EEOS 630
Biol. Ocean. Processes
Handout 1
1st class: 9/2/08 (Tu)
Gallagher home
Revised: 9/2/08

FALL 2008 EEOS630 SYLLABUS
BIOLOGICAL OCEANOGRAPHIC PROCESSES

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List of Tables

Key Web Links

Table 1 provides a quick listing of links needed to access course material.

Table 1. Web links.

URL	Site	Description
http://boston.umassonline.net	WebCT VISTA	Follow the instructions on the home page for registering for WebCT Vista. The course web page is now being added. I'll email you with instructions for getting access to the site.
http://www.muse.umb.edu	WIMBA	WIMBA Frequently Asked questions

Table 1. Web links.

URL	Site	Description
http://docutek.lib.umb.edu/eres/coursepage.aspx?cid=65	E-Reserve	The required readings from the primary literature are available as Adobe portable document format (pdf) files on the electronic reserve system at the UMASS/Boston library. Adobe pdf's can be read with the free Adobe reader (**www.adobe.com**), available for all web browsers.
http://www.lib.umb.edu/	UMB Library	The password for the EEOS630 course will be provided in class.
http://alpha.es.umb.edu/faculty/edg/files/edgwebp.htm	Gallagher's web page	Contains course-related links

Goals of the course

This graduate course will introduce students to the processes controlling phytoplankton, zooplankton, heterotrophic bacterial and benthic infaunal growth and abundance. We'll do a broad-scale survey of patterns of productivity and abundance in the coastal zones, upwelling centers, gyres, and the deep sea. We'll briefly survey ecosystem simulation models, especially those applicable to the Gulf of Maine. Readings will be from the primary literature and a few book chapters. The effects of anthropogenic effects on marine communities will be stressed throughout. Calculus will be used throughout the course, but there is no formal calculus requirement.

Prerequisites

There are no formal prerequisites for the course. However, biological oceanography is a quantitative field, so you must become familiar with some mathematical equations. Calculus isn't required, but it is strongly recommended. Calculus will be used in many of the primary papers. Equations describing population growth and many other concepts are based on differential and integral equations.

A Note for Non-matriculated students

I encourage non-matriculated students to take the class. To register for the class, bring your registration form for me to sign during the first class. Students from UMASS/Lowell and UMASS/Dartmouth should check with your local faculty for information on registration.

If you are uncertain about your ability to handle the material, try the course for the first couple of weeks. Most people are bewildered when first exposed to the primary biological oceanographic literature. I was as an undergraduate and first-year graduate student. This course is based almost entirely on papers from the primary biological oceanographic literature, and these papers contain a great deal of jargon. Most of these papers also involve mathematical equations. If you find yourself falling behind after a couple of weeks, drop the class. Take it again the following year or take one of the many other courses offered in the marine sciences at UMASS/Boston.

Class Logistics

Time & Location

The class will meet from 10:00 to 11:15 on Tuesdays and Thursdays in Presentation Room 3 in the lower level of the UMASS/Boston library. UMASS/Lowell and UMASS/Dartmouth students should check with their advisors for information on class location.

Office Hours and E-mail

Eugene D. Gallagher

I have scheduled office hours from 1-2:15 PM on Mondays and Wednesdays (before EOS Seminars). My office is in the Science Building, 1st Floor, Room 55. If possible, make an appointment in advance after class, by E-mail (Eugene.Gallagher@umb.edu), or by calling ([617] 287-7453 - leave a message with a return number to confirm appointment).

If you are having difficulty with the course, make an appointment to see me. I will explain the concepts and provide citations to additional papers and books so that you can learn more on a topic. The easiest way to get an answer about a specific question is to send me an E-mail message.

Angeliki Evgenidou, Course TA

Angeliki Evgenidou will be available throughout the course for students. She can be reached via email, **Angeliki.Evgenido001@students.umb.edu**, or phone 617 287-7468. Her office is in my lab, W-3-041, opposite the Biology Dept. main office.

WIMBA Virtual Office Hours

Sessions using WIMBA technology will be held on Monday and Thus nights (Mon: 7-7:45 pm & Thursday 9-9:45 pm). WIMBA Symposium is a synchronous online tool that allows students and faculty to meet in a virtual classroom where you can share applications and talk to each other in real time. The lectures for the course are being broadcast via WIMBA. In these sessions, you can ask questions, pose questions about the papers (which can be viewed on your screen). The last WIMBA session will be archived, so if you miss a session and want to listen in and see what was done, it will be available. Like the infamous black box on a jetliner, the previous WIMBA session is overwritten when a new session begins (so the Thus. session will be archived until the next Thursday).

To participate you will need to acquire a set of headphones with a microphone, and review WIMBA product instructions. Point your browser to: **http://www.muse.umb.edu** for WIMBA FAQ and to link to an on-line tutorial. A Login ID and password is necessary to access WIMBA. These will be provided by me during the 1st week of class. You may purchase headphones with an attached microphone at any computer or electronics store such as Radio Shack, Best Buy, Office Max, etc…. The prices range from $15-$25 for a set of headphones equipped with a microphone.

WIMBA Frequently Asked questions:
http://www.muse.umb.edu

I will provide your emails to the WIMBA coordinator who will create a username for you based on your first and last name. Your initial password will be your last name.

