

Economic Analysis of the Catch-and-Retain Bluefin Tuna Charter Fishery in the Atlantic
Canadian Gulf Region: An Exploratory Study

by

Khanh Tran

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ABSTRACT

Growing interest among Bluefin Tuna (BFT) commercial fishers in increasing economic opportunities led to the introduction of a catch-and-retain charter fishery in Atlantic Canada's Gulf Region in 2020. Unlike its catch-and-release counterpart, catch-and-retain allows fishers to capture their commercial quota allocation with charter clients on board. To assess the economic viability of this newly implemented fishery, the study administered an online survey to active BFT charter boat operators following the 2022 season. The survey asked charter boat operators about their BFT charter fishing operations, perspectives on the catch-and-retain fishery, and socio-economic backgrounds. The first study objective was to assess and describe important economic characteristics of the sample of BFT charter fishers, with a focus on catch-and-retain. The second objective was to evaluate and compare differences in trip expenses of catch-and-retain fishing relative to 1. commercial and catch-and-release BFT fishing; and 2. between the Gulf Nova Scotia and Prince Edward Island (PEI) fleet regions. Primary data for the analysis were based on thirteen usable responses from BFT charter boat operators. Notable findings include the following: all charter boat operators supported continuing the pilot BFT catch-and-retain fishery in future seasons. In addition, catch-and-retain generated less revenue than catch-and-release in 2022, partly because a limited number of commercial tags during the season capped the number of possible catch-and-retain fishing trips. There were also no significant differences in trip variable costs between catch-and-retain and catch-and-release BFT fishing in the Gulf Region. Additionally, charter boat operators reported that taking part in catch-and-retain helped eliminate unnecessary duplication of effort and expenses because they no longer needed to make separate commercial fishing trips.

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Chapter 1 : INTRODUCTION

1.1 Background

The Atlantic Bluefin Tuna (*Thunnus thynnus*; BFT) is a highly migratory species of considerable economic importance for commercial and recreational fisheries in the North Atlantic Ocean. Since the mid-1980s, commercial fishing for BFT has become an economically attractive activity, including the development of a multi-million-dollar market in Japan for gourmet consumption in sushi and sashimi (Fromentin & Ravier, 2005; Porch, 2005). For example, a 612-pound (278-kilogram) BFT was auctioned in the Tokyo Tsukiji fish market for up to US\$ 3 million in 2019 (Associated Press, 2019). The economic benefits of BFT also go beyond the sale receipts to commercial fishers. For instance, Sumaila & Huang (2012) estimated that BFT fisheries in the Mediterranean Sea bring about US\$ 226.8 million in total landed value, 3,500 full-time fishing jobs, and US\$ 635 million in aggregate economic impacts per year.

The economic importance of the BFT commercial fisheries is well-documented in Atlantic Canada. In 2019, the Canadian commercial fishery landed over 666 tonnes of BFT, valued at over CA\$ 9.6 million. These values are slightly higher than the average landed quantity and value between 2000 and 2019 (536 tonnes and CA\$ 9 million, respectively). The Atlantic Canadian Gulf Region hosts the most active BFT fisheries,¹ as shown by the area's sizable (43%) annual average contribution to Canada's total commercial BFT catch. Records also indicate that increasingly more Canadian BFTs were exported between 2000 and 2019. Export volume in 2019 was close to 490 tonnes and valued at over CA\$ 10.3 million, representing a 46% increase from 2000. The majority of Canadian BFTs are exported live to Japan. BFT is also traded in fresh or chilled form; between

¹ The Canadian BFT commercial fishery is undertaken in four Department of Fisheries and Oceans (DFO) Atlantic regions, namely: Maritimes, Gulf, Newfoundland and Labrador, and Quebec (Fisheries and Oceans Canada, 2019).

2010 and 2020, 71.2% of fresh or chilled BFT were exported to Japan, 28.2% to the U.S, and the remaining 0.6% to several other Asian and European countries. These data on total landed values and exports highlight the economic importance of BFT to Canadian commercial fishers.

Besides the commercial value, BFT is a principal target species for recreational fishers thanks to its large size (up to 700 kg) and fast speed at over 90 km/h (Porch, 2005). Sport fishing for BFT became popular during the 1930s, particularly off the North American coast between Cape Hatteras, North Carolina and Newfoundland, Canada in summer and early fall (Mather et al., 1995). Wedgeport, Nova Scotia, is one of the centres of intensive tuna fishing that once hosted the annual International Tuna Cup Match, which attracted fishers and teams from various nations to compete for the biggest catch (Hurley & Isles, 1980). Another popular fishing activity among BFT recreational anglers is catch-and-release. Unlike the sport fishery where anglers exert considerable effort to catch one giant BFT, the catch-and-release fishery provides anglers with opportunities to hook large BFTs multiple times in a single fishing trip (Bohnsack et al., 2002). Catch-and-release BFT fishing is of considerable economic value in the United States (U.S.) East Coast (Bohnsack et al., 2002; Hutt et al., 2014) and Northern Europe (Versloot, 2021; Maar, 2022). For example, the fishery at Hatteras, North Carolina, was estimated to generate a total output of US\$ 4.6 million and US\$ 5 million at the local and state levels, respectively, and contribute to 126 full and part-time jobs in 1997 (Bohnsack et al., 2002).

Catch-and-release is also an economically important fishing activity for Canadian BFT commercial fishers. The catch-and-release fishery has become a well-established, service-based industry since its opening in 2009, attracting approximately 57 licence holders in Atlantic Canada's Gulf Region in 2019 (Government of Canada, n.d.). Of the three Gulf Region's fleet

sectors,² Prince Edward Island (PEI) and Gulf Nova Scotia are the two consistently active fleets engaged in both commercial and charter catch-and-release fisheries. Commercial fishers eligible to participate in the catch-and-release fishery are known as charter boat operators; these individuals guide day trips for paying clients to hook and release live BFTs. The catch-and-release fishery reportedly provides larger economic benefits to Canadian BFT fishers than its commercial counterpart (Ecology Action Centre [EAC], 2014). Catch-and-release fishing was estimated to generate six times more revenue for every tonne of BFT compared to harvests based on commercial fishing in 2012 (EAC, 2014). Thus, catch-and-release can increase the economic returns of Canadian BFT fisheries without putting significant additional pressure on the fish population (EAC, 2014). This charter fishery can also generate local spin-off economic opportunities in the tourism sectors of car rental, eating and drinking, and hotels and lodging (EAC, 2014). Most importantly, the catch-and-release fishery presents an additional avenue for BFT commercial fishers to supplement the revenue from their licences.

