Scottish Science Advisory Council

Use of Science and Evidence in Aquaculture Consenting and the Sustainable Development of Scottish Aquaculture

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Executive summary

Aquaculture is a major contributor to the Scottish economy, has brought employment and investment to remote rural areas, and contributes to Scotland's domestic supply of healthy food. Scotland also has significant scientific expertise both in aquaculture itself and in assessing its environmental footprint. The report of Professor Griggs, published in February 2022, however, highlighted major concerns between some communities over the lack of trust and transparency within the aquaculture sector, including differing interpretations of science and evidence.

The Scottish Science Advisory Council (SSAC) was invited by the Cabinet Secretary for Rural Affairs, Land Reform and Islands to examine current use and communication of science and scientific evidence in aquaculture consenting and sustainable development of the sector. The SSAC approach was to have virtual discussions with a range of stakeholders individually, prior to convening a virtual roundtable (over 50 attendees) to collect ideas on how changes to the use of science and evidence by the different communities might help to identify a more sustainable development of the sector.

Areas for improvement in the understanding, interpretation, and use of science

Communication and engagement: the complexities of developing policies in the 21st century which are simultaneously trying to strengthen economies, enhance quality of life and protect the environment are exemplified by over 190 countries signing up to delivery of the 17 Sustainable Development Goals[1]. Social media, however (also a 21st-century phenomenon), tend to rely on short messages which are not designed to present a balanced or comprehensive perspective. Thus, some of the excellent science on aquaculture and the decisions underlying its use, is not sufficiently visible. Innovative ways of communicating key messages and greater engagement of social scientists and communication specialists should be encouraged.

Syntheses of science: it is instinctive to think that an authoritative synthesis of science could be produced to resolve conflicting interpretations, yet the dynamic nature of environmental science means this is unlikely to be true. The most heated conflicts are at a local level and informed, facilitated debate may be the best approach here to try and reach agreed compromise since consensus is unlikely. At a higher level, all stakeholders would benefit from independent, international horizon scanning syntheses to provide advance warning of likely environmental impacts of major external influences such as climate change and shocks to the global economy.

Fragmentation of research: aquaculture science is fragmented in Scotland with multiple funding streams and often separate from other parts of food production and the blue economy. Given the contribution of aquaculture to the economy and its use of natural resources, wider communication on relevant aquaculture issues, could open avenues to existing funding streams which are not currently targeted at aquaculture by identifying synergies with other research projects.

Opportunity

While lack of trust between communities within the sector was observed, discussions at the roundtable showed a willingness to engage collectively around science. Examples of positive engagement at a local level leading to conflict resolution were also referenced. Scotland has scientific excellence in animal

1 THE 17 GOALS | Sustainable Development (un.org)

health, environmental science, and increasingly in the interface of social science and policy. Encouraging networking to place aquaculture more mainstream in the food sector and blue economy could enhance collective engagement and a shared understanding of wider societal risks.

Key risks which science can help to manage

All food production has an impact on the environment. Major **environmental risks** of aquaculture systems which were identified by stakeholders (full list in Annex A) included: impacts to sensitive seabed habitats and features; cumulative impacts of aquaculture alongside other marine developments; sustainability of fish feed production and interactions with wild salmonids including sea lice, escapes, and introgression. In addition to these issues, stakeholders highlighted a number of likely **impacts of climate change and climate change policies** during the roundtable. As well as impacts associated with rising sea temperatures, these included increasing storminess, potential new salmon diseases, changing migratory patterns, and spatial squeezing (competition for the seabed). **Risks to wild salmon and salmon welfare issues were also raised as contentious issues**.

Regulations are the main policy tool for managing those risks and effective regulations require science. Scotland has been strengthening its scientific expertise and governance around aquaculture, as has the industry, but the work of the SSAC has highlighted the importance of engaging with impacted communities, including about the uncertainties intrinsic to science. Uncertainty in science is nothing new and the best example of good practice in communicating uncertainty is that developed by the Inter-Governmental Panel on Climate Change (IPCC) who explained the nature of that uncertainty and the importance of the burden of proof. Developing a shared vision as to how science can help to manage environmental risks and hence articulate the benefits which aquaculture can bring to Scotland should provide a basis for collective engagement.

