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Article

Influence of gear type on injuries and survival of adult Coho Salmon released from recreational marine fisheries

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ABSTRACT

Objective: Catch and release is a common conservation and management tactic that is used in marine Coho Salmon *Oncorhynchus kisutch* fisheries in British Columbia, Canada. Recent studies have found higher levels of release mortality when Coho Salmon are injured, but the role of specific gears or practices in causing injuries has not been explored for Coho Salmon that are released at sea.

Methods: We compared fishing injuries for Coho Salmon ($n = 226$) that were captured by two hook sizes (3/0 or 5/0) and three landing methods (knotless rubber-coated net, knotted polyethylene net, or no net). The captured adult Coho Salmon were then tagged and released with acoustic transmitters and tracked along their return migrations through the Salish Sea using an acoustic receiver network.

Results: Hook size had no effect on frequency of any hooking injuries (eye injuries and bleeding). The fish that were landed with knotless nets exhibited less scale loss than those that were landed with knotted nets but had a greater number of fins damaged. The fish that were landed without a net had the least scale loss and fin damage but were smaller overall than those that were landed with a net, so size differences may have influenced injury outcomes to some extent. Coho Salmon with less scale loss and larger body size had higher survival to a line of acoustic receivers that were located 50 km away in the Salish Sea. When considering multiple injuries, survival was compromised in fish that were in poor condition relative to those that were in good condition (37.2 vs. 21.4% release mortality, respectively; odds ratio = 2.04, $P = 0.044$).

Conclusions: These results indicate that reducing handling and netting (i.e., releasing fish at the waterline) will minimize injuries and improve release survival. We use our results to recommend best practices for capture and release of Coho Salmon at sea.

KEYWORDS: acoustic telemetry, angling, fin damage, hook size, mortality, net type, Pacific salmon, scale loss

LAY SUMMARY

Catch and release helps conserve Coho Salmon in British Columbia, but some die after release. In 226 tagged Coho Salmon, hook size did not affect injury. Fish released without nets had the fewest injuries. Larger fish and those with less scale loss had higher survival.

INTRODUCTION

Recreational fishing is a popular activity that is socially and economically important worldwide (Arlinghaus et al., 2021). While recreationally captured fish are often harvested, an estimated 60% of recreationally captured fish are released, although the release rates are highly variable (Cooke & Cowx, 2006). Capture and release (C&R) is commonly used as a conservation and management tactic whereby fishers are required by regulation to release fish that are a nontarget species or are too small or too large, or they do so voluntarily because of conservation ethic. The underlying assumption of C&R is that the released fish will survive, so it is often used to protect species or populations of concern while allowing fishing opportunities

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(Wydoski, 1977). However, the fate of the released fish is not always known and can be highly dependent on factors such as fish handling, gear type, fish condition (size, injuries), environmental conditions, and predator presence (Arlinghaus et al., 2007; Cooke & Suski, 2005; Raby et al., 2014). Even if a fish survives, it may experience sublethal effects, such as behavioral changes, reduced growth, compromised immune function, or unsuccessful reproduction (Wilson et al., 2014), which can have individual- or population-level effects, potentially undermining the intent of C&R.

Ensuring that Pacific salmon *Oncorhynchus* spp. recreational fisheries are managed sustainably is important because these species are the most sought by anglers in British Columbia's (BC; Canada) coastal waters, with over 200,000 salmon fishing licenses sold annually (Fisheries and Oceans Canada [DFO], 2022). Yet, the decline of many Pacific salmon populations coastwide (Connors et al., 2024) has led to numerous fisheries closures or restrictions to protect populations of conservation concern. Determining levels of release mortality (RM) is essential to stock assessment, and the development of biologically meaningful management measures and can also highlight possible ways for anglers to reduce fishery-related mortality through their fishing practices. As a result, Pacific salmon have been recently studied in BC within the context of C&R (Hinch et al., 2024; Lunzmann-Cooke et al., 2024; Prystay et al., 2025). Balancing fishing opportunities and population protection can be challenging (Coggins et al., 2007). Therefore, an angler's ability to release fish in a way that ensures survival is paramount as a management approach for the benefit of individual fish (Cooke et al., 2025) and the population (Corsi et al., 2025).

Coho Salmon *Oncorhynchus kisutch* is a targeted species for harvest and is also often released as bycatch as a nontarget species or due to size or daily catch restrictions. In response to the decline of the interior Fraser River Coho Salmon population in the 1990s, currently designated as threatened (Committee on the Status of Endangered Wildlife in Canada, 2016), many southern BC recreational Coho Salmon fisheries have since operated as mark-selective fisheries (MSF; DFO, 2015). In an MSF, different fishing regulations are applied to hatchery-origin fish (identified by a clipped adipose fin) and natural-origin fish with the intention of reducing harvesting pressure on natural-origin stocks. Generally, hatchery-origin Coho Salmon may be retained, whereas unmarked usually natural-origin Coho Salmon must be released. The success of an MSF, and C&R as a whole, is inherently dependent on an understanding of how much RM is experienced by released fish and ensuring that RM can be kept relatively low. Current BC marine recreational fisheries management plans for Coho Salmon adopt a 10% RM value (DFO, 2024), a level that was derived from short-term (0–24 h) holding studies (e.g., Cox-Rogers et al., 1999). Lunzmann-Cooke et al. (2024) conducted the first telemetry study on C&R for return-migrating Coho Salmon from a marine recreational fishery and found that short-term RM (~50 km from release) could be as high as 31.5% depending on fish condition. Release mortality was highest in the fish that had scale loss and eye injuries and were bleeding (Cook et al., 2018; Lunzmann-Cooke et al., 2024). Lunzmann-Cooke et al. (2024) had a primary focus on the effects of air exposure duration on RM, and while there was no clear pattern relating duration of air exposure to RM, air exposure was a component of nearly all of the "fishery treatments" (e.g., specific gear types or handling practices) that were examined. An examination of fishing gear and practices in the absence of significant levels air exposure is needed because recent C&R studies on marine Chinook Salmon *Oncorhynchus tshawytscha* have found that releasing fish at the waterline and thereby eliminating air exposure led to the best long-term survival outcomes for those fish (Hinch et al., 2024).

All fish are injured during recreational angling events. At a minimum, hooks cause puncture wounds into the mouth or other body parts, and if landing nets are used, scale loss, fin damage, and other dermal injuries can occur (Barthel et al., 2003; Lizée et al., 2018). All wounds increase susceptibility to infection and disease and potential migration mortality (Svendsen & Bogwald, 1997; Teffer et al., 2017). In recreational Pacific salmon fisheries, some types of fishing gear are mandated, such as the use of barbless hooks, whereas other gear choices are made voluntarily by the angler according to personal preference, including hook size and landing approaches (DFO, 2024). Hooking injuries have long been recognized as a major contributor to RM in Pacific salmon, with hooking in critical areas, such as the gills, eyes, and blood vessels, leading to especially high RM (Bendock & Alexandersdottir, 1993; Cowen et al., 2007; Diewert et al., 2002; Lindsay et al., 2004; Muoneke & Childress, 1994). Larger hooks are more likely to reach sensitive areas, such as arteries, eyes, and the brain (Gjernes et al., 1993; Muoneke & Childress, 1994; Wertheimer, 1988), whereas small hooks may be more likely to be swallowed (Brownscombe et al., 2017). Landing nets are often used to remove fish from the water, secure the fish during dehooking, or inspect it to determine whether it can be retained (e.g., measure, identify) prior to release. Landing nets are available in different sizes with varying materials (e.g., rubber, nylon, polyethylene), mesh sizes, and mesh types (e.g., knotted vs. knotless). Some landing nets are promoted specifically for C&R because they seemingly reduce common injuries, including tissue damage, scale loss, mucus loss, and fin fraying. Indeed, certain net types, such as large knotless rubber landing nets, have been found to reduce injury in angled fish (Barthel et al., 2003; Lizée et al., 2018). Vulnerability to fisheries injuries has generally been linked to fish size such that smaller fish are more susceptible to damage than larger fish (Broadhurst et al., 2006; Veldhuizen et al., 2018), but this can be species and gear dependent (Meka, 2004; Stalhammar et al., 2014). Injury susceptibility is concerning for smaller Coho Salmon that have a greater likelihood of RM (Lunzmann-Cooke et al., 2024) and are more likely to be released as bycatch. However, no studies have been conducted on whether recreational fishing gear choice, such as landing net type or use and hook size, can reduce RM and how this is influenced by fish size in marine Coho Salmon recreational fisheries.

