Welfare and survival of lumpfish in commercial salmon cages

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Introduction

Lumpfish are currently used as a part of the overall strategy for the prevention and control of sea lice in Atlantic salmon farming in Norway. Their use as biological delousers is advantageous as it exposes salmon to very little stress and injuries. Their use as cleaner fish in salmon farms along the Norwegian coast had increased from 10 million individuals in 2015 to almost 43 million in 2019, but was gradually reduced thereafter, down to 27 million in 2021. This decline was as a result of growing concern and criticism about their welfare and survival in commercial salmon cages.

Most of the available information is coming from surveys ordered and/or conducted by the Norwegian Food Safety Authority and the Norwegian Veterinary Institute which suggested that mortality of lumpfish in sea cages was 45% each year. However, there is very little systematic documentation on the welfare and survival of lumpfish in commercial salmon cages.

This study investigated lumpfish welfare and survival in four commercial salmon farms in Mid-Norway (sites A, B, C and D), from 2019 to 2021. Factors that may lead to reduced welfare and survival were monitored, including viral and bacterial infections, oxygen saturation, and sea temperatures, as well as production-related events such as mechanical delousing and net maintenance. In order to increase knowledge about lumpfish welfare and survival in commercial sea cages, two specific questions were formulated in this study: (1) How do the welfare and survival of

lumpfish evolve after transfer to sea cages? (2) To what extent is lumpfish welfare and survival related to production and environmental conditions?

Study details

All farms had lumpfish originating from Namdal Rensefisk AS, which were transferred to sea year-round from September 2019 to January 2021. The first lumpfish were stocked to site A and B in the beginning of August 2020 and to site C and D in August/September 2019.

A total of 2013 live lumpfish were sampled from the four farms. Sites A and C were monitored for one year from lumpfish transfer to sea. Site B was also followed from lumpfish transfer to sea, but due to logistical challenges sampling was only carried out for the first 6 months. Site D was monitored for one year, but from 2 months after transfer to sea because of logistical challenges.

An Operational Welfare Indicator (OWI) scoring was performed on each individual to assess welfare according to the procedure described in Boissonnot et al. (2022) and health status of live individuals was determined from samples for histology, PCR, and bacteriology that were taken from 15 lumpfish at each visit at sites A-D from April to December 2020. The overall welfare score was graded in four degrees of severity from completely flawless to seriously reduced, where the cut-off values were assigned based on our experience, in collaboration with fish health biologists and veterinarians. In addition, mortality data was recorded by the farm staff and the number of lumpfish stocked, dead, and culled was summed for each week. Further, fish health reports from the sites were used to obtain an overview of health and disease status.

Results

The results showed that most lumpfish in this study (60.7%) had slightly reduced welfare, while 18.3 % had good welfare, 18.8 % had clearly reduced welfare and 2.2 % seriously reduced welfare. In total 660,100 lumpfish were stocked to the cages, where 16.9 % of these were registered as dead during the production period. The time from when the first lumpfish were transferred to sea until the salmon farm stopped using lumpfish was 53 weeks on average.

The overall distribution of welfare status at each of the four sites varied very little, but site C had the highest proportion of lumpfish with good welfare. The total recorded mortality during the production period varied from 10.9% − 29.3% for the various sites (*Table 1, below*). Site A had the highest mortality while site D had the lowest mortality.

Site	Duration	Stocked	Mortality	Culled	Total loss
A	53 weeks	164678	29.3 %	3.2 %	96.8 %
B	53 weeks	112268	17.5 %	19.3 %	80.7 %
C	51 weeks	71840	13.8 %	40.4 %	59.6 %
D	55 weeks	311314	10.9 %	34.8 %	65.2 %

Table 1: Overview of the number of lumpfish each of the sites stocked, and the proportion of these that were recorded as dead. and culled. The total loss represents the proportion of stocked lumpfish that were not registered as culled.

Despite the relatively good welfare of the lumpfish that were examined, an increase in the overall welfare score was observed the longer the lumpfish remained in sea cages, indicating a reduction of welfare (*Figure 1*). Among the lumpfish assessed in the first month after transfer to sea, 64.4% had good or slightly reduced welfare, while 34.2% had clearly reduced welfare and 1.4% had seriously reduced welfare. After 7-8 months at sea, 76.7% had good or slightly reduced welfare, while 20.5% had clearly reduced welfare and 2.8% had seriously reduced welfare. And, after 11-12 months at sea, 34.5% had good or slightly reduced welfare while 59.7% had clearly reduced welfare and 5.9% had seriously reduced welfare.

