



Recreational anglers' attitudes, beliefs, and behaviors related to catch-and-release practices of Pacific salmon in British Columbia



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ABSTRACT

The fate of captured and released fish in recreational fisheries depends in large part on fisher handling and behavior. As such, there is a need for promoting adoption of responsible fishing practices. We interviewed recreational sockeye salmon anglers in the lower Fraser River, British Columbia, to assess their awareness of responsible fishing practices and identify gaps where improved education could promote conservation-oriented behaviors. Based on our interview data, we developed three latent class models of salmon angler typologies based on: 1) anglers' fishing behaviors and preferences, 2) anglers' perceived risks to salmon survival due to post-capture live release, and 3) anglers' level of support for education programs. In the first model, we identified salmon-only anglers (33% of sample), lake-species specialists (46%), and all-around anglers (21%). These classes were differentiated primarily by non-salmon fishing activities (e.g., other target species). In the second model, we found four classes of anglers who differed with regards to key factors they thought affected post-release survival: air exposure (39% of sample); water temperature (24%); hook location (22%); and revival effort (15%). In the third model, we found anglers were either supporters (73%) or non-supporters (27%) of angler education programs. Heterogeneity existed among anglers but we found no correlations in angler classes across models, nor any significant demographic or experiential predictors of class membership. Respondents generally had high awareness and application of catch-and-release best practices, with lake-species specialists rating a higher awareness and usage of recommended catch-and-release technique, and were significantly more likely to cut the line on deeply hooked fish than other groups. Our findings provide resource managers with important insight into the attitudes and behaviors of sockeye salmon anglers in the important lower Fraser River recreational fishery. Our findings also highlight, however, the need for further research on the determinants of angler beliefs and behavior in order to customize programs to build anglers' awareness and adoption of responsible fishing practices.

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1. Introduction

Recreational angling has been implicated in the decline of some freshwater fish populations (Post et al., 2002) through harvest, post-release mortality, or most likely a combination of both (Coggins et al., 2007). Anglers have access to some of the most sensitive ecosystems and critical habitats (Donaldson et al., 2011), often outnumber commercial fishers (Cooke and Cowx, 2006), and can represent a strong vocal and political constituency that may

constrain managers' options for achieving conservation targets (Danylchuk and Cooke, 2011). In some situations, recreational angling may be a threat to ecosystem viability and fish survival but, in other cases, anglers can positively influence conservation outcomes if successfully engaged in the management process (Granek et al., 2008; Gray and Jordan, 2010; Danylchuk and Cooke, 2011).

The potentially pivotal role of recreational anglers in the conservation of freshwater species (Cowx et al., 2010) implies that close attention needs to be paid to recreational anglers' attitudes and behaviors. Anglers come from different socio-demographic backgrounds, seek different fishing experiences, and vary in avidity and commitment to fishing (Fisher, 1997; Wilde et al., 1998; Oh and Ditton, 2008). Anglers' motivations can range from catching trophy fish to simply enjoying the outdoor experience (Fedler and

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Ditton, 1994; Hunt and Bettoli, 2007; Arlinghaus, 2006; Beardmore et al., 2011). Just as their motivations vary, so too can anglers' attitudes and preferences toward management and their willingness to engage in finding solutions to conservation challenges (Reichers et al., 1991; Salz and Loomis, 2004; Arlinghaus and Mehner, 2005; Dorow and Arlinghaus, 2012). Characterizing these differences among anglers (e.g., Fisher, 1997; Morey et al., 2006; Johnston et al., 2010) and the basis for such differences could assist managers in understanding and balancing stakeholder needs. Additionally, degree of angler specialization (skills, equipment, setting) has traditionally been used to characterize a continuum of general to specialized angler behavior, which may also influence angler preferences and attitudes toward various management paradigms (e.g., Bryan, 1977; Connelly et al., 1990; Salz and Loomis, 2005). The fate of captured and released fish thus becomes largely dependent on anglers' attitudes and behaviors (Cooke and Suski, 2005; Pelletier et al., 2007).

Stern et al. (1999) highlighted the importance of environmental values, threat salience, and peoples' ability to affect change as factors in designing management strategies that successfully facilitate behavioral change. Gray and Jordan (2010) recommended that similar goals and perceptions shared by managers, scientists, and anglers need to be highlighted for effective outreach strategies in promoting ecosystem-based management. They suggested that education should be framed around what is valued by the audience, not simply by managers supplying information. Threat salience is important because it directly affects people's willingness to take action to reduce threats to valued resources (Stern et al., 1999). Threat salience can be influenced directly by improved awareness of threats (e.g. increased angler awareness of the effects of water temperature on post-release survival) and indirectly via changes to deeper core values or worldviews (e.g., acceptance that climate change will inevitably lead to increased water temperature). How an angler reacts to a specific management measure – their propensity for compliance with water temperature-based fishery closures for example – depends on their perspectives on the legitimacy of that measure as well as the financial or other costs they personally bear. By better understanding behavioral aspects of recreational angling, it is possible to design and implement education and management strategies that have a higher likelihood of engaging anglers (Arlinghaus, 2006) and promote biological sustainability of fish populations (Johnston et al., 2010).