The objectives of this study were (1) to determine whether hook size, the use of a landing net, or different net types can reduce the frequency and severity of fisheries injuries and whether fish size influences fisheries injuries; (2) to explore how fisheries injuries, fish condition, and gear type are associated with RM; and (3) to examine the cumulative effects of fisheries injuries on RM. The results of this study will support biologically relevant management tools and provide recommendations for fishing best practices to promote sustainable Pacific salmon fisheries.

METHODS

Fish collection and tagging

Adult Coho Salmon were captured by angling in Juan de Fuca Strait (JDF), near Port Renfrew, BC, September 1–10, 2022, during daylight hours from a guided fishing boat. Fishing occurred using trolling with downriggers in areas open to the recreational fishery within DFO Management Area 20 (Figure 1). The mean daily sea surface temperature measured at the start of each fishing trip was 10.8°C (range: 10.4–11.1°C), median water depth over which fishing occurred was 168 m (range: 128–211 m), and the median line depth of the fishing gear was 14 m (range: 0 [surface]–31 m). The fishing boat included one professional fishing guide and three anglers of varying experience levels. To test for the effect of hook size, the anglers were restricted to using barbless, 3/0 (gap = 16 mm, throat = 16 mm) or 5/0 (gap = 18 mm, throat = 18 mm) Mustad Siwash fishing hooks, commonly used hook types and sizes in this fishery (Figure 2). To test for the effect of landing method and net types that are typically used in this fishery, we used a knotless rubber-coated landing net (20 mm; Figure 3), used a knotted polyethylene landing net (60 mm; Figure 3), or brought the fish directly on board without a net (i.e., by holding

Figure 2. Barbless, 3/0 (left; gap = 16 mm, throat = 16 mm) and 5/0 (right; gap = 18 mm, throat = 18 mm) Mustad Big Gun Siwash Open Eye fishing hooks.

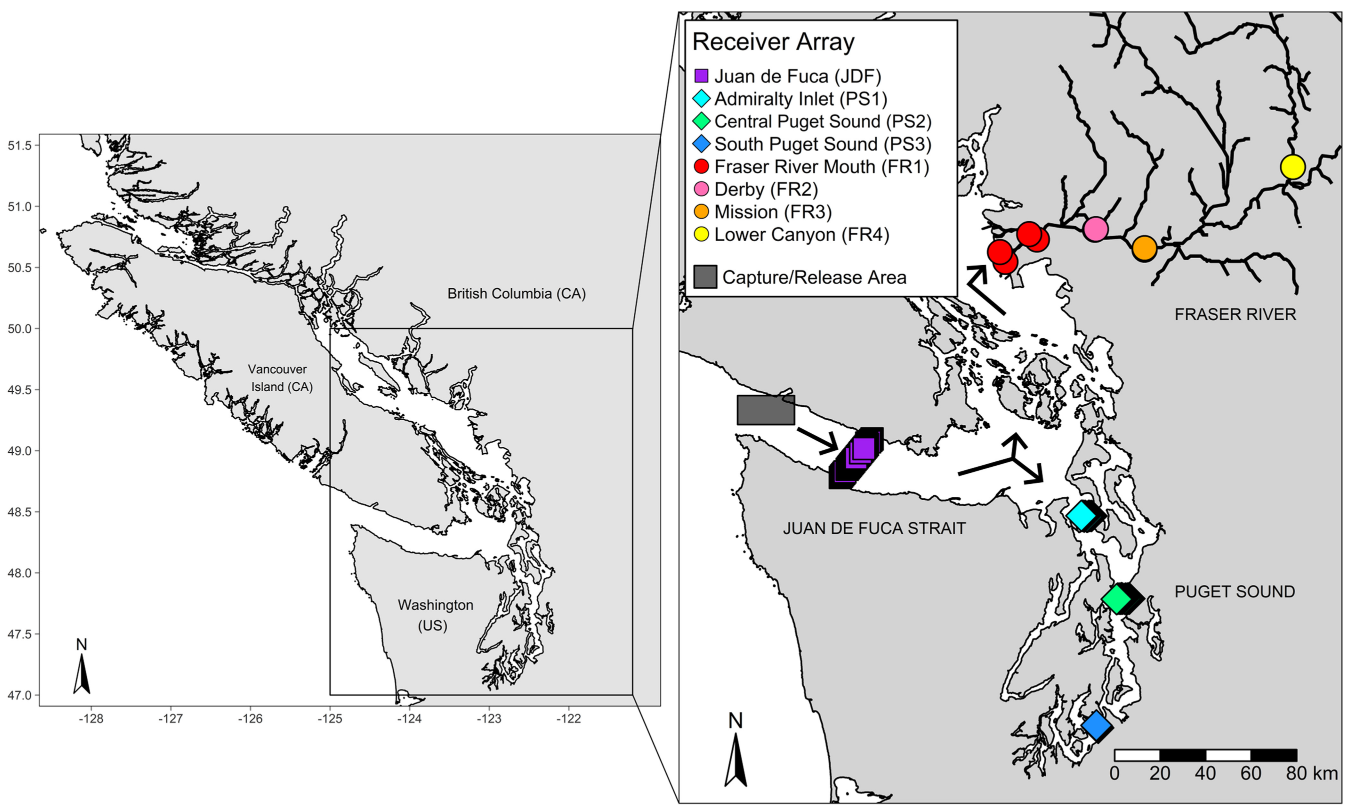

Figure 1. In 2022, adult Coho Salmon were captured via angling and released with acoustic tags near Port Renfrew, British Columbia, in the Juan de Fuca Strait (JDF) on the west coast of Vancouver Island. Acoustic receivers in JDF, Puget Sound (Admiralty Inlet [PS1], Central Puget Sound [PS2], and South Puget Sound [PS3]), and the lower Fraser River (Fraser River mouth [FR1], Derby Reach [FR2], Mission [FR3], and Lower Canyon [FR4]) were used to estimate release mortality of tagged Coho Salmon along their return migrations in Canada (CA) and the United States (US). The receivers are maintained by the Ocean Tracking Network (JDF receivers), the National Oceanic and Atmospheric Administration (Puget Sound receivers), Kintama Research, and the British Columbia Ministry of Water, Land and Resource Stewardship (Fraser River receivers). Detection radius of acoustic receivers is not reflected by the map. Arrows indicate the expected direction of migration for Coho Salmon detected on these receivers.

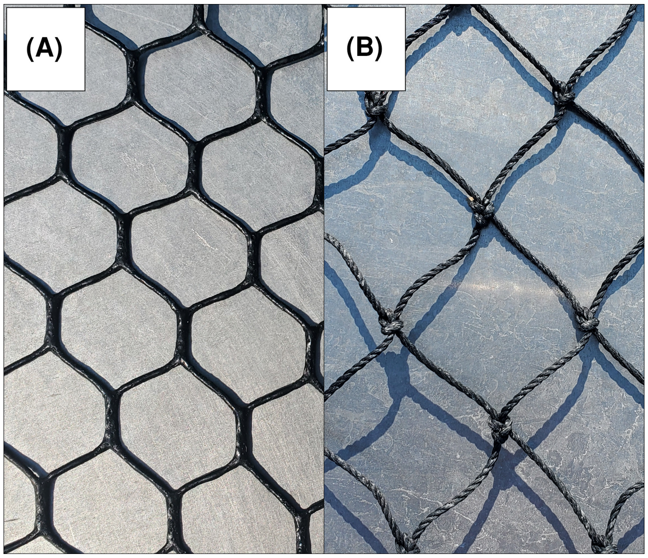

Figure 3. Landing net mesh: (A) knotless, rubber-coated mesh (20 mm) and (B) knotted, polyethylene mesh (60 mm).

the fishing line with the fish still hooked). Hook size and net type/use were assigned randomly.

Once captured, the fish were placed into a sampling cooler (79 × 34 × 37 cm) that was filled with fresh surface seawater. Each fish was submerged throughout sampling and tagging and was loosely held with one hand over the snout and one hand on the caudal peduncle when necessary. The fish were generally very calm during the sampling procedures. Each fish was assessed for new or recent unhealed injuries (e.g., fisheries injuries [as described below], nonfisheries wounds [e.g., predator wounds, other]), hooking location, and sea lice presence and was measured for fork length (FL; nearest half cm). Gear type (e.g., hoochies, spoons, plugs, bait, with or without flashers) and predator presence were recorded prior to release. Fisheries injuries were scored according to the following: scale loss as an estimate of percentage of whole body ($0 \leq 5\%$, $1 = 5$–10%, $2 = 11$–35%, $3 \geq 35\%$), bleeding (0 = none or small ooze from hook wound, 1 = notable/light bleed, 2 = significant/heavy bleed), eye damage (0 = absence, 1 = presence), fin damage severity (0 = no damage, 1 = minor fraying, 2 = significant fraying, 3 = broken fin rays or significant tissue damage), and number of fins damaged (ranging from 0 to 7). A summary of all gear and injury data are available in Supplementary Tables 1 and 2 (see online Supplementary Material). Lunzmann-Cooke et al. (2024) collected fish injury data in 2020 and 2021 using the same methods described here, and we compare those data with the data from the present study in the discussion.

