SAFE WAVE
STREAMLIING THE ASSESSMENT OF ENVIRONMENTAL EFFECTS OF WAVE ENERGY

DELIVERABLE 5.3

Refinement and validation of risk-based adaptive management approach

Co-funded by the EMFF programme of the European Union

WP 5

Deliverable 5.3 Refinement of a Risk-based Adaptive Management Approach with industry, regulatory and societal stakeholders

Lead partner
UCC

AUTHORS

Emma Verling
Iratxe Menchaca
Ibon Galparsoro
Inês Machado
Anne-Marie O'Hagan
Juan Bald

SUBMISSION DATE

08| 02| 2023

DISSEMINATION LEVEL

PU	Public	X
CL	Classified – EU classified (EU-CONF, EU-RESTR, EU-SEC) under Commission Decision No 2015/444	
CO	Confidential, only for members of the consortium (including Commission Services)	

DOCUMENT HISTORY

Issue Date	Version	Changes Made / Reason for this Issue
18/11/2022	1	Initial **DRAFT** shared with SAFEWave Consortium
08/02/2023	2	Final version created following input from SAFEWave project partners

CITATION

Verling, E., Menchaca, I., Galparsoro, I., Machado, I., O'Hagan, A.M. and Bald, J. (2023). Deliverable 5.3 Refinement of a Risk-based Adaptive Management Approach with industry, regulatory and societal stakeholders. SAVEWave Corporate deliverable of the SafeWAVE Project co-funded by the European Union, Call for Proposals EMFF-2019-1.2.1.1 - Environmental monitoring of ocean energy devices. 19 pp. DOI: http://dx.doi.org/10.13140/RG.2.2.17188.35201

This Project is co-funded by the European Climate, Infrastructure and Environment Executive Agency (CINEA), Call for Proposals EMFF-2019-1.2.1.1 - Environmental monitoring of ocean energy devices.

CONTENTS

1. SAFE WAVE project synopsis

The European Atlantic Ocean offers a high potential for marine renewable energy (MRE), which is targeted to be at least 32% of the EU's gross final consumption by 2030 (European Commission, 2020(European Commission, 2020). The European Commission is supporting the development of the ocean energy sector through an array of activities and policies: the Green Deal, the Energy Union, the Strategic Energy Technology Plan (SET-Plan) and the Sustainable Blue Economy Strategy. As part of the Green Deal, the Commission adopted the EU Offshore Renewable Energy Strategy (European Commission, 2020) which estimates to have an installed capacity of at least 60 GW of offshore wind and at least 1 GW of ocean energy by 2030, reaching 300 GW and 40 GW of installed capacity, respectively, moving the EU towards climate neutrality by 2050.

Another important policy initiative is the REPowerEU plan (European Commission, 2022) which the European Commission launched in response to Russia's invasion of Ukraine. REPowerEU plan aims to reduce the European dependence amongst Member States on Russian energy sources, substituting fossil fuels by accelerating Europe's clean energy transition to a more resilient energy system and a true Energy Union. In this context, higher renewable energy targets and additional investment, as well as introducing mechanisms to shorten and simplify the consenting processes (i.e., 'go-to' areas or suitable areas designated by a Member State for renewable energy production) will enable the EU to fully meet the REPowerEU objectives.

The nascent status of the Marine Renewable Energy (MRE) sector and Wave Energy (WE) in particular, yields many unknowns about its potential environmental pressures and impacts, some of them still far from being completely understood. Wave Energy Converters' (WECs) operation in the marine environment is still perceived by regulators and stakeholders as a risky activity, particularly for some groups of species and habitats.

The complexity of MRE licensing processes is also indicated as one of the main barriers to the sector's development. The lack of clarity of procedures (arising from the lack of specific laws for this type of projects), the varied number of authorities to be consulted and the early stage of Maritime Spatial Planning (MSP) implementation are examples of the issues identified as resulting in a delay to the permitting of projects.

