COMPLETED PROJECT CASE STUDY

EXPAND: EXPANDING ENVIRONMENTS, PHYSICS, AND ACCURACY IN NEWDEPOMOD

PARTNERS

Scottish Association for Marine Science (SAMS), a partner of UHI | Salmon Scotland (formerly Scottish Salmon Producers Organisation (SSPO) | SEPA (advisory role)

KEY PROJECT STAFF

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BACKGROUND

Accurate and reliable predictive modelling is essential to the future development and growth of the aquaculture industry in Scotland, with a need to unlock capacity at existing and new sites, particularly more energetic and dispersive sites. The development of NewDEPOMOD has created a world-leading tool for predicting benthic impacts of salmon farming and will become a core part of regulation and management of the industry in Scotland. This project brought together model developers from the Scottish Association for Marine Science (SAMS), a partner of UHI, the Scottish salmon industry (Salmon Scotland – formerly SSPO – and partner company modellers), and the Scottish Environment Protection Agency (SEPA) as an advisory body. The project aimed to adopt an innovative approach to bringing together industry, academia and regulators in a user group that would work in a new, creative, and collaborative way. Given the importance of accurate and reliable predictive modelling, this innovative approach was critically important in supporting the development of the industry and its aspiration to sustainably grow production in line with 2030 targets.

While the release of NewDEPOMOD during February 2017 created a new model for use by the aquaculture industry and SEPA, experience with the previous version of this model clearly demonstrated that remaining relevant and reliable in rapidly changing circumstances requires continuous development to improve both the veracity of its predictions and the confidence with which it can be applied in decision making. Additionally, continuing changes in industry best practice need to be reflected in the model, along with advances in knowledge arising from field and laboratory experiments on particle dispersion. Outputs from the model need to be closely targeted to meet industry and regulatory requirements within a new regulatory regime.

A significant contribution to the enhanced model understanding and utilisation was the development and revision of a comprehensive and up-to-date user guide for the software. This was developed by SAMS, with a process of user feedback and revision, and continues to be maintained in response to any model developments from users in both Scotland and internationally, as they occur. To further support modelling skills in the Scottish context, SAMS also hosted both group and individual training days.

A Scotland-specific Environmental Quality Standards (EQS) module has been developed within NewDEPOMOD in response to SEPA's published regulatory standards, first released in June 2019. This allows users to model using the newly adopted Infaunal Quality Index (IQI), replacing the previously used Infaunal Trophic Index (ITI). In addition, this includes new parameters to allow users to reflect the two primary SEPA impact measurements, assessing both intensity and area of predicted benthic impact.

The project also included efforts to improve the available information on the ability of the model to represent depositional patterns on real sites, and a study on the environmental factors driving benthic "fail" classifications. These allowed the SAMS technical staff to develop links with the project team and steering group, and gain experience in working with the model, processing data, and analysing outputs. In collaboration with project partners, this work has allowed a shared understanding of approaches to fitting the model to benthic survey data, identifying situations where fitting can be more straightforward or more challenging. The 'case study' on environmental influences was broad in scope, identifying the importance of current and wind speeds in the outcome of benthic assessments, although more refined data on the nature of benthic failure classifications would help to develop this understanding further.

AIMS

This project was developed to ensure that NewDEPOMOD remains relevant and fit-for-purpose for a rapidly evolving industry; and provides a regulatory tool that both facilitates growth by unlocking capacity and protecting the environment by providing accurate predictions of benthic impact.

The developments aimed to make use of advances in computing hardware and software to deliver a software package which was accurate, reliable and efficient to run – no comparable software exists. AutoDepomod was adopted by global aquaculture industries when it was introduced and the same can be expected of NewDEPOMOD. Additional fieldwork aimed at understanding the effects of cage infrastructure on the dispersion of waste material was planned to further enhance the scientific basis of the model.

Regular training opportunities for new users, and ongoing dissemination of improvements to the model code are essential to keep the users of the model informed of its attributes and capabilities. Training workshops, and the establishment of a User Forum were planned, to allow users to share experiences and lessons learned in applying the model, thereby more rapidly improving the quality of the modelling submissions to SEPA. This can only help facilitate the sustainable development of the aquaculture industry in Scotland.

WORK PACKAGE 1: USER GUIDE

A complete, revised user guide has been produced to enhance user experience and understanding. This was designed to cover both the command line and user interface versions of the software, including details of the background/theory behind the model as well as worked examples and parameter explanations. The user guide has been updated and maintained throughout the lifetime of the project, and particularly in response to each software update.

