Making the switch: Assessing the potential for catch-and-release in Nova Scotia's recreational shark derbies

by

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ABSTRACT

Many shark populations are regionally and globally threatened by overfishing and bycatch, often aggravated by the practice of shark finning. While most conservation efforts have been aimed at enforcing sustainable quotas, mitigating bycatch, and banning shark finning, the impact of recreational fisheries on some shark populations is increasingly recognized. Catch-and-release angling and the use of best handling practices is also growing in many areas of the world, as one measure to mitigate negative impacts. However, Canada is one of the few nations to still have a catch-and-kill policy for recreational shark derbies, despite mandating catch-and-release in all other recreational shark fishing. Moving towards a catch-and-release policy requires an understanding of the regulatory landscape, and derby participant motivations. This thesis presents results from surveys of 26 derby boat captains and 30 derby spectators on motivations, perceptions, and attitudes towards catch-and-release. Also presented here are case studies of the barriers, benefits, and strategies used in catch-and-release initiatives in the United States, Australia, and New Zealand. Survey results indicated that derby boat captains were uneven in their support for catch-and-release. However, most were primarily motivated by the overall challenge of catching sharks rather than winning awards, and were interested in receiving training on handling and tagging practices, suggesting anglers may be open to engagement. Spectators likewise had conflicting perspectives on sharks, and remarked that they learned little about the animals at derbies. Both stakeholder groups were interested in expanding scientific opportunities associated with existing derby events. Case study analyses revealed that catch-and-release initiatives in other countries had multiple drivers and often involved collaborative partnerships between anglers, scientists, and government. The thesis concludes that anglers should be further engaged in catch-and-release and tagging efforts, as well as mandatory training on best handling practices. Both survey and case study results suggest that a gradual transition to catch-and-release is both possible and desirable in the Canadian context.

Keywords: shark, elasmobranch, chondrichthyes, catch-and-release, tag-and-release, tagging, recreational fishing, recreational angling, sportfishing, gamefish, tournaments, derbies, fishing competitions

AFMA - Australian Fisheries Management Authority

ANSA - Australian National Sportfishing Association

ASF - Atlantic Shark Forum

CAP - Atlantic Canadian Conservation Action Plan for Selected Pelagic Shark Species

CITES- Convention on the International Trade in Endangered Species of Fauna and Flora.

CMS - Convention on the Conservation of Migratory Species of Wild Animals

CoP16 - Conference of the Parties

COSEWIC- The Committee on the Status of Endangered Wildlife in Canada.

DFO- Department of Fisheries and Oceans Canada.

DFO-Science – the Science division of Department of Fisheries and Oceans Canada

EEZ- Exclusive Economic Zone. A zone under national jurisdiction up to 200-nautical miles wide.

EPBC Act (Australia) - Environment Protection and Biodiversity Conservation Act 1999

FAO- Food and Agricultural Organization

GFAA - Game Fishing Association of Australia

GTMP (Australia) - Gamefish Tournament Monitoring Program

HMS – Highly Migratory Species

IGFA - International Game Fish Association

IUCN - International Union on the Conservation of Nature

IFMP- Integrated Fisheries Management Plan.

IPOA-Sharks- The UN FAO International Plan of Action for the Conservation and Management of Sharks.

MPI (New Zealand) - Ministry for Primary Industries

NGO - non-governemental organizations

NIWA (New Zealand) - National Institute of Water and Atmospheric Resources

NMFS- National Marine Fisheries Service (United States)

NOAA – National Oceanic and Atmospheric Administration (United States)

NPOA-Sharks - National Plan of Action for Sharks

NSCBD - National Strategy for the Conservation of Australia's Biological Diversity

NZBGFC (New Zealand) - New Zealand Big Game Fishing Council

NSSRLCF (Australia) - National Strategy for the Survival of Released Line-caught Fish

OCEARCH - global shark tracker (http://www.ocearch.org/tracker/) (based in United States)

OTN – Ocean Tracking Network (based in Canada)

Sharks MoU (Australia) - Memorandum of Understanding on the Conservation of Migratory Sharks

USC - Guy Harvey Ultimate Shark Challenge

WWF- World Wildlife Fund.

Recreational fishing – generally refers to hook-and-line angling, spearfishing, or the use of nets and traps for the purpose of recreating (rather than profit).

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"*Many men go fishing all their lives without knowing that it is not the fish they are after.*"

- Henry David Thoreau

"The fun of fishing is catching 'em, not killing 'em."

- Norman Schwarzkopf

1. INTRODUCTION TO THE MANAGEMENT ISSUE

1.1. Context

Sharks are one of the oldest extant predatory taxa, having appeared 400 million years ago and having survived several mass extinctions (Ferretti et al., 2010). As such, marine ecosystems have evolved with sharks as top predators for millions of years and their demise has been shown to have cascading effects on marine ecosystems (Ferretti et al., 2010). Sharks, like all marine species, are impacted by habitat loss, climate change, and ecosystem shifts (Techera & Klein, 2011). In addition to these widespread anthropogenic impacts, sharks face a number of specific threats, including overfishing, finning, and bycatch mortality (Worm et al., 2013; Shiffman et al., 2014). Targeted elasmobranch fisheries have grown dramatically in the last decades (Holts et al., 1998). In 2000, total mortality of sharks was calculated at 1,455,000t, or the equivalent of 100 million sharks per year, with similar levels assumed for 2010 (Worm et al., 2013). Thus, conservation action is needed. However, effective conservation often requires data on species growth rates, migration patterns, habitats, population dynamics, and other such information in order to assess the sustainability of fishing practices (White & Kyne, 2010). Effective shark management is often challenged by a lack of reliable data on which to base stock assessments and total mortality estimates from bycatch, discards, and landing records (Stevens et al., 2000). For example, in Eastern Canada, observer coverage is relatively low (Davis & Worm, 2013), and bycatch is typically not recorded, (and when it is, it is usually not to the species-level) (pers. comm., Corke WWF, 2014). Although changing, public perceptions of sharks as dangerous to humans and a nuisance to fisheries continue to deflate political will to allocate the necessary resources towards

effective protection of sharks (Field et al., 2009). The combination of these various threats have resulted in major population declines. In the NW Atlantic, Baum et al. (2003) estimated population reductions of at least 75% for several large pelagic and coastal shark species within 15 years, and Myers and Worm (2003) estimated large predatory fish biomass declined by over 90% worldwide over 50 years (Myers & Worm, 2003). These findings are particularly disturbing as sharks are thought to play an important role in maintaining healthy ecosystem structure (Heithaus et al., 2008; Baum & Worm, 2009; Ferretti et al., 2010; Heithaus et al., 2010).

While most efforts have been aimed at mitigating bycatch in commercial fisheries and banning the practice of shark finning to supply Asian markets, the potential for recreational fisheries to have a negative impact on shark populations and ecosystems is increasingly recognized (McPhee et al., 2010; Shiffman et al., 2014). The impact of recreational angling on fish populations depends on its scope and intensity. Modern recreational fishing is now more efficient with the use of technologies such as echo sounders, global positioning systems (GPS), and highly specialized fishing lines and hooks (McPhee et al., 2010). Social media technology is further increasing the efficiency of anglers, as "hot spots" are shared over the internet on forums and angling websites, allowing fishers to locate previously hard-to-find areas (McPhee et al., 2010). Trophy fishing (in which anglers compete to catch the largest fish to win an award) can have a disproportionate impact on marine ecosystems, as it targets the largest and often most fecund individuals in the population (Shiffman et al., 2014). This practice is likely to diminish the ability of the population to recover from anthropogenic impacts such as overfishing, even when the number of fish removed is relatively small compared to

commercial catches (Holts et al., 1998; Shiffman et al., 2014). Selective targeting of large fish can be particularly detrimental to species that already have reduced populations, are slow-growing, late to mature, and produce few offspring, such as sharks (McPhee et al., 2010; LeQuesne & Jennings, 2012). Furthermore, because it is not motivated by profit like commercial fishing, recreational fishing frequently occurs in isolated marine areas and targets rare and vulnerable species (Arlinghaus et al., 2007). In Eastern Canada, more than half of 42 reported elasmobranch species are listed on the International Union on the Conservation of Nature (IUCN) Red List, including 8 shark and 4 skate species (Davis & Worm, 2013). Worldwide, 85 of the 1222 species for which all-tackle records were issued by the International Game Fish Association (IGFA) are listed on the IUCN Red List of Threatened Species, including 15 species of shark and 4 skates and rays (Shiffman et al., 2014). While the IUCN Red List is a widely respected guide for scientists and environmental managers worldwide, as it does not lead to automatic protection, many listed species are not protected from hunting and fishing (Baillie et al., 2004).

Until recently, winning a world record fish required that it be transported to a weigh-station. This meant most fish, especially large pelagic fish caught far offshore, could not be caught and released (Shiffman et al., 2014). However, the IGFA has introduced a length-based catch-and-release world records division, which may help alleviate some of the pressure on large marine gamefish (Shiffman et al., 2014). Recreational anglers are increasingly using catch-and-release and tag-and-release when catching large gamefish (Holdsworth & Saul, 2010), and often use technologies such as digital cameras and smartphones to validate records without killing the fish (Shiffman et al., 2014). Approximately two-thirds of the over 47 billion fish caught globally are

released, though post-release survival is variable and depends on gear used, fish handling practices, and the sensitivity of the species (Shiffman et al., 2014; Holland & Ditton, 1992). In addition to the obvious conservation benefits of catch-and-release, several shark fishing tournaments have shown economic benefits as well (Shiffman et al., 2014). Catch and release is sometimes seen in cooperative tagging programs involving scientists and recreational anglers. Tagging programs produce data on the movement, age, growth, and stock structure of large pelagic species which would otherwise be costly and difficult to study, and provide benefits to both anglers and scientists (Ortiz et al., 2003; Holdsworth & Saul, 2010).

1.2. International laws on shark fishing

Since the FAO developed the IPOA-Sharks in 1999 (FAO, 1999), several member nations have developed a National Plan of Action for Sharks in their region (NPOA-Sharks, 2012), including Australia, Japan, Argentina, Uruguay, Seychelles, Malaysia, Ecuador, Australia, Taiwan, United Kingdom, United States, and one for the Mediterranean Sea, Mexico, and Canada (FAO, 2014). The IPOA and many (if not all) NPOA's include recreational shark fishing in their scope, although their focus is largely on commercial fishing and bycatch mitigation (NPOA-Sharks, 2012).

Several elasmobranch species are listed under Appendix II of the Convention on International Trade in Endangered Species of Wildlife (CITES), including basking shark (*Cetorhinus maximus*), whale shark (*Rhincodon typus*), and great white shark (*Carcharodon carcharias*), with the exception of sawfishes (*Pristidae*), which are listed under Appendix I. In 2013, at the conference of the parties (CoP16), six additional

elasmobranch species were added to Appendix II, including oceanic whitetip (*Carcharhinus longimanus*), porbeagle (*Lamna nasus*), scalloped hammerhead (*Sphyrna lewini*), great hammerhead (*Sphyrna mokarran*), smooth hammerhead (*Sphyrna zygaena*), and manta rays (*Manta spp*.). These additions may promote benefit conservation efforts as a number of endangered species are regularly targeted by recreational anglers (as mentioned previously).

1.3 Shark conservation in Eastern Canada

In some respects, Canada has been a leader in shark conservation. The development of the National Plan of Action for Sharks (NPOA-Sharks) in 2011 made Canada one of the first nations to implement the recommendations of the International Plan of Action for Sharks (IPOA-Sharks) (Davis & Worm, 2013). The IPOA-Sharks was developed by the Food and Agricultural Organization of the United Nations (FAO) in 1999 to guide shark-fishing states in the effective conservation and management of sharks and their relatives (skates, rays, and chimaeras) (Davis & Worm, 2013). According to the IPOA-Sharks, effective conservation and management is to be achieved through identifying data gaps, increasing research and improving data; mitigating threats to sharks; identifying priority conservation actions; enhancing educational programs; and strengthening collaboration and consultation amongst stakeholders (Davis & Worm, 2013). Canada's NPOA-Sharks was a direct response to the IPOA-Sharks, however, it fails to meet many of its recommendations, including i) engaging stakeholders in its design and implementation, ii) creating action points, developing timelines, and identifying responsible agencies for these action points, iii) having a review process

every 4 years, iv) reducing shark discards, and v) completing a shark assessment report (SAR) among others (Davis & Worm, 2013). Recognizing these shortcomings, in 2011 the World Wildlife Fund Canada (WWF) organized the Atlantic Shark Forum (ASF) to bring together various interest groups including the Department of Fisheries and Oceans Canada (DFO), fishing sector, non-governmental organizations (NGO), scientists, and industry representatives to agree upon top priorities of shark conservation for science, management, and the fishing industry (Atlantic Shark Forum, 2011). Stemming from this forum was the creation of Sharks of the Atlantic Research and Conservation Centre (ShARCC), a mechanism for maintaining communication amongst stakeholders of the ASF, as well as a venue for ongoing monitoring and feedback[1]. Among other improvements, this led to cooperative research on shark bycatch by NGOs, university researchers, and industry (Cosandey-Godin et al., 2013). In March 2014, a second meeting organized by WWF was held to bring together expert shark scientists from across Eastern Canada to comment on the DFO's first draft of the Atlantic Canadian Conservation Action Plan for Selected Pelagic Shark Species (CAP). The development of a CAP for sharks is an important step following from the establishment of the IPOA and NPOA, as integrated management plans at various scales have been shown to support effective management (Techera & Klein, 2011). However, there is doubt as to whether the CAP is an improvement upon the NPOA-Sharks; while its creation incorporated extensive stakeholder feedback, identified action steps, timelines, and accountable parties, it is lacking a clear objective and has yet to define a review process (Shark Expert Meeting, 2014; pers. comm., Corke WWF, 2014).

[1] http://atlanticsharks.org/

Recreational shark fishing is not adequately addressed in the IPOA-Sharks, Canada's NPOA-Sharks, the top priorities identified in the ASF, or the CAP. The NPOA in particular does not promote best handling and release practices that would, in the case of undersize sharks caught at fishing competitions, help to reduce post-release mortality (Davis & Worm, 2013). The focus on commercial fishing may in part be due to a lack of data on recreational fishing, however, these gaps are not outlined in the NPOA (Davis & Worm, 2013). Most of the recreational shark fishing in Eastern Canada focuses on blue sharks (*Prionace glauca*), which account for 99% of all landed sharks in recreational shark tournaments (Campana et al., 2004). Recreational shark tournaments were found to account for 3% of the fishing mortality of blue sharks in Canada, thus likely having a minor impact on population abundance and overall mortality (bycatch by foreign vessels being the most prominent cause of blue shark mortality) (Campana et al., 2004). The same study also found that both commercial and recreational catch rates of blue shark had declined in since 1995, and suggests that relative population abundance has decreased (Campana et al., 2004). Median size of blue sharks has also declined since 1987, implying an increased mortality rate (Campana et al., 2004). Despite these findings, the overall population of blue sharks appears to be healthy (pers. comm., Campana DFO, 2014).

1.4 Recreational shark fishing in Eastern Canada

Both commercial and recreational shark fisheries in Eastern Canada are managed by the DFO under the Department of Fisheries and Oceans Act, Oceans Act, and the Fisheries Act (NPOA-Sharks, 2007). The Fisheries Act provides the Minister of DFO with the authority to issue licenses and make regulations for the conservation and protection of fish (NPOA-Sharks, 2007). The first integrated fishery management plan (IFMP) specifically for sharks was developed in 1995, one year after the first shark fishing tournament in Nova Scotia (Babcock, 2008). The IPOA-Sharks was developed by the FAO in 1999. The IPOA-Sharks provided detailed guidelines and encouraged nations to develop national plans (Davis & Worm, 2013). In 2006, a new regulation specified that only blue sharks larger than eight feet are to be landed at derbies. Landing of mako and thresher sharks (the other two most commonly caught sharks at Canadian derbies) is only permitted for individuals a minimum of 6ft in total length (pers. comm., Corke WWF, 2014). Landing of porbeagle sharks is not permitted, as porbeagle are listed as *Endangered* ("A wildlife species facing imminent extirpation or extinction") under the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). Recreational shark fishing is restricted to rod and reel only, and all fishers require a special license to participate in the shark derbies which they can acquire from DFO[2]. Anglers are required to submit logbooks to DFO (pers. comm., Corke WWF, 2014).

Canada is one of the few nations to still have a catch-and-kill policy for recreational shark derbies. Recreational shark derbies, which have increased since their

[2] http://www.dfo-mpo.gc.ca/libraries-bibliotheques/toc-tdm/326182-eng.htm

inception in 1994, are commercially and/or community-sponsored competitions held several times during the months of July, August, and September. The purpose of these derbies is for anglers to compete to land the largest sharks. While recreational shark fishing licenses in Eastern Canada are normally restricted to catch-and-release only, authorized shark tournaments are exempt from this rule provided they contribute to the scientific data collection needs of DFO-Science (NPOA-Sharks, 2007). DFO-Science requires that sharks are landed whole/round, and that at a minimum, length, weight, sex, and location are recorded, and when possible, sexual maturity (NPOA-Sharks, 2007). Blue sharks are most often caught (99%), although thresher (*Alopias vulpinus*) and mako (*Isurus oxyrhincus*) are sometimes caught as well. Information gathered is in turn used by DFO's Shark Research Laboratory to examine data collected during the derbies, ideally, to help set sustainable catch rates for shark fisheries[3], although DFO-Science acknowledges that there is sufficient data from commercial fisheries and the data from recreational derbies provides a very small portion of overall data collection (pers. comm., Campana DFO-Science, 2014).

1.5 Project aims and research question

The aim of this project is to examine how other countries have increased catch-and-release in their recreational shark fisheries, and to apply this knowledge to the Canadian context in order to establish guidelines for a possible transition to a catch-and-release model. Data from surveys on derby boat captains and spectators conducted by

[3] http://www.bio.gc.ca/sharks/derbies-eng.php

WWF were analyzed to assess opinions on catch-and-release. The aim of the survey analysis was to explore how recreational derby anglers and spectators feel about moving to catch-and-release. The research question can be stated as, “How have other shark-fishing states implemented catch-and-release in their recreational shark fisheries, and what lessons can be applied to Canada?” Through case study analysis, the drivers, barriers, and strategies used in other countries were used to make recommendations for Canada to move towards catch-and-release.

