940 291" data-label="Text"> <p>NOTES:</p> </div>
<div data-bbox="289 655 748 695" data-label="Section-Header"> <h2>Guilds: arenas for competition</h2> </div> <div data-bbox="276 699 751 749" data-label="Text"> <p>Seed gathering ants & rodents are members of the same guild, Brown et al. (1986)</p> </div> <div data-bbox="233 753 651 972" data-label="Text"> <p>"[A guild is] a group of species that exploit the same class of environmental resources in a similar way. This term groups together species, without regard to taxonomic positions, that overlap significantly in their niche requirements." Root (1967)</p> </div> <div data-bbox="652 1001 769 1029" data-label="Text"> <p>EEOS630</p> </div>	<div data-bbox="815 623 1380 661" data-label="Section-Header"> <h2>Slide 26 Guilds: arenas for competition</h2> </div> <div data-bbox="815 745 940 779" data-label="Text"> <p>NOTES:</p> </div>
<div data-bbox="318 1144 714 1182" data-label="Section-Header"> <h2>Benthic functional groups</h2> </div> <div data-bbox="305 1188 709 1239" data-label="Text"> <p>Based on interactions with the sediment; Functional groups are not feeding guilds</p> </div> <div data-bbox="233 1234 664 1507" data-label="List-Group"> <ul style="list-style-type: none"> • Woodin's (1976) functional groups <ul style="list-style-type: none"> ▶ 1) Tube builders ▶ 2) Suspension feeders ▶ 3) Burrowers • Woodin & Jackson's (1979) functional groups <ul style="list-style-type: none"> ▶ 1) Mobile burrowing organisms, a.k.a. Thayer's (1979) bulldozers ▶ 2) Destabilizing sedentary organisms (e.g., <i>Molpadia oolitica</i>). ▶ 3) Sedentary organisms which project above and below the sediment surface (e.g., sea grasses). ▶ 4) Tube builders ▶ 5) Sedentary organisms which don't destabilize or stabilize sediments </div>	<div data-bbox="815 1110 1313 1148" data-label="Section-Header"> <h2>Slide 27 Benthic functional groups</h2> </div> <div data-bbox="815 1232 940 1266" data-label="Text"> <p>NOTES:</p> </div>

The oldest known polychaetes

Burgess shale, 505 MYA, Cambrian explosion

Simon Conway Morris remarks: "In comparison with the situation in many modern marine environments, the Burgess shale polychaetes had a relatively minor role." S. J. Gould in 'Play it Again'



Subsurface deposit feeders evolved about 150 million years ago; Thayer's (1979) bulldozer hypothesis for extinction of sessile species

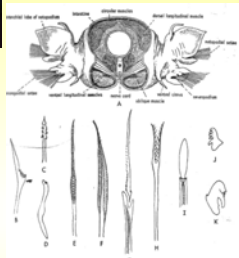
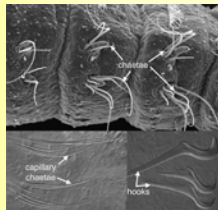


Slide 28 The oldest known polychaetes

NOTES:

The polychaete worm body type

Hooks usually indicate tube-dwelling orientation



Slide 29 The polychaete worm body type

NOTES:

Jumars & Fauchald's Feeding guilds

Guilds defined on the whether particles were ingested in bulk or individually and on motility

• Macrophages

- ▶ herbivores
- ▶ carnivores
- ▶ omnivores

• Microphages

- Suspension feeders
- Surface deposit feeders
- Subsurface deposit feeders

- **Interface feeders** (Many spionids & ampeliscids, not in Jumars & Fauchald)

• Motility

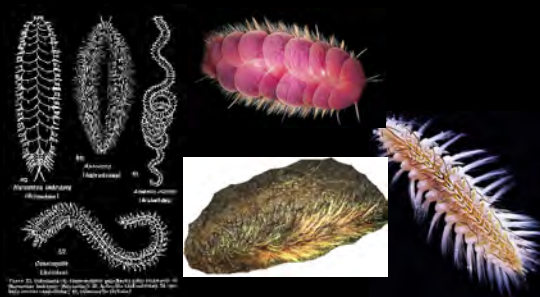
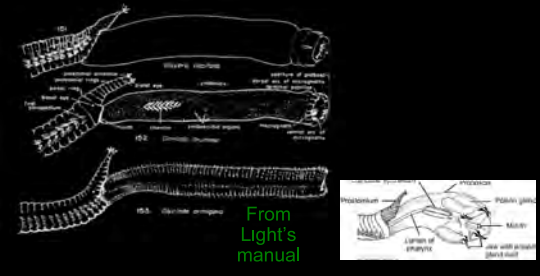

