



FELLOWSHIP SUMMARY REPORTS

Javier Atalah

Title: A global assessment of the impacts and risk-based management of farmed exotic fish escapes on marine ecosystems

Theme 2, Managing Risks in a Connected World

Host Institution: University of Alicante, Department of Marine Sciences and Applied Biology

Host Collaborator: Dr Pablo Sanchez-Jerez

Dates: 15 December 2018 to 15 April 2019

I hereby consent to my report being posted on the Co-operative Research Programme's website, or alternatively, a short paragraph about my fellowship which could be used anonymously.





Importance of the Project

As the global supply of fish from wild fisheries is limited, finfish aquaculture has the opportunity to meet the growing demand through increased production. However, the future development of the industry must rely on environmentally sustainable practices. Because of the open nature of net-pen systems where finfish are mostly produced, there is an inherent high risk of fish escapes into natural habitats. Massive escape events or chronic fish leakage are an inevitable occurrence caused primarily by operational accidents, failure of containment equipment, predator attacks, storms or sabotage. Substantial fish escapes have been recorded in most key finfish producing region. Escapes not only represent a considerable economic loss for the farmers, but can have drastic ecological, genetic, pathogenic and socio-economic impacts. Escapes are particularly problematic in areas outside the farmed species' native ranges, representing an important vector of introduction and subsequent spread of non-native species. Ecological impacts of non-native species include direct competition for resources with wild fish, predation, alterations to habitat complexity and declines in native fish populations. When escapees are native, there is the risk of genetic introgression of farmed fish, which can result in changes in genetic composition, long-term loss of fitness, adaptability and reduced survival of wild fish stocks. Additionally, crowded net-pen environments can promote the proliferation of diseases and parasites, and increase the risk subsequent of their transmission into wild fish, which in turn is exacerbated by the diversification and intensification of the industry. Infected escapees moving among farms and interacting with wild stocks, or wild fish aggregated within the plume of infected farms represent important vectors for pathogen transmission and are a major concern for the sustainability of wild fisheries. While the extent, causes and the ecological consequences of fish escapes has been well documented for particular species and ecoregions, there is a lack of knowledge about the global extent of these issues. Acquiring this information is crucial for the development of management measures aiming to improve the sustainability of aquaculture and to ensure the preservation of oceans' biodiversity.





Objectives

The objective of the project was to conduct a global assessment of the ecological, genetic and pathogenic impacts risk associated with escapes of farmed fish into natural marine ecosystems. Additionally, to rank marine provinces of the world based on the cumulative risk associated with fish escapes, with the aim of highlighting key issues for fish escapes management across ecoregions of the world.

Achievement of Objectives

The objectives of the project were achieved and completed during the fellowship. We used an exhaustive systematic search of global datasets and literature to collate information on fish production, pathogenic agents, species distribution ranges and ecological traits for the thirty most extensively farmed fish species globally. This information was combined to provide a visualisation of global geographical patterns of ecological, genetic and pathogenic impacts risk (Figure 1).



