Veterinary, sanitary and antiepizootic measures as a way of ensuring biosafety in Barents aquaculture: comparative analysis

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Abstract. Comparative analysis of veterinary and antiepizootic measures was held for three locations: Murmansk region, Russia, Norway and Finland. All these locations provide salmon and trout aquaculture, the main aquaculture industry in Barents territories. The article reveals some peculiar properties in veterinary maintenance of freshwater and marine cage aquaculture, restocking fish and hatcheries. Control and management of aquaculture from veterinarian institutes is vital for presence well epizootic condition among north establishments. The dynamics in quantity and quality of Murmansk aquaculture establishments was observed from 2013 to 2018. It demonstrates actual situation about epizootic well-being for today in region. There are differences between disease classifications in described countries, which noticeable change legislations in veterinary and attitude of stakeholders. The mechanisms of veterinary management are characterized in details, especially all regulations in live fish and sexual products treatment. In Finland the main groups of diseases depends on the ability of infection. The vaccination is held against furunculosis and vibriosis. In Norway the disease groups (A and B) are more under control, than the third group C. The vaccination against complex diseases is obligate in case of production, export and realization. Some strong and weak sides of measure complexes were identified and suitable proposals were compiled for introduction in Murmansk region veterinary sector.

1. Introduction
Salmon and trout aquaculture in Russia has been sustainable since the 30s of the 20th century, and it develops gradually [1]. The total water area in Barents Sea (Russian part), which is appropriate for marine cage fish farms is about 6 thousand hectares [2]. The total area of production on marine and freshwater sites in aquaculture in the Murmansk region was 1396 ha in 2018 [3], excluding hatcheries and artificial reservoirs.

The article presents the results of comparison between veterinary service activities in the Murmansk region and in countries of the Barents region [4]. The similar studies were held for the European Union countries. The main directions of activities were described in detail for aquaculture veterinary. Ubiquitous integration of veterinary maintenance was recommended for fish establishments, including concerned with decorative fish. [5]. Russian authors also carried out the same research [6]. There is a specific veterinary in industrial cold-water aquaculture in northern regions related to the climate features. Information about such specifics in literature review is missing.
The main aim: This research will support the main points of growth in biosafety system improvement in the veterinary practice of the Murmansk region.

2. Results

2.1. Aquaculture development in the Murmansk region, 2013-2019

Information on establishments and functioning aquaculture areas in Murmansk region is presented in Figure 1.

Figure 1. The number of aquaculture establishments and aquaculture areas/hatcheries/artificial reservoirs in 2013-2018.

Significant decrease of aquaculture areas in 2016 is related with stoppage in production of one of the large salmon-oriented establishments because of the financial difficulties and at the same time applied restrictions against viral disease outbreak. All aquaculture areas were stand for «fallowing» during a year. Rotation of marine cage farms affects fluctuations in the number of areas. After slaughtering fish aquaculture areas are left for a recovery period of «fallowing» up to 1 year without stocking.

In the Murmansk region low temperature conditions (as usual, not higher than 22°C), and maintaining a high level of oxygen in freshwater and marine areas, determine the two main fish species in aquaculture of the North-West: rainbow trout (Oncorhynchus mykiss (Walbaum, 1792)) and Atlantic salmon (Salmo salar (Linnaeus, 1758)). The Lena sturgeon and the Severodvinsk sterlet were also commercially introduced and approved for the Murmansk region in these years. Using warm discharge channel waters of the Kola Nuclear Power Plant provided success in this fish farming. It maintains a year-round temperature of water at least 6°C, even in winter. Species such as arctic charr, whitefish, pink salmon have been tested experimentally and are periodically used in production.

In the period 2013-2018 the number of different types of aquaculture increases in Murmansk region. Thus, the rainbow trout hatchery has started successfully; the number of sturgeon farms has increased to two. The number of marine and freshwater cage farms varies, but in general there is upward trend (Figure 2).
2.2. Veterinary-sanitary and antiepizootic measures of the veterinary service in the Murmansk region in the period 2013-2019

The responsibility for biosafety on fish farms in the Murmansk region belongs to the Department of physiology and diseases of fish, aquaculture objects of the Murmansk regional station for animal diseases control, subordinated to the Veterinary Committee of the Murmansk region.

All activities are fully regulated by the legal veterinary regulations (rules, instructions, guidelines, further in the text - VR). Unfortunately, many of them were produced and approved twenty or more years ago. Of course, this circumstance has negative impacts on the biosafety activities conduction, and makes the relationship between veterinary specialists and the management of establishments complicated. The paragraphs in the regulations are outdated and require immediate updating.