- ▶ sessile
- ▶ discretely motile, can move between feeding periods
- ▶ motile

Note that Jumars & Fauchald's guilds aren't defined rigorously in terms of resource use. They rely on feeding morphology. It's the food not the mechanism for acquiring food that should define guilds (e.g., ants vs. Rodents)

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Slide 30 Jumars & Fauchald's Feeding guilds

NOTES:

<div data-bbox="207 132 792 562"> <h3>Macrophages</h3> <p>Sea mice, scale worms, <i>Odontosyllis</i>, <i>Nereis</i></p>  </div>	<div data-bbox="820 132 1419 562"> <h3>Slide 31 Macrophages</h3> <p>NOTES:</p> </div>
<div data-bbox="207 625 792 1045"> <h3>Macrophagous polychaetes</h3> <p>Many feed with armed or unarmed eversible pharynges</p>  <p>From Light's manual</p> </div>	<div data-bbox="820 625 1419 1045"> <h3>Slide 32 Macrophagous polychaetes</h3> <p>NOTES:</p> </div>
<div data-bbox="207 1119 792 1539"> <h3>Macrophages: <i>Nereis</i> (rag worms, clam worms)</h3> <p>Jaws used to hold prey, chitinous paragnaths to chew</p>  <p>Can be deposit feeders, herbivores or predators.</p> </div>	<div data-bbox="820 1119 1419 1539"> <h3>Slide 33 Macrophages: <i>Nereis</i> (rag worms, clam worms)</h3> <p>NOTES:</p> </div>

Microphages: Surface deposit feeders

Hobsonia, Yoldia, Macoma

If a deposit feeder ingests food from the surface, it is a surface deposit feeder, even if most of the body is deep within the sediments

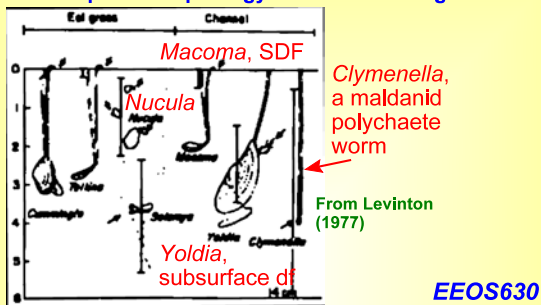


Slide 34 Microphages: Surface deposit feeders

NOTES:

Deposit-feeding bivalves

Siphon morphology indicates feeding mode

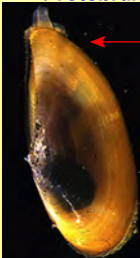


Slide 35 Deposit-feeding bivalves

NOTES:

Yoldia limatula: Buzzards Bay

Protobranch bivalve, Subsurface deposit feeder




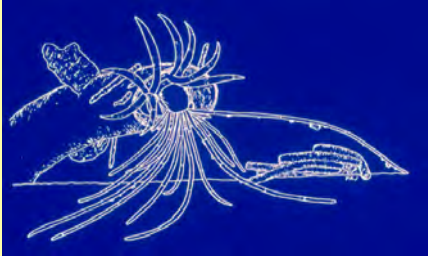
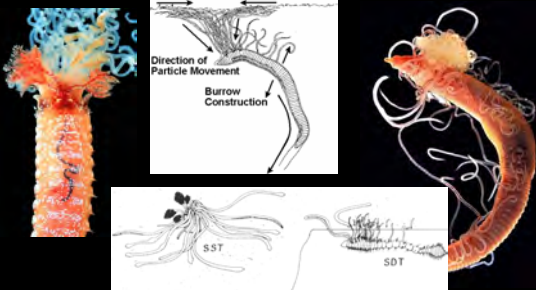
Feeds with palp proboscides





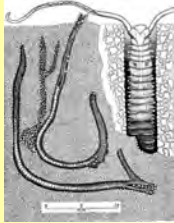


An indicator species for Buzzards Bay. Very abundant at the mouth of New Bedford Harbor, outside the storm barrier


