

## Risk management in the Greek mussel farming through ISO 31000

by

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DOI: <https://doi.org/10.26881/oahs-2024.1.09>

Category: **Original research paper**

Received: **April 8, 2023**

Accepted: **September 8, 2023**

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### Abstract

The main risks to the sustainability of Mediterranean mussel farming in Greece were assessed using a generic framework derived from the AS/NZS ISO 31000:2009 Risk Management Model. Risk management scenarios were reviewed after they were successfully tested in the field by semi-qualitative/quantitative data generation protocols. A critical synthesis of the results identifies key indicative aspects needed by stakeholders to formulate a valid operational risk management plan for the sector.

**Key words:** ISO 31000, risk management, Mediterranean mussel, aquaculture

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## 1. Introduction

As a niche and vulnerable primary production sector, mussel farming appears to be a high-risk activity, so it does not seem very promising for bank financing. For this reason, the financial viability of the venture depends largely on EU asset financing programs to share investment risk (Theodorou et al. 2015). In addition, farmers rely on personal deposits and engage in alternative activities to supplement cash flow when needed.

There is currently no insurance policy for the sector. The exception was limited compensation (in 2012) through the European Fisheries Fund only for losses in the mussel harvest due to human health protection. Consequently, there is no collateral to compensate for losses, making the business vulnerable to operational risk (Theodorou et al. 2011; 2021). The lack of data on losses and insurance policies in Greek mussel farming prompts the search for an alternative path to identify and analyze risks in the sector and support an effective risk management scheme.

This study aimed to identify the main indicative aspects needed by private companies, banks or the government to formulate a valid operational risk management plan for the sector.

## 2. Materials and methods

The present effort attempts to address this knowledge gap through a testing trial that can be used as a Risk Analysis Framework tool based on the Australian and New Zealand Standard AS/NZS ISO 31000:2009 Risk management – Principles and guidelines (Standards Australia 2009). The model is derived from an earlier version of AS/NSZ 2431:2004. There have been several updates (Purdy 2010), such as, AS/NZS ISO 31000:2018, that aims to simplify the process while incorporating the principles of the earlier version used here.

Specifically, it consists of the following processes (Fig. 1):

- (1) context establishment;
- (2) risk identification;
- (3) risk analysis;
- (4) risk assessment;
- (5) risk treatment;

(6) monitoring and review;

(7) communication and consultation.

The following is a synthesis of the combined results obtained in response to the requests of each step of the model.

## 3. Results

The analytical efficiency of the AS/NZS ISO 31000 Risk Management Standard is supported by continuous monitoring and review throughout the process (Fig. 2). Risk communication, as a core component of the risk management model, has indirectly contributed to this effort, with several actions (including the current one) taken to disseminate the results, as demonstrated in similar studies (e.g. De Vos 2005).

