Received: 8 December 2021 | Revised: 28 April 2022 | Accepted: 25 May 2022
DOI: 10.1111/jai.14337

ORIGINAL ARTICLE

Journal of Applied Ichthyology DWK WILEY

Effect of hook eye alignment on deep hooking rates for stream-dwelling trout caught with baited circle and J hooks

Kevin A. Meyer | **John M. Fennell** | **Luciano V. Chiaramonte**

Idaho Department of Fish and Game, Nampa, Idaho, USA

Correspondence
Kevin A. Meyer, Idaho Department of Fish and Game, 1414 E. Locust Lane, Nampa, ID 83686, USA.
Email: kevin.meyer@idfg.idaho.gov

Abstract

It has been well documented that circle hooks generally reduce deep hooking of bait-caught fish. However, for decades there has been speculation that the hook eye must be straight relative to the shank for circle hooks to function properly, yet this aspect of hook configuration has rarely been investigated. Using a passive hook set when strikes were detected, we compared deep hooking rates and catch probability for stream-dwelling trout (Yellowstone cutthroat trout [*Oncorhynchus clarkii bouvieri* Jordan & Gilbert], rainbow trout [*O. mykiss* Walbaum], and cutthroat trout × rainbow trout hybrids) caught using baited circle and J hooks with the eye either straight with or turned-up from the shank. Landed fish averaged 26 cm in total length and ranged from 11 to 46 cm. Most fish (83%) were hooked either in the upper or lower jaw, but 16% were hooked deeply (i.e., either in the esophagus or the gills). As expected, the deep hooking rate was lower for circle hooks (10%) than for J hooks (24%). Logistic regression model results indicated that hook eye orientation had no effect on deep-hooking, with deep hooking rates of 11.0% and 8.2% for circle hooks with angled-up and straight eyes, respectively, compared to 21.7% and 25.3% for J hooks with angled-up and straight eyes. Model results also revealed that deep hooking probability differed among anglers but did not differ between species and was not related to fish length. Catch probability (i.e., the proportion of fish strikes that resulted in a landed fish) did not differ between hooks or hook eye orientations. Contrary to some perceptions, our results suggest that changing the angle of the hook eye does not affect deep hooking rates when anglers use baited circle hooks to land stream-dwelling trout.

1 | INTRODUCTION

Decades of research has demonstrated that deep hooking of fish by anglers is often lethal for released fish because the ingested hook often damages the gill arches, esophagus, stomach, or heart, resulting in critical injury to vital organs (reviewed in Bartholomew & Bohnsack, 2005; Muoneke & Childress, 1994; Wydoski, 1977). Deep hooking rate in recreational fisheries is affected by numerous factors, including angling method and experience, terminal tackle being used, environmental conditions, and species and size of fish being caught, among other factors. In particular, bait fishing often results in higher rates of both deep hooking and hooking mortality compared to artificial flies and lures (Bartholomew & Bohnsack, 2005; Muoneke & Childress, 1994); this has been shown for numerous marine and freshwater taxa, but perhaps none more so than salmonids (e.g., High & Meyer, 2014; Hunsaker et al., 1970; Shetter & Allison, 1955; Stringer, 1967; Sullivan et al., 2013).

While fisheries managers often restrict bait use in fisheries with high rates of catch-and-release (Noble & Jones, 1999; Thurow & Schill, 1994), there are ways of reducing deep hooking of released fish besides banning bait fishing altogether. In particular, over the last few decades, circle hook use has become widespread in a variety of marine and freshwater bait fisheries as a means of reducing deep hooking (e.g., Cooke & Suski, 2004; Sauls & Ayala, 2012; Serafy et al., 2009). Circle hooks are designed with the hook point oriented at a 90° angle to the shank, which differs from conventional J-style bait hooks that are designed with the hook point parallel to the shank (Figure 1). As the angler tightens the line when a fish strike is detected, the circle hook is designed to pull free from deep hooking locations, rotate at the edge of the fish's mouth, and lodge in the jaw.

