AQUA EXCEL 2020

AQUAculture infrastructures for EXCELlence in European fish research towards 2020

Project News

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AQUAEXCEL2020 is a €9.7 million European Union-funded Horizon 2020 Research Infrastructure project that aims to support the sustainable growth of the aquaculture sector in Europe. It does so by integration of the European aquaculture community, and providing it with crucial tools, facilities, and novel services to conduct advanced fish research.

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Welcome from the AQUAEXCEL²⁰²⁰ Coordinator

Dr Marc Vandeputte
AQUAEXCEL²⁰²⁰ coordinator
French National Institute for
Agricultural Research (INRAE)

This is the last newsletter where I will reflect on the **AQUAEXCEL²⁰²⁰** project. It is now ten years since I started coordinating the **AQUAEXCEL** consortium. This has been a great experience, and we have built a strong network of scientists and research facilities, with benefits for our institutes and universities, but also for the wider aquaculture industry and aquaculture research communities. The production of results in all disciplines related to aquaculture has been incredible, as can be seen in the success stories highlighted in this newsletter. Many researchers from Europe and the rest of the world have accessed our infrastructures to produce a lot of exciting results! It took some time, but **AQUAEXCEL** is now a recognized brand and is identified by many young and experienced researchers as an opportunity to establish collaborations and develop new research lines. That is a huge achievement. Do not miss the online presentations of key outputs that will be organized this autumn! Although it is the last step for **AQUAEXCEL²⁰²⁰**, the brand new **AQUAEXCEL3.0** will start in November and will take us to 2025 with even more opportunities!

Marc Vandeputte

News and Highlights

AQUAEXCEL²⁰²⁰ to finish and new project AQUAEXCEL3.0 to begin

The highly successful **AQUAEXCEL²⁰²⁰** project will finish in December this year. The five-year project ran from 2015 and integrated 39 top class European aquaculture research facilities that cover all relevant scientific fields, fish species and systems. Unfortunately, due to the ongoing Covid-19 situation the final **AQUAEXCEL²⁰²⁰** consortium meeting did not take place in person in Cork (Ireland) as planned, but instead took place online. Visit the project website to see the resulting publications, Innovative Output Catalogues, public deliverables, previous newsletters and more.

AQUAEXCEL²⁰²⁰ was preceded by **AQUAEXCEL**, which took place from 2011 to 2015. We are delighted to announce that the excellent work performed in these projects will be carried on in **AQUAEXCEL3.0**, which will launch in November 2020 and continue until October 2025. The project, coordinated by Dr Marc Vandeputte from INRAE (the French National Research Institute for Agriculture, Food and Environment), will consist of 22 partners and has a budget of €10 million.

By integrating 40 top-class European aquaculture research facilities, **AQUAEXCEL3.0** will provide a continued world-class platform for aquaculture research, from biology to technology, in all types of rearing systems, covering all major EU farmed species as well as the most promising new species.

The project will deliver expanded access to high-quality services and resources, covering all scientific fields relevant to research and innovation in aquaculture, from genetics to technology through immunology, physiology and nutrition, and include new nanosensors and fish isogenic lines developed in the previous projects.

AQUAEXCEL²⁰²⁰ consortium partners at the last in-person meeting in Las Palmas, Gran Canaria

As with the previous projects, there will be great Transnational Access (TNA) opportunities. Almost 200 Transnational Access projects are scheduled which will consolidate the global leadership of European aquaculture research and advance the implementation of the European Aquaculture Technology and Innovation Platform's (EATiP) Strategic Research Agenda. The Industry and Research Advisory Panel (IRAP) will identify TNA results of high industry relevance and broker these to key stakeholders, and promote these success stories to industry, policymakers and the general public.

The project will incorporate a wider range of marine species with the addition of shellfish, macroalgae and recyclers (insects, marine worms). Integrating lower trophic level species is key to move towards more sustainable and circular aquaculture – a strong societal demand.