EEOS630

Slide 36 Yoldia limatula: Buzzards Bay



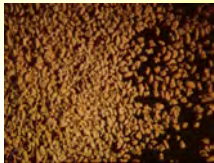

NOTES:

<p><i>Macoma balthica</i>, a key indicator species worldwide</p> <p><i>A shallow-dwelling surface deposit feeder; very thin shell, vulnerable to predation</i></p> 	<p>Slide 37 <i>Macoma balthica</i>, a key indicator species worldwide</p> <p>NOTES:</p>
<p>Tentaculate surface deposit feeder</p> <p><i>Hobsonia florida</i> (Jumars from "Diet of Worms")</p>  <p>EEOS630</p>	<p>Slide 38 Tentaculate surface deposit feeder</p> <p>NOTES:</p>
<p>Tentaculate surface deposit feeders</p> <p>Spaghettii worm (Terebellid) & Cirratulid (Shull)</p> 	<p>Slide 39 Tentaculate surface deposit feeders</p> <p>NOTES:</p>

<p>Surface deposit-feeding gastropods</p> <p>Fenchel (1977); feed mainly on microphytobenthos (benthic diatoms)</p>   <p><i>H. ulvae</i> <i>H. ventrosa</i></p> <p>EEOS630</p>	<p>Slide 40 Surface deposit-feeding gastropods</p> <p>NOTES:</p>
<p>Interface feeders: surface-deposit & suspension feeders</p> <p><i>Corophium salmonis</i> & <i>Corophium volutator</i> Build U-shaped tubes, Note large 2nd antennae</p>  	<p>Slide 41 Interface feeders: surface-deposit & suspension feeders</p> <p>NOTES:</p>
<p>Spionids: interface feeders</p> <p>Feed with tentaculate palps, can be deposit feeders, suspension feeders (with coiled palps) and predators</p>    <p>57 <i>Polydora</i> (Spionidae)</p>	<p>Slide 42 Spionids: interface feeders</p> <p>NOTES:</p>

<p><i>Pseudopolydora</i>, ‘the wrath of God’</p> <p>The spionid <i>P. kempj japonica</i> ingesting <i>Corophium salmonis</i></p> 	<p>Slide 43 Pseudopolydora, ‘the wrath of God’</p> <p>NOTES:</p>
<p>Interface feeders: <i>Ampelisca abdita</i></p> <p>Near Peddocks Island in Quincy Bay</p> 	<p>Slide 44 Interface feeders: <i>Ampelisca abdita</i></p> <p>NOTES:</p>
<p>Sediment Profile Imaging</p> <p><i>Ampelisca</i> assemblage, Hull Bay (1997)</p>  <p>Image from R. Diaz & ENSR</p>	<p>Slide 45 Sediment Profile Imaging</p> <p>NOTES:</p>

<p style="text-align: center;">Subsurface deposit feeders</p> <p style="text-align: center;">From Jumars & Fauchald (1977)</p> <p style="text-align: right;">EEOS630</p>	<p>Slide 46 Subsurface deposit feeders</p> <p>NOTES:</p>
<p style="text-align: center;">Maldanids: Bamboo worms</p> <p style="text-align: center;">Photo from MBL Web page</p> <p style="text-align: right;">EEOS630</p>	<p>Slide 47 Maldanids: Bamboo worms</p> <p>NOTES:</p>
<p style="text-align: center;">Pectinaria (Cistenides)</p> <p style="text-align: center;">Ice-cream cone worm, subsurface deposit (conveyor-belt) or funnel feeding</p> <p style="text-align: center;">The distinction between subsurface deposit feeding & funnel feeding is not at all clear for many animals</p>	<p>Slide 48 Pectinaria (Cistenides)</p> <p>NOTES:</p>