Recommendations for the Scottish Government[2]

1. Marine Scotland (in consultation with the community) should issue a call for expressions of interest for bids from consortia (which include a track record in convening multi-stakeholder meetings and social science expertise) to: i) convene **an annual, Scotland-wide multi-stakeholder discussion** with the aim of sharing knowledge on national and global scientific advances and policy changes within the aquaculture sector; ii) serve as a source of advice for the structured convening of similar meetings at a local and regional level.

2. Aquaculture (as for land-based food production) is an industry that has environmental impacts and is susceptible to climate change. The Scottish Environment Protection Agency (SEPA) or another part of the SG should consider commissioning **independent, horizon scanning syntheses** of the international literature to give advanced warning of where regulations may need to change. The frequency could be aligned with recommendations from the Climate Change Commission.

3. Marine Scotland Science are emerging from a review of their structures. Once concluded, they should aim to be an exemplar of being transparent about how research topics are prioritised, interpreted, and communicated.

4. The **fragmentation of research** for aquaculture needs to be addressed, in particular to fill the gap in evidence to answer specific policy-driven questions. Initiatives hosted by Marine Alliance for Science and Technology for Scotland (MASTS) and Sustainable Aquaculture Innovation Centre (SAIC), both at the time in receipt of funds from the Scottish Funding Council (SFC)[3], have helped enhance collaboration in aquaculture but there is scope for encouraging more support to understand aquaculture's contribution to Scotland's vision for domestic food production and the blue economy.

2 SSAC's remit is to advise Ministers hence SG recommendations are noted here – generic recommendations for the wider aquaculture community appear towards the end of the full report.

3 Forging alliances for the future (sfc.ac.uk)

Introduction

Aquaculture is a major contributor to the Scottish economy, with Scottish exports of fish and seafood accounting for 60% (or £1.0 billion) of total Scottish food exports in 2021. It consists of three sub-sectors: finfish, shellfish and seaweed, with finfish being by far the biggest sub-sector (over 95% of total marine aquaculture value). Shellfish are important for coastal communities in particular and interest in seaweed for food, animal feed, biostimulants (fertilizer) and its potential for carbon offsetting is growing rapidly. Care needs to be taken to ensure science and regulation keep pace with entrepreneurial interest.

In recent years the Scottish Government (SG) has published an overarching vision for the Blue Economy[4] to include the marine, coastal, and interlinked freshwater environment of Scotland, the different marine and maritime sectors it supports, and the people connected to it. Legislation, policies, and management need to be aware of the interconnections between sectors within this overarching vision, as does the scientific research which provides the data to inform policy development, monitor, and evaluate success.

Within aquaculture, each sub-sector is required to seek permissions and assessments prior to operating, although only finfish and shellfish are required to provide environmental impact assessments and not always for the latter. Permissions and assessments depend on science and local evidence (i.e. evidence collected in a systematic and independent way), and whilst it is understandable that stakeholders in the sector desire certainty from scientific advice, it is important to recognise that scientific knowledge is based on the best available data and understanding at any given time and is subject to refinement and revision as new data emerges. Indeed, science often progresses through disagreement. This emphasises the importance of a broadly shared understanding across the sector of where science can provide reassurance and how it should be used. Given the number of stages in the consenting process in which science is being quoted, this confirms the need identified by the Griggs report[5] for: "the creation of a central science and evidence base…" However, ensuring that such a synthesis is respected as authoritative (rather than simply an addition to the existing portfolio of papers) is not so straightforward and was a key challenge for this study.