Numerous studies have demonstrated that circle hooks generally reduce deep hooking relative to conventional J hooks, regardless of how the hooks are fished or what the target species or environment is (reviewed in Cooke & Suski, 2004; but see Chiaramonte & Meyer, 2021). However, circle hooks are manufactured in a variety of shapes and sizes (Cooke & Suski, 2004; Serafy et al., 2012), and not all circle hooks perform equally well at reducing deep hooking (High et al., 2014). Most circle hook manufacturers design circle hooks with the eye straight with the shank (as in Figure 1), although circle hooks with a turned-up and turned-down eye (relative to the shank) are also commercially available. Nearly two decades ago, the Atlantic States Marine Fisheries Commission (ASMFC, 2003) highlighted the need for research "to determine the effect of hook eye orientation on circle hook effectiveness" because "some data suggests that the orientation of the hook eye (in-line with the hook shank or angled up/down) is important to insure that circle hooks work as intended." To date such research has rarely been conducted. In fact, we are aware of only one study that investigated the effect of eye orientation on deep hooking rates, which found that for yellowfin bream (*Acanthopagrus australis* Owen), eye angle relative to the shank did not influence deep hooking (Butcher et al., 2008).

Considering the paucity of information on this subject, and differences across species in both deep hooking rates (Bartholomew & Bohnsack, 2005; Muoneke & Childress, 1994) and circle hook performance (Cooke & Suski, 2004), the primary objective of this study was therefore to evaluate straight and turned-up hook eyes on a circle hook to assess whether eye orientation affected deep hooking of bait-caught stream-dwelling trout. We included J hooks in our study

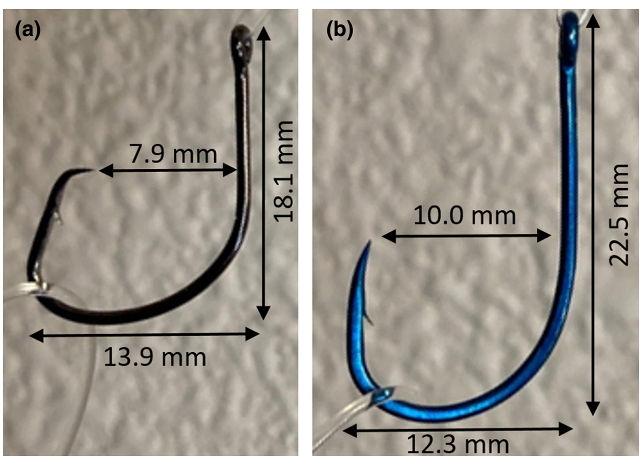

FIGURE 1 The circle (a) and J (b) hooks used to bait fish for trout in Idaho streams, showing hook dimensions as well as hook eyes being straight with the shank for both hooks; hooks were also fish with the eye at a ~35° turned-up angle from the shank.

design for comparative purposes, and also evaluated the relative success of landing fish with hooks having different eye orientations.

2 | METHODS

Angling was conducted in July 2021 at baseflow conditions in three streams (Badger Creek, 43.227°N 111.240°W; Bitch Creek, 43.926°N 111.285°W; and Bear Creek, 43.926°N 111.250°W) in eastern Idaho where trout densities are relatively high, providing relatively high catch rates and efficient angling. Streams were 1–3% in gradient, 8–19 m in mean wetted width, 209–381 µS/cm in conductivity, and 1675–1750 m in elevation. Water temperature was monitored periodically while angling and ranged from a low of 10.4°C to a high of 20.8°C. Species of trout encountered included Yellowstone cutthroat trout (*Oncorhynchus clarkii bouvieri* Jordan & Gilbert), rainbow trout (*O. mykiss* Walbaum), and cutthroat trout × rainbow trout hybrids. Anglers consisted of the authors and their seasonal staff, all of which had many years of angling experience.

Anglers fished each of two baited hooks (Figure 1), one being a size 2 Gamakatsu Octopus J hook (Gamakatsu ® USA Inc.; model 02409) and the other a size 8 Owner Mutu Light circle hook (Owner American Corporation; model 5114–031). Using the hook anatomy terminology in Serafy et al. (2012), hook sizes were selected to ensure approximately equal widths for each hook type. The J hook was manufactured with the eye being turned up at a ~35° angle to the shank, whereas the circle hook was manufactured with the eye straight relative to the shank. We bent the eyes on some hooks of each hook type so that both hooks could be fished with the eye straight and at a ~35° turned-up angle. The circle hook was also manufactured with the tip of the hook being slightly offset (~4°) from the shank, and since the degree of hook offset can affect deep hooking rates (Graves & Horodysky, 2008), we bent the fronts of the circle hooks to be inline with the shank to remove this potentially confounding factor. Limited hook availability during study planning required us to purchase J hooks in red, blue, and nickel colors, whereas all circle hooks were purchased in black chrome color; while lure color clearly affects angler catch rates (reviewed in Lennox et al., 2017), there is no reason to suspect that hook color would affect deep hooking with baited hooks.