Finally, there is also a need to provide more information on the sector not only to regulators, developers and other stakeholders but also to the general public. Information should be provided focusing on the technical aspects of ocean energy, its effects on the marine environment, the role in local and regional socio-economics and effects on a global scale as a sector producing clean energy and thus having a role in contributing to decarbonise human activities. Only with an informed society will it be possible to carry out fruitful public debates on MRE implementation at the local level.

These non-technological barriers that could hinder the future development of wave energy (WE) in EU, are being addressed by the WESE project funded by EMFF in 2018. The present project builds on the results of the WESE project and aims to move forward through the following specific objectives:

1. Development of an **Environmental Research Demonstration Strategy** based on the collection, processing, modelling, analysis and sharing of environmental data collected in WE sites in different European countries where wave energy converters (WECs) are currently operating (Mutriku power plant and BIMEP in Spain, Aguçadoura in Portugal and SEMREV in France). The SafeWAVE project aims to enhance the understanding of the negative, positive and negligible environmental effects of WE projects. The SafeWAVE project will build on previous work, carried out under the WESE project, to increase the knowledge on priority research areas, enlarging the analysis to other types of sites, technologies and countries. This will increase information robustness to better inform decision makers and managers about real environmental risks, broaden the engagement with relevant stakeholders, related sectors and the public at large and reduce environmental uncertainties in consenting of WE deployments across Europe;
2. Development of a **Consenting and Planning Strategy** through providing guidance to ocean energy developers and to public authorities tasked with consenting and licensing of WE projects in France and Ireland; this strategy will build on country-specific licensing guidance and on the application of the MSP decision support tools (i.e. WEC-ERA[1] by Galparsoro et al., 2021[2] and VAPEM[3] tools) developed

[1] https://aztidata.es/wec-era/;
[2] Galparsoro, I., M. Korta, I. Subirana, Á. Borja, I. Menchaca, O. Solaun, I. Muxika, G. Iglesias, J. Bald, 2021. A new framework and tool for ecological risk assessment of wave energy converters projects. Renewable and Sustainable Energy Reviews, 151: 111539
[3] https://aztidata.es/vapem/

for Spain and Portugal in the framework of the WESE project; the results will complete guidance to ocean energy developers and public authorities for most of the EU countries in the Atlantic Arch.

3. Development of a **Public Education and Engagement Strategy** to work collaboratively with coastal communities in France, Ireland, Portugal and Spain, to co-develop and demonstrate a framework for education and public engagement (EPE) of MRE enhancing ocean literacy and improving the quality of public debates.

2. Glossary of Terms

Adaptive Management - Adaptive management, also known as adaptive resource management or adaptive environmental assessment and management, is a structured, iterative process of robust decision making in the face of uncertainty, with an aim to reducing uncertainty over time via system monitoring.

Expert Judgement - Expert judgment is a technique in the project planning process that refers to making a judgment based on skill, expertise, or specialized knowledge in a particular area. The expertise can be based on an individual's training or educational background, career experience, or knowledge of the product/market[4].

Consequence - outcome of an event affecting objectives (ISO31000:2009).

Likelihood - chance of something happening (ISO31000:2009).

Pressure - any physical, chemical, or biological entity that can induce an adverse response.

Receptor - environmental components including (species and habitats).

Risk - there are many definitions of risk and some can be context specific. See text box in main text for further detail. A concise but broad definition of risk is that it is the probability of an undesired outcome or effect of uncertainty on objectives (ISO31000 (2009)

Ecological Risk Based Approach - a process whereby decisions are taken based on identifying, understanding, evaluating and prioritizing the risks in a given situation relating to ecology.

