The effect of light schedule on water quality

Case

In several systems we observed changes from having very stable water quality one day and the next it would become very cyclical. In co-operation with our customers we analysed the situation and saw, that this change in stability coincided perfectly with their changing from 24H to 12H lighting. We will show examples of this below.

Data

Figure 1 shows the CO_2 levels for a smolt farm over a 14-day period, on the 25/2 the farm changed from 12H lighting to 24H lighting. During this entire period the farm was feeding 24H with a small gradual increase. The feeding peaked every day around 17:00. During the first 7 days with 12H lighting the average CO_2 was 10,79 mg/L and the daily fluctuation was 2,16 mg/L. In the last 7 days with 24H lighting the average CO_2 was 9,3 and the daily fluctuation had dropped to only 0,53 mg/L. Despite a small increase in feed, we saw a lower and more stable CO2 concentration during the 24H period.

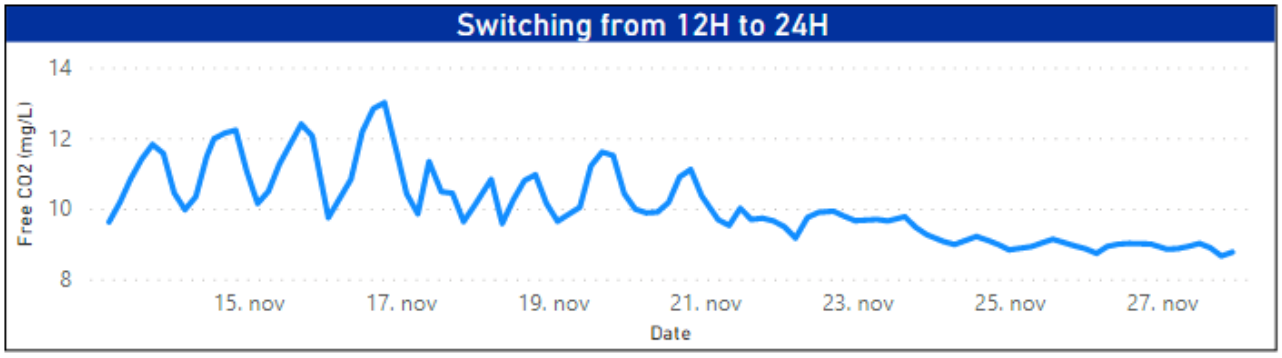

Figure 1 The figures shows CO_2(mg/L) over a two week period for a single tank in a smolt system. Up until the 25/2 the tank was on a 12H lighting schedule. After the 25/2 the tank was on a 24H lighting schedule. Feeding was the same throughout the period.

The pattern we see in figure 1 is something we could see in several farms around the world, it would always be clearest when looking at pH, turbidity and CO_2.

Figures 2 shows the daily fluctuation in 4 different water parameters during two different light schedules. The values in figure 2 and 3 are averages for more than a week of data for each photoperiod. CO_2, pH and turbidity are the water quality parameters which are most affected by a change in lighting. Of course, there will be some correlation between pH and CO_2 fluctuations. But as we see in figure 2, system 2 had the same pH fluctuations during both periods but a much higher CO_2 fluctuation during the 12H period.

We see that all four systems have a higher daily CO_2 fluctuation during the 12H cycle compared to the 24H. The four systems vary from 1 - 2,16 mg/L during the unstable 12H phase and is only between 0,25 – 0,61 mg/L during the more stable 24H phase. System 1 has a daily average fluctuation of 2,16 mg/L during the 12H phase. During this week fish are exposed to CO_2 levels ranging from 9,65 mg/L up to 12,89 mg/L during a single day. For the three other systems the fluctuation under the 12H period is not as high, but for both system 3 and 4, the fluctuation is 1 mg/L higher during the 12H phase. This is a clear indicator that the light setting can play a big influence on your water quality stability.

In previous papers we have discussed the importance of having a proper buffer capacity in your system, this small paper underlines that importance yet again. Figures 2 clearly shows this importance once again as

System 3 and 4 has considerably lower pH fluctuation when compared to System 1 and 2. System 3 and 4 have a bicarbonate level above 200 mg/L while bicarbonate in System 1 and 2 is less than 80 mg/L. Even though system 3 and 4 have a higher buffer capacity we still see a difference in stability under the different light schedules. Only in system 2 is there no effect on pH fluctuation according to lighting, but still we see a big difference in CO_2.