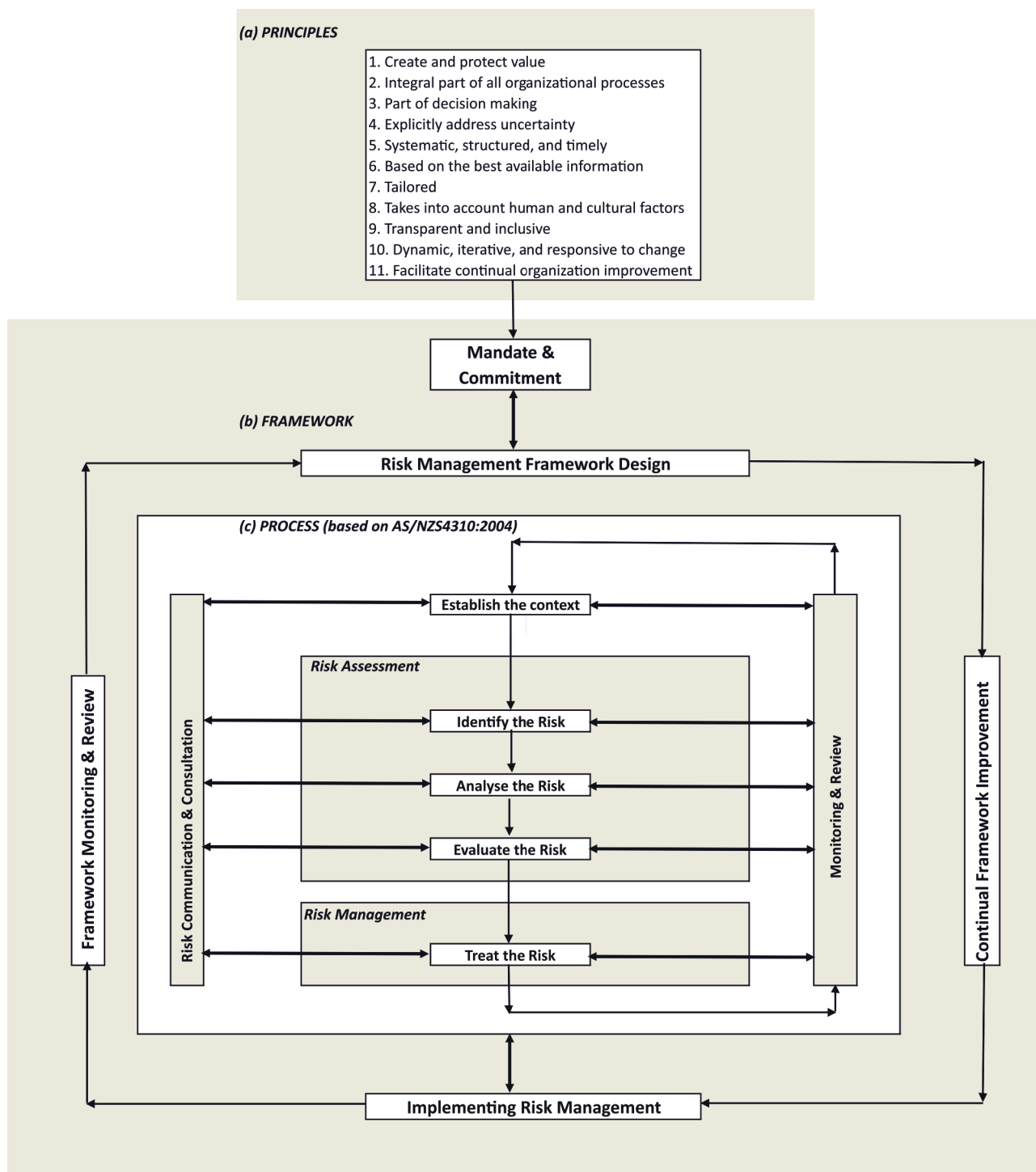
Data generated to support the primary and secondary risk analysis AS/NZ ISO 31000: 2009 modeling processes (Fig. 2) are presented in a series of reference sources in Table 1. In more detail, the Mediterranean Mussel industry profile in

**Table 1**

References to the results obtained for the risk analysis of Greek mussel farming acc. to AS/NZ ISO 31000: 2009 Model Processes (as demonstrated in Figure 2).