[4] https://www.wrike.com/project-management-guide/faq/what-is-expert-judgment-in-project-management/

3. Executive Summary

The development of a Marine Renewable Energy (MRE) sector is increasingly becoming one of the key low-carbon energy solutions for coastal nations in their drive both to tackle the impacts of a changing climate and to provide energy security in the face of this global challenge. While MRE development has led to significant growth in the design, testing and deployment of novel technologies, the challenge of gaining permissions to test and deploy these installations and the lack of detailed quantitative data as to their impact on the environment has represented a block to progress. While certainty about the impacts of the devices is some way off, there is an opportunity in the meantime to revisit consenting processes in order to determine whether changes to these could help to release this bottleneck.

SafeWAVE Deliverable 5.2 explored the use of ecological or environmental Risk Based Approach (RBA) in the MRE development context by reviewing the current state of knowledge around the use of RBAs, analysing five key RBAs (in short, the Environmental Risk Evaluation System, The Ecological Risk Assessment framework, Risk Retirement, Survey Deploy Monitor and ISO. See further details in the list in Section 5 below) that have been developed and finding the crosswalks and differences between them. Ultimately that deliverable made recommendations as to what work might be required to progress and make the use of RBA in consenting processes a practical reality.

This deliverable built on the work of SafeWAVE Deliverable 5.2 and on the depth of knowledge provided by the body of scientific work behind the five most relevant RBAs. The five RBAs were examined together, and a "simple stepwise approach" was created which reduced the complexity of the RBA but ensured that all the detailed scientific work was considered. The simple stepwise approach is presented here, each step is explained at a high level, and the links to the five core approaches are also shown.

4. Introduction

The development of a Marine Renewable Energy (MRE) sector is increasingly becoming one of the key low-carbon energy solutions for coastal nations in their drive both to tackle the impacts of a changing climate and to provide energy security in the face of this global challenge (Martinez et al., 2021). While harnessing the vast energy resources of the oceans has led to significant growth in the design, testing and deployment of novel technologies, progress in this area has often been slowed by - amongst other things - the challenge of gaining permissions to test and deploy these installations and the lack of detailed quantitative data as to their impact on the environment (Copping et al., 2018; Simas et al., 2015 and see Galparsoro et al., 2021 for a comprehensive summary of challenges). While certainty about the impacts of the devices is some way off, there is an opportunity in the meantime to revisit consenting processes in order to determine whether changes to these could help to release this bottleneck. One option is to adopt a Risk-Based Approach (RBA), whereby an assessment of risk is used in the decision-making process when undertaking the consenting process.

RBAs have already been used in the context of Marine Spatial Planning (e.g. Stelzenmuller et al., 2015) Ecosystem-Based Management (e.g. Sardá et al., 2015; 2017), and have been found to be useful for interpretation of data from experts, indicators and ecosystem models (Bland et al., 2018). A number of RBAs have also been developed that could be adapted for Marine Renewable Energy (MRE) consenting processes. Whilst some are more prescriptive, and others are cast more broadly, ultimately there are many similarities between these various approaches. This increased research interest and subsequent refinement of RBAs has greatly assisted with the understanding of risk assessment, and indeed in some cases has succeeded in unpicking the complexity of it (e.g. the work of Galparsoro et al., 2021 attempts to specifically capture of additional complexity compared with earlier approaches). Further detail on this background can be found in SAFEWave Deliverable 5.2 (2021) but it is clear that more work is needed to make RBAs truly accessible and applicable to the practical scenarios presenting the MRE sector. The development of a prescriptive procedure is likely not appropriate due to the varying nature of the MRE installations devices themselves as well as differing environmental conditions and impacts where devices are deployed, However, there is scope for providing guidance to assist regulators in taking a robust and holistic risk-based approach. Such a set of guidelines could facilitate a broader understanding and thus the wider use of RBAs, which in turn has the potential to remove one major block to progress in the field.

