Fisheries Research 172 (2015) 1–6

Contents lists available at ScienceDirect

Fisheries Research

journal homepage: www.elsevier.com/locate/fishres

Short communication

Does lure colour influence catch per unit effort, fish capture size and hooking injury in angled largemouth bass?

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ARTICLE INFO

Article history:
Received 15 April 2015
Received in revised form 28 May 2015
Accepted 16 June 2015
Handling Editor George A. Rose

Keywords:
Gear selectivity
Catch-and-release
Recreational fishing
Colour
Angling

ABSTRACT

The contemporary tackle box for recreational angling is packed with lures that cover the full spectrum of colours with the assumption that colour influences fishing success. Yet, there is little research that identifies how lure colour might influence capture rates or size-selectivity. Moreover, while much is known about the factors that influence hooking injury or hooking depth (which is a good predictor of mortality in released fish), to our knowledge no studies have examined if such factors are influenced by lure colour in fishes. Here we tested the effects of lure colour on catch-per-unit-effort (CPUE), size-selectivity and hooking injury of largemouth bass, *Micropterus salmoides*, using artificial 12.7 cm unscented soft-plastic worms. Lures comprising six colours in three colour categories (i.e., dark – bream 'blue', leech 'black'; natural – cigar 'red', wasp; bright – pearl 'white', sherbert 'orange'), which were individually fished for 20-min intervals multiple times per day. Data analysis revealed that CPUE was similar across individual colours and categories. However, bright colours appeared to selectively capture larger fish than either dark or natural lure colours. Lure colour did not influence length-corrected hooking depth or anatomical hooking location. Our study reveals that while different lure colours might capture the imagination and wallet of the angler, they do not influence CPUE or hooking injury in bass but appear to have a small influence on the size of captured fish.

1. Introduction

Recreational fisheries science has made great strides in understanding how various factors influence the catchability of fish (Anderson and LeRoy Heman, 1969; Ward et al., 2013), the size-selectivity of angling (Arlinghaus et al., 2008), and the factors that influence hooking injury and mortality in angled fish (Bartholomew and Bohnsack, 2005; Cooke and Schramm, 2007). Interestingly, to our knowledge there has been little effort to understand how lure colour influences these factors, which is the focus of this study. The contemporary tackle box for recreational angling is packed with lures that cover the full spectrum of colours with the assumption that colour influences fishing success but this, to a large extent, remains a formally untested hypothesis. Largemouth bass are a popular and intensively managed recreational species targeted by anglers in freshwater lakes and ponds and are frequently targeted by anglers using a diversity of lure colours (Quinn and Paukert, 2009). As such, they serve as an ideal model to explore issues related to lure colour and catchability, size selectivity, and hooking mortality.

Largemouth bass are sight feeders with their vision playing a major role in food consumption (Howick and O'Brien, 1983) and presumably how they interact with fishing lures. Indeed, catch rates of largemouth bass were negatively correlated with turbidity of the water reflecting the impact of vision on feeding behaviour (Kuwamura and Kishimoto, 2002). Experiments involving different coloured pipettes suggest that largemouth bass view colour in a manner similar to a human wearing yellow-tinted glasses. Bass are able to distinguish red, green, yellow, and blue individually but have difficulty distinguishing blue from green (Brown, 1937). An experiment using different coloured lures to examine hooking rates in mackerel, *Pneumatophorus tapeinocephalus*, commercial long line fishing indicated the hooking rates varied by colour, but not significantly (Hsieh et al., 2001). Little research on this topic exists for a recreational fishery. Different fishing gear can also be size-selective (e.g., Jørgensen et al., 2009), although this is often examined in the context of commercial fishing gear and relates to mesh size in nets (e.g., Heino and Godø, 2002). Size-selectivity can also occur in

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http://dx.doi.org/10.1016/j.fishres.2015.06.010
0165-7836/

recreational fisheries but has typically been examined in the context of lure size (Wilde et al., 2003; Arlinghaus et al., 2008), with little work on lure colour. In one of the few studies of lure colour size-selectivity, Wilde et al. (2003) examined catch rates of largemouth bass using actively fished lures (i.e., stick-bait crankbaits) in four colours and had findings that were equivocal.

