



## SYLLABUS

### AQUA 505: Ecological Sustainability of Aquaculture

#### Academic Calendar Description:

As the aquaculture industry expands, impacts on the natural environment must be minimized to ensure a sustainable development. In this course, aquaculture practices and management techniques will be analyzed for their effectiveness in mitigating impacts on wild species and ecosystems.

Winter term 1

Credits: 2

Pre-requisites: Science degree

#### Instructor: Andrea Frommel, PhD



Please refer to me as Andrea or Dr. Frommel.

I will not have formal office hours for this course, but feel free to contact me by sending me a message to: [andrea.frommel@ubc.ca](mailto:andrea.frommel@ubc.ca) for questions or to schedule a meeting.

About me: I grew up in California and Germany, and lived in lots of different places in the world, including Australia, Sweden, England and Brazil before settling in Vancouver. I have a BSc in Marine Biology from the University of California Santa Cruz, a MSc in Biological Oceanography from the University of Southern Denmark and a PhD from the Helmholtz Center for Ocean Research in Kiel, Germany. During my PhD, I started researching the effects of climate change on commercial fish species, which continues to be a large focus of my research program here at UBC. You can check out my lab website here: <https://frommel-lab.landfood.ubc.ca/>

I am also the Program Director for the Aquaculture Certificate. You can contact me with any issues that may arise during your time with us.

#### Welcome to AQUA 505

Welcome to AQUA 505: Ecological Sustainability of Aquaculture. The class will take place on the UBC Point Grey Campus, which is the traditional, ancestral, and unceded territory of the x̱m̱əθḵʷəy̱əm (Musqueam) people. The land UBC-V is situated on has always been a place of learning for the Musqueam people, who for millennia have passed on their culture, history, and traditions from one generation to the next on this site.

My main goal is to teach students basic principles and a mechanistic understanding of complex issues to provide them with a solid platform on which to build further learning. Taking an integrative approach bridging disciplines I strive to give students the information to ask relevant questions and teach them how to develop different approaches to address big problems. I practice learner-centered teaching, formulate



learning outcomes that support learners from different backgrounds and tailor my style to the experience level of the students, as well as the classroom size.

I am committed to an inclusive, fair and accessible classroom and expect all students to work towards a class culture where everyone feels welcome and valued. If you have any concerns, please let me know or contact the relevant office listed at the end of the syllabus.

### **Course Format**

This two-credit course will be delivered in 2-hour sessions, once a week over the course of 15 weeks. Each class will start with an introductory lecture followed by a discussion. The method of presentation makes use of powerpoint and other forms of visual presentation. Canvas will be used as a learning platform. We will have several guest lectures from different sectors, including government, industry and NGOs to give you a broad perspective of environmental management practices and allow you to make connections with these stakeholders.

### **Course Overview, Content, and Objectives**

By 2030, seafood from aquaculture is projected to be the primary source of animal protein as the demand for seafood overtakes the harvest potential of wild capture fisheries. However, as the aquaculture industry expands its output to meet this need, the impacts on the natural environment must be minimized to ensure a sustainable development of the sector. For aquaculture to be sustainable, it must meet the following criteria: effluents, water quality and disease must be effectively managed, wild broodstock, eggs and juveniles must be responsibly sourced, feed must be sustainably sourced, and escapees must be managed to minimize the impact of wild populations. We will discuss these issues in a global perspective, as well as a focus on specific case studies in British Columbia.

This course introduces the different aspects in which aquaculture can impact the natural environment and which aquaculture systems and management practices can minimize or mitigate these impacts. You will learn about ecological, social and ethical aspects of various aquaculture systems through a combination of lectures, review of the primary literature and class discussions. As natural resources become increasingly limited, this course is highly relevant to the developing aquaculture industry and will provide students entering the aquaculture sector with the knowledge to employ sustainable practices to minimize environmental impacts.