Improving the use of animal experiments for research according to the 3 Rs, Reduction (via stable fish models

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and improved design of experiments), Refinement (via the development of Operational Welfare Indicators and environmental enrichment) and Replacement (via e.g. Virtual Laboratories and cellular models) is integral to the concept of **AQUAEXCEL3.0**.

After the huge demand for face-to-face training courses in the previous **AQUAEXCEL** projects, **AQUAEXCEL3.0** will focus on online courses to broaden the trainees base, increase impact and to ensure sustainability of this knowledge. This capacity building feature will contribute to a sustainable and globally competitive European aquaculture sector with qualified staff.

> **For more information, please email the AQUAEXCEL²⁰²⁰ Project Coordinator Marc Vandeputte (marc.vandeputte@inrae.fr) , who will also coordinate AQUAEXCEL3.0.**

Over 45 scientific publications result from the AQUAEXCEL²⁰²⁰ project

AQUAEXCEL²⁰²⁰ has had an excellent record of publishing scientific papers over its duration. To date, over 45 scientific publications have been published, through the research carried out in the project and through the work of TNA researchers. To read some of the TNA Success Stories please go to page 6.

These publications cover a variety of European aquaculture species, including gilthead sea bream, European sea bass, pike perch, meagre, European perch, common carp, rainbow trout and Atlantic salmon.

Diverse topics such as behaviour monitoring and modelling, fish feed and nutrition, disease, management protocols and genetics are just some of the areas that have been covered.

To see the latest project publications please go to page 8. To view the full list of publications please visit the project website's publications section: **aquaexcel2020.eu/results**

Covid-19 changes brokerage plans for AQUAEXCEL²⁰²⁰

Due to the postponement of the Aquaculture Europe event, the **AQUAEXCEL²⁰²⁰** brokerage event planned for October 2020 is no longer going ahead. Partners EATiP and AquaTT have been working to develop a series of online events to showcase some of the research that has been identified as impactful for industry. For more details, please follow @**AQUAEXCEL²⁰²⁰** on Twitter and keep an eye on the project website.

AQUAEXCEL²⁰²⁰ Virtual Laboratory open for use

As part of **AQUAEXCEL²⁰²⁰**, standardised guides and new tools for aquaculture research are being developed, including a dedicated e-infrastructure which will support both actual and virtual research experiments.
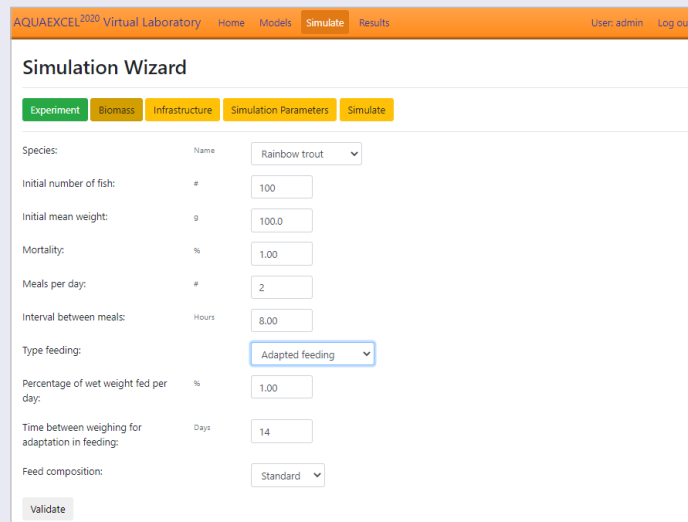
A virtual laboratory has now been developed which can simulate experiments with fish and receive data on expected growth and water quality. Based on numerical modelling, it allows *in silico* testing of experimental protocols with a user-friendly interface, prior to their practical application. The overall goal of the virtual laboratory is to assist in optimizing the use of experimental resources and improve experimental design and test power.