2. ANALYTIC FRAMEWORK

2.1 Methods

Research methods included an analysis of survey results, a case study analysis, and literature search. Surveys of derby boat captains and derby spectators (i.e. the public audience) were used to examine perceptions, motivations, and attitudes towards catch-and-release. Survey results from two quantitative surveys (one for derby boat captains and one for derby spectators) designed and administered by WWF between July and August 2014 were analyzed. Survey questions were based on studies looking at the behavior (Sutton & Ditton, 2001), psychology (Arlinghaus et al., 2007), preferences (Oh et al., 2007), and norms (Kagervall *et al.*, 2014) of recreational anglers towards catch-and-release. Three WWF representatives (one employee and two volunteers) handed out the surveys to derby boat captains three days before the Yarmouth Shark Scramble was to take place. This derby is one of the largest of the six annual shark tournaments organized in Nova Scotia. Surveys of public spectators were handed out by volunteers from a summer shark class at Dalhousie University during the day of the Yarmouth derby, after the last shark had been brought to shore. Participants were selected at random, and completed surveys were subsequently returned to the WWF office for analysis. Derby boat captains at the Louisbourg shark tournament were mailed surveys one week prior to the derby, to be handed out at the captains meeting by the derby organizer. No surveys of spectators at the Louisbourg derbies were conducted (due to lack of volunteers). Survey results were mailed back to WWF for analysis.

In addition to surveys, a case study analysis was conducted on catch-and-release programs in three nations in order to identify common drivers, challenges, and strategies

used to implement catch-and-release. Countries to be analyzed for case studies were chosen based on those shown in the literature to have significant pelagic shark recreational fisheries (Babcock, 2008); these included Australia, New Zealand, and the United States.[4] Shark fishing tournaments and clubs were identified using the interactive mapping tool on the IGFA website[5] and searching for weigh stations or fishing clubs containing the keywords "shark" or "sharks". Club names were subsequently entered into a Google search to gather more detailed information (i.e. confirm that the clubs fished for sharks, whether through leisure fishing, charter boat fishing, or tournaments).

2.2 Information sources

All other information from this report was accessed through internet research using Google Scholar and Dalhousie library access to various databases and online journals, as well as several books taken from the Dalhousie library. The major sources of information for this project came from i) government literature, such as the NPOA's of Canada, Australia, and New Zealand, ii) scientific and grey literature on other case studies of states that have catch-and-release or tagging programs, and iii) scientific publications on the effects of catch-and-kill derbies on shark populations as well as catch-and-release post-mortality rates. Search terms included the keywords "sharks, elasmobranchs, chondrichthyes, recreation(al), sport, trophy, competitive, fishing, tournament, derby", and "competition". When searching for derbies in specific countries, the above search terms were paired with "Canada, Australia, New Zealand", or the

[4] It should be noted that recreational shark fishing does occur, though to a lesser degree, in the United Kingdom, Ireland, Italy, the Azores, Mauritius, South Africa, the Caribbean, and Mexico (Babcock, 2008).
[5] http://www.igfa.org/Maps/Default.aspx

"United States". Surveys and personal communication (in person, via email or Google phone) with shark derby organizers, DFO, boat captains, fishers, and WWF personnel also informed the project.

3. RESULTS

3.1 Survey Results

3.1.1. Surveys of derby boat captains

Demographics and Fishing Experience

Most of the derby boat captains surveyed at Yarmouth and Louisbourg identified as fishermen by occupation (81%, n=26). The majority of captains at both locations were from the derby town, or a town nearby. Survey responses from derby boat captains from Yarmouth and Louisbourg differed on two questions. First, Yarmouth captains appeared to have attended more derbies than Louisbourg captains (Figure 1). The second divergence was on the question of whether captains would support a trial run of catch-and-release in the future. Yarmouth captains were divided almost equally between opposing, supporting, and feeling neutral about the trial run, whereas Louisbourg captains were more supportive (Figure 2). There was no difference in overall fishing experience between the two samples; the majority (65%) of captains surveyed had spent 11-30 years fishing (Figure 3). Number of days spent fishing in the previous year was also consistent between the two samples (Figure 4).

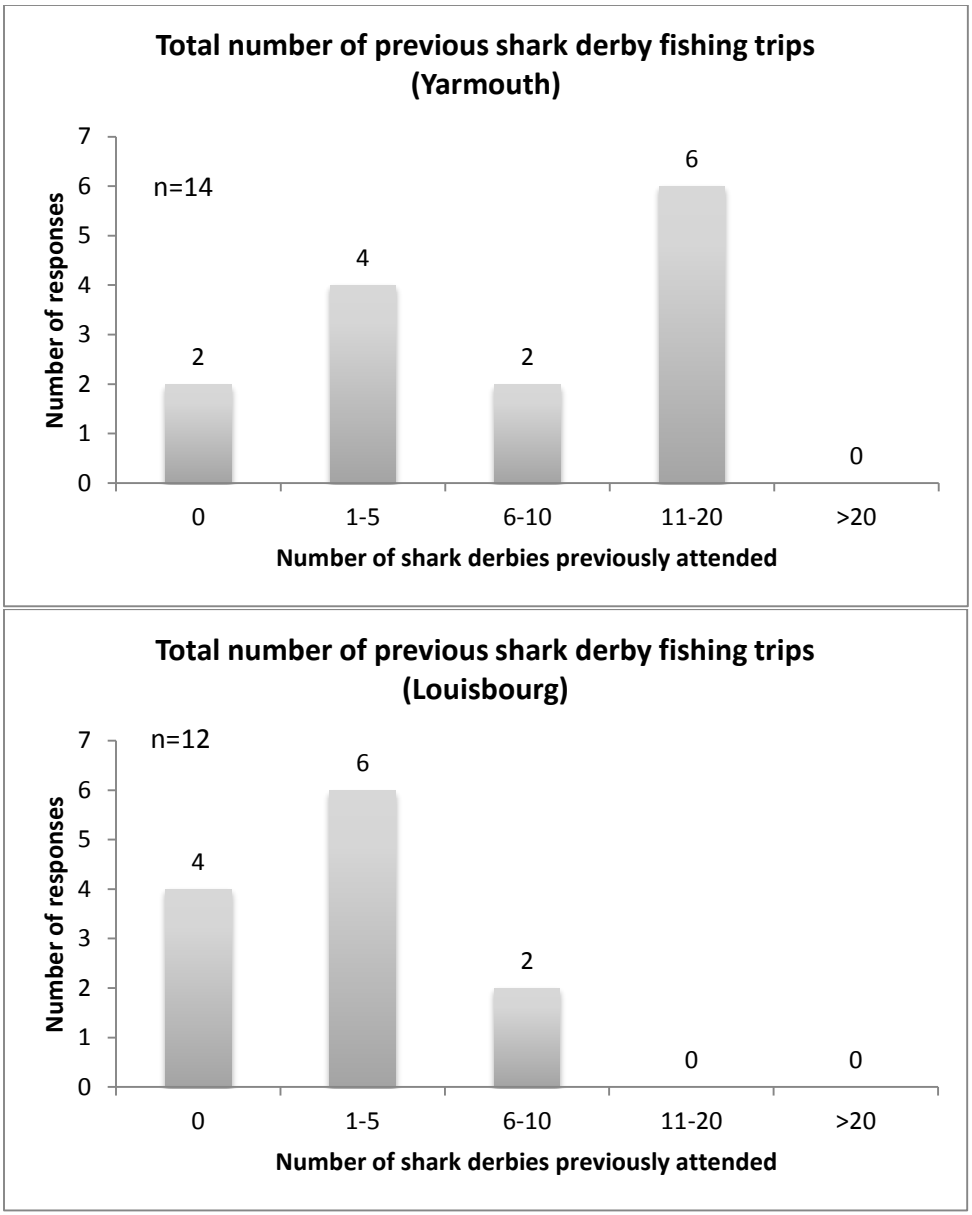

Figure 1 Total number of shark derby fishing trips previously attended by Yarmouth and Louisbourg derby boat captains in Canada or internationally.

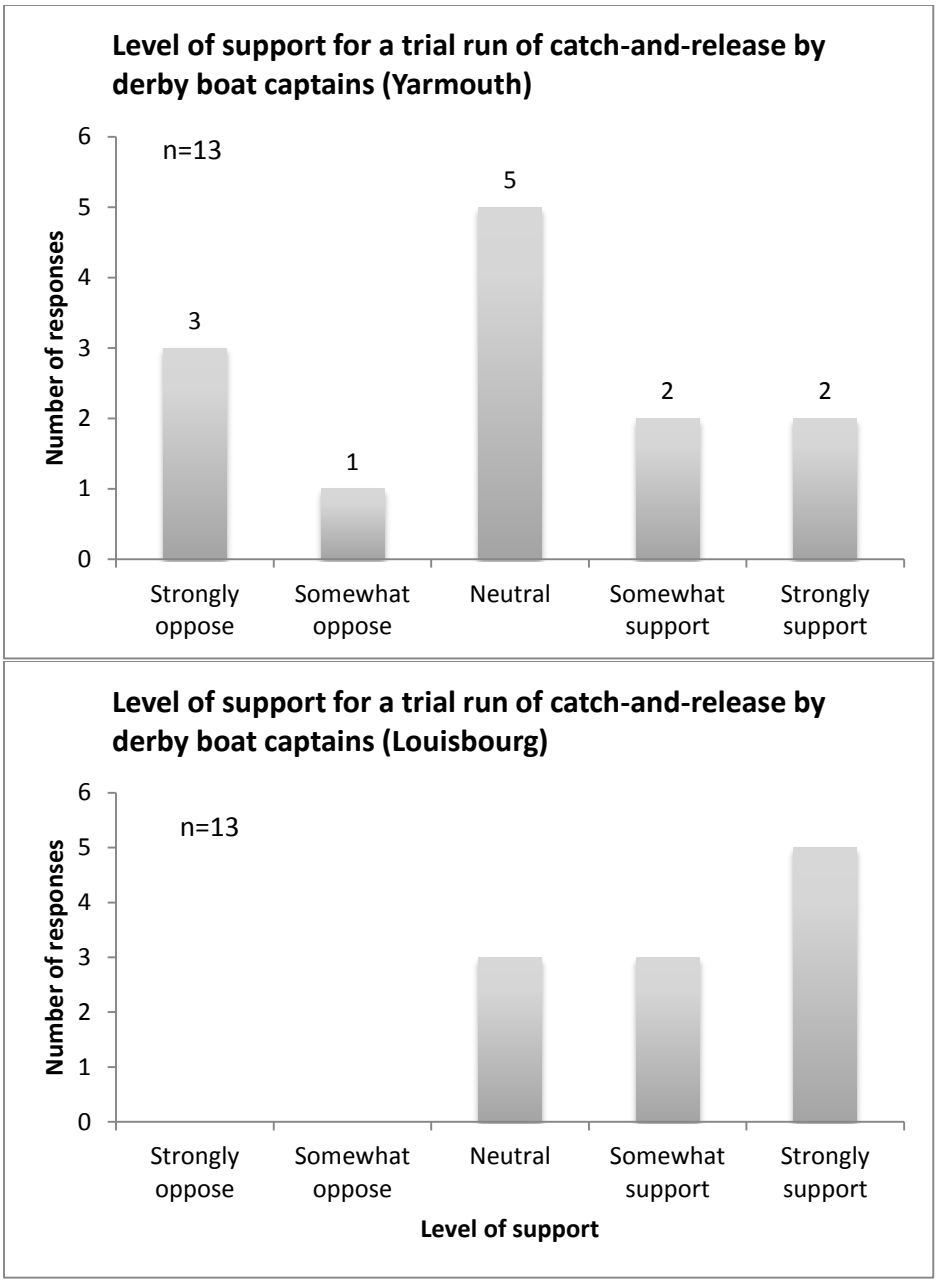

Figure 2 Level of support for a trial run of catch-and-release in the future as rated by derby boat captains at the Yarmouth and Louisbourg derby.

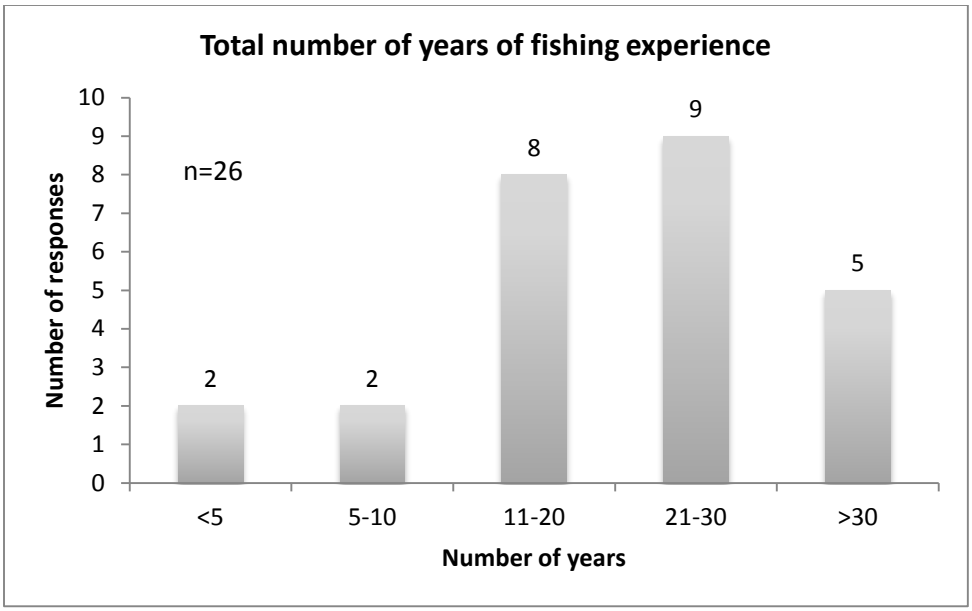

Figure 3 Total number of years spent fishing any species recreationally or commercially by derby boat captains.

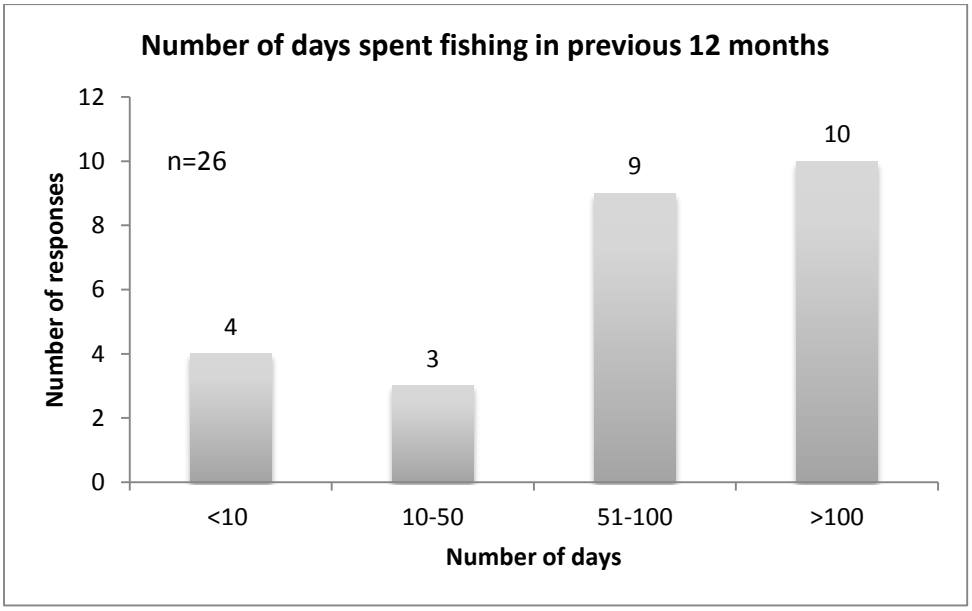

Figure 4 Number of days spent fishing any species (recreationally or commercially) in previous 12 months by derby boat captains.

Perceptions and Motivations

The majority (84%) of captains believed sharks to be an important part of the marine ecosystem. This response was chosen significantly more often than any other option (dangerous to people, nuisance to fisheries, neutral/don't know, and threatened species that needs protection), despite the ability for survey respondents to choose more than one option (Figure 5). Survey results found that winning an award was not as important as other motivations for shark fishing, such as the *Overall challenge of catching sharks*, *Spending time with friends and family*, or *Getting to interact with sharks* (Figure 6). Furthermore, the desire to *Catch as many sharks as I can* was rated as 'Not at all important' by 40% of respondents (Figure 6).

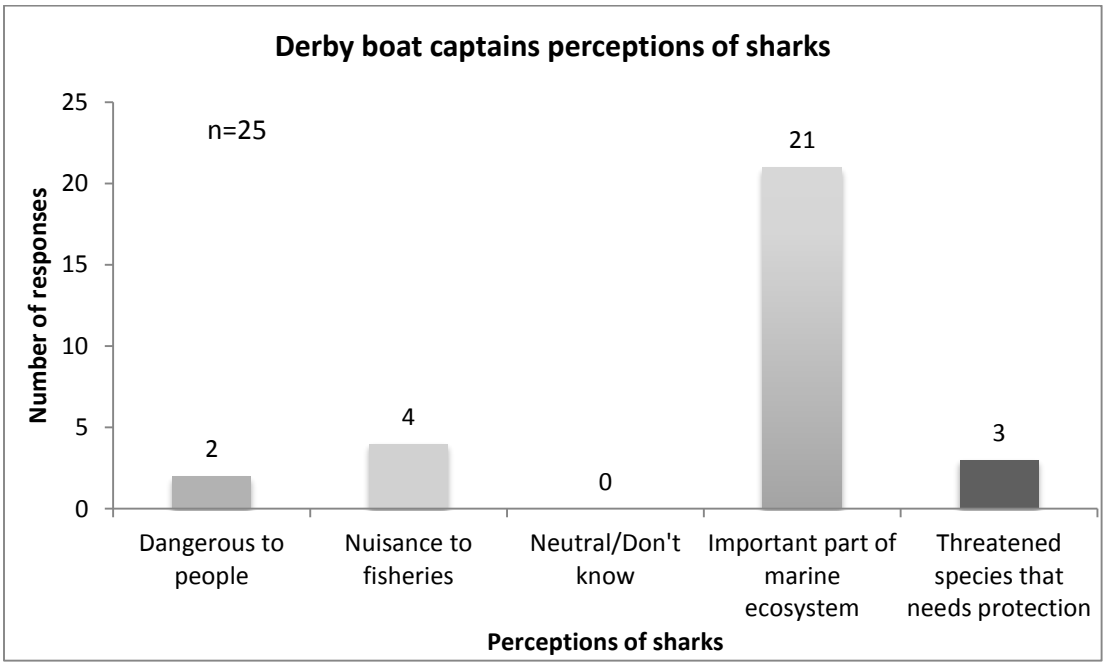

Figure 5 Number of responses by derby boat captains to the survey question, "What is your perception of sharks in our region?"