A small tissue sample (slightly larger than a hole punch) was taken from the adipose or caudal fin and affixed to a Whatman sheet for submission to Molecular Genetics Laboratory at the Pacific Biological Station (DFO, Nanaimo, BC, Canada). These samples were identified to sex and to stock using either genetic stock identification (GSI) or parentage-based tagging (PBT) for Canadian stocks (Beacham et al., 2017, 2020). Under the PBT program, hatchery broodstock are genotyped, allowing sampled offspring to be assigned to parent individuals and identified as hatchery origin with a high degree of confidence. The remaining samples were analyzed using GSI; reporting unit assignments were accepted if the probability of assignment was 80% or greater. Coho Salmon were assigned to a reporting unit (RU; Canada) or reporting group (RG; United States), which was used to predict their expected travel routes along their return migration (Beacham et al., 2020). If a Coho Salmon could not be assigned to a single RU/RG (i.e., probability of assignment was under 80%), that fish was either aggregated to a region or labeled "unknown." For example, if a Coho Salmon had a probability of 30% and 50% of belonging to the mid-Puget Sound and south Puget Sound RGs, respectively, we can still include that fish in our JDF and Admiralty Inlet estimates because both RGs would pass these receiver arrays (Figure 1).

Acoustic tags (Model V13; Innovasea, Bedford, Nova Scotia, Canada) were fitted with end caps so that a thin "spaghetti" tag would allow an external "backpack" attachment (Lunzmann-Cooke et al., 2024; Raby et al., 2015). After biosampling and injury assessments, we affixed an acoustic tag to each fish by threading the spaghetti tag through the back musculature of the fish (behind the dorsal fin) using a needle and secured it using a metal crimp. Because these Coho Salmon may still be feeding at this point in their return migration and we wanted to minimize tagging effects and recovery time, we did not use gastric or surgical tag-insertion approaches. Our external tagging method has been shown to have a minimal influence on adult salmon survival (Dick et al., 2018; Naughton et al., 2018; Runde et al., 2022). Each acoustic tag had battery life (545–633 d) that was adequate for the expected migration period based on previous Coho Salmon tagging studies that were conducted in DFO Pacific Fishery Management Area 20 (Cook et al., 2018; Lunzmann-Cooke et al., 2024; Raby et al., 2015). We tagged Coho Salmon with FL ≥ 30 cm, which would reflect a 2- to 3-year-old (total age) homeward-migrating fish (Committee on the Status of Endangered Wildlife in Canada, 2016). Both marked and unmarked Coho Salmon were tagged. After sampling and tagging (median handling time = 4 min, range = 1–8 min), Coho Salmon were released next to the boat. An extensive receiver network was used to track tagged Coho Salmon postrelease (Figure 1; Supplementary Figure 1 [see online Supplementary Material]).

Data analyses

All of the statistical analyses were conducted in R version 4.2.2 (R Development Core Team, 2022). All of the generalized linear models (GLMs) were fitted with specified error distributions and link functions for the response variable using base R. The assumptions for each model were evaluated as described below.

Influence of gear type on fisheries injuries

We investigated the influence of hook size (3/0 [$n = 112$] vs. 5/0 [$n = 109$]) on the presence of eye injury and bleed severity. Five fish were captured with a 4/0 hook and were excluded from the statistical analyses. We used the "vglm" function from the *VGAM* package (Yee, 2025) to fit generalized ordinal regression models for the response variables that were measured on an ordinal scale (i.e., bleed, scale loss, and fin damage severity). We ran a proportional odds logistic regression (POLR) model to test the effect of hook size and FL on bleed severity. The parallel regression assumption of a POLR model was assessed using the "poTest" function in the *car* package (Brant, 1990). We used a binomial GLM (logit link) to test the effect of hook size and FL on the eye injury presence. We tested for an interaction between hook size and FL, and if the interaction was not significant, hook size and FL were included as main effects only.

We investigated the influence of net type (a knotless, rubber-coated landing net [$n = 103$] vs. a knotted, polyethylene landing net [$n = 95$]) on scale loss, the number of fins damaged, and fin damage severity. Some Coho Salmon were landed without a net (i.e., boating the fish via the fishing line; $n = 28$); however, this group of fish had significantly smaller average FL and sample size than those that were landed with a net, and it was not included in any statistical models.

A POLR model was used to assess scale loss, and a partial POLR model was used to assess fin damage severity because net type violated the parallel regression assumption. We used a GLM (Poisson distribution with log link) to test the effect of net type and FL on the number of fins damaged. We assessed the model assumptions by examining the residual deviance relative to the residual degrees of freedom (chi-square test) to check for overdispersion. We tested for an interaction between net type and FL, and if the interaction was not significant, net type and FL were included as main effects only.

Release mortality and detection efficiency

Based on the expected migration pathways (as determined by GSI and PBT) and a high probability of detection at acoustic monitoring points, we focused our analyses on evaluating survival of the fish at three locations: JDF, Puget Sound, and the Fraser River (Figure 1). The Coho Salmon were expected to pass the JDF line first, followed by the Fraser River lines (i.e., FR1 → FR2 → FR3 → FR4) or the three Puget Sound lines (i.e., PS1 → PS2 → PS3), depending on the population of origin (Figure 1). Detection efficiency (i.e., false negative detection, where a fish passed a monitoring point without being detected) was calculated by determining how many Coho Salmon were detected past an individual receiver array of interest (based on the expected migration path) but were not detected on that receiver array. In the JDF, we evaluated survival using one line of acoustic receivers (hereafter, the JDF line) and used detections on all other receivers in the Salish Sea to estimate detection efficiency (Supplementary Figure 1). In Puget Sound, we evaluated survival to Admiralty Inlet (PS1) and used lines in central Puget Sound (PS2) and south Puget Sound (PS3) to evaluate the detection efficiency of PS1. In the Fraser River, we evaluated survival to the lower Fraser River near Maple Ridge (FR2) and used four receivers at the entrances to the river (FR1), one pair of receivers near Mission (FR3), and a single receiver in the lower Fraser Canyon (FR4) to evaluate migration routes and detection efficiency of FR2. Additional detections throughout the Salish Sea were used to determine migration pathways and distinguish any potential straying of the tagged fish from mortalities (Supplementary Figure 1).

Short-term RM was calculated based on detections at the JDF receiver array because a large proportion of the tagged Coho Salmon were expected to pass it, the receiver array is in proximity to the release area (~50 km), and detection efficiency was expected to be high. Long-term RM was estimated to PS1 and FR2 because these were the farthest receivers that would detect the highest number of tagged Coho Salmon.

Detection at a receiver was considered to indicate that fish was alive after release, and a lack of detection at an expected receiver or beyond on the migratory pathway was used as a proxy for mortality. Based on the number of detections and time between detections, we did not identify any false positive detections. We estimated RM by dividing the number of detected fish on a given receiver line by the expected number of fish to be detected. The number of detected fish was corrected manually when detection efficiency was less than 100%, using the detection efficiency of each receiver array (Raby et al., 2015). We calculated binomial confidence intervals (95% CI) for the RM estimates using the Clopper–Pearson exact method (Clopper & Pearson, 1934).

Effects of fisheries injuries, fish characteristics, and gear type on release mortality

We used a binomial GLM (logit link) to investigate the association of six predictor variables to RM between release and the JDF receiver line ($n = 218$). To avoid overfitting the model, the six predictor variables of interest were identified a priori: FL, number of fins damaged, scale loss, bleeding, eye injury, and sex. There was no strong correlation among the predictor variables based on Spearman's rank correlation ($r_s < 0.6$) and generalized variance-inflation factor (GVIF < 3; Zuur et al., 2010). We examined residual deviance relative to residual degrees of freedom to check for overdispersion (i.e., c-hat > 1) of the model, including all six predictor variables. To determine the most parsimonious models, we used model selection via Akaike's information criterion corrected for small sample size and overdispersion ($QAIC_c$). We used the "dredge" function in the *MuMIn* package to evaluate all possible variable combinations and ranked candidate models based on model weight (Bartoń, 2025). To account for model uncertainty, all models comprising 95% of model weights were extracted and variable coefficients were averaged from this subset of best models. We used 95% CI and full average estimates, where a value of zero was applied for a variable when it was not included in one of the candidate models (Burnham & Anderson, 2002; Grueber et al., 2011). An association between the response variable and an explanatory variable was determined when the 95% CI of an explanatory variable did not overlap zero.

Differences in RM among population groupings were analyzed separately because 76 Coho Salmon could not be assigned to a single RU/RG (Supplementary Table 4), which would have limited the sample size in the model investigating the influence of fisheries injuries, sex, and FL on RM. We analyzed the differences in RM among 12 population groupings with a minimum of three individuals: Boundary Bay, east coast Vancouver Island and Georgia Strait, Howe Sound and Burrard Inlet, Lillooet, interior Fraser River, lower Fraser River, north Thompson River, south Thompson River, lower Thompson River, north Puget Sound, mid-Puget Sound, and south Puget Sound. We used a binomial GLM (logit link) to assess the relationship between population group and short-term mortality to the JDF receiver array ($n = 147$).

To assess the influence of gear type on RM to the JDF receiver line directly, we used a binomial GLM (logit link) with net type (knotless and knotted) and hook size (3/0 and 5/0)

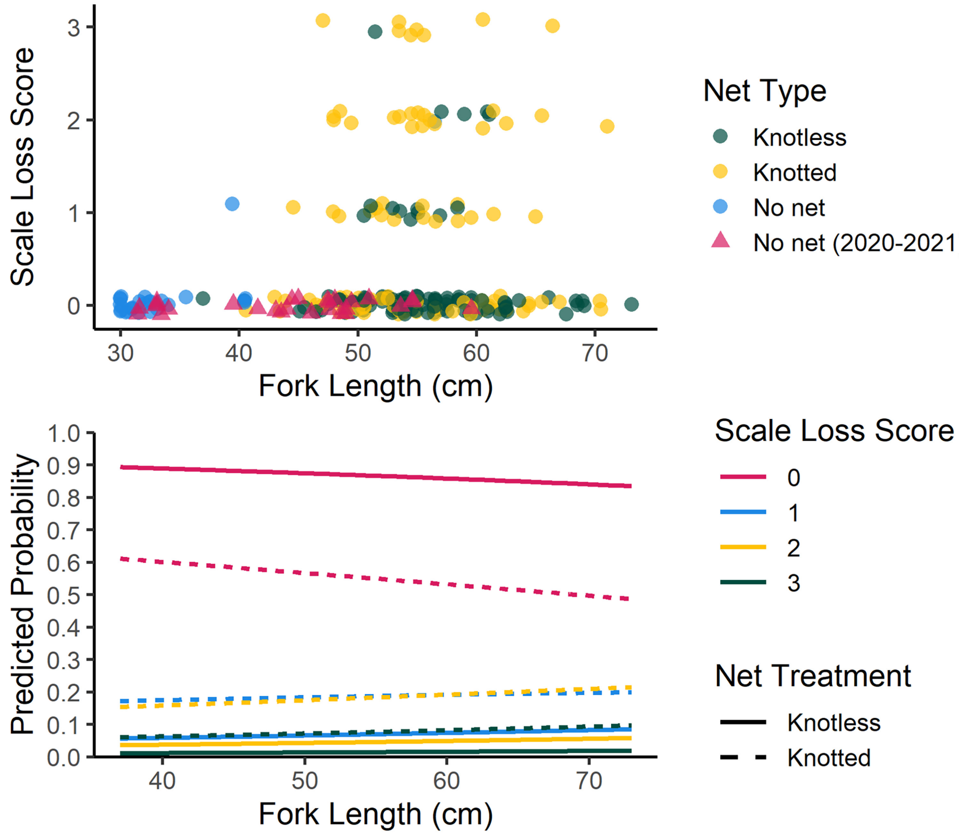

Figure 4. Relationship between fork length (cm) and scale loss score across net treatments. The top panel shows raw data, with individual fish plotted by their fork length and observed scale loss score, by net treatment. The "No net (2020–2021)" data were derived from Lunzmann-Cooke et al. (2024), where Coho Salmon were captured and handled using the same methods. The bottom panel shows predicted probabilities from a proportional odds logistic regression model, illustrating the effect of net treatment (knotless vs. knotted) on the probability of being assigned each scale-loss score across fork lengths.

as predictors. We did not include fish boated without a net in the model given the significantly smaller average FL of fish in this treatment group. We tested for an interaction between net type and hook size, and if the interaction was not significant, net type and hook size were included as main effects only.

Effects of multiple fisheries injuries on release mortality

Given the effect of fisheries injuries on Coho Salmon in recent studies (Lunzmann-Cooke et al., 2024), we used a binomial GLM (logit link) to compare RM with the JDF, FR2, and PS1 receiver lines for Coho Salmon that were assigned to three broad "fishery effects" groups: (1) "good condition" (no bleeding, no eye injuries, no scale loss), (2) "moderate condition" (no eye injuries and one or more of the following injuries: moderate scale loss [score 1–2], minor bleeding [score 1]), and (3) "poor condition" (one or more of the following injuries: eye injury, major bleeding [score 2], severe scale loss [score 3]).

RESULTS

We captured a total of 378 Coho Salmon, and 226 Coho Salmon met our minimum size requirements for tagging (i.e., FL ≥ 30 cm). Of the 226 Coho Salmon that we tagged (mean FL = 52.6 cm, SD = 9.4 cm), 86 were presumed to be hatchery origin (i.e., clipped adipose fin) and 142 were presumed to be natural origin (i.e., intact adipose fin and not identified as hatchery via PBT). Three fish were recaptured and reported by anglers after passing their final expected receivers in Puget Sound and were retained in all of the analyses.

The tagged Coho Salmon originated from a minimum of 27 individual streams among 15 RU/RG (excluding unknown origin; Supplementary Table 4). Most of the Coho Salmon were from Puget Sound (49.1%; $n = 111$) and the Fraser River (24.8%; $n = 56$) stocks, with fewer fish originating from Howe Sound and Burrard Inlet (5.8%; $n = 13$), east coast Vancouver Island (5.3%; $n = 12$), Boundary Bay (2.2%; $n = 5$), the Columbia River (0.4%; $n = 1$), and the west coast Vancouver Island regions (0.4%; $n = 1$). Of the 226 Coho Salmon, 76 could not be assigned to a single RU/RG (but could be aggregated to a region) and 6 could not be assigned to a region, and their expected migration paths were completely unknown.

Influence of gear type on fisheries injuries

We found no association between hook size (log odds = −0.116, SE = 0.342, $z = -0.339$, $P = 0.734$) or FL (log odds = 0.024, SE = 0.020, $z = 1.214$, $P = 0.225$) and the odds of a Coho Salmon having an eye injury. Similarly, we found that bleed severity was not related to hook size (log odds = 0.370, SE = 0.352, $z = 1.052$, $P = 0.293$) or FL (log odds = 0.015, SE = 0.019, $z = 0.771$, $P = 0.441$).

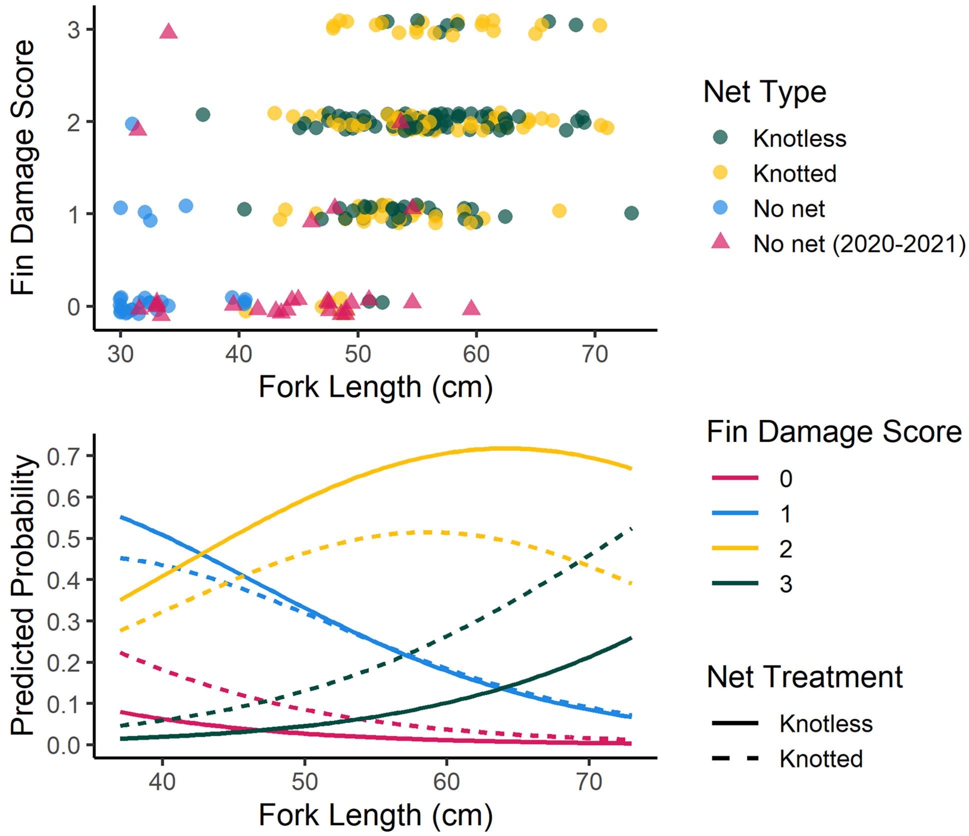

Figure 5. Relationship between fork length (cm) and fin damage score across net treatments. The top panel shows raw data, with individual fish plotted by their fork length and observed fin damage score, by net treatment. The "No net (2020–2021)" data were derived from Lunzmann-Cooke et al. (2024), where Coho Salmon were captured and handled using the same methods. The bottom panel shows predicted probabilities from a partial proportional odds logistic regression model, illustrating the effect of net treatment (knotless vs. knotted) on the probability of being assigned each fin damage score across fork lengths.

Using a knotted net was associated with 5.34 times (95% CI: 2.68–10.64) greater odds of the Coho Salmon having scale loss (i.e., a score of 1, 2, or 3 vs. no scale loss) relative to using a knotless net (log odds = 1.674, SE = 0.352, z = 4.754, P < 0.001; Figure 4). There was no association between scale loss severity and FL (log odds = 0.014, SE = 0.026, z = 0.550, P = 0.582). Net type influenced the likelihood of severe fin damage. Specifically, the likelihood of severe fin damage (score of a 3) is 3.15 times (95% CI: 1.29–7.63) higher for Coho Salmon that were captured with knotted nets than for those that were captured with knotless nets (log odds = 1.145, SE = 0.453, z = 2.529, P = 0.012; Figure 5). Larger salmon had more severe fin damage, where a 1-cm increase in FL is associated with a 1.09 times (95% CI: 1.04–1.14) higher odds of more severe fin damage (log odds = 0.087, SE = 0.023, z = 3.697, P < 0.001; Figure 5). The fish that were landed with a knotted net had fewer fins damaged (log rate ratio = −0.300, SE = 0.074, z = −4.024, P < 0.001) and were smaller (coefficient = 0.022, SE = 0.006, z = 3.821, P = 0.001; Figure 6).

Release mortality and detection efficiency estimates

Seven Coho Salmon (3.1%) were declared immediate mortalities (upon capture and/or prior to release) and were not released, and 219 were released alive with acoustic tags. Of the seven immediate mortalities, two fish had major bleeding, three fish had minor bleeding, and two had no obvious cause of death. The following RM estimates are cumulative and include immediate mortalities where relevant (i.e., based on the population assignment). The detection efficiency of all receiver arrays was high (63.3–100%); however, the detection efficiency of the final lines (FR4 and PS3) could not be estimated because there were no subsequent detections (Supplementary Table 3).

Release mortality to the JDF receiver array was 26.4% (95% CI: 20.7–32.8%; n = 218). Surviving Coho Salmon that were expected to pass the JDF receiver array took a median 3.4 d (min = 1.1, max = 29.9) at a median travel rate of 13.0 km/d (min = 1.8, max = 51.9) to their first detections, which were a median of 52.7 km (min = 32.6, max = 61.4) away from release points. Release mortality to the PS1 receiver array in Admiralty Inlet of Puget Sound was 64.1% (95% CI: 54.4–73.0%; n = 110) over a median 5.1 d (min = 4.0, max = 13.9; n = 25). Release mortality to FR2 near Maple Ridge in the lower Fraser River was 64.3% (95% CI: 50.4–76.6%; n = 56) over a median 10.5 d (min = 8.4, max = 30.7; n = 20).

Effects of fisheries injuries, fish characteristics, and gear type on release mortality

To explore the associations between fisheries injuries and fish characteristics, we averaged candidate models that comprised

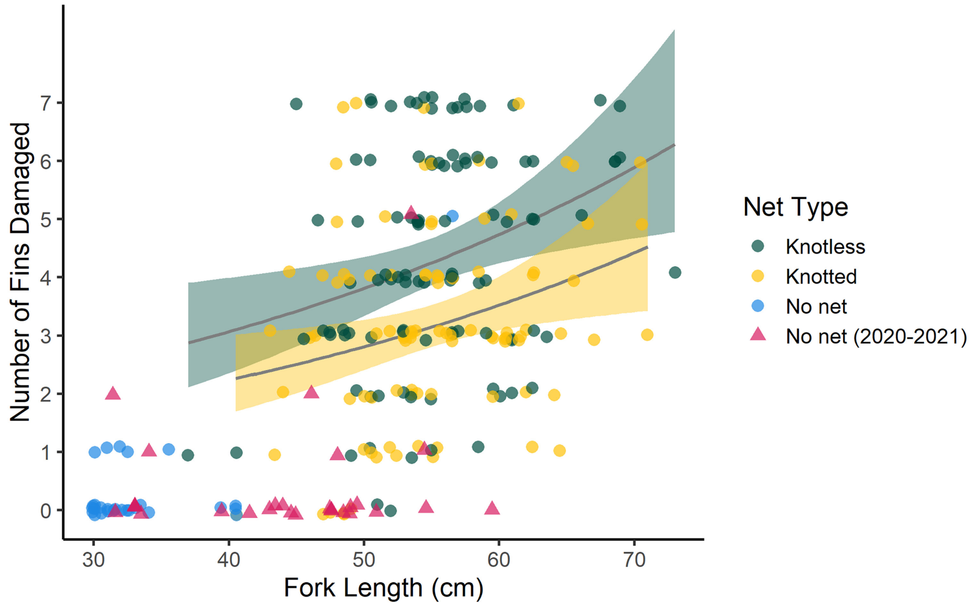

Figure 6. Relationship between fork length (cm) and the number of fins damaged across net treatments. Regression lines with 95% confidence intervals are shown for knotless and knotted nets from a generalized linear model (Poisson with log link). The data points for the "No net" and "No net (2020–2021)" treatments are included for comparison but were not modeled. The "No net (2020–2021)" data were derived from Lunzmann-Cooke et al. (2024), where Coho Salmon were captured and handled using the same methods.

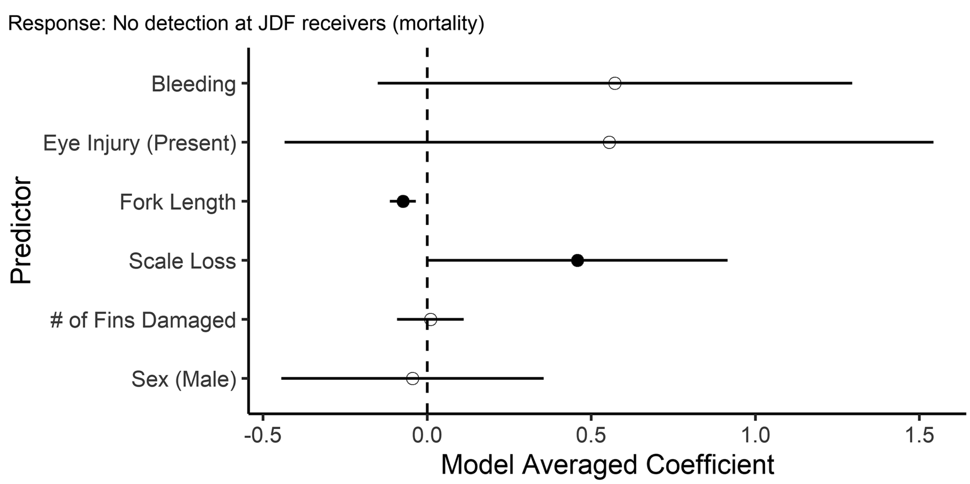

Figure 7. Full model-averaged coefficients (log odds) from a generalized linear model (binomial with logit link) of Coho Salmon release mortality (detected/not detected). Coho Salmon were tagged in the Canadian waters of the Juan de Fuca Strait (JDF) and tracked to the first point of detection (JDF receiver array; Figure 1) in 2022. Predictor variables included bleeding (0–2), eye injury (absent or present), fork length (cm), scale loss (0–3), number of fins damaged (0–7), and sex (female or male). Filled circles indicate variables that are significantly different from zero, and horizontal lines indicate the 95% confidence interval for each variable.

95% of all the model weights, which included combinations of all six independent variables (i.e., sex, eye injury, scale loss, bleeding, number of fins damaged, FL). The model-averaged parameter estimates suggested that increasing severity of scale loss and smaller FL were associated with increased odds of RM to the JDF line. Each increase in scale loss severity (i.e., 0–5% → 5–10% → 10–35% → > 35%) was associated with 1.59 times (95% CI = 1.00–2.50, $P = 0.0499$) greater odds of RM (Figure 7; Supplementary Table 5). Every 1-cm decrease in FL is associated with a 1.08 times (95% CI = 1.04–1.12, $P = 0.0002$) increase in the odds of RM. Population did not explain short-term RM to the JDF line ($P = 0.411$; Supplementary Figure 2). Neither net type (log odds = 0.410, SE = 0.354, $z = 1.159$, $P = 0.246$) nor hook size (log odds = 0.450, SE = 0.355, $z = 1.268$, $P = 0.205$) influenced the odds of RM between release and the JDF receiver line.

Effects of multiple fisheries injuries on release mortality

The fish that were in poor condition were more likely to die before the JDF receiver line than were those that were in good condition (log odds = 0.713, SE = 0.354, $z = 2.013$, $P = 0.044$; Figure 8), with their odds of mortality being 2.04 times (95%

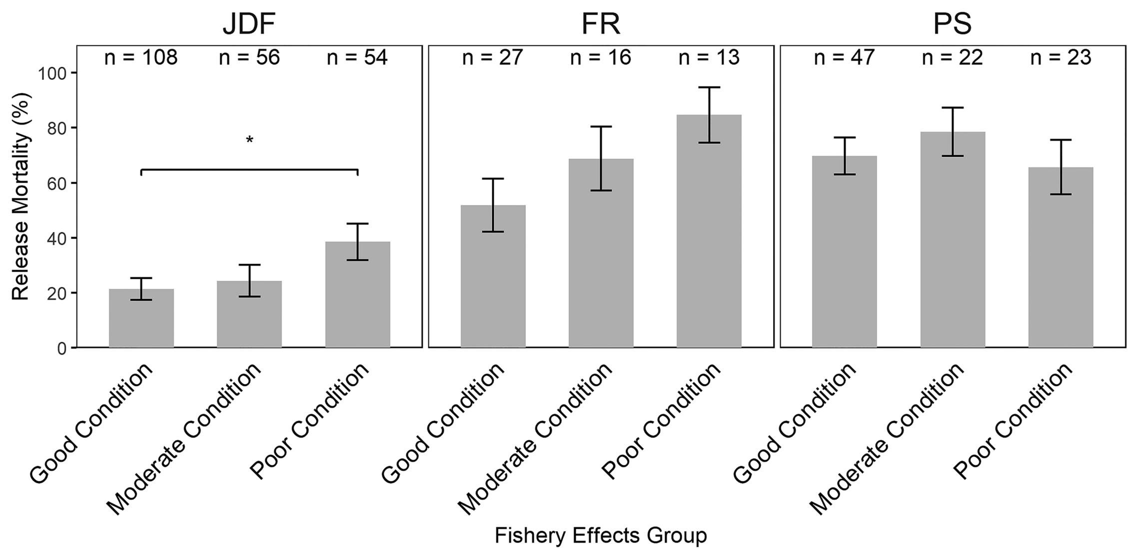

Figure 8. Cumulative release mortality (% ± SE) to the Juan de Fuca (JDF), lower Fraser River (FR), and entrance to Puget Sound (PS) receiver lines among fisheries effects groups: "good condition" (no bleeding, no eye injuries, no scale loss), "moderate condition" (no eye injuries, and one or more of the following injuries, moderate scale loss [score 1–2], minor bleeding [score 1]), and "poor condition" (one or more of the following injuries: eye injury, major bleeding [score 2], severe scale loss [score 3]). A difference between release mortality of Coho Salmon in good and poor condition at the JDF receivers (log odds = 0.713, SE = 0.354, $z = 2.013$, $P = 0.044$) is indicated with an asterisk.

CI: 1.02–4.1) greater than that for the fish that were in good condition: (1) good condition fish: 21.4% (95% CI: 14.1–30.4%; $n = 108$), (2) moderate condition: 25.3% (95% CI: 14.4–38.9%; $n = 54$), and (3) poor condition: 37.2% (95% CI: 24.6–51.1%; $n = 56$). Release mortality to PS1 was similar for Coho Salmon in good (69.8% [95% CI: 54.6–82.3%; $n = 47$]) and poor condition (65.7% [95% CI: 43.2–84.0%; $n = 23$]; log odds = 0.159, SE = 0.627, $z = 0.254$, $P = 0.800$), and although RM to FR2 had an increasing trend between fish in good (51.9% [95% CI: 32.0–71.3%; $n = 27$]) and poor condition (84.6% [95% CI: 54.6–98.1%; $n = 13$]), statistical support for this difference was weak (log odds = −1.631, SE = 0.860, $z = -1.897$, $P = 0.058$; Figure 8).

DISCUSSION

The survival of angled Coho Salmon is in the hands of the fishers that catch, handle, and release those fish. This study is the first to provide estimates about the influence of gear type on fisheries injuries and RM of recreationally captured adult Coho Salmon in the marine environment. Our study tested the effect of hook size and net type on fisheries injuries (i.e., scale loss, fin damage, eye injuries, and bleeding), which have been linked to increased odds of RM for Coho Salmon (Cook et al., 2018; Lunzmann-Cooke et al., 2024). We did not find evidence that hook size had an effect on frequency of any hooking injuries. We found that knotless nets reduced scale loss more than a knotted net but increased the number of fins that were damaged. When accounting for multiple fisheries injuries, mortality was significantly higher for fish that were in poor condition than for those in good condition. Therefore, it is clear that anglers play a role in the efficacy of C&R as a regulatory measure in Pacific fisheries.

Influence of gear type and fish size on fisheries injuries

Scale loss was associated with increased odds of RM between release and the first point of detection (median 3.4 d and 52.7 km after release); therefore, reducing scale loss is critical to the release survival of Coho Salmon. This conclusion is consistent with previous studies on marine-migrating, recreationally captured Coho Salmon in the same area (Cook et al., 2018; Lunzmann-Cooke et al., 2024). Younger and less mature marine migrating salmon, as in our study, have not started reabsorbing their scales as part of their physiological preparation for upriver migration and are more vulnerable to scale loss (Donaldson et al., 2012; Raby et al., 2013). The negative implications of dermal injuries, including mucus, skin, and scale loss, are well documented for many fish species and can reduce their osmoregulatory ability (Olsen et al., 2012; Tomás et al., 2024; Zydlewski et al., 2010) and alter their normal swimming behavior (Olsen et al., 2012), increasing the risk of short-term mortality (Butcher et al., 2010; Marçalo et al., 2008). Scale loss can have long-term implications by increasing susceptibility to infection and disease, which will increase considerably when approaching freshwater (Baker & Schindler, 2009; Di Cicco et al., 2023; Svendsen & Bogwald, 1997).