You can access the virtual laboratory at:
ae2020virtuallab.sintef.no

More information on the implemented models and species can be found on the site, and a helpful experiment wizard will help you configure your first experiments. Feel free to create a user account and start experimenting today!

A screenshot from the AQUAEXCEL²⁰²⁰ Virtual Laboratory

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Skills, Dedication and a Passion For Science at NAIK's Infrastructure

Over the past five years, many AQUAEXCEL²⁰²⁰ TNA applicants have carried out impactful aquaculture research using the infrastructures offered through the project. In this newsletter, NAIK installation manager Uroš Ljubobratović tells the story of one applicant who showed exceptional drive and determination.

As infrastructure and project manager at NAIK, the last 12 months have been busy. There have been three consecutive TNA projects, all with their own challenges. My main interest was the focus species they shared – pikeperch. If you know about the ethology of pikeperch, you will know that studying this species is not simple. To add to the challenge, the lead researchers set ambitious tasks – cage-rearing in a super-intensive carp pond, obtaining viable male gametes five months prior to season, and finally, feeding larvae with dry feed from the very start of exogenous feeding. These tasks are tough and complicated.

Jovanka is currently taking care of her new-born baby but nonetheless, she is working on preparations of manuscripts from the latest TNA project, with thanks to the help of the NAIK team

The *in vivo* phase of the first project started in early June and finished in September 2019, while the second TNA project started in late October with the researcher's visit ending in late November.

Christmas continued to be a busy period with an exciting project that involved performing artificial reproduction in outdoor pikeperch breeders earlier than ever reported, almost four months prior to spawning season. I was working with an extremely skilled and dedicated researcher, Jovanka Lukić from the Institute of Molecular Genetics and Genetic Engineering (IMGGE), University of Belgrade, for the fifth year. She was in her sixth month of pregnancy at the time her *in vivo* work started at the NAIK infrastructure. During the trial, she visited the infrastructure twice, working more than 40 hours per week in order to arrange her data properly.

Jovanka was working on her latest TNA project (PROFEE) aiming to evaluate whether inert feed enriched with probiotics could aid the growth of first feeding pike-perch larvae weaned from the start of exogenous feeding. Probiotic treatment was associated with an

Aside from actively working on TNA experiments during pregnancy, Jovanka also presented the results obtained in her previous TNA project at the AQUAEXCEL²⁰²⁰ brokerage event in Berlin (Germany), October 2019

increase of soluble protein and amino acid levels in inert feed, including glycine and proline, which are particularly important for growth of juvenile fish. Addition of probiotic treated feed was expected to improve skeleton development. The results obtained in the study are encouraging both in terms of scientific excellence and on-farm application of probiotics in aquaculture.

Passion and dedication for science is something amazing and worthy of profound respect. I already had great respect for Jovanka, and yet she was able to surprise me further.

Leila was born on 1st of April 2020 and Jovanka is enjoying time with her. The project was completed successfully and her report submitted. Jovanka is already thinking of publishing, and so we will witness the new wonders of pike-perch larviculture with the help of probiotics soon.

I wish Jovanka and Leila lots of luck!

Uroš Ljubobratović, NAIK Installation manager

To view the publications Jovanka was previously involved in through her work in **AQUAEXCEL²⁰²⁰** TNA projects, visit

aquaexcel2020.eu/index.php/transnational-access/tna-projects

and select: **Effects of lactobacilli supplemented to cultured pike-perch through live and inert diets on fish performance in the case of rapid and gradual weaning**

Upcoming Events

AQUAEXCEL²⁰²⁰ Industry Brokerage Webinars (Dates TBC)

The final **AQUAEXCEL²⁰²⁰** industry brokerage event will now be hosted as a series of webinars to highlight results from the Transnational Access and the internal project research with the highest application potential for the aquaculture sector.

The organisation of these webinars is currently taking place and more information will be available on the project website. It is expected the webinars will take place in autumn 2020.

