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Occupational safety in aquaculture – Part 1: Injuries in Norway

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ABSTRACT

This article presents an overview of reported injuries in the Norwegian aquaculture industry focusing on the production of Atlantic salmon and trout, which dominates the fish farming industry in Norway. Two different data sets form the basis for the analysis: (i) occupational injuries reported to the Norwegian Labor and Welfare Administration, and (ii) *serious* occupational injuries reported to the Norwegian Labor Inspection Authority. The data sets on occupational injuries and serious injuries provide information about mode of injury, type of injury, affected body parts, and time of year of the reported injuries. The results and the injury trends are analyzed and discussed in light of important characteristics and changes in the Norwegian fish farming industry, including underreporting. This information is useful in safety management and for allocating resources for risk-reducing measures.

1. Introduction

The aquaculture industry is well established in Norway, and further expansion is possible provided production and environmental challenges are met. In 2010, 1 million tons of fish was farmed in Norway, this number could be increased to 5 million tons by 2050 [1]. The industry is an important employer in Norwegian coastal districts and the workforce demand spans wider than the actual fish farms, as the industry also requires providers of equipment and services. This makes the aquaculture industry one of the most important socioeconomic factors for sustaining the rural communities in Norway [2].

The complete production line of farmed salmon and trout includes juvenile production, grow-out production and processing. Juvenile production, or land-based production, takes place on land, indoors or outdoors, where the fish, after hatching, are held in fresh water in smolt tubs with a diameter of 2–16 m and a height of up to 4 m (see Fig. 1). The workers access the largest tubs by ladders to elevated platforms, meters above the ground. Farming of juvenile salmon and trout requires fresh water and the facilities are often located where fresh water can be taken from lakes and rivers. The fish need to be moved to seawater when they are mature enough, usually after one year. This is mainly done by transferring the fish to well vessels, which sail the fish to the sea-based fish farms located in or outside the fjords. After about one and a half years, the fish are again transferred to well vessels, which deliver the fish for processing on shore.

The general mode of production for sea-based fish farming in Norway is net cages, either suspended from floaters, such as steel platforms, or from individual circular plastic collars with installed gangways (see Fig. 1). Net cages on steel platforms vary in size from 20 to 40 m in length and a depth of 20–35 m, whereas the circular plastic collar net cages are 90–157 m in circumference and 15–48 m deep. Steel platforms usually contain between four and 28 rectangular or square net cages per site where the cages are placed on a common platform. Sites with circular plastic collars usually have six to 12 net cages per site and are moored individually to an anchoring grid, and vessels have to be used to transport the fish from one net cage to another [3]. Circular plastic collars are installed with a greater distance between the production units and thus provide a better water quality and oxygen supply for the fish. There is a general shift from using steel platforms to circular plastic collar net cages because of their structural properties in harsh weather and the feasibility of maneuvering around the cage during operations.

Some basic operations can be performed manually from the platforms from which the net cages are suspended. These basic operations include daily inspection rounds to check the floaters, the nets and other equipment for damage. Most of the substantial operations, however, require stronger equipment and machinery, such as cranes and winches. These operations are performed from work vessels, which are moored to the net cages. This constitutes an unstable work platform since both net cages and vessels move with wind, waves and sea current. Operations carried out in this manner include net handling, removal of dead fish, fetching fish from the cage for lice counting and other operations related to maintenance such as tightening underwater moorings. Operators in the fish farming industry have expressed concerns for

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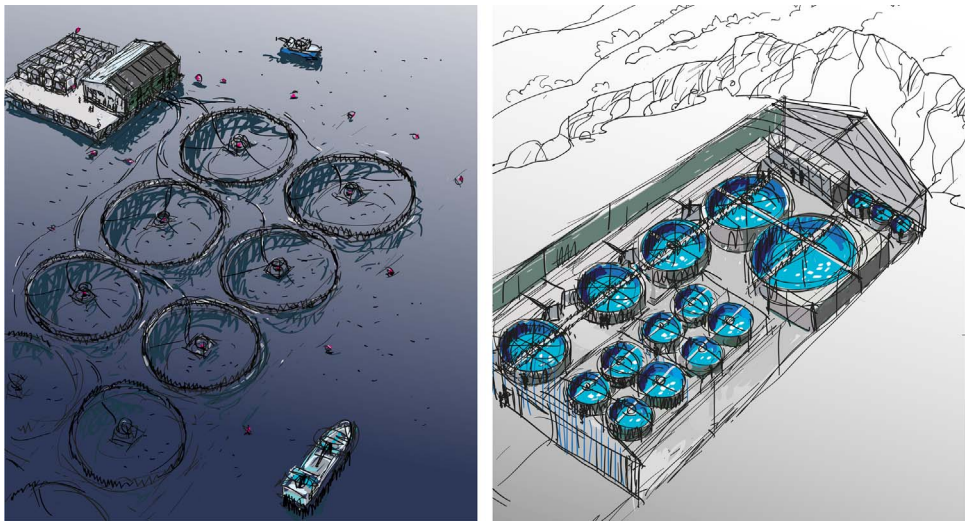