To diversify and potentially provide increased economic opportunities for licensed commercial BFT fishers, the DFO piloted a charter catch-and-retain fishery in 2020. Unlike the catch-and-release fishery which permits the hooked BFT to be brought only alongside the vessel, fishers and charter clients can take the caught fish onto the boat under catch-and-retain. The fish is then retained and counted towards the commercial fishery's quota allocation. This unique characteristic of catch-and-retain may allow such a fishing excursion to command a higher charter fee than catch-and-release, ultimately increasing the income of BFT commercial fishers. Only the Gulf Region in Atlantic Canada is now piloting this new BFT charter fishing activity. Little is known about the catch-and-retain fishery's economic activities due to its recent introduction and

² The Gulf Region comprises PEI, Gulf Nova Scotia, and Eastern New Brunswick fleet sectors (Fisheries and Oceans Canada, 2003).

the COVID-19 pandemic's disruptive impacts on data collecting. The paucity of information emphasizes the importance of collecting and analyzing primary data to better understand this fishery and its implications for fisheries management and decision-making.

1.2 Economic Problem

Key stakeholders interested in understanding the economic implications of the catch-and-retain BFT fishery include government fishery resource managers and policy analysts (e.g., the Canadian Department of Fisheries and Oceans (DFO)), local economic development officials, and BFT commercial fishers active or interested in charter fishing (i.e., charter boat operators).

DFO is a government agency in charge of fisheries licensing, regulations, management and conservation in Canada, and is an agency that also promotes economic development in the marine and fisheries sectors (Fisheries and Oceans Canada, 2022). Thus, federal fishery resource managers must understand the economic activities of BFT catch-and-retain charter fishing to assess the success or otherwise of this pilot fishery. Similarly, local economic development officials in Atlantic Canada, such as the Department of Economic Growth, Tourism and Culture of PEI (Government of Prince Edward Island, 2023), are interested in learning about the economic viability of the catch-and-retain fishery and whether this fishing activity could generate development opportunities for the area.

Charter boat operators are commercial BFT licence holders who have a Section 52 Scientific and Experimental licence and meet Transport Canada's requirements for carrying passengers onboard a fishing vessel (Fisheries and Oceans Canada, 2012; Deonarine & Dalton, 2019). Their growing interest in increasing economic opportunities prompted the DFO to introduce the BFT charter catch-and-retain fishery in 2020. Charter boat operators are interested in

understanding and demonstrating any economic benefits connected with catch-and-retain because the success of this pilot fishery might result in its permanent implementation. For instance, since they are allowed to combine commercial and charter operations under catch-and-retain, charter boat operators could see a reduction in some of the variable expenses associated with fishing trips. In addition, charter boat operators were required to take separate commercial fishing trips to fulfill their commercial quota allocation prior to the implementation of the catch-and-retain fishery. Thus, catch-and-retain operations may result in fewer fishing trips overall, which could lessen needless effort duplication and lower carbon emissions.

1.3 Research Problem

This research seeks to provide missing information on the economic viability of the BFT catch-and-retain fishery to key stakeholders by analyzing survey data of charter boat operators.

Prior analyses of a recreational fishery's important economic characteristics, such as demographics, profitability, and challenges, were based on survey responses from charter boat operators (Ditton et al., 1975; Ditton et al., 1978; Coughenower, 1986; Ditton et al., 2001; Lichtkoppler, 2003; Lichtkoppler et al., 2003; Hilger & Lovell, 2017; Howard et al., 2021). For instance, a 1975 descriptive analysis of the Texas charter fishing industry highlighted the sector's economic importance to small-town coastal tourism, partly due to the strong connection between charter operations and other tourism elements, such as hotels and restaurants (Ditton et al., 1978). However, the Texas charter fishing industry was not without challenges: the majority of charter boat operators were unable to sustain their operations on a full-time basis due to the lack of industry income, and variable costs were the largest contributor to operational costs incurred in 1975 (Ditton et al., 1978). More recently, Howard et al. (2021) examined important economic

characteristics of the Western Australian charter fishing industry by asking charter boat operators about their demographics, activity levels (e.g., number of clients), and operating costs. They found that in 2019, while the industry generated AU\$ 37.6 million in gross revenue, it also spent AU\$ 30.6 million on gross expenses (Howard et al., 2021). This finding indicates that by lowering operational expenses while also increasing revenue, a charter fishing industry may be profitable.

There is currently limited information on important economic characteristics of the BFT charter fishing industry in Atlantic Canada's Gulf Region, which includes both catch-and-release and catch-and-retain. A prior analysis by EAC (2014) focused on catch-and-release exclusively. For management and policy decisions, information on BFT charter boat operators' socioeconomic characteristics, charter fishing operations, and perspectives on the catch-and-retain fishery are important considerations. The present study fills this knowledge gap by using recent survey data on charter boat operators.

Another area of research in recreational fisheries analyzes data on fishing trip costs. Mathematical modelling and hypothesis testing are two study approaches employed in such analyses. Among different mathematical modelling methods³, the input-output (I-O) technique is well used in most fisheries economic impact studies (Seung & Waters, 2006). Of the most widely employed, ready-made I-O models for economic impact assessment⁴, the IMPLAN (Impact Analysis for Planning) system is commonly used in the recreational fisheries literature which uses survey data (Holland et al., 2012; Steinback & Brinson, 2013; Hutt & Silva, 2015). Analysis using IMPLAN estimates a fishery's economic impacts on total economic output, labour income, and

³ Different methods include input-output (I-O) modelling, social accounting matrices (SAM) modelling, integrated econometric input-output (EC-IO) modelling, fishery economic assessment model (FEAM), and computable general equilibrium (CGE) models. Each of these techniques has its merits and demerits, which have been well documented in the literature (Loveridge, 2004; Seung & Waters, 2006).

⁴ The three most widely employed, ready-made I-O models for economic impact assessment are the IMPLAN (Impact Analysis for Planning), REMI (Regional Economic Models, Inc.), and RIMS-II (Regional Input-Output Modelling System) (Rickman & Schwer, 1995).

employment at the county, state, and nation-wide levels. For instance, a 2013 study of the Atlantic highly migratory species (HMS) recreational fishery found that expenses associated with charter operations contributed to US\$ 51.3 million in aggregate economic output, US\$ 13.1 million in labour income, and 1,131 full and part-time jobs in communities along the U.S. Atlantic and Gulf of Mexico coasts (Hutt & Silva, 2015).

However, the I-O IMPLAN modelling framework has the drawback that in order to assess the economic impacts of a recreational fishery, additional information, such as region-specific data at the industry and commodities levels, is needed in addition to fishing trip costs. For example, Steinback & Brinson (2013) purchased the IMPLAN county-level datasets of 440 distinct business sectors to estimate the economic impacts of the Northeastern U.S. recreational fishing industry. IMPLAN datasets specific to Atlantic Canada's Gulf Region were not available at the time of conducting the present study (Slovachek, 2022). Thus, the economic impacts of BFT catch-and-retain fishing to the Gulf Region's economy have not been estimated in the current study.

