

Article

ARISA: Collection of Health Information at Farm Level in Spanish Fish Farming

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Abstract: The adequate collection of health information at the farm level is the first step in good health management. The objective of this study was to analyze how Spanish fish farms collect their census, disease occurrence, and mortality data through their farm record books and how they use them for reporting to competent authorities. Comparing and contrasting farm books between regions (autonomous communities) revealed a lack of standardization and substantial differences in the reporting. Therefore, this study points out the need to improve and standardize, at the national level, the design of fish farm record books in order to ensure the better collection of farm census data on mortality and disease occurrence, which may facilitate the production of epidemiological reports and the early detection of emerging diseases at the national level.

Keywords: pathogens; mortality; fish diseases; aquaculture census; surveillance

Key Contribution: Health and epidemiological reports are conditioned by the quality of data collected.



Citation: Muniesa, A.; Ruiz-Zarzuela, I.; Peribañez, M.; de Blas, I.; Basurco, B. ARISA: Collection of Health Information at Farm Level in Spanish Fish Farming. *Fishes* **2024**, *9*, 357. <https://doi.org/10.3390/fishes9090357>

Academic Editor: Rodolphe Elie Gozlan

Received: 26 July 2024

Revised: 4 September 2024

Accepted: 9 September 2024

Published: 12 September 2024



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1. Introduction

Spanish fish farming has a well-diversified aquaculture sector both in terms of species and production systems, with a total of 73,370 t produced in 2022 (59,123 t of marine fish, 14,122 t of freshwater fish, and 125 t of fish for restocking [1]). European seabass (*Dicentrarchus labrax*), at 21,179 t, is the main species produced, followed by Rainbow trout (*Oncorhynchus mykiss*) at 13,413 t, Bluefin tuna (*Thunnus thynnus*) at 8482 t, Turbot (*Scophthalmus maximus*) at 7504 t, Gilthead seabream (*Sparus aurata*) at 6.079 t, and Meagre (*Argyrosomus regius*) at 4833 t. There are other species such as sole, mullet, eel, brown trout, tench, sturgeon, and Atlantic salmon, all of them accounting for about 1200 t [1].

As regards production systems, whereas most marine fish (seabass, seabream, meagre, and tuna) are grown in offshore cages, they are also cultured in open flow (turbot) or Recirculating Aquaculture Systems (RASs) (sole). Rainbow trout is grown in open flow tanks and ponds. On the other hand, most marine and freshwater hatcheries and nurseries culture fish in RASs. In 2020, there were 150 active freshwater fish farms (mainly for rainbow trout and sturgeon) and 67 marine fish farms on the coast and in the sea. There were 43 operating using sea cages (seabass, seabream tuna, and meagre, mainly) [2].

As in most European countries, Spanish fish farming is vulnerable to exotic, endemic, and emerging disease epizootics. The median survival rate for seabass and seabream in 2018 in Spain was estimated to be at about 94%, and the main diseases affecting these species during the growth period were Photobacteriosis, VNN, Red rash, Sparicotylosis, and Winter syndrome [3,4]. Diseases may cause a direct impact on the economic performance of a fish farm due to mortality losses, treatments, etc. Although there is significant information about how nations should collect and report information about notifiable and emerging diseases to international institutions (i.e., European Union: EU, World Organisation for

Animal Health: WOA), there is little information available about how pathogens, diseases, and related health information should be collected at the farm level for the abovementioned cases or for the elaboration of industry or national epidemiological/health reports. There is, however, more significant information available about methods to collect fish mortality in the industry, especially for salmon [5–9].

The Animal Health Law, AHL Regulation (EU) 2016/429 of the European Parliament and of the Council on transmissible animal diseases [10], includes the operator's obligation to ensure that farms under their responsibility are subject to animal health surveillance and should detect the presence of both notifiable and emerging disease as well as abnormal increases in mortality in aquaculture animals and notify the competent authority or a private veterinarian for further investigations. However, the definition of "increased mortality" leaves room for different interpretations by administrations and stakeholders.

In that respect, farmers should guarantee traceability throughout the production process of a livestock farm, and administrations should ask them to keep defined records in their livestock farm record book (hereinafter farm book) for the necessary controls and inspections to be carried out. The information that needs to be collected includes information concerning the registration and discharge of animals; notifiable diseases and other infectious and parasitic diseases and diagnosed intoxications; medicines and medicated feed administered; feed supplied to the animals; products of animal origin (milk, eggs, bee products, fish fingerlings, embryonated eggs, etc.) that have left the farm; and the result of the controls and inspections carried out.

