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Informing obligations: Best practice information for catch-and-release in Swedish local recreational fisheries management

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Abstract

Catch-and-release (C&R) is a popular management tool that can support sustainable development of recreational fisheries, if anglers adopt scientifically informed "best practices." However, although the role of best practices is widely established in the academic literature, this knowledge is not always disseminated to anglers. In this paper, we investigated if and to what extent local management organizations provided best practice information to anglers. Based on a sample of 331 Swedish organizations, we reviewed the websites through which these organizations sold fishing licenses. Our review demonstrated widespread use of C&R as a management tool yet a general lack of best practice information. Among the small fraction of organizations that mentioned best practices, most mentioned only a single practice, with little consistency among practices that received attention. In addition, best practice information was particularly lacking for pike (*Esox Lucius*) and perch (*Perca fluviatilis*), which are by far the most landed and released species nationally. We discovered major knowledge deficiencies that provide insights about where and how to focus efforts for improving best practice information, in the context of local recreational fisheries management.

KEYWORDS
C&R science, hierarchical clustering, inland waters, institutional grammar, local management, mandatory C&R

1 | INTRODUCTION

Fishing for recreation, rather than for profit or subsistence, attracts hundreds of millions of people worldwide (Arlinghaus et al., 2021). Most of these people are anglers, who fish with a hook and line attached to a rod that often also includes a reel. Recreational fishing comes with substantial cultural, social, and economic benefits, but can also significantly influence fish population dynamics (Cooke & Cowx, 2004; Lewin et al., 2006). Scholars acknowledge the importance and impacts of recreational fishing and agree that proper management is key to facilitate its sustainable development (Arlinghaus et al., 2019; Potts et al., 2020).

"Catch-and-release" (C&R), or the process of capturing and then releasing fish alive back to the water, is central in conventional recreational fisheries management (Arlinghaus et al., 2007). C&R features many widely used management measures, such as size limits and harvest bans, which respectively requires anglers to release particular sizes of fish and fish caught during certain periods or in certain areas (Cooke & Suski, 2005). The premise is that most or all fish will survive unharmed after release (Wydoski, 1977). Because of

this premise, C&R is largely viewed as a powerful management tool for protecting fish populations, while simultaneously maintaining societal benefits surrounding recreational fishing (Adams, 2017; Cooke & Schramm, 2007; Radomski et al., 2001).

However, a growing body of research problematizes the enforcement of C&R in recreational fisheries management. Numerous studies have revealed that C&R can cause injuries and stress and may therefore negatively impact the health and survival of individual fish (Cooke & Suski, 2005; Lewin et al., 2006; Siepker et al., 2007). Research has also showed how impacts of C&R on fish largely depend on angler behavior (Dunmall et al., 2001; Ferter et al., 2013; Meka, 2004; Nguyen et al., 2012). For example, keeping fish out of water too long can hurt fish in several ways (Cook et al., 2015), while hook, lure, and bait type can influence the degree of tissue damage related to hooking and unhooking (Bartholomew & Bohnsack, 2005; Gutowsky et al., 2017; Muoneke & Childress, 1994; Weltersbach et al., 2019). As a result, management measures that require anglers to release fish can, counterintuitively, lead to overfishing (Ayllón et al., 2019). This body of research shows that C&R has potential to undermine sustainable development of recreational fisheries.

Scholars nevertheless agree that C&R can be an effective management tool, if anglers adopt scientifically informed "best practices" related to handling techniques and angling equipment, such as reduction of handling time, use of barbless hooks, and artificial baits (Arlinghaus et al., 2007; Brownscombe et al., 2017; Cooke & Suski, 2005; Pelletier et al., 2007). The role of best practices is widely established in the academic literature, yet previous studies have indicated that angler communities do not fully recognize or use this knowledge (Blyth & Rönnbäck, 2022; Sims & Danylchuk, 2017). Consequently, managers would benefit from informing anglers about best practices in relation to measures that require anglers to release fish, such as size limits and harvest bans, if they want their management to support a sustainable use of fish populations.

Relatively little research has addressed if and how managers communicate best practices to anglers, and if particular best practices are overlooked or acknowledged in certain management contexts. Such research is, however, necessary to gain insights about where and how to focus efforts for improvement (Pelletier et al., 2007). Herein, this research gap was addressed through a focus on the vast number of local organizations, composed of private fishing rights owners, which manage recreational fishing in most inland European waters without any greater involvement by governmental or academic authorities (Arlinghaus et al., 2002).

Anglers come in direct contact with these organizations when they buy a fishing license. A fishing license is a common requirement for fishing and many anglers today search for and buy fishing licenses online. E-commerce is rapidly becoming a cornerstone of social and economic development, and the Internet is a main source anglers use to find information related to fishing (Nguyen et al., 2012). Online sale of fishing licenses may thus provide a good opportunity for local management organizations to communicate best practice information to anglers. For example, organizations could include this information in descriptions of how, where, and when anglers are expected to fish in particular waters. Few have studied if and to what extent local management organizations use this opportunity.