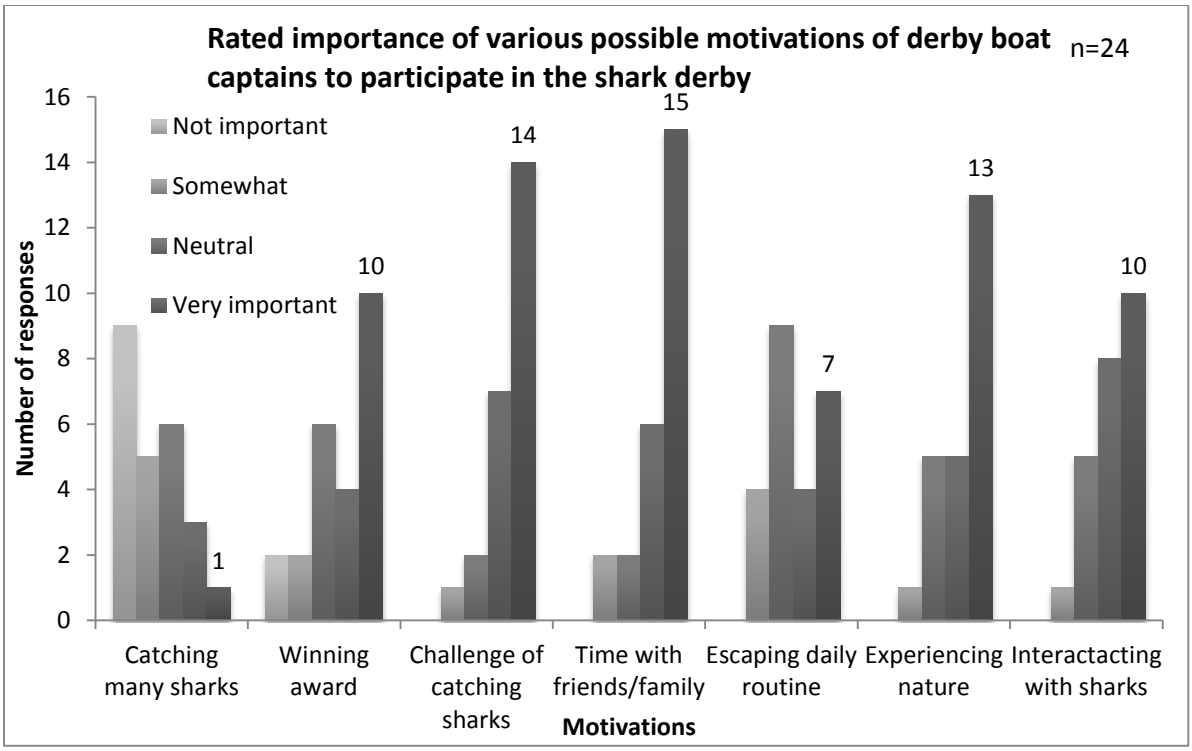

Figure 6 Motivations of derby boat captains to participate in the shark derby. Captains were asked to rate the importance of the various possible motivations on a 5-point scale from 'Not important' to 'Extremely important'.

Catch-and-Release Attitudes

About 96% of the captains had practiced catch-and-release before, nearly 70% of whom said they had a positive experience with it (Figure 7), and over half had released catch to keep the fish population healthy or conserve the species (Figure 8). Comments included, "*Good to see fish swim away healthy*" and *"Helps maintain the species*".

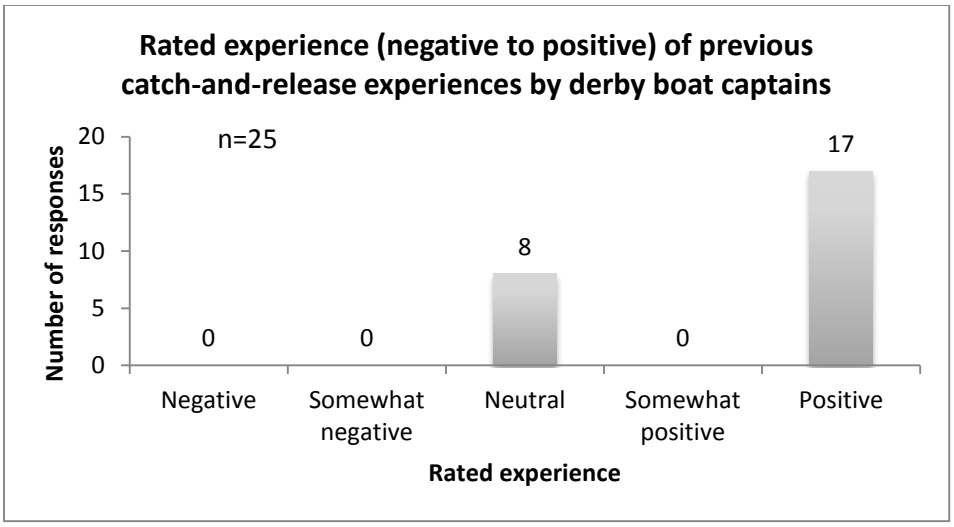

Figure 7 Previous experience with catch-and-release as rated by derby boat captains (on a 5-point scale from Negative to Positive).

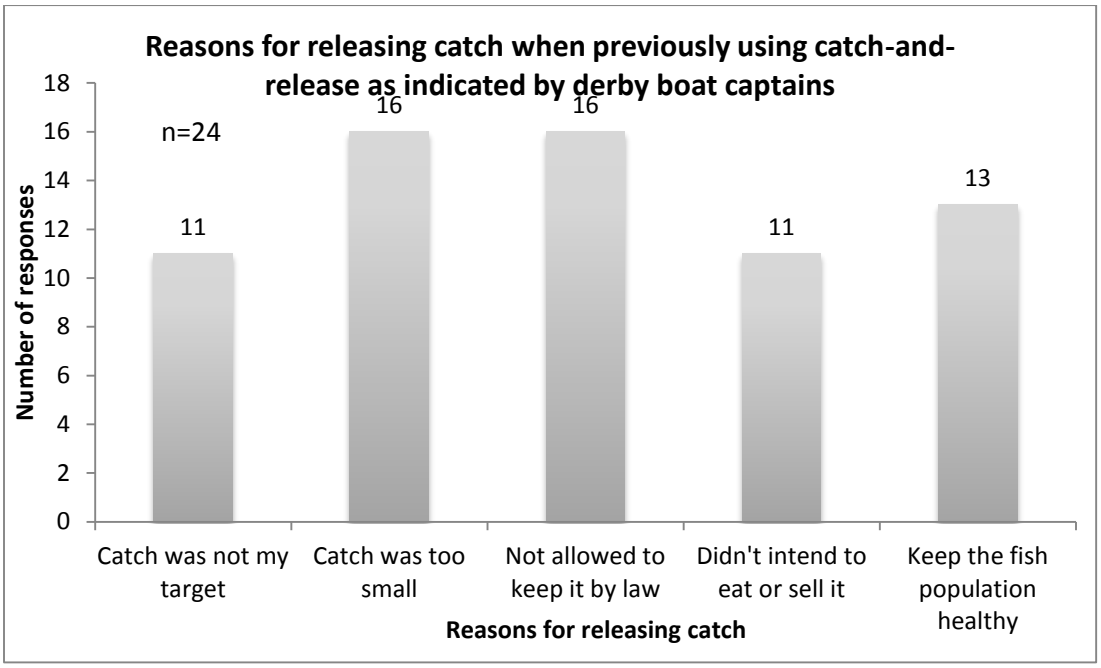

Figure 8 Reasons for releasing catch as reported by derby boat captains.

Derby boat captains were divided on whether they would support having an observer on the boat at a catch-and-release derby. One third were neutral, less than one third were opposed, and slightly over one third were supportive (Figure 9). About 95% of captains rated the option "Caught and kept an award-winning shark" as Very satisfying,

while only 67% rated "Caught sharks and released them (winning an award)" as "Very satisfying" (Figure 10).

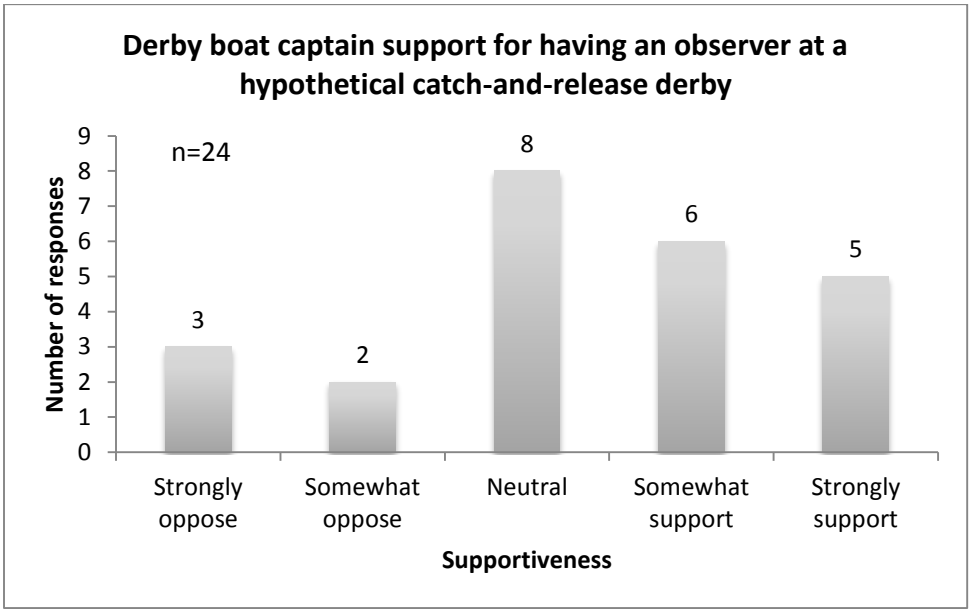

Figure 9 Support for having an observer as rated by derby boat captains.

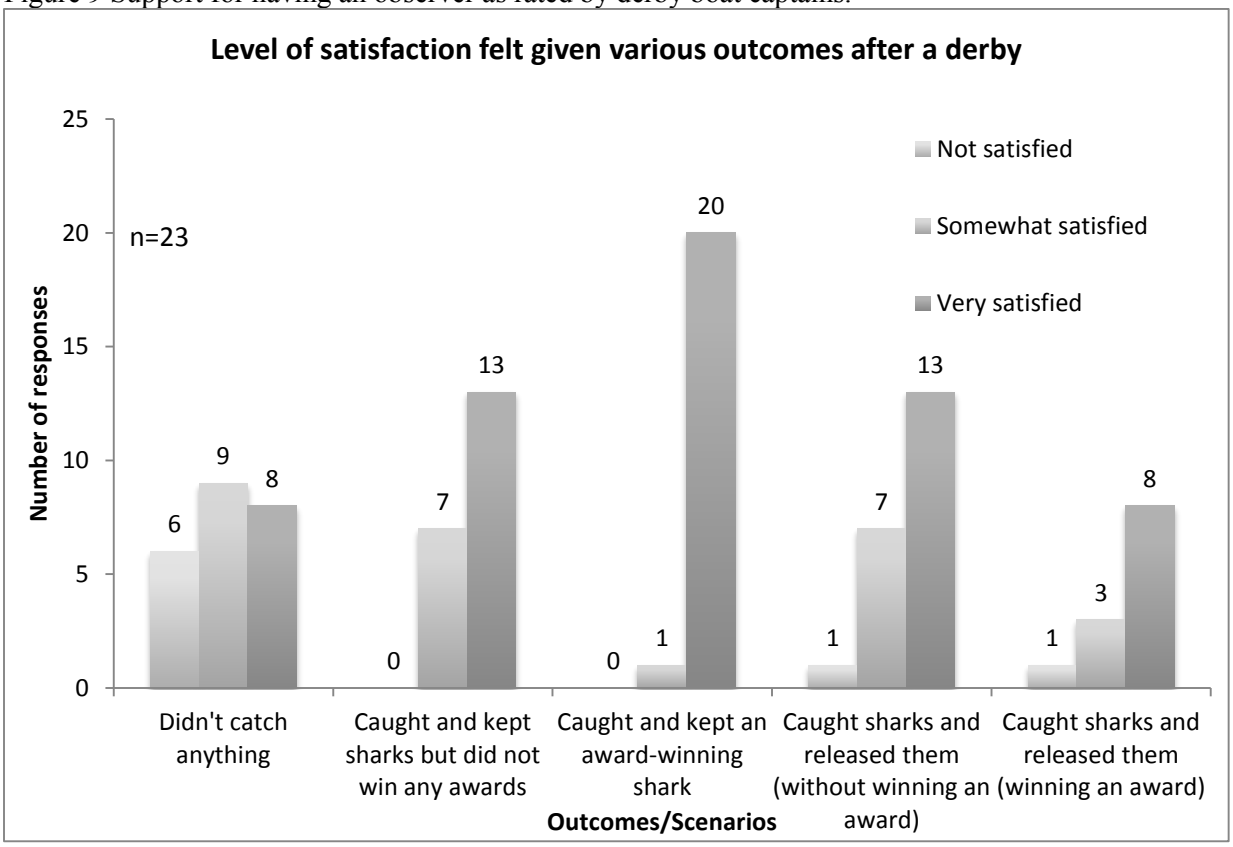

Figure 10 Rated level of satisfaction of derby boat captains given various scenarios of catch-and-kill and catch-and-release.

About half of all captains had received training on best practices in handling & releasing sharks, while half had not. When asked to describe where they had received training, two respondents wrote, "*Self-taught*" and "*Experience"*. Of those who had not received training, almost 60% said they were interested in doing so. While captains did not seem to find the idea of more information on sharks appealing (55% neutral), participating in scientific research (i.e. tagging studies) was rated as appealing as 'good prizes' and displaying photos/videos of shark fishing to spectators at the derby (all above 60%) (Figure 11).

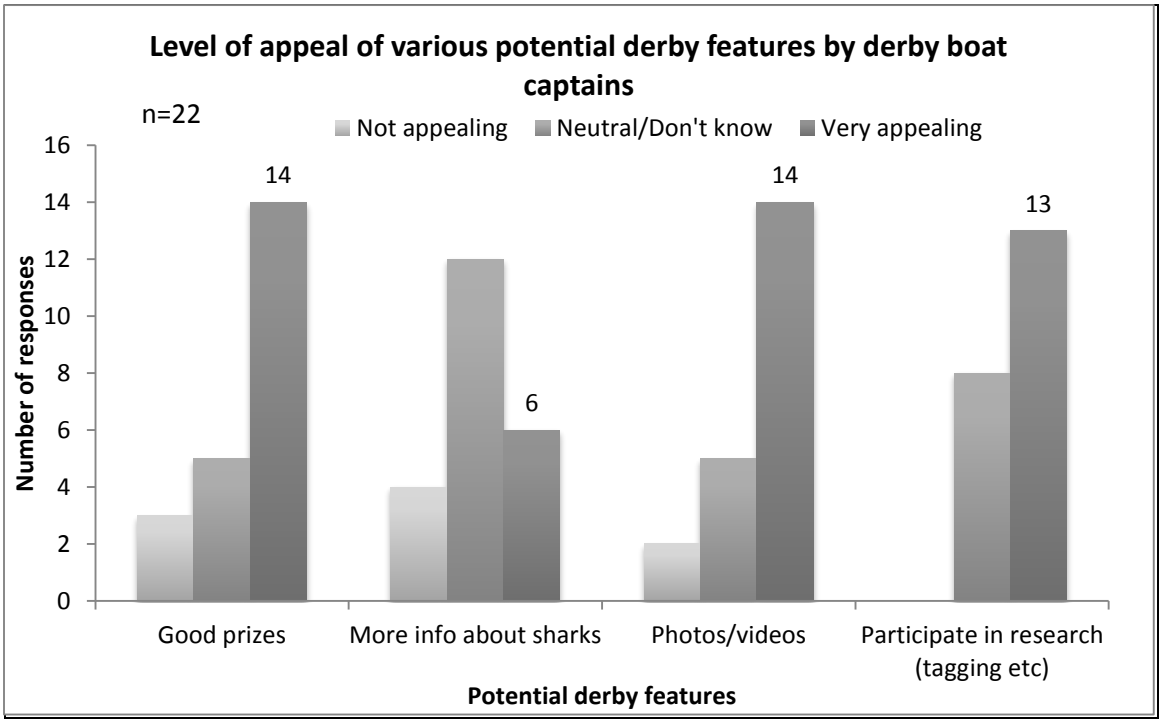

Figure 11 Rated appeal of various potential additions or changes to present derbies by derby boat captains.

3.1.2. Survey of derby spectators

Demographics and Motivations

Most of the spectators at the derby were local (93%) and over 40 years old (72%). The majority (60%) of spectators said they spent less than CAN$20 at the derby. When asked why they attend the derby, spectators rated spending time with family, participating in a community event, and supporting fishermen as *Very important* (63-70%), while learning about sharks was rated as less important (52%) (Figure 12).