The aim of this deliverable is to explore in more detail the possibility of producing a set of guidance for the use of RBA in MRE consenting processes. From the work of SAFEWave Deliverable 5.2 (2021), which described the existing RBAs and ways in which they are similar and different from each other, we identified a common a **risk-based framework.**

Among the RBAs examined in Deliverable 5.2 was the Ecological Risk Assessment (ERA) framework described by Galparsoro et al. (2021). This ERA framework also formed the basis of the Decision Support Tool developed within SAFEWave Deliverable 6.2 (Galparsoro et al., 2022). Therefore, to ensure consistency of project outputs, the steps of the risk-based framework presented here are equivalent to those of Galparsoro et al. (2021) but are presented in a simpler fashion with clear links to the other frameworks examined.

5. Creating a simple stepwise RBA process

Several key RBAs have been developed for practical use in implementation of different policies globally. Five of these approaches were considered most relevant to MRE were selected for analysis in SafeWAVE Deliverable 5.2. They are listed below and further detail can be found in SafeWAVE Deliverable 5.2.

- ISO: Risk Assessment approach from ISO Standard 31010 (from ISO, 2009).
- ERES: Environmental Risk Evaluation System (Copping et al., 2015).
- ERA: Ecological Risk Assessment Framework (Galparsoro et al., 2021).
- RR: Risk Retirement (Copping et al., 2020).
- SDM: Survey-Deploy-Monitor guidance (Marine Scotland, 2016).

Importantly, most of the frameworks explicitly define risk in a similar way and all provide a systematic approach to considering risk (see information box). There are many links and similarities between these five key RBAs and these A number of important points emerged from an examination of the five frameworks together:

1. All of RBAs focus on the overarching goal of identifying the **most pertinent risks** and addressing these. This is the ultimate aim of a Risk-Based Process.
2. All of the RBAs explicitly tackle the **receptor-stressor relationships**. This should be the focus of a Risk-Based Approach.
3. An assessment of the **likelihood and consequence** of a receptor-stressor interaction is a common theme in the majority of these approaches. This key step should be included in the Risk-based Approach.
4. All of them perform some sort of **risk evaluation** process in order to identify the most critical risks. This allows risks to be assessed relative to each other and managed appropriately.
5. The identification of risks must be based on **scientific evidence** although this is often not accessible or does not exist. In such cases, the use of **expert judgement** as part of a RBA in the absence of quantitative data, can be seen as an acceptable alternative.

There are several examples of specific **steps** within the different approaches which are equivalent or almost equivalent but have been given different names. There are also a number of key considerations that are common between all the approaches, though they have been called by different terms or divided between steps in various ways. These varied interpretations - whilst valid and essential in developing the ideas behind RBAs - have had the undesired effect of adding to the complexity of such frameworks for regulators and developers and may actually be a deterrent to their use. The simplified stepwise process presented here aims to take the key elements of all existing approaches, but to present them in a **more accessible way for practical use**.

RISK DEFINITIONS

Care should be taken that the meaning of risk is understood clearly in advance of applying a RBA to a given scenario.

A concise but broad definition of risk is that it is the ***probability of occurrence of an undesired ecological impact*** (Jorgensen & Fath, 2008). This definition can be refined once the context of the risk assessment is adequately understood. For example, in a risk management context, the International Organization for Standardization (ISO) define risk as ***the effect of uncertainty on objectives*** (ISO 31000:2009) while the Environmental Protection Agency in the USA defines risk as ***the chance of harmful effects to human health or ecological systems resulting from exposure to an environmental stressor (https://www.epa.gov/risk/about-risk-assessment).***

Each of these definitions are valid and all lend themselves to the concepts of likelihood (the chance of a pressure and receptor overlapping in space or time and consequence (the potentially negative result of that overlap). These are the two key concepts underpinning the risk-based approach outlined here.

6. The simple stepwise process

6.1 Risk-Based Approach process and steps

Using the understanding gathered from a detailed examination of the existing frameworks, the simple stepwise approach proposed here consists of four steps. Figure 1 provides a visual representation of this stepwise approach and it each step is described in detail below.