The ARISA project, coordinated by the Faculty of Veterinary Medicine of the University of Zaragoza [11], aimed to improve the methodology for obtaining information on Spanish fish farming to facilitate the analysis of the health situation of the sector and the standardization of health indicators that would allow epidemiological studies of quality and their possible correlation with environmental parameters. The objective was to analyze how fish farms collect their census, disease occurrence, and mortality data, and other health information (i.e., treatments) through their farm record books and how they used them for reporting to competent authorities. Thus, the ARISA project worked with the different parties involved in the collection and analysis of health information at the fish farm level to find out what information is collected by farmers and how it is analyzed and reported, with the final purpose of proposing a series of practical recommendations on how to improve data collection and health information about the Spanish fish farming sector.

2. Materials and Methods

Following the mandate of the regional administration (autonomous communities: ACs) competent authorities, the owners of livestock farms (fish included) must keep a farm record book. These farm books are based on a general template prepared by the Ministry of Agriculture, which comprises the information to be collected and reported for different purposes (e.g., census registration, traceability, diseases). Moreover, the ACs can prepare their own farm book templates (in paper or digital format) for different animal species, and can thus ask for additional information.

The farm books of the main farmed freshwater and marine fish producers for the following 6 out of the 17 Spanish ACs were reviewed and compared: Andalucía, Aragón, Castilla y León, Murcia, Navarra, and Valencia. These six regions account for 65% of the Spanish fish production. A seventh autonomous community, Galicia, which accounts for 16% of the Spanish production, was also consulted, but it was not considered for this study, since this administration had not prepared a book template for fish farms yet, and simply informs farmers/companies about the mandatory information they must collect for official reporting purposes (i.e., outbreaks of EU and WOA listed diseases, and abnormal mortalities).

The structure and data fields of the farm books were analyzed paying special attention to the census information, categories of fish inputs and outputs, and the recording of mortalities and pathologies.

Besides the compilation and comparison of production data, experts from private companies, health associations, research, and national and regional administrations are involved in the collection and analysis of health information in aquaculture. For this study, different from before, mentioned categories were selected to find out what information is collected by the companies and how it is analyzed and reported. These included the veterinarians of 4 regional Aquaculture Health Defence Groups (ADS) from the Canary Islands, Andalucía, Murcia, and Valencia, 5 officers from regional and national administrations, 6 managers of freshwater and marine fish production companies, and 8 researchers in aquaculture health.

Veterinarians and health managers from fish farms were face-to-face interviewed and stakeholders from other segments of the value chain (ADS, national and regional administrations, research) were interviewed by different means, i.e., face-to-face, phone, or videoconference. Interviews were purpose-designed, with questions according to the stakeholder profile, experience, and position in the value chain [11]. The scripts used for the surveys carried out with the managers of the ADS and aquaculture facilities are attached as Supplementary Materials (Tables S1 and S2). The recorded information was compiled, organized, and synthesized to elaborate a draft document summarizing the main results, conclusions, and recommendations.

In relation to freshwater, fish farm health managers located in four ACs (Aragón, Galicia, Navarra, and Castilla y León) belonging to three different business groups were interviewed. Production of these four ACs accounts for 53% of Spanish freshwater fish production [12].

In relation to marine fish, two fish farm health managers were surveyed, one of them from a large multinational business group with 11 marine cage facilities on the Spanish Mediterranean coast (Valencia, Andalusia, and Murcia) and the other with a single facility within a natural park in semi-extensive region sited in Andalusia. Production of these three ACs accounts for 68% of Spanish marine fish production [12].

On 26 November 2021, a workshop was organized by the project ARISA at CIHEAM Zaragoza (Spain) to present and discuss the draft conclusions and recommendation raised from the interview process.

3. Results

Each company is responsible for the collection and recording of its own zootechnical and health information in order to comply with administrative requirements and for its own management purposes. Through the comparison of the farm books and the interviews conducted, it was possible to observe a great variability in the method used for collecting data and information among the companies of different autonomous communities.

Farm book templates and reference documents of six regions (Andalucía, Aragón, Castilla y León, Murcia, Navarra, and Valencia) were reviewed (Table 1) in order to compare the main information that farms should report related with census, disease occurrence, mortality, and treatments, and they are included in the following table.

Table 1. Review of farm record books from ACs of Spain and health-related information. REGA: General Register of Livestock Farms (GRLF).