### **Learning Outcomes**

In this course, the main goals are for you to be able to:

- identify different aspects of aquaculture that can impact the environment
- critically assess different aquaculture systems based on their environmental impact and sustainability, as well as ethical concerns
- discuss implementable management techniques within federal and provincial regulations that can mitigate environmental issues arising from unsustainable aquaculture practices
- formulate an environmental impact assessment which includes all aspects learned in the course

Upon completion of the course, you should be able to: understand environmental issues related to aquaculture; appreciate the importance of sustainable aquaculture and conservation of wildlife and its natural habitat; recognize unsustainable aquaculture practices and identify management techniques to mitigate environmental impact; understand federal and provincial governmental regulations related to



aquaculture in Canada and BC; Weekly discussions, the term paper and the oral presentation will assist in these learning outcomes.

### Evaluation Criteria and Grading

- You will be evaluated based on participation during discussions (10%), weekly mini-assignments leading up to a term paper due in week 7 (45%) and a final project with oral presentation in week 14 (45%).
- For the term paper, you will choose an aquaculture system and critically assess it based on sustainability and environmental impact and discuss management techniques available to mitigate environmental issues.
- The final project will be a joint project with the other classes: in a group of 2-3 students you will design an aquaculture system, formulate a business plan, feed, health monitoring etc. For AQUA 505, you will write an environmental impact assessment and present your project as the final. The goal of this assignment is to bring together knowledge from all courses into one cohesive project and work as a group. There will be many small milestones throughout the second half of the program to guide you through the process. You will be graded as a group on the project and individually on your ability to answer questions after the presentation. Group work can be challenging! Should any issues arise, please contact me early and we will work together to ensure the success of your project.
- 68% constitutes a pass
- Note: most deadlines for assignments in this course are flexible and are there for your guidance. The earlier you hand in an assignment, the more feedback I will be able to give you. You can revise assignments as often as you like until the end of the term and I will grade you based on your final submission.

Discussion participation will be graded on the following rubric:

Criteria	< 59%	60-79%	80-100%
<b>Quality of contributions</b>	Comments reflect little understanding of the class material	Comments sometimes irrelevant, betray lack of preparation or indicate lack of attention	Comments are relevant and reflect understanding of the class material
<b>Impact on seminar</b>	Comments do not advance the conversation	Comments sometimes advance the conversation	Comments frequently help move the seminar conversation forward
<b>Frequency of contribution</b>	Seldom participates and is generally not engaged	Sometimes participates	Actively participates at appropriate times



Grading scheme for papers:

Criteria	Best evaluation	Maximum score
<b>Organization</b>	Concise abstract that reflects the content of the paper; Main topic stated clearly; Paper organized into sections defined by the headings that were presented in the outline; Paragraphs within each heading focus on a common subtopic; Ordering of sections and ideas flows logically	30
<b>Existing Knowledge and use of literature</b>	Paper provides a comprehensive overview of existing knowledge; Terms and jargon are defined; Key concepts are explained; Figures complement the text; Stated facts are supported by literature citations	30
<b>Originality of ideas</b>	Concepts are brought together and evaluated in an original and thoughtful manner; creative thinking is used to evaluate and communicate the subject	30
<b>Grammar, spelling, literature citations</b>	No spelling errors; No grammatically incorrect sentences; Literature citations following a common format	10

The oral presentation will be graded on the following rubric:

Criteria	< 59%	60-69%	70-79%	80-100%
<b>Communication of information and ideas</b>	Unable to communicate information and ideas	Communicates information and ideas with some clarity	Communicates information and ideas with considerable clarity	Communicates information and ideas with a high degree of clarity and with confidence
<b>Critical and creative thinking skills</b>	Does not use critical and creative thinking skills	Uses critical and creative thinking skills with limited effectiveness	Uses critical and creative thinking skills with considerable effectiveness	Uses critical and creative thinking skills with a high degree of effectiveness
<b>Knowledge of forms, conventions, terminology, and strategies</b>	Demonstrates limited knowledge of forms, conventions, terminology, and strategies	Demonstrates some knowledge of forms, conventions, terminology, and strategies	Demonstrates considerable knowledge of forms, conventions, terminology, and strategies	Demonstrates thorough and insightful knowledge of forms, conventions, terminology, and strategies
<b>Organization of ideas and presentation</b>	Ideas are unorganized and are presented in an ineffective manner	Ideas are somewhat organized and presented in an acceptable manner	Ideas are organized and presented in an effective manner	Ideas are clearly organized and presented in an exceptional manner