Past Events

Final AQUAEXCEL²⁰²⁰ Annual Meeting

The final **AQUAEXCEL²⁰²⁰** annual meeting took place online on Tuesday 29th September. Partners had the opportunity to present their achievements and to celebrate the overall success of **AQUAEXCEL²⁰²⁰**, before the start of the new project **AQUAEXCEL3.0**.

Open Distance Learning Training Courses

AQUAEXCEL²⁰²⁰ training courses aim to educate a new generation of aquaculture researchers and industry stakeholders to develop knowledge, skills and tools to advance innovation and sustainability in aquaculture. In total, nine online and face-to-face training courses are being offered between April 2016 and September 2020.

All face-to-face training courses have now taken place. Three free ongoing **AQUAEXCEL²⁰²⁰** distance learning courses remain OPEN for registration until the end of the project. These courses are a great opportunity for remote learning.

EXPERIMENTAL DATA MANAGEMENT: FROM GENERATING PROTOCOLS TO SHARING DATA COURSE

PROVIDER: University of South Bohemia in České Budějovice
FORMAT: Online, recorded lectures
CONTENT: Live element completed with all materials available online

USING MODELLING OF SCALE EFFECTS AS A TOOL FOR EXPERIMENTAL DESIGN COURSE
PROVIDER: SINTEF Ocean AS (SINTEF)
FORMAT: Online, recorded lectures
CONTENT: Live element completed with all materials available online

TRAINING IN THE USE OF THE FISH AND CHIPS TOOL COURSE

PROVIDER: Institut National de la Recherche Agronomique (INRAE)
FORMAT: Online
CONTENT: All materials are available online

Fish'n'Co – *Sander lucioperca*

Pike-perch (*Sander luciopera*) typically inhabits lakes, rivers, reservoirs and coastal marine waters, in the catchment areas of the Caspian, Aral, Baltic, Black, and North seas. It is widespread in France and western Europe, is rapidly extending its range in eastern and central England, and is acclimated to the waters of northern Africa (Algeria, Morocco, Tunisia), North America, and Asia (e.g. China, Kyrgyzstan).

This species generally attains lengths of 50-70 cm and body weights of 2-5 kg but a maximum length of 130 cm and weights of 12-18 kg have been reported. Males reach sexual maturity at 2-3 years, females at 3-4 years. Depending on geographical zone, spawning is from April to mid-June. Pike-perch deposit eggs into nests that they have built on sand, gravel (preferred substrate), or aquatic vegetation. Males actively guard nests with eggs for 5-8 days until the larvae hatch.

The beginnings of pike-perch culture date to the nineteenth century and are linked to carp (*Cyprinus carpio*) culture in earthen ponds in Central and Eastern Europe. Pike-perch was produced in low quantities as an "additional fish". In the early twentieth century, production began of pike-perch stocking material (summer and fall fry) in earthen ponds (natural spawning) for stocking open waters. It was produced in monoculture (summer fry) or in polyculture with carp (fall fry). Pond pike-perch culture also began to develop in Western Europe (e.g. France) in the second half of the twentieth century. This type of pike-perch production has been, and remains,

Fish'n'Co – *Sander lucioperca*

extensive in character, and this species has been and currently is viewed only as a supplementary fish.

At the beginning of the twenty-first century, the first aquaculture facilities producing pike-perch in recirculation aquaculture systems (RAS) were established in Western Europe and, by the close of the first decade, there were almost ten of these facilities. Methods for intensive pike-perch culture are in the initial stages of development but this species is considered to offer good prospects for European aquaculture.