<p>Burrowers or subsurface deposit feeders</p> <p>Drawings from Lights manual</p>  <p>Note burrowing shape (worm-like)</p> <p>EEOS630</p>	<p>Slide 49 Burrowers or subsurface deposit feeders</p> <p>NOTES:</p>
<p>Capitella sp. I</p> <p>Shallow subsurface deposit feeder & premier pollution indicator, see Gallagher & Keay 1998</p>  <p>Wang, Xu-Chen, Yi-Xian Zhang, and R. F. Chen. 2001. Distribution and partitioning of polycyclic aromatic hydrocarbons (PAHs) in different size fractions in sediments from Boston Harbor, United States. Marine Pollution Bulletin 42: 1139-1149.</p> 	<p>Slide 50 Capitella sp. I</p> <p>NOTES:</p>
<p>Capitella sp. Ia, flounder food</p> <p>Can reach 9 cm, dominant in Boston's Inner Harbor</p>  <p>EEOS630</p>	<p>Slide 51 Capitella sp. Ia, flounder food</p> <p>NOTES:</p>

Lug worm feeding (funnel feeding)

Atlantic: *Arenicola*; Pacific: *Abarenicola*

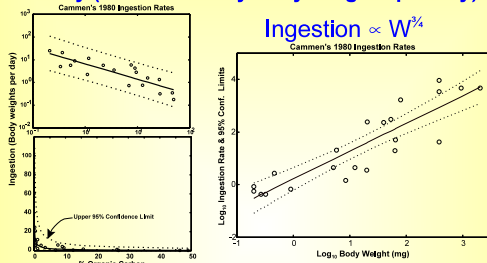


Slide 52 Lug worm feeding (funnel feeding)

NOTES:

Rate of deposit feeding

Cammen (1980): 0.2 to 100 dry body weights per day (Median \approx 3 dry body weights per day)

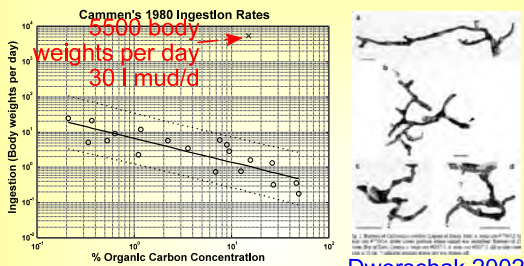


Slide 53 Rate of deposit feeding

NOTES:

How much mud can a ghost shrimp eat on the Palos Verdes Shelf?

D. J. P. Swift et al. (1996) Sci. Total Environment



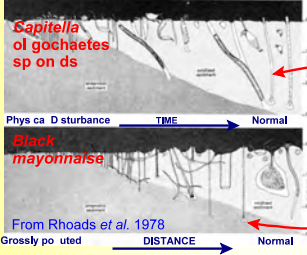


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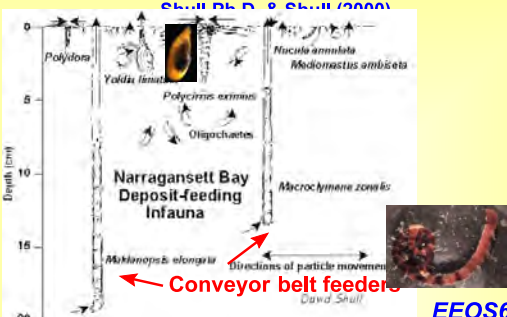
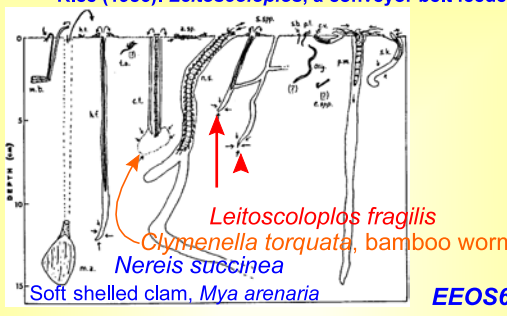
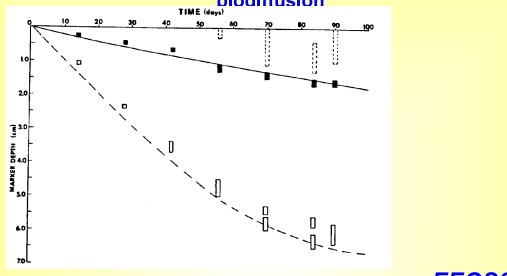
Slide 54 How much mud can a ghost shrimp eat on the Palos Verdes Shelf?