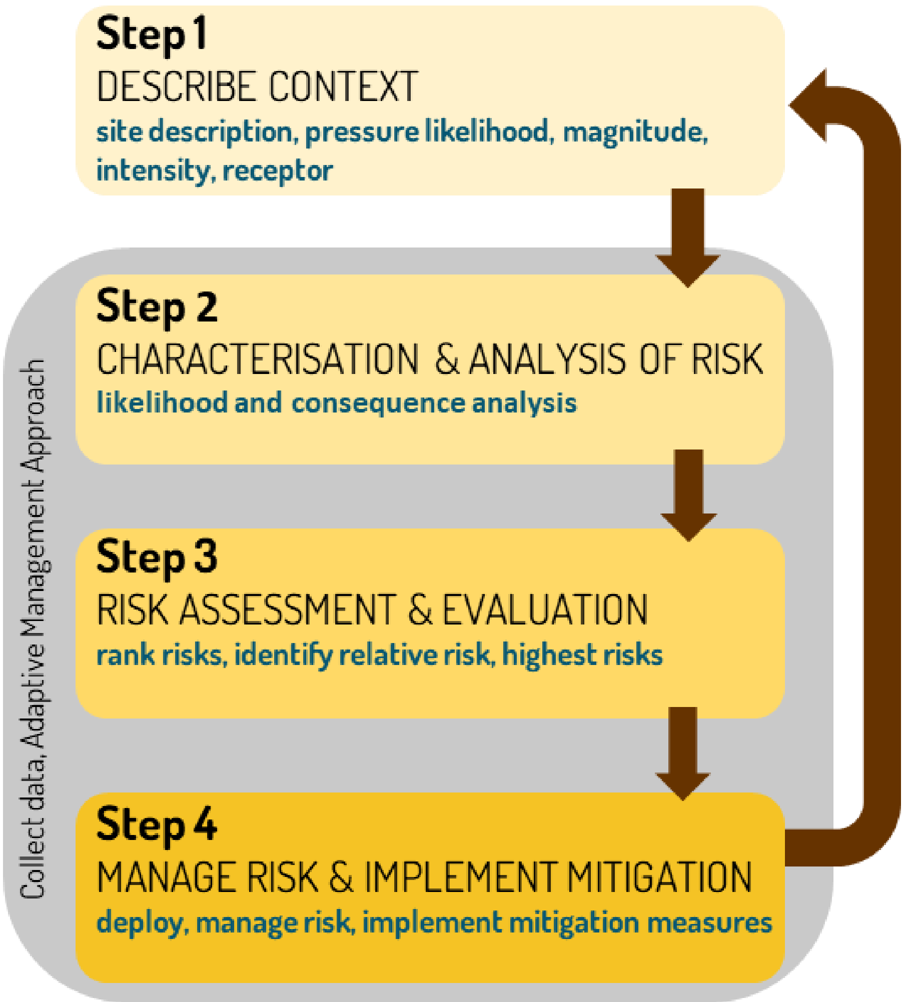

Figure 1. Diagram showing the stepwise Risk-Based Approach process and steps.

6.1.1 STEP 1. Describe Context and Identify Risk

The main tasks within this step include providing a background to the scenario such as a site and project description. A project description involves for example the type of MRE, production capacity, number of devices etc. This provides an idea of the magnitude of the project and of the types of pressures that can be produced by different MRE technologies. The site description refers to the ecosystem components that might be present in the area, and the associated vulnerability to the potential pressures produced by the project.

Crucially, this section also includes a description of the risks identified, by describing and identifying:

1. the potential **pressures (likelihood and intensity)**, and
2. the **receptors, ecosystem components** such as habitats and species, that are potentially sensitive to pressures.

This step can be detailed, or very simple, but in order to make it as comprehensive as possible, it is imperative to understand **what is meant by 'risk' in each particular case** (see Text Box above for definitions). Note that this process may reveal that there are several different pressure and receptor **combinations** to take into account. In considering pressures, it is also important that factors such as intensity and duration be taken into account where information is available.