Bait consisted of a 2–3 cm piece of worm (*Lumbricus terrestris* Linnaeus) attached to the hook. A 28-g removable split-shot was pinched onto the line ~25 cm above the baited hook to help sink the hook toward the bottom of the water column. Anglers fished in a variety of riffle, run, and pool habitats, attempting to keep a relatively tight line as the hook drifted downstream and setting the hook passively when a fish strike was detected; no strike indicators (e.g., bobbers) were used. A passive hook set refers to the reaction in which, when a strike is detected, the angler simply tightens any slack in the line and starts reeling in the fish. This is in contrast to an active hook set, during which the angler abruptly lifts the rod tip upon strike detection and quickly tightens the line in an attempt to "set the hook". Previous research has demonstrated that passive hook sets result in higher rates of deep hooking than active hook sets when bait fishing for stream-dwelling trout (High & Meyer, 2014; Sullivan et al., 2013) and other species (Butcher et al., 2008; Lennox et al., 2015), and our aim was to allow some deep hooking to occur in order to better evaluate the effect that hook eye orientation had on deep hooking. Moreover, manufacturers continue to promote a passive hook set on circle hook packaging information.

All anglers (five total in this study) fished all four hook type/eye orientation combinations, periodically switching from one combination to another to evenly accumulate a desired sample size of about 100 landed fish for each combination. Landed fish were identified to species, measured to the nearest cm, and assigned a hook location of esophagus, gills, upper jaw or mouth, lower jaw or mouth (including the tongue), or foul hooked (i.e. head, back, fin, etc.). For analyses, hook locations were grouped into a binary category of either deeply hooked or not, with deep hooking locations considered to be the esophagus and the gills.

Logistic regression modeling was used to evaluate whether hook type and eye orientation affected the probability of deep hooking. Each landed fish was considered the unit of observation, with a response variable of either 1 or 0 indicating whether the fish was deep hooked or not. Hook type, eye orientation, species (split into cutthroat, rainbow, and hybrid), angler, and fish length were all included as fixed effects.

We constructed the following models for comparison (see Table 1): a null model; all combinations of single parameter models, including either hook type, hook eye, species, angler, or fish length; a full model that included all parameters; a full model that also contained a hook × eye interaction term to evaluate whether hook performance was mediated by the orientation of the eye; and models with all factors except either hook type or eye orientation, to help evaluate which of these two factors were more influential to deep hooking rates. These 10 models were compared using Akaike's information criterion (AIC; Akaike, 1973; Burnham & Anderson, 1998), and plausible models were considered to be those with AIC scores within 2.00 of the best (i.e., most parsimonious) model (Burnham & Anderson, 2004). Akaike weights (w_i) were used to rank the relative plausibility of the candidate models. Model coefficient estimates and 95% confidence intervals (CIs) were used to evaluate the relative influence of each coefficient estimate, and for all models, we considered coefficients with 95% CIs that overlapped zero to be uninfluential, regardless of their inclusion in a particular model. The Hosmer and Lemeshow goodness-of-fit statistic (Hosmer et al., 2013) was used to confirm that the most plausible logistic regression models adequately fit the data.

For each hook type and eye orientation, the number of strikes, hook-ups, and landed fish were recorded. Hooking probability was calculated by dividing the number of successful hook-ups (i.e., the fish was hooked and fought for at least 1–2 s) by the number of strikes. Landing probability was calculated by dividing the number of fish landed by the number of successfully hooked fish. Capture probability was calculated by dividing the number of fish landed by the number of strikes. Probabilities were compared using 95% CIs (Fleiss, 1981), with overlapping CIs indicating non-significant differences. We used SAS (2009) for all statistical analyses.