Increased education and awareness can potentially be an efficient and cost-effective mean for encouraging responsible fishing behavior (Cooke et al., in press). Little, however, is known about anglers' perspectives regarding responsible fishing practices despite the fundamental importance of such information (see Margenau and Petchenik, 2004; Arlinghaus et al., 2007; Cooke et al., in press). By understanding anglers' attitudes toward responsible fishing and conservation, their underlying beliefs about what affects survival of fish after a catch-and-release event, and their fishing behavior, managers can make better decisions regarding initiatives to increase salmon survival.

We used British Columbia's (BC) lower Fraser River sockeye salmon recreational fishery as a case-study to explore how improving our understanding of anglers' diversity may inform management strategies meant to shape behaviors important for successful fish conservation. Specifically, we assessed angler awareness and uses of catch-and-release techniques recommended by management agencies to identify knowledge gaps where improved education could increase responsible fishing. We used exploratory latent class models as a segmentation tool to characterize heterogeneity among Fraser River salmon anglers with regards to their fishing behaviors and preferences, perceived risks to salmon survival due to post-capture live release, and level of support for angler education programs on

responsible fishing practices. We also sought to investigate relationships among selected predictor variables and identified angler sub-groups from the latent class models to gain new insights on and possibly predict angler behavior, perceptions, and responses to potential management initiatives. This information is likely central to the design of effective management measures to improve fish survival and conservation.

2. Case study

The Fraser River in British Columbia (Fig. 1) is one of the most productive salmon rivers in the world (Northcote and Larkin, 1989). Fisheries management in the Fraser River system is complex (Healey and Hennessey, 1998) and expensive: about CAD\$40 m is spent annually on salmon management and habitat conservation in BC. Multiple salmon species and stocks co-mingle during their migration upriver and more vulnerable non-target species and stocks (e.g., endangered, undersized) are required to be released alive after capture. Three fishing sectors (commercial, recreational and First Nations) target salmon in the Fraser watershed. Various organizations share management responsibilities and the Pacific Salmon Treaty guides transboundary management. First Nations depend on salmon for food, social, and ceremonial purposes (Muckle, 2007) and have opportunities to fish commercially in some years. Recreational fishers target salmon for both food and leisure purposes. Different stakeholders and sectors differ in their priorities and views, so there is a pressing need to identify management options that minimize potential conflicts and improve salmon specific conservation outcomes.

The recreational Fraser River sockeye salmon (*Oncorhynchus nerka*) fishery, one of the primary recreational fisheries in the river system targeting Pacific salmon, can consist of over 1000 anglers fishing simultaneously. Although a 'sport' fishery, it is primarily a harvest-oriented fishery and has a catch limit of two sockeye salmon per person daily (DFO Creel Survey, 2010). However, catch-and-release in this fishery becomes prominent when non-target species (e.g., protected species and/or stock, undersized or juvenile fish) co-migrate with sockeye salmon. Also, anglers may voluntarily release sockeye salmon (e.g., if seeking to catch a larger fish or continuing catch-and-release fishing after the daily bag limit is reached) or when a fish is not hooked by the mouth or lip (i.e. foul hooking), of which the fish must be released to remain compliant with regulations. Of the estimated 200,000 sockeye salmon landed in 2010, just over 100,000 were released (DFO Creel Survey, 2010).

The effects of recreational salmon catch-and-release is of particular concern in the Fraser River system in the face of climate change. Rising river water temperatures and changing hydrological regimes are forecasted and will lead to higher en-route mortality of migrating adult salmon (Battin et al., 2007; Farrell et al., 2008; McDaniels et al., 2010; Martins et al., 2011). Capture events during warm water temperatures can cause increased stress, behavioral impairment, and potentially increased mortality of migrating adult salmon (Gale et al., 2011). Therefore, it is critical that appropriate handling and release methods (i.e., 'responsible fishing') are developed now and used to minimize additional physiological disturbances and mortality in the Fraser River system.

3. Methods

3.1. Survey instrument

We conducted face-to-face semi-structured interviews to collect both quantitative (rating and rankings) and qualitative (open end) data needed to explore the attitudes and behaviors of active Fraser River sockeye salmon anglers (see Appendix A in the online

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