Reading Assignments

There will usually be a chapter and two assigned papers for each class. The course handouts, called chapters, will be posted on WebCT Vista, the UMASS online software system.

I recommend purchasing a large loose-leaf binder for the several hundred pages of handouts for the course. I based several of the handouts for this class on handouts that I was given by Drs. Karl Banse, Bruce Frost, Pete Jumars and Mary Jane Perry in their graduate phytoplankton, benthos, and zooplankton classes at the University of Washington in the late 70's. I have revised these handouts and upgraded them continuously since I first offered this course at UMASS/Boston in 1984. Each handout contains the list of required readings, supplemental readings, comments on the topic and readings, outlines of the papers, and annotated supplemental references.

The required readings from the primary literature are available as pdfs on the electronic reserve system at the UMASS/Boston library (See **E-Reserve Information**, below).

I expect you to read the assigned papers and my commentary before each class. To make your reading easier, I have provided my personal outlines of most of the assigned papers. These outlines show the points that I consider important.

HANDOUT DISTRIBUTION

The handouts will available in pdf format on the web. These pdf documents can be viewed and printed with the free Adobe Acrobat reader, available at: **http://www.adobe.com**

The Adobe Acrobat reader works both as a stand-alone application and as a plug-in for Netscape Navigator and Microsoft Internet Explorer.

The pdf-format handouts will be distributed only via WebCT. They'll be posted, usually 1 week in advance.

I want you to become comfortable with the primary biological oceanographic literature. For each topic, I usually list several supplemental references. These are often papers that address the same issues as the assigned papers. The supplemental references will also be available in alphabetical order in the library. These are often the papers that I had used as assigned papers in previous offerings of the course. You may wish to consult these key supplemental references for information on specific topics, Study Questions, and final examination essays. At the end of each handout will be an annotated listing of dozens of papers. These additional references are for your future use. You may find them helpful in preparing for the study questions, exams, and your research.

Table 2 lists what should be read before each class.

TABLE 2. ASSIGNMENTS FOR EACH CLASS

ITEM	BEFORE CLASS	LOCATION
Gallagher's chapter	Read the Comments & Outlines	Available as pdf files
Assigned readings (Usually 2)	Read and outline main ideas (See Discussion Format below)	Textbook or available as pdfs on E-Reserve
Supplemental Readings	Scan the Outline in Handout Read if you are interested.	JSTOR or electronically from Gallagher

LIBRARY

The sixth floor of the library contains the bound copies of most of the top marine science journals. The current periodical room on the 5th floor contains the latest issues of each journal.

WebCT Vista

There will be a course website on the WebCT Vista server, accessed through:
http://www.lms.umb.edu

You will be sent instructions for accessing the course WebCT site after you are officially registered through the UMASS/Boston WISER registration system.

WebCT Vista support

WebCT Vista support is available 24x7 to students and faculty via any one of the following methods:
Web CT Log in Page -
Click on Get Help link

email **bostonsupport@umassonline.net**
phone 800.569.6505

You will receive an email providing information about accessing the course site (which will be available on 9/6/06) when you have registered for the course in the UMB Wiser system

E-Reserve

The required readings from the primary literature are available as pdfs on the electronic reserve system at the UMASS/Boston library. The link to the UMB E-Reserve system is:
http://docutek.lib.umb.edu
and the direct link the ECOS630 reserves is:
http://docutek.lib.umb.edu/coursepage.asp?cid=65

The password for the ECOS630 course will be posted on WebCT Vista (or email me).

The E-Reserve system is also linked to the main UMB library page:
http://www.lib.umb.edu/

Search for the course readings under the course name, ECOS630, or Professor Gallagher. The papers are listed alphabetically. You will need the course password to access these readings. I will provide the password in class. Email me if you've forgotten the password.

Learning through Discussion Format

Note for the 2006 class

This will be the twenty-second time that I've offered this course since 1984. During this period, I have usually offered the course using **Hill's (1977, 1989)** "Learning Through Discussion" (LTD) teaching method. Because of large class sizes, in the last several years I have presented much of the course material in lectures. I am convinced that the discussion method is superior to lectures in teaching biological oceanography.

I will present the LTD format during the first class period. The format of the method is the Group Cognitive Map (GCM), which Hill discusses on p. 23 of his book. I have copied the GCM below for your reference and discuss some of my changes in the Hill's method.

Group cognitive map

Step One - Definition of Terms and Concepts

The goal of this step to get the definitions of technical terms and jargon out of the way. In Step Five we should be discussing ideas, not jargon.

During your reading of the assigned papers, please make a list of all terms and concepts with which you are unfamiliar. Covering these terms can take up to 15 minutes of the 75-min class. Check the Appendix of Statistical terms, posted on WebCT, and the class handout for definitions of terms before you ask about them in class. If you don't understand my definition from handout 2 or the class handout, ask. I will try to have other students define the terms and concepts, and then I'll add my refinements of the definitions if necessary.

LTD Step One on WebCT Vista

It would save time if you would post a list of terms and definitions on the **WebCT Vista** message board when you come across them. Then, I could check the list, answer the items online, or bring the definitions to class.

Step two - general statement of the author's message

What is the author's main point? State it in one or a few sentences. Step two lays the foundation for the big issues to come.

