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REVIEW

by Prof. Eliza Petrova Uzunova, PhD
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of

Dissertation thesis: "**Technological solutions for reducing discards in fisheries**" under the procedure for acquiring an educational and scientific degree "Doctor" in professional field 4.3. Biological sciences

Author: Yordan Raev

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Relevance of the topic and general description of the doctoral thesis

The doctoral thesis by Eng. Yordan Raev focuses on an extremely topical environmental issue - the selectivity of fishing gear and the reduction of by-catch and discards in the Black Sea. In the context of the EU's Common Fisheries Policy and the increasing requirements for the protection of marine ecosystems, the research is dedicated to identifying scientifically sound technological and management solutions.

The set of materials submitted by Eng. Yordan Raev includes all the required documents and is fully compliant with the requirements set out in the Law on Scientific Research and Academic Degrees (ZRASRB), as well as with the provisions governing the conditions and procedures for the award of academic degrees and the appointment to academic posts at the Institute of Oceanology at the Bulgarian Academy of Sciences.

The thesis spans 156 pages and is structured into seven chapters, a conclusion, a list of contributions, a list of publications and three appendices. It includes detailed lists of abbreviations, notations and symbols. The literature review comprises a detailed analysis of the international, European and national regulatory frameworks, as well as the current state of research on the subject. The list of references contains 218 titles, of which 216 are in the Latin alphabet and 2 in the Cyrillic alphabet. The abstract meets generally accepted requirements, is 32 pages in length and successfully summarises the main points

of the doctoral thesis.

Literary awareness and theoretical background of the candidate

The doctoral candidate demonstrates an excellent understanding of the thesis topic, presenting a focused, analytical and concise literature review. This review explores in depth the issue studied by the doctoral candidate: the investigation of a key problem relating to the conservation of the biological resources of the world's oceans, namely the reduction of the volume of so-called by-catch. Under current regulations, by-catch (non-target fish species and other organisms caught alongside the target species) is returned to the water, regardless of its condition. Its volume is often significant when using fishing gear with low selectivity. Given the increased fishing pressure on a global scale, allowing significant volumes of by-catch is incompatible with the objectives of sustainable and responsible fishing.

The author has examined, in their entirety, the factors that influence the selectivity of fishing gear, and in particular trawls - the design characteristics of the trawl, operational parameters, hydrodynamic characteristics, etc. Possible approaches for improving the selectivity of fishing operations are also presented - technical, managerial and informational. Technological measures are examined in greater detail - optimisation of the dimensions and shape of fishing nets, the size and shape of the mesh, fibre characteristics, etc. The circumstances hindering the implementation of measures to improve selectivity are also analysed. Some of the information presented has been summarised and set out in tables, which makes it easier to understand. This literature review is based on a wide range of sources and covers all the major publications from the last thirty years.

It is clear from the literature review that, although the problem of declining by-catch is one of particular significance and directly affects biodiversity and the favourable status of fish populations (particularly in water bodies with characteristics specific to the Black Sea - high sensitivity to anthropogenic pressure, climate change, eutrophication processes, changes in trophic relationships and intensive exploitation), information on scientific research relating to by-catch and its reduction in the Black Sea is scarce. Based on the global practices examined, the author concludes that 'the effectiveness of any

solution depends on regional conditions, the design of the device, the target species and the specific fishing practice', and therefore 'the direct transfer of solutions from one geographical area to another is not always effective and requires experimental verification'. The literature review also includes an overview of the international, European and national regulatory frameworks directly or indirectly related to the reduction of by-catch, the reduction of discards and responsible fishing.

The aim of the thesis is well formulated and follows logically from the literature review and the problems identified. The scope, subject matter and scientific hypothesis are clearly defined. The main objective is to develop technological solutions and mathematical models for assessing operational selectivity. The author focuses his research on assessing the operational selectivity of conventional trawl fishing gear for catching Black Sea red mullet (Mullus barbatus) and whiting (Merlangius merlangus) in the Bulgarian waters of the Black Sea. Based on experimental data, quantitative analysis and statistical modelling, scientifically grounded recommendations have been developed regarding the design and technical characteristics of the trawl codend, aimed at improving selectivity, reducing by-catch and supporting the sustainable management of fish stocks.