Approach and analysis

One or more members of the Working Group (WG) conducted virtual interviews with a total of 15 stakeholder groups from coastal community networks, community councils, environmental NGOs, industry representatives, academics, SG and SG agencies. Over 100 stakeholders, including all interviewees plus additional stakeholders who had been identified through their interactions with Marine Scotland, were invited to a virtual roundtable which was held on 14 February 2023 from 9 a.m. to 1 p.m. (details in Annex B). The initial interviews informed the format of the roundtable. Six independent (of the original WG) experts were invited to chair the breakout sessions during the roundtable (presentations can be viewed in Annex C).

SSAC agreed with Marine Scotland at the start of this review that this project would examine current use and communication of science and scientific evidence in aquaculture consenting against the following principles taken from the International Science Council's (ISC) Principles and Structures of Science Advice[6]: independence, legitimacy, relevance and access, diversity, and reducing uncertainty. We conducted our analysis against those criteria.

4 The Blue Economy Vision
5 Aquaculture regulatory process: review - gov.scot (www.gov.scot)
6 Principles-and-structures-of-science-advice-WEB.pdf (council.science)

1. **Independence: "Science advice should take the form of honest brokerage rather than advocacy. This requires a level of independence from the policymaking apparatus to ensure trusted advice for evidence-informed policy."[7]**

   Mention of advocacy as something to be avoided draws attention to the need for use of science across the sector to be objective. In other words, independent from **ALL** agendas. In our discussions, a widely held perception seemed to be that any science is considered independent if an article had been published in a peer-reviewed journal. However, research funders also use peer review by independent experts at an earlier stage, when awarding grants. That is to ensure that the questions being addressed by research are subject to independent challenge. For policy relevance, asking the right question is important, as well as the quality of the science. These peer reviewers can be both experts and users of research outputs. An example of good practice for innovation is SAIC having a Board with industry representation as it aims to increase the economic impact of aquaculture whilst also reducing its environmental footprint – but with final funding decisions being taken by the Board, some stakeholders question SAIC's independence and in particular its legitimacy in identifying research required by policy.

   We heard frequent references by interviewees and during the roundtable discussion (see Annex A) to the selectivity of the science being quoted as well as observing this in our interactions. Representations from communities using different models to those used by government agencies earlier in the consenting process may identify different levels of risk, but this happens too late in the process and leaves final decision making to Councillors at local government level being advised by officials with some, but limited, scientific input. In Norway, the Institute of Marine Research (which is 40% funded by the Ministry of Trade, Industry and Fisheries[8]) and considered to be independent of government and industry, produces an annual Risk Report for Norwegian Farming[9]. (This report for 2022 includes a chapter on the effect of sea lice.) SSAC supports Marine Scotland's consideration of the appointment of an independent Chief Scientific Adviser (CSA) and one of the roles of this post (if approved) could be to commission independent reviews of disputed areas of science (which cannot be resolved in the annual forum) or to bring existing published syntheses to the attention of all stakeholders. There are a number of CSAs within the SG and across the UK, and a Marine CSA would be well positioned to consult their colleagues from other disciplines and their own professional networks to bring perspectives from biology, ecology, analytics, fisheries science, data and social science, to take account of multiple factors (we were told that there are 12) which influence wild salmonid numbers. These influences need to be looked at holistically.

2. **Legitimacy: "Science advice must be conscious of the need to maintain trust and legitimacy with multiple communities simultaneously; the political community, the policy community, the public and the science community."[7]**

   It is clear from the Griggs report that there is a significant absence of trust and a failure of the acceptance of the legitimacy of the individual stakeholders with an interest in Scottish aquaculture. This is a complex ecosystem comprising: the Scottish Government; Marine Scotland Science's academic and policy advisors; SEPA; a diverse range of "the public"; the academic science community; and the aquaculture industry: - individual companies, including some international, and trade associations. Each of these communities has a diversity and plurality of membership. For example, "the public" includes, inter alia: isolated individuals, and community groups with a range of knowledge and expertise; through to highly organised, professionally run advocacy groups, with significant resources. This ecosystem has multiple nodes of interaction, some informal but many based on the statutory regulation framework. Details of the Scottish Aquaculture Regulatory Framework are in Annex D and of international comparisons in Annex E.