NOTES:

<div data-bbox="235 163 755 205" data-label="Section-Header"> <h3>Suspension feeders</h3> </div> <div data-bbox="284 216 755 262" data-label="Text"> <p>Feed with tentacles, mucous bags, crustaceans with maxillae</p> </div> <div data-bbox="235 262 641 493" data-label="Image"> </div> <div data-bbox="235 472 641 546" data-label="Text"> <p>Sabellid, "Feather duster"</p> <p>Chaetopterus, Suspens on mucous bag</p> <p><small>Examples of filtering strategies (see Table 1). FST: Fabriciidae; FDI-P: Flatworms (Nereidae); FSP: Chaetoptera; F-SST-P: Polydora (Chaetoptera); FDP: Arenicola (Arenicolidae).</small></p> </div>	<div data-bbox="820 132 1414 174" data-label="Section-Header"> <h3>Slide 55 Suspension feeders</h3> </div> <div data-bbox="820 315 1414 352" data-label="Text"> <p>NOTES:</p> </div>
<div data-bbox="235 655 755 724" data-label="Section-Header"> <h3>Suspension feeding serpulid polychaetes</h3> </div> <div data-bbox="341 724 690 751" data-label="Text"> <p>Christmas tree worms, <i>Spirobranchius</i></p> </div> <div data-bbox="235 751 706 1029" data-label="Image"> </div>	<div data-bbox="820 623 1414 699" data-label="Section-Header"> <h3>Slide 56 Suspension feeding serpulid polychaetes</h3> </div> <div data-bbox="820 781 1414 819" data-label="Text"> <p>NOTES:</p> </div>
<div data-bbox="235 1180 755 1222" data-label="Section-Header"> <h3>Suspension feeding sabellids</h3> </div> <div data-bbox="406 1228 609 1255" data-label="Text"> <p>Feather duster worms</p> </div> <div data-bbox="235 1255 738 1554" data-label="Image"> </div>	<div data-bbox="820 1148 1414 1186" data-label="Section-Header"> <h3>Slide 57 Suspension feeding sabellids</h3> </div> <div data-bbox="820 1270 1414 1308" data-label="Text"> <p>NOTES:</p> </div>

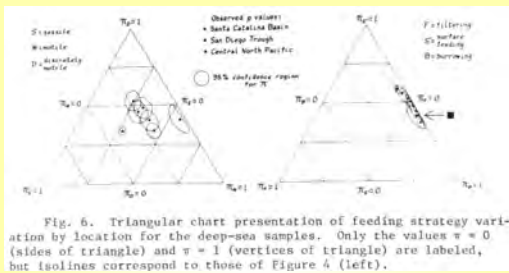
<p>Sabellaria reefs</p> <p><i>Sabellaria alveolata</i> studied by D. P. Wilson</p>  <p>EEOS630</p>	<p>Slide 58 Sabellaria reefs</p> <p>NOTES:</p>
<p>Bivalve suspension feeders</p> <p>From Light's manual, Stanley studied functional morphology</p> 	<p>Slide 59 Bivalve suspension feeders</p> <p>NOTES:</p>
<p>Rhoads, Pearson-Rosenberg Succession among functional groups</p> <p>One functional group modifies the environment and is replaced by another</p>  <p>From Rhoads et al. 1978</p> <p>EEOS630</p>	<p>Slide 60 Rhoads, Pearson-Rosenberg Succession among functional groups</p> <p>NOTES:</p>

