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Vegetation during Incubation Improves the Hatching Success of Yellow Perch Eyed Eggs

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Abstract: *Incubation of yellow perch Perca flavescens eggs from the eyed stage of development until hatch can be problematic, particularly in hatchery ponds devoid of vegetation. This study used a small scale experimental approach to evaluate the use of vegetation during perch eyed-egg incubation. Eyed eggs were incubated in 1.89-L plastic containers either with, or without, artificial vegetation. At a mean of 98.6%, survival to hatch of eyed perch eggs incubated with vegetation was significantly greater than the 46.2% survival of those eggs incubated without vegetation. Over each of the six incubation days needed for the eyed eggs to hatch, mortality was minimal in the vegetation treatment. However, dramatic increases in eyed egg mortality in the non vegetation treatment were observed beginning on the fourth day. The presence or absence of artificial vegetation had no effect on incubation water dissolved oxygen levels. The significant improvement of yellow perch eyed egg survival with the use of vegetation in this study suggests that vegetation should be present in hatchery ponds to maximize the hatching of yellow perch eyed eggs.*

Keywords: *Egg survival, vegetation, yellow perch, Perca flavescens*

1. Introduction

Yellow perch *Perca flavescens* are an economically important fish species in North America, with considerable recreational and aquaculture interest [1, 2]. They have a stranding reproductive strategy with eggs encased in gelatinous ribbons deposited on vegetation [3]. After water hardening, the egg strand can measure over two meters [4].The closely related Eurasian perch *P. fluviatilis* also prefers to deposit egg strands on submerged vegetation compared to bare bottom [5], with eggs on vegetation experiencing higher survival than those deposited on the lake bottom [6]. Higher survival of eggs deposited on vegetation may be due to increased ventilation and reduced siltation [7] or decreased micro-organism-induced mortality[6].

Ponds used for rearing fingerling yellow perch are typically stocked in one of two ways. Eyed eggs can be placed into a pond where the final stages of incubation and hatching occur [8] or the eggs can remain in the hatchery, force-hatched, and then moved to the ponds as newly hatched fry [9]. In either scenario, incubation after the eyed-egg stage is critical because of an increase in embryo metabolism and potential suffocation from the deteriorating ribbon overlaying on itself [9].Although eyed eggs have successfully been directly stocked into hatchery ponds without any structure (i.e. vegetation) to maintain ribbon integrity [8, 10], no studies have experimentally examined the importance of physical structure for the survival of yellow perch eyed eggs through hatch. This information is critical to the success of rearing yellow perch in hatchery ponds. Thus, the objective of this study was to determine the effect of vegetation on survival-to-hatch of yellow perch eyed eggs during hatchery incubation.

2. METHODS

Wild caught yellow perch from West Oakwood Lake, South Dakota USA were manually spawned and fertilized on April 15, 2015. Upon arrival at Blue Dog State Fish Hatchery, Waubay, South Dakota USA, 100 ml of newly-fertilized eggs were placed into a vertically-flow tray incubator (Mari Source, Fife, Washington USA) supplied with filtered 9.8°C well water (total hardness = 506 mg/L $CaCO_3$; pH = 7.5; total dissolved solids = 612 mg/L) at 20.4 L/minute. Eggs were treated with 834 mg/L formalin for 15 minutes daily until the eyed stage of egg development.

Approximately 1.6 g (wet weight) of eyed eggs was stocked into each of eight, 1.89-L buckets containing 1.0-L of filtered well water. Four buckets (n=4) contained artificial vegetation (Reel Weeds, LaDredge Outdoors, LLC, Mosinee, Wiscons inUSA) which held the entire egg sample, while the other four buckets were void of any structure and the eggs sat on the bucket bottom. Water temperature and dissolved oxygen were measured when eyed eggs were initially stocked and then every 24 hours. Incubation water was not exchanged during the experiment. In each bucket, the number of expired embryos (which turned a white color) were counted each day. The counting procedure began by transferring the strand of eggs into a petri dish filled with water from the originating incubation bucket. The petri dish had a black background which allowed the white, expired embryos to be counted quickly without any magnification. The water and strand of eggs were returned to the source bucket within 60 seconds after removal.

All of the eggs had either hatched or died by the sixth incubation day. At that time, all hatched fry and dead eggs were counted using a dissecting scope at 10X magnification. The following formulas were used:

Initial number of eyed eggs = number of hatched fry + number of dead eggs.

Survival to hatch = 100 – ((number of dead eggs/initial number of eyed eggs) * 100).

Survival to hatch was calculated cumulatively for each incubation day.

Due to a small sample size (n=4) and an increased risk of violating assumptions of normality and homogeneity of variance, a nonparametric Mann-Whitney U test was used to compare survival and dissolved oxygen levels between the treatments with significance predetermined at $P < 0.05$.