Rubber-coated landing nets yield less scale loss than knotted polyethylene nets for Coho Salmon, but avoiding nets altogether was the least injurious. Although the probability of scale loss was not associated with FL, the average size of the Coho Salmon that were boated without a net was notably smaller (mean FL = 33.6 ± 5.6 cm; $n = 28$) than those captured with a net (mean FL = 55.3 ± 6.2 cm; $n = 198$) in this study. However, Lunzmann-Cooke et al. (2024) boated larger Coho Salmon (mean FL = 44.1 ± 7.9 cm; $n = 28$) without a net in the same fishery in 2020 and 2021 and no fish had scale loss

(Lunzmann-Cooke et al., 2024; Figure 4). A comparable result was found for marine, recreationally caught Chinook Salmon, where 97% of fish had no scale loss when they were landed without a net (mean FL = 70.4 ± 8.8 cm; *n* = 117; S. D. Johnston and K. M. Zinn, unpublished data). Barthel et al. (2003) and De Lestang et al. (2008) similarly found that knotted mesh resulted in more severe dermal damage (mucus and scale loss) than knotless nets when landing recreationally captured Bluegill *Lepomis macrochirus* and Barramundi *Lates calcarifer*. Lizée et al. (2018) also found that a large, knotless, rubber net with mesh size that was similar to that of the one that we used here resulted in low mucus and scale loss for Brook Trout *Salvelinus fontinalis*. Interestingly, Lizée et al. (2018) found that knotted polypropylene mesh resulted in the least scale loss; however, our results likely differ because of the larger mesh and thicker strand of our knotted net. The increased abrasive surface area in contact with the fish may increase the likelihood or severity of injury.

Although we have not identified fin damage as a driving factor in RM of Coho Salmon, fin damage has been associated with adult short-term survival of Chinook Salmon in the marine environment (Hinch et al., 2024; Prystay et al., 2025). We also did not identify which fins were damaged, rather the overall number and severity. The damage of certain fins (e.g., caudal and pectoral fins) is more likely to have sublethal effects through its effects on swimming efficiency (e.g., predator avoidance, foraging, migration speed), which could potentially also contribute to RM (Barthel et al., 2003). Fin damage does not heal for Pacific salmon (Hinch et al., 2024) and may hinder their upstream migration during later stages of the migration and create an entryway for infection.

We found that net type influenced the number of fins damaged and fin damage severity differently. Coho Salmon that were landed with the knotted net had a higher likelihood of severe fin damage, whereas Coho Salmon that were landed with the knotless, rubber-coated net had a greater number of fins damaged. The smooth rubber material coupled with the thinner mesh strand width could have allowed fins to be damaged more easily than the uncoated material. However, the uncoated material and thicker strand width of the knotted net caused more severe injury when fins were cut by the net. In studies on other angled fish species that measured fin damage severity, using a coarse uncoated larger-mesh knotted net has consistently been associated with greater fin damage (Barthel et al., 2003; De Lestang et al., 2008; Lizée et al., 2018). Ultimately both net types caused fin damage, likely because the mesh size for both nets was large enough to allow fins to protrude through the net (Barthel et al., 2003). A landing net with a smaller mesh size would likely reduce fin damage (Moltumyr et al., 2024) but may result in higher mucus and scale loss (Lizée et al., 2018). Fin damage caused by both rubber-coated and uncoated nylon nets has also been found for marine, recreationally captured Chinook Salmon (Hinch et al., 2024). Of the Coho Salmon that were boated without a net in this study, 96% had 0–1 fins damaged, and 89% of larger Coho Salmon (as described above) had 0–1 fins damaged in a similar study in 2020 and 2021 (Lunzmann-Cooke et al., 2024; Figure 6). Even for larger recreationally caught Chinook Salmon, 97% of fish had 0–1 fins damaged when landed without a net (mean FL = 69.3 ± 9.0 cm; *n* = 69; Johnston, unpublished data). Longer Coho Salmon had a greater number of fins damaged and more severe fin damage. Larger fish likely have worse fin damage because they are heavier and sink into the net, pushing their fins through the mesh, and are relatively stronger, leading to more severe injuries when they thrash and become entangled in the net. Barthel et al. (2003) similarly found that larger Bluegill had more caudal fin abrasions and that all the Bluegill that died had caudal fin abrasions.

We found no effect of hook size or FL on the frequency of eye injuries or severity of bleeding. The Siwash-style 3/0 and 5/0 hooks used in this study are commonly chosen in marine recreational Pacific salmon fisheries and are a J-hook variation with a kirbed hook point, similar to octopus-style hooks. Larger hooks can cause deeper injuries and reach critical areas, such as the gills, blood vessels, eyes, and brain (Gjernes et al., 1993). However, the size difference between the two hook sizes we contrasted may have been too small (2-mm gap difference from point to the shank) to significantly influence injury outcomes. For Chinook Salmon, 3/0 recreational octopus-style hooks have been related to fewer and less severe eye injuries and bleeding than 6/0 hooks (Hinch et al., 2024). Our results likely differ because the 3/0 hooks used in Hinch et al. (2024) have a gap width of 14 mm, whereas the 3/0 hooks that we used have a gap width of 16 mm. There was no effect of FL on the odds of eye injuries or bleeding, but adult Coho Salmon are smaller on average than Chinook Salmon, which may have influenced the relative influence of hook size. The 3/0 hooks were likely already large relative to the mouth size of Coho Salmon, increasing the likelihood of injury even with the smallest hook size we tested. Eye injuries and bleeding have been identified as primary risk factors for RM (Lunzmann-Cooke et al., 2024), and future research should investigate the ability of smaller hook gap widths (i.e., <16 mm) to reduce the frequency of eye injuries and bleeding for Coho Salmon.

Consistent with Lunzmann-Cooke et al. (2024), we found that smaller Coho Salmon had higher odds of RM. A higher likelihood of mortality for smaller-bodied individuals has been found for other Pacific salmon species, including Sockeye Salmon *Oncorhynchus nerka* (Bass et al., 2018) and Chinook Salmon (Bendock & Alexandersdottir, 1993; Hinch et al., 2024; Wertheimer, 1988; Wertheimer et al., 1989). Unlike for Pacific salmon that are captured in net fisheries (Cook et al., 2019; Raby et al., 2015) or angled Chinook Salmon (Hinch et al., 2024), smaller angled Coho Salmon did not experience more injuries than larger Coho Salmon (Lunzmann-Cooke et al., 2024). The mechanisms underlying elevated RM for smaller Coho Salmon could be a combination of lower anaerobic capacity, longer physiological recovery period, and greater recovery costs from the capture event (Davis, 2002; Kieffer, 2000).

Release mortality estimates

We estimated RM to the first point of detection (i.e., JDF receiver line; a median travel time of 3.4 d) to be 26.4% (95% CI: 20.7–32.8%). Our RM estimate is comparable to those that were reported by Lunzmann-Cooke et al. (2024; recreational) and Cook et al. (2018; commercial purse seine), who found 31.5% and 36.1% RM of Coho Salmon to the JDF receiver line, respectively. Our long-term RM estimates (~64% to both

Puget Sound and the Fraser River) were comparable to those of Lunzmann-Cooke et al. (2024) and Cook et al. (2018), suggesting that mortality losses are not just transient effects but may persist over extended periods (discussed further in *Limitations and future research*).

Releasing fish that are in poor condition was a strong predictor of RM. Hinch et al. (2024) reported a comparable decline in survival, with 17.0 and 48.1% RM for Coho Salmon that were captured in good and poor condition, respectively, in the same fishery in 2020 and 2021. Multiple injuries, including eye injuries, have been found to increase mortality rates for other fish species that are captured in hook-and-line fisheries. For example, Pálsson et al. (2003) found that Atlantic Cod *Gadus morhua* with more than one fisheries-related injury had higher mortality than fish with only one injury. Although not statistically significant, there was a substantial decline in survival RM to the lower Fraser River between fish that were in good and poor condition, and Hinch et al. (2024) found that the ~30% difference in RM between Coho Salmon that were in good and poor condition at the JDF receiver line remained to the entrance to Puget Sound. Collectively, these results suggest that a considerable portion of RM can be attributed to both short- and long-term postrelease injuries. Despite Coho Salmon in good condition having no fisheries injuries, our results suggest that Coho Salmon are sensitive to capture and handling stress. Gear type alone (net type or hook size) was not associated with RM; however, importantly, we were not able to empirically test the effect of no net use on RM. Despite knotless nets reducing abrasion that causes scale loss, this reduction of injury alone may not be sufficient to significantly lower RM. However, as scale loss is consistently associated with RM, the ability for knotless nets or the absence of a net altogether to reduce scale loss has an indirect benefit on fish survival by mitigating a critical risk factor.

Limitations and future research

The gear types that we used are commonly employed in recreational marine Pacific salmon fisheries, but there are other options that are available to anglers. For example, although we contrasted two popular sizes of siwash-style hooks for this fishery, testing smaller hooks (i.e., <16-mm gap width) is warranted given their success in reducing eye injuries and bleeding for Chinook Salmon (Hinch et al., 2024). Similarly, there is also a need to assess other hook designs, such as circle hooks, which have shown promise for reducing mortality in Chinook Salmon that were captured while drift mooching (Grover et al., 2002). While no difference in injury was detected for the hook treatments (16-mm vs. 18-mm gap width), it is important to note that the chosen hook gaps may not have been varied enough in size (2-mm difference) to detect an effect.