Instead, this study applied hypothesis testing to evaluate the relative costs of the BFT catch-and-retain fishery in comparison to commercial and catch-and-release, as well as differences between Gulf Nova Scotia and PEI. There is a small body of recreational fisheries literature that uses hypothesis testing to analyze fishing trip cost data. Notably, Hilger & Lovell (2017) stratified fishing expenses data by large and small vessel categories and tested for significant differences in various expense categories between the two groups. Some fishing expenses evaluated included payroll for skipper and crew, vessel fuel costs, bait costs, equipment purchases, repairs and maintenance, and food and drink costs. For example, fuel costs were found to be the highest average expense for small vessels and the second highest expense for large vessels. Additionally, the difference in fuel costs between small and large vessels was statistically significant at the 1%

level (Hilger & Lovell, 2017). Similar to the analysis by Hilger & Lovell (2017), this study used hypothesis testing to assess the relative economic viability of the BFT catch-and-retain fishery.

1.4 Purpose and Objectives

This research study aims to assess the economic viability of the recently introduced BFT catch-and-retain fishery in the Atlantic Canadian Gulf Region and its implications for BFT fisheries management and decision-making. Specific objectives of the study include the following:

- 1) *To assess and describe important economic characteristics of the Bluefin Tuna charter fishing industry in the Atlantic Canadian Gulf Region using charter boat operators' survey data for the 2022 fishing season.*

An online survey was administered to collect data from charter boat operators who actively participated in BFT charter fishing activities in 2022. Respondents were asked to report their socio-economic characteristics, charter fishing operations (including catch-and-release and catch-and-retain), and perspectives on the catch-and-retain fishery. A qualitative and descriptive approach was adopted to analyze the survey data. Survey results provided important economic characteristics of the BFT charter fishing industry in the Gulf Region and highlighted their implications for fisheries management.

- 2) *To evaluate and compare differences in average fishing trip expenses of catch-and-retain Bluefin Tuna fishing with commercial and catch-and-release Bluefin Tuna fishing, and between Gulf Nova Scotia and PEI.*

As BFT commercial, catch-and-release, and catch-and-retain fishing activities are distinct, the three fisheries might incur different average per-trip expenditures. For instance, given BFT

fishers are permitted to combine commercial and charter operations into a single fishing trip under catch-and-retain, a reduction in some variable fishing trip costs may be possible. Similarly, fishing trip expense data on catch-and-retain may be different in Gulf Nova Scotia and PEI. Survey research methods were used to elicit information of BFT charter operators' trip expenses for each fishing activity type. Important variable costs evaluated included hired equipment (excluding boat-related costs), fuel for fishing vessel(s), repairs and maintenance, wages paid for the vessel crew, tackle costs, meals, ice for onboard fish storage, and bait. The two-tailed paired samples t-test and Wilcoxon signed rank test were applied to test for significant differences in trip expenses between BFT fishing activities. The two-tailed two-sample t-test and Mann-Whitney U test were conducted to compare trip costs of catch-and-retain between fleet regions.

1.5 Outline of the Thesis

The thesis consists of five chapters. Chapter 1 presents the background, economic and research problems, and outlines the purpose and objectives of the study. Chapter 2 provides an overview of the management measures and economic importance of BFT fisheries in Atlantic Canada's Gulf Region. Chapter 3 details a profile of important economic characteristics of the BFT charter fishing industry in the Gulf Region for the 2022 season. Chapter 4 applies hypothesis testing to compare differences in trip expenses of catch-and-retain with commercial and catch-and-release BFT fishing. It also compares how catch-and-retain BFT fishing trip expenses differ between Gulf Nova Scotia and PEI. Chapter 5 presents a summary of the study, major findings, and recommendations for consideration in future research.

Chapter 2 : MANAGEMENT MEASURES AND ECONOMIC IMPORTANCE OF BLUEFIN TUNA FISHERIES IN THE ATLANTIC CANADIAN GULF REGION

2.0 Outline

This chapter provides an overview of the management measures and economic importance of the Atlantic Bluefin Tuna (*Thunnus thynnus*; BFT) fisheries in Atlantic Canada's Gulf Region. Section 2.1 reviews the governance and management of BFT fisheries at the international level and how this international context translates into Canada's management approaches. Section 2.2 studies the management measures of three BFT fishery types in the Gulf Region: commercial, catch-and-release, and catch-and-retain. The economic importance of these three fishing activities is discussed in Section 2.3. A summary in Section 2.4 finishes the overview. The chapter identifies the knowledge gap in understanding the economic activities of the newly implemented BFT catch-and-retain fishery.

2.1 Management of Bluefin Tuna Fisheries

Management of the BFT fisheries occurs at the international and federal levels. The following review highlights how the BFT fisheries are managed through a Total Allowable Catch (TAC) system in the North Atlantic region and Atlantic Canada.

2.1.1 International Legal Regime and Management

BFT's highly migratory and stateless nature requires coastal states to cooperate with one another to regulate the fisheries. Established in 1969, the International Commission for the Conservation of Atlantic Tunas (ICCAT) is responsible for managing more than 30 tunas and tuna-like species, and administering an international regulatory regime that binds 52 member

governments. Canada is among the 52 ICCAT contracting parties as of 2021 (ICCAT, n.d.a). One of the Commission's major responsibilities is to set the annual TAC for BFT based on stock assessment analyses informed by a body of ICCAT scientists. As BFT is managed under two separate western and eastern stock units (ICCAT, n.d.b), the Commission sets different TACs for each stock based on the respective assessment results.

The western stock is the only group of BFT harvested in Canadian waters (Fisheries and Oceans Canada, 2019) and is, therefore, the focus of the background review on the fisheries. The western BFT populations have endured a long history of over-exploitation partly due to poor management by ICCAT (Safina & Klinger, 2008; Webster, 2008; Korman, 2011). For example, the Commission has been criticized for consistently setting quotas much higher than the levels recommended by its group of scientists (Safina & Klinger, 2008). Table 2.1 presents the annual TACs for the western BFT stock since 2000. Between 2007 and 2014, ICCAT promoted stock rebuilding by establishing the TAC at relatively lower levels than in previous periods. Positive estimates from the 2014 stock assessment subsequently enabled ICCAT to increase the TAC to 2,000 tonnes annually for the 2015-2017 seasons. The annual TAC was further increased to 2,350 tonnes during 2018-2021, despite the scientific advice from ICCAT's scientists that setting the constant TAC at 2,350 tonnes over the period would cause further decline in the western BFT population (ICCAT, 2017b). Nonetheless, estimates from the 2021 assessment reported that the total biomass had increased by 9% between 2017 and 2020 (ICCAT, 2021). In light of the positive results, ICCAT fishery managers agreed to raise catch limits on western BFT from 2,350 to 2,726 tonnes in 2022, representing a 16% increase from 2021 levels. The 2022 season had the largest quota set at 2,726 tonnes since 2000.

Table 2.1 Total Allowable Catch Levels of Western Atlantic Bluefin Tuna, 2000-2022

Year	Total Allowable Catch (tonnes)
2000-2002	2,500
2003-2006	2,700
2007-2008	2,100
2009	1,900
2010	1,800
2011-2014	1,750
2015-2017	2,000
2018-2021	2,350
2022	2,726

Data Sources: Fisheries and Oceans Canada (2019), ICCAT (2008; 2010; 2012; 2013; 2014; 2016; 2017a; 2020; 2021).