<div data-bbox="341 170 678 207" data-label="Section-Header"> <h3>Conveyor-belt feeders</h3> </div> <div data-bbox="263 212 760 260" data-label="Text"> <p>Coined by Rhoads (1974). Maldanids & <i>Molpadia</i> are the model.</p> </div> <div data-bbox="238 260 583 357" data-label="Text"> <p>Don Rhoads' (1974) descriptive phrase for a subsurface deposit feeder that feeds at depth and defecates at the sediment surface.</p> </div> <div data-bbox="238 361 602 529" data-label="Text"> <p>The less common reverse conveyor-belt feeders feed at the surface and defecate at depth. Both feeding modes are called non-local mixing because the movement of particles doesn't fit the commonly used diffusion analogy</p> </div> <div data-bbox="654 512 771 541" data-label="Text"> <p>EEOS630</p> </div>	<div data-bbox="816 134 1260 172" data-label="Section-Header"> <h3>Slide 61 Conveyor-belt feeders</h3> </div> <div data-bbox="816 256 940 291" data-label="Text"> <p>NOTES:</p> </div>
<div data-bbox="378 653 638 693" data-label="Section-Header"> <h3>Non-local mixing</h3> </div> <div data-bbox="414 697 589 726" data-label="Text"> <p>Boudreau (1986b)</p> </div> <div data-bbox="235 724 660 861" data-label="Text"> <p>"Infaunal macroorganisms are capable of exchanging sedimentary material over distances equal to or greater than the scale over which the concentration of tracer changes substantially. This type of non-diffusive bioturbation is called nonlocal mixing."</p> </div> <div data-bbox="230 877 451 1008" data-label="Image"> </div> <div data-bbox="289 875 384 903" data-label="Caption"> <p><i>Pectinaria</i></p> </div> <div data-bbox="456 877 631 1024" data-label="Image"> </div> <div data-bbox="542 1001 631 1024" data-label="Caption"> <p><i>Arenicola</i></p> </div> <div data-bbox="638 970 727 1024" data-label="Text"> <p>Funnel feeders</p> </div>	<div data-bbox="816 621 1193 659" data-label="Section-Header"> <h3>Slide 62 Non-local mixing</h3> </div> <div data-bbox="816 741 940 777" data-label="Text"> <p>NOTES:</p> </div>
<div data-bbox="264 1142 773 1180" data-label="Section-Header"> <h3>Conveyor-belt feeding echinoderm</h3> </div> <div data-bbox="264 1188 735 1257" data-label="Text"> <p><i>Molpadia</i>, sea cucumber, an echinoderm; Cape Cod Bay through the Gulf of Maine, Rhoads & Young (1971)</p> </div> <div data-bbox="238 1255 534 1314" data-label="Text"> <p><i>Euchone incolor</i>, a feather-duster polychaete worm</p> </div> <div data-bbox="237 1335 475 1505" data-label="Image"> </div> <div data-bbox="475 1335 743 1505" data-label="Image"> </div>	<div data-bbox="816 1110 1261 1180" data-label="Section-Header"> <h3>Slide 63 Conveyor-belt feeding echinoderm</h3> </div> <div data-bbox="816 1266 940 1302" data-label="Text"> <p>NOTES:</p> </div>

<p style="text-align: center;">Narragansett Bay benthos</p>  <p style="text-align: right;">EEOS630</p>	<p>Slide 64 Narragansett Bay benthos</p> <p>NOTES:</p>
<p style="text-align: center;">Lowes Cove Maine mudflat</p> <p style="text-align: center;">Rice (1986): <i>Leitoscoloplos</i>, a conveyor belt feeder</p>  <p style="text-align: right;">EEOS630</p>	<p>Slide 65 Lowes Cove Maine mudflat</p> <p>NOTES:</p>
<p style="text-align: center;">Subduction of a chalk layer</p> <p style="text-align: center;">Rice 1986: Model as bioadvection ($\approx 1\text{mm/d}$), not biodiffusion</p>  <p style="text-align: right;">EEOS630</p>	<p>Slide 66 Subduction of a chalk layer</p> <p>NOTES:</p>

Jumars & Fauchald strategies

50:50 surface and subsurface feeders in deep sea



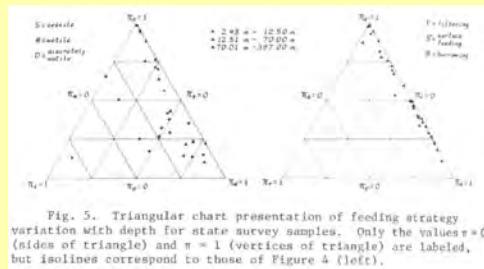
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Slide 67 Jumars & Fauchald strategies

NOTES:

Jumars & Fauchald strategies

Filter feeders relatively rare on shelf



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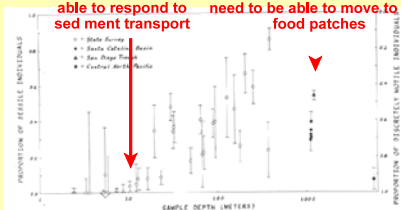
Slide 68 Jumars & Fauchald strategies

NOTES:

Jumars & Fauchald Motility

% Sessile species shows an Intermediate peak

Shallow: High energy need to be able to respond to sediment transport
Deep: Food flux to local area too low, need to be able to move to find food patches



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Slide 69 Jumars & Fauchald Motility

NOTES: