Oceanography Senior Thesis Guidebook

For winter-spring 2010

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Criteria defining the Oceanography Senior Thesis Experience

The UW School of Oceanography provides each of its undergraduate majors with the opportunity to conduct research and/or independent study on a topic of their choice and to write an undergraduate thesis formally presenting the results. Students typically complete their senior thesis by completing the two course sequence Ocean 443-444 in the winter and spring of their senior year. Motivated students can complete the thesis requirements through independent research outside of the formal thesis coursework - see the appendices to this document for the forms necessary to 'opt-out' of the traditional senior thesis courses.

For many students research is an experience with which they have little experience. Thus, it is often seen as a big hurdle and it can cause anxiety and worry. This guidebook is designed to clarify procedures, expectations and deadlines, explain options, provide resources, and reduce some of the anxiety.

Your thesis experience should prove to be one of the most rewarding parts of your Oceanography education.

The goals of the senior thesis are:

1. To create a thesis proposal that is self-generated, written to departmental guidelines, and that undergoes at least two rounds of review by faculty and students in the School.
2. To perform independent research. If the research is conducted as part of a larger project, the individual's research must have its own hypotheses or goals that are definable within the context of a larger research frame.
3. To provide opportunities for students to develop interpersonal skills and a sense of how individual research is conducted within a larger frame. The two examples of this used in 443/444 include group planning of the research cruise and peer-to-peer review of research proposals and reports.
4. To create a final report, separate from the initial project proposal, that is written wholly by the student. The final report is an opportunity for the student to explain how their research fits within the work of the larger Oceanographic community. The final report will undergo both student and faculty review and will be made publicly available through the UW's Digital Library (ResearchWorks).
5. To present the results of the research in a public venue either through a poster presentation or an oral presentation. The senior thesis course 444 provides this opportunity via its spring symposium.

Ocean 443 Schedule Winter 2010

Class Periods: Tues & Thurs 1:30-2:50 pm OTB 205

Sun	Mon	Tues	Wed	Thu	Fri	Sat
	Jan 4	5 Course Orientation (RK) Group Intros (All Instructors)	6	7 Introduction to Patagonia and research there // Tech Services	8	
	11	12 Faculty Presentations: Chemical Oce Biological Oce	13	14 Faculty Presentations: Physical Oce Geological Oce	15 Prelim Topic Summary due 5pm	
	18	19 Shari et al. video conference call to class (1/2 hour)	20	21 Proposal writing workshop (TA)	22 Prop. Outlines due 5pm	
	25	26 Guest Speakers (Chuck Nittrouer and Bernard Halliet)	27	28 Student Oral presentation of ideas	29	
	Feb 1	2 Class Discussion: evolving themes	3	4 Option Group Meetings	5 Prop Drafts & STR due 5pm	
	8	9 Option Group Meetings	10	11 Peer Review of proposal Drafts	12	
	15	16 Option Group Meetings	17	18 Option Group Meetings	19 Final Props due 5pm	
AGU-ASLO Week	22	23 Cruise Planning session 1 (by group)	24	25 Cruise Planning session 2 (across groups)	26	
	Mar 1	2 Cruise Plan Presentations	3	4 Chuck re-visit with new data?	5	
Last week of classes	8 Depart for Chile	9 Arrive Punta Arenas	10 Load ship	11 Cruise begins in Punta Arenas	12	13
14 Finals week	15	16	17	18	19 Cruise ends in Puerto Montt	20 Demob
21	22 Spring Break	23	24	25	26	27

Ocean 444 Schedule Spring 2010

Class Periods: Tues & Thurs 1:30-2:50 pm OSB425. We will meet as a class every Thursday. On Thursdays you will meet individually with your mentors and peers. We have the SAL lab reserved on Tuesdays.

Sun	Mon	Tues	Wed	Thu	Fri	Sat
	Mar 29	30	31	Apr 1 Class Organizational Meeting	2	
	5	7	8	9 Lecture: components of a great scientific paper	10	
	12	14	15	16 Student Updates	17	
	19	21	22	23 Student Updates	24	
	26	28	29	30 Lecture: How to give a great presentation	May 1	
	3	5	6	7 Student Updates COMPLETE DRAFT Due 5:00pm	8	
	10	12	13	14 Peer Review Session	15	
	17	19	20	21 *Practice presentations*	22	
	24	*26* *Practice presentations*	27	28 *Practice presentations* Final paper due 5:00pm	29	
	31 Memorial Day	June 1 CLASS SYMPOSIUM	2	3 CLASS SYMPOSIUM	4	
	7	8	9	10	11	12 Commencement

Syllabus: Ocean 443 Design of Oceanographic Field Experiments

Winter Quarter - Tuesdays and Thursdays 1:30-2:50 PM, OSB410)

I. Instructors

Prof. Eric D'Asaro (Phys. Ocean.)
512 Applied Physics Lab
685-2982 [dasaro@apl.washington.edu.]

Prof. Deb Kelley (Geol. Ocean.)
909 Boat Street Office 104
(by the University Bridge)
685-9556 [dskelley@uw.edu]

Prof. Rick Keil (Chem. Ocean.)
517 Ocean Science Building
616-1947 [rickkeil@uw.edu]

Prof. Bob Morris (Biol. Ocean)
316 Ben Hall IRB
221-7228 [morrisrm@uw.edu]

Colleen Durkin (TA, Biol. Ocean)
327 Ben Hall IRB
685-1047 [cdurkin@uw.edu]

Kathy Newell (all options)
21 OTB
543-6119 [newell@ocean.washington.edu]

II. Course goals

The primary function of Ocean 443 is to provide guidance for the formulation of your research proposals and for timely cruise planning of the Ocean 444 fieldwork that will take place in March. The multi-faceted goal of Ocean 443 is to familiarize you with strategies and methods in field Oceanography, with thinking beyond the confines of your own option, with fitting into group efforts, with interpreting and presenting the resulting information, and, finally, with learning more about this year's field site, the inland fjords of Patagonia, Chile. You will have principal responsibility for selecting a research topic/goal and then planning, executing, and reporting on your work. Experience tells us that you will enjoy this unique opportunity to develop your scientific skills in a real world framework.

The key to success in Ocean 444 is solid preparation in Ocean 443. Your major individual goals for winter quarter are 1) to produce a detailed research proposal to test an hypothesis or explore an emvironment using the best possible experimental/observational strategy, given the limitations in time and available equipment, 2) to prepare to go to sea, and 3) to assist in the cruise planning (schedule, logistics, etc.) for the ship that will be used. The combination of background research, proposal writing, and cruise planning (Ocean 443), the research cruise itself, paper writing, and the class symposium (Ocean 444) is what makes this capstone course sequence such a unique, rewarding, and educational experience.

III. Setting, Scheduling, and Resources

Fieldwork is tentatively scheduled aboard the *R/V Thomas G. Thompson* 11-19 March. Careful cruise planning will be necessary in order to provide adequate research opportunities to all of the class members. *Thompson* is permanently equipped with an ADCP (75 kHz), a dual-frequency (12 and 3.5 kHz) echo sounder/subbottom profiler, a Simrad EM300 (30 kHz) swath mapping system, a CTD system, and GPS positioning systems. The CTD system includes a transmissometer, fluorometer, O_2 sensor, PAR sensor, altimeter, and up to twenty-four 10 L Niskin bottles. Other sampling equipment can be requested and rented from Pooled Equipment (http://www.ocean.washington.edu/services/techservices.html). Additional laboratory equipment (bench-top fluorometer, filter rack and pump, microscopes, glassware, etc.) is available through Classroom Services (Kathy Newell, 543-6119, 21 OTB). Our Marine Chemistry Lab can provide a wide range of analytical services.

In choosing your research project, we encourage you to think in terms of a team approach that crosses option boundaries. More useful insight can typically be gained if a problem is viewed and

understood from multiple perspectives. This approach may also provide valuable experience as you enter the job market or graduate school.

IV. Course Requirements and Grading

In Ocean 443, each of you will be responsible for a written research proposal that lays out a scientific background and rationale, a cruise/analytical work plan, and a budget. Copies of some proposals from previous years are available from your advisers for short-term loan. To assist you in keeping on pace, additional assignments (Topic Summary, Proposal Outline) are designed to help you develop your library, organizational, and writing skills. Instructions for these assignments are on the class web site (http://courses.washington.edu/Ocean443) and in this handout pack. During winter quarter, you are expected to invest significant time reading relevant literature and your proposal should reflect this with a discussion of published work related to your study (including appropriate citations). You will assist, during formal class exercises, in formulating a detailed cruise plan for the ships and vessels that will be used and for ensuring that research vessel time is apportioned adequately and fairly. Prior to any cruise work, you will also be responsible for ordering necessary supplies and expendables, seeking out the equipment you need, and mastering necessary shipboard measurement techniques.

Your grade in Ocean443 will be derived from the following components:

- Topic Summary incl. web post. 5%
- Proposal Outline incl. web post. 10%
- Individual Ship Time Request 5%
- Draft Proposal 20%
- Peer Review exercise 15%
- Group Cruise Planning 10%
- Final Proposal and web posting. 35%

On the due dates shown above you will also be required to post the Topic Summary, Outline, and final Proposal on your web site, which in turn will be linked to the class web site. Deductions of 2 points per day will be made for late submissions. A passing grade in Ocean 443 and admission to Ocean 444 are contingent upon submission of an acceptable proposal demonstrating that you are thoroughly prepared for the research cruise.

V. Class Web Space

The Ocean 443 and 444 Senior Research Web Sites serve a broad community of interested persons, including other Oceanographers, your parents, friends and relatives, and our alumni. These pages are popular and receive thousands of hits each year. Your research is something that the school is proud of and we enjoy providing a web outlet for your work.

Each of you is asked to share material for posting thesis-related documents. The course web pages will provide the general public with your content. As you carry out your research, you will be asked to post various components of the work to the class page. If you need help, please ask one of your advisors.

Ocean 443: Writing Your Project Topic Summary

- Due via E-submit/Collect It

Goal

Once you have assembled and read a variety of papers on your chosen topic, you should be able to flesh out and present your embryonic project idea and/or hypothesis in the form of a Topic Summary. This Topic Summary, described in detail below, should be fully supported by citations of relevant literature.

In the past, students in this class have frequently overlooked the importance of comprehensive literature reviews. This assignment will give you practice in integrating library research with project validation and design. Literature reviews are a critical and fundamental part of any scientific enterprise. If used early and wisely in the initial phases of your research, library resources can assist in fine-tuning project design and in clarifying your own research objectives by placing your goals within the context of previous work. Through literature reviews we become acquainted not only with what is known about a given subject, but also with how something becomes known. What methods were used? What assumptions were made? Are conclusions believable and are they supported by the presentation of adequate data and facts? Reviewing literature is an opportunity to identify questions that interest you and with methods that you might use. A literature review also functions as a first 'gauntlet' through which to test your own ideas and challenge the ideas of others. Finally, if you review the literature well, you are not likely to spend valuable resources (time and money) reinventing the wheel or repeating someone else's mistakes.

Note: persons who work on this assignment right away
(late fall quarter, over winter break) have an easier time with the entire course.

Homework Assignment: Topic Summary

You should by now have fastened onto a topic or question that you intend to make the focus of your own independent research project. You have already started a literature search to learn more about it. Survey the abstracts to find articles most pertinent to your interests, and then get the articles themselves. It would be prudent to include past student papers in your searches. After you have read the articles and papers write a one-page, one-paragraph-long summary of your research topic. Discuss what you have learned about the subject, trying to integrate the information from the different articles. In this Topic Summary, support assertions as you make them using appropriate references. Complete citations for these references should be listed following the Topic Summary. Conclude by identifying a further question, direction, or hypothesis suggested by the library research that you might wish to pursue, for example, as your research proposal. This hypothesis can be speculative (and daring, if you like) but it must be supported by what you've cited. The required ingredients of your Topic Summary include:

- *Tentative Title*
- Clear statement of *Objectives*, i.e. the question or hypothesis under investigation
- *Why* – what is the scientific relevance of the research?
- *What* – what data/samples/measurements/analyses will be required to meet your Objectives?
- *Where* – where is your study area?
- *When* – when will the work be done and what conditions are necessary or critical?
- *How* – what equipment will be needed (aboard ship and ashore) and what analytical procedures will be used? What outside services are required?
- *Who* – is involved other than yourself (external adviser/experts etc.)?
- *References*
- *Figure(s)* as appropriate

All Topic Summary paragraphs must be supported by citations from at least five **different** articles from refereed publications. Past student papers do not fall into this category, although they may still be referenced and cited in support of your ideas. Past student papers are the only unpublished sources that may be included as references in your Ocean 443 proposal and Ocean 444 paper. Also pay attention to when the article was written – a lot of things change, even in a few years. Feel free to dispute claims in one article with evidence or arguments from another, etc. You should include at least one supporting figure with your Topic summary. This figure can be of the proposed study area, sampling locations, data from previous work, etc. You will be graded on your coverage of the required elements (above), effective use of citations, and your web posting of the Topic Summary (including the References, and the Figure). Use the Limnology and Oceanography bibliographic style, following the examples in the L&O Style Guide at http://www.aslo.org/lo/instructions/authors.html.

Oral Presentation of Ideas

A few days after completing your topic summary you will be asked to briefly provide to the class an updated overview of your ideas and plans. This informal presentation should make use of maps or hand drawings on a white board, as appropriate, but graphics (PowerPoint) are forbidden. The point is to informally get the entire class involved in helping you with your ideas.

How to proceed with this assignment

- Create your UW web site (or suitable alternative) and create a link within the web site that will take visitors to your Ocean443 class documents.
- Read papers! Talk with students and faculty!
- Write a draft of the topic summary and get someone else to read it!
- Submit the Topic Summary through the class E-submit/Collect It link (questions? Email the TA)
- Post the topic summary to your web site

Ocean 443: Guidelines For A Research Proposal

- Due by E-submit/Collect It

Don't delay – you do not have much time to write your proposal

The purpose of a research proposal is to clearly define a scientific question to be addressed. Proposals commonly takes a form consisting of five major components; an **abstract** that describes the research within a single page, **background** setting up the proposed research and justifying the need for the research, **proposed work** including the questions and hypotheses to be tested and the exact work to be done, **references** to prior research, a financial **budget** and a time plan. A good proposal persuades the reviewer and makes the reviewer advocate for the work to be conducted.

Clearly state the problem to be addressed or hypothesis to be tested, explain why your proposed research is important, and detail your plans for the cruise and subsequent analyses of samples. Be sure to demonstrate a basic familiarity with published work relating to the problem. The proposal should sum up your individual scientific goal(s) for the course. The style/format used for the proposal (and for your final paper due next quarter) is that of the journal Limnology and Oceanography (http://www.aslo.org/lo/instructions/authors.html).

A collection of past research proposals is available to you through your instructors so that you can see what your predecessors produced.

You are asked to turn in the proposal three times in the following forms:

Outline:
The outline of your proposal helps you organize and prioritize your thoughts and should contain bulleted phrases and text for each of the components listed above. Make it clear when and where you still need to obtain more information. Outlines are graded for completeness of ideas and themes, and are also used by the instructors to help identify areas where you need help.

Draft:
The proposal draft should be as complete as possible. It will be reviewed by your peers and by your major advisors. Good grades on the final proposal and in 443 are strongly linked to complete and thoughtful effort on this draft. Do not look for your peers to help you with constructive criticism if you do not provide to them a complete draft of your hypotheses and research ideas.

Final Proposal:
There is no length limit for the proposal, but 5-6 pages (double-spaced) *not* including references, figures, and tables, are reasonable and most effective to convey the information.

Submission of an acceptable proposal will be the prerequisite for taking part in the Ocean 444 cruise and passing that course.

The proposal should consist of the following main sections:

- **Title Page:** Give the title of your research project, your name, address, phone, e-mail address and the date. (Home phone numbers and e-mail addresses may be used to contact you before and during the cruise in the event of schedule changes/emergencies)

- **Project Summary:** In a one paragraph summary of the proposal, briefly and clearly state the objectives of the proposed work, succinctly describe the methods and approach to be used in accomplishing the objectives, and provide a rationale for the research.

- **Introduction:** Give a description of the problem you are addressing and place it in the broad perspective of its importance to marine science, environmental policy, etc. State the questions you are asking and try to frame your research goal in terms of an hypothesis or the objective(s) that is to be tested in the proposed work that follows. Review the current state of knowledge concerning the problem and briefly summarize previous applicable research. Why is it important to do more research on the problem?

- **Proposed Research:** Describe the research that you will do in the context of the goals stated in the previous section. Give a thorough description of the field and laboratory methods that will be used and be sure to cite relevant literature. You should address the time, duration, and sequence of your shipboard sampling and observations. Show how your proposed work will allow a test of your hypothesis or objective(s). In addition, describe how your expected results should complement (and be complemented by) measurements to be made by others.

  Other things to include in this section would be: 1) charts and tables showing sections, lines, station descriptions, 2) description of on-cruise and post-cruise analyses to be conducted, 3) any important special considerations for collection and/or analysis of samples or data that might constrain your work. Examples of this latter category might be 1) the need to begin shore-based analyses within a short time after sample collection or 2) the need for a key piece or type of information from another investigator before you can effectively accomplish your cruise/research goals.

- **Project Budget:** A tabular summary of all costs associated with carrying out your work. This should include ship time, equipment rental, supplies and expendables, analytical costs, etc. Rental charges for all pooled equipment and chemical analyses, are on the Technical Services web site (http://www.Ocean.washington.edu/2004/services/tech/techintro.html). Use a cost of $28,500/day for *Thompson*. Clearly indicate which are real project costs and which items (such as *Thompson* time) are being provided at no charge to your project.

- **References:** Complete list of all publications cited in your proposal. Use the format given in the Limnology and Oceanography style guide.

Ocean 443: Peer Review of Proposal Drafts

- To be completed before the class peer review session
- Please email each review to the individual you are reviewing, and also to the class TA.

You will be emailed 3 other proposals from your classmates to review. The instructors expect you to take peer review seriously, and as such have assigned 15% of the class grade to this effort. Peer review is the process of subjecting an author's scholarly work to the scrutiny of others who are also knowledgeable in the same field. The peer review process encourages scientists to meet high standards and serves to prevent the dissemination of unwarranted claims, unacceptable interpretations or personal views. Most peer review is anonymous. In our class, we will use an open review process where you know who reviews your work. While this is atypical, it serves the course well because it provides accountability to both the proposal writer and the reviewers. Reading anonymous reviews can hurt your feelings. Be aware that while it is your obligation as a reviewer to promote the best scientific practices and interpretations, use of harsh language and personal pronouns can be unintentionally hurtful. **Try for constructive criticism** but also try to determine how you would feel if you received the review you have just completed. If you have a criticism to levy, but cannot determine how to say it thoughtfully, consult your advisor.

The point of this exercise is to gain experience in evaluating the scientific writing of others. Your goal is to identify the strengths and weaknesses of the proposals you are reviewing and provide some specific ideas for improvement. In return, you should receive constructive suggestions to improve your own proposal. First read an entire proposal without commenting--resist the temptation to provide specific comments straight away--then read it again and comment. Comments on scientific content are most important, but other comments are welcome and encouraged (spelling, grammar, paragraph transitions, awkward sentences etc). Focus on ideas for improvement of each of the proposal sections.

Title: From the title, is it easy to understand the question under consideration and the methods that will be employed to address it?

Topic Summary: Does the summary provide background about the problem at hand? Is the hypothesis or objective(s) of the proposal explicitly stated? Is the methodological approach that will be taken presented concisely? Are the potential significance of the results to be obtained stated? Are all the important elements of proposed work summarized?

Introduction: Is the broad significance of the topic introduced? Is there enough information referenced from primary sources (journal articles) to provide sufficient background? Is the motivation of the study at hand clear?

Proposed work: Are the sampling location and scheme defined? Are the methods to be employed clear? Is enough detail provided for a reader to evaluate that the work will be successful and to replicate the study?

Figures/Tables: Is prior data presented where appropriate? Are maps of sampling locations clear? Do figure legends fully describe each figure?

References: Are references used appropriately? (Are there enough, are they cited properly, and is their format in L&O style?)

Overall impression is the proposal: Is the proposal well organized the work well thought through, and doable considering the given framework and resources.

Ocean 443: Ship Time Request

Due by E-submit/Collect It

Page 1: the general request

The purpose of the Ship Time Request is to give you practice in describing your cruise needs very precisely and succinctly so that a Marine Operations group could adequately plan for your needs. This 2-page-long document should take considerable thought and probably a significant amount of chart work in order to provide all of the necessary information. Ship Time Requests also form the basis of a request to Pooled Equipment for support of all of the class projects. The Request should tell a reader what you're doing, where you're going, what you need, and how much time your observations will require.

1. Principal Investigator:
   Your name, together with the names of any co-investigators who would be sharing ship time/stations with you.
2. Project Title:
3. Platform required (circle):
   What vessel or vessels will you require for your work.
4. Geographic Area(s) of Research (please attach a chartlet):
   This chart should preferably be a copy of the portion of a NOAA charts, with latitude and longitude axes clearly labeled
5. Shipboard Equipment Required (circle):
   Designate each required piece of equipment. Be very specific.

Bathy	CTD	WinFrog	IMET	Hiab crane
EM300	Aux. Winch	Trawl wire	.680 wire	Portable Capstan
Kevlar line	Rad van	Walk-In Coolers (temp?)		ADCP
Thermosalinograph				

6. CTD sensors required:
   Name each component that you will need. Sensors are frequently taken off the CTD for calibration if users don't request that they be made available.
   Niskin Bottles (# and size) Fluorometer Transmissometer PAR O2 pH
7. Pooled Equipment Required:
   List each piece of Pooled Equipment that you will need. These are listed on the PE web site at http://Oceanweb.Ocean.washington.edu/ships/pooled.equipment.html.
8. Non-Pooled Equipment Required (note source or location):
   List each and every piece of gear and all supplies and expendables that you are buying or borrowing from sources other that (than) Pooled Equipment.
9. Time Considerations and Constraints (tides, currents, night/day):
   Note all special conditions that are required for your objectives. If you need to be on a station at high tide, be specific and show the time and stage of the tide.
10. Operational Summary
    Fully but briefly describe your field program. Describe the order in which stations and/or track lines are to be run. Be sure to show how much time will be involved for each component of your work plan. In the table at the bottom of the sheet show the correct locations for all stations and waypoints. Double-check these locations. The best way to do that is to plot them using a computer.

Ocean 443: Ship Time Request

Page 2: Details of Ship Use

Operational Summary: Give all details needed by the Planning Groups in order to address your operational and data-gathering needs.

Station	Latitude	Longitude	Equipment to be used	Time	Time constraints (be specific)

Additional Comments as Necessary:

Syllabus: Oceanography 444 Advanced Field Oceanography

(5 credits)

I. Overview

Your principal objective is to carry out a complete short-term scientific study. The key phases are:

1) Executing your field/observational program according to a basic plan (your Ocean443 Research Proposal);
2) Analysis of data, samples, and observations;
3) Interpretation and presentation of your results in both written and oral formats and posting to your web site.

Remember that because Ocean 444 is a W-course, grading emphasis will be placed on your final written paper. By adhering to a course time line (see schedule), we will assist you in developing and polishing the product through several intermediate stages. Your faculty advisers will be grading your written submissions on-degree of organization, format and writing style (in addition to scientific content) and will present general advice about how to produce a professional scientific manuscript.

II. Grading

Your Ocean444 grade will be determined as follows:

- Oral Presentations/Updates 10%
- Draft of complete paper 15%
- Peer Review Exercise 15%
- Symposium presentation 15%
- Final Report – Scientific Content 30%
  (scientific organization, scientific reasoning,
  facility with literature, use of figures and tables)
- Final Report – Writing Style 10%
  (following style sheet, grammar, references, etc.)
- Web Posting of complete Final Paper (with all figures and tables) 5%

III. Schedule

Instead of regularly scheduled meetings, we will meet as a class only on selected dates (see the class schedule earlier in this guide). Most of the time designated for Ocean 444 (1330-1620, Tues and Thurs) will be available to you for lab/computer work, report preparation, and consultation with your faculty adviser. Faculty advisers may schedule formal or informal instructional periods at any of the other class times. Many of you who are dependent on others for expertise, instrumentation, co-processing of samples, etc., will need to adjust your schedules accordingly.

Don't let the light class schedule trick you!

Experience has shown that you will need the equivalent of all six scheduled class hours per week (at a minimum) to achieve your objectives. Stay organized, flexible, and realistic. Time management is a skill you must employ continually in Ocean 444.

IV. Research Dissemination

A course requirement is that you provide your final thesis content (manuscript with images) as a .pdf file to the UW's open digital research portal *ResearchWorks* (https://digital.lib.washington.edu/dspace/).

There are different rationales for the ResearchWorks posting. Your research will be of interest to other scientists, agencies, and consultants outside the University (particularly if you are working with one of our external sponsors). Also, an archive of Ocean 444 reports for future student use depends to a large degree on the existence of an electronic information base.

Please note that employers know about ResearchWorks and routinely access student theses during the hiring process. Your thesis work makes you stand out – most students at UW do not conduct senior thesis research. Your thesis lives longer than the 20 weeks of the class.

Ocean 444: Manuscript Guide

- Due by E-submit/Collect It

The Manuscript; an overview

Drafts of your research papers are to be submitted using E-submit/Collect It and the pdf format. A draft of your entire paper, including revisions from the first draft, is due roughly half way through the quarter. This submission should include Results, Discussion, Conclusions, Abstract, Non-Technical Summary, References, and should include all tables and illustrations. This draft will be peer-reviewed by your fellow students. Try *to make this draft as good as possible*. Throughout this review process you are encouraged to discuss specific interpretations of your data with your project advisor(s). If you desire a draft review by an external adviser (an excellent idea in many cases), you should set this up independently.

Your drafts will be graded for quality and completeness and on how well you have responded to suggestions and criticisms. *Please note that 40% of your grade (the updates, draft submission and peer review) is based on how well you take advantage of this iterative review process. Manuscript review is something all scientists take very seriously.*

Your final product will typically be about fourteen to eighteen double-spaced pages (excluding non-technical summary, acknowledgments, references, appendices, tables, figures). If your project is more complex, you should expand the scope and text as necessary. This final paper will be graded for scientific content, writing quality, and adherence to the L&O style guide.

Manuscript Components

In writing your paper, assume a scientifically literate audience – not necessarily 100% Oceanographers, but a literate and interested audience that understands the basic tenants of the scientific method. Present your story accordingly. Draw on the text of your research proposal from Ocean 443; you may already have on hand the basic prose for your Introduction, Background, and Methods. We strongly advise the use of outlining as a tool for keeping your paper organized. Not doing this will virtually ensure that you have some Results in the Discussion section, Discussion in the Conclusions section, Results in the Methods section, etc. The style and format of the Journal of Limnology and Oceanography, with some specific exceptions described below, will be used for all written submissions.

Drafts and your final paper should be double-spaced, with numbered pages. The following is an abbreviated description of a suggested organization for your paper.

- NON-TECHNICAL SUMMARY
  This section is not normally a part of an L&O manuscript but we require it for your Ocean 444 paper and web posting. It is a short summary, in laypersons terms, of your project and its results. Length should be about the same as for an Abstract (250 words or no more than a single page) but more descriptive and less scientifically terse.

- ACKNOWLEDGEMENTS
  This is an opportunity for you to give recognition to those who were of special assistance to you and the success of your project. The acknowledgements section is optional and is not graded.

- ABSTRACT
  Despite coming near the beginning, this is typically one of the last sections of a paper to be composed. It is also often the most difficult because it must capture the essence of your entire effort in a few lines (the L&O limit is 250 words). Explain why you performed the study, how you did it (not too much detail here), and what you found and what you think it means. Do not present anything

that has not been covered in the body of the paper. Think about all those database searches you've conducted and what distinguishes a useful abstract from a poor one. A good abstract contains facts and interpretations, it does not contain gross generalities and sweeping statements.

- INTRODUCTION
  This section should proceed from the general to the specific and include:
  - An overview of the project theme and the central question, objectives or hypothesis being addressed;
  - A description of your specific project and how it ties into the overall theme.
  - Development of your specific project theme and help in educating the interested reader. Its basis is generally a scholarly survey of the literature pertinent to your project.
  -

- METHODS
  Describe in detail how your work was carried out, including any variations from standard methods. You may wish to break out your field/sampling methods from your laboratory/analytical methods. If a complex or novel approach to data evaluation is a part of your project, include a description. For example, in the case of a salt budget calculation, make clear the method of the determination and any underlying assumptions. If this section is disproportionately long or detailed, you might want to relocate some of it to an Appendix (see below). Methods sections are typically either brief and contain references to papers that directly deal with methodologies used, or are more robust and describe novel methods or alterations to existing methods. The reader should be able to reproduce your work. Methods sections *never contain results or interpretations.*

- RESULTS
  Describe the results of your field and laboratory measurements. What data or information did your methods yield? Make efficient use of figures and tables and refer to them in a logical sequence. Always refer to figures and tables in the order they are introduced in the text. A basic written explanation (caption) should accompany your figures and tables, serving to highlight the key features observed. Where applicable, you must include an estimate of accuracy and precision and how you arrived at those estimates. Figures and plots should include error bars where appropriate. Virtually all your graphics and tables are introduced here. Results sections *never contain methods or interpretations*.

  NOTE: some people like to combine their results and discussion sections. The journal L&O discourages this and so do the instructors of Ocean 444. However, if you wish to pursue the idea, please seek the advice of your major advisor.

- DISCUSSION
  This section should be the most fun but is also the most demanding component to write. It is where you interpret the meaning of your data and place it within a scientific frame. Proceed logically to prove or disprove your hypothesis or otherwise argue your interpretations. Cite the results of published studies to support or contrast your claims. You don't have to rely solely on figures from the Results section; if warranted the Discussion section can be an excellent place to introduce an interpretive figure(s) to help you explain meaningful correlations between properties or mined the literature to produce a comprehensive data plot never before seen.

  If you have several key interpretations (e.g. effects of grain size vs polychaete abundance; effects of pollutants on polychaetes; etc) break up your discussion into sections with appropriate headers. Finally, a frequent outcome of short-term studies of the type you are conducting is the realization that

a different approach or better experiment is needed, or that a new question needs to be considered. Mention these for the sake of future investigators, but keep it brief (some reviewers disapprovingly view this as advertising for future work of your own).

- CONCLUSIONS (not a summary)
  The L&O style guide does not specifically require a Conclusions section; but it is a requirement for Ocean 444. Why? This is a concise restatement of the findings of your study, larger than the abstract and containing all the jewels of information you learned. Do not present any data or information here that you have not already appeared in the body of the paper. The conclusions section may be bulleted.

  We discourage the use of a summary paragraph. The difference between a Conclusion and a Summary is largely that the former singles out specific results and collated them, whereas the latter is a more complete recap similar to an abstract. In papers which require an Abstract (such as yours), Summaries are discouraged.

- REFERENCES
  For most journals (L&O included), this is purely a matter of following directions as to precise typographical mechanics. *Examine the style guide very closely*. Listing references in the wrong format can needlessly lose grading points. The style guide prohibits inclusion of unpublished papers and reports in your references section. We allow one exception to this: you can certainly include past Ocean 444 student papers. Note also that the L&O style guide places a limit on the length of your References section.

- APPENDICES (optional)
  The L&O style guide specifically forbids appendices, but they can be included as part of your paper. This section could contain information that you may wish to preserve and present, but which is not crucial to the body of the paper. For instance, this section might contain a comprehensive data listing that you feel should accompany the report. Another example might be a detailed computational description (not routine arithmetic), original computer algorithms, description of your own instrument design, etc. Large appendices that only seem to be ‘padding' will probably not survive the draft submission phase.

Link to the L&O Style Guide:
http://www.aslo.org/lo/instructions/authors.html

See also the appendices to this document for an abbreviation of the L&O guidelines.

Ocean 444: Peer Review of Manuscript Drafts

- To be completed before the class peer review session
- Please email each review to the individual you are reviewing, and also to the class TA.

You will be emailed 3 manuscripts from your classmates for you to review. The instructors expect you to take peer review seriously, and as such have assigned 20% of the class grade to this effort. **Try for constructive criticism** but also try to determine how you would feel if you received the review you have just completed. If you have a criticism to levy, but cannot determine how to say it thoughtfully, consult your advisor.

Your goal is to identify the strengths and weaknesses of the manuscripts you are reviewing and provide some specific ideas for improvement. In return, you should receive constructive suggestions to improve your own manuscript. First read an entire manuscript without commenting - resist the temptation to provide specific comments straight away - then read it again and comment. Comments on scientific content are most important, but other comments are welcome and encouraged (spelling, grammar, paragraph transitions, awkward sentences etc). Use the rest of this worksheet to focus on ideas for improvement of each of the proposal sections.

Title:
From the title, is it easy to understand the question under consideration and the methods that will be employed to address it?

Abstract: Does the abstract provide quantitative information about the problem at hand? Is the methodological approach that was taken presented concisely? Are the significant results stated? Are all the important elements of completed work summarized? Are the significant conclusions and interpretations clearly stated?

Introduction: Is the broad significance of the topic introduced? Is there enough information referenced from primary sources (journal articles) to provide sufficient background? Is the motivation of the study at hand clear?

Methods: Are the sampling location and scheme defined? Are the methods clear enough that another scientist could replicate the methods? Is the section devoid of results or discussion?

Results: Are the results of the study presented clearly and precisely? Are figures and tables presented in a logical order? Are interpretations avoided, or did they accidentally slip into this section abberantly?

Discussion: Is the research framed within other research conducted previously? Does the author describe how the present work fits into previous work? Are clear and understandable conclusions made based on the research and its literature frame?

Conclusions: Are the primary findings clearly restated at the end?

Figures/Tables: Is prior data presented where appropriate? Are maps of sampling locations clear? Do figure legends fully describe each figure?

References: Are references used appropriately? (Are there enough, are they cited properly, and is their format in L&O style?)

Ocean 444: Oral Presentation Guide

- Symposium is scheduled for two days, the last Tuesday and Thursday of the quarter, 1:30-4:00pm each day

Oral Presentations

During the quarter, each student will give at least one 8-minute-long presentation of their research results to date. This presentation will serve as a practice for the final symposium and should be aimed at the same audience (that is, at a general audience, not at your peers). We recognize that analytical work will still be underway and that the Results section will still be under construction to varying degrees. However, this presentation should emphasize your Results to the degree possible depending on your progress to date.

For the final Symposium each student will be given 15 minutes for their presentation; you should plan on 12 minutes for the talk, with 2 minutes for questions and 1 minute to switch to the next speaker. PowerPoint presentations are the de-facto standard method of providing visual aids in support of your talk, but other formats are acceptable provided that you insure the computer in OSB425 is capable of displaying your content correctly. As it is not unusual for a figure that is acceptable in a manuscript to make a poor 'slide' for presentation purposes, design your visual aids accordingly.

OSB 425 will be made available for rehearsal prior to any presentations.

HUMOUROUS SUBJECT: How NOT to Give Talks

These are the Immunology News' "Guidelines For Giving a Truly Terrible Talk." Strict adherence to the following time-tested guidelines will ensure that both you and your work remain obscure and will guarantee both a sleeping audience and a low grade.

SLIDES AND OVERHEADS

- Use lots of slides and overheads. A rule of thumb is one slide for each 5 seconds of time allotted for your talk. For the senior thesis, this means 125 slides minimum. If you don't have enough, borrow or cycle back and forth between slides.
- Put as much information on each slide as possible. Graphs with a dozen or so crossing lines, tables with at least 100 entries, and maps with 20 or 30 units are especially awful; but equations, particularly if they contain at least 15 terms and 20 variables, are almost as good. A high density of detailed and marginally relevant data usually preempts penetrating questions from the audience.
- Use small print. Anyone who has not had the foresight to either sit in the front row or bring a set of binoculars is probably not smart enough to understand your talk anyway.
- Make sure at least one image will not show up on the computer, causing a computer crash. This relieves tension in the room.

PRESENTATION

- Don't organize your talk in advance. It is usually best not even to think about it until your name has been announced by the previous speaker. Above all, don't write the talk out, for it may fall into enemy hands.
    - Note: Actually, if you want to give a *truly memorable* presentation, WRITE OUT THE ENTIRE TALK word for word -- and read from the script in as close to a monotone voice as you manage. This method is especially effective if you speak to the floor and mumble.

- Never, ever, rehearse, even briefly. Talks are best when they are given spontaneously with thoughts organized in a random fashion. Leave it as an exercise for the listener to assemble your thoughts properly and make some sense out of what you say.
- Discuss each slide and overhead in complete detail, especially those parts irrelevant to the main points of your talk. If you suspect that there is anyone in the audience who is not asleep, return to a previous slide and discuss it again.
- Face the projection screen, mumble, and talk as fast as possible, especially while making important points. An alternate strategy is to speak very slowly, leave every other sentence uncompleted, and punctuate each thought with "ahhh," "uhhh," or something equally informative.
- Wave the light pointer around the room, or at least move the beam rapidly about the slide image in small circles. If this is done properly, it will make 50% of the people in the front three rows sick and with luck you can cause someone an epileptic seizure.
- Use up all of your allotted time and at least half, if not all, of the next speaker's. This avoids foolish and annoying questions and forces the class instructor to cut short the following student's time. Remember, the rest of the speakers don't have anything important to say anyway. If they had, they would have been assigned times earlier than yours.

Here are some *real* Guidelines:

- Try for one slide per minute plus an intro and acknowledgements slide. Therefore, about 12-15 slides total for a 12-minute talk.
- Don't put too much info into each slide, and avoid too much text, especially text that is small and hard to read.
- Try to allow each graphic to tell only one or two points – don't jam too much into each graphic.
- Paraphrase, don't simply read the words off your slides.
- If you tend toward nervousness, write notes for yourself onto flash cards.
- PRACTICE in front of an audience. Time will be made for practice sessions the week before the symposium.
- Place your talk on the computer and text it BEFORE your talk begins – it may not look or function the same in the presentation room as it does on your computer.

One strategy Rick likes to use is this: tell them what you are about to tell them, tell them, then tell them what you just told them. Thus, start with an outline and one bulleted conclusion (maybe say something like this: "if you fall asleep now, just remember this one thing…"). Then tell your scientific story in all its glorious detail. Use 8-10 slides for this. Finally, wrap up with a conclusions section that briefly reiterates using different words. Finish with acknowledgements (unless you did them first, which some people like to do).

The final words that should come out of your mouth: THANK YOU. Not, "Thanks and I'll be happy to answer questions" or some other long mumbly phrase. Why? Because by asking for questions you have just preempted the opportunity for people to clap for you. End simply and graciously, let people clap in appreciation of your hard work. Then ask for questions if there aren't hands already up in the audience.

Oceanography Senior Thesis: Agreement for External Advisors

University of Washington
School of Oceanography
Box 357940
Seattle WA 98103-7940

Thank you for agreeing to help advise a student in the School of Oceanography's undergraduate senior research program. Your help is of tremendous value to the student as they develop their scientific skills. The School appreciates your efforts. By signing this document, you acknowledge that you:

- Accept the responsibilities of mentoring this undergraduate for the duration of their research project (typically two academic quarters)
- Will uphold the highest academic and scientific principles during the collaboration
- Are willing to participate in the proposal and manuscript review process with the instructors of the course (reading proposal and manuscript drafts and providing written commentary to the student you are mentoring)
- Are willing to help the instructors in the class adequately assess the effort, scholarship and growth of the student so that a grade may be assigned to the work. Note: the Senior Thesis is graded competitively (on a curve) and it is a great benefit to the instructors of the course to get your input to help assess your student relative to the others in the class.

Full details of expectations of students during the senior thesis experience are given in the *Oceanography Senior Thesis Guide*, which your student should make available to you.

In acknowledgment of your mentoring efforts, after a grade has been assigned to the student the School of Oceanography will provide a letter of recognition to you and your immediate supervisor outlining your efforts and thanking you for your contribution.

Signature and Date:

External Advisors Name, Email and Mailing Address:

Name and address of person to send letter of acknowledgement to:

Oceanography Undergraduate Thesis Substitution Petition

Name _____ Date _____

Email _____ Expected Date of Graduation _____

Part 1 *To be completed before project initiation. This initiates the bypass process and notifies the department of your intent to bypass the traditional senior thesis coursework.*

Please attach a detailed statement describing the coursework and research that you wish to substitute for the thesis courses 443 and 444. Note that Ocean 443 and 444 total to 8 credits, of which 5 are writing credits.

Courses to be taken , if any

Number	Name	Credits	Quarter to be taken

Initial Approval (office use) _____

Part 2 *To be completed at least two months prior to commencing the research component of project. Upon submission of this part, the Oceanography Senior Thesis committee will convene to discuss the application and provide a decision on the appropriateness of the request.*

Please attach a statement detailing how your planned research will meet the goals of the Oceanography Senior Thesis. These goals are explained in the *Oceanography Senior Thesis Guide*, and are briefly stated here:

1. A thesis proposal is self-generated, written to departmental guidelines, and undergoes at least two rounds of review by faculty in the School.
2. The research is independently conducted. If the research is conducted as part of a larger project, it has its own hypotheses and goals that are definable within the context of a larger research frame.
3. The project provides opportunity for development of interpersonal skills and the opportunity to develop a sense of how individual research is conducted within a larger frame. The two examples of this used in 443/444 include group planning of the research cruise and peer-to-peer review of research proposals and reports.
4. A final report, separate from the initial project proposal, will be written by the student. The final report will undergo faculty review and will be made publicly available through the UW's Digital Library (Research Works).
5. The results of the research will be presented in a public venue either through a poster presentation or an oral presentation.

Approval to Move Forward (office use) _____

Part 3 *To be completed after conclusion of research and writing component.*

Please submit:

- one hard copy of your thesis and one electronic copy (.pdf preferred format).
- A personal statement of how you met the requirements of the senior thesis, and a self-reflection of your experience.
- If necessary, please provide evidence of public presentation.

Checklist for submitted documents and progress

- Initiation of bypass process _____
- Submission of form part 2 documentation _____
- Copy of thesis proposal _____
- Copy of final document _____
- Personal statement _____
- Statement of personal growth _____

The Limnology and Oceanography Style Guide

http://www.aslo.org/lo/instructions/authors.html

The *L&O* Style

As you prepare your paper, refer to a recent issue of *L&O* for examples of the journal's style. The order of the different parts of a submission should be:

- Title page
- Acknowledgments page
- Abstract page
- Text
- References
- Tables
- Figure Legends
- Figures

General style:

- Use a 12-point font (Times Roman preferred), double-spaced on one side of non-glossy "letter" (8-1/2x11 inch; 21.6x28 cm) paper throughout the manuscript. Use 1-inch (2.5-cm) margins on all sides.
- Number all pages, starting with 1 on the title page. If the software used to prepare the manuscript can do so, number all lines of text (making it easier for reviewers to comment on the manuscript).
- Do not justify the right-hand margin.
- Do not break (hyphenate) words over lines.
- Indent the first line of each paragraph.
- The only allowable footnotes are for author addresses on the title page or when they are unavoidable in tables.
- Do not number or letter sections of the manuscript.
- Thoroughly proofread and spell-check the manuscript with a computer program.
- Use a single serifed font (Times New Roman preferred); if special mathematical or Greek symbols not available in that font are needed, use the Symbol font. Note: superscripts, subscripts, italic, boldface, underline, and changes of font size are not considered to be different fonts.
- Cite all figures and tables in the text and number them in the order that they appear in the text.
- Do not use punctuation (commas or periods) in numbered equations.
- Cite literature in the text in chronological, followed by alphabetical, order and formatted like these examples: "Campbell (1983, 1987*b*)," "(Smith et al. 1984; Karl and Craven 1988; Korobi 1997, 1998)." In the *References* section, list citations in alphabetical, followed by chronological, order.
- Use only SI units (metric and Celsius; for detailed SI specifications, click here). The following are required formats for situations that are commonly formatted incorrectly:
    - Use exponents to indicate multiplication or division in units (slashes are not allowed).
    - Use mol L^{-1} for molar concentrations ('M' is not acceptable).
    - Use mol quanta for photosynthetically available radiation (PAR) (Einsteins is not acceptable).
    - Use × for multiplication (* is not acceptable).
    - To indicate a power of 10, write, e.g., 5×10^{-8} (5E-8 is not acceptable).
- Do not italicize common Latin terms and abbreviations such as i.e., e.g., in situ, in vivo, and et al.

The Title page:

- Capitalize only the first word, proper nouns, and acronyms in the title. I.e., *Do not* capitalize all words nor use all capitals for the entire title.
- Do not use abbreviations in the title (e.g., use 'iron', not 'Fe'; and 'southeast', not 'SE').
- List the names of all authors in a single continuous character string below the title. Use footnotes to indicate the corresponding author (if different than the first author listed) and author addresses; these addresses should be those where the authors resided *at the time that the work presented in the paper was done* (use separate footnotes for current addresses, if different). Spell out state or province names in full and include postal codes. Double-space all footnotes on the title page.
- For Articles, provide a condensed *running head* of no more than 40 characters (including spaces) at the bottom of the page.

The Acknowledgments page:

- Include brief statements about granting agencies, important aid received from institutions, and any potential conflicts of interest (as detailed in the *L&O* Ethics statement section 3.4 and 3.4.1).
- Thank anyone who made a substantial contribution to the work (e.g., data collection, analysis, or writing or editing assistance) but who did not fulfill the authorship criteria, along with their specific contributions.
- You are responsible for ensuring that all persons named in the Acknowledgments section know and agree to being identified there (since it may be interpreted as endorsement of the data or conclusions).

The Abstract:

- A single paragraph of no more than 250 words (15 to 17 lines of text in a 12-point, Times New Roman font, where the line width is 17 cm [=6.5 in]). State what you did and what you found; omit 'introductory' statements that summarize previous work and avoid statements that do not identify actual findings (e.g., "The implications of these results are investigated with a dynamic model.") Summarize rather than advertise important findings and their significance. (In the jargon of scientific writing, L&O abstracts must be informative rather than indicative. *See* http://www.southernct.edu/~brownm/inform_ab.html for further explanation of these terms.) Because the abstract must stand on its own, it cannot include references. Comments have no abstracts.

Text:

- Follow all directions given in the General style section above.
- Describe statistical methods in enough detail to enable a knowledgeable reader with access to the original data to verify the reported results. Give degrees of freedom for *F*-tests as subscripts (e.g., $F_{3,4}$); for other statistics, report degrees of freedom as "df=*n*" following the test result (e.g., t=3.4, df=20). Use italics for symbols representing a statistic: p for probability level, n for the sample size, r for the correlation coefficient, R^2 to denote the coefficient of determination. ($r^2 = R^2$ only for a linear regression.)
- Use the same font for the same mathematical symbol regardless of where it appears in the manuscript (text, displayed equations, tables, figures, or figure legends).
- Use periods after all abbreviations except for metric measures, compass directions, and time (s, min, h, d, yr; do not abbreviate 'week' or 'month'). Use hh:mm h or hh:mm:ss h for time of day. Do not use a.m. or p.m. E.g., 09:30 h, 18:24:44 h.
- Provide the full expansion of all acronyms on first use (even common ones like DNA).
- Format dates like "15 June 1999" throughout the text, figures, and tables. If it is necessary to conserve space, abbreviate month names to the first 3 letters of the month name (no period) and the year to the last two digits.

- Do not abbreviate names of states, provinces, or cities. Abbreviate names of countries only after defining on first use, e.g., United Kingdom (U.K.), United States of America (U.S.A.)

References:

- The ratio of pages of references to pages of text must be less than 1:4. (See the editorial commentary Web page for reasons.) For Reviews only, the ratio of references to text may be relaxed at the discretion of the editor. Nevertheless, Reviews should limit citations to prior reviews and key papers published since the last review or omitted from prior reviews. Exhaustive bibliographies (annotated or not) may be useful and can be submitted to the ASLO Teaching Tools web page.
- All references cited in the text must appear in the *References*, and vice versa.
- No more than 3 references can be cited to support any statement. (See the editorial commentary Web page for reasons.)
- Double check the spelling of author names and years of publication. All author names must be given--even if there are more than eight (the copyeditor will abbreviate the list to 'and others' if appropriate).
- Manuscripts in preparation, submitted, unpublished theses, or other inaccessible sources should be referred to in text by referring to the author(s) by last name and initials, e.g., Jones, A. B., followed by 'pers. comm.' or 'unpubl.' -- such materials must **NOT** appear in the *References*.
- Verify all references against original sources; check especially journal titles, accents, diacritical marks, and spelling in languages other than English.
- Make sure that each citation is complete, according to the following examples:

  Article:
  Fenchel, T. 1986. Protozoan filter feeding. Prog. Protistol. **1:** 65-113.

  Articles with a Digital Object Identifier (DOI):
  De Pol-Holz, R., O. Ulloa, L. Dezileau, J. Kaiser, F. Lamy, and D. Hebbeln. 2006. Melting of the patagonian ice sheet and deglacial perturbations of the nitrogen cycle in the eastern South Pacific. Geophys. Res. Lett. **33**, L04704, doi:10.1029/2005GL024477.

  If there are page numbers, then the last part would be **33:** 15-32, doi:10.1029/2005GL024477.

  Papers that have been assigned DOIs must also cite either page number(s) or an article number, but not both. Electronic journals, for which HTML is the primary form of publication, are assigned article numbers, which must precede the DOI to make the identifier unique.

  Book:
  Stumm, W., and J. Morgan. 1981. Aquatic chemistry, 2nd ed. Wiley.

  Chapter:
  Codispoti, L. A. 1983. Nitrogen in upwelling systems, p. 513-564. *In* E. J. Carpenter and D. G. Capone [eds.], Nitrogen in the marine environment. Academic.

  Thesis:
  Kimmance, S. A. 2001. The interactive effect of temperature and food concentration on plankton grazing and growth rates. Ph.D. thesis. Univ. of Liverpool.

- Papers which are unconditionally accepted for publication but for which exact publication data are not yet available should be formatted according to the above examples but with the phrase "In press" appearing instead of the year of publication.
- Use mixed case (upper and lower case OR caps and small caps) for all text in the *References* section. In particular, do not use all capital letters for author names because doing so makes it impossible to for the copyeditor to properly typeset names like "MacKenzie".
- For abbreviations of journal names refer to Chemical Abstracts Service Source Index (CASSI) or Biosis.
- Do not include part (issue) numbers after volume numbers unless each part of the volume is paginated separately.
- **Websites.** A websites may be referred to only if it is sponsored by an organization that is committed to maintaining it in perpetuity. Personal or university-based websites are *not* allowed in L&O because such websites are prone to disappear when the scientist who created them moves or loses interest in material. Websites are referred to only in the text and are not included in the list of references.

Tables:

- Start each table on a new page.
- Format tables so that they will fit on the printed page: A 1-column table can be up to 60 characters wide, and a 2-column table up to 130.
- Type table legends as double-spaced paragraphs at the top of each table.

Figure Legends:

- Group figure legends together on the page(s) preceding the figures; one paragraph per figure.
- Explain all panels in each figure (A), (B), ...
- Symbols used in the figure (e.g., circles, squares, ...) must be explained on the figure itself (i.e., not in the figure legend). No special symbols are allowed in the figure legend.

Figures:

- Do not put figure legends on the figures. Put only "Fig. #." on the figure.
- Figures must be camera-ready (no modifications will be made by the *L&O* editorial staff or printer). They must be printed at high resolution (minimum of 600 dpi).
- Number all figures serially (In figure numbering, L&O does not distinguish color "plates" from black-and-white figures).
- Number figures with Arabic numerals in the order of their citation in the text. If panels of a figure are labeled (A, B, ...) use the same case when referring to these panels in the text (A, B, ..., not a, b,...).
- If a figure consists of multiple panels, put all panels on one page and repeat axes titles on each panel only if they are different.
- Put scale bars on the figure, NOT in the figure legend.
- Use the Times New Roman font for all text and numerals on figures. Font sizes size should be from 9 to 11 points. If mathematical or Greek symbols are not available in Times New Roman, use the Symbol font.
- Submit figures at the intended print size. The *L&O* column width is 8.9 cm (3.5 in) and full page width is 18.4 cm (7.25 in). The maximum size for a figure is 18.4 x 23.2 cm (7.25 x 9.125 in).
- Make figures as simple as possible. For example, avoid grid lines and boxes around symbol definitions.
- Maps must include latitude and longitude, an indication of compass direction, and a thin line as a border. All markings must be legible.

Guidelines for Color Figures: Do you need to use color?

Although color is useful and attractive, it may not be necessary to get your message across. Be aware that many people who download your paper will print it in black-and-white. Also, 10-15% of men have some form of color blindness. If you need to use color, design your figures to accommodate these situations and minimize or eliminate the loss of essential information.

If you use color, check what your figures will look like …

- in B&W. Most programs that create color figures allow quick conversion to B&W, or simply print your figure in B&W.
- to a person with color blindness. Use a color checker designed for that purpose. Vischeck (www.vischeck.com) has a practical service that simulates the appearance of color figures under various forms of color blindness.
- Color graphics files and output devices must be set to CMYK mode, not RGB. For final (i.e., accepted) submissions the resolution must be a minimum of 350 dpi; prior to acceptance, lower resolutions (150 dpi) should be used to minimize file size.
- Figures on disk should be the final size desired, and all mounting should be electronic.
- Indicate the input resolution on any images that have been scanned. For final (i.e., accepted) submissions color images must be scanned at 350 dpi; if your layout includes line art, it should be scanned at 1200 dpi and grayscale images scanned at 450 dpi.
- Note that nearly all images downloaded from the Internet are in JPEG or GIF format at 72 dpi and are not acceptable for the printing process.

Maximum sizes

- The maximum width for a 1-column figure is 8.9 cm; for a 1.5-column figure, 13.1 cm; for a 2-column (full width) figure, 18.4 cm.
- The maximum height of the printed page is 23.2 cm. If the color figure is full page, take into account the space required at the bottom of the page for the figure legend.

Instructors Rubric: Ocean 443 Summary Paragraph Evaluation Form

(5% of total score, divide by 5)

Student Name_____

Title		**1**	**2**
Accurately reflects question under investigation and method(s) to be used			
Summary			
Objectives/hypothesis/problem clearly stated	**1**	**2**	**4**
Research rationale, why the work is important	**1**	**3**	**5**
What/where/when	**1**	**2**	**3**
How – brief methods overview	**1**	**2**	**3**
Who (mention helpers? Mentors?)	**1**	**2**	**3**
References (at least 5)	**1**	**3**	**5**
Adequate number			
Primary literature			
Complete (all cited refs listed)			
Figures (optional)	**1**	**2**	**3**

(extra points for good use of figures, no total points above a 25 allowed.

Comments:

Instructors Rubric: Ocean 443 Proposal Outline Evaluation Form

Student Name_____

Title				**1**	**2**
Accurately reflects question under investigation and method(s) to be used					
Summary			**1**	**2**	**3**
Objectives/hypothesis/problem					
Research rationale					
Methods overview					
Significance of expected results					
Introduction	**6**	**7**	**8**	**9**	**10**
Significance of Topic					
Relevant past studies covered					
Introduction leads to question(s) to be investigated					
Proposed Research	**6**	**7**	**8**	**9**	**10**
Methods description is detailed and ref'd					
Adequate sampling/surveying design (replicates, etc.)					
Rationale for methods/sampling design explained					
Budget				**1**	**2**
Complete and consistent with proposed research					
References (at least 5)			**1**	**2**	**3**
Adequate number					
Primary literature					
Complete (all cited refs listed)					

Comments:

Instructors Rubric: 443 Proposal Draft Evaluation Form

20 points possible (add points divide by 2)

Student Name_____

Summary		**1**	**2**	**3**	**4**
Concise, 1 paragraph					
Context of work explained					
Hypothesis clearly stated					
Significance of results to be obtained					
Introduction	**6**	**7**	**8**	**9**	**10**
Broad significance of topic					
Relevant past studies described specifically					
Intro material leads to questions to be investigated					
Proposed Work	**6**	**7**	**8**	**9**	**10**
Methods description detailed (& referenced)					
Adequate sampling design (replicates)					
Rationale behind methods choice/sampling design explained					
References		**1**	**2**	**3**	**4**
Adequate number					
Primary literature					
Complete (all cited refs listed)					
L&O style					
Figures and Tables		**1**	**2**	**3**	**4**
Adequate number					
Descriptive legends/axes					
Cited appropriately					
Budget complete					
Overall project design		**1**	**2**	**3**	**4**
Hypothesis supported by prev. data?					
Results likely to prove/disprove hypothesis?					
Overall Writing style		**1**	**2**	**3**	**4**
no grammatical errors, typos					
use of topic sentences					
smooth transitions between ideas					

Total _____

Comments?

Instructors Rubric: Ocean 444 Final Paper Evaluation Form

Student Name:

Scientific Content	Writing Style	
75	25	**Overall**
3	2	**1. Non-technical Summary** A. Written in lay terms? B. Does it completely describe study (what, how, when, where, why, and by whom?) including results and conclusions?
3	2	**2. Abstract** A. Are where, when, how reported? B. Are results and conclusions reported quantitatively? C. Concise, 1 paragraph
7	3	**3. Introduction/background** A. Are general and relevant specific issues introduced (in that order), B. Previous work properly used and cited? C. Does Intro lead reader to the questions/hypothesis investigated? D. Are scope and objectives clearly stated? E. Does Intro connect with Discussion?
10	4	**4. Methods** A. Is section well sequenced, e.g. sampling scheme/processing/data treatment? B. Are subsections used and if so clearly labeled? C. Are procedures complete enough to allow duplication? D. Are relevant papers cited?
16	4	**5. Results** A. Is section well sequenced, e.g from hydrographic overview to specific untreated data to processed or composite data? B. Are results thematically structured? C. Does structure of this section correspond to that of the Intro/ Background and/or Methods sections? D. Do the tables and figures represent the data accurately? E. Are any extraneous data presented?
22	4	**6. Discussion** A. Is principal finding(s) reported early in section? B. Does structure of Discussion correspond to that of the Results and/or proceed from most to least important findings? C. Are limitations and strengths of methods, data, and analyses discussed? D. Is the relevant literature cited and related to study? E. Is Discussion scientifically valid based on Results?
4	1	**7. Conclusions** A. Are primary results of study clearly restated? B. Are conclusions supported (scientifically) by Discusion? C. Are there suggestions for how results can be used or built upon by future studies?

3	2	**8. References**
		A. Are all References cited in text or figure captions?
		B. Are all citations in the References section?
		C. Are all relevant?
7	3	**9. Tables / Figure Legends / Figures**
		A. Are all relevant and properly formatted/labeled?
		B. Do legends completely describe contents and meaning of figures?
		C. Are figures clear, complete, and thoroughly annotated and labelled?
		D. Are all figures necessary?

Notes on Rubric Usage:

Each instructor gives an overall score for each section in bold type, and separately assigns points for writing and scientific content. These scores include whether or not the structural elements in columns D&E are present/well done, as well as "section relevant" (to be determined by each instructor) general criteria from below. The balance between these things is at the discretion of individual instructors.

Difference between science content and writing style:
Writing style is limited to grammar, meeting the guidelines, punctuation, etc. Scientific 'voicing and style' counts as scientific content.

Scientific Content:
The rubric can be used to measure:
(a) conceptions and use of evidence
(b) applicability of performed research in evaluating complex problems
(c) ability to consider alternative perspectives
(d) ability to frame research within existing literature (within both the intro and discussion)
(e) scientific organization of thoughts and logic
(f) response of writing to previous suggestions and criticisms

Salient points for scientific style points that can be applied to all sections:

* Discussion has a coherent structure that is explicitly laid out at the beginning and that flows conceptually from the simple to the more complex; clear connections are made between various parts of the paper.
* Language is unambiguous and concise; terminology is clearly defined
* Uses scientifically valid experimental and data analysis techniques, with appropriate references to the supporting literature
* Patterns in the data, as reflected in figures and tables, are clearly identified and used in support of scientific arguments
* Does not present confounding or superfluous concepts

Writing Style:
The rubric can be used to measure:
(a) grammar, punctuation, usage of voice and tense, etc.
(b) ability to follow the guidelines
(c) completeness

Instructors Rubric: Final Oral Presentations Evaluation Form

Student Name:

Scoring:	Best - - - - - - - - - - - -> Worse				
Scientific Content Adequate background Statement of question/hypothesis Results support conclusions	5	4	3	2	1
Organization Clear Logical Time management	5	4	3	2	1
Speaking Style Direct Understandable Audience contact		5	4	3	2	1
Visual Aids I – Style Fully labeled Readable Uncluttered	5	4	3	2	1
Visual Aids II – Content Excess/inadequate in number? Supports presentation?	5	4	3	2	1

Total Points:_____

Comments: (optional)