In the context of catch-and-release angling, whether done voluntarily or to comply with regulations, some component of the catch does not survive the capture, handling, and release process (Wydoski, 1977; Cooke and Schramm, 2007). Catch-and-release mortality can be acute, generally associated with injury or stress, or come in the form of delayed mortality, which often includes a disease component (Arlinghaus et al., 2007). Of all the potential factors that influence hooking mortality, location of hooking injury is the best determinant of mortality (Bartholomew and Bohnsack, 2005; Muoneke and Childress, 1994), including for largemouth bass (Wilde and Pope, 2008). Shallow hooking locations such as the jaw region tend to have comparatively lower levels of mortality than deeper locations such as the gill or gullet. Generally, the deeper the hook is ingested, the greater the amount of bleeding and the higher the chance of mortality for the released fish (Arlinghaus et al., 2007). Many factors influence deep hooking such as hook type (Cooke and Suski, 2004), type of bait/lure (Bartholomew and Bohnsack, 2005) and size of bait (Wilde et al., 2003; Arlinghaus et al., 2008), but little is known about how lure colour influences deep hooking.

The quality of black bass fisheries are influenced by many factors including the level of fishing pressure and the effectiveness of catch and release programmes, which can either support or undermine the quality of the fisheries as indicated by larger fish size or better catch rates (Cooke and Schramm, 2007). To develop a successful catch and release management strategy it is important to determine how different types of angling gear influence injury and bleeding of fish given that it is a variable anglers can directly control (Cooke and Suski, 2005). We are unaware of any studies that have examined how lure colour, when lure type is standardized and lures are fished rather passively such that fish have time to inspect the lure, influences aspects of catchability, size-selectivity and hooking injury. The purpose of this study was to determine if colour of artificial lures influences such factors in largemouth bass.

2. Methods

2.1. Study site

The study was carried out at Queens University Biological Station on Lake Opinicon in Leeds and Grenville United Counties, Ontario. Lake Opinicon is a shallow mesotrophic lake with significant littoral habitat characterized by abundant macrophytes (Keast and Fox, 1992). The fish community is centrarchid-dominated with reasonable populations of largemouth bass that are targeted by resident and visiting anglers. The experiment was conducted from July 28 until August 13, 2014 when water temperature was stable at 26 °C (Fig. 1).

2.2. Sampling procedure

Largemouth bass were caught using artificial 12.7 cm unscented soft-plastic worms in six colours representing three colour categories (i.e., dark – leech 'black', bream 'blue'; natural – cigar 'red', wasp; bright – sherbert 'orange', pearl 'white'); a medium-action spinning rod and reel with braided line (6 kg breaking strength), and size 1 octopus hooks. The soft-plastic lures were fished quite passively where they were cast out and left to slowly sink at which time the angler would pick up the slack line and then slowly bring the lure back to the boat. Nearly all fish took the lure on the fall rather than the retrieve. The anglers ($N = 8$) were considered to be intermediate in experience. Each lure colour was fished for 20-min intervals. Fishing all six colours for a 20-min interval by an individual angler was referred to as a cycle and an entire cycle was completed before a previously fished lure colour was fished again. After a cycle was completed each participating angler started the new cycle with a different lure colour than they had used in the previous cycle. We did not record "angler" or use it as a factor in the analysis because it was randomized and each angler completed entire cycles. Each largemouth bass caught was processed as follows. First, the lure colour and size of the fish (total length in mm) were recorded. Next, hooking depth was measured from the tip of the nose to the location of hook insertion (as per Cooke et al., 2001; mm) and anatomical hooking location was recorded. Hooking locations were standardized by classifying them as shallow or deep; shallow hooking was considered to include upper jaw, lower jaw, and corner, and deep hooking was considered to include; roof, gullet, and tongue. Next we qualitatively assessed bleeding at the hook wound site as being present or absent, if bleeding was present it was classified as (A) 'some bleeding' or (B)'lots of bleeding'. At time of release we assessed whether the fish was able to maintain equilibrium as an indicator of fish condition (Davis, 2010) and as a predictor of post-release mortality (Raby et al., 2012). We also noted any immediate hooking mortality and if the fishing line needed to be cut to release the fish given that the hook placement was too deep to safely remove with pliers.

Fig. 1. The six artificial lure worm colours (black, blue, red, wasp, orange, and white) with the accompanying octopus hook used to angle largemouth bass in Lake Opinicon. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

Largemouth bass were caught from all around Lake Opinicon with a particular focus on littoral areas, with occasional fishing taking place in the deeper pelagic waters near the middle of the lake. Fishing took place each day (rain or shine) and only ceased in the presence of lightning/thunder, with fishing being resumed when the lightning/thunder ceased. Fishing occurred from approximately dawn to dusk each day.

2.3. Data analysis

For all analyses we examined both individual colours (i.e., six) as well as three groups where we categorized lure colour as dark, natural or bright given similarities among several lure colours. Catch per