The total quota for the western BFT stock is split among six jurisdictions: Canada, Japan, the United States (U.S.), Mexico, Saint Pierre and Miquelon (France), and Bermuda (the United Kingdom) (Fisheries and Oceans Canada, 2019). Table 2.2 presents the quota allocation to each jurisdiction since 2010. The U.S., Canada, and Japan receive the majority of the Western stock quotas. While Japan’s allocation was lower than Canada’s between 2010 and 2021, Japan’s quota share was higher than its Canadian counterpart’s in 2022 (664.52 tonnes and 543.65 tonnes, respectively). Further, allocation to Japan in 2022 represented a significantly higher percentage increase than other jurisdictions. Whereas the U.S. and Canada had approximately a 5.4% increase in their respective quota share in 2022 compared to 2021, Japan received a 63% increase.

In addition to Canada’s initial allocation, the country receives the entirety of the transferred quota from Mexico and Saint Pierre and Miquelon, as well as the by-catch allowance. For example, Canada received an aggregate of 714.17 tonnes of the western BFT TAC in 2022 (543.65 tonnes received via initial allocation, 149.34 tonnes from Mexico, 6.18 tonnes from St. Pierre and Miquelon, and 15 tonnes of by-catch quota) (Table 2.2). Consequently, Canada’s total allocation makes up just over one quarter (26-28%) of the western BFT quota annually.

Table 2.2 ICCAT Allocation of Western Atlantic Bluefin Tuna Quotas (tonne) by Jurisdiction, 2010-2022

Country/Territory	2010	2011-2014	2015-2017	2018-2021	2022
U.S.	952.44	923.70	1,058.79	1,247.86	1,316.14
Canada	393.54	381.66	437.47	515.59	543.65
Japan	311.02	301.64	345.74	407.48	664.52
Mexico	95.00	95.00	108.98	128.44	149.34
St. Pierre and Miquelon	4.00	4.00	4.51	5.31	6.18
Bermuda	4.00	4.00	4.51	5.31	6.18
Others*	40.00	40.00	40.00	40.00	40.00
Total	1,800	1,750	2,000	2,350	2,726

Data Sources: ICCAT (2008; 2010; 2012; 2013; 2014; 2016; 2017a; 2020; 2021).

Note: Others include 25 tonnes of by-catch allowance for the U.S. and 15 tonnes of by-catch allowance for Canada.

2.1.2 Domestic Legal Regime and Management

Individual countries and territories are responsible for regulating and managing their annual TAC allocation to their fleet(s), and implementing domestic management measures to ensure that catches do not exceed TAC. In Canada, BFT fisheries and management are governed by the federal Department of Fisheries and Oceans (DFO) through a robust regulatory framework. Critical legislative instruments guiding the harvesting and conservation of BFT include the *Fisheries Act* (1985), the Fishery (General) Regulations, and the Atlantic Fisheries Regulations (Fisheries and Oceans Canada, 2019). The *Fisheries Act* is an overarching legislation that manages and protects all of Canada’s fisheries resources, including BFT fisheries. The Fishery (General) Regulations specifies licence conditions and agreements between licence holders and the DFO. The Atlantic Fisheries Regulations (Part X) outlines regulations directly applicable to the BFT fisheries, such as gear restrictions, minimum legal size for retention, fishery season openings and closures, tagging, and control of incidental catches.

Besides the Acts and the Regulations, a detailed list of objectives for the BFT fisheries, ranging from stock conservation to economic prosperity, and management measures required to achieve these objectives, are outlined in an Integrated Fisheries Management Plan (IFMP) (Fisheries and Oceans Canada, 2019). The management measures are also reviewed annually post-season, both at the local and DFO regional levels, and adjustments are made as appropriate.

The Canadian BFT quota is divided between four DFO Atlantic regions, namely: Maritimes, Gulf, Newfoundland and Labrador, and Quebec (Figure 1: panel a). The four regions are managed in terms of seven inshore fleets, namely: Southwest Nova Scotia, St. Margaret's Bay (also in Nova Scotia), Eastern New Brunswick, Prince Edward Island (PEI), Gulf Nova Scotia, Newfoundland and Labrador, and Quebec. In 2004, to ensure equitable access to the BFT commercial fishery across all 7 fleet sectors, the DFO changed the domestic allocation process from a competitive to a fleet quota system, which has remained the management regime for BFT fisheries in eastern Canada (Fisheries and Oceans Canada, 2019). Although fleet quotas helped eliminate inter-fleet competition (Phyne et al., 2013), within-fleet competition prompted some harvesters to fish early in the season before others fill their fleet quota first. To address this “race to fish” problem (Moore, 2011), in 2011, DFO started assigning individual quotas to fishers, giving each licence holder a specified number of tuna tags calculated based on the fleet quota.



Panel a: Geospatial Map of the Department of Fisheries and Oceans Administrative Areas
 Data Source: Fisheries and Oceans Canada (2016)



Panel b: Gulf Region Management Areas (in dark green)
 Data Source: Fisheries and Oceans Canada (2003)

Figure 2.1 Maps of the Department of Fisheries and Oceans Administrative Areas and the Gulf Region Management Areas

Table 2.3 shows the quota shares for each fleet calculated based on historic fleet harvest amounts. The Gulf Region, comprising PEI, Gulf Nova Scotia, and Eastern New Brunswick fleets

(Figure 2.1: panel b), has the highest Canadian BFT quota share (i.e., 49.1%) among the four DFO Atlantic regions. Additionally, the Gulf Region has the largest number of commercial licence holders. Of the 846 total number of BFT commercial fishing licences in 2017, the Gulf Region received the highest allocation of 596 licences (roughly 71%) (Table 2.4).

Table 2.3 Bluefin Tuna Inshore Quota or Shares according to Fleet Sector, Canada

Fleet Sector	Percentage of Inshore Quota (%)
PEI	30.02
Gulf Nova Scotia	11.27
Eastern New Brunswick	7.81
Newfoundland and Labrador	12.84
Quebec	5.09
Southwest Nova Scotia	21.7
St. Margaret's Bay	11.27
Total	100

Data Source: Fisheries and Oceans Canada (2019)

Table 2.4 Total Number of Bluefin Tuna Commercial Fishing Licences and Aboriginal Commercial Communal Licences, Canada, 2017

Fleet Sector	Total Number of Commercial Licences	Aboriginal Commercial Communal Licences*
PEI	359	16
Gulf Nova Scotia	135	14
Eastern New Brunswick	102	32
Newfoundland and Labrador	49	6
Quebec	53	1
Southwest Nova Scotia	42	4
St. Margaret's Bay	24	0
Swordfish/other tunas (by-catch)	78	4
Total	846	77

*These licences are included in the total number of licences listed in the table's second column.
Data Source: Fisheries and Oceans Canada (2019)

2.2 Management Measures of Bluefin Tuna Fisheries in Canada

Currently, Canada has five types of BFT fisheries: commercial, charter catch-and-release, charter catch-and-retain, by-catch caught by commercial fishers for swordfish and other tunas, and tournaments (Fisheries and Oceans Canada, 2019, 2022a, 2022b). This study focuses on the BFT commercial, charter catch-and-release, and charter catch-and-retain fisheries, particularly in the Gulf Region. Because catch-and-retain practices share some similarities with those of commercial and catch-and-release, a better understanding of catch-and-retain is incomplete without studying the other two activities. This section reviews the commercial, catch-and-release, and catch-and-retain fisheries' characteristics and management measures.