Our objective was to determine if, when, and how much best practice information appeared on websites used by local management organizations to sell fishing licenses. We used Sweden as a case study and conducted a website review of 331 organizations. Based on the review, we mapped how many organizations would benefit from including best practice information, how many actually did so, and what kind of best practices were mentioned. In addition, we explored patterns in best practice information in relation to other website information describing the organizations and fishing activities prescribed in particular waters, as well as landing estimates of Swedish recreational inland fisheries. Overall, we identified major knowledge deficiencies, important areas for future research and suggested how to increase the use of best practices more widely.

2 | MATERIALS AND METHODS

2.1 | Background

Fishing is a major recreational activity in Sweden. The Swedish Agency for Marine and Water Management [SwAM], together with Sweden Statistics [SwS], monitors the sector through an annual web and postal questionnaire sent to a random sample of permanent residents. Based on 22,000 questionnaires in 2020, over 1.5 million people engaged in recreational fishing and landed more than 24,000 tons of fish (SD = 7500 tons), of which 16,000 tons (SD = 4500) were caught in inland waters. Common target species in inland waters are pike (*Esox lucius*, Esocidae), perch (*Perca fluviatilis*, Percidae), zander (*Sander lucioperca*, Percidae), brown trout (*Salmo salar*, Salmonidae), char (*Salvelinus alpinus*, Salmonidae), grayling (*Thymallus thymallus*, Salmonidae), rainbow trout (*Oncorhynchus mykiss*, Salmonidae), and salmon (*Salmo salar*, Salmonidae) (Table 1). A variety of other species are also caught, including burbot (*Lota lota*, Lotidae), whitefish (*Coregonus lavaretus*, Salmonidae), and several species of cyprinids (Cyprinidae sp.). In light of commercial landings that were estimated to reach 1500 tons in 2020 (SwAM and SwS, 2020b), recreational fishers are clearly predominant users of fish in Swedish inland waters.

Local organizations manage recreational fishing in all Swedish inland waters, except for the five biggest lakes, which are managed by regional and national governmental authorities. More than 2000 management organizations exist today, and they are composed of property owners who, through ownership, hold legal right to use lakes, streams, and rivers. Some represent businesses, fishing clubs, community organizations, or municipalities, but most are fishing associations (called "fiskevårdsområdesförening" [FVOF] in Swedish), as defined by the Swedish Codes of Statues [SCS] 1981:533. With exceptions for some national regulations, such as bans on certain fishing methods or species (SCS, 1993:787), these organizations manage recreational fishing independently of governmental bodies (Paulrud et al., 2011; Rova, 2009).

TABLE 1 Estimated annual landings by fish family and species caught in Swedish inland recreational fisheries, including standard deviation (SD) of landings and percentage of landings released after capture (C&R).

Species family	Species	Total landings (tons)	SD of total landings (tons)	% C&R of total landings
Esocidae	Pike	4017	744	83
Percidae	Perch	2349	369	50
	Zander	740	287	58
Salmonidae	Brown trout	1055	218	47
	Char	262	84	31
	Grayling	234	77	55
	Rainbow trout[a]	654	273	28
	Salmon	421	118	28
Other	Other[b]	704	209	39

Note: Landings represent the error-weighted average of annual estimates during 2018–2022 for each species (Official statistics from Swedish Agency for Marine and Water Management and Swedish Statistics).

[a]Rainbow trout landings only refer to 2020.

[b]Including species such as eel (*Anguilla anguilla*, Anguillidae), catfish (*Silurus glanis*, Siluridae), carp (Cyprinidae sp.), burbot (*Lota lota*, Lotidae), and asp (*Aspius aspius*, Cyprinidae).

To track anglers and their fishing and to raise money, most organizations require anglers to buy a fishing license. No nationwide fishing license exists, and there is no governing body to oversee all license sales for inland waters, so individual organizations decide on what fishing licenses are sold and how to regulate fishing activities that occur in their waters. Thus, anglers must buy different licenses for different waters. Anglers can purchase licenses at various physical locations, such as gas stations, tourist information offices, or even private homes, but to buy licenses over the Internet is increasingly common. Organizations can sell licenses through private websites or their own license sales point on larger online sales platforms that with marketing and administration. During our study, one platform (https://www.ifiske.se/) sold fishing licenses for 1136 organizations (hereafter, "Platform 1") and another platform (https://www.fiskekort.se/) sold licenses for 400 organizations (hereafter, "Platform 2"). Platform 2 closed in autumn 2022, but was administrated by the Swedish Anglers Association ("Sportfiskarna" in Swedish), a not-for-profit organization with a goal to promote sustainable development of recreational fisheries.

2.2 | Data collection

Organizations for our review were primarily identified using an online register of all fishing associations in Sweden (https://fiskekartan.se/) and also Platform 1 and 2. Based on a population of 2349 organizations, a 5% margin of error, and a 95% confidence level, a minimum representative sample size was 331 organizations. To identify the sample, each of the 2349 organizations was first assigned a random number using the Excel function RAND() and sorted from smallest to largest. Organizations were then picked sequentially from the top of the list, and the Google search engine was used to locate information. In total, 660 organizations were searched for, out of which 331 sold fishing licenses online.

The selected websites were reviewed during June to October 2021. Information was compiled about the organizations and activities that were relevant to fishing licenses available. The collected information was accessible to all visitors, but we did not verify if any information was communicated to anglers after purchase of fishing licenses (e.g., as an attachment). Information was entered into an Excel table, and screenshots of every website were copied into Word documents. Data collection focused on written information, because other sources of information (e.g., videos or photos) were absent from most websites.

For over 300 organizations, the reviewed websites were subsites to either of the two fishing license sales platforms. Neither of the platforms communicated any general best practice information on their main site, and individual organizations were responsible for subsites and information included. A few organizations were connected to both Platform 1 and 2, or had their own website and a platform subsite. For these organizations, information was compiled and compared from all sites. Information for all websites was recorded for organization characteristics, including name, geographical location, type of water under management, platform of online fishing license sale, and type and price of fishing licenses. Links to websites were also recorded with an organization ID number.

All websites included text about how to behave and fish as a license holder. Best practice information falls under this category, along with various rules about fishing areas, gear, or catch. The methodological approach "Institutional Grammar" (IG) was used to structure compilation of this text. The IG is based on a syntax for observing, collecting, and analyzing institutional statements, where a statement refers to "a shared linguistic constraint or opportunity that prescribes, permits or advises actions or outcomes for actors (both individual or corporate)" (Crawford & Ostrom, 1995, p. 583). Text indicating do's and don'ts for license buyers was conceptualized as an assembly of institutional statements, and the statements

were recorded in Excel columns that represented different components of the syntax (Table S1; Siddiki et al., 2011). The IG provides a robust classification system of institutional statements that can be used to analyze how rules, strategies, and norms are linked to behavior and outcomes across a variety of situations (Siddiki et al., 2022). However, the IG was applied solely as a tool to systematize data collection and navigation, but not to analyze empirical material. We focused on overall meaning, not analyzing how statements were composed of different components.

2.3 | Data analysis

Data were analyzed in two phases, the first was descriptive and the second was exploratory. In the first phase, the total number of organizations that included institutional statements to which C&R was a mandatory response was calculated. Five different types of statements were then identified, and the number of organizations per type and the fish species specifically addressed in the statement were calculated. Such data do not currently exist for local recreational fisheries management in Sweden, but highlights the relevance of best practice information in this context. Presumably, organizations that included statements mandating anglers to release fish would benefit from providing best practice information. Such information may ultimately facilitate use of these practices and thereby ensure that management supports a sustainable use of fish populations. Hereafter, statements mandating C&R are labeled as "mandatory statements."

The extent to which best practice information appeared on organization websites was assessed next. The assessment was based on a list of 12 practices identified in the C&R as important for reducing C&R impacts (Table 2). Some strategies were not specific for C&R,

TABLE 2 Twelve best practices for catch and release (C&R) categorized into fishing tools or fishing tactics, and motivation for why each of these practices are important for reducing C&R impact on fish, largely based on reviews by Arlinghaus et al. (2007) and Brownscombe et al. (2017). Additional example references are included in the motivation for each practice.

Category	Best practice	Motivation
Fishing tactics	Do not fish at extremely high or low temperatures	Fish are poikilothermic animals which means that they are very sensitive to changing water temperatures. In extremely high or low water temperatures, fish therefore become more sensitive to the stress that C&R may induce (e.g., Boyd et al., 2010; Van Leeuwen et al., 2021).
	Do not fish at too great depths	If a fish is hooked in deep waters and quickly brought up to the surface, there is risk that a fish's swim bladder becomes inflated or even bursts. An inflated or burst swim bladder led to immediate or increased likelihood of mortality (e.g., Eberts et al., 2018; Haggarty, 2019).
	Do not fight fish longer than necessary	The period between hooking and landing a fish, often called the "fight," puts fish under stress. The degree of stress experienced by the hooked fish increases with the time it takes to retrieve it (e.g., Kieffer et al., 1995; Sepulchro et al., 2013).
	Do not handle fish longer than necessary Handle fish in or just above water Handle fish with wet hands	A fish is typically handled during landing and before being released back to the water. Handling can put fish under stress and involve air exposure, which may be viewed as acute hypoxia for fish and led to cardiac disturbances. The longer time a fish is handled and exposed to air, the higher is the likelihood of mortality (e.g., Schreer et al., 2005). Handling fish without wet hands can also damage the protective layer of mucus covering fish skin (e.g., Colotelo & Cooke, 2011; Foster et al., 2020).
Fishing tools	Use hooks of the appropriate shape and type Use barbless hooks	The main source of mortality caused by C&R is hooking injury. Single hooks are often associated with less injuries and easier removal than treble hooks (e.g., Gutowsky et al., 2017). In addition, barbless hooks do not damage the fish at the point of hook entry as much as barbed hooks, and they are also easier to remove, which may cut handling time and air exposure (e.g., Meka, 2004).
	Use specifically designed tools for de-hooking fish	A fish must be unhooked before it can be released back to the water. The process of hook removal can cause injuries related to hooking as well as to air exposure and handling times. Specially designed tools, such as pliers, can help to quickly remove hooks with minimal damage on fish tissue (e.g., Cooke et al., 2022).
	Use artificial lures	Bait type influences the degree of injuries related to hooking and unhooking a fish. In comparison to artificial lures, natural baits (i.e., live or dead animals, or other organic baits such as corn of bread) led to higher mortality. Fish tend to swallow these baits, and such deep hooking is likely to damage vital organs as well as increases the risk of injuring the fish when removing the hook (e.g., Payer et al., 1989).
	Use rubber nets	A net is a common tool for landing fish, but can cause damage to the protective layer of mucus covering fish skin. The degree of damage depends on the type of net and nets made out of rubber seem to minimize such damages (Barthel et al., 2003; Lizée et al., 2018).
	Use rods, reels, and line of appropriate strength	Too light gear can prolong the "fight" time (e.g., Cooke & Suski, 2005).

but addressed consequences of fishing in general. For example, avoiding fishing during periods when fish are reproducing will ensure that mature fish are not killed, stressed, or injured before spawning (Cook et al., 2015). In contrast, other strategies, such as using artificial lures, single hooks, and wet hands while handling the fish, specifically apply to C&R. These strategies relate to either fishing tactics or fishing tools, where tools refer to gear and equipment used for fishing, and tactics refers to how anglers use tools and behave during the angling event (Brownscombe et al., 2017). Strategies that can be used by anglers to change their method of catching and releasing are hereafter termed "best practices" (Table 2).

Best practices may have different effects in different situations (Table 2). For example, the risk of barotrauma is not relevant in shallow waters, and anglers interpret the practice to "not fight fish longer than necessary" differently. Nevertheless, all best practices provide some level of protection for fish, so statements related to best practice on websites were compared to the final list of C&R best practices. For all organizations, each of the 12 practices was scored a "0" if it was not mentioned and a "1" if it was mentioned on the website. The number of practices per organization was then summed, along with the number of organizations per practice, and the total number of organizations that mentioned one or more best practices. In 19 cases, organizations indicated how to release fish using vague terms such as "gently" and "with care" (in Swedish: "*försikigt*" or "*varsamt*"), but did not explicitly define the meaning of these terms. Therefore, they were not counted as organizations that communicated best practices. This assessment of best practice information was inspired by previous studies (Pelletier et al., 2007; Sims & Danylchuk, 2017) and was tested in a pilot study in 2018, where 151 websites were analyzed (Raditya Hanindyawan Handoko, 2018).

The second phase of data analysis investigated when best practice information was included or not included on websites. Specifically, relationships between presence or absence of best practice information and other organization characteristics were examined. This phase was exploratory data analysis because we had a priori expectations for relationships, but we were also interested in discovering new or unexpected relationships. Our approach followed typical exploratory data analysis of variable selection, pattern recognition, and cluster detection (Yu, 2010).

Relationships were explored between best practice statements and following characteristics that described the organizations and their management: average daily permit cost, presence of best practice statements, average number, and type of best practices mentioned, platforms organizations used to sell fishing licenses, presence and type of mandatory statements; fish family mentioned in mandatory statements, presence of statements related to enforcement of rules; presence of statements allowing fishing with passive gear types such as nets and traps, and type and location of water being managed. Hierarchical clustering was used to organize data into discrete clusters based on patterns in data (Murtagh & Contreras, 2012). Data were transformed into binary variables (present or absent), and the Jaccard index was used to create a pairwise dissimilarity matrix of the 331 organizations for use in hierarchical clustering (Fletcher & Islam, 2018). Clusters of organizations were identified based on presence of best practice statements, platforms organizations used to sell fishing licenses, water type managed, and fish family (Esocidae, Percidae, and Salmonidae) mentioned in mandatory statements. The other characteristics did not contribute to the clustering because they led to overly similar clusters yet they still illustrated differences across clusters. Clusters were compared using pairwise Fisher's exact tests of independence (Sprent, 2011). One-way ANOVA was used in combination with Tukey–Kramer tests to compare means among clusters (Kramer, 1957).

To put the results in context, best practice statements were related to estimated release rates for species caught in Swedish inland recreational fisheries (Table 1). Best practice statements were viewed as particularly relevant for organizations that managed fish species with a high release rate that are most exposed to C&R impacts. To examine the relationship between best practice statements and release rate of fish species, the number of organizations was counted that included mandatory statements per species and that included best practice statements. Untrimmed permutation one-way ANOVA tests with 10,000 replications were used to determine if presence of best practice statements differed among species mentioned in the mandatory statements. This analysis compensated for the uneven distribution in the number of mentions of fish species and families in mandatory statements. Fisher's exact tests were used to compare pairwise differences in best practice statements between individual species and families. Fisher's exact tests were also used to test if co-occurrence rate of best practice statements for species varied with estimated release rates for each species (Table 1).

3 | RESULTS

3.1 | Mandatory C&R

On websites, most organizations (n = 266, 80%) included one or several institutional statements to which C&R was a mandatory response. Five types of mandatory statements were identified: minimum size limits, maximum size limits, window size limits, bag limits, and harvest bans (Table 3). The first three types require anglers to release fish below, above, or within certain lengths. The two other types address if and how many fish anglers can kill. Bag limits allow fishers to kill a certain number of fish and thus release fish exceeding this number, while harvest bans forbid harvest, but not C&R. All of these five types of statements often contained a specified object, primarily the species or family (Table 3). The object differed among type of statement. For example, rainbow trout was primarily the subject of bag limits, while pike was the subject of both size and bag limits. Overall, brown trout was the species mentioned most often, but zander, pike, and grayling were also mentioned often. Less popular target species, such as cyprinids and whitefish were rarely mentioned.