Step three - identification of major themes or subtopics

Come to class with a list of the major ideas from the papers. I will ask you for these ideas and outline them on the blackboard.

LTD Step three on WebCT Vista

It would save time if you would post a list of terms and definitions on the **WebCT Vista** message board before class. In leading the discussion, I would like to be able to provide references, discussions, figures, web links, that we can access during class for the discussion. If I can see these by the night before class, I can put the information together before class.

Step four - allocation of time

Usually, I list more topics on the board than we can discuss. I will outline the major topics for discussion and set a rough time for each. The discussion of major items must stop by **12:30** if we are to wrap up the day's topic.

Step five - discussion of major themes and subtopics

This will take the bulk of the class. I will try to keep the discussion fast-paced and orderly.

Step six - integration of material with other knowledge.

How does this material relate to other material that we have discussed?

Step seven - application of the material

How does this relate to your potential research or work interests?
For example, how would you use the ^{14}C method to estimate primary production in Massachusetts Bay? The reference lists are for your own information.

Step eight - evaluation of the author's presentation

A brief statement about the author's writing style.

Step nine - evaluation of group and individual performance.

I will consider these comments in organizing the remainder of the course.

Reference on LTD

Hill, W. F. 1989. Learning through discussion. Second edition. Sage publishers. Newbury Park, CA 91320 [ISBN 0-8039-0711-7] *[This inexpensive paperback ($11.50 on Amazon.com) describes the discussion method that will be used in the course. I recommend that you buy a copy if you plan on teaching for a career. This method is now used in several other courses at UMASS/Boston, at Carleton College (my alma mater), and the UW School of Oceanography.]* [7]

GRADING

Table 3 shows the relative weight given to items in calculating grades.

Table 3. Course Grading

AREA	% OF GRADE
Project 1 on Benthos	25%
Project 2 on plankton & modeling	25%
Final Exam	25%
Discussion	25%
TOTAL	**100%**

Study Questions

I will assign two study projects during the semester. You will have about 1 month to complete each project. The first project will be assigned in mid September and the second study question will be assigned during the 1st week of November. You will be asked to do research on a topic drawn from three broad areas. You will present your work in a 12-minute oral presentation and submit a 5-10 page research paper on the topic.

I will base the projects on papers from the primary literature. Together, the grades on these projects will determine 50% of your grade.

I'll provide a handout on suggestions for writing a good essay. I do grade on grammar and writing style. I am primarily interested in the force of your arguments, but you could lose a point or more on a ten-point grading scale for grammatical errors, improper citation format, and gross stylistic errors.

You must always hand in a brief outline of your essay. I always look at the outline first. In that outline, I should clearly see the major style of your essay, the major arguments, and the conclusion in this outline.

Final Examinations

There won't be a midterm in the class. I will base 25% on the final examination.

The final examination questions will be a combination of short definitions and essays. I will hand out the final examination questions at least 2 weeks before the final. The hitch is that I will hand out many more questions than I will ask on the final. The final examination will be in class. There will be no set time limit on the examination, but most students finish within the allotted 3-h period.

Discussion

I will base 25% of your grade based on participation in online discussions in WebCT Vista and in-class discussion. Post questions on WebCT Vista about the topics covered in class, topics that you want raise that are related to class material. Post questions about terms or definitions that you encounter in the readings. In class, I will often ask for a 1- or 2-sentence summary of the major points in a reading.

TEXTBOOKS

REQUIRED

None

SUPPLEMENTAL

Software

Matlab student version 13. This can be ordered through the Mathworks (**http://www.mathworks.com**). This package which costs $99 will be used to run simulation models near the end of the course. This is a tremendous deal because this package will be used in a number of other ECOS (ECOS601, ECOS611, and ECOS612) and Biology graduate courses, especially Solange Brault's population modeling class. Most of the figures generated throughout the course were produced in Matlab. Release 13, which came out in late 2003, works very well on all Windows platforms. There are copies of Matlab on all computers in the UMB graduate computing center behind the reserve desk on the 2nd floor of the UMASS/Boston library. It is also installed on all student computers in the library.

Supplemental Textbooks

Over the years, many students have asked what books I'd recommend in the field. There are many that I recommend but none that I could use as a text. Last year, I used **Miller's (2004) Biological Oceanography**. This textbook covers many of the same topics as this course, but I was disappointed in the quality of the book. It would be a good supplemental text for the course.

I've listed several texts that would provide good background reading. There are several that I would strongly recommend for those with a very strong interest in biological oceanography. **Mann & Lazier's (1996)** text is excellent, but it is limited in scope and it follows a different framework from that used in this course. This course tends to follow the N→P→Z→B format, standing for nutrients, phytoplankton, zooplankton, and benthos. Mann & Lazier focus on the interaction of physical and biological oceanography. They discuss how physics affects biological processes from molecular to global scales. The first edition, published in 1991, was excellent. There are no major differences in the first and second editions. If you can find a used copy of the 1991 text, it would be adequate for supplemental reading for this course. The 2005 edition is available for $74.95 (at **http://www.amazon.com**).

Eric Mills' (1989) history of biological oceanography is a must for students interested in the early history of biological oceanography, and it is a bargain at $55.00 for the hardcover edition (on Amazon.com). I recommend this book for those interested in the early history of biological oceanography (prior to the 1960s). This book is a special order at amazon.com, taking 4-6 weeks to ship.

There are several books that provide valuable supplementary and background reading on biological oceanographic processes. About half these books are still in print, but all can be obtained through the library. The following is a list of some of these recommended books:

Day, J. W, C. A. S. Hall, W. M. Kemp. A. Yáñez-Arancibia. 1989. Estuarine ecology. John Wiley & Sons, 558 pp. *[An excellent introduction to the physics, chemistry and biology of estuaries. It is aimed at the senior undergraduate or introductory graduate level. This book can be obtained through the library. It is very good, but it isn't worth $175 its current cost on Amazon.com]*

Falkowski, P. G. and J. A. Raven. 1997. Aquatic Photosynthesis. Blackwell Science, Malden MA. 375 p. *[A tremendous book, describing the biochemistry of photosynthesis. A second edition is due soon.]*

Harris, G. P. 1986. Phytoplankton ecology. Chapman and Hall. *[A controversial review of freshwater and marine phytoplankton. Most of the concepts are handled very well, but some of the speculations on nutrient limitation are highly controversial.]*

Jumars, P. A. 1993. Concepts in Biological Oceanography: An interdisciplinary primer. Oxford University Press, New York. *[An interesting approach to presenting biological oceanographic processes to non-biological oceanographers. His application of optimal foraging and digestion theory to biological oceanographic problems is the highlight of the book. The hardcover price is $54.50]*

Kirchman, D. L. (editor) 2000. Microbial ecology of the oceans. Wiley-Liss, New York. 542 pp. *[This recent volume includes a superb set of reviews of marine bacteria and the nitrogen cycle]*

Mann, K. H. 1982. Ecology of coastal waters: a systems approach. U. California press. *[An excellent overview of biological oceanographic processes. Mann is particularly strong on heterotrophic processes, detritus and seagrass systems.]*

Mann, K. H. 1999. Ecology of coastal waters: with implications for management. Blackwell Science. *[This is an excellent book. It is $59.95 on Amazon]*

Mann, K. H. and J. R. N. Lazier. 1996. Dynamics of marine ecosystems: biological-physical interactions in the oceans, 2nd Edition. Blackwell Scientific Publications. *[$64.95 at Amazon]*

Miller, C. B. 2004. Biological oceanography. Blackwell Publishing, Malden MA. 402 pp.

Mills, E. L. 1989. Biological Oceanography: An early history. Cornell University Press, Ithaca NY and London. *[This provides the history and origin of many of our modern concepts about the biological oceanography of phytoplankton. It is not an introductory text however. Mills reviews the work of the Kiel School, Plymouth Biological Laboratory and Gordon Riley (at Yale and W.H.O.I.). These schools laid the foundation for the study of phytoplankton ecology, especially the cause of the vernal phytoplankton bloom. The hardcover version is available at $55]*

Parsons, T. R., M. Takahashi, and B. Hargrave. 1984. Biological Oceanographic Processes. 3rd Edition. Pergamon Press, Oxford & New York. *[An excellent source of facts, figures, equations and relationships, but the style is*

very dry. The book is now badly dated. The book is still available at $44.95 and ships from amazon.com in 2-3 days]
Valiella, I. 1995. Marine Ecological Processes, 2nd Edition. Springer-Verlag, New York. *[A very good summary of the field. $62.95 at Amazon.com]*

Outline of the Course

I. Introduction to the course and a description of marine environments (**Class 1**)
- A. Course logistics
- B. Definitions of terms and some concepts
- C. Survey of discussion topics

PART I: BENTHOS

II. **Chapter 1** Introduction to benthic organisms & feeding guilds (**Class 2**)
- A. **Case studies**
  - 1. **Jumars & Fauchald's 1977** classification of feeding guilds
  - 2. **Cammen's (1980)** model of ingestion rate
- B. Classifications of marine benthic organisms
  - 1. Macrofauna, meiofauna, and microfauna
  - 2. Benthic Feeding Guilds & Functional groups

III. **Chapter 2** Microphytobenthos & benthic primary production (**Class 3**)
- A. **Case studies**
  - 1. Savin Hill Cove
    - a. **Gould & Gallagher (1990)**
  - 2. Ems Dollard
    - a. **Admiraal et al. (1982)**
    - b. **Admiraal (1984)**
- B. Benthic diatoms

IV. **Chapter 3** Bioturbation (**Class 4**)
- A. **Case Studies**
  - 1. **Cammen (1980)**
  - 2. **Boudreau (1998)**
  - 3. **Shull (2001)**
- B. What is Bioturbation?
- C. Why is it important?
- D. How is it measured?
- E. Effects of the benthic infauna on sediment geochemistry
- F. Pelletization

V. **Chapter 4** Benthic population processes (**Class 5**)
- A. **Case studies**
  - 1. **Gallagher et al. (1990)**
  - 2. Competition
- B. Predation
- C. Amensalism

VI. **Chapter 5** General patterns of community structure (**Class 6**)
- A. **Case studies**
  - 1. **Jumars & Gallagher (1982)**
- B. Methods to describe community structure
  - 1. Diversity indices
  - 2. Classification
  - 3. Ordination
  - 4. Canonical Analysis
- C. Factors controlling community structure
  - 1. Biogeography
  - 2. Environmental Factors
  - 3. Biological interactions
- D. Examples
  - 1. The intermediate disturbance hypothesis
  - 2. Succession in the Skagit flats
  - 3. EMAP Virginian Province data
- E. Deep-sea community structure and patterns of marine biodiversity (Class 9)
- F. Case studies
- G. Patterns of deep-sea community structure
- H. Sanders' stability-time hypothesis
- I. Other hypotheses for patterns of deep-sea diversity.

VII. **Chapter 6** Effects of pollution on marine benthic communities (Class 10**)**
- **A. Case studies**
  - 1. Organic enrichment gradients **Rhoads et al. (1978)**
  - 2. The West Falmouth oilspill, **Grassle & Grassle (1974)**
- B. General Principles
- C. Effects on communities
- D. Effects on individuals
- E. Statistical models for monitoring and assessing the effects of pollution
- F. **Chapter 7** Effects of pollution in East Coast Benthos
  - 1. **Case studies**
    - a. The EMAP program
    - b. Boston Harbor: **Gallagher & Keay (1998)**
    - c. New Bedford Harbor
- G. EPA's EMAP program & patterns of east coast community structure: salinity effects dominate
- H. Effects of pollution on Boston Harbor, New Bedford Harbor, and MA Bay benthos

PART II : PRIMARY PRODUCTION

VIII. **Chapter 8** P, B, and μ: the fundamental units of phytoplankton ecology (Class 11)
- A. Readings
  1. **Eppley (1972)**
  2. **Lorenzen (1966)**
  3. Gallagher's Chapter 1
- B. Distinguishing among B, P, and μ: Biomass, production and specific growth rate
- C. C:Chl *a* ratios **Gallegos & Vant (1996)**
- D. The effects of temperature on μ_{max} **Ahlgren (1987)**

IX. **Chapter 9** The C-14 & oxygen methods (Class 12)
- A. Readings
  1. **Peterson (1980)**Estimating primary production using the ^{14}C and O_2 methods.
- B. The great productivity debate

X. **Chapter 10** Environmental factors controlling primary production: Light (Class 13)
- A. Readings
  1. Required:
     - a. **Harrison et al. (1985)**
     - b. **Falkowski & Raven (1997)**
- B. What is photosynthesis?
- C. P *vs*. I curves
  1. simulated *in situ* incubations.
  2. Jassby-Platt equation
  3. Estimating primary production using the P *vs.* I approach in MA Bay.
- D. Diel and vertical patterns of production.
- E. Photoadaptation & photoinhibition
- F. Importance of light quality

XI. **Chapter 11** Environmental factors controlling primary production: Nutrient limitation (**Class 11**)
- A. Readings
  1. **Howarth (1988)**
  2. Liebig's Law of the minimum and Brandt's denitrification hypothesis
- B. Phytoplankton growth & the nitrogen cycle
- C. Chemostats in oceanography
  1. Coupling N uptake and growth with Michaelis-Menten style equations
     - a. The Droop equation & the cell quota
     - b. Caperon & Meyer's equation
     - c. growth kinetics
  2. Goldman's relative growth rate and the Redfield ratio
- D. Other nutrients: P, Si, metals (Fe and Zn)

XII. **Chapter 12** The spring and fall blooms (**Class 12**)
- A. Readings
  1. Required
     - a. **Sverdrup (1953)**

b. **Townsend & Spinrad (1986)**

2. Recommended: **Parsons et al. (1966)**

B. Sverdrup's critical depth concept

1. Non-dimensional critical depth
2. The vernal bloom in the North Pacific and North Atlantic.
3. The spring bloom in MA Bay
    a. **Nelson & Smith's (1991)** explanation for the lack of an Antarctic bloom
    b. The timing of the MA Bay bloom

C. The fall bloom

XIII. **Chapter 13** Upwellling & El Niño (**Class 13**)

A. **Case studies**

1. **Ryther et al. (1971)**
2. **Mann & Lazier (1996)**

B. The physics of upwelling

1. The role of wind stress
2. Ekman spiral, Ekman mass transport
3. coastal upwelling
4. Equatorial divergences

C. Succession at upwelling centers

D. Upwelling and fish production

E. Upwelling and bottom-water anoxia off New Jersey

F. El Niño and La Niña

XIV. **Chapter 14** Production in the coastal zone (**Class 14**)

A. **Case studies**

1. **Riley (1967)**
2. **Eppley et al. (1979)**

B. Why Nitrogen is the key limiting nutrient in the sea

C. The advection-diffusion equation, and the importance of horizontal and vertical eddy diffusive fluxes of nitrate

D. Box and Markov models of nitrogen transport

E. The role of vertical stability and the importance of horizontal nutrient transport

XV. In class midterm examination (10/24/06 Tu, **Class 15**)

XVI. **Chapter 15** Production in Harbors and Bays, especially MA Bay (**Class 16**)
- A. **Case studies**
  - 1. **Cole & Cloern (1987)**
  - 2. **McGillicuddy et al. (2003)**
  - 3. Boston Harbor
    - a. **Adams et al. (1992)**
- B. Types of estuaries and fronts
- C. The seasonal cycle of production in MA Bay
- D. The N cycle in the Gulf of Maine, MA Bay, Boston Harbor
- E. Edmondson's definition of eutrophication
- F. Effects of light and nutrients and the Cole-Cloern/ Platt relationship.
- G. The vertical distribution of phytoplankton & the subsurface chlorophyll maximum
- H. Effects of the MWRA outfall
  - 1. Importance of vertical stratification
  - 2. Secondary treatment and phytoplankton biochemical oxygen demand
  - 3. Upwelling & hypoxia in NJ