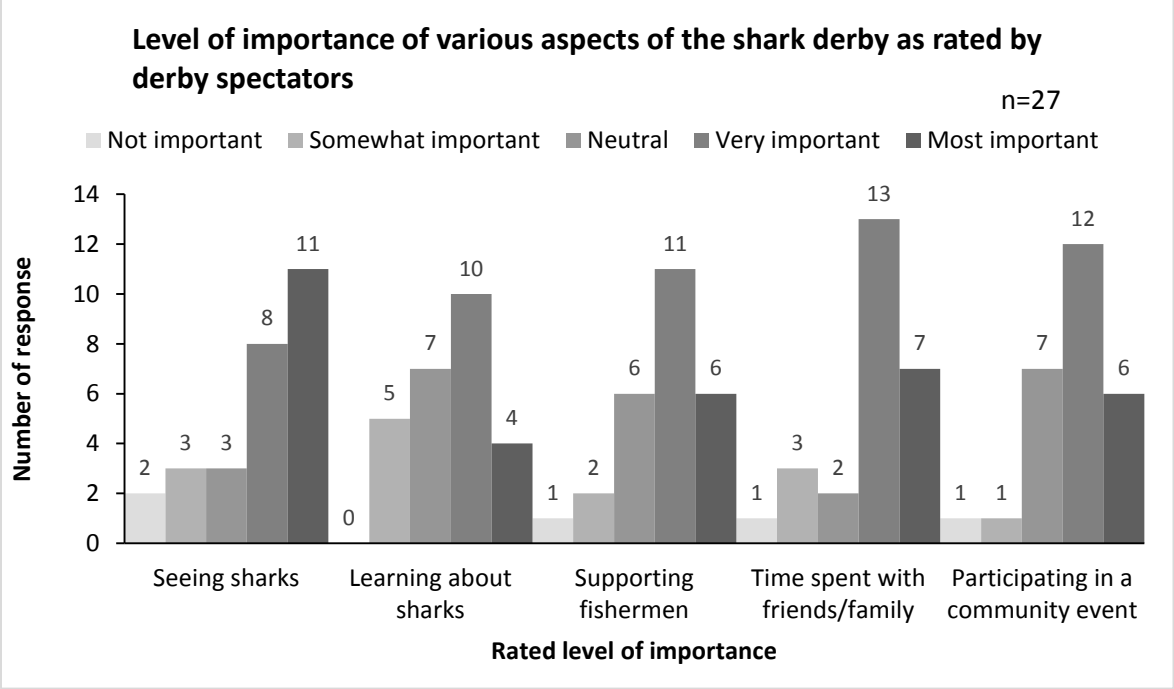

Figure 12 Rated importance of various aspects of attending the shark derby by derby spectators.

Catch-and-Release

After reading a brief description of what catch-and-release is (Appendix II), spectators were asked, "If this was a catch-and-release derby, would you be more likely, less likely, or equally likely to attend?" About 1/3 said they would be more likely to

attend a catch-and-release derby, 1/3 said less likely, and 1/3 said it makes no difference (Figure 13). Comments supporting catch-and-release included, "*Sharks & wild animals should be free and not killed for sport or tournaments*", while those opposing catch-and-release wrote, "*Have to see the fish to have the crowds"*, and "*Catch-and-release you don't actually see the sharks"*.

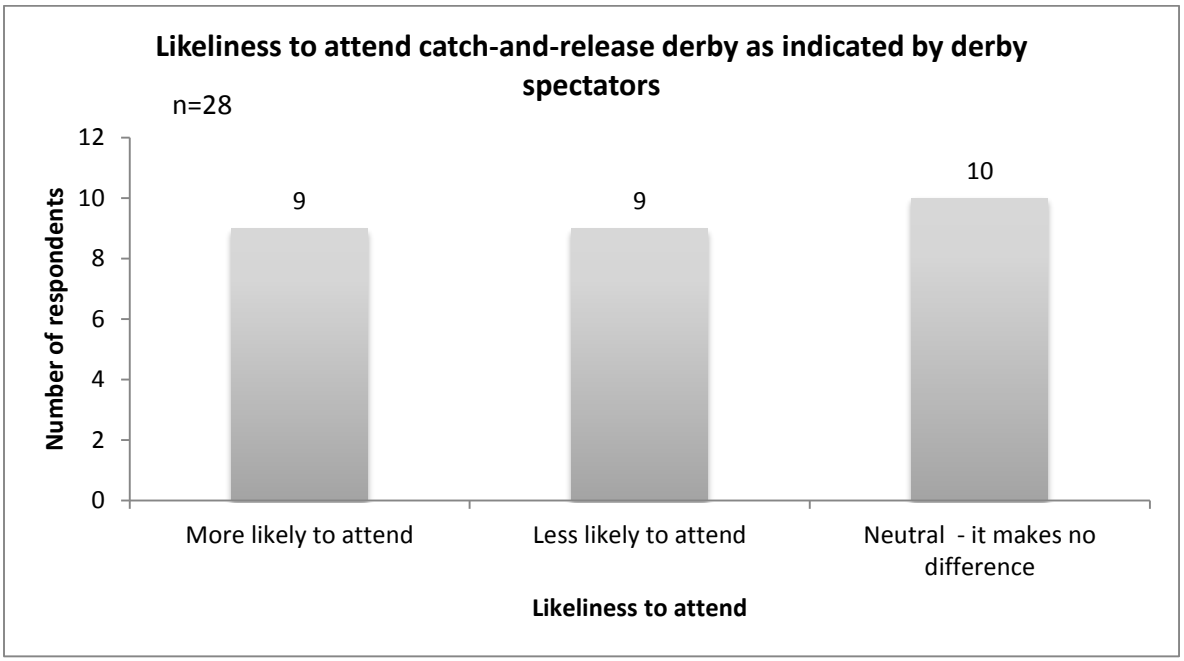

Figure 13 Likeliness to attend a catch-and-release derby as rated by derby spectators.

When spectators were asked, "What would make a catch-and-release derby appealing to you?", 56% said reducing the number of sharks killed was "Not appealing" or "Neutral/Makes no difference", while "Having the derby participate in shark research" was rated as "Very appealing" by 71% of respondents (Figure 14).

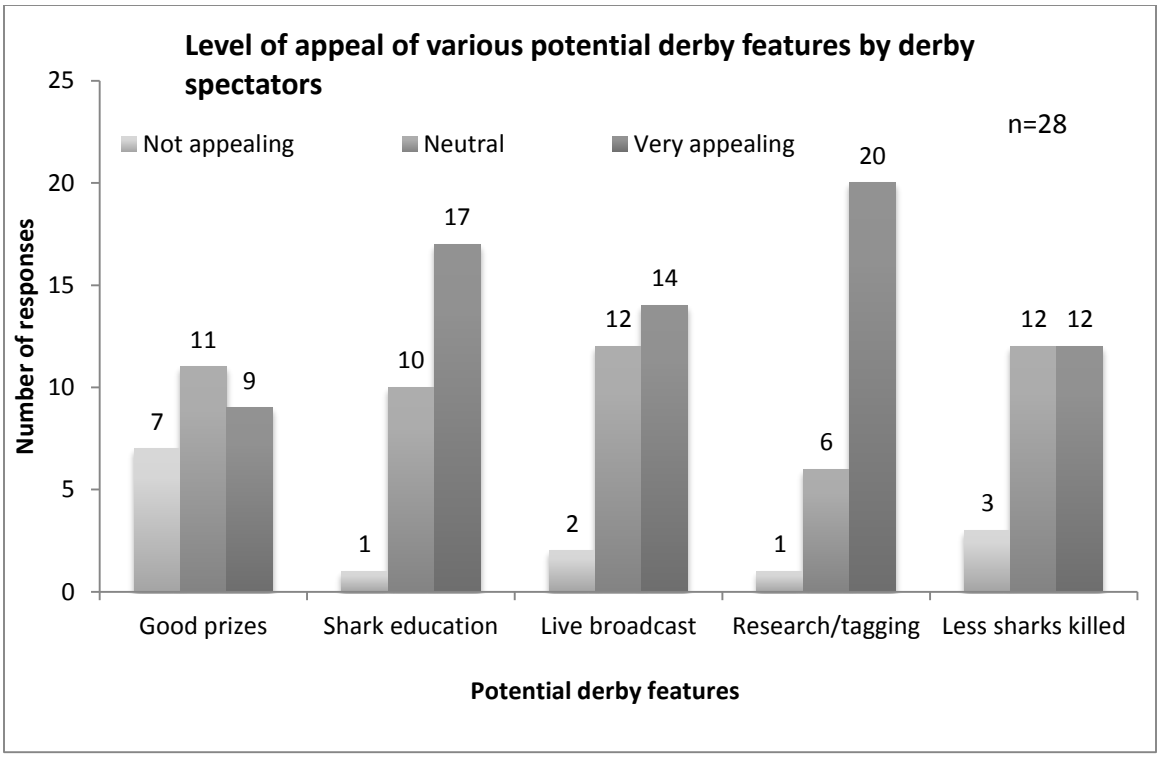

Fig 14 Rated 'appeal' of various hypothetical derby features by derby spectators.

Most spectators (63%) rated what was done with the sharks after being caught as important (Figure 15). Landfills received the least support, while scientific study was the most popular (91% said they strongly supported this use) (Figure 16).

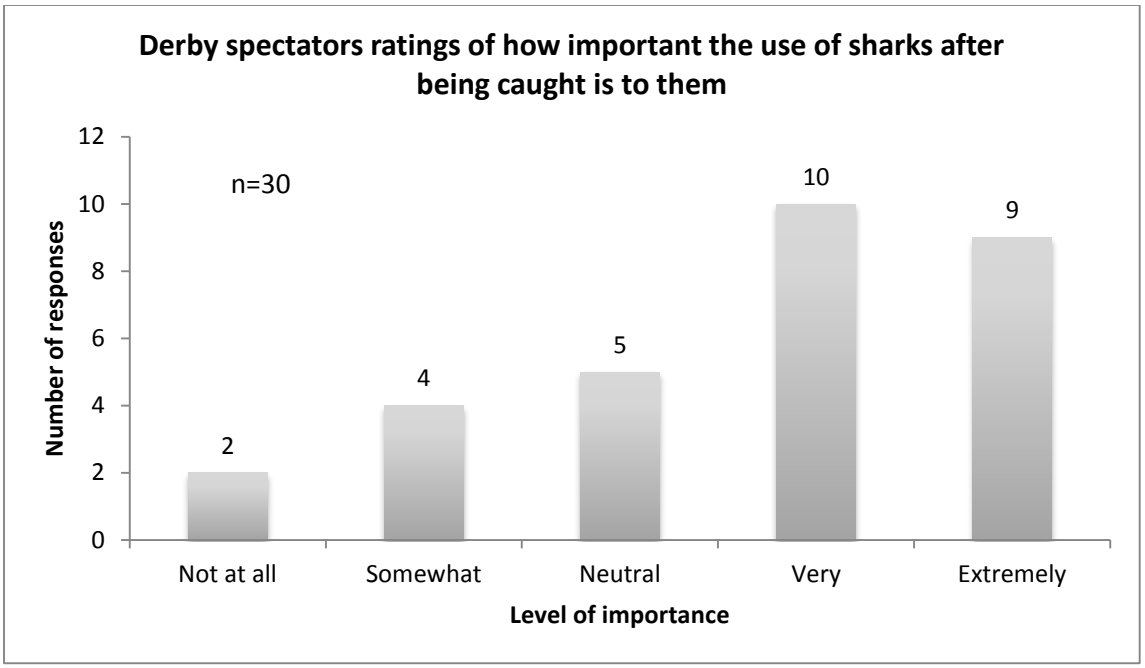

Figure 15 Responses to the question, "Is it important to you what is done with the shark after it is caught?" by derby spectators.

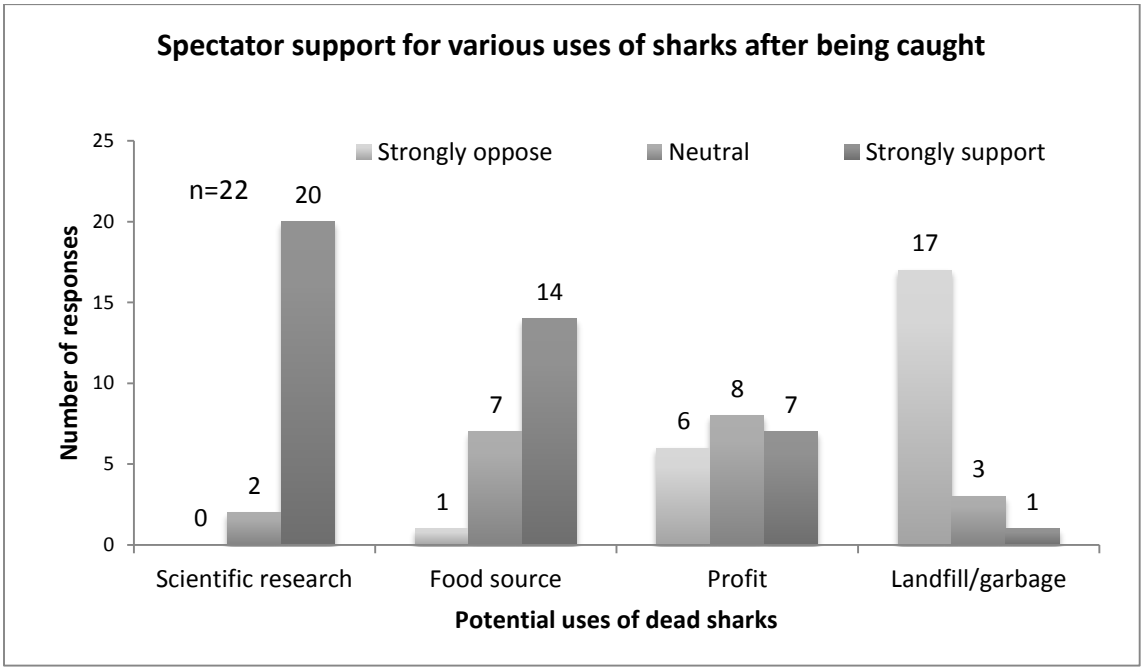

Figure 16 Spectator support for various uses of sharks after being caught at derbies.

Shark education

Both spectators and derby boat captains were asked about their perceptions of sharks in the region (Figure 17). Eighty-four percent of captains and 61.5% of spectators said that sharks are an "Important part of the marine ecosystem." Compared to derby boat captains, more spectators believed sharks to be "Dangerous to humans" (27% vs. 8% of captains), while also being more likely to say sharks are a "Threatened species that needs protection" (19.2% vs. 12%). No derby boat captains responded "Neutral/Don't know" to the question, while 15.4% of spectators did (n=25). Less than one quarter of spectators and derby captains believed sharks are a "Nuisance to fisheries" (Figure 17).

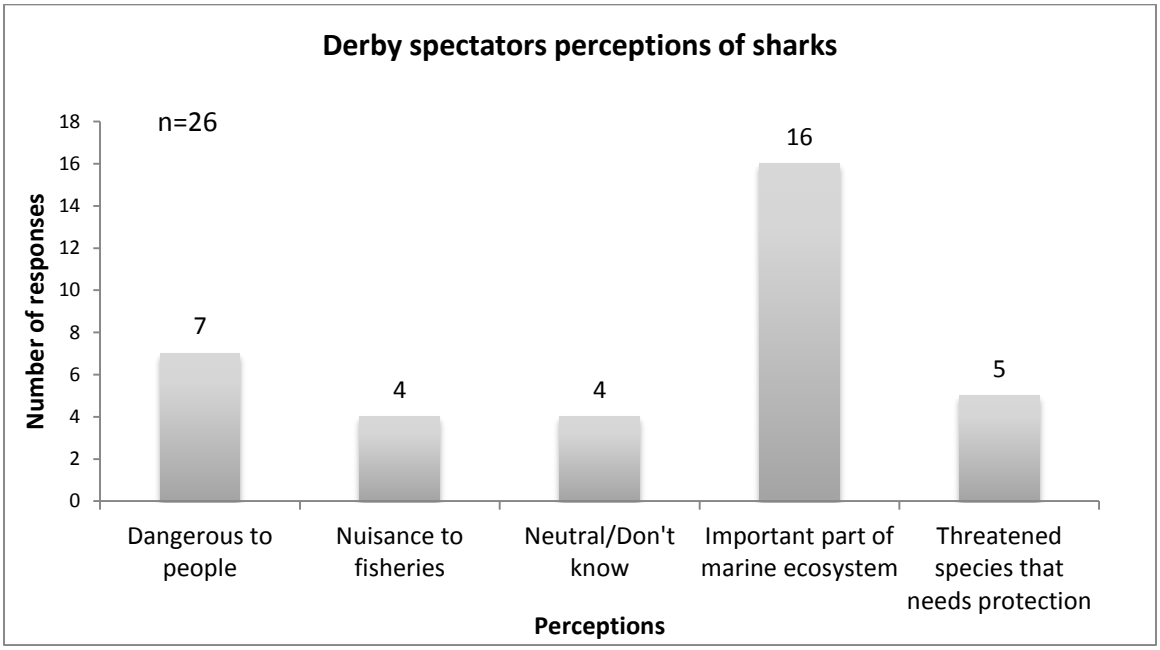

Figure 17 Perceptions of sharks as indicated by derby spectators. (More than one option could be marked).

Most of the spectators indicated they learn "little" about sharks at the derbies (Figure 18) and were most interested in learning about types of species and the biology of sharks. Threats to sharks and fishing practices were less popular options (Figure 19).

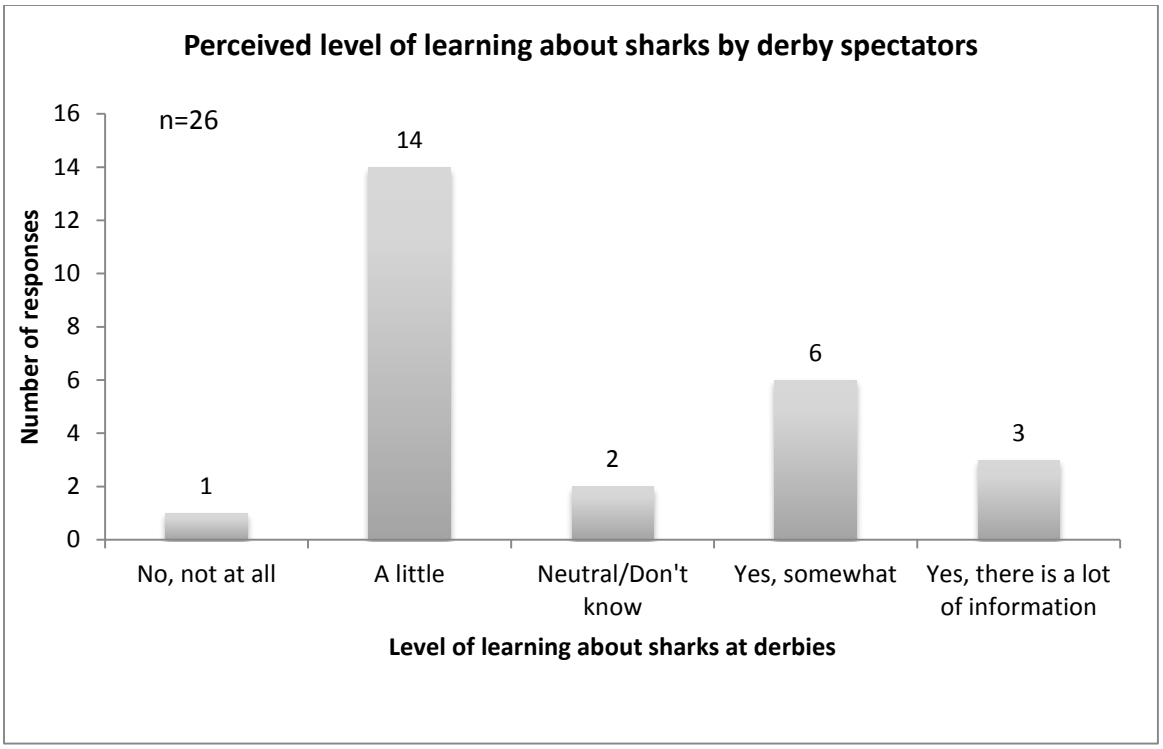

Figure 18 Responses of derby spectators when asked "Do you feel you learn about sharks at the derby?"