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7 These definitions are quotes from the ISC report.
8 About us | Institute of Marine Research (hi.no)
9 Report-pdf (hi.no)

The foundation of the regulatory framework is the scientific evidence base, upon which, ideally, the components of the "ecosystem" could agree and rely. However, as Griggs noted, and as was clear from our interviews, there is a lack of trust between some of the stakeholders not only about the interpretation of the science but also its source. This is partly driven by what is accessible. Marine Scotland Science (MSS) reports on specific topics in a series called Scottish Marine and Freshwater Science (SMFS) and some of these reports attract stakeholder attention for being limited in terms of the extent of literature referenced (e.g.[10]). Their peer review system lacks transparency, but our understanding is that it is more internal than external. Collaborative studies published in peer-reviewed journals such as this collaboration to develop a standardised framework for sea lice modelling[11] do not seem to attract the publicity or attention.

This highlights the point that not all evidence is accessed by all stakeholders. For example, the "industry" is open about the evidence it collects for its own purposes. Not unreasonably much of this is deemed as commercially confidential. In addition, some members of the ecosystem – for example applicants for planning applications – commission scientific studies to support their particular positions. Such evidence can be easily de-legitimised by being deemed "not independent" as was noted for one Argyll and Bute application, although the consultee (NHS Highland) did go on to conclude they were not able to give a definitive opinion and ultimately did not object to the application.[12] This illustrates the difficulties posed when evidence is used very selectively rather than more holistically.

Another, slightly tangential aspect of legitimacy (but raised by a number of stakeholders) is the perceived disproportionality of scientific evidence being requested of the aquaculture sector, relative to the less extensive evidence required of land-based agriculture. In coastal areas other bodies may also be adding to pollution; e.g., the quantity of chemicals used by Local Authorities in maintaining communal areas was a topic raised during the roundtable. This is another example of where the environmental impact of aquaculture, as a relatively new industry, is more in the public eye than pollution from other, more mature sectors. Scottish marine scientists have recently been involved in a European project which developed a toolbox of tools for assessing sustainability[13] which may help stakeholders understand the complexities and give some ideas to Local Authorities.

3. Relevance and access: "This involves an iterative process of knowledge brokerage which begins with the collaborative work of framing the policy question and continues through ongoing dialogue between policy and science community collaborators to ensure that the evidence provided aligns with the needs of the policy community."[7]

There are strong moves in the international science community for more open access to data[14], and that data management schemes abide by the FAIR principles being "findable, accessible, interoperable and reusable"[15]. In addition, in both the interviews and roundtable, points were made concerning data including challenges over data accessibility, the vision of open data allowing data discovery, improved data sharing and the platform to gain intelligence from data. Scotland's Aquaculture | Home is a major source of data for the sector and there is also a web-based tool developed by NatureScot to investigate the sensitivity of marine features (habitats, species, geology and landforms) in Scotland's seas Feature Activity Sensitivity Tool (FeAST) | NatureScot. For a more detailed discussion on Scotland's data see SSAC's report on geospatial knowledge[16].

10 3. Results - Atlantic salmon 2021: Scottish Marine and Freshwater Science Vol 14 No 4 - gov.scot (www.gov.scot)
11 Sea Lice Biology and Control (5mbooks.com)
12 Issue - items at meetings - Scottish Sea Farms LTD: Modification of fin fish farm (atlantic salmon) from 9 x 80m circumference cages to 14 x 100m circumference cages, including increasing biomass to 2350 tonnes and installation of replacement feed barge: Dunstaffnage Fish Farm, - Argyll and Bute Council (argyll-bute.gov.uk)
13 About Aquaculture Toolbox TAPAS Sustainability Toolbox manuals created for aquaculture licence applicants and decision-making authorities.
14 open-data-in-big-data-world_short.pdf (council.science)
15 FAIR Principles - GO FAIR (go-fair.org)
16 Future Landscapes Report on Geospatial Knowledge.pdf (scottishscience.org.uk)

Comments from the roundtable and interviews stressed that improving "access" also means having data all in one place, in comprehensive and understandable format and accessible at various levels of knowledge. However, that would be difficult to curate, given the differing objectives of the major data collectors (e.g., industry vs regulators). There were also suggestions that providing background to information (e.g., demonstrating why data is reported and what it means) would also be beneficial. These are important points which are key to the interpretation of generic data with respect to specific contexts and hence important for the licensing of new fish farms in specific locations and indeed to the wider question of the cumulative impacts of multiple fish farms within a region. This question of cumulative impact came up repeatedly in both interviews and the roundtable discussions.