Methodological approach

A towed submersible fishing gear (trawl) for catching demersal and sub-demersal species - red mullet (M. barbatus) and whiting (M. merlangus) - was investigated. Observations were carried out on 203 experimental trawls using three different designs of trawl fishing gear. To assess the selectivity of the fishing gear, a comprehensive mathematical model was applied, taking into account numerous design characteristics and operational factors, such as the size and shape (rhombic/square) of the mesh, fibre thickness and elasticity, as well as operational factors (trawling speed, duration, catch volume) and variation between individual trawls. Linear and non-linear models were used to describe the effect of the investigated factors on selectivity. Random factors leading to differences between trawl hauls whilst other parameters remain constant were

accounted for using Generalised Linear Mixed Models (GLMM). The methods applied are entirely appropriate for the stated objective and tasks.

Significance and credibility of the results obtained, interpretations, and conclusions

The experimental data were analysed using a modern set of statistical methods in the R environment. Various statistical models were employed: GAM (Generalised Additive Models), GAMLSS and GLMM. The models demonstrate a high degree of explained variation and statistical determinism. The results obtained and their interpretation lead to the formulation of several alarming conclusions regarding the status and prospects of the populations of the sprat and the red mullet in the Black Sea. Analysis of the size structure of individuals from the two species studied shows that a significant proportion of the caught individuals had not reached sexual maturity at the time of capture. There is a real likelihood that fishing mortality is concentrated on age groups that do not yet contribute effectively to population reproduction. Analysis of the data provides clear evidence of insufficient selectivity in the trawl gear used with regard to sexually immature individuals.

Based on an analysis of catch data, the author assesses the minimum reference sizes for catch retention of 8 cm, as legally stipulated in the Fisheries Act for the Black Sea, for both species as significantly lower than the actual sizes at which the species reach sexual maturity. Specific, scientifically grounded technical recommendations have been made for updating the current technical measures in Bulgarian waters. The recommendations include increasing the mesh size, altering its geometry, incorporating escape windows for fish, shortening the trawl bag, using fibres with a low degree of deformation, controlling the filling of the trawl bag, and so on. These measures would improve selectivity, thereby preventing juvenile fish below the minimum size for sexual maturity from being caught. An analysis of fishing statistics shows that the pressure exerted on the populations of red mullet and red seabream is extremely intense and requires urgent corrective action.

Three management scenarios have been developed and assessed: Maintaining

the existing regime, Partial improvement and a Comprehensive selective approach. Whilst the first two scenarios predict no change or only a slight change in the selectivity of fishing gear and the continuation of the unfavourable status of the stocks, the third scenario, involving a wider range of structural changes to the trawl and a parallel change in the regulatory framework (relating to an increase in the minimum reference size of fish), would lead to a significant increase in selectivity, a reduction in discards and technical mortality of fish, an improvement in the size-age structure of the populations, and an increase in the economic efficiency of fishing operations.

Critical comments and questions on the dissertation

Critical comments:

1. Chapter 4, 'Materials and Methods', contains a substantial amount of information relating to the biology of the species under study, data and analysis on the status of the stocks, and so on (pp. 24-32). It also includes a number of analytical and discursive elements which, in my view, would be better placed in the chapters 'Literature Review' and 'Discussion'. At the same time, the description of the species studied lacks data on fish size, age, body length at sexual maturity, and the minimum reference sizes stipulated in national and international legislation.

2. It would be advisable to provide a diagram illustrating the fish measurement methods used and to specify the accuracy of the measurements. Furthermore, the water depth at which the catches were made is not specified.

3. Little attention has been paid to by-catch of species other than the grey mullet and the red mullet, with size groups below the minimum reference sizes. In my view, this is an omission and the thesis should provide more detailed information, as selectivity should also be linked to the avoidance of catching unwanted species, which are primarily found in specific habitats during part or all of their life cycle.

4. The thesis contains some technical and editorial omissions. The citation of sources in the text does not follow a consistent format. The cited Regulation 37 is not from 2014, as stated in the text, but from 2008. The content of Table 6.2 and Figure 6.3 is identical, whilst the figure caption incorrectly states that

it includes the modelled values for the percentage of individuals retained below L50.

Questions:

1. Why does Chapter 4, 'Materials and Methods', include a description of methods that were not applied in this study - for example: assessing selectivity by operating trawls with different design modifications in parallel and subsequently comparing the composition of the catches, or covering the trawl codend with a larger codend made of much finer mesh? The description of possible methodological approaches should be presented in the 'Literature Review' chapter, whilst Chapter 4 should cover only the methods used in this study.
2. What does 'sample' mean in the context of the biological studies in this study? The collection of 299 'species-specific samples' is mentioned, in which over 36,000 specimens of the two species were measured. However, it is unclear what the sample itself consists of. If it is a sample from the trawl catch, how was its size determined by species, and does this sample represent a relevant proportion of the catch volume for each species? How were the individuals included in it selected?
3. On page 68, the selectivity of fishing gear is linked to 'the characteristics of the population structure of the species studied'. What is this structure, and what does a comparison of it with the size structure recorded in the catches reveal?
4. Given that red mullet and grey mullet have quite different body morphologies and probably different behaviours, to what extent is it possible to achieve an optimal compromise in selectivity when catching them simultaneously using the same fishing gear?
5. What exactly is the so-called traditional or conventional trawl? If we look at the statistics available from the IARA, we see that 97.5 per cent of red mullet and 98.7 per cent of grey mullet in 2025 were reported as having been caught using a pelagic trawl. Is it possible for the conventional trawl under investigation to be classified in accordance with any of the internationally recognised classifications, such as that of the FAO?