TABLE 1 Comparison of logistic regression models constructed to estimate deep-hooking rates of trout caught in Idaho streams with baited circle and J hooks with either straight or turned-up hook eyes, fished with a passive hook set. Akaike's information criteria (AIC), change in AIC (ΔAIC), and AIC weights (w_i) were used to assess the most plausible models

Parameters	AIC_c	ΔAIC_c	w_i
Hook + fish length + angler	325.03	0	0.48
Hook + angler	326.27	1.24	0.26
Hook + eye + fish length + angler	327.08	2.05	0.17
Hook + eye + hook*eye + fish length + angler	328.52	3.49	0.08
Null (intercept + angler)	338.73	13.7	<0.01
Fish length + angler	339.17	14.14	<0.01
Eye + angler	340.70	15.67	<0.01
Eye + fish length + angler	341.17	16.14	<0.01

3 | RESULTS

In total, 394 fish were landed in the three streams combined, including 238 cutthroat trout, 75 rainbow trout, and 81 hybrids. Fish averaged 26 cm in total length and ranged from 11 to 46 cm. Most fish (82.7%) were hooked either in the upper or lower jaw, whereas 64 fish (16.2%) were hooked either in the esophagus or the gills (Figure 2). Deep hooking rate was 11.0% and 8.2% for circle hooks with angled-up and straight eyes, respectively, compared to 21.7% and 25.3% for J hooks with angled-up and straight eyes.

The most parsimonious model explaining what factors affected deep hooking included hook type, fish length, species, and angler (Table 1). However, based on coefficient estimates with CIs that did not overlap zero (Table 2), the best model indicated that deep hooking with baited hooks was reduced when using circle hooks, and when anglers 1 and 4 were fishing (relative to anglers 2 and 3). The next best model, with less than half the w_i as the best model, included all of the above factors as well as hook eye (Table 1), but based on coefficient estimate with CIs that did not overlap zero (Table 2), parameters considered influential in the second-best model did not differ from the best model. There was very little support for any other candidate models (Table 1).

Among all hook type and eye orientation combinations, 62.5% of the strikes that anglers detected while fishing resulted in a hooked fish, and 73.5% of hooked fish were landed, resulting in a catch probability of 45.9% for all detected strikes (Table 3). There was no statistical difference in the hook-up, landing, or catch probabilities between hook types or hook eye orientations, as indicated by overlapping CIs for all comparisons.

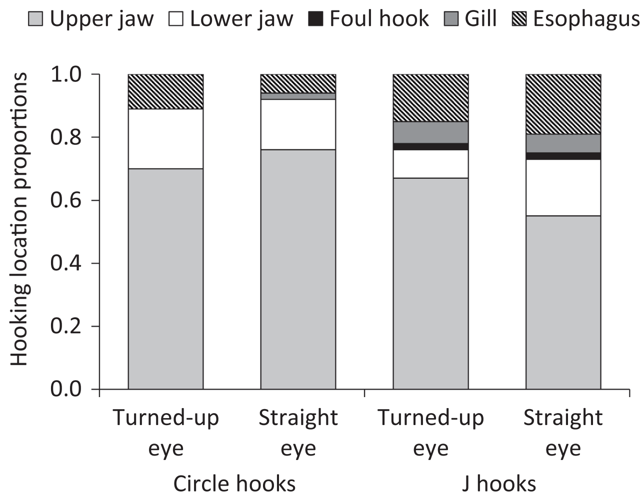

FIGURE 2 Proportions of trout caught by hooking location in Idaho streams fished with baited circle and J hooks with either straight or turned-up hook eyes, using a passive hook set.

TABLE 2 Coefficient estimates and upper and lower 95% confidence limits (CLs) for the top two logistic regression models constructed to estimate deep-hooking rates of trout caught in Idaho streams with baited circle and J hooks with either straight or turned-up hook eyes, fished with a passive hook set. Reference categories were J hook and angler 1 for best model, and a straight hook eye (relative to the shank) was an additional reference category for the next-best model

		95% CLs	
Coefficient	Estimate	Lower	Upper
Best model			
Intercept	−2.46	−3.85	−1.08
Hook—circle	−1.19	−1.79	−0.59
Fish length	0.04	0.00	0.09
Angler	0.54	−0.31	1.39
Next best model			
Intercept	−1.41	−2.15	−0.67
Hook—circle	−1.11	−1.70	−0.52
Angler	0.50	−0.29	1.29