In conjunction to the user guide, SAMS and SEPA co-ordinated the production of a set of Matlab scripts for data pre- and post-processing, which were made available to project members.

WORK PACKAGE 2: SOFTWARE DEVELOPMENT

Following new objectives and suggested directions from the steering group in the early stages of the project, software development was adapted from the original proposal to better fit the needs and requirements of users.

Users can now interact with the plotted contours via the user interface, to meet SEPA's new regulation requirements (contour level control is present on the surface display in the UI and there is a new EQS settings panel). The option to retain ITI contours remains so that users can compare results with historical data. Easier generation of aggregate data at preferred resolution was also facilitated (min, mean and max deposition over specified period of interest, e.g. last 90 days). Output surface plots can now be generated in NetCDF format.

There have been a number of software improvement actions undertaken, including extra flowmetry panel information and transect displays within the UI, the addition of stylesheets for reports, report generation control and progress monitoring during a model run.

Users can now check for software updates via the user interface, which also summarises any changes made. Any software updates remain compatible with use of SEPA's defined defaults. A new release which constituted a change to the model's physics would require re-evaluation by SEPA to define new defaults, and so the version number would then be important to note. Anyone carrying out site-specific validation can use any version of the model because it is assessed as a discrete modelling exercise.

EQS development – an update was released that addresses the implementation of SEPA's latest regulatory positions (setting different benthic and EmBZ pass criteria of interest). Basic particle analysis is also now available for a download as a separately generated file. The steering group also agreed to SAMS developing a specific EQS module within the source code for easier adaptation in the future.

Subcontractor, Trevor Carpenter, one of the key researchers behind the initial development of DEPOMOD, AutoDEPOMOD, and NewDEPOMOD, while employed at SAMS undertook significant advancement of the SEPA-specific version of NewDEPOMOD defaults to ensure their smoother operation within the model, in July 2020.

WORK PACKAGE 3: USER SUPPORT

A formal workshop was hosted at SAMS during the last week of February 2020, to better engage the users and collect their feedback. This was a great success and platform from which to gain insights and foresights regarding the software and its day-to-day use. This identified several advancements and future plans.

Due to Covid a follow-up workshop was not possible and therefore a technical group was formed instead, who met online every 6 weeks for the last few months of the project. This allowed invaluable exchanges between SAMS, SEPA and modellers to aid the modelling and submission process. This allowed everyone the opportunity to ensure submissions were consistent and in line with SEPA's requirements.

IMPACT

ExPAND has had a positive impact on the issues it was designed to address. Previous versions of NewDepomod (i.e., Depomod and AutoDepomod) had been delivered as defined "off the shelf" software packages and, over time, they had become out of date with current science and understanding. Following its development, NewDepomod became the preferred regulatory modelling tool for assessing benthic impacts. At that time, it was acknowledged that it was a significantly more complex model than its predecessors, and that operators would need specialist modelling expertise and bespoke training in the model itself. It was also acknowledged that there was a clear need to ensure it remained up to date with relevant knowledge. The ExPAND project was established to address these two

key areas, during the initial phase after NewDepomod was developed.

ExPAND has facilitated regular engagement between operators and developers of NewDepomod, alongside representatives of SEPA, and this has ensured that the modelling community works collectively, such that all can utilise NewDEPOMOD to its full capacity. This structure has also allowed the project to identify and work on key developments, keeping the software up to date. The structure of the project, and the flexibility with which SAIC operates, has also allowed the project to be reactive and flexible to changing needs, allowing a shift in focus from field-based work to the case study review (outlined above), when this was identified by the project team as the most effective route forward.

The success of the ExPAND project led to establishment of a follow-on project: ExPAND in2 the future: realising the full potential of the Scottish salmon industry, which began in 2021 and is due to complete in Spring 2024. It continues the collaboration with Salmon Scotland, SAIC, SEPA, and all the aquaculture sector modellers, in addition to bringing a new direction of research though collaboration with Dr Alan Cuthbertson from the University of Dundee.

ADDITIONAL INFORMATION

All salmon farming companies have been represented on the ExPAND project, with SEPA's modelling team also engaging throughout. As such, dissemination to relevant parties has been a natural and integral aspect of the project. No further dissemination activities have been required or undertaken outwith the project.