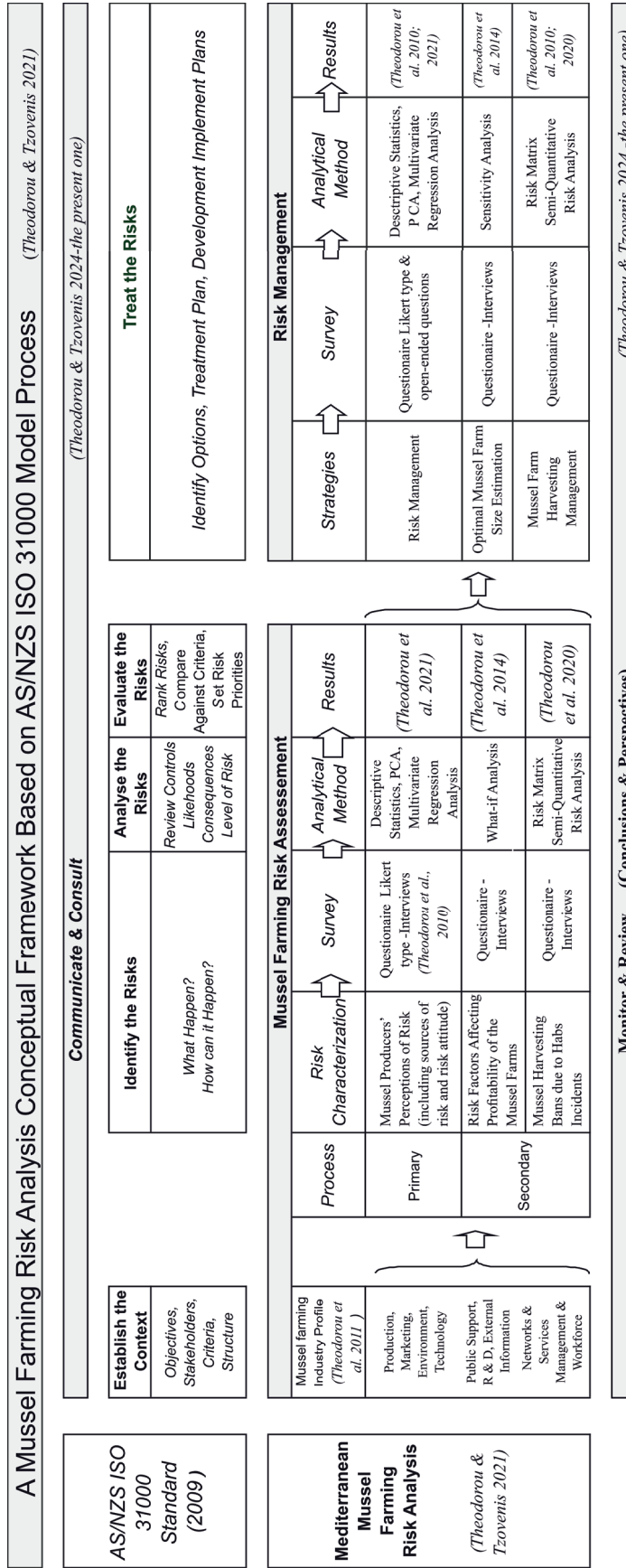
Reference	Description
Theodorou et al. (2011)	Mussel industry profile, including the sector infrastructure.
Theodorou & Tzovenis (2021)	Applied risk management framework provided the required research steps for risk analysis.
Theodorou et al. (2010; 2021)	Mussel farmers' risk perceptions and management strategies.
Theodorou et al. (2014)	Risks factors affecting profitability of farms.
Theodorou et al. (2010; 2020)	Harvesting bans due to HAB incidents, identified as a major risk, and therefore were analyzed for their potential socio-economic implications.





**Figure 1**

Generalized overview of the adapted AS/NZS ISO 31000: 2009 Risk Management Standard showing the relations between the added principles (a) of the effective and mandatory risk management framework development (b) with the existing process (c) of the earlier version of AS/NSZ 2431:2004.



**Figure 2**

Overview of the steps and data used for the Risk Analysis of Mediterranean Mussel Farming in Greece based on AS/NZ ISO 31000: 2009 Model Processes, with references to the results.

