More food from water?

Responsible institution:
Department of biology, University of Bergen (UiB)

Disciplines:
Biology, Aquatic Ecology, Fisheries, Aquaculture, Environmental Impacts, Management, Fish Nutrition, Human Nutrition

Course Leaders:
Jeppe Kolding, Associate professor, Fisheries Biology/Fisheries Management
Petter Larson, Professor in Aquatic Biology/Ecology
Ragnar Nortvedt, Professor in Seafood Quality and Food Processing
Rune Rosland, Associate professor, Marine Biology/Ecological Modelling

Invited course leader:
Christophe Béné, Senior Advisor, Small-scale Fisheries and Development, WorldFish Center Cairo Offices Consultative Group on International Agricultural Research (CGIAR)

Course Description, Goals and Objectives:
This course focuses on food production in aquatic ecosystems. Emphasis is put on the production potentials and limitations of different aquatic ecosystems and on strategies to enhance production capacity and food quality. Different aquatic production systems, from natural harvest to human controlled production systems, will be presented and discussed. Theory and selected case studies on applied enhancement methods will provide a basis for discussion on potentials and constraints for aquatic food production.

The course aims to develop a critical perspective and understanding of aquatic food production processes, and how production potential may be enhanced through harvest practices, artificial production systems, and ecosystem manipulations. The costs linked with such actions in terms of economical, social and environmental impacts will also be discussed.

This is a doctoral level course that will be comprised of lectures, seminars, and a written paper (assessment). The course will address four seminar topics:

1. Environmental possibilities and limitations for biological production in water.

2. Natural food production – harvest enhancement strategies

3. Ecological potential and limits to production in human production systems

4. Strategies to enhance utilisation and quality of aquatic food

Based on own background, experience and the course readings as their basic resources, the students will take the responsibility for preparing and leading the seminars.

Lectures:

Friday 8 August (1400-1600)
Introduction to the course, faculty and students.
Introductory lecture: Introduction to fisheries and aquaculture based food production – Potentials and challenges (Christophe Béné)

Saturday 9 August (0900-1100)
Introduction to fisheries and aquaculture based food production – Potentials and challenges (Christophe Béné)

Sunday 10 August (0900-1100)
Socioeconomic perspectives on fisheries and aquaculture based food production and management (Christophe Béné)

Sunday 10 August (1400-1600)
Aquatic ecosystems as food providers. Environmental possibilities and constrains for biological production. (Petter Larsson)

Monday 11 August (1400-1600)
Aquatic ecosystems as food providers. Manipulation of ecosystems for improved production of favourable species. (Petter Larsson)

Tuesday 12 August (0900-1100)
Improving fish productivity in tropical lakes and reservoirs I (Jeppe Kolding)

Wednesday 13 August (1400-1600)
Improving fish productivity in tropical lakes and reservoirs II (Jeppe Kolding)

Thursday 14 August (0900-1100)
Enhanced food production in marine ecosystems – restocking and manipulation of natural ecosystems (Rune Rosland)

Thursday 14 August (1400-1600)

Nutrion, based on freshwater and marine production I: Fish nutrition and slaughter routines related to food quality. Nutritional composition of fish, decapods, molluscs and shellfish (Ragnar Nortvedt)

Friday 15 August (1130-1300)

Nutrion, based on freshwater and marine production II: Product development from freshwater and marine resources. Byproducts. Human health benefits and hazards from freshwater and marine resources (Ragnar Nortvedt)

Prerequsites:

Students should have a background in biology or biologically oriented sciences (Ecology, Fisheries, Aquaculture, or Environmental Sciences).

Proficiency in the English language is required.

Target Candidates:

The course is primarily targeted for PhD students and junior faculty. MA level students will be accepted depending on space and academic qualifications.

The target students are working on subjects related to aquatic ecology, fisheries, aquaculture, either in science or management. Other students with a relevant background are also welcome to join the course.

Work Required:

About 250 hours of work is required (10 ECTS), inclusive all Bergen Summer School activities (this course plus plenary activities). Preparatory work includes completing the Required Reading prior to arrival in Bergen. Each student is to deliver a paper linked to the subject of the course within four weeks after the end of the course. The paper will receive careful attention from the Course Leaders and written feedback will be provided.

Four groups of students will be assigned the responsibility for the four seminar topics listed above (one topic each). The responsibility means to prepare and lead the seminars. The course leaders (for each main topic) will participate as tutors in the seminar preparation and during the seminars. Students will prepare an introductory presentation for the seminar and a list of stimulating and challenging questions that can provide a basis for the seminar discussion. All students are expected to have completed all reading well prior to the Summer School start, and group work assignments will be made prior to the Summer School start.

At the final day of the BSRS, participants of the course will make a report on what they have learned and present it in plenary.

ECTS:
10 ECTS granted for approved course performance (full course attendance, course readings and approved essay)

Course readings:

Bell, J. D., D. M. Bartley, et al. (2006). Restocking and stock enhancement of coastal fisheries: Potential, problems and progress. *Fisheries Resea*rch 80(1): 1-8.

Brett, M. T., and D. C. Muller-Navarra. 1997. The role of highly unsaturated fatty acids in aquatic food web processes. *Freshwater Biology* 38: 483-499.

Berntsen, J., D. L. Aksnes, et al. (2002). Production enhancement by artificial upwelling: a simulation study. *Hydrobiologia* 484(1-3): 177-190.