XVII. **Chapter 16** Primary production in the oceanic gyres (**Class 17**)
- A. **Case studies**
  - 1. **Platt et al. (1989)**
  - 2. Rates of production in gyres.
  - 3. Problems with the ^{14}C method.
  - 4. Indirect measures of primary production
- B. Models of gyre production.
  - 1. Are the gyres analogous to a chemostats?
  - 2. Goldman et al.'s (1978) micro-nutrient patch hypothesis
  - 3. The two-layer hypothesis
  - 4. The role of mesoscale phenomena

XVIII. **Chapter 17** Satellite remote sensing of Chl *a* and primary production (**Class 18**)
- A. Case studies
  - 1. **Platt & Sathyendranath (1986)**
  - 2. **Behrenfield & Falkowski (1997)**
- B. Types of satellites and their sensors
- C. The CZCS algorithm to estimate Chl *a*
- D. Estimating primary production from space.

PART III SECONDARY PELAGIC PRODUCTION

XIX. **Chapter 11** Zooplankton grazing mechanisms (**Class 19**)
- A. **Case studies**
  - 1. **Koehl & Strikler (1981)**
- B. Life at Low Reynolds number
- C. Frost's empirical relationships between grazing and phytoplankton conWIMBAtion
- D. Interaction between phytoplankton size and grazing
- E. How to measure zooplankton grazing rates.

F. Are noxious phytoplankton blooms in the coastal zone due to lack of grazing, eutrophication, or both?

XX. **Chapter 12** Predation on zooplankton (**Class 20**)
- A. **Case studies**
  - 1. **Brooks & Dodson (1965)**
- B. Brooks and Dodson's (1965) 'Size-efficiency hypothesis'
- C. The role of invertebrate predation
- D. The trophic-cascade hypothesis
  - 1. Carpenter's whole-lake experiments
  - 2. Critical analysis of the design

XXI. **Chapter 13** Vertical migration of zooplankton (**Class 21**)
- A. **Case studies**
  - 1. **Ohman et al. (1983)**
- B. Zooplankton life histories
- C. Demography
- D. Demographic analysis of the adaptive value of vertical migration
- E. Game theoretic analysis of vertical migration

XXII. **Chapter 14** Heterotrophic microbial processes (**Class 22**)
- A. **Case studies**
  - 1. **Azam et al. (1983)**
- B. Methods for determining microbial standing stocks & production
- C. What limits bacterial production?
- D. The microbial loop hypothesis
  - 1. sources of dissolved organic matter (DOM)
  - 2. Control of bacterial standing stock and production
  - 3. Nutrient regeneration
  - 4. transfer of DOM to macrozooplankton and fish
- E. Microbial biodiversity (**Class 23**)

XXIII. **Chapter 15**: The Ecological Implications of Body Size (**Class 24**)

XXIV. **Chapter 16** Factors controlling primary and secondary production HNLC regions, the subarctic Pacific and Southern Ocean. (**Class 25**)
- A. Case studies
  - 1. **Martin & Fitzwater (1988)**
  - 2. **Boyd et al. (2000)**
- B. The North Pacific
  - 1. The Major-grazer paradigm
  - 2. Refutation/Revolution: the micrograzer paradigm
  - 3. Martin's iron limitation hypothesis
  - 4. New paradigm: the ecumenical iron hypothesis
- C. The Southern Ocean

D. **Chapter 17** Oceanographic production and atmospheric CO_2 (**Class 26**)
  1. Martin's Geritol solution to global warming: Fe limitation
  2. IronEx II & III
  3. Southern ocean: Fe or light limitation?

PART IV: ECOSYSTEM SIMULATION MODELING

XXV. Ecosystem Modeling (**Class 27**)
A. **Chapter 18**
  1. Readings: TBA
  2. Recommended
    (1) **Steele (1974)**
    (2) **Evans & Parslow (1985)**
  b. Steele's North Sea Ecosystem Model
    (1) the standard run & Landry's modifications
  c. Model stability: the role of refuges and predation

B. **Chapter 19** Coastal marine ecosystem modeling (**Class 28**)
  1. **Case studies**
    a. **Kremer & Nixon (1978)**
    b. **MA Bay model**
  2. Kremer and Nixon's Narragansett Bay Model
    a. Physical model
    b. Phytoplankton growth
    c. Zooplankton growth
    d. Predation
    e. Benthic-pelagic coupling
  3. Predicting the effects of man's activities: DiToro's Hydroqual model of MA Bay

XXVI. Final Examination during the scheduled final exam period.

Links to handouts & slide presentations

HANDOUTS

By clicking on the boxes in the third column from your web browser, you can view and download the handouts in Adobe Acrobat pdf. The free reader with plugins for Netscape and Microsoft Internet explorer is available at **http://www.adobe.com.** The files are password protected, but you can save & print the handouts. The password was provided in class. E-mail me at **Eugene.Gallagher@umb.edu** if you've forgotten the password. Microsoft Internet Explorer may refuse to download the pdf files unless you set your security settings (in preferences) to something other than high. The files can be printed on any printer either from your browser or from the downloaded file. The files range in size from 78kb to 1.2 MB. The latest revision date is provided underneath each box in the table below. Study question 3 isn't posted yet.