AC	Entry Info.	Exit Info.	Census Updates	Treatments
1 (Inland Marine) Andalucía [13]	Date, n°, initial weight (g) Origin: hatchery, wild, purchased, other. REGA n° of origin farm. Sanitary doc.	Date, n°, initial weight (g) Cause: mortality, sale, slaughter, other REGA n° of destination farm. Sanitary doc.	Balance: Weight (t or kg) Date, broodstock, fry, juveniles, other.	Not included in template
2 (Inland) Aragón [14]	Origin or destination for each cage or tank: date, type of production, specimens, species, additions or deletions, origin or destination, guide. City, country, REGA n° of farm; for release into the wild (river name and coordinates) Cause of entry or exit: birth, purchase, internal movement, natural environment, slaughter, sale, death on the holding. Note: the n° of dead was given as a whole and rounded.			Included: tank, batch, pond, initial date, dose, duration, trade name, prescription n°, prescriber, supplier, administration route, withdrawal time
3 (Inland) Castilla y León [15]	For each farm: date, cause of entry or exit, origin or destination, document n°, n° of animals For origin or destination: REGA code, zoological nucleus, approved zone. Cause of registration or deregistration: birth, death, entry or exit.			Included (also medicated feeds): date, prescription, medicine, species.
4 (Inland Marine) Murcia [16]	Date, batch, n° of fish, average weight, source code (REGA n° or catch coordinates), sanitary doc.	Date, n° of fish, biomass (kg), destination, sanitary doc. Cause of exit: sale, disease discards, carcass manager, to other farm tank, cage, escapee.	Monthly updates per cage or tank: date, n° of fish, average weight (g), biomass (kg). Mortality (%).	Not included in bulletin.
5 (Inland) Navarra [17]	Date, species, biomass (n° or kg), type of production, origin, approved zone, source (REGA n° or catch coordinates), sanitary doc.	Date, species, biomass (n° or kg), type of production, destination, source code (REGA n° or release coordinates), sanitary doc.		Included: batch, start date, end date, dose, trade name, prescription no., prescriber, supplier, withdrawal period, nature of treatment.
6 (Inland Marine) Valencia [18]	Origin or destination by farm unit and species: Category: eggs, fry, on-growing, breeders. Entry or exit: n° of animals, weight, date, REGA code origin/destination, type of destination, sanitary doc. and balance sheet. Type of destination: sale for market, carcass manager (dead, etc.), other farm, escapees due to breakage of cage or tank.		By farm unit: date, species, n° of eggs, n° of fry, n° of adults for on-growing. Egg/year (t), fry/year (t), n° of adults for on-growing/year.	Included: start date, type and route of administration, medicine name, prescription n°, animals treated, n° identification), duration, dosage, withdrawal period, supplier. Biocides registration sheet.

- Animal entry records, including date, species, lot, number of animals, weight, type of production, cause of entry, National Registry of Animal Production Units (REGA) code of origin, and health documentation.
- Record of departure including date, species, lot, number of specimens, weight, type of production, cause of departure, REGA code of destination, and sanitary documentation.
- Census update including date, species, lot, number of specimens, weight, and type of production.
- Identification of the destination that would explain the cause of entry or exit, such as birth, purchase, internal movement or movement to another farm, release to the environment, escape, slaughter, sale, death on farm, and carcass management.
- Treatments: identification of tank, lot, pond, initial date of treatment, duration, number of animals treated, commercial name, dosage, route of administration, suppression period, prescriber, prescription number, and supplier.
- Diseases: This includes pathologies of infectious and parasitic origin and intoxications. It would include date, diagnosis, associated document, number of affected animals, measures taken, date of resolution of the disease, and veterinarian's number.

It was noted that there were few differences between the farm books for the entry census records, and most differences were found in the way that the census exits and their categorizations were recorded. There were cases in which sections were merged, such as those for entry, exit, and updating of the census. Furthermore, some of these sections did not exist in the farm books of all the communities; for instance, the treatment section only appeared in four of the books, while the disease section only appeared in two of them.

With the exception of the notifiable diseases, it was observed that currently, the national administration and, to a different extent, the regional administrations have limited knowledge of the main diseases that impact the sector.

Moreover, except for the information needed to comply with the legal requirements of each AC, it was observed that there was no shared standardized system for all the farms integrated into a given regional ADS. Since there is no exhaustive official follow-up of the information gathered, the role of the ADS's veterinarian is just to check that farms collect all the required information. The ADS usually communicates disease and mortality occurrence to their associates in meetings between them. However, in most cases, there is no detailed or epidemiological analysis of these data, as they are considered "sensible" information by the aquaculture companies.