2.2.1 Commercial Fishery

The BFT commercial fishery does not have a fixed season as it operates on a quota-based management system. Nevertheless, the main directed fishery typically commences in late July and concludes in mid- to late November of the same year (Fisheries and Oceans Canada, 2019). Figure 2.2 shows the Gulf Region's average BFT landed values for each month of the season between 1998-2010 and 2011-2018. Prior to the introduction of individual quotas in 2011, harvesting activity was more prominent in July and August compared to the 2011-2018 period, where activity was concentrated between September and November. One explanation for this shift is that harvesters no longer have to compete to fish. Another explanation is that fishers recognize potential higher payoffs when they catch and sell tuna later in the season. Research findings show that the industry can reap the most significant gains later in the fishing season. Carroll et al. (2001) find that the price of an individual U.S. fresh BFT is determined primarily by the grade of its attributes, including freshness, fat content, colour, and shape. These four quality attributes are graded by

brokers in the U.S. and auction market officials in Japan on a scale of A to E, where A represents the highest and E the lowest possible grade. Higher grades for each quality attribute tend to positively impact price, and this effect is most significant for fat content and shape (Carroll et al., 2001). A BFT receiving the highest grade for fat content was estimated to command a 76% higher price relative to a BFT receiving the lowest grade, other conditions kept constant. With respect to shape, the highest-graded BFT resulted in an expected price that was 65% higher than the lowest-graded fish, holding other conditions unchanged. Additionally, Martínez-Garmendia et al. (2000) find that the fat content and shape of an individual BFT increase substantially over the course of the fishing season.

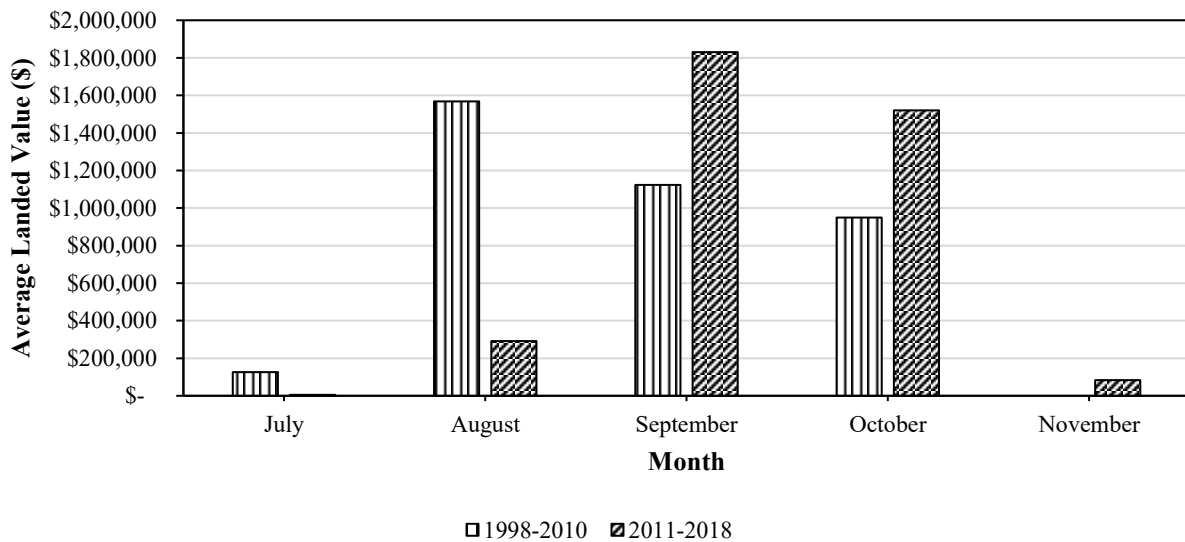


Figure 2.2 Average Bluefin Tuna Landed Value for the Gulf Region for Selected Months During the Fishing Season, 1998-2010 and 2011-2018

Data Source: Fisheries and Oceans Canada, Fisheries and Marine Economics Statistical Services (n.d.)

The Canadian BFT commercial fishery is regulated by the federal Department of Fisheries and Oceans (DFO). To control and monitor harvesting activities of the fishery, the DFO uses

licences and their associated conditions as a binding agreement between licence holders and the Department. Participation in the fishery requires that eligible commercial harvesters abide by several management measures prescribed in the licence conditions, such as tag allocation and transfers, completion and return of logbooks, and installation of onboard electronic monitoring systems (EMS). With respect to the number of tags distributed to a tuna licence holder, it is based on the fleet allocation available at the beginning of the fishing season and the projected average weight of BFT. Each tag allows the capture of one fish, and licence holders might receive additional tags later in the season depending on the outcome of the Department's review of landings. Tag transfers between commercial fishers are permitted only for the Gulf Nova Scotia fleet, where licence holders may receive or transfer a maximum of four tags per season (Inverness South Fishermen's Association, 2022). As a compliance monitoring tool, the completion and return of DFO-approved logbooks are mandatory for all vessels fishing for BFT. Licence holders are required to complete and submit a logbook for each fishing trip where there was fishing effort, regardless of whether a fish has been caught. The required utilisation of an onboard EMS is applicable to all licence holders, and installing the camera is at no cost to the fisher. In general, each fleet sector has their Conservation Harvesting Plan (CHP)⁵ that details all applicable management strategies for the BFT commercial fishery.

⁵ Fleet CHPs are plans developed by industry and submitted to the DFO annually to ensure an open and transparent understanding of how the fishing activity will be managed by each fleet. More precisely, CHPs detail management measures to ensure fleets do not exceed their allocated quotas, minimize by-catch, encourage economic prosperity and enhance scientific information (Fisheries and Oceans Canada, 2019). For example, the CHP for Gulf Nova Scotia fleet for the 2022 fishing season can be found online at Inverness South Fishermen's Association (2022).

2.2.2 Charter Fisheries: Catch-and-Release versus Catch-and-Retain

The BFT charter fisheries in the Gulf Region include catch-and-release and catch-and-retain. The following sections review the fishery characteristics and management measures of catch-and-release and catch-and-retain, respectively.

2.2.2.1 Catch-and-Release Fishery

The shift to the fleet quota management system in 2004 and limited TAC levels in the late 2000s severely limited BFT commercial fishers' potential revenue (Deonarine & Dalton, 2019). In light of existing catch limits, commercial BFT harvesters proposed establishing a charter catch-and-release fishery to add value to their fishing without putting significant additional pressure on the fish population. Catching and releasing BFT is an activity where fishers and charter clients are permitted to bring the hooked BFT alongside the vessel before releasing it. However, they are prohibited from taking the hooked BFT ashore. Furthermore, operations of the catch-and-release fishery in Atlantic Canada could be considered sustainable and productive as the most-recent post-release mortality rate of BFT was relatively low at 3.4% (Stokesbury et al., 2011; Muoneke & Childress, 1994).