Slides from class

I've included links to html files containing all of the slides used in my presentations in class. A few slide shows will also be provided as Macromedia Flash shows, which can be viewed using the fee Macromedia flash plugin (requested by both IE and Netscape when you click on the show).

WebCT Vista Online Software

Course handouts and the slideshows will also be linked to the ECOS630 course on the WebCT Vista system at **http://www.lms.umb.edu** Class message boards and chat will only be available on the online server. Instructions for accessing the ECOS630 course on WebCT Vista are available at:

This course web page is only accessible by registered students.

Lecture Schedule for 2008

Table 4. Lecture schedule.

	Date	Topic	Readings	
			Required	Recommended
9/1/08 Mo		Labor Day		
9/2/06 Tu		semester Start		
1	9/2/08 Tu	Introduction to the course.	**Syllabus** **Appendix 1: Terms (pdf)** **Appendix 1: Terms (html)** **html version**	

	Date	Topic	Readings	
			Required	Recommended
2	9/4/08 Th	Benthic Feeding Guilds, Functional Groups	Chapter 1 Benthic feeding guilds **Jumars & Fauchald (1977) Cammen (1980)**	**Boudreau (1998)**, **Fauchald & Jumars (1979)**, **Jaksic (1981)**,**Jumars (1993)**, **Woodin & Jackson (1979)**
3	9/9/08 Tu	Benthic Feeding Guilds Continued		
4	9/11/08 Th	Benthic Feeding Guilds (end) & Bioturbation	Chapter 2 Bioturbation **Boudreau (1998)**, **Shull (2001)**	**Boudreau (1994)**,**Boudreau (1998)**, **Cammen (1980)**,**Gallagher & Keay (1998)**, **Jumars (1993b)**, **Matisoff (1982)**, **Miller (2004) Chapter 13, pp 287-299**, **Rhoads (1974)**,**Rice (1986)**, **Shull & Yasuda (2001)**
5	9/16/08 Tu	Bioturbation (end) & Microphytobenthic production	Chapter 4 **Gould & Gallagher 1990**	**Admiraal 1984 Admiraal et al. 1982 Ludden et al. 1985 Redalje & Laws 1981**
6	9/18/08 Th	Benthic Population Processes & Community Structure	Chapter 3 **Gallagher *et al.* (1990)**	**Fenchel (1977)**, **Virnstein (1977)**
7-8	9/23/08 Tu 9/25/08 Th	Benthic Community Structure: Case Study 1 & 2, Buzzards Bay & MA Bay	Chapter 3	

	Date	Topic	Readings: Required	Readings: Recommended
9		Global patterns of benthic community structure	Chapter 5	**Mills (1969)**, **Sanders (1968)**, **Huston (1979)**, **Etter & Grassle (1992)**, **Grassle & Maciolek (1992)**, **Trueblood *et al.* (1994)**
		Deep-sea benthic diversity & rate processes	**Jumars & Gallagher (1982)** **Rex et al. (2005)**	**Sanders (1968)**, **Huston (1979)**, **Etter & Grassle (1992)**, **Grassle & Maciolek (1992)**
10		Pollution problems in Boston & New Bedford Harbors	Chapter 6 & Chapter 7 **Gallagher & Keay (1998)**	**Gray *et al.* (1988)**, **Pearson & Rosenberg (1978)**, **Grassle & Grassle (1974)**, **Rhoads *et al.* (1978)** **Rosenberg (2001)**
11		Methods for estimating primary production using the ^{14}C- and O_2 methods	**Chapter 8** **Peterson (1980)** **Falkowski & Raven (1997, Chapter 9**	**Fogg (1980) 24-45**, **Miller (2004) Chapter 3**, **Parsons *et al.* (1984a) [Pp. 115-120]**, **Harrison & Platt (1980)**, **Parsons *et al.* (1984b) 61-66**, **Pregnall (1991) 53-75**
12		The effects of light on phytoplankton growth, P *vs.* I curves & light adaptation	EDG Chapter 9 **Harrison *et al.* (1985)** **Falkowski & Raven (1997) Chapter 9 *263-276, 282-288***	**Miller (2004) Chapter 3**; **Parsons *et al.* (1984b) 61-80**
		Columbus Day Holiday		