4 | DISCUSSION

Our results suggest that when anglers bait fish for stream-dwelling trout, the orientation of the eye relative to the shank does not influence deep hooking rates for circle or J hooks. Most circle hooks are manufactured with the eye straight relative to the shank, and there has been speculation that if the eye was not in such an orientation, the well-documented propensity of circle hooks to reduce deep hooking of bait-caught fish may be reduced (ASMFC, 2003). Butcher et al. (2008) evaluated deep hooking rates while landing hundreds of Yellowfin Bream using circle and J hooks of various configurations and sizes, including eyes that were straight, turned up, and turned down. While the results of both the present study and that of Butcher et al. (2008) suggest that eye orientation does not influence deep hooking, it is curious that in both studies, deep hooking rates were slightly lower for circle hooks with a straight eye orientation compared to an angled eye orientation. Considering the paucity of studies directly addressing the effect of hook eye orientation on deep hooking, the variation in circle hook designs by hook manufacturers, and the widespread use of circle hooks in commercial and recreational bait fisheries (especially in marine settings), we encourage research on additional species to confirm or refute these initial findings.

The deep hooking rates in the present study for passively-fished inline circle and J hooks (10% and 24%, respectively) were comparable to previous studies of anglers fishing for stream-dwelling trout with a passive hook set, including deep-hooking rates of 19% and 10% for inline circle hooks and 24% and 20% for inline J hooks (High & Meyer, 2014; Sullivan et al., 2013). These results further support that when using bait in recreational fisheries, anglers can reduce deep hooking by using circle hooks rather than J hooks. Previous research has demonstrated that passive hook sets result in higher rates of deep hooking than active hook sets when bait fishing for stream-dwelling trout (High & Meyer, 2014; Sullivan et al., 2013) and other species (Butcher et al., 2008; Lennox et al., 2015), and our aim was to allow some deep hooking to occur in order to better evaluate the effect that hook eye orientation had on deep hooking.

We found that the probability of any given fish being deeply hooked was in part dependent on the individual angler. Prior studies demonstrating differences among anglers in bait-fishing deep hooking rates have attributed their findings either to differences in size of fish caught by anglers (Sullivan et al., 2013) or to marked differences in angler experience (i.e., novice vs expert anglers: Dunmall et al., 2001; Meka, 2004). However, in the present study, all anglers were quite experienced at bait fishing for trout in relatively small streams, suggesting that even subtle differences in hook setting or acuity to fish strikes among anglers can translate into differences in deep hooking. This also supports the assertion that educating anglers on best angling practices for caught and released fish can be beneficial (reviewed in Brownscombe et al., 2017), especially for those anglers catching and releasing the most fish. Most agencies and provinces provide guidance on best handling and release practices for anglers, though not all of this information is consistent (Pelletier et al., 2007).

For anglers to fully accept the use of circle hooks, catch rates must be comparable to other commonly used hooks. For anglers fishing for stream-dwelling trout with baited hooks and using a passive hook set, catch probability for circle hooks compared to J hooks was reduced in some studies (e.g., Lennox et al., 2015; Sullivan et al., 2013) but not in others (High & Meyer, 2014; Kazyak et al., 2016). In the present study, hooking and landing success were not affected by hook type or eye orientation, but we tested this with only a passive hook set, and hook set method can also influence catch probability (Chiaramonte et al., 2021; High & Meyer, 2014; Kazyak et al., 2016; Sullivan et al., 2013). Considering

TABLE 3 Number of fish strikes, hookups, and landing, and probabilities of hookup, landing, and catch (and 95% confidence intervals [CIs]) for trout caught in Idaho streams with baited circle and J hooks with either straight or turned-up hook eyes, fished with a passive hook set

			Fish		Probabilities		
Hook	Hook eye	Strikes	Hookups	Landed	Hookup	Landing	Catch
Circle	Turned-up	246	140	109	0.57 ± 0.06	0.78 ± 0.07	0.44 ± 0.06
	Straight	182	128	98	0.70 ± 0.07	0.77 ± 0.07	0.54 ± 0.07
J	Turned-up	219	136	92	0.62 ± 0.06	0.68 ± 0.08	0.42 ± 0.07
	Straight	220	132	95	0.60 ± 0.07	0.72 ± 0.08	0.43 ± 0.07

the variability observed in prior studies, the wide array of circle hook designs commercially available, and the myriad marine and freshwater fisheries that circle hooks are now commonly used in, additional evaluation would be useful to support our conclusion that hook eye configuration does not affect circle hook performance in bait fisheries.