Greece, including the infrastructure of the sectors is presented in Theodorou et al. (2011). The applied risk management framework provided the required research steps to analyze the risks associated with mussel farming in Greece, as presented in Theodorou & Tzovenis (2021). Risk perceptions and management strategies of Greek mussel farmers are given in Theodorou et al. (2010; 2021). A supporting process that focuses on risk factors affecting profitability is described in Theodorou et al. (2014). Mussel harvesting bans resulting from HAB (harmful algal bloom) incidents in Greece, identified as a major risk in the primary process detailed in Theodorou et al. (2010), were analyzed in depth for their potential economic and other implications for the industry (Theodorou et al. 2020).

### 3.1. Framework outcomes

The framework tool for Mediterranean mussel farming risk analysis consists of a primary process that provides generic points of the management process, definitions of options within quantitative risk analysis and risk management options, followed by an audit process, as demonstrated in Theodorou & Tzovenis (2021).

The context of this effort was established by Theodorou et al. (2011), providing a profile of the industry, which is concentrated in northern Greece, covering an area of 375.5 ha of sea surface and consisting of about 523 mussel farms (registered and unregistered), most of which are less than 3 ha in size.

The production capacity of the farms is approximately 100 t/ha. Total annual production increased to 23,500 tons in 2019 (Fig. 3), most of which is exported, with an annual value of about €9 million (HELSTAT 2020).

### 3.2. Primary process

The primary process of the risk analysis was carried out by assessing 33 identified risk sources suggested by producers through a Likert-type questionnaire (Theodorou et al. 2010). Highly rated sources of risk were ex-farm prices, disability and health of the farmer and farmer's family, availability of vessels, and harvesting bans due to HABs. The most preferred risk management strategies were the development of financial and credit reserves, followed by off-farm employment (in agribusiness, commerce and other services that provide income certainty), generating as little costs as possible, and horizontal collaboration between farmers (i.e. by sharing equipment, supplies, labor, etc.). Moreover, mussel farmers prefer to take risks in areas they are familiar with, such as production, and try to avoid areas they have less knowledge and experience, such as finance. However, risk mitigation appears to involve a high level of education and experience, and depends on the legal status of the company in question.

Most of them agree that a public policy must be established to compensate for disasters, mainly harvesting bans due to harmful algal blooms, predator attacks, extreme weather events, illegal actions, and diseases (Theodorou et al. 2021).



**Figure 3**

Mussel production in tons and value from aquaculture in Greece since 2007 (Source: HELSTAT 2020).

### 3.3. Secondary Process

The above results of the primary risk assessment process can be further enhanced by a secondary process. The same methodological procedures were used to answer questions arising from the risk communication of the primary results, such as a) which factors affect the profitability of farms / why ex-farm prices are perceived as a major source of risk; and b) when harvesting bans due to HABs lead to losses. The answers to these questions were fed back into the primary process (Theodorou & Tzovenis 2021).

### 3.4. Risk factors affecting profitability

To analyze the financial risks of mussel farming in Greece, risk factors affecting profitability at the farm level were examined following modern production practices. Theodorou et al. (2014) showed that mussel farms using the widely accepted long-line technique for less than 3 ha were not economically viable. Moreover, the construction of new facilities and the modernization of existing ones was only feasible if larger enterprise structures were adopted. Consequently, EU and/or public support (up to 45% of the total cost of fixed assets) was critical for the development of the industry. The proposed risk management process, given that the majority of Greek mussel farms are rather small (1–3 ha), showed that for the sector to be financially sustainable, it needs to be restructured and organized into larger systems, such as those of producers' organizations or cooperatives, in order to benefit from economies of scale and attract better funding.

### 3.4. Effects of mussel harvesting bans due to HABs

A similar ancillary process was followed to analyze the risks from the increasing number of HAB incidents during the past decade. A semi-quantitative approach at the farm level was used, as demonstrated by Fletcher et al. (2004; 2005), where again the main principles of the methodology were rooted in the AS/NZ 4360 Risk Management Standard (1999; 2004). Harvesting bans resulting from HABs have proved disastrous for mussel production only when the phenomenon occurred when the product was ready for market (late spring to early autumn) and when the site was closed for more than 6 weeks. The damage resulted from yield losses, price reductions caused by oversupply in the market after harvesting restrictions were lifted, as well as space restrictions imposed on farms to deploy new seed for production the following season. Risk management strategies also suggested

actions to mitigate the losses, such as diversified handling of marketable mussels and expansion of farm installations (Theodorou et al. 2020).

