Fisheries Research 183 (2016) 128–137

Contents lists available at ScienceDirect

Fisheries Research

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

Influence of anglers' specializations on catch, harvest, and bycatch of targeted taxa

Kevin L. Pope [a,*], Christopher J. Chizinski [b], Christopher L. Wiley [b,1], Dustin R. Martin [b,2]

[a] *U.S. Geological Survey—Nebraska Cooperative Fish and Wildlife Research Unit, and School of Natural Resources, University of Nebraska, Lincoln, NE 68583, USA*
[b] *Nebraska Cooperative Fish and Wildlife Research Unit, and School of Natural Resources, University of Nebraska, Lincoln, NE 68583, USA*

ARTICLE INFO

Article history:
Received 22 December 2015
Received in revised form 8 April 2016
Accepted 25 May 2016
Handled by George A. Rose
Available online 9 June 2016

Keywords:
Catch rate
Harvest rate
Recreational fishing
Species sought

ABSTRACT

Fishery managers often use catch per unit effort (CPUE) of a given taxon derived from a group of anglers, those that sought said taxon, to evaluate fishery objectives because managers assume CPUE for this group of anglers is most sensitive to changes in fish taxon density. Further, likelihood of harvest may differ for sought and non-sought taxa if taxon sought is a defining characteristic of anglers' attitude toward harvest. We predicted that taxon-specific catch across parties and reservoirs would be influenced by targeted taxon after controlling for number of anglers in a party and time spent fishing (combine to quantify fishing effort of party); we also predicted similar trends for taxon-specific harvest. We used creel-survey data collected from anglers that varied in taxon targeted, from generalists (targeting "anything" [no primary target taxa, but rather targeting all fishes]) to target specialists (e.g., anglers targeting largemouth bass *Micropterus salmoides*) in 19 Nebraska reservoirs during 2009–2011 to test our predictions. Taxon-specific catch and harvest were, in general, positively related to fishing effort. More importantly, we observed differences of catch and harvest among anglers grouped by taxon targeted for each of the eight taxa assessed. Anglers targeting a specific taxon had the greatest catch for that taxon and anglers targeting anything typically had the second highest catch for that taxon. In addition, anglers tended to catch more of closely related taxa and of taxa commonly targeted with similar fishing techniques. We encourage managers to consider taxon-specific objectives of target and non-target catch and harvest.

1. Introduction

There are suites of anglers targeting various groups of taxa (herein taxa targeting groups) during any given time at a waterbody. Further, there is a suite of anglers for which seeking a specific taxon is not a motivation to fish (Chizinski et al., 2014b), and this segment can compose a large percentage of total angling effort (Chizinski et al., 2014a, 2014b). Awareness that the influence of recreational fishing extends beyond the simple, angler-taxa targeted relationship is increasing (Beardmore et al., 2015; Cooke and Cowx, 2004, 2006; Lewin et al., 2006). The influence of fishing on targeted taxa is well known, which includes decreases in abundances of targeted taxa, changes in age and size structures of targeted taxa, and changes in fish community composition (Blaber et al., 2000). Anglers tend to prefer certain taxa because of their value for food and angling challenge (Lewin et al., 2006).

Fishery managers often group anglers based on taxon targeted (Malvestuto, 1996; Newcomb, 1992) to evaluate size selectivity in catch (Miranda and Dorr, 2000), to determine the effectiveness of standardized sampling to predict angler catch (Isbell and Rawson, 1989), and to monitor shifts in angler behavior following establishment of an invasive taxon (Coelle et al., 1987) or implementations of new regulations (Hale et al., 1999; Johnston et al., 2011; Stone and Lott, 2002). Fishery managers often limit data used to evaluate catch-rate objectives for a sportfish to a subset that only includes catch by anglers that targeted the taxon (e.g., Miranda, 2005; Stephens and MacCall, 2004) likely because managers assume catch rates are most sensitive to changes in taxon density for this group of anglers. However, this assumption has not been tested, and though catch rates are often positively correlated with fish density (Buynak and Mitchell, 1993; Engstrom-Heg, 1986; Newby et al., 2000; Olson, 1958), there are several well-illustrated

* Corresponding author.
E-mail address: kpope2@unl.edu (K.L. Pope).
[1] Current address: Florida Fish and Wildlife Conservation Commission Southwest Regional Office, 3900 Drane Field Road, Lakeland, FL 33811, USA.
[2] Current address: Virginia Department of Game and Inland Fisheries, 4010 West Broad Street, Richmond, VA 23230, USA.

http://dx.doi.org/10.1016/j.fishres.2016.05.025
0165-7836/Published by Elsevier B.V.

Table 1
Physical characteristics of reservoirs and years anglers were interviewed.