The extracts above are taken from: Food and Agriculture Organization of the United Nations: Fisheries and Aquaculture Department **fao.org/fishery/culturedspecies/Sander_lucioperca/en**

(Cultured Aquatic Species Information Programme. Sander lucioperca. Cultured Aquatic Species Information Programme. Text by Zakęś, Z. In: FAO Fisheries and Aquaculture Department [online]. Rome. Updated 1 January 2012)

Transnational Access (TNA) Success Stories

The **AQUAEXCEL²⁰²⁰** TNA programme enables external teams to access project partners' facilities via submission of research proposals, which are funded based on an independent evaluation. Access is offered to 39 research infrastructures of participating institutes, with experimental costs, travel and subsistence covered by **AQUAEXCEL²⁰²⁰**. Available facilities cover the entire range of production systems, environments, scales, fish species and fields of expertise. Access is available to EU and Associated States' research teams, industry, and small and medium-sized enterprises (SMEs), based on the scientific excellence of proposals and relevance to the aquaculture sector.

Improving Atlantic salmon feeding process efficiency by the Smart System for Feeding Control (SICA)

The recently completed **AQUAEXCEL²⁰²⁰** TNA project *"Improving salmon feeding process efficiency by the Smart System for Feeding Control (SICA)"* was carried out by TNA applicant Rosa Martínez of Centro Tecnológico Naval y del Mar (Marine Technology Centre – CTNAVAL, Spain), with assistance from Ivan Felis, Hamid Er-Rachdi and Ana Juan (CTN), Eleni Kelasidi, Kevin Frank, Kjetil Øvretveit and Terje Bremvåg (SINTEF ACE), and Site Manager of Salmar, Christer Johansen. This research project carried out in SINTEF ACE facilities (Norway) investigated the behaviour of farmed salmon in cages during the feeding stage using a cost-efficient, non-invasive, real-time passive acoustic system (SICA) aimed at detecting when salmon stop eating.

The salmon farming sector is keen to reduce production costs and increase production efficiency, while also reducing environmental impact. Feed waste can cause pollution in the marine environment. Feeding efficiency can contribute to increasing competitiveness while reducing environmental impact. Most Atlantic salmon production takes place in marine net cages, where fish is fed through the distribution of feed at the water surface. Computer vision technology has been widely used in recent years for behaviour monitoring. This video underwater methodology allows an estimation of the appetite of fish to achieve precision feeding by assessing the

velocity, acceleration, degree of aggregation between fish, but also the amount of excess feed in the water. Acoustic systems provide an added advantage in that they aim to automate feeding, resulting in less human time required for monitoring.

The Smart System for Feeding Control (SICA) was developed by the Marine Technology Centre (CTN). SICA is a non-invasive,

Image: SICA deployed in one of the cages and SINTEF ACE Control Centre (at the back). Credit: Hamid Er-Rachdi and Rosa Martínez (CTN)

passive acoustic system comprised by two modules: Data Logger and Control Unit. The Data Logger, which is deployed in the sea cages' infrastructures, performs the acquisition stage through the passive acoustic sensor and a pre-processing stage of the data acquired to be transmitted via the Wireless Communication Module. The Control Unit is placed where the feeding process is undertaken. In this project, it was installed at the SINTEF ACE Control Centre. Its function is to apply the algorithms on the data received from the Wireless Communication Module and make decisions about the feeding process. The SICA system operates on its own, acquiring and processing the acoustic data. The technology is non-invasive and provides real-time monitoring. The hardware core is not very complex, it is a passive system and it is nearly maintenance free and so it is cost-effective.

The SICA system was found to more effectively detect unusual behaviour of salmon during the feeding process in contrast to the traditional methodology undertaken with underwater video cameras. It identified low feed intake earlier than the video method. By improving the efficiency of the feeding process, salmon farmers can reduce environmental impacts and increase their competitiveness.