4. Diversity: "Science advice mechanisms comprising a diversity of expertise, cultures, and languages (where relevant to context) help to uncover hidden bias, which supports self-reflexivity in individuals and teams."[7]

The type of knowledge considered valid and relevant for regulation of aquaculture activities encompasses both expert knowledge from a range of different disciplines (e.g. biology, social sciences, veterinary medicine, engineering, and many others), and knowledge derived from experience – such as that of fishers who are well familiar with spawning grounds in their local area, or the insights of community stakeholders in terms of current controversies that should be resolved to ensure aquaculture has a strong social licence. Furthermore, the knowledge and experience of public authorities in applying available knowledge towards regulating aquaculture is a very valuable input towards creating efficient regulation balancing the needs of both industry and society. The aquaculture industry itself has insight into how their production practices can best be adapted and have knowledge of its needs towards creating a sustainable and thriving industry. The combination of such expert knowledge and experience is a powerful tool to shape and form how aquaculture is regulated, and this approach is endorsed by the ISC[6]: "Evidence synthesis aims to establish the state of available knowledge on a given issue through a range of methods including literature reviews, scientific assessments, and expert inputs." Nonetheless, the ISC also adds: "Importantly it must consider the multiple disciplines and framings that should contribute knowledge to the question in hand." Only a limited number of disciplines appear to have been involved in this process in aquaculture in Scotland (although change is happening as described in one of the presentations in the roundtable (see Annex C and a recent study of the social licence between communities and companies[17]) and the framing of dialogues could benefit from a reappraisal.

The principle of diversity is strongly related to the status of actors, and whether they are perceived as having a stake in the issues. For example, being considered a statutory consultee is one way of granting status. Who is granted such a status could be reconsidered in parts of the consenting process. There appears to be a lack of shared arenas for voicing concerns and dialogue which continues to fuel a perception of secrecy and misunderstandings. Are regulators and industry aware of their responsibilities in relating to community and in providing information? While diversity in knowledge helps progression towards inclusion and a broader knowledge base, such an understanding should be coupled with an emphasis on the concerns and questions many have in regard to aquaculture. Providing an outlet for voicing concerns and questions might point to more common ground between stakeholders, and, allow such concerns to be addressed.

17 The role of community and company identities in the social license to operate for fin-fish farming — University of the Highlands and Islands (uhi.ac.uk)

5. Reducing uncertainty: "This principle holds that the main function of knowledge brokerage is to clarify what is known, not known, knowable and unknowable about an issue without seeking to provide a definitive answer or explanation, but rather to reduce doubt to the extent possible, from multiple perspectives."[7]

The nature of the science process is that the accumulation of knowledge over time and spatially should reduce the uncertainty in its broader interpretation. A large body of research has led to identification of "concentrations of substances identified within relevant legislation and international obligations are below levels at which adverse effects are likely to occur" which form the basis of regulation of the coastal, estuarine and freshwaters across Europe. The regulatory regime is widely based on a set of environmental quality standards (EQS) which are (or have been) set at EU level for priority substances and which are regularly updated, both in terms of numerical values but also on the addition of new priority substances. EQS are based on a synthesis of the science (predominantly from peer reviewed international science) surrounding the environmental effects of the substance (in freshwater, seawater, sediment and biota and also human health). Where there is uncertainty, assessment factors are used, to add an additional level of protection and as a realisation of the precautionary principle (PP).