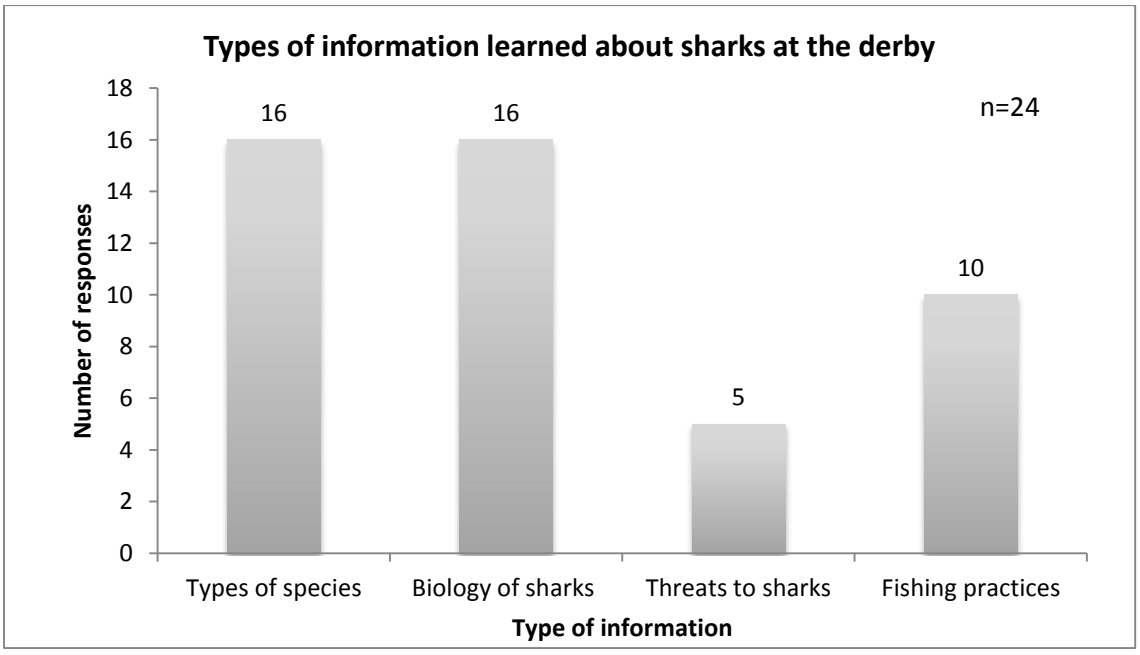

Figure 19 Types of information learned about sharks as indicated by derby spectators.

Several survey respondents included additional comments. One comment in support of catch-and-release read, "*I do not believe in the shark derby as is, I believe this could be done without harming sharks*". A second respondent wrote, "*Mixed feelings about if [catch-and-release] should be allowed. There are only a few select tournaments, so that makes it good to get data & gain knowledge. Great local event, great for tourists and great for local economy & support*."

3.2. Case Study Analysis

3.2.1. Australia

Introduction to Recreational fishing in Australia

Recreational fishing in Australia has a long history and is an important cultural, economic, and tourism activity (McLoughlin & Eliason, 2008). Australia is home to an estimated 180 shark species, about 70 of which are endemic to its waters (NPOA-Sharks, 2012). Angling for sharks became popular in the early 1900s (Pepperell, 1992), and of the 1.2 million sharks caught by recreational anglers in Australia each year, more than 1 million are released, many of which are tagged (McLoughlin & Eliason, 2008). Recreational angling in Australia includes competition gamefishing and leisure angling, sharks being primarily targeted in the former, and occasionally in the latter (McLoughlin & Eliason, 2008). Under the Australian National Sportfishing Association (ANSA), twelve species of shark and several ray species are eligible to be targeted in fishing competitions, including blue, tiger (*Galeocerdo cuvier*), porbeagle, mako, and eagle rays (*Myliobatidae spp.*) (McLoughlin & Eliason, 2008).

The Game Fishing Association of Australia (GFAA) is associated with 65 game fishing clubs, which are responsible for the majority of shark angling in Australia. Between 1961 and 1990, half of all species caught were shortfin makos and blue sharks (Pepperell, 1992). In the 1970s, grey nurse shark (*Carcharias Taurus*) populations were depleted primarily by recreational spearfishing in the New South Wales coast, and are now an endangered species (McPhee et al., 2010).

Tourism and associated economic gains from gamefishing are a significant aspect of the Australian economy. Every year, Western Australia alone hosts an estimated

740,000 recreational anglers (Department of Fisheries, 2014). Economically, recreational fishing brings in AUD$19 million (Department of Fisheries, 2014). However, the Australian government has recognized that increasing pressures on marine animals and habitats will require more sustainable, non-consumptive forms of tourism such as catch-and-release angling. Indeed, most shark angling in Australia today is catch-and-release, and since the 1970s, the GFAA has led a Gamefish Tagging Program, tagging and releasing over 70% of sharks caught in tournaments from 1993 to 2000 (Murphy et al., 2002). Voluntary catch and release by recreational anglers in Australia has been attributed to a cultural shift as demonstrated by its promotion on many television shows, and to a general rise in public understanding of environmental issues (McLoughlin & Eliason, 2008).

Laws, Policies, and Regulations regarding recreational shark fishing

Prior to the establishment of Australia's National Fishing Policy in 2001, recreational fishing in Australian marine waters was unmonitored (Bauer & Herr, 2004). The development of a national policy was motivated by a widespread recognition of declining marine and freshwater fish populations due to pollution, damming, erosion, land use, and invasive species. The importance of regulating the recreational fishing sector, in particular, was informed by a national survey that found an estimated 5 million Australians (about 1/4 of the population) identify as recreational fishers (Bauer & Herr, 2004). Since the implementation of the national policy, all individuals require a license to fish. License fees are funneled into two recreational Fisheries Trusts (one marine and one freshwater), which govern, support, and finance conservation activities including

monitoring programs, habitat restoration, fish hatcheries, and education and outreach (Bauer & Herr, 2004).

In Australia, the Commonwealth has jurisdiction over commercial fishing, while recreational fishing is the responsibility of each state/territory, meaning that there are unique regulations for Victoria, South Australia, New South Wales, Northern Territory, Queensland, Tasmania, and Western Australia (Australian Fisheries Management Authority (AFMA), 2014). Fisheries regulations of individual states differ but can be exemplified by the Victorian Government's Fisheries Regulations (1998), which require fish to be returned to the water alive and as healthy as possible when the fish is caught during a closed season, caught in a closed area, is below the minimum required length, will not be used for food or bait, or is beyond the personal catch limit for the species (McLoughlin & Eliason, 2008). There is no regular monitoring of recreational catches in any Australian State, despite recreational catches exceeding commercial harvest in some places and for some species (McPhee et al., 2010). Fisheries management regulations that apply to all Commonwealth states include the Nature Conservation Act (1992) which covers several marine and freshwater species such as whales and porpoises, but does not cover sharks. The National Strategy for the Conservation of Australia's Biological Diversity (NSCBD) (1996) emphasizes a proactive and precautionary approach to the management of marine resources (meaning a lack of scientific data should not postpone taking measures to protect and conserve marine life) (McLoughlin & Eliason, 2008). The NSCBD recognizes the lack of information on recreational angling and its impacts on fish, fish habitats, and fisheries needs to be addressed in order to improve fisheries management (McLoughlin & Eliason, 2008). Recovery plans exist for the grey nurse,

whale, and white shark, and plans are in progress for the sawfish and glyphis species (*Glyphis spp.)* (Australian Government, Department of the Environment, 2014). A number of shark species are protected under Australia's Environment Protection and Biodiversity Conservation Act (EPBC) 1999 (Table 1). In 1999, Australia developed its NPOA-Sharks after FAO published the IPOA-Sharks the same year (McLoughlin & Eliason, 2008). Australia also became a signatory under the Memorandum of Understanding on the Conservation of Migratory Sharks (Sharks MoU) designed by the Convention on the Conservation of Migratory Species of Wild Animals (CMS) in 2011 (Australian Government, Department of the Environment, 2014).

Australia has several policies and strategies that specifically address tagging, including the National Recreational Fishing Policy (1994) which recommends anglers cooperate with scientific researchers in fish tagging programs (McLoughlin & Eliason, 2008). In 2008, the Fisheries Research and Development Corporation produced the National Strategy for the Survival of Released Line-caught Fish (NSSRLCF), which aims to increase post-release survival through education of anglers on best handling practices and promoting better catch-and-release techniques (McLoughlin & Eliason, 2008). Amongst the numerous educational materials produced by the NSSRLCF, only one brochure mentions best handling and releasing practices for sharks and rays (McLoughlin & Eliason, 2008).

Table 1 Shark species protected under Australia's Environment Protection and Biodiversity Conservation Act (EPBC) 1999. Source: http://www.environment.gov.au/marine/marine-species/sharks.

Vulnerable	Endangered	Critically endangered
• Grey nurse shark (*Carcharias Taurus*) – West coast population • Whale shark (*Rhincodon typus*)* • White shark (*Carcharodon carcharias*)* • Dwarf sawfish (*Pristis clavata*) • Freshwater sawfish (*Pristis microdon*) • Green sawfish (*Pristis zijsron*)	• Northern river shark (*Glyphis Garricki*)	• Grey nurse shark (*Carcharias Taurus*)* • Speartooth shark (*Glyphis glyphis*)

* indicates species that have recovery plans. Sawfish and glyphis species have recovery plans in progress.

Illustration: Australia's Gamefish Tournament Monitoring Program

The New South Wales recreational gamefish fishery is an example of a government-led initiative to promote tag-and-release in Australia's recreational fishing sector. The fishery targets billfish, sharks, tuna, and other gamefish (Lowry & Murphy, 2003). Between 1996 and 2000, nearly 40,000 angling trips took part in the Gamefish Tournament Monitoring Program (GTMP), gathering information on the proportion of tag-and-release for targeted gamefish species. The GTMP is part of an integrated approach to monitor the recreational gamefish fishery, designed by the New South Wales Gamefish Fishery and New South Wales Fisheries state government department (Lowry & Murphy, 2003). Under this partnership, the GTMP is one of three programs including the Gamefish Tagging Program and Charterboat Monitoring Program (Lowry & Murphy,

2003). A number of shark and ray species are monitored under the GTMP, including blue, hammerhead, shortfin mako, tiger, whaler (*Carcharhinus brachyurus*), white pointer (*Carcharodon carcharias*), thresher, porbeagle, tope (*Galeorhinus galeus*), gummy sharks (*Mustelus antarcticus*), and eagle rays (Lowry & Murphy, 2003). The results of this 4 year monitoring program between 1996 and 2000 found that only 16% of anglers specifically targeted sharks, and when sharks were caught, over 70% were tagged-and-released; those that were not tagged were generally killed and weighted.

While the integrated management approach of the New South Wales recreational gamefish fishery has successfully engaged many recreational fishers in tag-and-release programs, several challenges associated with increasing catch-and-release within recreational fishing exist. These include the growing gamefish tourism industry (and thus demand on marine wildlife), as well as illegal fishing practices which may undermine efforts to conserve fish populations. Illegal practices include fishing without a license, fishing within protected areas, and using illegal fishing methods (Lowry & Murphy, 2003). However, these same challenges can also be seen as opportunities, or at least areas that may indirectly benefit from growing interest in tag-and-release. For instance, as sportfishing tourism increases, fisheries departments and sportfishers will have more opportunities to incorporate tag-and-release and the collection of scientific data into their activities. Indeed, engaging citizens in the gathering of scientific data (i.e. 'citizen science') has been increasingly employed worldwide (Silvertown, 2009), is especially useful when funding is limited, and can produce scientifically reliable data (Davies et al., 2012). For example, a recent study found amateur photographs taken by tourists produced data similar to those produced by experts when monitoring whale sharks (Davies et al.,

2012). Efforts to engage tourists and recreational fishers in monitoring and conservation may serve to strengthen an (often) already existing conservation ethic among fishers, encourage citizen monitoring and reporting of illegal practices, and reduce illegal fishing practices. In fact, AFMA already has a telephone hotline called CRIMFISH for this exact purpose, although this is intended for commercial infractions (AFMA, 2014). The New South Wales recreational gamefish fishery may provide an example of how government, through an integrative approach, may collaborate with recreational fishers to increase non-consumptive fishing practices and strengthen conservation of gamefish such as billfish, tuna, and shark.

3.2.2. New Zealand

Introduction: Recreational fishing in New Zealand

New Zealand is home to at least 113 species of shark, of which 70 have been reported in fishing logs (New Zealand NPOA-Sharks, 2013) New Zealand has records of game fishing as early as 1915 (Francis, 1998), and angling continues to be a popular sport (Cox & Francis, 1997). Catch-and-release fishing has also increased with programs such as the New Zealand Cooperative Gamefish Tagging Programme, initiated by the Ministry of Agriculture and Fisheries in 1975. As such, large pelagic shark landings (mostly shortfin makos and blue sharks) have decreased from 1,248 sharks landed in 1981 to an average of 600 per year between 1990 and 1996 (Francis, 1998). Most shark fishing has been a result of leisure fishing, however organized shark fishing contests are increasing in popularity (Francis, 1998). In 2005, a total of 60 game fishing clubs were affiliated with the Big Game Fishing Council. Fishing competitions often target both shark and tuna, are held over 2-5 days in the summer months, and have a minimum weight limit of 40kg to reduce catches of smaller fish (Francis, 1998). Sharks are often caught on drifted baits, and are either targeted, or otherwise caught incidentally during billfish and swordfish fishing (Holdsworth & Saul, 2010). Blue and mako sharks are the primary targets, although whaler, hammerhead, thresher, and sevengill sharks (*Notorynchus cepedianus*) are also known to be caught.

Laws, Policies, and Regulations regarding recreational shark fishing

In New Zealand, recreational fishing rules are made and enforced by the Ministry for Primary Industries (MPI) (New Zealand Ministry of Fisheries, 2014). Shark species are managed under four categories (Table 2), and can either be protected under the Wildlife Act (1953) which protects species within New Zealand's waters, or the Fisheries Act (1996) which provides protection to the high seas (NPOA-Sharks (New Zealand), 2013).

Table 2 Shark species and their categories of protection in New Zealand. Source: New Zealand NPOA–Sharks, 2013.

Protected (utilisation is not considered appropriate)	**Schedule 4C of the Fisheries Act 1996** (may not be targeted)	**Quota Management System** (90% of all catch)	**Open Access**
Basking shark (*Cetorhinus maximus*) Whale shark *Rhincodon typus)* Oceanic whitetip shark (*Carcharhinus longimanus*) White pointer shark (*Carcharodon carcharias*) Deepwater nurse shark (*Odontapsis ferox*) Manta ray (*Manta birostris*) Spinetail devil ray (*Mobula japanica*)	Hammerhead shark (*Sphyrna zygaena*) Sharpnose sevengill shark *(Heptranchias perlo)*	Spiny dogfish (*Squalus acanthias*) Dark ghost shark (*Hydrolagus novaezelandiae*) Ghost shark *(H.bemisi)* Smooth skate *(Dipturus innominatus)* Rough skate *(Zearaja nasutus)* Tope shark *(Galeorhinus galeus)* Elephantfish (*Callorhinchus milii*) Rig (spotted dogfish; *Mustelus lenticulatus*) Mako shark Porbeagle shark Blue shark	All others not listed elsewhere in this table

Fishing regulations differ slightly between New Zealand's seven marine areas (Auckland & Kermadec, Central, South East, Kaikoura, Southland, Challenger, and Fiordland), although all have daily catch limits of up to 5 sharks/person for sevengill, mako, blue, whaler, hammerhead, porbeagle, and thresher sharks, with higher limits for tope sharks (up to 20 in some areas) (New Zealand Ministry of Fisheries, 2005). New Zealand's MPI and Minister of Conservation developed its first National Plan of Action for Sharks in 2008 (White & Kyne, 2010), and released the second iteration in 2013 (New Zealand NPOA-Sharks, 2013). Several objectives listed in New Zealand's 2013 NPOA pertain to recreational fishing and catch and release (Table 3).

Table 3 New Zealand's 2013 NPOA five-year objectives pertaining to recreational fishing and catch and release.

New Zealand NPOA-Sharks Goals	**Corresponding objective**
Biodiversity and long-term viability of shark populations	**Objective 1.6** Ensure adequate monitoring and data collection for all sectors (including commercial, recreational and customary fishers and non-extractive users) and that all users actively contribute to the management and conservation of shark populations.
Utilisation, waste reduction and the elimination of shark finning	**Objective 2.1** Review and implement best practice mitigation methods in all New Zealand fisheries (commercial and non-commercial). **Objective 2.2** Minimise waste by promoting the live release of bycaught shark species, and develop and implement best practice guidelines for handling and release of live sharks. **Objective 2.3** Develop and implement best practice guidelines for non-commercial fishing and handling of sharks.
Domestic engagement and partnerships	**Objective 3.3** Encourage compliance with regulations, implementation of best practice (including catch avoidance and correct handling), and cooperation with ongoing research among commercial and non-commercial stakeholders.