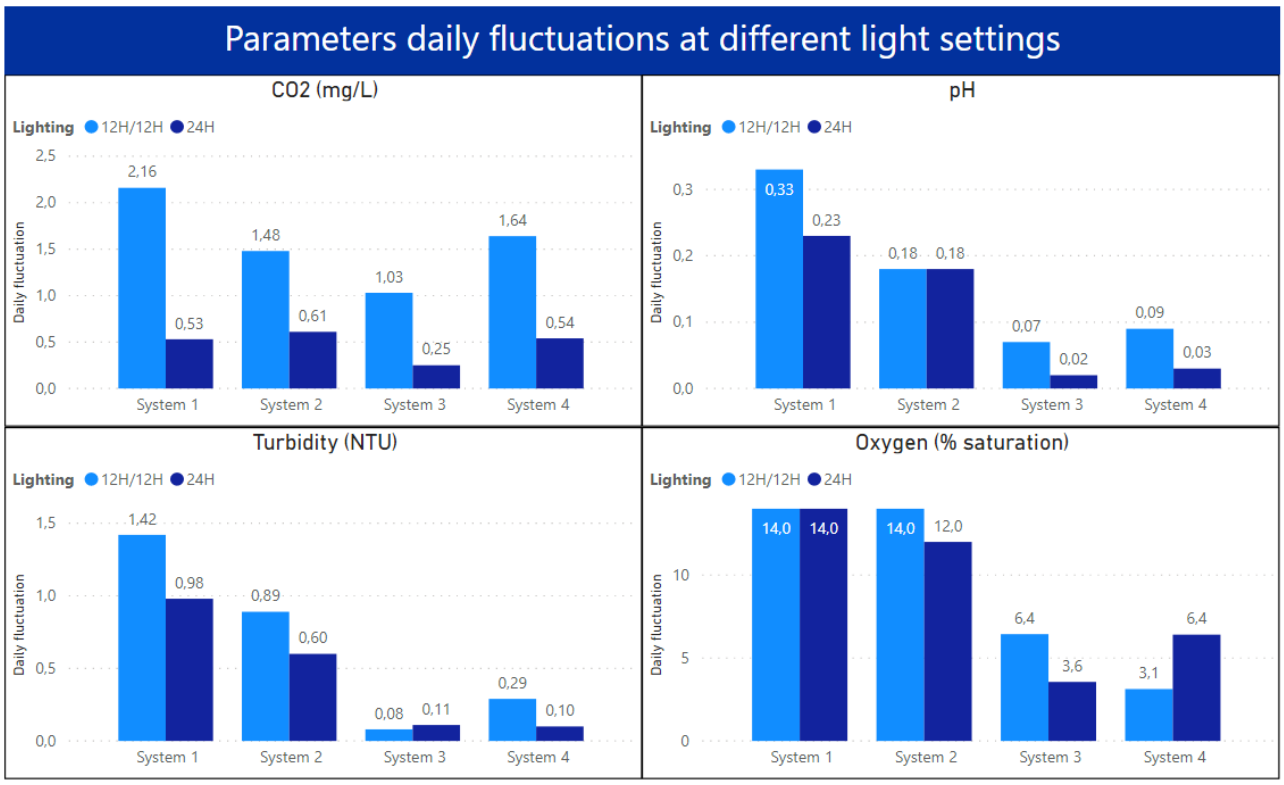

Figure 2 The daily fluctuation for pH, CO_2, turbidity and oxygen is shown for four systems.

All four systems had the same feeding schedule and almost the same feed amount during the two different periods. A reason for the change in turbidity fluctuations is therefore not from a change in feeding regiment. We have however seen, that during the dark period of the 12H schedule, the fish will move towards the bottom of the tank. In some tanks, the particulate matter will not leave the tank properly. When the fish then move towards the bottom during the dark phase, they will stir up the particulate matter and release it to the system. This causes it to be released into the water column every evening and it will move throughout the system and slowly be removed throughout the day (Figure 6).

Conclusion

A lot of factors are affecting the stability of a systems water quality, in this small paper we tried to show the importance lighting also played. On the four systems in this case there was a considerably higher daily fluctuation in pH, CO_2 and turbidity when they had 12H lighting. This could potentially influence the production rate of the fish since a fluctuating environment means the fish has to constantly adapt to new circumstances.

It is important to note that we also see systems which were much less affected by the change from 12H lighting to 24H. This underlines the importance of continues measurements of a systems water quality as no two systems acts in the same way.

Appendix

System	Bicarbonate (mg/L)	Free CO2 (mg/L)	Oxygen (% Saturation)	pH	Salinity (ppt)	Turbidity (NTU)
System 1						
12H/12H	77,79	10,79	101,00	7,12	0,18	3,56
24H	70,29	9,30	102,11	7,03	0,19	4,23
System 2						
12H/12H	66,01	6,27	101,00	7,12	0,24	3,52
24H	60,71	5,82	100,78	7,10	0,16	3,22
System 3						
12H/12H	189,95	6,25	88,44	7,65	9,10	0,28
24H	217,14	7,10	85,39	7,70	12,06	0,27
System 4						
12H/12H	240,16	7,81	84,10	7,53	1,32	0,70
24H	255,90	10,86	81,86	7,44	2,55	0,43

Figure 3 Average values of different water quality parameters during the two different light settings.