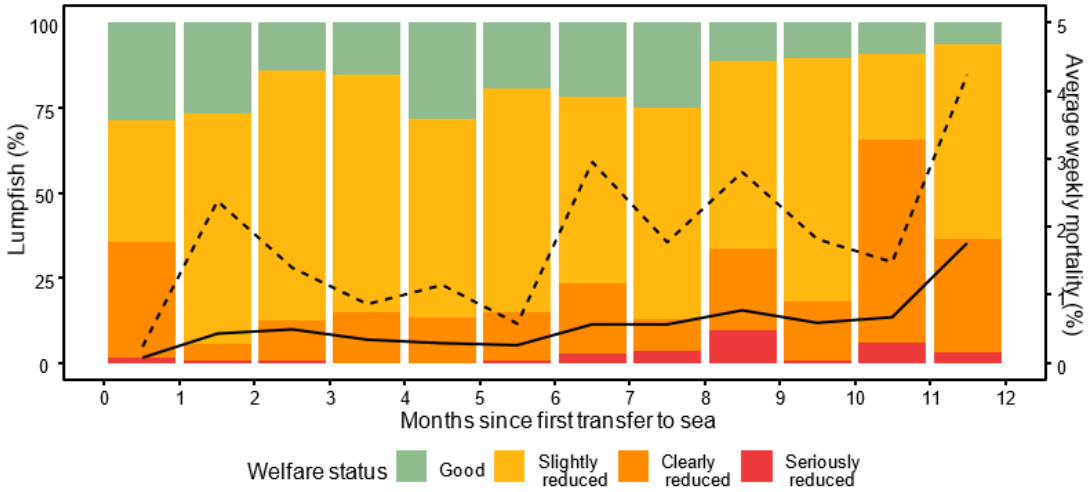

Figure 1: Development of lumpfish welfare and mortality at the studied sites grouped by the number of months since the first transfer to sea. The bars show the distribution of welfare status for each sampling month, while the average weekly mortality (%) is the black solid line and the dashed line is the standard deviation. Number of lumpfish assessed: 2,013.

Average weekly mortality was below 0.5% from transfer and up to six months in sea cages (0.08-0.5%). Thereafter, the average weekly mortality exceeded 0.5% and remained so throughout the production period (0.57-1.75%).

Average weekly mortality peaked at 1.75% at 11-12 months after transfer to sea. Among the 160 live lumpfish that were analysed for possible infections (157 live, 3 weakened), 86.9% were considered healthy (without disease) while disease was detected in 3.1% and suspected in 10%.

Typical and atypical furunculosis were the most diagnosed diseases (once at sites A and C and four times at D). Tenacibaculosis was diagnosed once at all sites. Site D was the one with most diagnosed diseases, both in terms of number of episodes and in variety of diseases (*Figure 2*). There was no apparent relation between diagnosed diseases and decrease of welfare and survival.