The BFT catch-and-release fishery first began among the commercial fleet fishers in PEI in 2009 and Gulf Nova Scotia in 2010. Of the three Gulf Region's fleet sectors, PEI and Gulf Nova Scotia are the two consistently active fleets engaged in both commercial and charter catch-and-release fisheries.⁶ Currently, participating in the catch-and-release fishery is permitted only for BFT commercial licence holders (Fisheries and Oceans Canada, 2019). To be eligible to operate

⁶ The Eastern New Brunswick fleet has been active mostly in the commercial fishery, although there has been occasional charter fishing in the past (Deonarine & Dalton, 2019). It is unknown whether the fleet is active in the charter catch-and-release fishery for the 2022 season.

charters, commercial licence holders must obtain a Section 52 Scientific and Experimental licence, satisfy Transport Canada’s requirements for carrying passengers on board the fishing vessel, and complete a mandatory DFO catch-and-release training course (Fisheries and Oceans Canada, 2012; Deonarine & Dalton, 2019). Geographically, charter boat operators are limited to offering chartered excursions in the same fishing areas as their commercial fishing areas (Fisheries and Oceans Canada, 2019).

The opening and closing dates for catch-and-release fishing vary yearly for PEI and Gulf Nova Scotia fleets. For example, the 2022 catch-and-release season was announced to open from July 15 to October 31 in PEI, compared to July 1 to December 31 in Gulf Nova Scotia (Fisheries and Oceans Canada, 2022a; 2022b). As with the commercial fishery, catch-and-release fishery activities are regulated by the DFO via licensing systems. Throughout the season, charter operators are allowed to conduct one fishing trip per calendar day, and each fishing trip is limited to three hook-ups.⁷ Specific rules also apply to the equipment options, including the required usage of rod and reel and barbless circle hooks⁸ to reduce injury to the fish and assist in immediate release (Deonarine & Dalton, 2019). Additionally, since its classification as an ICCAT/DFO scientific fishery in 2015, the catch-and-release fishery requires charter operators to tag BFT once brought alongside the vessel (Deonarine & Dalton, 2019). Installation of an EMS on board the vessel is also mandatory to ensure fishers adhere to proper fish handling guidelines. Similar to the commercial fishery, each fleet sector has their CHP detailing the applicable management strategies for the BFT catch-and-release fishery.

⁷ A “hook-up” is defined as a fight time exceeding 10 minutes with BFT or any bycatch species.

⁸ A barbless circle hook is a hook with its point orientated perpendicular to its shank, manufactured without its barb or has had its barb completely removed (Deonarine & Dalton, 2019).

Since the first catch-and-release licence was issued in 2009 for the PEI fleet and in 2010 for the Gulf Nova Scotia fleet, there were approximately 37 and 20 licence holders in the respective fleets in 2019 (Government of Canada, n.d.). While BFT catch-and-release activities are commonly practised in many places⁹, charter fishing in the Gulf Region has attracted many tourists for multiple reasons, ranging from the pleasant scenery to historic record catches. The world record for biggest BFT catch is a 1,496-pound (679-kilogram) fish taken off Aulds Cove, Nova Scotia in 1979 (Environment Canada, 2017; The American Oceans Campaign, n.d.). Many BFT charters are based in North Lake – famously known as the tuna capital of the world, Tignish, North Rustico, Souris in PEI, and Antigonish, Pictou, Chéticamp in Nova Scotia. In addition to the local scenery and attractions, most towns offer a short drive (i.e., under 5 hours) to major municipalities in the provinces, such as Charlottetown and Halifax, allowing tourists to combine their BFT excursions with other non-fishing activities conveniently.

2.2.2.2 Catch-and-Retain Fishery

In 2020, DFO piloted a charter catch-and-retain fishery to provide increased economic opportunities for BFT commercial licence holders. To be eligible to participate in the fishery, licence holders must also be a Section 52 Catch-and-Release holder and meet Transport Canada's requirements for carrying passengers on board a vessel. The catch-and-retain fishery differs from the catch-and-release fishery in that fishers can bring the hooked BFT onto the vessel and retain it as a commercial catch.

⁹ One example is Canada's neighboring country, the U.S., where the BFT catch-and-release fishery is an established sector (National Marine Fisheries Service, 2022a).

As with the commercial and charter catch-and-release fisheries, DFO uses licences and their associated conditions to monitor catch-and-retain activities.¹⁰ Catch-and-retain fishing typically runs concurrently with the already established catch-and-release fishing season. However, charter boat operators are prohibited from catching and releasing BFT while fishing under a catch-and-retain trip as per their licensing conditions (Prince Edward Island Fishermen’s Association [PEIFA], 2022). To retain any caught BFT, charter boat operators must use tags other than those received through transfers. Additionally, they are authorized to have a maximum of one fishing trip per calendar day and are eligible for full-cost coverage of the EMS.

2.3 Economic Importance of Bluefin Tuna Fisheries in Canada

This section reports key economic indicators related to the BFT commercial and charter fisheries in Atlantic Canada, particularly the Gulf Region, including total landed quantities and values, exports of commercial catches, and estimated revenues from catch-and-release activities. The section also provides a broad discussion of the potential economic benefits associated with the pilot catch-and-retain fishery.

2.3.1 Bluefin Tuna Landed Quantities and Values

On average, Canadian commercial BFT landings from the Gulf Region (in tonnes) accounted for almost half of the overall BFT landings between 2000 and 2020 (Figure 2.3). More precisely, the annual quantity of BFT landed (round weight) averaged 538 tonnes (and valued at \$9 million), of which fishers from the Gulf Region landed 230 tonnes (and valued at \$3.8 million).

¹⁰ Full details of catch-and-retain management measures for PEI and Gulf Nova Scotia fleets for the 2022 season can be found online at Fisheries and Oceans Canada (2022a) and Fisheries and Oceans Canada (2022b), respectively.

The Gulf Region’s significant landings are not surprising given that it receives the highest Canadian quota allocation and has the largest number of commercial licence holders across the four DFO Atlantic regions. BFT landed real prices averaged \$14.60/kg¹¹ for the same period (Figure 2.4). Landed real prices fluctuated from a high of \$24.58/kg in 2000 to \$10.31/kg in 2015 and to \$9.02/kg in 2020.