TABLE 3 The number of Swedish organizations that included mandatory statements for different fish families and species, and the percentage of organizations that mentioned species for each type of statement, including minimum size limits, maximum size limits, window size limits, bag limits, and harvest bans.

			Type of mandatory statement				
Species family	Species	No. org	Minimum size limit (%)	Maximum size limit (%)	Window size limit (%)	Bag limit (%)	Harvest ban (%)
Esocidae	Pike	75	29	32	33	35	11
Percidae	Zander	90	54	3	41	51	32
	Perch	19	37	42	16	26	21
Salmonidae	Brown trout	146	75	1	11	40	50
	Char	27	81	4	4	48	11
	Grayling	69	82	1	6	28	49
	Rainbow trout	19	11	0	0	95	0
	Salmon	56	71	0	7	54	70
	Whitefish	4	25	0	0	50	25
	Unspecified[a]	36	19	0	0	92	0
Other	Other[b]	28	39	4	0	11	61
	Unspecified[c]	71	8	0	6	76	34

Note: Percentages exceed 100% because organizations may have mentioned one species in several types of statements.

[a]Unspecified salmonids. In these cases, organizations referred to "nobel" fish or "salmonids."

[b]Including species such as eel (*Anguilla anguilla*, Anguillidae), catfish (*Silurus glanis*, Siluridae), carp (Cyprinidae sp.), burbot (*Lota lota*, Lotidae), and asp (*Aspius aspius*, Cyprinidae).

[c]Statements not mentioning a specific species or family but rather fish in general.

3.2 | C&R best practices

Few organizations (21%) communicated best practices through institutional statements. Of 70 organizations, 45 mentioned one practice, 17 mentioned 2–4 practices, and eight mentioned 5–8 practices. No organization mentioned all 12 practices. The three most frequently mentioned practices were use of artificial lures, use of barbless hooks, and handling fish with wet hands (Table 4). Overall, best practices about fishing gear and equipment were more common than best practices about fishing tactics. While practices related to tools were mentioned 81 times, practices related to tactics were mentioned 61 times (Table 4). All best practice statements addressed fish in general, rather than species or families.

3.3 | Best practice statements and other organization characteristics

Organizations were grouped into five clusters (Table 5). The average number of best practices mentioned was below 0.3 in Cluster 1–3, close to one in Cluster 4, and almost two in Cluster 5. Consequently, Clusters 1–3 were labeled as "Low info," Cluster 4 as "Moderate info," and Cluster 5 as "High info." No characteristics were strongly associated with presence or absence of best practice statements. For example, best practice statements were not mentioned by organizations that both included and not included mandatory statements for salmonids, that managed fishing in both streams and lakes located in different parts of Sweden, and that included different types of mandatory statements. Nevertheless, "Low info" clusters tended to be water type "lake" while "stream" was more common in the "High info" and "Moderate info" clusters. Fewer organizations in Southern Sweden were in the "Moderate info" and "High info" clusters than in "Low info" clusters. In addition, the "Low info" cluster with the highest number of organizations (Cluster 3) contained the fewest organizations with mandatory statements specifically for salmonids and mandatory statements in general. Also, the average daily license cost was lower in "Low info" clusters than in "Moderate info" and "High info" clusters.

3.4 | Best practice statements and estimated landings

Best practice statements co-occurred more frequently with mandatory statements that addressed grayling, salmon, and salmonids than with mandatory statements that addressed pike, zander, and perch (Figure 1), but did not differ significantly among species, or families (permutation ANOVA, pairwise Fisher's exact tests). Furthermore, the co-occurrence rate of best practice and mandatory statements differed significantly among release rates for pike ($p < 0.001$), perch ($p = 0.011$), zander ($p < 0.001$), and brown trout ($p = 0.003$). For all four species, the proportion of catches released was significantly higher than the proportion of organizations that included mandatory statements for both species and best practice statements.

TABLE 4 The number of Swedish organizations that mentioned best practices for catch and release (C&R) as fishing tactics or fishing tools.

Category	Best practice	No. org
Fishing tactics	Do not fish at extremely high or low temperatures	6
	Do not fish at too great depths	6
	Do not fight fish longer than necessary	6
	Do not handle fish longer than necessary	12
	Handle fish in or just above water	12
	Handle fish with wet hands	19
Fishing tools	Use appropriate hook size and shape	16
	Use barbless hooks	21
	Use specifically designed de-hooking tools	7
	Use artificial lures	32
	Use rubber nets	2
	Use rods, reels, and line of appropriate strength	3

4 | DISCUSSION

Our review indicated a high relevance for best practices in Swedish local recreational fisheries management, but a lack of best practice information on websites that local organizations used to sell fishing license. As showed by the high presence of mandatory statements, organizations relied heavily on C&R as a management tool, which corresponds to the tradition of using measures that mandate anglers to release all or part of their catch in recreational fisheries management of European inland waters (Arlinghaus et al., 2002). Still, few organizations included any best practice information on their websites.

Among the few organizations that included best practice statements, most only mentioned one practice and there was little consistency in which practices were mentioned. This lack of consistency was also found in other studies that analyzed online best practice information (Pelletier et al., 2007; Sims & Danylchuk, 2017). Practices related to handling fish were mentioned less frequently than practices such as use of artificial baits and barbless hooks, yet handling tactics are of vital importance for reducing air exposure, which is universally stressful for all fish (Cook et al., 2015). In addition, practices related to handling are strongly featured in the Keepemwet Fishing (KWF) campaign (http://www.keepemwet.org) that was designed by fisheries scientists to communicate best practices that transcend species and angling communities (Danylchuk et al., 2018). We therefore recommend that efforts for improving the communication of best practice information should prioritize best practices related to tactics.

The generally low level of best practice information among websites, regardless of organizational characteristics, indicated a broad lack of awareness of best practices. It is possible that organizations may use other communication channels than websites we reviewed, but our finding aligned with previous studies that also showed a lack of information and knowledge about best practices in other contexts (Blyth & Rönnbäck, 2022; Pelletier et al., 2007; Sims & Danylchuk, 2017). In general, recent research indicates that best practices are relatively unknown outside of academia and confirms a general need to educate anglers and managers (Holder et al., 2020).

The uncovered diversity of local management organizations justify further studies about what and why organizations manage fish resources by, for example, requiring anglers to use best practices. First, this diversity can guide further exploration of other aspects of importance for understanding presence and absence of best practice information. For example, many organizations that included best practice information also sold fishing licenses at a higher price and managed running waters. This combination of a high price for a fishing license and the "stream" water type may indicate the presence of uniquely valuable fish such as wild Atlantic salmon, which is a popular target in some rivers (ICES, 2021) and anglers are often willing to pay for that species (Olaussen & Liu, 2011). Further study is warranted on the relationship between best practice information and the type of fish, beyond the species level, under management. Second, the diversity raised questions about motivations and abilities that underpin local management, as also illustrated in other studies (e.g., Olsson & Folke, 2001; Sandström & Rova, 2010; Stensland, 2012). For example, an overall absence of institutional statements could perhaps suggest little knowledge and willingness to engage in fisheries management, which may be widespread among private fishing right holders who control local management (Paulrud et al., 2011). Overall, further studies of what and why local management organizations manage fish resources could reveal and clarify possible leverage points for improving best practice information as well as management in general (Daedlow et al., 2011; Klefoth et al., 2023; Sandström & Rova, 2010).

We found a general absence of best practice information, especially for pike and perch, the most released species nationally. Considering that pike and perch are primarily caught in lakes (SwAM, 2022), increasing best practice information for organizations that manage lake fishing appears to be an urgent policy priority. Targeting lake fisheries can also positively affect other species that are targeted in lakes, such as zander, char, and whitefish, because best practices become more of social norm and their effects are not limited to single species (Mannheim et al., 2018; Sass & Shaw, 2020). However, in light of uncertainties associated with estimated landings (SwAM & SwS, 2020a), we suggest further study of websites and landings for organization that manage lakes.

The mismatch between available information and released landings for pike and perch may also have indicated that people view and handle these species as relatively less sensitive to C&R (Arlinghaus et al., 2007; Hühn & Arlinghaus, 2011; Meyer et al., 2021). Such views do not align with scientific knowledge, because both species suffer a range of lethal and sublethal effects from C&R, despite being relatively more resilient than other species, (Arlinghaus et al., 2008; Czarkowski & Kapusta, 2019; Klefoth et al., 2011). C&R can negatively affect both perch and pike behavior and health

TABLE 5 Characteristics and types of best practices advertised by five clusters of local Swedish recreational fisheries management organizations.