In other areas of environmental impact in aquaculture, the evidence base is made up from: (1) numerical models – which we know by their nature are simplifications, and which depend to varying extents on data and assumptions about what data are relevant; (2) data obtained through observation and monitoring – which by their nature are incomplete, informed by priorities over what should be monitored and technical realities of what can be monitored, and sometimes not widely accessible; and (3) expert opinion – which is inevitably inflected in sometimes useful and sometimes less desirable ways by personal and professional experience. With multiple lines of evidence, procedures are widely used, known as a "weight of evidence" approach ("the extent to which evidence supports possible answers to a scientific question"[18]). "Factors such as the quality of the data, reliability of the model(s), consistency of results, nature and severity of effects, relevance of the information will have an influence on the weight given to the available evidence."[19]

The use of these lines of evidence (and their uncertainties) in the licensing process and in decision making introduces the basis of the precautionary principle.

"The precautionary principle enables decision-makers to adopt precautionary measures when scientific evidence about an environmental or human health hazard is uncertain and the stakes are high. The precautionary principle is closely linked to governance. This has three aspects: risk governance (risk assessment, management and communication), science-policy interfaces and the link between precaution and innovation."[20]

Reliable and robust science is the basis for applying precaution while recognising that this will change and be expanded over time.

Opinions in interviews and the roundtable were divided on the application of precautionary measures, with some views expressed that PP has lost its meaning, and that it needs to be more socialised, while others were supportive of adaptive management – which uses monitoring and review to inform the evolution of licensing and management, responding to the fact that the science base and our understanding improves with time. The Griggs Report noted: "Also without an agreed framework within which everyone operates to ensure that decisions are made consistently then different and

18 Guidance on the use of the weight of evidence approach in scientific assessments - - 2017 - EFSA Journal - Wiley Online Library
19 House of Lords - Science and Technology - Written Evidence (parliament.uk)
20 The precautionary principle: Definitions, applications and governance | Think Tank | European Parliament (europa.eu)

sometimes conflicting decisions can be made on the same subject by different parts of the regulatory process." As part of the socialisation of PP, there should be clear mechanisms for re-evaluating decisions and they should be transparent to all parties.

Best practice: perhaps the most commonly encountered illustration of this is in climate change science, where the scientific evidence base has evolved over more than 30 years, where science and policy are closely entwined and where there was and is considerable uncertainty. Of relevance for aquaculture was the creation by IPCC of a common language and simple scales dealing with scientific evidence, and their uncertainties[21]. **The evidence/agreement scale** allows separate assessment of the type, amount, and quality of the evidence base supporting a claim and the level of scientific agreement (both on three-point scales). The five-point **confidence scale** is closely tied to the evidence/agreement scale and the **likelihood scale** is used to communicate quantified, probabilistic assessments of uncertainty produced by statistical or modelling analyses, or formal expert elicitation methods. Such a system addresses the uncertainties in the climate change evidence base, but does not necessarily reduce uncertainty. Rather, it acknowledges it explicitly and ensures that there is a shared, transparent, common language to facilitate debate.

Generic recommendations to the aquaculture communities with respect to procuring, interpretating and using science (science practice)

The four main recommendations (executive summary) are assigned ownership within the SG since the remit of SSAC is to advise Scottish ministers. However, for the aquaculture sector to deliver the benefits it can undoubtedly bring for the Scottish people, there are actions that all stakeholders can take. Aquaculture is a significant contributor to Scotland's future success and therefore it behoves all stakeholders with evidence and experience to share those in an objective and efficient manner.

Communication: it is clear that social media is extensively used by communities to discuss concerns around various aspects of aquaculture. This is not necessarily closely connected to the scientific literature and evidence based. There is perhaps a role for scientists in government and its agencies to adopt more innovative approaches to engage the wider public with their research through seeking advice from professionals in the use of social media in science communication space. (For example, Science Media Centre.)