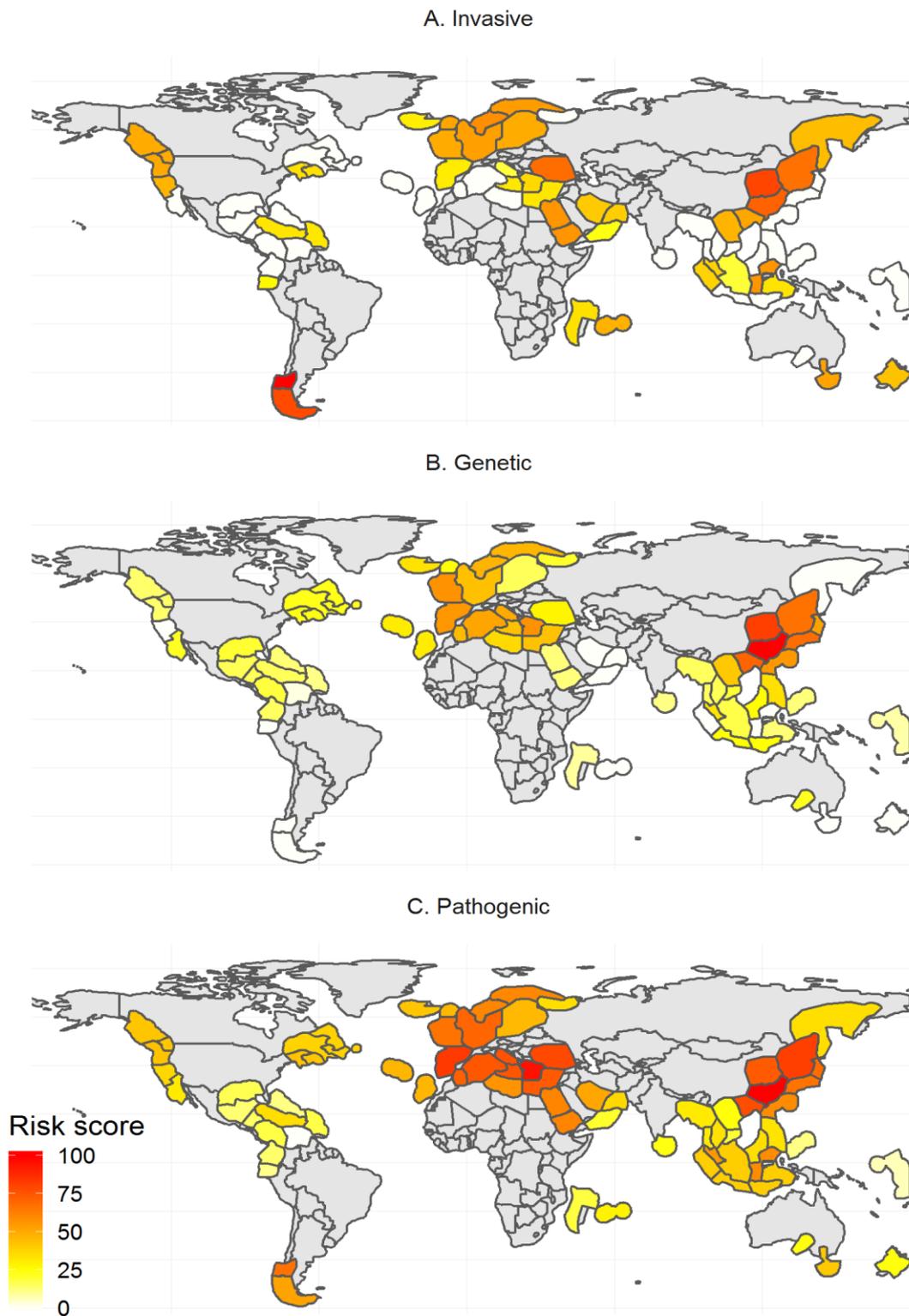


Figure 1. Invasive, genetic and pathogenic risk scores associated with the impacts of escapes of the thirty most extensively farmed marine fish species in net-pen systems.



Major achievements of the fellowship

- The development of an extensive and comprehensive database on ecological, genetic and pathogenic impacts associated to fish farmed escapes, the distribution by introduction status (i.e. native or exotic) of major farmed fish and associated pathogens by species and ecoregions of the world accessible to all stakeholders and government regulatory bodies, which can be updated as required.
- Global GIS maps displaying the vulnerability of marine ecosystems to ecological impacts associated to escape events of farmed fish by species.
- A manuscript entitled “A global assessment of ecological risks associated with farmed fish escapes”, currently under review in the journal Nature Food (<https://www.nature.com/natfood/>) presenting the finding of the first global quantitative evaluation of risks associated with the impacts of fish escapes from marine net-pen aquaculture.

Follow-up work

The fellowship developed a new collaboration between University of Alicante and the Cawthron Institute, and it is hoped this project will be the beginning of further shared projects and co-operation between institutions.

Follow-up work will involve the review process of the manuscript submitted to the journal Nature Food. This process might take over 6 months and, if accepted, it is envisaged to be published in 2020.