Organization characteristics		Clusters					
Cluster number		1	2	3	4	5	
Cluster label	Total	Low info	Low info	Low info	Moderate info	High info	
Number organizations	331	19	99	125	62	26	
Characteristics							
Average daily permit cost in Swedish krona[¶]	75	51[b]	73[ab]	64[b]	95[a]	104[a]	***
Best practice statements							
Present	**70**	**5%**	**4%**	**11%**	**40%**	**100%**	
Average number of best practices[¶]	0.43	0.05[c]	0.06[c]	0.22[c]	0.90[b]	1.97[a]	***
Type of best practice							
Tools[§]	54	5%[a]	2%[a]	5%[a]	37%[b]	85%[c]	***
Tactics[§]	31	0%[a]	2%[a]	9%[a]	15%[ab]	35%[b]	***
Platform type							
1	**236**	**95%**	**70%**	**100%**	**2%**	**88%**	
2	**80**	**16%**	**13%**	**2%**	**100%**	**0%**	
Other	23	5%	19%	0%	0%	12%	
Mandatory statements							
Present[§]	266	89%[a]	92%[a]	61%[b]	92%[a]	96%[a]	***
Type of mandatory statement							
Min size[§]	175	74%[a]	59%[a]	31%[b]	71%[a]	77%[a]	***
Max size[§]	33	16%	9%	11%	11%	0%	ns
Window size[§]	69	32%	16%	24%	18%	23%	ns
Bag limit[§]	185	74%[a]	60%[a]	38%[b]	77%[a]	62%[ab]	***
Harvest ban[§]	125	58%[ab]	41%[a]	16%[c]	56%[ab]	69%[b]	***
Fish family in mandatory statement							
Esocidae	**75**	**26%**	**16%**	**33%**	**21%**	**0%**	
Percidae	**98**	**47%**	**23%**	**38%**	**23%**	**15%**	
Salmonidae	**180**	**79%**	**90%**	**6%**	**76%**	**85%**	
Other[§]	27	16%	5%	9%	8%	12%	ns
Unspecified[§]	71	16%[ab]	17%[a]	15%[a]	31%[ab]	50%[b]	***
Prescence of statements enforcing rules[§]	123	26%[a]	30%[a]	37%[a]	42%[ab]	62%[b]	*
Prescence of statements allowing passive gear types[§]	44	11%	20%	12%	8%	8%	ns
Water type							
Lake	**278**	**0%**	**100%**	**100%**	**63%**	**0%**	
Stream	**161**	**100%**	**55%**	**20%**	**60%**	**100%**	
Part of Sweden							
South[§]	143	42%[ab]	29%[a]	66%[b]	27%[a]	27%[a]	***
Mid[§]	73	26%	26%	19%	19%	23%	ns
North[§]	115	32%[ab]	44%[a]	15%[b]	53%[a]	50%[a]	***

Note: Clusters were identified based on differences among characteristics marked in bold. Characteristics not marked in bold did not contribute to clustering, but differences were statistically tested among clusters, as indicated by the significance stars and letters. Clusters are ordered based on the average number of best practices mentioned on websites of organizations within each cluster. Cluster 1 has the lowest average and Cluster 5 the highest. [abc]Letters indicating significant differences between clusters. *p-value < 0.05; ***p-value ≤ 0.001; [ns]p-value > 0.05.

[§]Independence across clusters was tested with Fischer's exact test.

[¶]Independence across clusters was tested with Tukey-Kramer test.

