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The Effect of Light Shock on Short-Term Survival of Walleye Fry

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Understanding the causes of mortality associated with stocking walleye (*Stizostedion vitreum*) fry is important for the evaluation and improvement of stocking techniques. Walleye fry (2–3 d old) were exposed to three light intensities (high, 2015.0–2042.0 μmol/m^2/s; intermediate, 142.0–186.8 μmol/m^2/s; control, 0.0–0.07 μmol/m^2/s) for two durations (15 min and 30 min) and mortality was assessed at 15 min, 60 min, and 120 min post-shock. Survival of walleyes from the high intensity, 30-min duration treatment also was examined at 720 min post-shock. Survival ranged from 99.8% to 100% and was not affected significantly by light intensity or exposure time (P = 0.22). Results of this study suggest that light shock is not an important mechanism influencing the short-term survival of walleye fry.

INTRODUCTION

Walleye (*Stizostedion vitreum*) angling has become increasingly popular throughout North America; however, many management agencies have determined that natural reproduction may be insufficient to maintain populations at desired levels (Ellison and Franzin, 1992). Thus, many agencies stock hatchery-reared walleyes to supplement or maintain walleye populations. The vast majority of walleyes stocked in North America are released as fry, rather than fingerlings, because of the low cost and high numbers of produced fish (Fenton, Mathias, and Moodie, 1996).

In Kansas, walleyes are gaining popularity and were ranked as the fourth most preferred sportfish by resident anglers (Burlingame, 1998). The Kansas Department of Wildlife and Parks (KDWP) annually produces approximately

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35 million walleye fry to enhance walleye fisheries. In order to transport walleye fry, fish are double bagged in square, plastic hatchery bags (100 μm thick) and placed into 0.45-m × 0.45-m × 0.25-m styrofoam coolers. Fry then are transported to the reservoir where the bags are removed from the coolers and allowed to temper in the reservoir. For the past four years, KDWP has marked walleyes chemically with oxytetracycline (OTC) to determine the contribution of stocked walleyes to the fishery. Preliminary results have suggested that one reservoir has experienced high success of fry stockings (J. Stephen, unpubl. data). The method of stocking fry differs in that reservoir from the method employed in other Kansas waters. Walleye are tempered in covered coolers (i.e., reservoir water is added to the cooler) instead of having the plastic hatchery bags float on the surface of the water in the reservoir. Thus, an important difference prior to stocking is the amount of time walleye fry are exposed to high light intensity. This is especially important because light is considered one of the strongest stimuli influencing behavior of walleyes (Ryder, 1977). We investigated the influence of light shock on walleye fry survival, and hypothesized that short-term survival of walleye fry would decrease with increasing light intensity and exposure time.

METHODS

Walleye fry (2–3 d old) were obtained from Milford Fish Hatchery (KDWP), Junction City, Kansas. Fry were removed from raceways by hatchery personnel, packaged in hatchery bags, and enclosed in styrofoam coolers following standard shipping procedures. Fry were transported approximately 30 min to an outdoor facility 19 km southwest of Manhattan, Kansas

Experiments were conducted in 470-ml cylindrical bioassay chambers (acrylic). Water temperatures were maintained (16.7–17.0°C) by placing chambers into 500-L circular tanks. Prior to the transfer of walleye fry from the hatchery bags to bioassay chambers, bags were allowed to temper in the dark for 30 min. In the dark (i.e., <0.10 μmol/m^2/s), 10 walleye fry were transferred to each chamber using a tablespoon to minimize handling stress. Fish were kept in the dark for an additional 45 min until the experiment began.

Two treatment factors, light intensity and exposure time, and one control were tested to evaluate main effects and interactions among factors (Table 1). Treatment levels were high (2015.0–2042.0 μmol/m^2/s) and intermediate (142.0–186.8 μmol/m^2/s) light intensity and 15 min and 30 min exposure times (10 replicates per treatment combination). Solar radiation was used as the light source because attempts to mimic high light intensities with artificial lights were unsuccessful. The intermediate and control light intensities were accomplished by shading with 200-μm black plastic. Temperature and dissolved oxygen were monitored with a YSI Model 85 meter and light

Table 1. Mean temperature (°C), dissolved oxygen (mg/L), light intensity (μmol/m²/s), and post-shock survival of walleye fry (2–3 d old) by treatment combination (light intensity × exposure time). Numbers in parenthesis represent one standard error.