Engagement: there is increasing recognition in other countries of the importance of stakeholder engagement in policy relevant research through co-creation, co-design, and co-delivery (New Zealand: Our Land & Water - Toitu te Whenua, Toiora te Wai (ourlandandwater.nz); and Europe: Home - FIT4FOOD2030). Such programmes give examples of relevant social science methodology. Scotland too has examples of good practice in stakeholder engagement; for instance, Loch Roag Management Group and the Salmon Interactions Working Group (SIWG) (examples provided during the roundtable). Recommendation 1 suggests SG action to facilitate access by all stakeholders to expert advice from social scientists to manage and better understand differences of opinion. All stakeholders should be encouraged to proactively seek such advice when conflicts of interpretation arise.

Transparency: it is recognised that scientists within industry are often ahead of science produced by government but for competitive advantage reasons are not in a position to share those data publicly. The same is true for academics and entrepreneurs who need to protect their intellectual property to generate investment for future development. It would increase trust, however, if confidentiality agreements could be reached to share as much data as possible with government and its agencies to provide insights on where aquaculture is going in the longer term, to ensure regulation can be up to date and ideally with enough foresight to model future impacts. Other stakeholders are encouraged to be wholly transparent about their processes and sources and avoid using limited funding for repeating research already published. A regular forum of all the stakeholders to discuss the scientific evidence openly would enhance transparency and help build the trust that is currently absent.

21 Uncertainties Guidance Note - IPCC AR5

Resolving contested science areas: as in most areas of science in the 21st century, large volumes of research results have already been published. Models help make sense of large amounts of data, but as highlighted in one of the roundtable presentations (see Annex C) and emphasised to us by multiple stakeholders, models need to evolve as understanding deepens and new data become available - with interpretation again being key. During the acute phase of the Covid-19 pandemic, the Scientific Advisory Group for Emergencies (SAGE) advisers used the outputs of multiple models and discussions with scientists from a range of disciplines to inform their decision making. The chapter on sea lice modelling[11] refers to the coupling of models as a means of driving sea lice models. This was the result of a collaborative effort amongst scientists. It was clear from our stakeholder discussions that engaging in professionally moderated face-to-face discussion with a range of disciplines and perspectives represented is more likely to lead to resolution than other approaches including exchanges of emails.

Fragmentation of aquaculture research: one of the issues for Scottish researchers accessing funding, is that while there are funds available in Scotland for applied research, funding for more upstream research usually comes from the UKRI Research Councils (RC). In Norway, the Norwegian RC has funding for four aquaculture-relevant funding themes every year, namely: social perspectives, management and market; fish health and fish welfare; production biology, nutrition, breeding and genetics, and; production and processing technology. If the communities agree these are a priority for Scotland, these themes could be passed on to UKRI research strategy development.

How to make change happen?

An earlier SSAC report on the Science Legacy of Covid[22] recommended strengthening the porosity of employment between academia, the public and private sectors to encourage understanding of different perspectives and between disciplines in academia to gain access to more generic (rather than aquaculture-specific) sources of public funding for aquaculture research. Aquaculture is not part of the SG strategic research programme on environment, natural resources and agriculture[23], but this is balanced by the economic strength of the aquaculture industry and greater investment in research by the industry through initiatives which have brought industry, government, and academia together. One academic institution in the aquaculture sector in Scotland showed us their range of funding: UKRI, charities, UK Government, industry (both in Scotland and overseas), and European research funds. Many of the projects funded, however, will be short-term and one-off projects, with priorities being driven by funders. SAIC's governance enables it to answer questions where industry and government have mutual interests, with the majority of funding coming from SFC, HIE, and Scottish Enterprise. However, a gap remains in funding for policy-driven research. The Griggs report made some suggestions and Annex F gives examples of levies in Norway and in the agriculture and horticulture sector. If the gaps are clarified and agreed collectively, these priorities could help inform research funders such as UKRI. Annex G outlines funding currently available for aquaculture research in Scotland.

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22 SSAC Report - Building on the Science Legacy of Covid-19 in Scotland.pdf (scottishscience.org.uk)
23 Strategic Research Programme 2022 to 2027 - Environment, natural resources and agriculture - strategic research 2022-2027: overview - gov.scot (www.gov.scot)

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