Illustration: New Zealand Gamefish and Billfish Tagging

Since 1975, New Zealand's Ministry of Agriculture and Fisheries developed a cooperative gamefish tagging program at the request of anglers (Harthill & Davies, 2001). Prior to the implementation of the program, there already existed a cooperative arrangement between recreational and commercial anglers whom voluntarily tagged-and-released, recaptured, and reported information to the Ministry (Harthill & Davies, 2001). The rise of tag-and-release during this period (1975-1987) corresponded with a gradual decline in the number of sharks landed by recreational fishers (Francis, 1998). Both anglers and the government were interested in the information on geographical distribution of species the tag-and-release data would provide. The government, in particular, was interested to gather information on the interactions between recreational and commercial fisheries that may help reduce conflict between gamefish fisheries and tuna longline fisheries (Harthill & Davies, 2001). Declining yields from many fisheries prompted governments worldwide to reassess their management approaches and take on a more precautionary approach (Sharp, 1997). From 1998-1999, the Ministry of Fisheries contracted the National Institute of Water and Atmospheric Resources (NIWA) to manage a gamefish tagging database. During the program, the New Zealand Big Game Fishing Council (NZBGFC) distributed around 3000 visual implant tags to gamefish clubs, while NIWA supplied tags to commercial boats (Harthill & Davies, 2001). Data filled out by participating anglers was then given to the NZBGFC or directly to NIWA, who managed the tagging database for the Ministry of Fisheries (Harthill & Davies, 2001). Data from the tagging program included migration patterns, age, growth, longevity, and stock structure, and was used to inform management (Holdsworth & Saul,

2010). As an incentive for anglers to report recaptured tags, a note was inscribed on tags telling anglers they would receive an award for recaptured data (Harthill & Davies, 2001). The New Zealand Gamefish and Billfish Tagging program provides an example of a long-running program based on a cooperative partnership between anglers, scientists, and the New Zealand government.

3.2.3. United States of America

Introduction

The recreational shark fishery in the United States has existed for at least 60 years (McClenachan, 2009) and is one of the largest in the world (Shiffman & Hammerschlag, 2014). In 2011, approximately 11 million anglers went on 70 million fishing trips, providing an estimated USD$56 billion to the American economy from direct sales and another USD$29 billion in value-added impacts (National Oceanic and Atmospheric Association (NOAA) Fisheries, 2014/2015). On the eastern coast, in the region from Maine to North Carolina alone, private Highly Migratory Species (HMS) angling trips contributed an estimated USD$4.7 million (NOAA Fisheries, 2014/2015). Between 2003 and 2012, there were approximately 260 recreational fishing tournaments per year for highly migratory species (NOAA Fisheries, 2014/2015). Most shark tournaments are held in New England, New York, and New Jersey, although there are tournaments in other regions as well (NMFS, 2006). Internet searches conducted in this study (using primarily the IGFA database) detected 13 shark fishing tournaments along the eastern coast, although this is almost certainly an underestimate; Holts et al. (1998) estimated 6 to 10 annual shark tournaments in Southern California alone. Non-consumptive uses of sharks such as tourism and catch-and-release fishing are increasing in many places (Fisher & Ditton, 1993; Rodriguez-Ferrer et al., 2008; Gallagher & Hammerschlag, 2011; Gore et al., 2011; Ward-Paige, 2014). However, catch-and-release shark tournaments remain a minority, at least in the case studies examined here. Of the 13 shark tournaments found in the United States, only 2 of them (about 15%) were catch-and-release. Some of the larger kill tournaments such as the *Annual South Jersey Shark Tournament*, *Mako Fever*

Tournament in New Jersey, and the *Annual Monster Shark Tournament* in Massachusetts, have over 200 boats, charge an entry fee of USD$450/boat, and award over USD$55,000 to USD$220,000 in prize money (NMFS, 2006). Small tournaments have approximately 20 boats, while larger tournaments have up to 200 (pers. comm., Paxton USC, 2014), and most tournaments have restrictions on the number of sharks that can be landed. However, shark catches from these tournaments are likely low; data from the California Department of Fish and Game estimated about 200 makos and under 3000 blue sharks were caught between 1989 and 1993 (Holts et al., 1998). In 2002, recreational landings (including non-shark species) accounted for 4% of total marine fish landed in the United States (Coleman et al., 2004). While reliable data on shark landings is lacking, historical data shows a peak in the number of sharks caught by recreational fishers between 1974 and 1975, with a substantial drop in the years following (Scott et al., 1996). Evidence from historical photographs of recreational fishing in the Florida Keys show more than a 50% decrease in shark size over the last 50 years, from just under 2m in the 1950s and 60s, to less than 1m in 2009 (McClenachan, 2009). Even so, the number of federal shark permits increased from 1706 permits to 2026 between 1993 and 1994. In 2012, approximately 25,000 permits for highly migratory species were issued by the Atlantic HMS Management Division (NOAA Fisheries, 2014/2015). As recreational shark fishing continues to become more popular, derby fishing may impose increasing pressure on the shark population and require added management strategies (Stone et al., 1998); catch-and-release fishing may be one such strategy.

Laws, Policies, and Regulations regarding recreational shark fishing

In the United States, regulations pertaining to commercial, recreational, and First Nations fisheries depend on the type of fish being targeted, the location of fishing, and the person fishing (NOAA, 2014). Atlantic and Pacific regions have separate regulations. Atlantic shark fisheries are managed as part of the Consolidated Atlantic Highly Migratory Species (HMS) Fisheries Management Plan under the Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act) (NOAA Fisheries, 2014/2015). Table 4 provides a summary of recreational fisheries regulations on the West Coast (NOAA, 2014). Commercial and recreational fisheries within the 200nm EEZ in the Atlantic Ocean, Gulf of Mexico, and Caribbean Sea are managed by the Highly Migratory Species Management Division of the National Marine Fisheries Service (NMFS) (Stone et al., 1998).

On the West Coast (Pacific Ocean), recreational fisheries within federal waters (3 to 200nm) are managed by the Pacific States Marine Fisheries Commission, the Pacific Fishery Management Council, and NOAA (NOAA, 2014). Most recreational fishing on the West Coast occurs within 3nm of the coast, within which marine areas are under the jurisdiction of the states of Washington, Oregon, and California (NOAA, 2014).

Table 4 West Coast United States recreational shark fisheries regulations.

Management areas	**Species**	**Bag limit**	**Size limit (minimum)**
• Northern Management Area • Mendocino Management Area • San Francisco Management Area • Central Management Area • Southern Management Area	1. Sixgill shark (*Hexanchus griseus*), and Sevengill shark (*Notorynchus cepedianus*)	One fish per day	None
	2. Shortfin mako shark (*Isurus oxyrinchus*), thresher shark (*Alopias vulpinus*), and blue shark (*Prionace glauca*)	Two fish per day	None
	3. Leopard shark (*Triakis semifasciata*)	3 fish	36 inches total length
	4. Soupfin shark (*Galeorhinus zyopterus*)	One fish	None
	5. Spiny dogfish (*Squalus acanthias*)	10 fish	None

The Atlantic Sharks Fisheries Management Plan released by NMFS in 1993 outlines several regulations intended to improve the sustainability of recreational shark fisheries, including daily catch limits for anglers, shark species for which fishing is prohibited or catch-and-release only, best practice requirements for sharks that are not kept, required logging of landed sharks by shark fishing tournaments, and NMFS observers on vessels with shark permits (NMFS, 1993). NOAA produces a best handling practices brochure (Appendix III) and features a video titled “Sharks: Best Practices for Healthy Catch & Release” on its website, which lists ten ways to optimize post-release

survival.[6]

The following sections provide two illustrations of catch-and-release shark fishing. The *Guy Harvey Ultimate Shark Challenge* is a popular catch-and-release shark tournament that has supported the development of other catch-and-release tournaments such as the *Montauk Shark's Eye* tournament in New York. Second, I examine charter boats shark fishing as a potential source of insight into catch-and-release motivations.

First Illustration – Guy Harvey Ultimate Shark Challenge

History

Since opening in Punta Gorda, Florida in 2010, the Guy Harvey Ultimate Shark Challenge (USC) has received widespread recognition for its innovative approach to implementing catch-and-release while integrating sport, science, and conservation (Guy Harvey Ultimate Shark Challenge, 2013). The tournament was developed by Sean and Brooks Paxton, two sports fishermen who wanted to raise public awareness of the importance of sharks in the marine ecosystem and to promote a system of best handling practice to increase post-release survivorship (pers. comm., Paxton USC, 2014). Prior to starting the USC, the Paxton's had volunteered with scientists from the NMFS in a shark tagging project. With their experience using science-based best handling practices, and the growing interest in catch-and-release shark fishing in land-based tournaments in Texas and other areas of the United States, the Paxton's began developing the idea of integrating sport, science, and conservation. In 2008/2009, the Paxton's were contacted

[6] https://www.youtube.com/watch?v=FaOKxYcllr4&list=PLqjRqI1v493Il0Z5UAPjmTUiHQ-0BNWp3&index=10.

by the organizer of the *Are You Man Enough* catch-and-kill tournament in Fort Myers, Florida, who had received intense pressure from activist groups and local politicians to shut down, and was seeking assistance to transition to catch-and-release (pers. comm., Paxton USC, 2014). Applying lessons from the *Are You Man Enough* tournament, the Paxton's created the USC in 2010, connecting expert anglers, scientists, and conservationists to make a competition that would take advantage of anglers pre-existing experience in tail-roping sharks, while receiving best practice training from the scientific community, and garnering support from conservation organizations such as the Guy Harvey Ocean Foundation, Humane Society, Florida Fish and Wildlife Conservation Commission, and Shark Savers. Their unique approach to incentivizing anglers to enter a catch-and-release tournament incorporated the use of high-tech satellite tags, live streaming broadcast of shark fishing, and live, interactive educational exhibits for children and adults. Cash and prize money amounted to USD$15,000, and extra prize money was allocated to those who caught pre-tagged sharks[7]. In addition to prize money, teams and anglers bet against each other in what is called a "Calcutta", adding money to the prize purse which further attracts anglers to the derby (NMFS, 2006; pers. comm., Paxton USC, 2014). In 2013, the USC was aired on Discovery Channel's *Shark Week*, which led to several other derbies contacting the Paxton's for assistance in creating catch-and-release shark competitions, such as the Shark's Eye Tournament in Montauk, New York, and the Ocean City Shark Tournament in Delaware (pers. comm., Paxton USC., 2014).

[7] Several sharks in the area were tagged prior to the start of the USC to incentivize tagging and reporting by anglers during the competition.

Format

The entry fee into the USC for a two or three person team is USD$950, with up to 20 boats entering and a grand prize of USD$10,000, with a total of USD$15,000 in cash and prizes (Guy Harvey Ultimate Shark Challenge, 2013). The types of fishing gear, fishing, handling, and release practices used at the fishing tournament are designed to optimize post-release survival of sharks based on scientific research. Circle hooks minimize the chance of hook ingestion, while certified USC observers professionally trained in tag and release procedures, tournament rules, and species identification accompany teams to ensure proper technique. Sharks are tail-roped and brought alongside the boat where length measurements and photographs are taken before tagging them. Tags are provided by NOAA and MOTE Marine Laboratory (pers. comm., Paxton USC., 2014).

Strategies

The success of the USC may be in part due to the Paxton's unique approach to increasing catch-and-release tournaments in their region. Rather than a protest against kill tournaments, the USC was presented as an attractive alternative since catch-and-kill tournaments are legal in the United States. Identifying as sports fishermen themselves, the brothers did not wish to alienate fellow fishers by casting catch-and-kill anglers as immoral or unethical. Instead, the USC capitalized on an already shifting culture of conservation-minded anglers, using their experience in the entertainment industry to make the tournament exciting and fun with the hope that the success of the tournament would inspire others like it (pers. comm., Paxton USC., 2014). In exchange for the

'bragging rights' associated with bringing a shark to shore in kill tournaments, anglers in the USC were given access to high-tech science equipment such as satellite tags which they used to track their (named) shark on OCEARCH (a global shark tracker)[8] along with other media coverage. Live shark fishing action was broadcast on a big screen for spectators to watch from the festival. Rather than having an observer from the government or science community, each team was required to nominate a friend or relative to act as an observer on another boat. This created a sense of ownership, control, and trust amongst angling teams and the observers they were assigned. Furthermore, to reduce potential tension between observers and angling teams, observers were given extensive interviews to ensure they would be comfortable on a boat.

Challenges

Because the USC was not presented as a protest or a replacement to catch-and-kill tournaments, there was little to no resistance from anglers who preferred catch-and-kill. While securing prize money and funders through celebrities like Guy Harvey was also not a major challenge, competing with the prize money from larger kill tournaments such as the one in Montauk, which had 200 boats and USD$1 million in prize money, was difficult (pers. comm., Paxton USC., 2014). In order to offset the prize differential, the USC had to employ creative strategies, such as live streaming, teaming up with scientists to gain access to high tech equipment, and a festival with live music and an interactive educational exhibit. The major challenges were the high expense and technical difficulties of live streaming the fishing action to a large screen for spectators.

[8] Anglers name the sharks they tag and track them at OCEARCH (http://www.ocearch.org/tracker/)

Lessons learned

The Paxton's strategy was to encourage an already burgeoning change in the culture of fishing towards conservation and science, rather than protest against kill tournaments. Through entertainment and education, their aim was to expose a wide audience to catch-and-release fishing, supporting a long-term shift in perceptions (pers. comm., Paxton USC., 2014). The Paxton's recognized that there is a demographic of anglers that cannot be converted – those who want to kill sharks and are opposed to catch-and-release. Thus, they focus on targeting the next generation who may be more open-minded.

While live streaming was likely a factor in the popularity of the USC, it may not be practical for other derbies to emulate. First, it is extremely expensive and requires highly sophisticated technical skills. Second, streaming is restricted to boats within cell phone range, or about 20nm from shore. Therefore, even if the expense were not an issue, this feature would only work for short-range fishing trips (this is not the case with Canada's most popular derbies which often travel further than 20nm from shore).

The Guy Harvey Ultimate Shark Challenge offers inspiration and insight into creative alternatives to killing sharks, whilst maintaining angler interest and participation.

Second Illustration – Charter Boat Shark Fishing in Florida

Charter boat shark fishing is a form of non-consumptive use that may shed light on catch-and-release motivations, incentives, and behaviors. Within the United States, Florida is the most popular state in which to recreationally fish for sharks (Shiffman & Hammerschlag, 2014). Charter boat shark fishing often involves a half-day or full day

trip into federal waters and fishing is typically by rod & reel (Shiffman & Hammerschlag, 2014). Charter boats require a NMFS Highly Migratory Species Charterboat/Headboat permit if they operate inside federal waters (as do most shark fishing boats) (Shiffman & Hammerschlag, 2014).

Shiffman & Hammerschlag (2014) analyzed 137 charter boat companies that referenced shark fishing, and surveyed 25 charter boat captains on their knowledge, attitudes, and practices. In 2012, over 550,000 sharks (mostly Atlantic sharpnose (*Rhizoprionodon terraenovae)*, nurse, hammerhead, and blacktip (*Carcharhinus limbatus*), were caught by charter boat anglers (Shiffman & Hammerschlag, 2014). Their results found that of the charter boat websites analyzed, 24% advertised a specific shark-fishing trip, 10% of those websites advertised themselves as catch-and-release only, and less than 2% as catch-and-kill. While catch-and-release is not a legal requirement, the study showed many boat captains choose to practice it, listing economic and ecological reasons. When asked how often they use catch-and-release for sharks, 82% said they "always practice catch-and-release", about 8% said they "almost always practice catch-and-release", and 8% said they "sometimes practice catch-and-release". When asked how clients feel about practicing catch-and-release for sharks, 65% of boat captains said their clients were happier when sharks were released, and 35% said clients were just as happy to release sharks. When asked about their motivations for practicing catch-and-release, charter boat captains included preserving the fishery/ensuring a future for their business, maintaining a healthy ecosystem, avoiding bad press, not wanting to eat sharks ("not tasty"), and an overall increase in public consciousness towards shark conservation (Shiffman & Hammerschlag, 2014).

Economically, shark fishing was found to be the most expensive type of boat excursion compared to other gamefish, at about USD$775 a trip (Shiffman & Hammerschlag, 2014). When the catch-and-kill companies were asked "why not catch-and-release", they responded that the decision depended on the species of shark caught, meeting their client's needs, and attempting to win an IGFA world record (for which landing sharks is required) (Shiffman & Hammerschlag, 2014). In sum, Shiffman & Hammerschlag (2014) found that practicing catch-and-release is a decision made by the charter boat captain or company based on a conservation ethic and perceived preference from their clientele. They conclude that the high conservation ethic exhibited by the charter boat community is evidence of a change in attitudes of recreational shark fishing boat captains. Furthermore, they suggest charter boat operators could be an untapped ally of shark conservationists and managers (Shiffman & Hammerschlag, 2014). The strong preference for catch-and-release exhibited by charter boat operators in Florida may shed light on the drivers and motivations of catch-and-release practices. In this example, the tour operators have an economic incentive to cater to their clients who have a strong conservation ethic. This conservation ethic, in turn, is likely bolstered by education and outreach on sharks from government initiatives as well as popular media.

4. DISCUSSION

4.1 Overview

Two Nova Scotian shark derbies were surveyed to provide insight into the motivations, perceptions, and attitudes of derby boat captains and derby spectators towards catch-and-release. Case studies in Australia, New Zealand, and the United States were analyzed to examine the drivers, barriers, and strategies used in developing catch-and-release programs. Survey results indicated that for most derby boat captains, the overall challenge of catching sharks and spending time with friends and family were more important than winning awards or catching a large number of sharks. Public audiences had conflicting views on sharks and learned little about sharks at the derbies. Half of all derby boat captains had not been trained in handling sharks, of which 60% were interested in receiving training.

The case study analysis revealed that many catch-and-release initiatives are angler-led and often involve collaborative partnerships between anglers, scientists, and government. Furthermore, catch-and-release practices in both derbies and charter boat fishing often involve a broader 'cultural shift' towards conservation and sustainability in society, and can be supported by shark education and outreach.