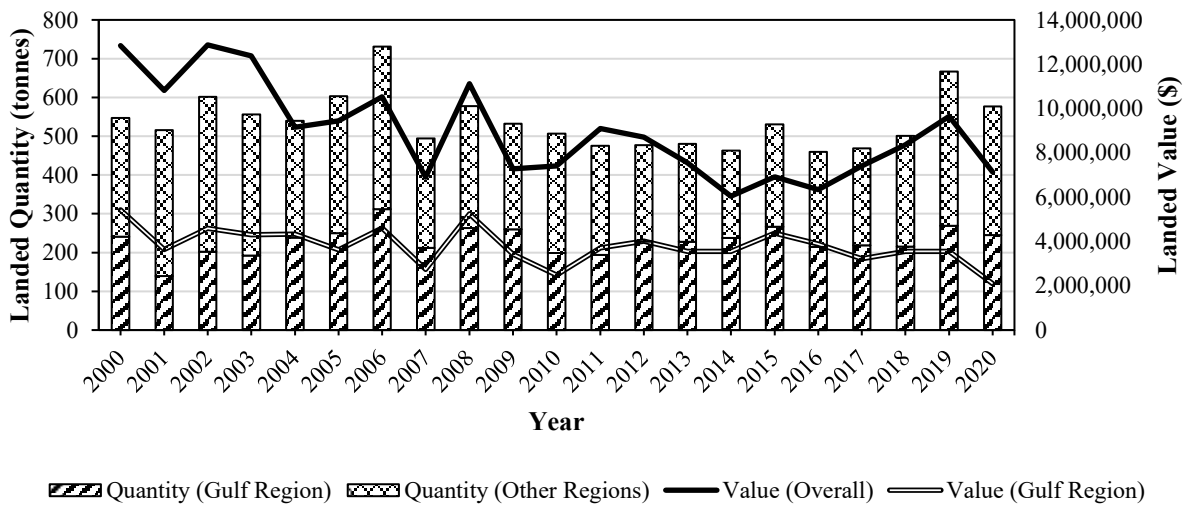


Figure 2.3 Bluefin Tuna Landed Quantity (Round Weight, Tonnes) and Landed Value (Nominal Canadian Dollars) for the Gulf Region and Canada, 2000-2020

Data Source: Fisheries and Oceans Canada, Fisheries and Marine Economics Statistical Services (n.d.)

¹¹ 1 kg is equivalent to 0.001 tonne.

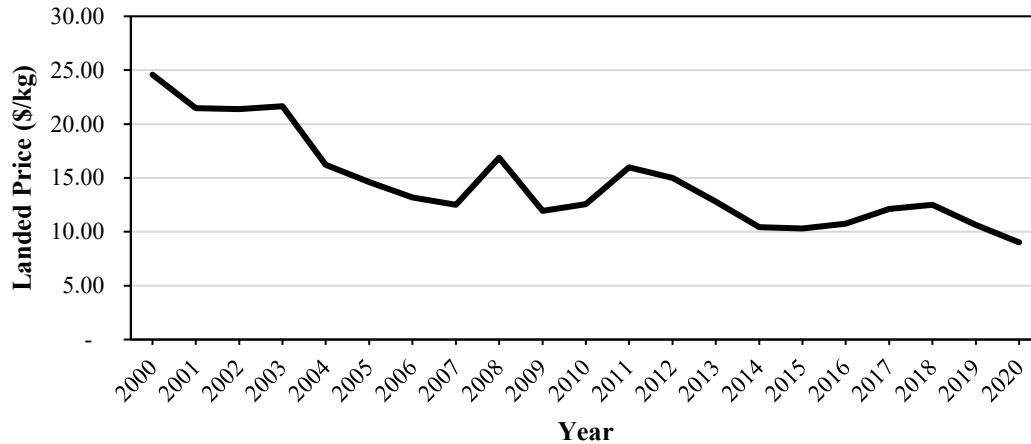


Figure 2.4 Bluefin Tuna Landed Price (Real Canadian Dollars/Kg) for Canada, 2000-2020

Data Sources: Nominal prices were obtained from Fisheries and Oceans Canada, Fisheries and Marine Economics Statistical Services (n.d.); Consumer Price Index (CPI) data were obtained from Statistics Canada (n.d.).

Note: Nominal prices were deflated to real prices using the CPI with 2002 as the base period.

2.3.2 Bluefin Tuna Exports

Canadian BFT are ideal for export because of their high-quality, firm red meat (Phyne et al., 2013). Canada saw a 35% increase in the annual volume of BFT exports from 2000 to 2020 (Figure 2.5). During this period, annual quantity of BFT exported averaged 367 tonnes (and valued at \$7.6 million). Export real prices have experienced a downward trend from a high of \$30.24/kg in 2001 to a low of \$11.55/kg in 2020 (Figure 2.6). In addition to being influenced by the typical quality attributes such as freshness, fat content, colour, and shape, the export price of an individual fish is also subject to the quality of that fish relative to the available supply; the quantity of products in the market; and the presence of other types of tuna in the market (Carroll et al., 2001).

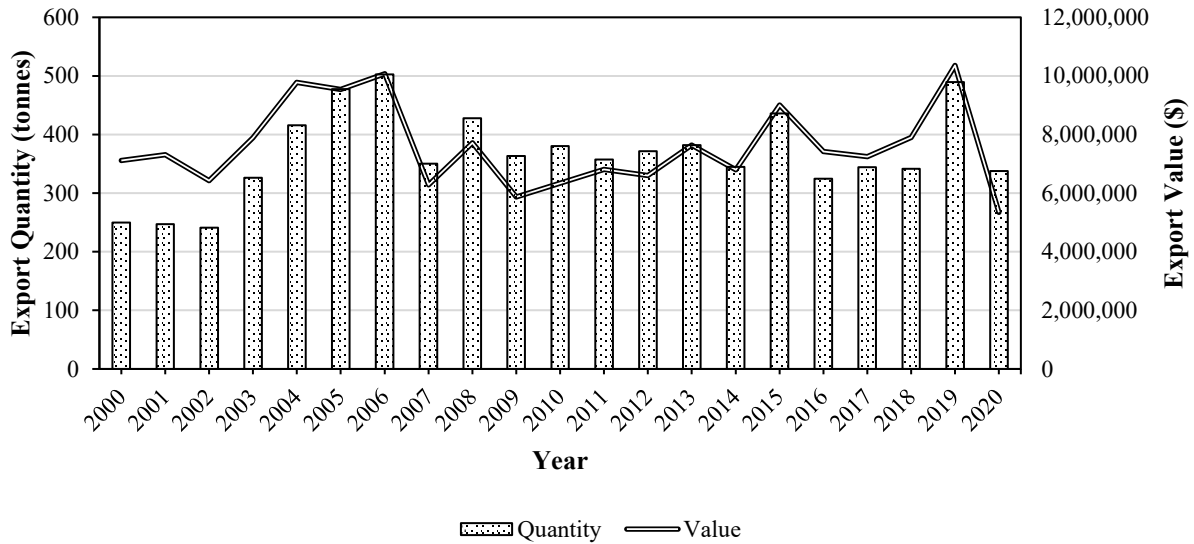


Figure 2.5 Canadian Bluefin Tuna Export Quantity (Product Weight, Tonnes) and Export Value (Nominal Canadian Dollars), 2000-2020

Data Source: Statistics Canada’s Canadian International Merchandise Trade Database (various years)