## 4. Discussion

The principles of the joint Australian and New Zealand AS/NZS ISO 31000:2009 Risk Management Standard were useful as a framework and action plan to mitigate the risks affecting the Greek mussel aquaculture. The perspectives and relevant policies extrapolated by this effort are discussed below.

### 4.1. Farmers perspectives

The results of the sensitivity analysis in Theodorou et al. (2014) indicated that modern vessels (bigger than 15 m in length) equipped with "French-type" grading machines are a profitable investment only when the production exceeds 300 t. Since most mussel farms in Greece are well below this production capacity, in order to be profitable they may need to collaborate among themselves by sharing equipment and working with larger crews of 4–7 workers per vessel. Increasing the number of workers per trip increases the return on unit labor and minimizes the operating cost of each trip.

It is proposed to consider a "cluster management" of small-scale mussel farmers enabling the producers to work together and improve production, develop sufficient economies of scale and knowledge to participate in modern chains, increase their ability to join certification schemes, improve their production reliability and reduce risks.

### 4.2. Industry Perspectives

The results of an exploratory survey of Greek mussel farmers' risk perceptions show that the ex-farm price of mussels was regarded as the major source of risk. We have studied price fluctuations over the past two decades and concluded that prices are relatively stable despite increasing production costs. Thus, the problem is profitability rather than the price itself and, as an extensive system, it is constrained by the availability of farming space. In contrast to the rather flexible policy of land-based agriculture in Europe, the size of marine aquaculture farms is dictated by national licensing systems and the lack of suitable space availability (eutrophic sea areas suitable for bivalve culture). As the farm size is related to the licensing system, it has been demonstrated that this could indirectly be a major risk factor for the financial



sustainability of the sector. In our case, for the majority of Greek mussel farms that have an area of less than 3 ha each, there is a problem of survival, which is directly related to the space limitations imposed by the state licensing system, which lacks reasonable flexibility and therefore functions as an institutional risk (Theodorou et al. 2014). The findings from this study also indicate the importance of EU governmental support for the viability and sustainability of the sector. The initial investment was a high-risk opportunity, as the variability of production due to the extensive nature of the business increased the financial risk, and consequently there was limited interest from the banking sector in supporting this type of operation.

The future of the industry, as well as the organization of producers into larger schemes, therefore depends on the industrialization of production methods and the scaling up of production units to reduce average production costs and enhance the marketability of the product (Theodorou & Tzovenis 2017).

Risks, such as harvesting bans due to HABs, have not always resulted in economic losses. A semi-quantitative risk assessment based on the principles of the joint Australian and New Zealand Risk Management Standard, AS/NZS ISO 31000:2009, showed that economic losses vary depending on the season and duration of episodes (Theodorou et al. 2020). In our case in Greece, summer is the most sensitive risk season for catastrophic losses if the closure period is more than 6 weeks. However, the effort put into assessing the limitations resulting from the risk of farm closure due to HABs could be factored into insurance policies. Key issues for this risk sharing strategy, include covering only measurable losses from specific well-defined causes of loss, where the probability of loss and the distribution of losses can be calculated with some confidence and producers' management behavior can be monitored (Beach & Viator 2008). As stated above, to realistically assess the impact of closures resulting from HABs, assessments must be completed at the farm level in the relevant local ecosystems within the local bioregion. However, the current qualitative (semi-quantitative) method needs to be supplemented by a quantitative risk assessment to estimate the magnitude of economic risk (Kam & Leung 2008), which involves monetary losses resulting from closures caused by HABs.