Among the recently reissued VRs are general laws and rules, for example, the «List of infectious and other animal diseases» [7]. There are the following dangerous diseases of fish (in relation to the salmonids in the Murmansk region): viral hemorrhagic septicemia (VHS), infectious haematopoietic necrosis (IHN), infectious pancreatic necrosis (IPN), infectious salmon anaemia (ISA), bacterial kidney disease (BKD), furunculosis (aeromonosis) of salmonids (ASS), myxobacteriosis (flavobacteriosis, bacterial cold-water disease) of salmonids, gyrodactylosis. [7]

In general, the measures of veterinary, sanitary and epizootic control in aquaculture are divided into three areas, which are reflected in the flowchart (Figure 3).
Figure 3. Flowchart for aquaculture biosafety in the Murmansk region.

The list of existing VR that implement the activities of the department is presented below, and biosafety measures are carried out in accordance with them [7-12].

Aquaculture establishments annually develop and approve «Plan of veterinary and sanitary measures» which regulates the quantity of ordinary epizootic observations. Usually there are 3-4 visits, in each quarter of the year, if area has year-round fish stocking. 100 specimens are clinically estimated in cages/pools visually (exterior and behavior). Pathoanatomical and parasitological research is held for 15-25 juveniles, fish in age 1+, for the older fish in amount 3-5 specimens.

Hydrological observations are carried out regularly, twice a year for freshwater areas, and once (in spring) for marine ones. Water standards exist in VR only for freshwater aquaculture. Contacting fish with molluscs, water birds, wild fish populations causes negative consequences for epizootic situation in the area. Consequently, it is strongly recommended to avoid such contacts, use molluscocids, loud noises to frighten birds, special acoustic devices against marine mammals.

The other annually approved document is «Plan of fish transportation». In case of live fish or sexual products import veterinarians obligatory apply quarantine for 30 days. During this period all necessary virological, bacteriological, parasitological observations are conducted. The quarantine is removed when negative results for diseases from the «List…» [7] are obtained. Inter- and intraregional transportations involve an epizootic irregular observation by veterinarian. Veterinarian writes a statement about the actual epizootic background, and the document is valid for transportation during 30 days.

The director of the aquaculture establishment is obliged to inform regional veterinarians about disease outbreaks, suspicious behavior or symptoms on fish, and about rising of fish mortality. After diagnosis veterinarian and fish farm representative form individual «Plan for treatment measures» together. Fish farmer accomplish all positions of this plan, including manipulation with medicines, then the observation is carried out again. Veterinarian should verify the absence of ill fish on the farm. Diseases from the «List…» [7] lead obligatory restriction measures, other disease – it depends on concrete instructions.
2.3. Finland aquaculture biological safety activities review

In Finland the fish diseases control is carried by Finnish Food Safety Authority (Evira). The rainbow trout is a main object of aquaculture production in Finland. The Animal Health Law (consistent with «European Union animal health requirements for aquaculture animals and products thereof, and on the prevention and control of certain diseases in aquatic animals Directive») and «Regulation on combatting animal diseases in fish, crustaceans and mollusces» dictates the activities if disease outbreak occurs. According to law the fish diseases are divided into 3 groups (table 1).

| Under control | Dangerous | Highly virulent |
|---------------|-----------|-----------------|
| • furunculosis (aeromonosis) of salmonids (ASS) | • THN | • viral hemorrhagic septicemia |
| • bacterial kidney disease (BKD) | • herpesvirus *Oncorhynchus masou* (OMV) | • infectious haematopoietic necrosis (IHN) |
| • gyroactylosis | | • infectious salmon anaemia (ISA) |
| • *Piscirickettsia salmonis* | | |
| • infectious pancreatic necrosis (IPN) | | |

The position of each disease is executed by International Epizootic Bureau – IEB (as department of The World Organization for Animal Health – OIE). Finnish Food Safety Authority controls and limits the fish transportation in Finland. The transportation of live fish, ova and sperm from spawning rivers connected to sea, marine and coastal areas is prohibited as the default. The permission could be only obtained for broodstock formation or some special purposes.

Generally Finland imports salmon from safe areas of Europe Union without fish diseases. The several required observations are made when fish is imported: viral hemorrhagic septicemia (VHS) and infectious haematopoietic necrosis (IHN). The export region should be safe for these diseases. Also bacterial kidney disease (BKD), infectious pancreatic necrosis (IPN) and *Gyrodactylus salaris* are tested.

Epizootic safety of fish farms is regulated by Europe Union specifications: fish observation is occurred at least once a year at water temperature lower than 14°C.