ACKNOWLEDGMENTS

We thank J. Unsworth and J. Valdez for field assistance. Funding for this work was provided by anglers and boaters through their purchase of Idaho fishing licenses, tags, and permits, and from federal excise taxes on fishing equipment and boat fuel through the Sport Fish Restoration Program.

CONFLICT OF INTEREST

The authors have no conflict of interest.

DATA AVAILABILITY STATEMENT

Any and all data can be made available from the authors upon request

ORCID

Kevin A. Meyer https://orcid.org/0000-0002-1192-3906

REFERENCES

Akaike, H. (1973). Information theory as an extension of the maximum likelihood principle. In B. N. Petrov & F. Csaki (Eds.), *Second international symposium on information theory* (pp. 267–281). Akademiai Kiado.

Atlantic State Marine Fisheries Commission. (2003). Circle hook definition and research issues. Special Report no. 77.

Bartholomew, A., & Bohnsack, J. A. (2005). A review of catch-and-release angling mortality with implications for no-take reserves. *Reviews in Fish Biology and Fisheries*, *15*, 129–154.

Brownscombe, J. W., Danylchuk, A. J., Chapman, J. M., Gutowsky, L. F., & Cooke, S. J. (2017). Best practices for catch-and-release recreational fisheries–angling tools and tactics. *Fisheries Research*, *186*, 693–705.

Burnham, K. P., & Anderson, D. R. (1998). *Model selection and inference: A practical information-theoretic approach*. Springer-Verlag.

Burnham, K. P., & Anderson, D. R. (2004). Multimodel inference: Understanding AIC and BIC in model selection. *Sociological Methods and Research*, *33*, 261–304.

Butcher, P. A., Broadhurst, M. K., Reynolds, D., & Cairns, S. C. (2008). Influence of terminal rig configuration on the anatomical hooking location of line-caught yellowfin bream, *Acanthopagrus australis*. *Fisheries Management and Ecology*, *15*, 303–313.

Chiaramonte, L. V., & Meyer, K. A. (2021). Effect of hook type and hook setting method on deep hooking rates in lakes and reservoirs of Idaho. *Fisheries Management and Ecology*, *28*, 556–563.

Cooke, S. J., & Suski, C. D. (2004). Are circle hooks an effective tool for conserving marine and freshwater recreational catch-and-release fisheries? *Aquatic Conservation: Marine and Freshwater Ecosystems*, *14*, 299–326.

Dunmall, K. M., Cooke, S. J., Schreer, J. F., & Mckinley, R. S. (2001). The effect of scented lures on the hooking injury and mortality of smallmouth bass caught by novice and experience anglers. *North American Journal of Fisheries Management*, *21*, 242–248.

Fleiss, J. L. (1981). *Statistical methods for rates and proportions*. Wiley.

Graves, J. E., & Horodysky, A. Z. (2008). Does hook choice matter? Effects of three circle hook models on postrelease survival of white marlin. *North American Journal of Fisheries Management*, *28*, 471–480.

High, B., & Meyer, K. A. (2014). Hooking mortality and landing success using baited circle hooks compared to conventional hook types for stream-dwelling trout. *Northwest Science*, *88*, 11–21.

High, B., Meyer, K. A., & Sullivan, C. L. (2014). Performance of circle hooks when bait fishing for stream-dwelling trout. In: Carline, R. F., & LoSapio, C., (Eds.) *Wild trout symposium XI: Looking back and moving forward* (pp. 247–253). Wild Trout Symposium.

Hosmer, D. W., Jr., Lemeshow, S., & Sturdivant, R. X. (2013). *Applied logistic regression* (3rd ed.). John Wiley and Sons, Inc.

Hunsaker, D., Marnell, L. F., & Sharpe, F. P. (1970). Hooking mortality of Yellowstone cutthroat trout. *Progressive Fish-Culturist*, *32*, 231–235.