	Date	Topic	Readings: Required	Readings: Recommended
13		Nutrient effects on phytoplankton growth	EDG Chapter 10 **Howarth (1998)**	**DeBaar (1994)**, **Goldman (1980)**, **Miller (2004) Chapter 3 p. 56-69**, **Mills (1989)**, **Nixon & Pilson (1983)** **Parsons et al. (1984, pp. 100-108)** **Ward (2000)**
14		Sverdrup's critical depth concept & "Why is there a March bloom in MA Bay?"	EDG Chapter 11; **Sverdrup (1953)**, **Parsons et al. (1984)**, **Townsend & Spinrad (1986)**	**Evans & Parslow (1985)**, **Miller (2004) Chapter 1**, **Nelson & Smith (1991)**, **Mills (1989)** Pp. 120-171,**Parsons *et al.*(1966)** **Parsons *et al.*(1984b)** *Pp. 87-100* **Smetacek & Passow (1990)**,
15		Upwelling, Ekman Transport, and ENSO events	EDG Chapter 12 **Mann. and Lazier (1996)*[pp. 161-212]***, **Ryther *et al* (1971)**	**Barber & Chavez (1986)**, **Pickard & Emery (1982)** *[Read pages 215-218 on coastal upwelling.]*, **Pond & Pickard 1978.** [Skim pages 81-96.], **MacIsaac *et al.* (1985)**, **Schreiber & Schreiber (1984)**
16		Factors controlling primary production on continental shelves	EDG Chapter 13 & Chapter 14 **Eppley *et al.* (1979)**, **Riley (1967)**	**Lunven et al. (2005)**

	Date	Topic	Readings: Required	Readings: Recommended
17		Primary production in Boston Harbor & Massachusetts Bay	EDG Chapter 14 **Cole & Cloern (1987)** **McGillicuddy et al. 2003**	**Adams *et al.* (1992)**, **Cullen (1982)**, **Haury *et al.* (1983)**, **Kelly (1997)**, **Kelly & Doering (1997)**, **Mann & Lazier (1996)**, **Lunven et al. (2005)**, **Nixon (1995)** **Officer & Ryther (1977)**, **Townsend (1997)**
18		Upwelling & El Niño	Upwelling, Ekman Transport, and ENSO events	EDG Chapter 12 **Mann. and Lazier (1996)*[pp. 161-212]***, **Ryther *et al* (1971)**
19		Primary production in oligotrophic gyres	Chapter 15 **Platt *et al.* (1989)**	**Eppley (1980)**, **Gieskes & Kraay (1984)**, **Grande *et al.*(1989)**, **Laws *et al.* (1990)**, **Venrick (1990)**
20		Satellite remote sensing	Gallagher Chapter 16, **Perry (1986)**, **Behrenfield & Falkowski (1997)**	**Campbell & O'Reilly (1988)**, **Eppley *et al.* (1985)**, **Platt (1986)**, **Platt *et al.* (1988)**, **Platt & Sathendrayath (1988)**
21		Zooplankton grazing mechanisms	EDG Chapter 17 **Koehl & Strickler (1981)** **Miller Chapter 7**	**Banse (1992)**, **Frost (1980a)** *Pp. 465-491* **Purcell (1977)** **Price (1988)** **Welschmeyer & Lorenzen (1985)**

	Date	Topic	Readings: Required	Readings: Recommended
22		Size-selective predation & competition **Virtual copepod page: for Jaffe, Fowler & Yen *Euchaeta* movies**	Gallagher Chapter 18 **Brooks & Dodson (1965)**	**Greene (1983)**, **Kerfoot (1975)**, **Neill (1975)**, **Paine (1966)**
23		Vertical Migration Playing cards for the vertical migration game Scorecard & rules for the vertical migration game	Chapter 19 **Ohman *et al.* (1983)**	**Frost (1988)**, **Gliwicz (1986)**, **McLaren (1974)**, **Ohman (1990)**
24		The microbial loop. Factors controlling bacterial production and standing stocks	Gallagher Chapter 20	**Azam *et al.* (1983)**, **Ducklow (2000)**, **Fenchel (1988)**, **Fuhrman & Azam (1982)**, **Hoppe et al. (2002)**, **Jumars *et. al* (1989)**, **Jumars (1993, 179-197)**,**Miller Chapter 5**, **Riemann & Bell (1990)**
25		Primary production in nitrate-rich seas	Gallagher Chapter 23 **Boyd et al. (2000)**, **Morel & Price (2003)**	**Boyd *et al.* (1996)**, **Coale *et al.* (1996)** **Evans & Parslow (1985)**, Frost (**1987**, **1991**), **Martin & Fitzwater (1988)**, **Miller *et al.*(1991)**, **Parsons *et al.*(1966)**
26		Numerical models - the standard form of pelagic theory. North Sea Ecosystem model	**Steele (1974)**, **Landry (1976)** Gallagher Chapter 25	

<table>
<tr><th rowspan="2"></th><th rowspan="2">DATE</th><th rowspan="2">TOPIC</th><th colspan="2">READINGS</th></tr>
<tr><th>REQUIRED</th><th>RECOMMENDED</th></tr>
<tr><td>27</td><td></td><td>Last class
New England Coastal Ecosystem Modeling: Narragansett Bay and Hydroqual MA Bay Eutrophication Model</td><td>Chapter 26
Kremer & Nixon (1978)
(3 chapters) Read 1-5, especially 23-59</td><td>Frost (1980b)
Kremer & Nixon (1978)
Mills (1989), Steele (1976)</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="5">(Final Exam Period) 8 am in Presentation Room 3 & ITV classrooms at Dartmouth & Amherst
Final exam, in class, 3 hours, closed book</td></tr>
</table>

Reading list

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