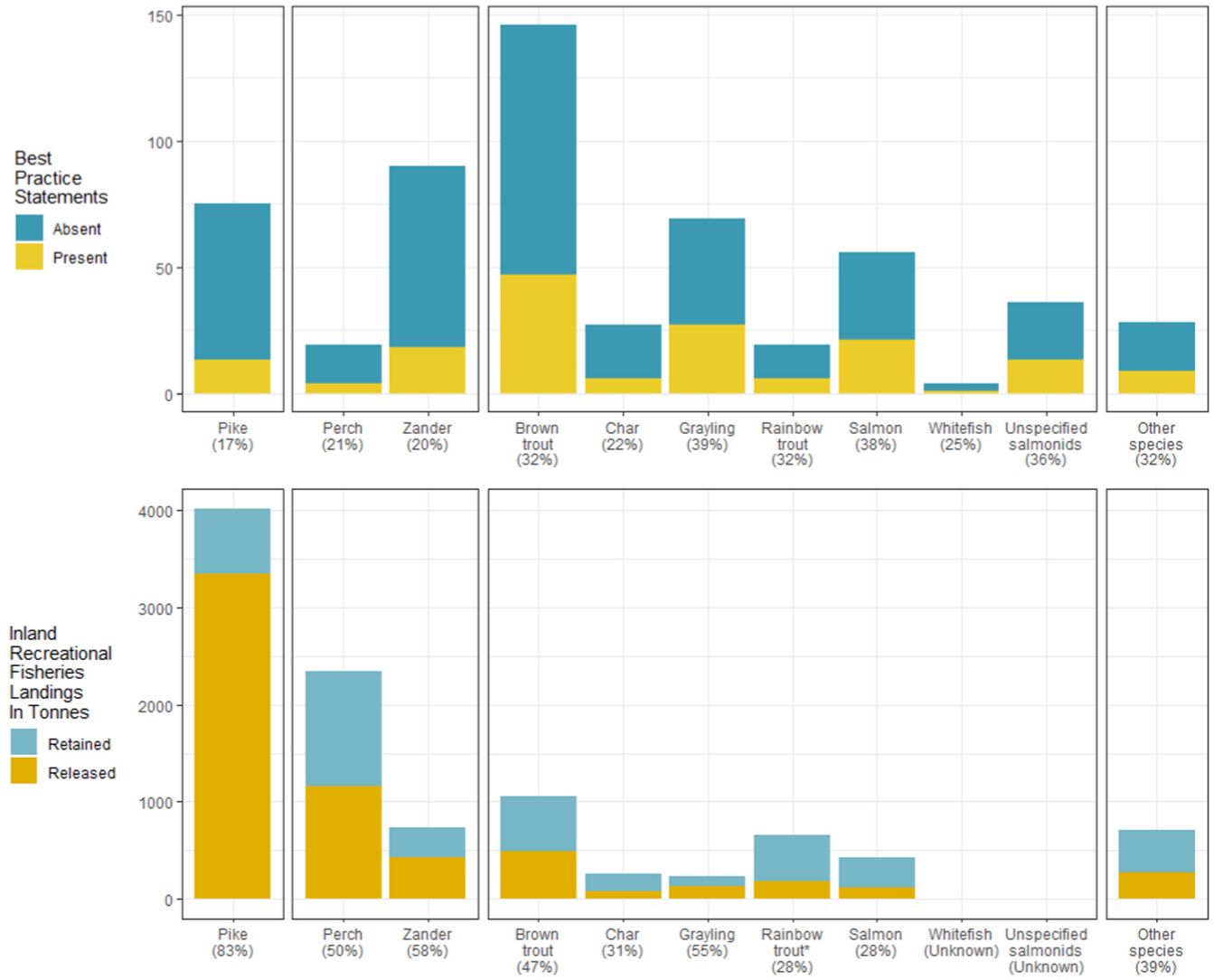

FIGURE 1 Co-occurrence of best practice and mandatory statements (top panel), and estimated annual landings within Swedish recreational inland fisheries by species (bottom panel). In the top plot, the y-axis indicates the number of organizations, and blue color indicates the number of organizations that included mandatory statements only, while yellow color indicates the number of organizations that included both mandatory and best practice statements. The percentage of organizations that included both mandatory and best practices statements is shown in brackets below the species name. In the bottom plot, blue bar color indicates retained landings, and orange color indicates released landings. Landings represent the error-weighted average of annual estimates during 2018–2022 for each species (Official statistics from Swedish Agency for Marine and Water Management and Swedish Statistics). The percentage of landings released is shown in brackets below the species name.

(Garner et al., 2016; Stålhammar et al., 2012, 2014). Therefore, we encourage further research about human perceptions of different species and their potential ecological consequences, which would also contribute to scholarly discussion about the role of cultural values in management and conservation (e.g., Danley et al., 2021; Langlois et al., 2022; Rypel et al., 2021; Sass & Shaw, 2020).

Considering that nearly 1200 organizations sell fishing licenses through a platform (https://www.ifiske.se/), license sale platforms could be instrumental in disseminating best practice information to a vast number of anglers. For example, a website could use a "default nudge" (Thaler & Sunstein, 2009), in which standardized best practice information appears on all websites unless organizations choose to opt out of such statements. Best practice information could build on practices identified and knowledge assembled in the KFW campaign (Danylchuk et al., 2018). Feasibility of this suggestion would first need to be explored to determine if those behind platforms are motivated and able to disseminate best practice information to license buyers.

Like others (Brownscombe et al., 2015, 2017; Cooke & Suski, 2005; Sims & Danylchuk, 2017), we assumed that use of best practices can be facilitated through communication of information. One type of information source was explored here, but different anglers prefer different information sources, so several communication channels and initiatives are likely needed (Nguyen et al., 2012).

Moreover, presenting best practice information alongside other information comes with a risk of diluting the importance of best practices, which could reduce the potential to influence angler behavior (Lee & Lee, 2004). The KFW campaign is one example of a promising initiative for bridging the gap between science and practice (Danylchuk et al., 2018). Yet considering the diverse nature of recreational fisheries, more initiatives are required to emphasize and foster responsibility among anglers, managers at different levels, and people involved in the angling industry for communicating best practice information (Cooke et al., 2019).

Another topic for future research could be to what extent communication of information actually facilitates the use of best practices. Recent research highlights the need to move beyond supplementation of information by applying other outreach approaches, including behavioral interventions (Mannheim et al., 2018) and education (Delle Palme et al., 2016). Equally important are questions related to compliance or lack of compliance, which is a common problem in recreational fisheries management (Mackay et al., 2018). For example, what do anglers think about C&R impacts, do they agree with practices identified in C&R science, and do they see a reason to behave in line with available information?

5 | CONCLUSION

This and previous studies indicated a general lack of awareness of C&R best practices outside of academia. In the context of local recreational fisheries management in Sweden, we found that best practice information needs to improve overall, but especially for pike and perch fishing in lakes, the most released species nationally. Our results also indicated that species were viewed and handled differently by managers and anglers, although C&R can have numerous consequences for all fish, with the degree of consequences largely dependent on the situation (Arlinghaus et al., 2007). We therefore emphasize the importance of communicating best practice information widely for all species.

Our findings highlighted issues related to responsibility in recreational fisheries management. To ensure that management measures mandating C&R fulfill their goals, local managers must develop and establish information related to best practices. How much responsibility can be put in the hands of this group of people and how to ensure that local managers are aware of and acknowledge available scientific knowledge? Indeed, local management organizations manage most inland waters independently and therefore have great potential to influence freshwater fish and environments by mitigating fishing impacts. Much work remains to be done to facilitate a broad use of best practices, some of which will likely require closer collaboration and coordination among local managers and stakeholders, including governmental and non-governmental organizations and C&R scientists. We look forward to continued scholarly discussion about how to promote best practices and who should bear responsibility for doing so.

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CONFLICT OF INTEREST STATEMENT

The authors have no conflicts of interests to declare.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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