4. Discussion

The structure of the farm books and the information that fish farming companies should collect on diseases and health were analyzed. The analysis and comparison made showed that there were noteworthy differences between the record books from the different regions, since the categories for the classification of the census exits (e.g., the inclusion of escapees) and mortalities varied. In some cases, it was not clear how the population size was calculated. This variable is the key for calculating survival and should at least be provided at two or more agreed time/size points: seeding (e.g., fry, juveniles, adults one year, adults two years, etc.) and harvesting. A major drawback is the incorrect estimation of the initial and final populations due to the use of indirect methods (i.e., biomass divided by average weight, stocking density multiplied by area or volume of the production unit). Another problem that limits the comparison of the values is the length of the growth/culture period. Altogether, such differences in formats, record fields, and value estimations make comparability, harmonization, and, therefore, sound analysis extremely difficult.

It has been observed that the structure and the information collected vary among regions. Among the regions studied, Murcia and Valencia, two of the leading regions in marine fish farming production, have good farm books defining in more detail the entries and categories, which can thus provide a more precise census on mortality and other causes of losses. It should be noted that not all regional farm books include a section for treatments (e.g., Murcia). It is recommended that autonomous and national administrations work

together on the improvement and standardization of these production books. Based on the current study, the main recommendations for the improvement of fish farm record books were as follows:

- Standardize the categories (types) of entry and output fields, as well as the length of growth/culture periods of the different ACs' farm books.
- Standardize the categories (types) of mortality/losses (e.g., diseases, escapees, discards due to malformations, discards due to other causes).
- Include and standardize the section concerning disease reporting.
- Include information on cumulative monthly and annual mortality or mortality estimated by taking into account the number of deaths in an agreed culture/growth period.
- Include and standardize the section on treatments (e.g., antibiotics, antiparasitics) and prevention (e.g., vaccines, autovaccines, others).

Several tools have been developed to help responsible health authorities and experts evaluate and improve their surveillance programs. Examples include work by Oidtmann et al. (2014) [19], who proposed a model to classify freshwater fish farms according to their infection risk in a more objective manner. Mazzucato et al., 2023 [20], presented an interesting study that evaluated the levels of biosecurity of Italian trout farms in order to rank the risk of introduction and spread of infectious fish diseases. Bondad-Reantaso et al. (2021) [21] developed a methodology for disease surveillance of aquatic organisms in developing countries. More recently, we have applied the FAO's Surveillance Evaluation Tool (SET) to assess the Spanish disease surveillance system for farmed fish species [22].

A recent article from Persson et al. (2022) describes the patterns of mortality and investigates the sources of variation in mortality during the marine phase of commercial salmon farming. In this case, the mortality categories considered were 'molt-related mortality', 'infectious diseases' and 'handling and treatment'. In addition, Soares et al. (2011) has addressed the methodology to calculate abnormal mortality as an indicator of disease presence in the Atlantic salmon industry.

The Aquaculture Health Information Network established in this project will contribute in a very positive way with collaboration in the development and planning of master plans, by providing strategies for collecting relevant information in the productive and health field that can allow for the more reliable identification of risk indicators that have a negative impact on the aquatic environment, contributing to its conservation. In addition to this, it will promote more sustainable aquaculture that is respectful of the use and exploitation of natural resources in these protected spaces.

The analysis of the information generated has been discussed with different actors involved in aquaculture health. The current work has focused on trying to understand better the way that Spanish administration requires fish farms to compile health-related information. As aquaculture is administratively managed by regional administrations (ACs), such improvement will require important administrative coordination. Alternatively, the Spanish administration could better empower and structure the regional ADS or even the FEADSA (Spanish Federation of Aquaculture Health Defense Groups). They could prepare and disseminate updated coordinated reports at the national level on the health situation of the fish farming sector, so that they serve as a reference when improving the health and welfare conditions of both fish and the environment around them. These reports would include standardized and elaborated information with health indicators, such as the prevalence of disease, acute and annual mortality, vaccinations, etc.

There is also a need to conduct further studies to determine better what is understood by normal (baseline) mortality/survival or escape rates for the different fish species cultures in Spain. The project GLORIA 2 (GLOBAL change Resilience in Aquaculture-2), that has worked on improving the knowledge, management, and mitigation of fish escapes in marine fish farming in Spain, has tried to assess escapes from fish farms by indirect means (e.g., increasing captures in fishing ports) due to the difficulties in obtaining such information from farm books [23].