6.1.2 STEP 2. Analyse Risk

For each pressure and receptor combination identified in Step 1, this step undertakes a **likelihood** analysis and a **consequence** analysis. A likelihood analysis considers the chance that a pressure and a particular receptor (e.g., species or habitat) will overlap in space (and by extension in time). A consequence analysis considers the potential outcome or result of that overlap (i.e., environmental impact or changes on the environmental status). The aim is to produce a **quantitative measure** of both of these parameters which (in the next step) can be used together to calculate **an overall measure of risk**. This is the most complex of all the steps as it requires a process to be devised to determine the likelihood and consequence measures in a particular situation. Variations in factors such as pressure intensity and duration can impact both the likelihood and consequence scores. It may be necessary to calculate different scores based on varying levels of pressure intensity, for example. Additionally, the cumulative pressures should be also considered when implementing a RBA (e.g., Stellzenmuller et al., 2018; 2020).

6.1.3 STEP 3. Evaluate Risk

This step takes the information gathered in Step 2 and uses it to determine the **relative risk.** Relative Risk is obtained by taking the product of the likelihood and consequence analyses in Step 2 (**likelihood x consequence**) for different combinations of pressure and receptor and comparing the results with each other to identify those risks that are most significant. This concept is illustrated in Figure 2 below.

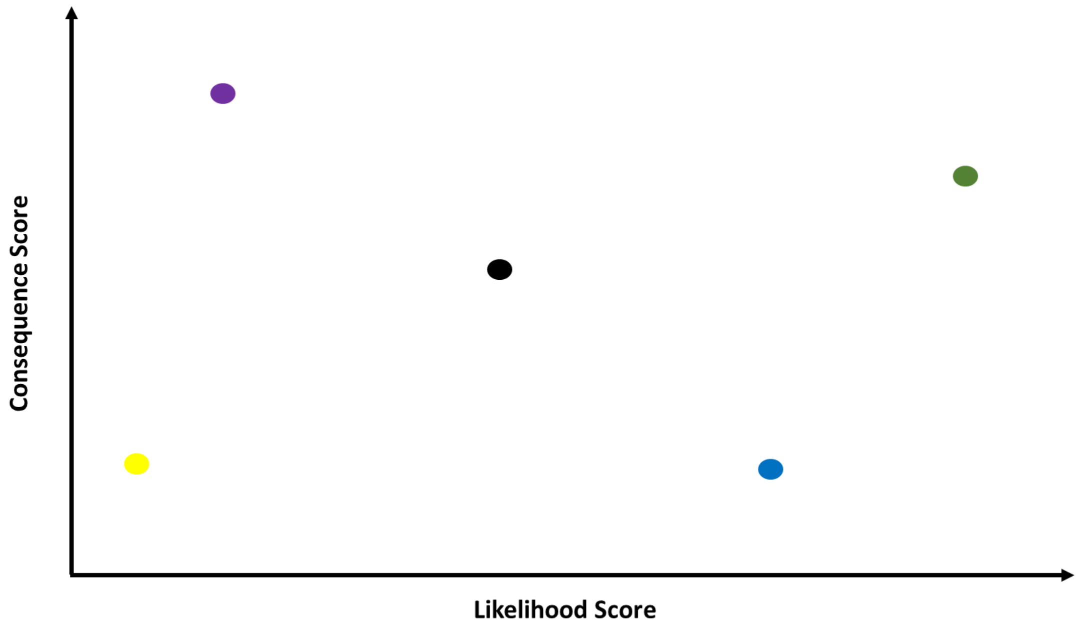

Figure 2. A visual representation of Relative Risk, whereby the results of Step 2 are graphically represented and can be compared to one another. The coloured circles represent different scenarios, for example, a high likelihood and high consequence situation (green circle) and a high likelihood but low consequence (blue circle). Each of these scenarios would require the adoption of different management and risk mitigation measures.