Additional follow-up work will involve the analyses of a questionnaire developed and sent to a global network of world experts in relation to the impacts of farmed fish escapes <https://forms.gle/3B9vkgqj6BozWSz4A>. For each species we ask expert to rank the relevance, causes and frequency of escape events. Then we asked them to rank the relevance, spatial scale, susceptibility of the recipient habitats and the recovery time of four impact categories. This will generate a database that will fill information gaps in a quantifiable way that will help to assess the relative weights of the potential impacts of fish escapes, which might result in an additional related journal publication.





Policy Applications and Social Benefits

The proposed project is highly relevant to aquaculture management globally, particularly in light of the rapid growth experienced by the industry and associated increased in fish escapes. Legislation regarding management of fish escapes is already in place in some countries; however, there is still a lack of knowledge around the extent and nature of the ecological impacts with regards to fish escapes. For example, the European Union (EU) requires a risk assessment for the introduction or translocation of species for aquaculture purposes. Furthermore, the EU encourages member states to develop specific legislation to address this issue on a regional basis. In other countries, such as New Zealand, there is no specific national legislation regarding risk assessment and management relating to fish escapes; however, escape risk and impacts need to be considered at a regional level as part as of regulatory requirements.

At an international level most major finfish producing countries have policies in place that require considerations and management practices to minimise the risk associated with the transfer and escape of exotic fish species. By contrast, in countries where marine aquaculture is developing at a fast pace, but where environmental sustainability requirements or standards are few (e.g. China and Ecuador), this project will provide the underpinning knowledge to facilitate appropriate policy development.

Elucidating the simultaneous risks associated to multiple farmed species is one of the major challenges for the aquaculture industry and needs to be addressed urgently to underpin management measures to halt the impacts to the functioning and structure of marine ecosystems. Our study provided global insights into the extent and magnitude risks associated with fish escapes, highlighting key issues for fish escapes management across ecoregions of the world. There is a substantial body of literature showing that fish escapes are inevitable events in most cases and that the impacts are widespread in the marine environment. Sound operational practices coupled with effective management and mitigation measures to reduce fish escapes need to be considered if ecosystems impacts are to be avoided and the sustainable development of the aquaculture industry promoted.





Relevance to Co-operative Research Programme objectives and theme

The project aligned well with the broad aims of the Co-operative Research Programme Biological Resource Management for Sustainable Agricultural Systems, which are "to strengthen scientific knowledge in its field of competence and to provide relevant scientific information and advice that will inform future policy decisions related to the sustainable use of natural resources, in the areas of food, agriculture, forests and fisheries". The research project strengthens scientific knowledge with regards to issues surrounding invasive exotic species associated with aquaculture activities, in particular the potential risks posed to the environment. The project promotes international scientific co-operation and presents an opportunity for a new collaboration between New Zealand and Spain in relation to the sustainable management of the aquaculture industry.

The project fit well within "Theme II: Managing risks in a connected world" which aims to fund activities that link research "to assess the biosecurity risks posed by invasions of alien or exotic species leading to increased pest and disease risk, which may impact on aquaculture systems to achieve food security". The central theme of the project involves understanding the impacts of biological stressors (i.e. escaped fish) in relation to the sustainable use of natural resources in aquaculture. The information provided will also aid in understanding the interactions between invasive species and aquaculture to improve risk assessment and management related to operational practices. Furthermore, the proposed research provided information on marine ecosystem vulnerability to farmed fish escapes globally to develop precautionary and risk-based management measures for farmers and policymakers which aligns well the sub-theme Risk assessment. This sub-theme encourages "simple, easily accessible risk assessment tools are essential to help governments and managers of agricultural systems to anticipate, avoid and react to biosecurity, climate or market access risks and so minimise impacts at local or country scale."

Satisfaction

The fellowship was highly satisfactory, professionally enriching and totally conformed my expectations. The new links developed between the University of Alicante and Cawthron Institute will foster future scientific collaborations, for example we are already contemplating development joint funding proposal and additional





scientific exchanges. The fellowship was a great opportunity to broaden my skills and increase the motivation towards scientific challenges, particularly in the area of aquaculture environmental interactions and the industry sustainability.

Advertising the Co-operative Research Programme

I learnt from the Co-operative Research Fellowship Programme through a work colleague who was granted a fellowship in a previous cycle. Then I obtained detailed information through Co-operative Research Programme website.