5. Conclusions

According to this study, for the studied ACs, the one that has implemented more standardized systems to collect health, mortality, and disease information was Murcia. In contrast, there is Galicia, for which the administration has still not designed a farm book.

The ARISA project advocates for a greater empowerment of ADS, recommending that they work on the preparation of epidemiological reports on the health situation of the fish farming sector, so that these can serve as a reference for companies and health managers to better understand the health situation of the sector and propose improvements in the health and well-being conditions of both the fish and the environment around them.

It is recommended that these reports perform the following actions:

- Be prepared for regular inspections, for example, every two years.
- Include information on health indicators, such as the following:

The prevalence of diseases;

Annual mortality rates on farms (total and categorized by major causes: diseases, deformities and discards, escapes, others, etc.);

Abnormal mortality rates due to diseases and their causes;

Escapes;

Treatments;

Vaccinations, etc.

The different ADS need to work on the standardization of the abovementioned indicators, so that the reports of the different ADS are comparable, and can be the basis of reports at a national level.

ARISA has also analyzed the structure of the farm books and the information that fish farming companies must collect on diseases and health. It has been possible to see how the structure and the information collected varies significantly according to the different autonomous communities. ARISA has been able to meet with representatives of the central administration (of animal health and fishing and aquaculture) to transmit the results of the project and its conclusions and to discuss with them the need for autonomous and national administrations involved in the health surveillance of aquaculture to work on the improvement and standardization of health information that the farm books must collect.

In this case, our recommendations focus on the following aspects:

- Standardizing the input and output fields of the farm books of the different ACs.
- Standardize the categories (types) of the input and output fields (for example, mortality due to disease, mortality due to other causes, escapes, cullings due to malformations, cullings due to other causes, etc.).
- The farm books should contain information on the monthly and annual mortality recorded on the farms.
- The books should contain information on abnormal mortality and its causes (diseases, other causes, etc.). Regions should coordinate to agree on the definition/s to avoid discrepancies at the national level and to facilitate the production of aggregated information. It is noted that several important companies have farms in different regions.
- The books should also contain standardized information on preventive treatments (vaccines, autovaccines, others) and curative treatments (antibiotics, antiparasitics, etc.).

Thus, ARISA recommends strengthening the structure and functionality of the ADS and strengthening the integrating role of the FEADSA by seeking the preparation of reports with standardized information that allows for a comparative analysis between the autonomous communities and their evolution over time and the method of sharing said information.

Supplementary Materials: The following supporting information can be downloaded at <https://www.mdpi.com/article/10.3390/fishes9090357/s1>, Table S1: ADS SURVEY—ARISA; Table S2: FARM SURVEY—ARISA.

Author Contributions: Conceptualization, A.M., I.R.-Z. and B.B.; methodology, A.M., I.R.-Z. and B.B.; validation, A.M. and B.B.; formal analysis, A.M., I.R.-Z. and B.B.; investigation, A.M., I.R.-Z., M.P., I.d.B. and B.B.; resources, A.M. and B.B.; data curation, A.M.; writing—original draft preparation, A.M. and B.B.; writing—review and editing, A.M., I.R.-Z., M.P., I.d.B. and B.B.; visualization, A.M. and B.B.; supervision, A.M. and B.B.; project administration, A.M.; funding acquisition, A.M. All authors have read and agreed to the published version of the manuscript.

Funding: This research has received funding from the ARISA Project, funded by the Biodiversity Foundation of the Ministry for Ecological Transition and Demographic Challenge through the Pleamar Programme, co-financed by the European Maritime and Fisheries Fund 2014–2020.

Institutional Review Board Statement: No research has been conducted with humans or animals. The work done refers to how fish farm companies are collecting health related information in their own farms. No experimentation has been conducted of those farms related with our project. Fish farms culture for food, and must comply with strict regulations (licensing, environmental, labour, fish health, fish welfare etc.) and are subject of strict administrative supervision.

Informed Consent Statement: Not applicable.

Data Availability Statement: No new data were created.

Acknowledgments: The authors acknowledge all stakeholders that have participated in the consultation activities for the assessment of the surveillance system. Special recognition is given to the veterinary services of the ADS of Valencia, the Canary Islands, and Murcia.

Conflicts of Interest: The authors declare no conflicts of interest.

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