Transnational Access (TNA) Success Stories

A scientific publication is currently planned. If you have questions about this research or technology you can contact Rosa Martinez Álvarez-Castellanos at **rosamartinez@ctnaval.com**

Personalized aquaculture – non-invasive real-time fish identification

The **AQUAEXCEL²⁰²⁰** TNA project *"Personalized aquaculture – non-invasive real-time fish identification"* has recently resulted in the publication of a scientific paper and submission of a second paper. The project focused on testing the feasibility of fully automatic individual fish identification using visible patterns and was carried out in NOFIMA's facilities in Norway (Sunndalsora Research Station for Sustainable Aquaculture). The team consisted of Rudolf Schraml (main applicant, University of Salzburg), Mohammadmehdi Saberioon, Petr Císař, Dinara Bekkozhayeva and Oleksandr Movchan (University of South Bohemia) and Andreas Uhl, Heinz Hofbauer Salzburg and Ehsaneddin Jalilian (University of Salzburg).

Individual fish identification is used in many areas of aquaculture research and production. Nowadays, fish tagging is the most common approach of same-species individual fish identification. Tagging has several advantages, but is also an invasive method. Each fish must be caught, tagged and caught again once there is a need for identification. This process can be stressful for the fish. The main limitations of tagging are fish size, the number of fish which can be tagged, and the requirement to retrieve the tag before fish processing.

The development of new digital cameras and methods of image processing can enable automation in many fish cultivation processes. The new concept of "Precision Fish Farming" introduces the advantages of fish farming based on new technologies for data measurement, analysis and data-based decision making. The existence of non-invasive individual fish identification which can work under real fish cultivation conditions would lead to new possibilities for fish farming.

The concept of non-invasive individual identification for humans has existed for several decades. Several different human body patterns are used for biometrical identification, such as fingerprints, iris and the face. This concept has also been adopted for individual identification of certain animals. It was successfully used for individual identification in sheep, cows and whales. Several studies have tested the possibility of using fish skin patterns for individual fish identification of the same species. These studies demonstrated that the dot pattern (Atlantic salmon), scale pattern (Common carp) or stripe pattern (Zebra fish) can be used for individual fish identification. The problem with these studies is that a very low number (up to 30 fish) was used and the analysis was based on manual data processing. Therefore, the aim of this TNA project was to develop fully automatic individual fish identification and to test the long-term stability of the selected patterns for fish identification. The data of 328 individual Atlantic salmon were collected during 6 months of cultivation in the tank. The images of the fish eyes and fish skin dot pattern (out of water and under water) were collected by digital cameras.

The fully automatic method for individual fish identification was developed for eye-based identification and skin dot pattern identification. The methods are based on automatic
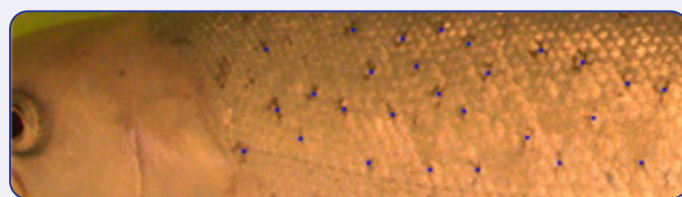

Image: The unique skin spot pattern with detected dots (blue) that is used to identify individual fish of the same species

localization of the eye/part of the fish body with the dot pattern, parametrization of the pattern (extraction of the information about the pattern) and classification of the fish into one of the 328 individuals. The methods of machine vision and deep learning were used for these tasks. Two different tasks were performed in the study: short-term identification and long-term identification. The short-term identification involved identification using images of 328 fish collected over 5 days. The long-term identification tested the identification using images of 30 fish collected over 6 months. The fish eye identification was 95% accurate for short-term, and 28-80% accurate for long-term identification depending on the time period between data collections. The skin dot pattern approach was 100% accurate for short-term and 100% accurate for long-term identification.

The conclusion is that the salmon eye pattern can be used for short-term identification, but it is not stable for long-term identification due to changes during growth. The skin dot pattern can be used for short- and long-term individual identification without error. The results are described in two research papers (the fish eye approach is published in *IEEE Transactions on Industrial Informatics* and the fish skin dot pattern was submitted to *IEEE Transactions on Pattern Analysis and Machine Intelligence*) which were produced together with the software for fish identification. The collected dataset will be published as an open access dataset for other researchers.