4.2. Survey of derby boat captains

Demographics

Survey responses from derby boat captains from Yarmouth and Louisbourg differed on two questions. First, Yarmouth captains appeared to have attended more

derbies than Louisbourg captains. This result is not surprising, since the Yarmouth derby is older than the Louisbourg derby, and the majority of captains were also found to be residents of the local town or nearby towns, meaning local residents were likely to have attended the local derby. The second divergence was on the question of whether captains would support a trial run of catch-and-release in the future. Yarmouth captains were divided almost equally between opposing, supporting, and feeling neutral about the trial run, whereas Louisbourg captains were more supportive. It is possible that because the derby boat captains from Louisbourg had attended fewer derbies, they were less entrenched in their ideas of how they should be run, and thus more open to the idea of catch-and-release. Interestingly, there was no difference in overall fishing experience between the two samples; the majority of captains surveyed had spent 11-30 years fishing, suggesting derby experience, and not fishing experience, may influence openness to catch-and-release fishing.

Perceptions

The majority (84%) of captains believed sharks to be an important part of the marine ecosystem. This response was chosen significantly more often than any other option (dangerous to people, nuisance to fisheries, neutral/don't know, and threatened species that needs protection), despite the ability for survey respondents to choose more than one option. This may be evidence of a general increased understanding of the important role of sharks amongst fishers, perhaps the result of involvement in scientific research at the derbies. It is also an encouraging finding, as it suggests captains may be supportive of conservation efforts that keep sharks present in the ecosystem.

Motivations for trophy fishing

For many competitive anglers, winning an award for the largest fish, and the prestige associated with that award is a major motivation (Holland & Ditton, 1992). However, the results of this survey found that winning an award was not as important as other motivations for shark fishing, such as the overall challenge of catching sharks, spending time with friends and family, or getting to interact with sharks. Furthermore, the desire to catch as many sharks as possible was not a top priority for many anglers. Sutton & Ditton (2001) refer to an anglers desire to catch many fish as their "consumptive orientation". Results from our survey suggest a low consumptive orientation amongst the boat captains surveyed.

Arlinghaus et al*.,* (2007) found many anglers have positive attitudes towards sharks and shark protection and concluded that garnering support from recreational anglers to minimize fisheries impacts is likely achievable. Indeed, the survey results provide several indications that conservation efforts would be supported by local derby captains. First, there was a low priority placed on catching many sharks (low consumptive orientation) and winning awards in conjunction with the high priority placed on spending time with family, getting to interact with sharks, and the enjoyment of the overall challenge of catching sharks. Second, captains demonstrated a widespread belief that sharks play an important role in marine ecosystems. Third, 96% of the captains had practiced catch-and-release before, nearly 70% of those said they had a positive experience with it, and over half had previously released catch to keep the fish population healthy or conserve the species.

However, several results also suggest that efforts to transform derbies to a catch-and-release model would face some opposition. For example, the majority of captains said they would be more satisfied if they "Caught and kept an award-winning shark" compared to "Caught sharks and released them (winning an award)". Thus, despite winning an award in both scenarios, the difference between keeping and releasing the shark is an important aspect of angler satisfaction to at least one in four derby captains surveyed.

Derby boat captains were divided on whether they would support having an observer on the boat at a catch-and-release derby. One third were neutral, less than one third were opposed, and slightly over one third were supportive. This result suggests a large portion of captains could potentially be open to catch-and-release if incentivized and/or engaged, particularly when taking into account their understanding of the importance of sharks from previous questions.

About half of all captains had received training on best practices in handling & releasing sharks, while half had not. However, some of the comments suggest "training" may have been defined as personal experience, rather than exposure to more formal science-based techniques, so this result may reflect a low level of training. Of those who had not received training, almost 60% said they were interested in doing so. The WWF has disseminated information on handling practices and species ID in the form of presentations, videos, and brochures at several tournaments in the past few years. Captains are required to attend these sessions, and anecdotally are often eager to finish in order to start fishing (pers. comm., Paxton USC., Corke WWF 2014). However, it appears the majority are interested in receiving more training.

While captains did not seem to find the idea of more information on sharks appealing, participating in scientific research (i.e. tagging studies) was rated as appealing as good prizes and displaying photos/videos of shark fishing to spectators at the derby. This suggests captains are eager to collaborate in tagging projects, and that this may be a way to engage captains in catch-and-release fishing practices.

4.3. Survey of derby spectators

Demographics

Most of the spectators at the derby were local, suggesting the event is important for the community and likely involves friends and family of the competing fishermen. While the majority of spectators said they spent less than CAN$20 at the derby, given that most of the towns that hold shark derbies are quite small (Yarmouth has a population of 7200)[9], there are upwards of 200 spectators at these events (pers. obs.), and many of the spectators visit local restaurants, gift shops, and hotels, these derbies may have a measurable (albeit moderate) economic benefit to local communities. As an example, the shark derby is arguably the most important event of the summer season in Yarmouth (pers. comm., Corke WWF, 2014).

Motivations to attend the derby

When asked why they attend the derby, the majority of spectators rated spending time with family, participating in a community event, and supporting fishermen as very important. Learning about sharks was rated as less important. These results mirror the

[9] http://townofyarmouth.ca/

captains survey responses in that the importance of the derby is largely about the community event (i.e. spending time with friends and family) and that there is a general lack of interest in learning about sharks.

Support of catch-and-release

Similar to the Yarmouth derby respondents, spectators were equally divided in their support of catch-and-release. These results suggest the majority of derby spectators are not highly concerned with reducing shark mortality. Indeed, when asked what would make a catch-and-release derby appealing, 56% said reducing the number of sharks killed was "Not appealing" or "Neutral/Makes no difference". This may not be entirely surprising, as many of the spectators at these catch-and-kill derbies are local, and have likely been to catch-and-kill derbies before, and may be friends or relatives of fishermen competing in the tournament.

As with derby captains, most spectators rated participating in scientific research/tagging projects as very appealing. While spectators did not rate learning about sharks as a primary motivation for attending the derby, 61% rated this as an appealing aspect of a catch-and-release derby, suggesting spectators would like to have more educational material on sharks at the derbies.

Compared to spectators, derby boat captains rated good prizes to derby winners as more appealing. This is not a surprising difference, since derby boat captains are the ones winning the prizes. Captains rated more information about sharks at derbies as less appealing than spectators. It is possible that captains feel they already know a lot about sharks, since many of the respondents in the survey had many years of fishing

experience. Both derby captains and spectators rated having photos/videos at the derby and participating in scientific research as very appealing.

Although reducing the number of sharks killed was not rated as highly important, most spectators were highly concerned with what was done with the sharks after being caught, rating landfills as the least popular use, and scientific study as the most popular. The strong support of scientific study may in part be due to the strong presence of DFO-Science at the derbies, where scientists take samples in view of the spectators. Spectators have likely grown to see this as an important part of the derby, and this may explain both the lack of interest in reducing shark mortality, and strong support of using sharks for scientific study.

Perceptions

The highly varied and sometimes contradictory responses of spectators in response to their perceptions of sharks may be an indication of the mixed messages the public receives from the media, as well as a general lack of education and misinformation about sharks. Indeed, sharks are often portrayed as both important top predators of the marine food web, and dangerous man-eaters.

Education

Most of the spectators indicated they learn "a little" about sharks at the derbies, and were most interested in learning about types of species and the biology of sharks. Threats to sharks and fishing practices were less popular options. It is likely that many spectators are lacking knowledge on the basic biology of sharks and various shark species

in Eastern Canada, as there is very little educational engagement at the derbies (pers. obs.), and the only species caught are blue sharks, occasionally mako, and rarely thresher sharks. A summary of positive indicators of support for catch and release as well as indicators of challenges to catch and release from derby captains and spectators are shown in Table 5.

Table 5. Positive indicators and possible challenges to gaining support for catch-and-release fishing at shark derbies in Eastern Canada.

	Positive indicators of support for catch-and-release	**Possible challenges to gaining support for catch-and-release**
Derby captains	• Catching many sharks given low priority • Winning awards rated as less important than the overall challenge of catching sharks, interacting with sharks, or spending time with friends/family • Majority believe sharks play an important role in marine ecosystem • Majority have previous experience with catch-and-release; and those have mostly been positive • Majority have previously released fish for conservation reasons	• Yarmouth captains were less supportive of catch-and-release trial than Louisbourg captain's • Captains rated '*keeping sharks and winning an award*' as more satisfying than '*releasing a shark and winning an award'* • Responses were divided on having an observer on board • Little interest in learning about sharks
Spectators	• Highly supportive of scientific uses/tagging • Would like more information on shark biology and species • Highly concerned with what sharks are used for after caught (preferring scientific use over all others)	• 'Learning about sharks' was not rated as a major motivation for attending derbies • Neutral responses to catch-and-release • Reducing shark mortality is low priority • Mixed perceptions of sharks

5. LIMITATIONS OF THE STUDY

While the majority (81%) of derby boat captains surveyed were fishermen by occupation, their opinions are not necessarily representative of the other derby participants (i.e. non-captain anglers in the derby). Subsequent research directly surveying non-captain anglers would be useful to gauge how their opinions and demographics may be similar or different to boat captains, and how this may influence the future of catch-and-release derbies in Eastern Canada. Likewise, the opinions, attitudes, and motivations of derby spectators are not likely representative of the wider public. It would be interesting for future research to compare derby spectators' opinions to the general public's understanding of sharks and opinions on catch-and-release.

6. SUMMARY

Catch-and-release is a widely under-examined non-consumptive use of sharks. Several patterns can be extracted from the case studies reviewed here (Table 6). First, recreational anglers played a central role in implementing tag-and-release programs and were often the parties responsible for initiating catch-and-release tournaments (Table 6). Drivers often came from a number of sources and operated at various levels. In the case of the *Are You Man Enough* derby that was converted to catch-and-release by the Paxton's, it was the combined pressures of local activist groups and politicians that motivated (if not necessitated) the switch. Likewise, the Australian Gamefish Tournament Monitoring Program was government-led, but was motivated by a broader cultural shift towards conservation and a rise in public understanding of the need for sustainable management. Second, there were often multiple benefits to developing the

tagging program or derby. In addition to the obvious ecological benefits of reducing shark mortality, scientists were able to gather information on migration, growth, and behavior to better inform management while anglers were able to use that information to better inform their fishing behavior. In the case of charter boat shark fishing in Florida, captains were able to ensure the future of their business by allowing sharks to be caught multiple times, avoid bad press, and capitalize on the growing interest in sustainable shark tourism. In the Guy Harvey tournament, being exclusively catch-and-release gained the attention, endorsement, and in some cases financial support of highly prestigious scientific bodies and environmental groups such as the Guy Harvey Ocean Foundation, MOTE marine laboratory, and Shark Savers. Lastly, all the case studies examined here involved collaborative efforts of anglers and the government. Cooperative partnerships allow all parties to accomplish something that would be difficult to achieve individually: scientists gain access to highly knowledgeable anglers and their boats, while anglers are able to use high-tech tagging devices, enjoy contributing to science, and benefit from better fisheries data. Sometimes the government or scientific body provides rewards to anglers to further incentivize reporting found tags. In either case, collaboration and cooperation from multiple parties is required.

Table 6 Factors contributing to increase in catch-and-release in recreational shark fishing in Australia, New Zealand, and the United States with comparison to Canada.

Country	**Derby/Program name**	**Initiating party**	**Enforcing agents**	**General reasons/drivers for C-R**	**Source**
Australia	Gamefish Tournament Monitoring Program	Game Fishing Association of Australia (GFAA) with support from Government of Australia	Government of Australia	Government and GFAA recognized need for sustainability. Tag-and-release program started to monitor recreational gamefish fishery.	Babcock, 2008 Lowry & Murphy, 2003
USA	Charter boat shark fishing in Florida	Charter boat captains	Charter boat captains	Desire to ensure future of business, maintain healthy ecosystem, avoid bad press	Shiffman & Hammerschlag, 2014
	Guy Harvey Ultimate Shark Challenge	Gamefish anglers	No enforcement, presented as voluntary alternative to catch-and-kill	Love of sharks/desire to increase post-release survivorship and educate public	Personal communication with Sean & Brooks Paxton (2014).
	'Are You Man Enough' Tournament	Tournament organizer	None, but intense political pressure	Intense pressure from activist groups and political figures to shut down formerly catch-and-kill derby Needed to switch or else tournament would be shut-down	Personal communication with Sean & Brooks Paxton (2014).
New Zealand	New Zealand Cooperative Gamefish & Billfish Tagging Program	Gamefish anglers	New Zealand Ministry of Fisheries	Tagging to gain information on species distribution and reduce conflict between recreational and commercial fisheries	Francis, 1998 Harthill & Davies, 2001
Canada	N/A	Potentially WWF and/or scientists	Likely DFO	Harmonize policies, enforce best handling practices, education and understanding	(Current research paper)

While the practice of catch-and-release angling for sharks is increasing worldwide, particularly through tagging programs (Babcock, 2008), the number of exclusively catch-and-release tournaments is still a small portion of the total shark fishing tournaments. For example, only 2/13 derbies found in the United States were catch-and-release.

7. RECOMMENDATIONS FOR CANADA

Combining the results from the survey, case studies, and literature search, eight major recommendations for Canada have been derived to increase catch-and-release practices at its shark derbies (summarized in Table 7). First, results from the survey suggest derby boat captains who had attended fewer derbies were more open to the idea of catch-and-release than those who had attended many. In the case study analysis, the Paxton brothers (creators of the Guy Harvey USC) targeted a new, more conservation-minded community of anglers to attend the derby. Survey results suggest long-standing derbies such as those in Yarmouth and Brooklyn, Nova Scotia may represent communities of anglers that are less open to catch-and-release, at least initially. Therefore it is recommended that Canada target younger derbies for pilot studies. Once the methods are proven effective, derbies such as Yarmouth and Brooklyn may be more likely to reconsider catch-and-release.

Second, both derby captains and derby spectators strongly supported scientific research and tagging of sharks at derbies, and captains identified this as an appealing feature of the derby. There are many examples of angler interest in tagging in the literature, including the case studies reviewed here (New Zealand Gamefish and Billfish Tagging Program and Australia's Gamefish Tournament Monitoring Program). It is

recommended that Canada leverage this interest by further incorporating tagging efforts into existing derbies and increasing angler participation in tagging. Furthermore, it is recommended that Canada hold stakeholder meetings involving derby organizers, boat captains, anglers, the DFO, scientists, and NGOs such as the WWF to further engage anglers in tagging. Tagging should be further incentivized by emphasizing to anglers how tagging can benefit them directly. In addition to those benefits aforementioned (i.e. access to high-tech tagging technology, contributing to science and improving fisheries data), linking up with organizations such as the Ocean Tracking Network (OTN) or OCEARCH to allow anglers to name and track sharks they tag could be another way of increasing participation. Derby organizers who incorporate more shark tagging and catch-and-release can similarly be incentivized by pointing to the potential economic benefits of appealing to a growing market for sustainable shark tourism (e.g. Charter Boat shark fishing in Florida).

Third, the majority of the angler's surveyed believed sharks to play an important role in the ecosystem, had previous positive experiences with catch-and-release, and were interested in learning proper shark handling practices. Evidence from case studies reviewed here shows that several successful tagging and catch-and-release initiatives were either led or strongly supported by anglers (e.g. Australia's Gamefish Tournament Monitoring Program, Guy Harvey Ultimate Shark Challenge, New Zealand Cooperative Gamefish & Billfish Tagging Program). Thus, it is recommended that Canada organize a group of interested and dedicated anglers and derby organizers to help design and develop a catch-and-release division of an existing catch-and-kill derby.

Fourth, results of the survey indicate the primary motivations of derby boat captains

for participating in shark derbies include the overall challenge of catching sharks, getting to interact with sharks, and spending time with family and friends. Catch-and-release fishing would still enable anglers to enjoy the overall challenge of catching sharks as well as interacting with sharks. Thus, it is recommended that catch-and-release efforts focus on enhancing these aspects of the derby and not invest in greater prizes/awards.

Fifth, at the Guy Harvey Ultimate Shark Challenge, the Paxton's allowed angler teams to nominate an observer – often a friend or fellow angler – to be assigned to another boat (as discussed earlier). Only 1/3 of derby boat captains surveyed here were supportive of having an observer present on board during a hypothetical catch-and-release derby; thus, it is recommended Canada employ a similar strategy in future catch-and-release derbies.

Sixth, the results of the spectator survey suggest public audiences have conflicting views of sharks and learn little about sharks at the derbies. While spectators showed little interest in learning about sharks, they were even more interested in research and tagging than captains (62% captains versus 71% spectators). It is recommended that existing catch-and-kill derbies as well as future catch-and-release derbies provide a greater educational component, perhaps incorporating information on the tagging process, as spectators were highly interested in this aspect of the derby. Ideas on how to make education entertaining should be informed by the educational workshops, seminars, and interactive exhibits used at the Guy Harvey derby, using local experts, anglers, and scientists to assist. Canada could seek out funding for educational projects from industry sponsors such as Canadian VEMCO telemetry[10].

[10] http://vemco.com/

Based on survey results, about half of derby boat captains had not received training on proper shark handling practices, and 60% of those said they would like to receive training. Training is important in any derby that practices catch-and-release as the use of these practices is related to post-release survival (Skomal, 2007). In the Guy Harvey derby, all observers are thoroughly trained in handling practices. It is recommended that Canada make training mandatory for all derby anglers, with observers and anglers receiving thorough training. Furthermore, techniques should be tailored primarily to blue sharks with some mention of mako and thresher, since sensitivity differs amongst shark species (Skomal, 2007) and blue sharks make up the majority of derby catches (Campana et al., 2006).

Finally, the case study analysis revealed that drivers for catch-and-release often came from multiple sources, both bottom-up (e.g. anglers) and top-down (e.g. government), and often developed simultaneously through cooperative partnerships. Collaborative research programs and regular collaboration between stakeholders is important to effective conservation of elasmobranchs (Davis & Worm, 2013). Thus, it is recommended that Canada facilitate the building of collaborative partnerships between anglers, scientists, government, and NGOs in order to foster the development of effective catch-and-release training and practice at Canadian shark derbies. Moreover, since recreational shark fishing apart from derbies is strictly catch-and-release, making shark derbies catch-and-release would serve to harmonize all recreational shark fishing across Canada. A summary of recommendations are outlined in Table 7 and possible action items that derive from the abovementioned recommendations are summarized in Table 8.

Table 7 Recommended actions for Canada to implement catch-and-release practices in Nova Scotia's recreational shark derbies.