Brzeski, V. and G. Newkirk (1997). Integrated coastal food production systems - A review of current literature. *Ocean & Coastal Management* 34(1): 55-71.

Conover, D. O. (1998). Local adaptation in marine fishes: Evidence and implications for stock enhancement. *Bulletin of Marine Science* 62(2): 477-493.

Cowx, I. G., and D. Gerdeaux. 2004. The effects of fisheries management practises on freshwater ecosystems. *Fisheries Management and Ecology* 11: 145-151.

Ervik, A., P. K. Hansen, et al. (1997). Regulating the local environmental impact of intensive marine fish farming - I. The concept of the MOM system (Modelling Ongrowing fish farms Monitoring). *Aquaculture* 158(1-2): 85-94.

Flanagan, K. M., E. McCauley, and F. Wrona. 2006. Freshwater food webs control carbon dioxide saturation through sedimentation. *Global Change Biology* 12: 644-651.

Gulati, R. D., and W. R. DeMott. 1997. The role of food quality for zooplankton: remarks on the state-of-the-art, perspectives and priorities. *Freshwater Biology* 38: 753-768.

Hanson, P. C., S. R. Carpenter, D. E. Armstrong, E. H. Stanley, and T. K. Kratz. 2006. Lake dissolved inorganic carbon and dissolved oxygen: Changing drivers from days to decades. *Ecological Monographs* 76: 343-363.

Henderson, A., S. Gamito, et al. (2001). Use of hydrodynamic and benthic models for managing environmental impacts of marine aquaculture*. Journal of Applied Ichthyology* 17(4): 163-172.

Jeppesen, E., J. P. Jensen, M. Sondergaard, T. Lauridsen, L. J. Pedersen, and L. Jensen. 1997. Top-down control in freshwater lakes: The role of nutrient state, submerged macrophytes and water depth. *Hydrobiologia* 342: 151-164.

Kasprzak, P., J. Benndorf, T. Mehner, and R. Koschel. 2002. Biomanipulation of lake ecosystems: an introduction. *Freshwater Biology* 47: 2277-2281.

Kitada, S. and H. Kishino (2006). Lessons learned from Japanese marine finfish stock enhancement programmes. *Fisheries Research* 80(1): 101-112.
Kolding, J. and Zwieten, P.A.M. van, 2006. Improving productivity in tropical lakes and reservoirs. Challenge Program on Water and Food - *Aquatic Ecosystems and Fisheries Review Series 1*. Theme 3 of CPWF, C/o WorldFish Center, Cairo, Egypt. 139 pp. ISBN: 977-17-3087-8.
Landsberg, J. H. 2002. The effects of harmful algal blooms on aquatic organisms. *Reviews in Fisheries Science* 10: 113-390.
Leflaive, J., and L. Ten-Hage. 2007. Algal and cyanobacterial secondary metabolites in freshwaters: a comparison of allelopathic compounds and toxins. *Freshwater Biology* 52: 199-214.
Loiselle, S. A., A. Cozar, A. Dattilo, L. Bracchini, and J. A. Galvez. 2007. Light limitations to algal growth in tropical ecosystems. *Freshwater Biology* 52: 305-312.
Lu, K. H., C. H. Jin, S. L. Dong, B. H. Gu, and S. H. Bowen. 2006. Feeding and control of blue-green algal blooms by tilapia (Oreochromis niloticus). *Hydrobiologia* 568: 111-120.
Luten, J.B., Jacobsen, C., Bekaert, K., Sæbø, A. And Oehlenschläger, 2006. *Seafood research from fish to dish. Quality, safety and processing of wild and farmed fish*. Wageningen Academic Publishers, The Netherlands, 567 p., ISBN-10:90-8686-005-2.
McClimans, T. A., G. Eidnes, et al. (2002). Controlled artificial upwelling in a fjord using a submerged fresh water discharge: computer and laboratory simulations. *Hydrobiologia* 484(1-3): 191-202.
Mishra, A. and R. K. Mohanty (2004). Productivity enhancement through rice-fish farming using a two-stage rainwater conservation technique. *Agricultural Water Management* 67(2): 119-131.
Muller-Navarra, D. C., M. T. Brett, A. M. Liston, and C. R. Goldman. 2000. A highly unsaturated fatty acid predicts carbon transfer between primary producers and consumers. *Nature* 403: 74-77.
Mustafa, S. (2003). Stock enhancement and sea ranching: objectives and potential. *Reviews in Fish Biology and Fisheries* 13(2): 141-149.
Peterson, C. H., J. H. Grabowski, et al. (2003). Estimated enhancement of fish production resulting from restoring oyster reef habitat: quantitative valuation. *Marine Ecology-Progress Series* 264: 249-264.
Salvanes, A. G. V. and V. Braithwaite (2006). The need to understand the behaviour of fish reared for mariculture or restocking. *ICES Journal of Marine Science* 63(2): 346-354.
Seaman, W. (2007). Artificial habitats and the restoration of degraded marine ecosystems and fisheries. *Hydrobiologia* 580: 143-155.
Shahidi, F., 2007, *Maximising the value of marine by-products*. CRC Press, Woodhead Publishing Ltd., Cambridge, England, 532 p., ISBN-13: 978-1-84569-013-7.
Smaal, A. C. (2002). European mussel cultivation along the Atlantic coast: production status, problems and perspectives. *Hydrobiologia* 484(1-3): 89-98.