Agroecological practices in fish pond systems: Comparative study of three approaches of polyculture

Internship proposal for engineering or master student (master 2, only)

Keywords – Agroecology, polyculture, aquaculture, pond, functional ecology, traits, fish.

Supervisors – Thomas Lecocq (Ph-D, associate professor) and Marielle Thomas (Ph-D, associate professor)
Research unit - Research Unit Animal and Animal Product Functionality (UR AFPA), team: Domestication in Inland Aquaculture (DAC), Université de Lorraine, Faculté des Sciences et Technologies, Boulevard des Aiguillettes BP 70239, F-54506 Vandœuvre-lès-Nancy, France

Internship duration - 6 months
Internship localization - UR AFPA, Vandœuvre-lès-Nancy, France. Depending on the evolution of the sanitary crisis, a part of the internship could be performed remotely but, as far as possible, this solution will be avoided.
Internship grant - 554.40 €/ month.

Application deadline: 30/11/2020. Application should include (i) a cover letter, (ii) curriculum vitae, and (iii) the contact details of two references. This should be sent as a single pdf at *marielle.thomas@univ-lorraine.fr* and *thomas.lecocq@univ-lorraine.fr*

Context – Aquaculture is the farming of aquatic organisms through several different practices (i.e. monoculture/polyculture, outdoor/indoor, flow-through systems/recirculated systems and extensive/intensive). Since the 1960s, aquaculture production has rapidly expanded and exponentially grown worldwide as far as to provide more than 50% of the world's aquatic food consumption nowadays. Aquaculture has thus become a key factor in human food security. However, it is facing major challenges that will be even more important in the next decades. Indeed, sustainability and resilience of current aquaculture production raises concerns. For instance, intensive monoculture based on few species has often (i) significant environmental negative impact, (ii) low ability to withstand competition and disease/pest attacks, and (iii) a low adaptation potential facing to changes in environmental and socio-economical contexts.
Polyculture in fish production is a long-standing practice, which has been somewhat disregarded in recent aquaculture development in some parts of the world, especially in a production intensification option. Yet, it can avoid some of the drawbacks of fish monoculture. Indeed, there is growing evidence that species diversity contributes to the production system resilience in the context of economic changes, improves farm inputs' utilization, and decreases the amount of waste by the recycling of co-products of some taxa by the other co-farmed species. Nevertheless, such benefits can be reached only when a relevant combination of species is used. This can be achieved by designing fish community based on species compatibility (i.e. species can live in the same farming environment without detrimental interactions) and complementarity (i.e. complementary use of available resources and/or commensalism/mutualism). This one of the aims of the SEPURE project (i.e. « *Nouvelles stratégies de construction et de conduite de systèmes de production en étang pour une pisciculture durable* ») in which scientists (6 research units, INRAE) and fish farmers work together to achieve sustainable and efficient aquaculture.

Work – The scientific program mobilizes seven partners, involving a work on ten fish ponds in three French regions. A preliminary step consisted to establish ten different fish rearing scenarios for each pond. These polyculture scenarios combined with innovative practices were defined on the basis of the expertise of the scientific partners and fish farmers coupled with functional ecology approaches. In particular, a prospective method based on trait-environmental analysis for about 40 species was used to establish the fish species mixtures. During the training period, the engineering or master student will apply and study three polyculture scenarios in pond systems, in the region 'Grand Est'. First, she/he will describe the study site (pond characteristics and the watershed). Second, the student will develop (bibliography) and apply a global monitoring protocol for environmental and biological matrices. This step will concern the water and sediment compartment, with the definition of sampling techniques (representativeness and repeatability of samples) and the recording of physico-chemical parameters (pH, dissolved oxygen, turbidity, azote and phosphorus) and biological components (fish, invertebrates, macrophytes), in collaboration with all project partners and fish farmers. Third, she(he) will be in charge of data analysis and will participate in the scientific valorization of the data (writing an article) and in the dissemination of the results to the partners. The engineering or master student will be also trained in recirculated aquaculture systems and the regulatory framework related to the use of animals for scientific purposes.