6. Is it possible to make changes to other parameters of the trawl's design (apart from those analysed) in order to standardise the gear and reduce fishing pressure?

7. Given that Scenario 3, which you have developed, provides for the inclusion of additional devices to reduce by-catch (such as escape windows), how would this alter the mathematical structure of the model?

Scientific contributions

The thesis makes clearly defined, original scientific and applied scientific contributions.

• Scientific contributions: An original, comprehensive model for assessing the operational selectivity of trawl fishing gear in the Black Sea has been developed and successfully validated, integrating design, material and biological variables.

• Applied scientific contributions: New, critically important empirical data have been obtained on the size-frequency distribution and the lengths of retained individuals (L_{50}) of Mullus barbatus and Merlangius merlangus. An analytical approach has been developed to estimate the effective mesh opening (\(d_{eff}\)), based on the inclusion of design and operational parameters related to actual trawling conditions. Specific simulation scenarios have been examined which can directly inform the management decisions of the Executive Agency for Fisheries and Aquaculture (EAFA).

Assessment of the quality of scientific papers reflecting the research in the dissertation

Four publications are presented, two of which are directly related to the topic of the thesis. One of the publications is a solo work by the PhD candidate, whilst the others are co-authored (with PhD candidate Yordan Raev listed as the second author in two of them and the third author in one). Two of the articles appear in Q4-ranked journals, whilst one is in a Q3-ranked journal. One of the publications is not indexed in the Scopus and Web of Science databases.

To the publications by Eng. Raev relating to the thesis topic, I would also add 'Effects of anthropogenic and environmental stressors on the current status of red

mullet (Mullus barbatus L., 1758) populations inhabiting the Bulgarian Black Sea waters', which concerns the status of one of the sites covered by the present study. Although the data from two of the articles cited by the author (Nos. 2 and 3) were not used directly in the thesis, even if only publications Nos. 1 and 4 are taken into account, they fully satisfy the existing minimum national requirements and the criteria of the Institute of Oceanology, Bulgarian Academy of Sciences. The results of the thesis have been presented at one scientific forum.

A reasoned answer to the question of the extent to which the research in the dissertation is primarily the work of the doctoral student

The publications presented in connection with the doctoral thesis fully reflect its content and meet the national minimum requirements for the award of the academic degree of 'Doctor'. The personal contribution of Eng. Yordan Raev is indisputable - from the planning of field experiments and the collection of raw data on board fishing vessels, to complex statistical modelling. A duly signed declaration of originality is available. Furthermore, it should be emphasised that the doctoral candidate has successfully combined a biological approach with an engineering one to the subject.

Undoubtedly, the academic supervisors and the scientific adviser have played a key role in shaping Mr Raev as a researcher capable of employing both classical and new, promising methods in the field. I have every reason to believe that the main research, analyses and interpretations are the doctoral candidate's own work.

Conclusion

Mr Yordan Raev has submitted to the Academic Jury a thesis which can be regarded as a fully completed academic work, meeting all the legal requirements for the award of the academic and scientific degree of 'Doctor'. The thesis is clearly focused on precisely defined problems relating to the assessment of the selectivity of fishing gear traditionally used in Bulgaria for catching red mullet and sea bream. A sufficiently substantial body of experimental data has been processed and analysed, and a comprehensive research approach has been applied, incorporating a diverse methodological arsenal from both engineering and biological

perspectives. The results obtained are original, and the proposed scientific contributions are significant.

On the basis of the above and in accordance with the Law on the Development of Academic Staff in the Republic of Bulgaria (ZRASRB), as well as the specific requirements of the Regulations for the Implementation of the ZRASRB at the Institute of Oceanology, Bulgarian Academy of Sciences (IO-BAS), I propose that the distinguished Scientific Jury admit Yordan Raev to the defence and award him the academic and scientific degree of 'Doctor'.

15.10.2026

Prof. Eliza Uzunova, PhD

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