Fig. 1. Sketch of a sea-based production site (left) and a land-based production site (right).

lifting operations involving the use of cranes and winches with regards to personal safety [4]. These operations have also been identified as critical in terms of potential escape of salmon from the fish farms, due to resemblance in the contributing factors leading to both injuries and escapes [5].

Limited research efforts have been made towards improving occupational safety in the Norwegian aquaculture industry, and no in-depth analysis of injury statistics is available. Given the worldwide size of the workforce in aquaculture and its rapidly growing production [6], there is very sparse internationally published research on the occupational hazards that the workers face on a daily basis [7]. A large part of the research on occupational safety in aquaculture originates from medical research [7–9], and mostly comprises descriptive presentations of the hazards aquaculture operators' face [7,10–12]. Examples of hazards presented in the literature are provided by Myers and Durborow [6], where noise, cuts, sprains, asthma, chemical burns, hearing loss, slips and falls, infections and hypothermia are amongst the common challenges. In addition, the work operations in different types and modes of aquaculture production vary greatly; thus, the hazards vary accordingly. Myers [8] presents consequences related to different species produced, which also shows that even though some consequences are present in several production types, each type of production has its own set of characteristic hazards.

Historical data are important to understand the risk phenomena to be studied [13]. Knowledge about data regarding occupational incidents and fatalities in an industry is valuable input to risk analysis, which is a common method used in managing safety in organizations [6,14–16]. A statistical overview of, for example, types of injuries, injury mode, fatalities and operations conducted at the time of the occurrence of fatalities will support risk assessments. A common source of statistical data regarding occupational injuries is mandatory accident reporting. However, underreporting is a challenge in many official accident-reporting systems [17–19]. A study of the Norwegian official reporting system for occupational injuries from all industries was conducted in Oslo in 2001 [19]. The study showed a high level of underreporting in all professions. Underreporting might thus influence the results found using official reporting systems. However, the information found through statistical data is an important step towards understanding the characteristics of accidents that occur in a particular industry. General underreporting is thus not an argument for not investigating existing statistical data about injuries. Through employing the data in analysis, improvements of the current reporting system can also be suggested, e.g. by proposing information that should be added to reporting.

The overall objective of this article is to provide a quantified overview of occupational injuries in the aquaculture industry in Norway through analysis of the available information in the two different official registries of occupational injuries. More specifically, the article focuses on the following study objectives: (i) to investigate whether the number of injuries in Norwegian aquaculture shows an increasing or decreasing trend; (ii) to determine injury characteristics and rates of the injuries in the two registries, e.g. types of injuries, injury modes and body areas affected; and (iii) to assess whether there are distinctive injury characteristics to the land-based production mode of fish farming. The extent of underreporting related to occupational injuries is also discussed. The above information enables targeted risk reduction efforts in planning of operations, for risk assessments in the companies, and for mitigating hazardous events in both the private and public sector. The article is related to [18], which focuses on occupational fatalities in the Norwegian aquaculture industry.

The following parts of this article is structured as follows: Section 2 describes the data material used, Section 3 presents results, and Sections 4 and 5 include the discussions and conclusions.

2. Methodology and data

The data on occupational injuries from the aquaculture industry in this article are collected from two different sources: (i) the Norwegian Labor and Welfare Administration (NAV), and (ii) the Norwegian Labor Inspectorate Authority (LIA). The two data sets contain data from the official systems for reporting occupational injuries of which the LIA until recently has been the end receiver. There are two official reporting systems due to different regulations, which means that the data sets represent different types of reported injuries. Ideally, all reported injuries reported to LIA should also have been included in the data set from NAV. This is, however, not the case, and therefore we have to use both data sets in the analysis in the article. Also, the two data sets on occupational injuries are from two different time periods and are therefore presented separately. Only the periods presented were made available upon request to LIA, due to limitations in the reporting system.

In the data sets, each entry represents one person injured. If more than one person has been injured in relation to the same incident, there is one entry for each injured person.

2.1. Data reported to the Norwegian Labor and Welfare Administration (NAV)

The NAV system of reporting occupational injuries is founded on regulations stating that to get access to an additional national insurance