Reservoir	Latitude (N)	Longitude (W)	Surface area (ha)	Years surveyed
Bluestem Lake	40.633831°	−96.796253°	132	2010
Branched Oak Lake	40.972539°	−96.863604°	728	2009–2010
Conestoga Lake	40.766403°	−96.850289°	93	2009
Cottontail Lake	40.647234°	−96.765408°	12	2010
Enders Reservoir	40.437152°	−101.538343°	500	2010–2011
Harlan County Reservoir	40.057313°	−99.272493°	5544	2009–2011
Holmes Lake	40.781431°	−96.633498°	40	2009
Lewis and Clark Lake	42.852479°	−97.603113°	12,550	2009–2011
Medicine Creek Reservoir	40.399800°	−100.231497°	642	2010–2011
Merganser Lake	40.602544°	−96.854616°	17	2010
Merritt Reservoir	42.627675°	−100.871769°	1093	2009–2011
Pawnee Lake	40.842609°	−96.869964°	300	2009–2010
Red Cedar Lake	41.163304°	−96.875188°	20	2009
Red Willow Reservoir	40.358777°	−100.671773°	240	2010–2011
Sherman Reservoir	41.302863°	−98.885985°	1174	2009–2011
Stagecoach Lake	40.603445°	−96.637604°	79	2009–2010
Swanson Reservoir	40.161328°	−101.068364°	1657	2010–2011
Timber Point Lake	41.196186°	−96.977591°	11	2009
Wildwood Lake	41.034361°	−96.838234°	42	2010–2011

examples in which catch rates are not linearly related with fish density (Gaertner and Dreyfus-Leon, 2004; Harley et al., 2001; Tsuboi and Endou, 2008; VanDeValk et al., 2005; Ward et al., 2013a).

A variety of aspects influence the decision on which taxa to target. The most influential, within the context of the fishing trip (Beardmore et al., 2011), is perhaps anglers' motives. For example, anglers may target a particular taxon to satisfy different catch-related attributes, such as targeting harvestable-sized channel catfish *Ictalurus punctatus* to eat on one trip and targeting trophy-sized muskellunge *Esox masquinongy* to test their fishing skill on the next trip. Further, catchability of fish likely differ among habitat types; the use of littoral zones by bluegill *Lepomis macrochirus* and largemouth bass *Micropterus salmoides* often shifts with size (Wanjala et al., 1986; Werner and Hall, 1988). Therefore, anglers may alter approaches used to target different taxa to accomplish specific goals during a fishing trip. For example, if catch of bluegill is greater in the littoral zone, then anglers may choose to target bluegill from the bank. Taxon preferences of anglers are linked to harvest preferences (Reitz and Travnichek, 2006; Wilde and Ditton, 1991), but it is unknown whether the likelihood of harvest on a given trip is related to taxon targeted during that trip. Differences in likelihood of harvest between targeted and non-targeted taxa are expected if taxon targeted on a given day is a defining characteristic of anglers' attitude toward harvest. For example, an angler targeting walleye (a harvest-orientated species) on a given trip may be more willing to harvest other incidentally caught taxa (e.g., largemouth bass and white bass *Morone chrysops*) during a trip. In contrast, an angler targeting largemouth bass (a catch-and-release-orientated species) may be unwilling to harvest other incidentally caught taxa (e.g., walleye *Sander vitreus* and white bass) during a trip.

The purpose of this study was to quantify taxon-specific catch and harvest for anglers targeting various fish taxon. We examined catch and harvest of eight fish groups (six species, one hybrid, and two species combined; hereafter taxon) for anglers targeting "anything" (no primary target taxon, but rather targeting all fishes), bluegill, channel catfish, common carp *Cyprinus carpio*, crappie (black crappie *Pomoxis nigromaculatus* and white crappie *P. annularis* combined), hybrid striped bass *Morone chrysops* × *M. saxatilis*, largemouth bass, walleye, and white bass in 19 Nebraska reservoirs during 2009–2011. Specifically, we predicted that taxon-specific catch across reservoirs (random categorical variable) would be influenced by targeted taxon (categorical variable of interest) after controlling for number of anglers in a party and time spent fishing (these combine to form effort); we also predicted similar trends for taxon-specific harvest.

2. Materials and methods

2.1. Angler interviews

We interviewed anglers in person during 2009–2011 at 19 reservoirs throughout Nebraska (Table 1). We use a stratified multistage probability sampling regime (Malvestuto 1996) to determine days of interviews. We completed surveys on 10, 12, 20, or 24 days per month at each reservoir depending on logistics and surface area. As time and duration of creel shifts varied among reservoirs, we only included interviews completed between sunrise and sunset and between 01 April and 31 October in the analyses. Only data from complete-trip interviews were included in this assessment. One angler, the representative, completed the survey for all members of the party (i.e., a group of individuals travelling together for the purpose of fishing); thus, data were collected at the party level. During the interview, creel clerks identified and counted harvested fish. Creel clerks recorded, as specified by anglers, the number of anglers in the party, the time spent fishing, and the numbers and taxa of released fish. Angler catch is the sum of fish harvested and fish released.

2.2. Data analysis

For this analysis, we considered a reservoir to have sufficient incidence of anglers targeting a taxon if there were 50 or more interviews of angler-parties that targeted a specific taxon. Further, we only considered taxon for which there were five or more reservoirs with the aforementioned criteria. We were interested in a broad description of catch and harvest characteristics; thus, we combined data across reservoirs and years for this analysis. Anglers targeting anything, bluegill, channel catfish, common carp, crappie, hybrid striped bass, largemouth bass, walleye, and white bass met our requirements for inclusion in this analysis (Table 2).

We tested for differences in taxon-specific catch and harvest among angler groups by modelling catch and harvest with mixed-effects models. The taxon-specific number of fish caught, or harvested, was a function of number of anglers, time spent fishing (h), taxon targeted, and angler type (bank or boat) (all fixed effects) and reservoir (random effect). We evaluated three distributions (Poisson, negative binomial, and zero-inflated Poisson) for catch and harvest of each taxon (Maunder and Punt, 2004; Venables and Dichmont, 2004), and identified the best fitting model with a log-likelihood test using the bblme package (Bolker et al., 2014) in R (R Development Core Team, 2014). This approach allowed us to