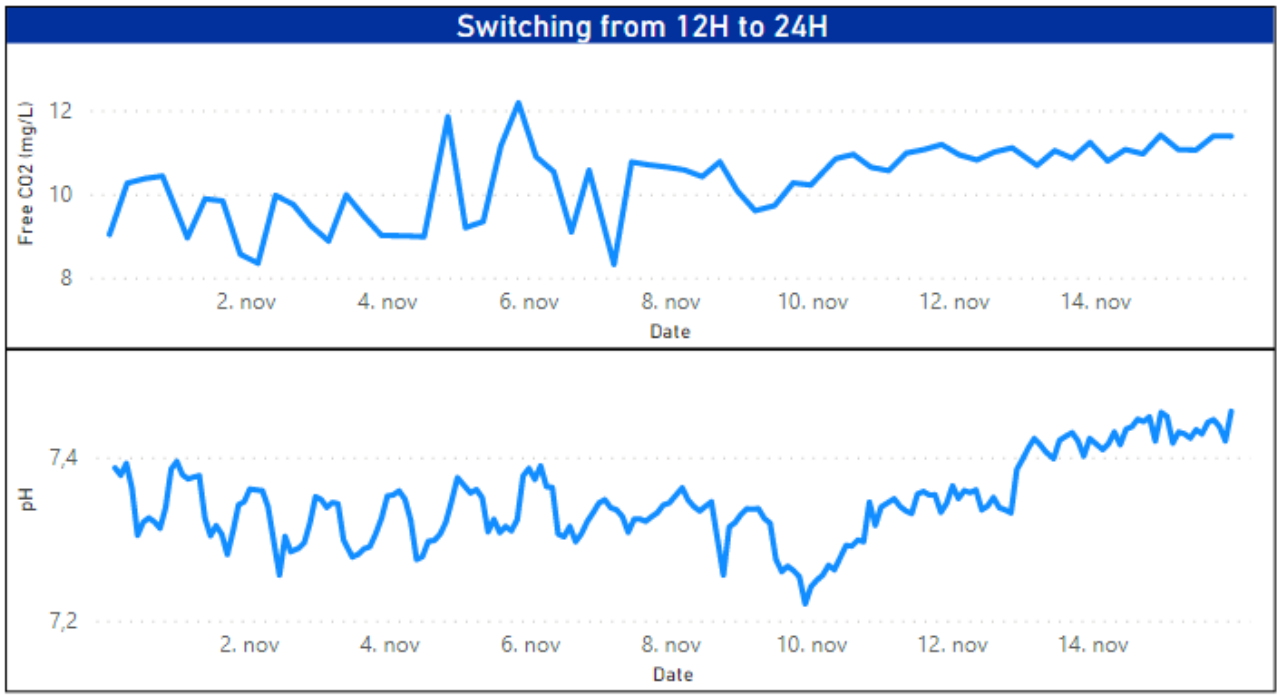

Figure 4 An example of CO_2(mg/L) and pH fluctuations on a system changing from 12H to 24H lighting.