Profile - We are looking for highly motivated and rigorous engineering or master student (master 2, only). The candidate is expected (i) to search, read, and understand scientific literature including in English, (ii) to have team skills, a sense of responsibility, (iii) to have core skills in statistical data analyses (in R language), and (iv) to have aptitude for field work.

References

1. Lecocq, T., Benard, A., Pasquet, A., Nahon, S., Ducret, A., Dupont-Marin, K., Lang, I. & Thomas, M. (2019). TOFF: a database of Traits OF Fish to promote advances in fish aquaculture. *Scientific Data*, 6, 301.
2. Aubin J., Robin J., Wezel A., Thomas M., 2017. Agroecological management in fish pond systems. In Agroecological Practices for Sustainable Agriculture: Principles, Applications, and Making the Transition. A. Wezel (Eds), World Scientific, ISBN 978-1-78634-307-9, 355-394.

Assessing fish abiotic requirements by ecological niche modelling to design (new) fish species communities for tomorrow's aquaculture

Internship proposal for engineering or master student (master 2, only)

Keywords - ecological niche modelling, species distribution modelling, geographic information system, fish, climate changes, aquaculture.

Supervisors – Thomas Lecocq (Ph-D, associate professor) and Marielle Thomas (Ph-D, associate professor)
Research unit - Research Unit Animal and Animal Product Functionality (UR AFPA), team: Domestication in Inland Aquaculture (DAC), Université de Lorraine, Faculté des Sciences et Technologies, Boulevard des Aiguillettes BP 70239, F-54506 Vandœuvre-lès-Nancy, France

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Internship duration - 6 months
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Work – Evaluating species compatibility requires first to assess whether different species can live in the same abiotic environment (e.g., by considering pH, temperature, water current, etc.). The engineering or master student will perform this assessment with the researchers of the University of Lorraine. She/he will develop ecological niche modelling (ENM) for 50 fish species that have been pointed out by aquaculture stakeholders as relevant for the tomorrow's fish farming in outdoor production. First, she/he will be involved in the selection of relevant abiotic parameters for fish ENM by considering parameters available in databases (e.g., https://www.earthenv.org/streams). Second, the student will develop abiotic parameter and species occurrence datasets through geographic information system (GIS) application. Third, she/he will analyze these datasets to determine the niche position and niche breadth

for each species via outlying mean index (OMI) analyses. Multivariate analyses (e.g., MANOVA) will be used to test for significant differences in the mean niche values of species. This step will provide useful insights on the species compatibility. Fourth, ENM will be developed (e.g., boosted regression tree method) for each species. These ENMs will be projected across Europe or the World (depending on the species considered) for current and future climate. This step will provide pieces of information about how the species compatibility could change according to fish farming locations and climate changes. The last step will be to determine what fish community will be the best for fish farming under a given abiotic niche.

Profile - We are looking for highly motivated and rigorous engineering or master student (master 2, only). The candidate is expected (i) to search, read, and understand scientific literature including in English, (ii) to have team skills, a sense of responsibility, and (iii) to have good skills in GIS and core skills in statistical data analyses (in R language).

References

1. Lecocq, T., Harpke, A., Rasmont, P., and Schweiger, O. (2019). Divers. Distrib. 25, 1088–1100. doi:10.1111/ddi.12916.
2. Segurado, P., Branco, P., Jauch, E., Neves, R., and Ferreira, M. T. (2016). Sci. Total Environ. 562, 435–445. doi:10.1016/j.scitotenv.2016.03.188.
3. Pandit, S. N., Maitland, B. M., Pandit, L. K., Poesch, M. S., and Enders, E. C. (2017). Sci. Total Environ. 598, 1–11. doi:10.1016/j.scitotenv.2017.03.228.