6.1.4 STEP 4. Manage Risk and Implement mitigation measures

This step refers to the actions taken pre, during and post deployment to manage the risks identified in the preceding steps. This step will be specific to a particular setting and will vary depending largely on the environmental and regulatory factors. Importantly, this step also includes the testing of reduction measures and novel mitigation strategies in order to increase knowledge and expertise in the future. This feedback is represented in Figure 1 through the large arrow on the right.

Alongside each of these four steps is the overarching consideration of **new data collection (monitoring),** which does not fit into any particular step – in fact the opportunity to collect new information exists for all steps. This concept is strongly emphasised in the Survey Deploy Monitor (SDM) and Risk Retirement (RR) approaches (via the Collect Additional Data in RR and Monitor in SDM) but less so in the others. Emphasising the need for this consideration draws the process further into the Adaptive Management space and allows knowledge to improve and influence the other parts of the process.

6.2 Relationship between the stepwise approach and the five core RBAs

A relationship can be suggested between the stepwise process proposed here and each of the five core RBAs previously proposed by other authors. However, it is important to note that these relationships are not rigidly defined and the boundaries between them can be considered somewhat fuzzy. However, Figure 3 aims to illustrate the proposed relationship between each step relative to those of the core RBAs. The aim is to help define each step insofar as possible and to assist in directing the user to the appropriate aspect of the underlying approaches if they would like to obtain more detail or refer to examples of the risk approach in action.

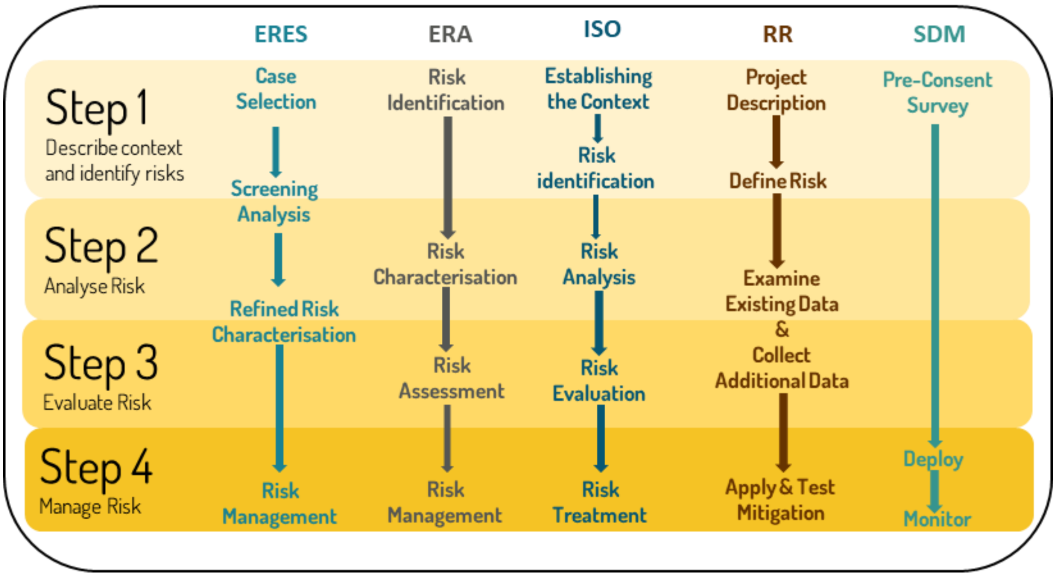

Figure 3. Showing the suggested relationships between the steps in the simple stepwise approach and the five core RBAs that contributed to this work.

The final deliverable of Work Package 5 will include the output of further consultation with stakeholders from Ireland and France and will use all of the information obtained and developed to date (in deliverables 5.1, 5.2 and 5.3) to produce a guidance document for the use of RBA in consenting processes in both countries.

7. References

Bland LM, Watermeyer KE, Keith DA, Nicholson E, Regan TJ and Shannon LJ. (2018). Assessing risks to marine ecosystems with indicators, ecosystem models and Experts. Biological Conservation 227 (2018) 19–28.