Survey	**Case study**	**Interpretation**	**Recommendations**	**Sources**
1. Derby boat captains who had attended less derbies were more open to catch-and-release.	Paxton brothers of Guy Harvey derby (USA) targeted new conservation-minded community of anglers to attend their derbies.	There is evidence of a growing culture of conservation-minded anglers in support of catch-and-release (e.g. Florida Charter Boat shark fishing)	Canada should target newer/younger derbies for pilot studies. If these projects succeed, older/long-running derbies may be more willing to try catch-and-release.	Lowry & Murphy, 2003 Shiffman & Hammerschlag, 2014 Pers. comm., Paxton USC, 2014
2. Derby boat captains and spectators strongly support scientific research and tagging of sharks	Both New Zealand and Australia have tagging programs led by anglers (NZGBTP and AGTMP).	Tagging provides a good avenue to engage anglers in catch and release programs and scientific research. It also provides an incentive to return sharks in good condition.	Canada should leverage angler interest in tagging by increasing tagging component at existing derbies and increase angler participation in tagging. Stakeholder meetings with anglers, derby organizers, DFO, scientists, and WWF may help further increase angler involvement in tagging and catch-and-release efforts.	Harthill & Davies, 2001 Lowry & Murphy, 2003
3. Anglers believe sharks are important to the ecosystem, have previous	Both New Zealand and Australia have tagging	Enabling conditions exist, that lend themselves to	Canada should organize a group of interested and dedicated anglers to	Harthill & Davies, 2001 Lowry & Murphy, 2003

catch-and-release experience, and are interested in learning better handling practices.	programs led by anglers (NZGBTP and AGTMP).	stakeholder engagement, dialogue, and training	design a catch-and-release derby. (Stakeholder meetings as outlined above could help in identifying interested anglers).	
4. Derby boat captains are more motivated by interacting with sharks, the challenge of shark fishing, and spending time with friends/family than winning awards or catching many sharks.		Primary motivations are compatible with catch and release	Catch-and-release efforts should focus on enhancing time spent with friends/family, interacting with sharks, and shark fishing, rather than investing in prizes and awards to incentivize anglers.	
5. Only 1/3 of derby boat captains supported the idea of having an observer on board.	At the Guy Harvey derby, angling teams nominate observers for other boats, providing a sense of trust and familiarity amongst observers and anglers.	Observer coverage needs to be carefully implemented and should not be forced	Canada should ask anglers to nominate observers at catch-and-release derbies to increase angler support for this rule.	Pers. comm., Paxton USC, 2014
6. Public audiences have conflicting views on sharks and learn little about sharks at current derbies.	Guy Harvey derby has interactive educational exhibits, seminars, and workshops to entertain and educate audiences.	Derbies present an opportunity for broader public engagement and education in shark biology and conservation	Canada should increase the educational component at existing derbies, and future catch-and-release programs.	Pers. comm., Paxton USC, 2014
7. Half of all derby boat captains had not been trained in handling sharks, and 60% wanted training.	Observers are trained at Guy Harvey derby, and responsible for ensuring angling teams use proper handling practices.	Proper handling practices should be a cornerstone of catch and release practices; this should be motivated by reducing	Canada should make training mandatory for all derby participants. In derbies with observers, anglers and observers	Skomal, 2007. Pers. comm., Paxton USC, 2014

		post-release mortality and successful tagging	should be thoroughly trained.	
8.	Catch-and-release drivers are often bottom-up and top-down and involve a general 'cultural shift' towards conservation and sustainability.	The shift from catch and kill to catch and release needs to be motivated from multiple stakeholders and should involve close cooperation between these parties.	Government agencies, NGOs, academia, and derby organizers should all support shark conservation through catch-and-release derbies. Catch-and-release efforts should be matched to existing IPOA and NPOA goals, including increased shark outreach and education, data collection, and establishment of collaborative partnerships. (See recommendation to hold stakeholder meetings above).	Pers. comm., Paxton USC, 2014 NPOA-Sharks (Canada), 2014

Table 8. Action items for Canada to increase catch-and-release practices in Nova Scotia's recreational shark derbies.

	Recommendations	**Action items**	**Responsible parties**
Education & Outreach	• Canada should increase the educational component at existing derbies, and future catch-and-release programs (6) • Catch-and-release efforts should be matched to existing IPOA and NPOA goals, including increased shark outreach and education, data collection, and establishment of collaborative partnerships (8)	• Encourage change in public perceptions through better marine/ocean education in Nova Scotia curriculum	• Government (Provincial)
		• Support stronger educational component at derbies, especially in shark biology and shark species • Work to improve spectators perceptions of sharks	• DFO and derby organizers with help from WWF, student volunteers, and other academic or NGO partners
Collaborative partnerships	• Canada should leverage angler interest in tagging by increasing tagging component at existing derbies and increase angler participation in tagging (2) • Catch-and-release efforts should focus on enhancing time spent with friends/family, interacting with sharks, and shark fishing, rather than investing in prizes and awards to incentivize anglers (4) • Stakeholder meetings with anglers, derby organizers, DFO, scientists,	• Further collaboration between anglers and DFO to expand tagging programs either within or outside existing derbies • Engage DFO-Science in catch-and-release efforts (discuss ways to access get similar data without kill derbies)	• DFO-Science • WWF

	and WWF may help further increase angler involvement in tagging and catch-and-release efforts (2)		
Catch-and-release development and training	• Canada should make training mandatory for all derby participants. In derbies with observers, anglers and observers should be thoroughly trained (7) • Canada should target newer/younger derbies for pilot studies (1) • Canada should organize a group of interested and dedicated anglers to design a catch-and-release derby (3) • Canada should ask anglers to nominate observers at catch-and-release derbies to increase angler support for this rule (5)	• Create or pilot catch-and-release division within existing derbies	• WWF in partnership with Derby organizers; support from DFO-Science
		• Require boats to have observers in order to ensure proper handling and release, species ID, and compliance with derby regulations	• DFO-led initiative, with participation from derby organizers and participants

*Numbers in brackets indicate the corresponding recommendation (1-8) as shown in Table 7.

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APPENDIX I –SURVEY OF DERBY BOAT CAPTAINS

Shark Derby Participants Survey

What is the purpose of this survey?

WWF-Canada is interested in learning more about your fishing experience and opinions on sharks and catch-and-release fishing.

PART ONE – FISHING EXPERIENCE

City of residence _____ Province _____ Country _____

Occupation _____

Number of days spent fishing any species (recreationally or commercially) in previous 12 months?

- ☐ Less than 10 days
- ☐ Between 10-50 days
- ☐ 51-100 days
- ☐ Over 100 days

Total number of years fishing recreationally or commercially (any species)?

- ☐ <5 years
- ☐ 5-10 years
- ☐ 11-20 years
- ☐ 21-30 years
- ☐ Over 30 years

Total number of previous shark derby fishing trips (both in Canada and internationally)?

- ☐ First time
- ☐ l-5
- ☐ 6-10
- ☐ 11-20
- ☐ Over 20

Have you participated in other derbies? (Please check the derbies you have participated in and indicate the year(s) beside.

Location	When you participated (year)
☐ Yarmouth	_____
☐ Brooklyn	_____
☐ Riverport	_____
☐ Lockeport	_____
☐ Louisbourg	_____

- ☐ Halifax _____
- ☐ Dartmouth _____
- ☐ Jeddore _____
- ☐ Eastern Passage _____
- ☐ Split Crow _____
- ☐ Petit de Grat _____
- ☐ Other / International

_____

PART TWO – SHARK AND SHARK DERBY FISHING

What do you think of sharks (check all that apply)?

- ☐ Dangerous to people
- ☐ Nuisance to fisheries
- ☐ Neutral/Don't know
- ☐ Important part of marine ecosystem
- ☐ Threatened species
- ☐ Other: _____

How do you rate the following aspects of the shark derby in terms of how valuable they are to you?

	Not at all	Somewhat	Neutral	Very	Extremely
Catching as many sharks as I can	☐	☐	☐	☐	☐
Catching the biggest shark/winning an award	☐	☐	☐	☐	☐
The overall challenge of catching sharks	☐	☐	☐	☐	☐
Spending time with friends/family	☐	☐	☐	☐	☐
Escaping daily routine	☐	☐	☐	☐	☐
Experiencing nature	☐	☐	☐	☐	☐

Getting to interact with sharks	☐	☐	☐	☐	☐

PART THREE – CATCH AND RELEASE FISHING

What is catch-and-release and how does it work in a shark derby?

Many derbies around the world use catch-and-release rather than catch-and-kill as a method for game fishing. At catch-and-release derbies, sharks are caught measured against a standardized measuring device and released back into the water alive. Information is collected such as species, length, and sex, and photographs/video are used to verify the catch and administer an award Tournament scores are awarded based on a number of variables including the species (e.g. how likely or rare it is to catch), length, and the catch time. (If you have any questions, feel free to ask one of the volunteers who provided you with the survey).

If you have any questions, feel free to ask one of the WWF volunteers

Have you ever released your catch (of any species, not just sharks) either in a derby or when fishing for personal recreation?

Yes / No

If yes, what was your reason for releasing the catch?

- ☐ Caught something I wasn't trying to catch
- ☐ Catch was too small
- ☐ Not allowed to keep it by law/regulation
- ☐ Didn't intend to eat or sell it, so put it back
- ☐ Wanted to help keep the fish population healthy/conserve the species
- ☐ Other _____

What has been your experience with catch-and-release?

Negative	**Somewhat Negative**	**Neutral**	**Somewhat Positive**	**Positive**
☐	☐	☐	☐	☐

Please explain.

_____

After a shark derby, how satisfied would you feel if you…

	Not satisfied	Somewhat satisfied	Very satisfied
Didn't catch anything	☐	☐	☐
Caught and kept sharks but did not win any awards	☐	☐	☐
Caught and kept an award winning shark	☐	☐	☐
Caught sharks and released them (without winning an award)	☐	☐	☐
Caught sharks and released them (winning an award)	☐	☐	☐

Would you support a trial run of catch-and-release in the future?

Strongly oppose	Somewhat oppose	Neutral	Somewhat support	Strongly support
☐	☐	☐	☐	☐

In a catch-and-release derby, would you support having a voluntary observer on your boat to assist with identification, measurement, and catch-and-release practices?

Strongly oppose	Somewhat oppose	Neutral	Somewhat support	Strongly support
☐	☐	☐	☐	☐

Have you received training on how to properly handle & release sharks?

Yes / No

If so, where and from whom?

_____

Would you be interested in receiving training on catch-and-release practices?

Yes / No

In a catch-and-release derby, would you support having a voluntary observer on your boat to assist with identification, measurement, and catch-and-release practices?

Strongly oppose	**Somewhat oppose**	**Neutral**	**Somewhat support**	**Strongly support**
☐	☐	☐	☐	☐

Please explain.

_____

_____

Would you support a trial run of catch-and-release in the future?

Strongly oppose	**Somewhat oppose**	**Neutral**	**Somewhat support**	**Strongly support**
☐	☐	☐	☐	☐

Please explain _____

If not, what would make a catch-and-release derby appealing?

	Not appealing	**Neutral/Don't know**	**Very appealing**

Good prizes to derby winners	☐	☐	☐
More information/ education about sharks	☐	☐	☐
Having photos/videos recorded and broadcast to derby audience	☐	☐	☐
Participate in shark research (e.g. through tagging and tracking)	☐	☐	☐

Other (please tell us your ideas)

_____
_____
_____

Other comments:

_____
_____
_____
_____
_____
_____

Thank-you for your time!

Shark Derby Public Survey

What is the purpose of this survey? The World Wildlife Fund is interested in learning more about your derby experience and opinions on catch-and-release fishing.

PART ONE – Derby Experience

City of residence _____ Province _____ Country _____

Occupation _____ Age _____

Is this your first time at a shark derby? **Yes** / **No**

Have you attended other shark derbies? (Please check the derbies you have attended and indicate the year(s) beside.

Location	When you attended (year)
☐ Yarmouth	_____
☐ Brooklyn	_____
☐ Riverport	_____
☐ Lockeport	_____
☐ Louisbourg	_____
☐ Halifax	_____
☐ Dartmouth	_____
☐ Jeddore	_____
☐ Eastern Passage	_____
☐ Split Crow	_____
☐ Petit de Grat	_____

Others/International:_____

Approximately how much money do you spend at the derby each year (including travel and accommodation)?

- ☐ $0-20
- ☐ $20-50
- ☐ $50-100

□ $100-200
□ > $200

We are interested in what brings you to the shark derby. How important do you rate…

	Not important	**Somewhat important**	**Neutral**	**Very important**	**Most important**
Seeing sharks	☐	☐	☐	☐	☐
Learning about sharks	☐	☐	☐	☐	☐
Supporting the fishermen	☐	☐	☐	☐	☐
Time spent with friends/family	☐	☐	☐	☐	☐
Participating in a community event	☐	☐	☐	☐	☐

Other? _____

PART TWO – Catch-and-Release Fishing

What is catch-and-release and how does it work in a shark derby?

Many derbies around the world use catch-and-release rather than catch-and-kill as a method for game fishing. At catch-and-release derbies, sharks are caught but released back into the water and measured against a standardized measuring device. Information is collected such as species, length, and sex, and photographs/video are used to verify the catch and administer an award. Tournament scores are awarded based on a number of variables (such as shark length and catch time).

If you have any questions, feel free to ask one of the WWF volunteers.

If this was a catch-and-release derby, would you be:

- ☐ More likely to attend
- ☐ Less likely to attend
- ☐ Neutral – it makes no difference

Please explain. _____

What would make a catch-and-release derby appealing to you?

	Not appealing	**Neutral**	**Very appealing**
Good prizes to derby winners	☐	☐	☐
More information/ education about sharks	☐	☐	☐
Having a live broadcast of the fishing events so you can watch from the festival	☐	☐	☐
Having the derby participate in shark research (e.g. through tagging and tracking)	☐	☐	☐
Reducing the total number of sharks killed	☐	☐	☐

Other?_____

Is it important to you what's done with the shark after it is caught?

Not at all	**Somewhat**	**Neutral**	**Very**	**Extremely**
☐	☐	☐	☐	☐

If yes, indicate your level of support for the following uses of sharks after being caught:

	Strongly oppose	**Neutral**	**Strongly support**
Scientific study/research	☐	☐	☐
Food source	☐	☐	☐
Profit (selling of fins or other parts)	☐	☐	☐
Landfill/garbage	☐	☐	☐

Other: _____

PART THREE – Shark education

What is your perception of sharks in our region? Check all that apply.

- ☐ Dangerous to people
- ☐ Nuisance to fisheries
- ☐ Neutral/Don't know
- ☐ Important part of marine ecosystem
- ☐ Threatened species that needs protection
- ☐ Other: _____

Do you feel you learn about sharks at the derby? Please check the box.

- ☐ No, not at all
- ☐ A little

- ☐ Neutral/Don't know
- ☐ Yes, some information is provided
- ☐ Yes, there is lots of information about sharks provided at the derby

If yes, what information have you learnt about sharks? (Check all that apply).

- ☐ Types of species
- ☐ Biology of sharks (e.g. behaviour, anatomy)
- ☐ Threats to sharks
- ☐ Fishing practices
- ☐ Other _____

What sort of information would you like to learn more about?

	Less interesting	Neutral	Very interesting
Types of shark species	☐	☐	☐
Biology of sharks (e.g. behaviour, anatomy)	☐	☐	☐
Threats to sharks	☐	☐	☐
Fishing practices	☐	☐	☐

Other? _____

Other comments:

_____

_____

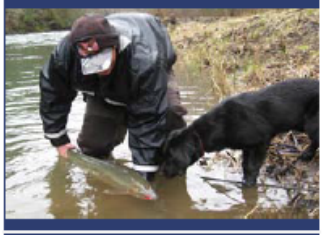
_____

_____

Thank-you for your time!

Catch and Release Best Practices

NOAA FISHERIES SERVICE
Office of Sustainable Fisheries



Catch and Release Fishing

Do

- Keep the fish in the water as much as possible
- Use circle hooks and barbless hooks to enhance survival
- Assist in the recovery process of the fish prior to release
- Learn the proper release technique for the type of fish you're pursuing

Don't

- Don't simply toss a fish back into the water
- Don't play the fish to exhaustion
- Don't try to pull the hook out of a gill or gut hooked fish
- Don't squeeze the fish or handle it more than necessary

Many anglers now use the practice of Catch and Release to help ensure that their favorite fishing spot has plenty of fish to catch. Catch and Release fishing is a great way for anglers to enjoy their sport, and still maintain adequate stocks of fish and a healthy ecosystem for future anglers. Some wildlife regulations require anglers to release certain fish to help ensure robust populations in the future.

What Else Should I know?

Unfortunately, releasing a fish after it's been caught takes more effort than some anglers think. It's just not enough to toss a fish back in the water after you unhook it as many fish released that way will die later. In order to provide the fish with a good chance at survival, Catch and Release must be practiced correctly and there are several things to consider.

Proper release means using the right gear and techniques to help improve the chances that fish will survive. Research your chosen fishing location and be prepared for the species of fish you are pursuing. The correct tools make releasing fish much more efficient and effective, so keep pliers, nets, measuring tape, camera, etc., close at hand in order to limit the amount of stress a fish will experience as you release it.

Important Catch and Release Reminders

- Never play a fish to complete exhaustion. Use tackle of sufficient strength for the potential size of your quarry.
- If possible, unhook the fish while it is in the water. If a hook is swallowed and you can't get it out, do not try to pull the hook out. Cut the line as close to the hook as possible and leave the hook in the fish. Use barbless hooks to make release easier.
- If you must remove a fish from the water, keep air exposure to a minimum. Less than 30 to 60 seconds is ideal.
- Handle the fish as little as possible and only use wet hands and/or a wet towel to touch the fish. Use an appropriate release tool.
- When holding large fish for a photo, support their weight by holding them horizontally, not vertically which may cause fatal injuries.
- Re-acclimate a fish by facing it into the current then gently release it into the water.
- Use a soft rubber mesh landing net which is less damaging to eyes, fins, scales and the protective mucous membrane.
- Not all fish that are released will survive, so an angler's restraint plays an important part in the practice of Catch and Release.
- Catch and release fishing is all about preserving the sport of fishing. Anglers that take the time to learn to handle and release a fish unharmed are ensuring that others will be able to enjoy the sport in the future.

Where Can I learn More About Catch and Release Fishing?

Catch and release is more than just tossing the fish back in the water. Proper release means using the right gear and techniques to help improve the chances that fish will survive. Learn more things you can do to help fish survive at www.nmfs.noaa.gov.

The future of sportfishing is in your hands.
Pass it on!

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