Kazyak, D. C., Sell, M. T., Hilderbrand, R. H., Heft, A. A., & Cooper, R. M. (2016). A comparison of catchability and mortality with circle and J hooks for stream-dwelling brook trout. *North American Journal of Fisheries Management*, *36*, 259–266.

Lennox, R. J., Alós, J., Arlinghaus, R., Horodysky, A., Klefoth, T., Monk, C. T., & Cooke, S. J. (2017). What makes fish vulnerable to capture by hooks? A conceptual framework and a review of key determinants. *Fish and Fisheries*, *18*, 986–1010.

Lennox, R., Whoriskey, K., Crossin, G. T., & Cooke, S. J. (2015). Influence of angler hook-set behaviour relative to hook type on capture success and incidences of deep hooking and injury in a teleost fish. *Fisheries Research*, *164*, 201–205.

Meka, J. M. (2004). The influence of hook type, angler experience, and fish size on injury rates and the duration of capture in an Alaskan catch-and-release rainbow trout fishery. *North American Journal of Fisheries Management*, *24*, 1309–1321.

Muoneke, M. I., & Childress, W. M. (1994). Hooking mortality: A review for recreational fisheries. *Reviews in Fisheries Science*, *2*, 123–156.

Noble, R. L., & Jones, T. W. (1999). Managing fisheries with regulations. In C. C. Kohler & W. A. Hubert (Eds.), *Inland fisheries Management in North America* (2nd ed., pp. 455–477). American Fisheries Society.

Pelletier, C., Hanson, K. C., & Cooke, S. J. (2007). Do catch-and-release guidelines from state and provincial fisheries agencies in North America conform to scientifically based best practices? *Environmental Management*, *39*, 760–773.

SAS (Statistical Analysis Systems). (2009). *SAS/STAT 9.2 user's guide* (2nd ed.). SAS Institute.

Sauls, B., & Ayala, O. (2012). Circle hook requirements in the Gulf of Mexico: Application in recreational fisheries and effectiveness for conservation of reef fishes. *Bulletin of Marine Science*, *88*, 667–679.

Serafy, J. E., Cooke, S. J., Diaz, G. A., Graves, J. E., Hall, M., Shivji, M., & Swimmer, Y. (2012). Circle hooks in commercial, recreational, and artisanal fisheries: Research status and needs for improved conservation and management. *Bulletin of Marine Science*, *88*, 371–391.

Serafy, J. E., Kerstetter, D. W., & Rice, P. H. (2009). Can circle hook use benefit billfishes? *Fish and Fisheries*, *10*, 132–142.

Shetter, D. S., & Allison, L. N. (1955). *Comparison of mortality between fly-hooked and worm-hooked trout in Michigan streams*. Miscellaneous publication 9. Michigan Department of Conservation, Institute of Fisheries Resources.

Stringer, G. E. (1967). Comparative hooking mortality using three types of terminal gear on rainbow trout from Pennask Lake, British Columbia. *Canadian Fish-Culturist*, *39*, 17–21.

Sullivan, C. L., Meyer, K. A., & Schill, D. J. (2013). Deep hooking and angling success when passively and actively fishing for stream-dwelling trout with baited J and circle hooks. *North American Journal of Fisheries Management*, *33*, 1–6.

Thurow, R. F., & Schill, D. J. (1994). Conflicts in allocation of wild trout resources: An Idaho case history. In: Barnhart, R., Shake, B. & Hamre, R. H. (Eds.), *Wild trout V: Wild trout in the 21st century*. Yellowstone National Park, MT. Wild Trout Symposium, pp. 132–140.

Wydoski, R. S. (1977). Relation of hooking mortality and sublethal hooking stress to quality fishery management. In R. A. Barnhart & T. D. Roelofs (Eds.), *Catch and release fishing: A decade of experience* (pp. 43–87). Humboldt State University.

How to cite this article: Meyer, K. A., Fennell, J. M., & Chiaramonte, L. V. (2022). Effect of hook eye alignment on deep hooking rates for stream-dwelling trout caught with baited circle and J hooks. *Journal of Applied Ichthyology*, *00*, 1–6. https://doi.org/10.1111/jai.14337