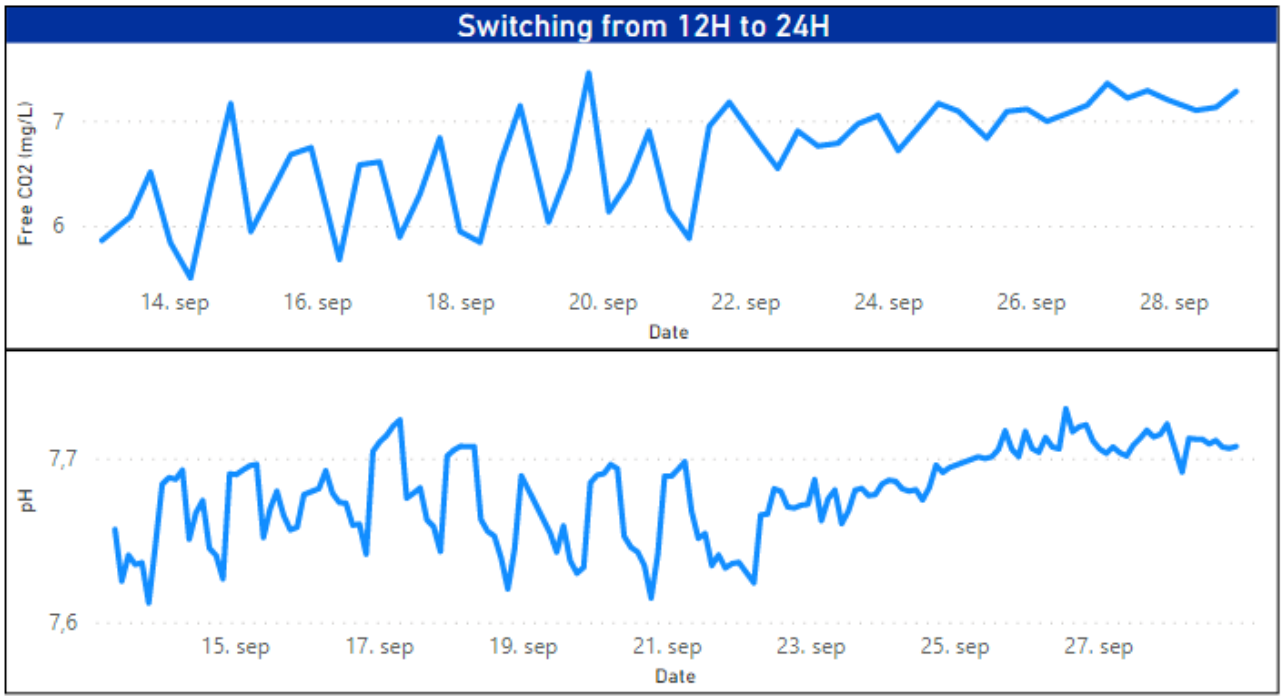

Figure 5 An example of CO_2(mg/L) and pH fluctuations on a system changing from 12H to 24H lighting.

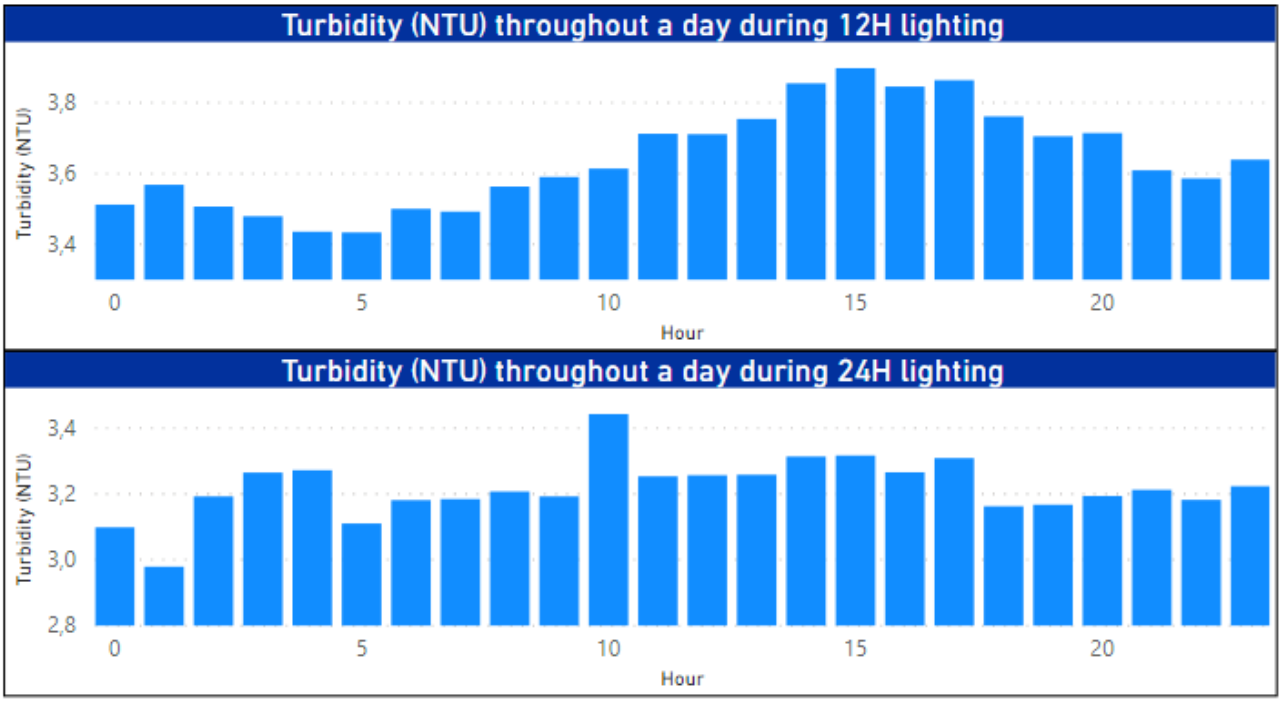

Figure 6 An example of how turbidity throughout a day looked at system 1. An aggregation of data for the two periods show how turbidity fluctuates through a day.