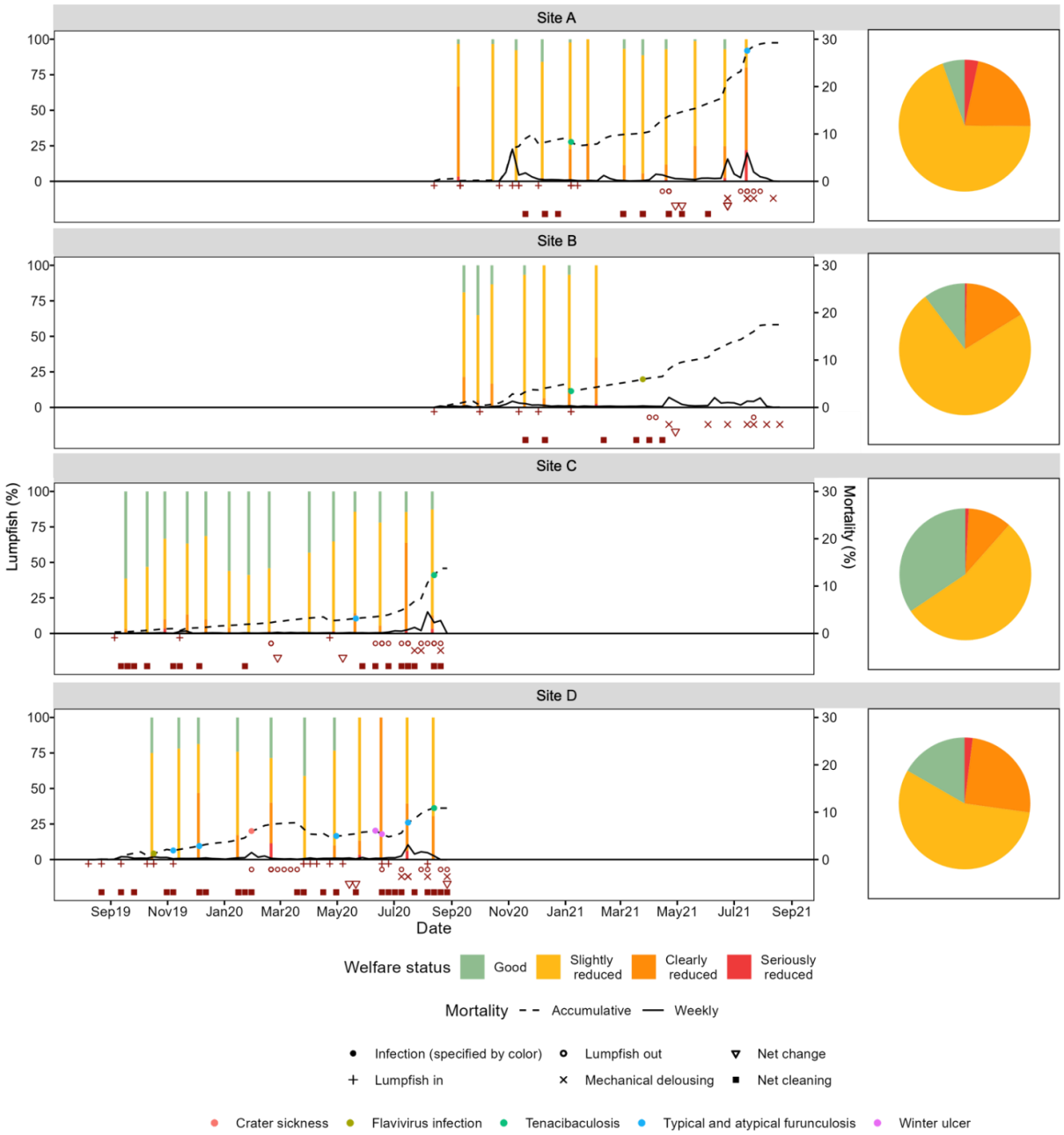

Figure 2: Timeline of the lumpfish welfare and mortality at the studied sites from August 2019 to September 2021. The bars visualise the distribution of welfare status at each of the

sampling dates, where the colours represent the lumpfish overall welfare status. The black dashed line is the registered accumulated mortality at each site and the solid line is the weekly reported mortality. Diagnosed diseases in dead lumpfish are marked as points on the line of accumulative mortality, while registered production events are marked below the x-axis. The overall distribution of the welfare status at the studied sites (all sampling dates gathered) is presented in the pie charts. Number of lumpfish assessed: 717 at site A, 223 at site B, 720 at site C and 353 at site D.

Fin damages and emaciation were the OWIs that most often were observed during the study period.

On average 42.5% lumpfish were observed with damage on caudal fin, while 26.9% lumpfish were observed with damage on other fins.

At most times, 36.4% lumpfish were slightly emaciated, whilst 1.4% were clearly and severely emaciated, respectively. The proportion of lumpfish with cataract varied highly, but without clear temporal trend. Most of the observed lumpfish with cataract within the first month in sea cage had bilateral cataract (72.7%), while 48.5% had bilateral cataract during the rest of the study period. The severity of skin damages also increased during the study period.

No clear relation was found between production conditions such as net maintenance and delousing and lumpfish welfare at the site level. The assessment of the various OWIs nevertheless showed an increase in the severity of skin, eye, and fin injuries after delousing. In addition, weekly mortality increased after the first mechanical delousing in all sites.

Discussion/Conclusions

In this study, most sampled lumpfish exhibited good or slightly reduced welfare. This was quite surprising, given the general concern regarding the poor welfare of lumpfish used in salmon production. Lumpfish exhibited nonetheless a decreasing welfare during their life in sea cages and present findings clearly indicate that mechanical delousing critically affected lumpfish welfare and survival. According to Norwegian aquaculture management regulations, it is required to remove cleaner fish before delousing. Unfortunately, current recapture and sorting methods are not good enough, as the salmon farm staff rarely manages to take out the entire population shortly before delousing, and recapture can itself lead to injuries and increased stress. The reduced welfare and survival that were observed after mechanical delousing indicated that there is an urgent need to develop recapture methods that allow removal of all lumpfish quickly and gently from a sea cage, without causing additional stress or injuries. As long as there are no better methods

for recapture, the use of lumpfish in salmon sea cages should be discontinued when the sea lice pressure increases in spring-summer and the probability of a need for delousing increases.

Mortality rate was low in the first few months after transfer to sea but increased thereafter. Mechanical delousing affected the welfare and survival most negatively of all monitored external parameters. Even though diseases are often pointed out as the main factor for mortality of lumpfish in sea cages, it was not the case in the present study. However, there were indications that diseases are more likely to occur when lumpfish are already weakened by other factors such as mechanical delousing. One to two thirds of lumpfish were assessed as underweighted or emaciated at all times during the monitoring period, suggesting that the nutritional requirements of lumpfish are not fully met in commercial sea cages.