The medicine usage is regulated by Medicine Law. The veterinarian write explanation for fish prescribed medicine. The fish is not allowed to be sold from 2 to 3 weeks after medicine application. This period could be prolonged by veterinary service in case of residual amounts of medicine in presale laboratory observation results. The farmer should keep records of prescribed medicines (the fish group, the date of issue, medicine name, the time period before fish selling, medicine seller contacts). [13]

2.4. Norway aquaculture biological safety activities review

The veterinary supervision of aquaculture objects in Norway is carried by Norway Food Safety Authority (Mattilsynet). Universities and research institutes take a part in monitoring and analysis. The atlantic salmon is a main object of aquaculture production in Norway. Local laws dictate that all fish disease outbreaks should be immediately reported to veterinary specialist. The information about rising level of fish mortality should be reported too. Mattilsynet sends the specialist for investigation and sampling fish for laboratory research and fish health report forming. [14]

The fish diseases in Norway are divided into 3 groups. Table 2 contains information about the specific salmon diseases.

The veterinary activities, features of veterinary service work and informing about diseases depends on group of disease and differs. The fish transportation is limited for groups A and B. For group C restrictions are not used or could be applied in individual order. Informing other fish farms and
Norway regions is highly attended in regulatory documents and appeared as important part of national epizootic control.

Table 2. Groups of fish (salmonids) diseases in Norway.

| Group A                                   | Group B                                        | Group C                                  |
|------------------------------------------|-----------------------------------------------|-----------------------------------------|
| • viral hemorrhagic septicemia (VHS)     | • bacterial kidney disease (BKD)              | • cold-water vibriosis                   |
| • infectious haematopoietic necrosis (IHN)| • furunculosis (aeromonosis) of salmonids (ASS)| • septicemia Pseudomonas sp.             |
| • herpesvirus Oncorhynchus masou (OMV)   | • infectious pancreatic necrosis (IPN)         | • ulcerative dermal necrosis (UDN)      |
| • rhabdovirus of salmonids               | • infectious salmon anaemia (ISA)             | • yersiniosis                            |
|                                         |                                               | • hexamitosis                            |
|                                         |                                               | • salmon lice Lepeiothoeirus salmonis    |

Specific requirements exist for fish farms specialized on incubating and hatching fish, population restocking of wild fish species. The restocking fish farms are inspected twice a year: at the moment of sexual products taking and at the moment of juveniles releasing to rivers. The smolt production fish farms are inspected 4 times a year, broodstock—12 times a year. Disinfection of the roe is strongly required before transportation and in other biotechnical periods.

During staying on fish farms and hatcheries all visitors should follow disinfection procedure: hands, clothes, shoes and equipment should be disinfected.

It should be noticed that Norway veterinary rules are labile. In case of abnormal situations of fish diseases or fish mortality it potentially can adjust. Besides all agricultural animals including fishes are protected by «Animal Welfare Act» that declares the forbiddance of cruelty to animals, inhumane methods of slaughtering and manipulations on fishes without anaesthesia [15].

2.5. Comparative analysis of biosafety systems in Barents region countries

There is no separation in fish diseases in the Russian Federation, in contrast to European countries. For diseases which are not included in the «List…» [7], instructions on preventive measures and treatment, restrictions, diagnostics are outdated and require revision, while abroad in the case of a specific disease the veterinary specialist follows clear, modern instructions.

Vaccination of fish is not provided by the veterinary legislation in Russia at all. There is no commercial production of vaccines for fish in Russia, only several experimental researches. Foreign vaccines are not registered and cannot be used in the country. Vaccination in Finland is carried out for commercial fish, against furunculosis and vibriosis [13]. In Norway the variation of vaccines is wider. Multivalent vaccines are used. The use of vaccines has reduced the quantity of antibiotics in fish farming [15].

The frequency of control observations and laboratory researches by veterinarians in Russia is not inferior to foreign practice. All transportations are carefully monitored. Regardless of the epizootic situation, the regulatory framework allows to hold an additional research before issuing permits to transport fish or its sexual products. The requirements for disinfection of equipment and treatment of fish are also at a high level in Russia. They are strictly followed by business entities under the supervision of the veterinary service in Murmansk region.

3. Conclusion

General proposals as a result of comparative analysis are listed below:
- to stimulate the improvement and reissue of the new legal framework and the set of veterinary rules and instructions for fish diseases control;
- to establish the production of vaccines for aquaculture at the state level, or to simplify the registration procedure of modern foreign vaccines in Russian Federation;
- to consider the foundation of specialized aquaculture laboratories and diagnostic centers conducting virological and bacteriological research;
- to regulate the requirements for fish farms: to prevent fish leaving from the cage, to treat fish humanely during the production process, to inform the public about the disease outbreaks for epizootic situation control; it implies issuing of specialized rules for cage fish farms;
- to encourage scientific research about fish diseases for knowledge development in this area, which promote to growth of productivity in aquaculture both for the Barents Region and for other regions of the Russian Federation.

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