The TNA project proved the possibility of fully automatized individual fish identification using a non-invasive approach based on fish image only. The immediate impact is in the area of fish identification under controlled conditions, but the more important impact is expected in fish production. The developed methodology must be adapted to the real conditions of the fish cultivation industry, which will be a focus of the team's future work.

For any questions on this research, please contact Petr Císař at **cisar@frov.jcu.cz**.

Satisfy your Tastebuds!
Tasty Recipe – Jamie Oliver's Pike Perch and Roasted Beet Salad

© David Loftus / Jamie Oliver's Food Escapes: Over 100 Recipes from the Great Food Regions of the World

INGREDIENTS (*serves 4*)

- Extra Virgin olive oil
- 300g spinach leaves (washed and spun dry)
- A few knobs of butter
- 1tsp caraway seeds
- Olive oil
- 150ml soured cream
- 4 x 150g fillets of pike perch
- Sea salt
- Freshly ground black pepper
- 1 x Lemon
- A small bunch of fresh dill (with flowers if you can get them). Flowers reserved. Leaves finely chopped
- Red wine vinegar
- A small bunch of finely sliced fresh chives
- 700g mixture of raw red, white and candy coloured beetroot, scrubbed and clean
- 1 x medium red onion, peeled and finely sliced

PREPARATION

1. Preheat your oven to 200 ºc/gas 6. Scatter a few handfuls of rock salt around the base of a large roasting tray. Cut the bottom off each beetroot and stand them up on the salt. Pop into the oven to cook for 1 hour. Mix a pinch of salt and a good squeeze of lemon juice into your soured cream and put to one side.
2. Once the beets are beautifully roasted, take them out of the oven and turn the temperature down to its lowest setting.
3. Let the beets cool down a little, then peel them and discard their skins. Quarter the darker purple beets and put to one side. Halve, quarter and slice the rest of the beets and put those into a bowl with the chives, most of the dill and the sliced onion.
4. Add a pinch of salt and pepper, pour in a splash of red wine vinegar and a lug of extra virgin olive oil, and use your hands to toss everything together really well.
5. Put a large pan on a medium to high heat. Pinch the skin side of each fish fillet and lightly score a few times, 3cm (1¼in) apart. You just want shallow incisions. Rub olive oil, salt and pepper all over each fillet. lay them in the hot pan, skin side down, cook for about 3 minutes, until the skin is crispy, then flip them over and cook for 1 minute more, until cooked through.
6. Add the caraway seeds, reserved dill (if you have any dill flowers, add those too) and spinach leaves. Sprinkle over a pinch of salt and leave for 30 to 60 seconds, until the spinach starts to wilt. At that point, take the pan off the heat, dot a few knobs of butter over the spinach, and squeeze over the juice of ½ the lemon.
7. Quickly toss the reserved dark purple beets into the rest of your beet salad and divide between your plates. Top each salad with some of your spinach and a fillet of fish.
8. The juices from the bottom of the pan are absolute gold, so spoon those over the fish too.
9. Finish with a dollop of soured cream and a drizzle of extra virgin olive oil and serve right away.

Marc's Wine Tip: Red wine can also be great with fish, but you need wines with good acidity, low tanins, high drinkability, served lightly chilled. With this pike perch and beet salad, a nice Beaujolais of a recent vintage will be perfect, and even more a Morgon, one of the finest crus of Beaujolais.

Recipe from: mydish.co.uk/recipe/8258/jamie-olivers-pike-perch-and-roasted-beet-salad

AQUAEXCEL2020 Recent Publications

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Contact Us

Coordination: **marc.vandeputte@inrae.fr**

Project Management: **nesrine.mezghrani@inrae.fr**

Communication & Press: **rebecca@aquatt.ie**

WWW.AQUAEXCEL2020.EU
@AQUAEXCEL2020

Designed & developed by AquaTT