# DenMod: Working group for the advancement of marine species density surface modelling

## *Report of the first working group meeting and public workshop*

21-22 October 2017

***First working group meeting.***

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Summary

This section briefly reports on the first meeting of the US Navy-sponsored DenMod working group, held on 21 October 2017 at Dalhousie University, Halifax, Canada. The overall aim of the working group is to develop and implement innovative approaches for advancing spatial modelling methods to best characterize the seasonal abundance and distribution of marine species, focussing on marine mammals. In this start-up meeting we shared knowledge on approaches and issues, and spent time in break-out groups discussing the project priorities for the coming years.

Background and objectives of the working group

The Navy has a pressing need for reliable estimates of density for many marine species, and how these densities vary in space and time. Such information is central to estimates of "takes" arising from testing and training activities, and for long-term population monitoring; it can also be used when planning operations, where appropriate, to minimize expected impact.

Many approaches have been proposed and applied to density surface models used by the US Navy (and more widely in the ecological research community). Four key points are: (1) different approaches can lead to very divergent estimates; (2) the relative merits of many methods are at present largely unclear; (3) many issues that make modelling these data complex remain unresolved; and (4) there are several approaches that remain untested in this context. Given this, the reliability of current estimates is somewhat open to question.

We have created a working group of scientists involved in density surface modelling to coordinate advances on this topic. The group is supported by dedicated post-doctoral staff, tasked with solving issues identified by the group. Specific goals of the group are:
1. Bring together scientific leaders in density surface modelling.
2. Share information about best practices, without being prescriptive.
3. Develop and implement innovative approaches for advancing spatial modelling methods to best characterize seasonal abundance and distribution of marine species, focused on US Navy training and testing areas.
4. Provide user-friendly no-cost tools, where possible, implementing new approaches.
5. Provide statistical support to those tasked with undertaking density surface modelling for the US Navy's Phase IV analysis.
6. Provide accessible guidance for practitioners in the form of public reports or scientific publications.
7. Highlight priority areas for continued research.
8. Solicit input from the wider scientific community and share findings through public workshops.

The project represents a collaboration between the University of St Andrews, Duke University and the regional NOAA Fisheries labs that are largely responsible for collection and analysis of line transect visual survey data used in Navy impact assessments.

The group will hold annual face-to-face working group meetings to share information, establish and update priorities, discuss potential solutions, and receive feedback on solutions implemented. The first of these working group meetings took place on Saturday 21 October 2017 in Halifax Nova Scotia, immediately prior to the Society for Marine Mammalogy biennial conference. The first public workshop took place on Sunday 22 October to solicit input from users, developers and stakeholders on project goals and plans.

Overview of meeting

The first half of the day consisted of a series of presentations. The first two presentations provided an overview of the project goals, objectives and format. The roles of the working group members and the postdoctoral staff working on the project were discussed.

The third presentation provided a detailed overview of density surface modelling, including how these density surfaces are used by the US Navy to calculate take estimates. Methods available for providing density estimates, from stratified or design-based methods to density surface modelling, were presented.

There followed four research presentations by personnel from different NOAA Fisheries labs describing the modelling approaches they use and the issues they face.

Prior to the working group meeting a questionnaire was circulated to the group to give everyone time to consider their priorities for the project. Working group members contributed responses either individually or as a lab group. St Andrews and Duke personnel analyzed the questionnaire responses prior to the working group meeting and presented the results to the group at the meeting. The full list of topics was presented, along with the ranking of importance. It was suggested that four topics, that were identified by the majority of respondents and ranked highly in terms of importance, be taken forward as priorities for the first year of the project. These priorities are: (i) uncertainty estimation & spatial autocorrelation, (ii) extrapolation, (iii) model unification, (iv) workflow (e.g., documenting the end-to-end workflow to ease analysis and enhance repeatability). These priorities will be reassessed on an annual basis.

For approximately one hour participants were split into four small breakout groups to discuss these priority topics. Each group then presented a summary of their discussions to the larger group.

At the end of the day there was an open discussion session to resolve any outstanding questions. There was a brief discussion about species focus and the potential for modelling at-sea pinniped distributions. It was noted that the focus of the project is on line transect data but that the group should consider establishing a technical sub-group to specifically discuss the issues with modelling at-sea pinniped distributions.