				Time (min) post-shock			
Treatment	Temperature	Dissolved oxygen	Light intensity	15	60	120	720
High							
15 min	16.9 (1.4)	7.5 (0.07)	2022.7 (1.5)	99.9 (0.01)	100 (0)	99.9 (0.01)	
30 min	17.0 (1.5)	7.5 (0.07)	2021.0 (2.2)	99.9 (0.01)	100 (0)	99.9 (0.01)	100 (0)
Intermediate							
15 min	16.9 (1.4)	7.5 (0.07)	143.3 (1.4)	99.8 (0.01)	99.9 (0.01)	100 (0)	
30 min	16.9 (1.4)	7.5 (0.07)	147.9 (1.7)	100 (0)	100 (0)	100 (0)	
Control	16.7 (1.5)	7.5 (0.07)	0.03 (0.01)	100 (0)	99.9 (0.01)	100 (0)	

intensity was measured with a LI-COR quantum photometer. Mortality was assessed at 15 min, 60 min, and 120 min post-shock by randomly removing 10 chambers at each time period and visually inspecting the chambers for dead fry. We also examined five replicates from the high intensity, 30-min duration treatment at 720 min post-shock. Although the experiment was designed with a factorial treatment structure, we considered treatment combinations as individual treatments-eliminating statistical problems associated with missing cells resulting from the inclusion of a control (Milliken and Johnson, 1992). This allowed us to perform an analysis of variance (ANOVA) on the collapsed treatment structure (i.e., one-way treatment structure with each combination of factors representing a treatment). Statistical tests were conducted at $\alpha = 0.05$.

Results

Temperature and dissolved oxygen averaged ≤17.0°C and 7.5 mg/L, respectively, throughout the duration of the experiment (Table 1). Light intensity averaged >2000.0 $\mu mol/m^2/s$ in the high-intensity treatment, approximately 145.0 $\mu mol/m^2/s$ in the intermediate-intensity treatment, and 0.03 $\mu mol/m^2/s$ in the control. Mean survival of walleye fry ranged from 99.8 to 100% among all treatment combinations and was not affected significantly by light intensity and exposure time ($F = 1.29$; $df = 15, 135$; $P = 0.22$). Live fish recovered at the conclusion of the experiment did not appear stressed from the various light treatments. No differences in behavior of walleye fry were observed among experimental treatments.

Discussion

It is well known that light intensity can influence the early life history of fishes. Smith (1916) reported that larval chinook salmon (*Oncorhynchus tshawytscha*) and pink salmon (*O. gorbuscha*) reared under lighted conditions were more active, weighed less, and experienced higher mortality than those reared in the dark. Bell and Hoar (1950) determined that larval sockeye salmon (*O. nerka*) experienced slow growth and high mortality when exposed to ultraviolet radiation. Similar results have been reported for other larval salmonids (Lindsey, 1958; Dey and Damkaer, 1990).

In contrast to coldwater species, few studies have been conduced to evaluate the effects of light on warmwater and coolwater fishes. Humphries and Cumming (1973) suggested that light shock may be an important factor related to the survival of hatchery-reared striped bass (*Morone saxatilis*) fry. McHugh (1978) investigated the effects of light shock on striped bass survival and found that survival was high, but their behavior changed considerably (i.e., increased activity). Most studies involving the influence of light on walleyes have focused on intensive rearing techniques and have not specifically addressed the influence of light shock on fry survival (e.g., Siegwarth and Summerfelt, 1992).

Although the effects of light shock have not been investigated previously for walleye fry, numerous studies on short-term, pre- and post-stocking survival have been conducted to determine the causal mechanisms influencing mortality of hatchery-reared walleye fry. Pitman and Gutreuter (1993) determined that larval walleyes experienced high mortality (66–100%) when hauled for longer than 3.5 h. Similarly, Colesante (1980) noted that mortality of walleye fry exceeded 20% during transport and suggested that mortality was the result of fry becoming entrapped in the corners of hatchery bags. Conversely, Peterson (1997) reported <10% mortality when walleye fry were hauled for 4 h. Peterson (1997) also determined that the stress of chemically marking fry with OTC and high transport density, coupled with long hauling time, did not significantly decrease survival. It also has been suggested that pH may influence survival of walleye fry; however, Bergerhouse (1992) noted no mortality of 3-d old fry at pH < 10 (characteristic of most Kansas waters). Results of the current study and previous research indicate that the stresses of chemical marking, transporting at high densities, and light shock do not adversely affect the short-term survival of walleye fry-given adequate water quality and short hauling times.

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