## Course Schedule

	Date	Topics	Lecturer	Readings
<b>Week 1</b>	Sept. 8	1: Overview of different aquaculture systems and their environmental impact	AF	1
<b>Week 2</b>	Sept. 15	2: Resources: land, water and emissions	AF	2
<b>Week 3</b>	Sept. 22	3: Pollution: organic waste and chemicals	AF	3
<b>Week 4</b>	Sept. 29	4: Alien species and interactions with wild populations	AF	4
<b>Week 5</b>	Oct. 6	5: Food: fish meal, fish oil and alternatives	Ian Forster (DFO)	5, 6
<b>Week 6</b>	Oct. 13	6: Disease, pathogens and HABs	AF	
<b>Week 7</b>	Oct. 20	7: Environmental certifications	Katherine Dolmage (ASC)	7, 8
<b>Week 8</b>	Oct. 27	Field Trip to PSEC		
<b>Week 9</b>	Nov. 3	8: Integrated Multi-Trophic Aquaculture	Chris Pearce (DFO)	9
<b>Week 10</b>	Nov. 10	Midterm Break		
<b>Week 11</b>	Nov. 17	9: Governmental Regulations	Myron Roth (DFO)	
<b>Week 12</b>	Nov. 24	10: Salmon Aquaculture in BC	AF	10
<b>Week 13</b>	Dec. 1	11: Animal welfare and ethics	Nina von Keyserlingk (LFS)	11, 12
<b>Week 14</b>	Dec. 5-9	FINAL/ Oral presentations	students	

## Readings

No textbook is required for this course. You will be provided with weekly readings of current literature and videos uploaded to canvas to prepare for the class and facilitate discussion.

- 1.) Edwards, P. (2015) Aquaculture environment interactions: Past, present and likely future trends. *Aquaculture* 447, 2-14.
- 2.) Froehlich, H.E., Runge, C.A., Gentry, R.R., Gaines, S.D. and Halpern, B.S. (2018) Comparative terrestrial feed and land use of an aquaculture-dominant world. *Proceedings of the National Academy of Sciences* 115(20), 5295-5300.
- 3.) Wang, X., Olsen, L. M., Reitan, K. I., Olsen, Y. (2012) Discharge of nutrient wastes from salmon farms: environmental effects, and potential for integrated multi-trophic aquaculture. *Aquaculture Environment Interactions* 2, 267-283.
- 4.) Savini, D., Occhipinti–Ambrogi, A., Marchini, A., Tricarico, E., Gherardi, F., Olenin, S. and Gollasch, S. (2010) The top 27 animal alien species introduced into Europe for aquaculture and related activities. *Journal of Applied Ichthyology* 26(s2), 1-7.
- 5.) Cao, L., Naylor, R., Henriksson, P., Leadbitter, D., Metian, M., Troell, M. and Zhang, W. (2015) China's aquaculture and the world's wild fisheries. *Science* 347(6218), 133-135.
- 6.) Fry, J.P., Love, D.C., MacDonald, G.K., West, P.C., Engstrom, P.M., Nachman, K.E. and Lawrence, R.S. (2016) Environmental health impacts of feeding crops to farmed fish. *Environment International* 91, 201-214.
- 7.) Valenti, W. C., Kimpara, J. M., de L. Preto, B. Moraes-Valenti, P. (2018) Indicators of sustainability to assess aquaculture systems. *Ecological Indicators* 88, 402-413.