We could not empirically test the difference in injury frequency for Coho Salmon that were landed with and without a net due to significant differences in their average size. We are confident that Coho Salmon of any size would exhibit the lowest injury frequency when landed without a net, but future research should investigate the effects of landing method on a wider range of fish sizes, as many Coho Salmon that are released in the recreational fishery are released boat-side without the use of a net. Future research should also examine the potential trade-offs between net use, handling time, injury potential, and air exposure. Using a landing net can sometimes result in longer handling times if the hook gets entangled (LaRochelle et al., 2023; Lizée et al., 2018) but can reduce air exposure by allowing the fish to remain in the water during admiration and hook removal. Using bare wet hands can reduce handling time but may increase odds of dropping the fish (Lizée et al., 2018) and promoting bacterial infection (Di Cicco et al., 2023).

Our RM estimates build on Lunzmann-Cooke et al. (2024), improve on previous RM developed using short-term holding studies (e.g., Cox-Rogers, 2004), and contribute to the broader synthesis of RM in Pacific salmon fisheries (Prystay et al., 2025). Holding studies are important to identifying mechanisms of mortality but may confound RM estimates by worsening fish stress and infection and are typically conducted over a short period (24–48 h), which may underestimate RM (Di Cicco et al., 2023; Raby et al., 2015). Biotelemetry allows more accurate estimates of RM by tracking fish in their natural environment over a longer period (Donaldson et al., 2008). However, our RM estimates cannot be separated from natural mortality, tag effects, or other types of fisheries-related mortality (e.g., dropout, depredation, escape, avoidance), which may inflate our estimates, especially over longer periods and distances (Patterson et al., 2017; Prystay et al., 2025). Other than a lack of detection as a result of mortality, fish may not have been detected due to factors such as tag loss or malfunction, straying from their expected migration path, or prolonged ocean residence. The smaller Coho Salmon (~30 cm) may have remained in the ocean before returning to spawn the following year (Chittenden et al., 2009). However, small Coho Salmon do return to spawn, and we would have detected tagged survivors the following year on the extensive receiver network. There were only three Coho Salmon detected on unexpected receivers. Two Coho Salmon were detected on Puget Sound receiver lines, but there was no clear evidence of straying because we did not track the Coho Salmon to spawning grounds. However, one Coho Salmon with a 99% probability of assignment to south Puget Sound was last detected in the Discovery Islands. Tag loss, tag malfunctioning, and tagging effects have not been quantified for marine migrating Coho Salmon and may inflate our RM estimates, but the external tagging method was chosen to minimize the effects of tagging, and mortality and has high tag retention rates (Jepsen et al., 2015; Runde et al., 2022; Sutton & Benson, 2003).

Coho Salmon may enter Puget Sound through three potential entrances: Admiralty Inlet, Deception Pass, or Swinomish Channel. We are unaware of any study that identifies specific migration paths into Puget Sound for adult Coho Salmon, but juvenile salmonids have used all three passageways while outmigrating (Moore et al., 2015). Our RM and detection efficiency estimates assume that all tagged Coho Salmon are expected to use the Admiralty entrance, but they should be used with caution considering these uncertainties. Detection efficiencies at the JDF and Fraser River lines were close to 100%; however, we acknowledge that the detection efficiency at the Admiralty line (PS1) was lower relative to that of other receiver arrays (~63%), which could inflate uncertainty in the RM estimates. However, RM estimates between JDF and PS1 did not differ in any analyses, and incorporating detection efficiency uncertainty would only widen confidence intervals rather than alter these patterns. Therefore, while this limitation should be acknowledged, it is unlikely to change the overall conclusions of the study.

Recommendations for anglers and fisheries management

Most southern BC recreational fisheries are managed as an MSF, where different fishing regulations are applied to adipose-fin-clipped fish, typically of hatchery origin, with the intention of reducing harvesting pressure on natural origin stocks. Generally, only adipose-fin-clipped fish may be retained or retained at a higher rate than unclipped, typically natural-origin fish. The effectiveness of an MSF depends on low RM and a high proportion of caught fish having marks, thereby reducing adverse effects on unmarked (natural origin) fish. We found that even the RM for Coho Salmon that were in good condition was 21.4%, exceeding the 10% value currently used in management. Future research is needed to disentangle fisheries-related mortality from other sources to determine the significance of this discrepancy and better inform management strategies. Additionally, the possibility that individual fish may be repeatedly caught and released could substantially increase the overall level of release mortality.

The use and implications of gear type and landing method depends on several factors, such as angler experience, target species, regulations, and whether the angler intends to release fish. The knotless, rubber-coated net caused more fin damage than the knotted net but reduced scale loss. Considering the strong link between scale loss and high RM, this trade-off may be justified. Ultimately, no net use and limited handling or, if necessary, a knotless net, will reduce injuries, giving fish a better chance of survival (also recommended by Barthel et al., 2003; De Lestang et al., 2008; Lizée et al., 2018). If the angler intends to release the fish, we recommend that they use a tool (e.g., gaff, pliers) to dehook and release the fish at the waterline, eliminating netting, handling, air exposure, and any related injuries to the fish. To unhook a fish using a gaff, slide the gaff down the fishing line to the hook; then, pull forward with the gaff while simultaneously pulling the fishing line backward above the hook with the other hand. However, using a landing net is often necessary. If the intention is to harvest a fish, the angler may need to ensure they are adhering to management regulations (e.g., identify the species, estimate the size, recognize whether the fish is marked [i.e., hatchery or natural origin]), which can be difficult to do quickly without a net. An angler may require a landing net because of physical ability or experience level or to conduct biosampling. Furthermore, the hook may be located in an area where it is difficult to remove quickly at the waterline (e.g., deep-hooked, gills). Therefore, if using a landing net is unavoidable, we recommend that anglers use a large, knotless, fine-mesh (<5 mm), rubber-coated net that is kept loose and submerged in the water while holding the fish.

Using a hook with a gap width of 15 mm or smaller (e.g., a 3/0 octopus hook) is recommended. We emphasize a 15-mm gap width due to inconsistencies in hook sizing across styles and brands. For example, in our study, the gap width of a 3/0 siwash hook measured 16 mm, whereas a 3/0 octopus-style hook, as reported by Hinch et al. (2024), had a 14-mm gap width. Although we did not test hooks with a gap width that was smaller than 16 mm, larger hooks have been associated with more severe injuries, such as eye damage and bleeding, which increase the likelihood of RM for Chinook Salmon (Hinch et al., 2024; Prystay et al., 2025). Given the possibility of Chinook Salmon bycatch in marine Coho Salmon fisheries, these findings are relevant. A smaller hook may also allow quicker release of nontarget fish (Harris et al., 2021). Further research is required to investigate the potential for smaller hooks or other hook configurations to increase incidences of deep hooking in marine Pacific salmon fisheries (Brownscombe et al., 2017) or whether smaller hooks increase chances of drop-off (i.e., fish being hooked but not captured), introducing other forms of fisheries mortality (Patterson et al., 2017).

Smaller-bodied salmon have a higher likelihood of RM. If anglers frequently encounter undersized fish that cannot be harvested due to minimum size limits, we recommend that they cease fishing, relocate to a different area, or adjust their gear to target larger fish (e.g., using a larger lure). We do not recommend high grading (i.e., choosing to release a fish you could legally harvest in the hopes of catching a larger one).

Pacific salmon anglers are generally open to modifying their fishing practices to improve the survival of fish and many already follow our recommendations in their current fishing best practices (Hinch et al., 2024; Nguyen et al., 2012, 2013). Although getting fine-scale fisheries injury data may not be realistic, gear type could be feasibly monitored through surveys (e.g., Creel, FishingBC App; Sayles et al., 2025) and can be linked to the probability of injuries. Fisheries injuries are important drivers for postrelease outcomes for Pacific salmon, and information on injury frequency and severity is critical to develop biologically relevant fisheries management measures.

SUPPLEMENTARY MATERIAL

Supplementary material is available at *North American Journal of Fisheries Management* online.

DATA AVAILABILITY

Data will be made available upon request.

ETHICS STATEMENT

This study was conducted under the guidelines of the Canadian Council on Animal Care approved by the Animal Care and Use Program at the University of British Columbia.

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CONFLICTS OF INTEREST

The authors declare no conflict of interest.

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