Greek mussel farmers opted for financial reserves as the best risk management strategy, followed by farming excellence. Although previous work has demonstrated the necessity of collaboration between producers to achieve economies of scale, Greek producers lack this tradition and do not trust

these practices. Greek producers do not consider dealing with persistent bureaucracy problems as a risk management strategy, as they perceive it as a common daily activity. Diversification (into other species) seems to be the last priority for Greek mussel farmers, as their traditional stance does not allow for easy adoption of new products, let alone the needs for new markets. Price contracts were also not perceived by mussel farmers as important risk management tools to mitigate marketing risk. Finally, producers expressed a limited preference for insurance products, because such "risky" products are usually expected to receive state support or compensation in times of disaster, as practiced in agriculture (Theodorou et al. 2021).

It is concluded that risk management priorities of Greek mussel producers are based on their local experience (e.g. low prices). Risk-sharing strategies were focused on self-protection mechanisms such as capital reserves and farming optimization. Other tools, such as price contracts or insurance policies, were considered too complicated and beyond routine for most of them. Further research into improving risk management tools would ensure recovery from possible future disasters.

#### 4.3. Policy Perspectives

State policy should focus on issuing more licenses to help the sustainability of the industry. Furthermore, public services should collect accurate data on production and losses. State or private insurance underwriters should be encouraged to develop policies based on such accurate databases. The present risk analysis demonstrates that the size of the mussel farm (extensive system entirely dependent on local natural productivity) has a direct impact on the performance of mussel production and, consequently, on the operation of the industry. As this has a direct impact on the wealth of the local society, the social factor can create relevant policies focused on the local sustainability and profitability. The results of the research partly further clarify what is needed to make mussel farming viable in Europe (European maritime governance), despite completely different local adoptions of common EU management policies (Jouanneau & Raakjær 2014; Kraan et al. 2014). European and national regulations and directives seem to be applied locally by "modifying" the rules. This refers to the lack of control over their application (due to negligence, inadequacy or corruption), which after a while become the norm, with people seemingly forgetting the original rule. In the case of Greek mussel farming, the application of rules created by centralized authorities (EU, Greek State), e.g. in

terms of spatial planning, legitimate technology, etc., is applied locally with different criteria, sometimes illegal, driven by ignorance or deliberate negligence, but production continues. This is a competitive evolutionary advantage for the future, because once things are normalized, piracy will become a status quo. Piracy refers to the fierce defiance of local stakeholders against rules imposed by centralized authorities, leading to the diverse behavior that governs local business. This is not just a Greek or mussel industry practice. As Jouanneau & Raakjær (2014) recently demonstrated, this is common in Mediterranean governance and a structural difference from the application of common rules in the Baltic countries. According to North (1993), since the institutional framework promotes and accepts “piracy”, this pattern will eventually emerge. This explains why this study is consistent with Ostroms’ (2011) theory of multilevel governance as a socio-ecological system approach and explains the legalization of piracy (North 1993). Even if mussel farms are not profitable (most of them are < 3 ha), they continue to operate successfully even under economic crisis, because they are outside the mainstream legal culture (Theodorou et al. 2017). Consequently, this reinforces the farmers’ view of EU regulations, which they find “destructive”.

## 5. Conclusions

The generic approach of the risk management tool (standard AS/NZS ISO 31000:2009) used has the advantage of being easily adapted to the specific national characteristics at all levels of business activities and functions of the mussel sector.

The conceptual framework has been successfully developed, based on the dataset required to establish the context (Theodorou et al. 2011) and farm-level risk management strategies (Theodorou et al. 2010; 2021). Additional support for the overall risk management process is adequately provided by answering survey questions about the magnitude of specific risks identified, including financial risks (Theodorou et al. 2014) and losses due to harvesting bans resulting from HABs (Theodorou et al. 2020).

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