- 8.) Bergleiter, S., Meisch, S. (2015) Certification Standards for Aquaculture Products: Bringing Together the Values of Producers and Consumers in Globalised Organic Food Markets. *Journal of Agricultural and Environmental Ethics* 28, 553–569.
- 9.) Chopin, T. (2015) Marine Aquaculture in Canada: Well-Established Monocultures of Finfish and Shellfish and an Emerging Integrated Multi-Trophic Aquaculture (IMTA) Approach Including Seaweeds, Other Invertebrates, and Microbial Communities. *Fisheries* 40(1), 28-31.
- 10.) Video “Trash fish”: <https://vimeo.com/354755732>
- 11.) Watch recorded talk by Dr. Lynn Sneddon, professor for fish welfare at the University of Gothenburg on fish sentience before class: <https://www.youtube.com/watch?v=NHhEsDpkKII>
- 12.) Franks, B., Ewell, C., Jacquet, J. (2021) Animal Welfare Risks of Global Aquaculture. *Science Advances*, 7, eabg0677.

### **Final Examination (oral presentation)**

The examination period for Winter Term is week 14. Except in the case of hardships or unforeseen events, students will be permitted to apply for out-of-time final examinations only if they are representing the University, the province, or the country in a competition or performance; serving in the Canadian military; observing a religious rite; working to support themselves or their family; or caring for a family member. Unforeseen events include (but may not be limited to) the following: ill health or other personal challenges that arise during a term and changes in the requirements of an ongoing job.

Further information on Academic Concession can be found under Policies and Regulation in the *Academic Calendar* <http://www.calendar.ubc.ca/vancouver/index.cfm?tree=3,48,0,0>

### **Academic Integrity**

The academic enterprise is founded on honesty, civility, and integrity. As members of this enterprise, all students are expected to know, understand, and follow the codes of conduct regarding academic integrity. At the most basic level, this means submitting only original work done by you and acknowledging all sources of information or ideas and attributing them to others as required. This also means you should not cheat, copy, or mislead others about what is your work. Violations of academic integrity (i.e., misconduct) lead to the breakdown of the academic enterprise, and therefore serious consequences arise and harsh sanctions are imposed. For example, incidences of plagiarism or cheating may result in a mark of zero on the assignment or exam and more serious consequences may apply if the matter is referred to the President’s Advisory Committee on Student Discipline. Careful records are kept in order to monitor and prevent recurrences.

A more detailed description of academic integrity, including the University’s policies and procedures, may be found in the *Academic Calendar* at

<http://www.calendar.ubc.ca/vancouver/index.cfm?tree=3,54,111,958>



## Resources

### **UBC Disability Resource Centre**

The Disability Resource Centre ensures educational equity for students with disabilities, injuries or illness. If you are disabled, have an injury or illness and require academic accommodations to meet the course objectives, please contact Access and Diversity: <https://students.ubc.ca/about-student-services/access-diversity>

### **UBC Ombuds Office**

The Ombuds Office offers independent, impartial, and confidential support to students in navigating UBC policies, processes, and resources, as well as guidance in resolving concerns related to fairness.

email: [ombuds.office@ubc.ca](mailto:ombuds.office@ubc.ca)

Web: <http://ombudsoffice.ubc.ca/>

### **UBC Equity and Inclusion Office**

UBC is a place where every student, staff and faculty member should be able to study and work in an environment that is free from discrimination and harassment. UBC prohibits discrimination and harassment on the basis of the following grounds: age, ancestry, colour, family status, marital status, physical or mental disability, place of origin, political belief, race, religion, sex, sexual orientation or unrelated criminal conviction. If you require assistance related to an issue of equity, discrimination or harassment, please contact the Equity and Inclusion Office.

Web: <http://equity.ubc.ca/>

### **Mental Health**

These are challenging times. UBC has mental health resources for students to provide support and help you achieve your academic goals. Visit <https://students.ubc.ca/health> to learn more.

## **SAFEWALK**

*Don't want to walk alone at night? Not too sure how to get somewhere on campus? Call Safewalk at 604-822-5355*

***For more information, see:*** <https://www.ams.ubc.ca/services/safewalk/>