***First public workshop***

Summary

This section briefly reports on the first public workshop of the US Navy-sponsored DenMod working group, held on 22 October 2017 at Dalhousie University, Halifax, Canada. One important goal of the DenMod project is to "solicit input from the wider scientific community and share findings through public workshops." We plan to achieve this through holding three public workshops over the course of the project. This first workshop provided an opportunity for stakeholders to provide feedback on the proposed priorities for the first year of the project. There were 60 participants, including members of the working group.

Overview of meeting

The project team presented an overview of density surface modelling in general, followed by details of the DenMod project goals and objectives. These introductory presentations were followed by five research presentations given by workshop participants external to the DenMod project (with the exception of one). All participants were invited to submit an abstract for a presentation when they registered for the workshop to allow for two-way exchange of knowledge and information.

The final presentation of the day outlined the priorities identified by the working group that will form the basis of research efforts in the first year of the project. These priorities are: (i) uncertainty estimation & spatial autocorrelation, (ii) extrapolation, (iii) model unification, (iv) workflow. The rationale for these priorities was briefly outlined.

There followed an hour long open discussion session to provide stakeholders with the opportunity to provide feedback on these priorities.

The following points were raised and discussed by participants:

- Model verification as a priority
    - The project team were asked what plans they may have regarding model verification and why it was not included as a priority for the first year of the project. It was agreed that model verification is an important topic and will be considered later in the project, but probably not in year 1. The group briefly discussed the various options for model verification and the issues with identifying whether the best fitting model is actually a good model. It was noted that the group are considering interactive visual data checking methods.

- Model focus - species versus stocks
    - It was mentioned that, for the purposes of the Marine Mammal Protection Act (MMPA) and Endangered Species Act (ESA), there is a requirement to report at the stock level rather than species level. The group were asked whether it would

be possible to produce density surfaces for stocks rather than species. It was noted that the ability to model stocks is dependent on the ability to identify which individuals relate to which stock and this is rarely the case. The use of tag data for known individuals was briefly discussed, but it was thought unlikely that this will be a priority for DenMod.

- Determination of biologically important habitat
    - It was noted that the project team had not mentioned biologically important habitats and their determination. It was felt by some that this topic be explicitly included in the project priority list. There followed discussion about the relationship between high density and biological importance and whether/how density surfaces can be used to help identify biologically important areas. The Navy clarified that they are supporting a separate effort specifically relating to biologically important areas.

- Extrapolation
    - The project team were asked their opinion on what should be done in an area which is “too far” to extrapolate to as there still needs to be some basis for estimating impact (e.g., “takes” in the US regulatory framework). The team provided an overview of previous research efforts on this topic and their plans for the first year of the project. One focus will be looking at geographic extrapolation versus environmental extrapolation. We would like to be able to make predictions outside the geographic range of data but still within environmental space. It was also noted that it will be important to consider how to inflate uncertainty to reflect extrapolation.

- At-sea density surfaces for pinnipeds
    - It was suggested that pinniped tag data could provide a good test case for creating at-sea density surfaces for pinnipeds. It was noted by the project team that this had been discussed at the working group meeting the previous day and realistically is unlikely to be a focus of the project (as the priority is to focus on line transect data). However it was felt that a technical group to specifically discuss pinnipeds and data available for density surface modelling would be useful as there are special issues to consider with pinnipeds. The working group will plan to establish such a technical group during the first year.

- Integration/melding of density surfaces
    - The project team were asked about reconciling density surface models from different datasets, e.g., visual and acoustic. It was agreed that this is going to be important as there already different models outputs available for the same species in the same location. There was a brief discussion about different types of melding and the fact that there is a need for methods to reconcile different models from different datasets and also different models from the same dataset. It was noted by participants that better guidance is required on model outputs as

it is difficult for users to know which models and outputs to use, and when to use them.

- The use of opportunistic data
    - The project team were asked why utilising opportunistic data sources is not on the priority list as there is a wealth of information available. The team noted a lack of confidence in outputs from models fitted to such data. Also there was uncertainty about whether such outputs would be acceptable to regulators. Problems from such data include bias (e.g., whale watching data) and the presence of ongoing activities (e.g., monitoring data collected during seismic activities). In addition outputs from these kinds of data and models are often relative density rather than absolute density. It was felt however that these data could be useful for validation.

All participants were thanked for their attendance and contributions to presentations and discussions. It was announced that the next public workshop will be coincident with the Society for Marine Mammalogy conference in 2019.