Copping A, Hanna L, Van Cleve B, Blake K and Anderson R. (2015). Environmental Risk Evaluation System— an Approach to Ranking Risk of Ocean Energy Development on Coastal and Estuarine Environments. Estuaries and Coasts 38: 287–302.

Copping A, Freeman MC, Gorton AM, Hemery LG. (2020). Risk retirement—decreasing uncertainty and informing consenting processes for marine renewable energy development. Journal of Marine Science and Engineering 8:172.

Galparsoro I, Korta M, Subirana I, Borja A, Menchaca I, Solaun O, Muxika I, Iglesias G, Bald J (2021) A new framework and tool for ecological risk assessment of wave energy converters projects I. Renewable and Sustainable Energy Reviews 151 (2021) 111539.

ISO (2009). International Standard. Risk Management - Risk assessment techniques. Edition 1.0 2009-11 International Standards Organisation, Geneva.

Jorgensen, SE and Fath, BD (eds). (2008). Encyclopedia of Ecology. Elsevier, Amsterdam.

Marine Scotland (2016). Survey, Deploy and Monitor Licensing Policy Guidance; 2016; p. 11. Available online: https://www2.gov.scot/Topics/marine/Licensing/marine/Applications/SDM.

Sardá, R, Valls JF, Pintó J, Ariza E, Lozoya JP, Fraguell RM, Martí C, Rucabado J, Ramis JR and Jimenez JA. (2015). Towards a new Integrated Beach Management System: The Ecosystem-Based Management System for Beaches. Ocean & Coastal Management 118:167-177.

Sardá R, Moren SR, Dominguez-Carro C. and Gili JM. (2017). Ecosystem Based Mangement for Marine Protecte Areas: A Network Perspective. In: Management of Marine Protect Areas (PD Goriup, Ed). John Wiley and Sons. pp 145-162.

Stelzenmüller, V., H. O. Fock, A. Gimpel, H. Rambo, R. Diekmann, W. N. Probst, U. Callies, F. Bockelmann, H. Neumann, I. Kröncke, 2015. Quantitative environmental risk assessments in the context of marine spatial management: current approaches and some perspectives. ICES Journal of Marine Science: 1022-1042.

Stelzenmüller, V., M. Coll, A. D. Mazaris, S. Giakoumi, S. Katsanevakis, M. E. Portman, R. Degen, P. Mackelworth, A. Gimpel, P. G. Albano, V. Almpanidou, J. Claudet, F. Essl, T. Evagelopoulos, J. J. Heymans, T. Genov, S. Kark, F. Micheli, M. G. Pennino, G. Rilov, B. Rumes, J. Steenbeek, H. Ojaveer, (2018). A risk-based approach to cumulative effect assessments for marine management. Science of The Total Environment, 612: 1132-1140.

Stelzenmüller, V., M. Coll, R. Cormier, A. D. Mazaris, M. Pascual, C. Loiseau, J. Claudet, S. Katsanevakis, E. Gissi, A. Evagelopoulos, B. Rumes, S. Degraer, H. Ojaveer, T. Moller, J. Giménez, C. Piroddi, V. Markantonatou, C. Dimitriadis, (2020). Operationalizing risk-based cumulative effect assessments in the marine environment. Science of The Total Environment, 724: 138118.

SafeWAVE Deliverable 5.2 (Verling, E. and O´Hagan, A.M.) (2021). RISK-BASED APPROACHES AND ADAPTIVE MANAGEMENT. Corporate deliverable of the SafeWAVE Project co-funded by the European Union, Call for Proposals EMFF-2019-1.2.1.1 - Environmental monitoring of ocean energy devices. 34 pp. Available Online: https://www.researchgate.net/publication/360473761_DELIVERABLE_52_RISK-BASED_APPROACHES_AND_ADAPTIVE_MANAGEMENT