3. RESULTS

Perch fry began hatching on incubation day four in both treatments, and complete hatch occurred by the sixth incubation day. Eyed egg survival remained high through incubation day three for both treatments and was not significantly different (Test statistic = 2.0 to 8.0, df = 1, P = 0.081 to 1.000; Table 1). However, beginning with fry hatching on the fourth day until complete fry hatch on the sixth day, eyed egg survival through hatch was significantly higher for those placed on vegetation (Test statistic = 0.000 to 1.000, df = 1, P = 0.021 to 0.043).

Table1. *Mean (SE) survival (%) of yellow perch eyed eggs incubated with or without vegetation through hatch (day six). Within a day, means with a different letter indicate a significant difference (P< 0.05; n = 4)*

	Vegetation	
Incubation day	No	Yes
2	99.7 (0.1)	99.4 (0.2)
3	93.3 (5.0)	98.9 (0.4)
4	80.4 (14.0) z	98.6 (0.6) y
5	65.2 (6.5) z	98.6 (0.6) y
6	46.2 (23.7) z	98.6 (0.6) y

Initial water temperatures varied between 9.8 and 10.5 °C and then increased to 16.2 or 16.3 °C on the second day of incubation. Temperatures remained between 16.2 and 16.6 °C for the remainder of the study and only varied by 0.1 °C among buckets. Initial dissolved oxygen levels were between 8.7 and 9.1 mg/L in all replicates, decreased below 8.0 mg/L on the second incubation day, and decreased further to below 7.0 mg/L on the fourth day (Table 2). Dissolved oxygen did not decrease below 6.0 mg/L in any of the treatments throughout the study. Dissolved oxygen was significantly higher in the no vegetation treatment on the third day (Test statistic = 16.0, df = 1, P = 0.02), but no significant differences were detected on any other day (Test statistic = 3.0 to 14.0, df=1, P = 0.08 to 1.0).

Table2. *Mean (SE) dissolved oxygen (mg/L) in water incubating yellow percheyed eggs with or without vegetation until hatch (day six). Within a day, means with a different letter indicate a significant difference (P< 0.05; n = 4)*

	Vegetation	
Incubation day	No	Yes
2	7.75 (0.04)	7.58 (0.04)
3	7.58 (0.04) z	7.15 (0.04) y
4	6.90 (0.32)	6.95 (0.11)
5	6.48 (0.53)	6.95 (0.21)
6	6.28 (0.50)	6.98 (0.07)

4. Discussion

The results of this study are consistent with the positive effect of vegetation on yellow perch abundance in lakes reported by Ridenhour [11], Nelson and Walburg [12], and Hanchin et al. [13]. Smith et al. [6] also observed an increase in survival of perch eggs deposited on vegetation compared to those just placed on the bottom. Vegetation or other structure is likely beneficial for yellow perch eyed egg incubation because it prevents the egg strands from overlaying and potentially suffocating [9]. Placing the eyed eggs on vegetation also likely improves water quality surrounding the egg by reducing the risk of siltation [7]. In addition, by suspending the egg strands off the bottom, bacterial degradation of the external egg membrane is also likely reduced [6, 14, 15].

The hatching rates in the no-vegetation treatment observed in this study are similar to those reported previously. Jansen et al. [16] reported hatching rates of 37 to 55% for yellow perch eggs incubated in aquaria void of structure. West and Leonard [8] observed a minimum of 35% survival from perch eyed eggs incubated on floating screens in ponds. In contrast, in a smaller laboratory setting, hatching rates greater than 80%were consistently achieved with perch eggs incubated in trays[9]. However, incubation trays that receive continuous flowing water cannot be compared to incubation in standing water. When incubating eggs in lentic situations, placing eyed eggs on vegetation near the surface where wind and wave action can oxygenate and agitate the eggs is likely beneficial [9], but must be balanced with the possibility of ultraviolet radiation-induced mortality in water with low dissolved organic carbon [17].

Although water temperatures increased approximately 6.4 °Cover the first 24 hours of this study and then remained relatively constant between 16.2 and 16.6 °C, all of the temperatures were within the range reported for successful hatching of yellow perch eggs [18]. Each bucket also experienced the same temperature pattern, making it unlikely that temperature affected the results. Similarly, it is unlikely that dissolved oxygen concentrations had any effect. Although incubation water temperatures were statistically significantly different on the third day, this difference is likely not biologically significant. Dissolved oxygen levels on third day in both treatments were above 7 mg/L, which was well above the critical level of 3.5 suggested for yellow perch culture Hart et al. [9].

5. Conclusion

In conclusion, this study clearly indicates the benefits of incubating eyed yellow perch eggs on vegetation through hatch. This strongly suggests that vegetation should be present in hatchery ponds to maximize the hatching success of yellow perch eyed eggs. Additional research is needed to further refine yellow perch egg incubation techniques in still water and evaluate the use of vegetation in large scale production ponds.

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