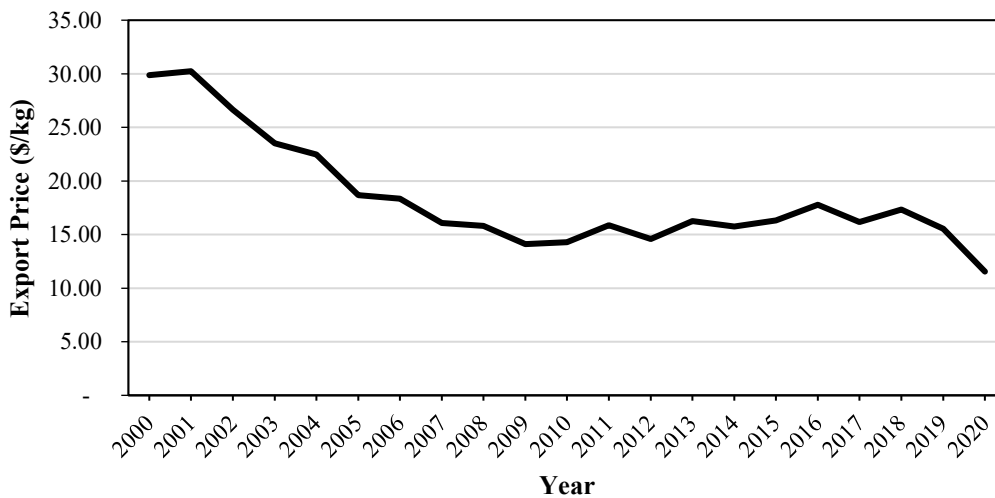


Figure 2.6 Canadian Bluefin Tuna Export Price (Real Canadian Dollars/Kg), 2000-2020

Data Sources: Nominal prices were obtained from Statistics Canada’s Canadian International Merchandise Trade Database (various years); Consumer Price Index (CPI) data were obtained from Statistics Canada (n.d.).

Note: Nominal prices were deflated to real prices using the CPI with 2002 as the base period.

The popularity of sushi and sashimi consumption has made Japan the largest importer of all BFT species (FAO, 2017), including BFT caught in Canadian waters. From 2010 to 2020, almost all live Canadian BFT were exported to Japan (Figure 2.7). Over 70% of fresh or chilled Canadian BFT were also exported to Japan during the same period, as shown in Figure 2.8. After Japan, the U.S. is the next most important market for Canadian BFT, buying almost 30% of fresh or chilled Canadian BFT between 2010 and 2020 (Figure 2.8).

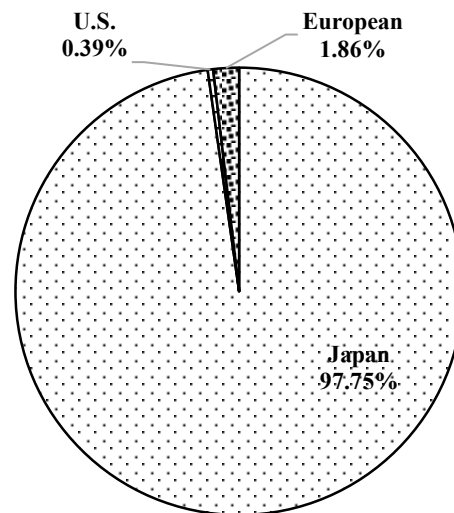


Figure 2.7 Share of Canadian Live Bluefin Tuna (Atlantic and Pacific) Export Quantity by Destination, 2010-2020

Data Source: United Nations International Trade Statistics Database (n.d.)

Notes:

1. Data were not available for 2011.
2. As there are no landings of Pacific Bluefin Tuna (*Thunnus orientalis*) in Canada, the data on exports from Canada can be safely assumed to consist of only Atlantic Bluefin Tuna.

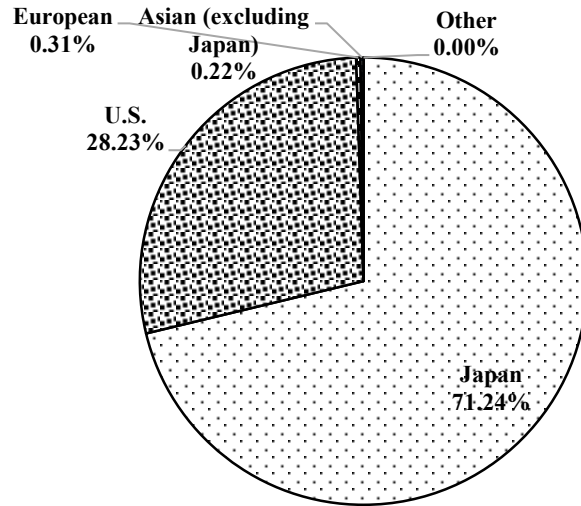


Figure 2.8 Share of Canadian Fresh or Chilled Bluefin Tuna (Atlantic and Pacific) Export Quantity by Destination, 2010-2020

Data Source: United Nations International Trade Statistics Database (n.d.)

Note: As there are no landings of Pacific Bluefin Tuna (*Thunnus orientalis*) in Canada, the data on exports from Canada can be safely assumed to consist of only Atlantic Bluefin Tuna.

2.3.3 Bluefin Tuna Catch-and-Release Estimated Revenue

The BFT catch-and-release fishery in Canada is economically important in terms of gross revenue earned from trip rates charged to charter clients. In the Gulf Region, a full-day (i.e., 8 hours or more) catch-and-release excursion costs about \$2,000 per group (plus 15% Harmonized Sales Tax (HST)). This rate covers fishing gear, tackle, bait, lunch, and light refreshments. Between 2015 and 2018, the catch-and-release fishery in PEI and Gulf Nova Scotia was estimated to conduct an average of 812 trips per charter season (Deonarine & Dalton, 2019). Given this estimate and the average trip rate, the Gulf Region alone is expected to generate over \$1.6 million per season in gross revenues from catch-and-release activities. A comparison of the estimated gross revenue per participant between the BFT commercial and catch-and-release fisheries is presented in Table 2.5. For every fishing season, whereas a catch-and-release charter operator is estimated to earn an average of \$28,491 in gross revenue, a commercial fisher is expected to

receive about a fifth of that amount in gross revenue. This observation is further corroborated by findings from a study by the Ecology Action Centre [EAC] (2014). According to the study, the catch-and-release fishery can generate six times more revenue than its commercial counterpart for every tonne of BFT. The catch-and-release fishery can also create spin-off economic opportunities, such as car rentals and hotel accommodations, ultimately generating additional economic benefits for communities in the region (EAC, 2014).

Table 2.5 Estimated Gross Revenue (Nominal Canadian Dollars) Comparison per Participant between Bluefin Tuna Commercial and Catch-and-Release Fisheries in the Gulf Region

	Commercial Fishery	Catch-and-Release Fishery
Number of Participants	596	57
Total Gross Revenue	\$3,218,039	\$1,624,000
Gross Revenue per Participant	\$5,399	\$28,491

Data Sources: Number of commercial fishers was obtained from Fisheries and Oceans Canada (2019); Total gross revenue for the commercial fishery was obtained from Fisheries and Oceans Canada, Fisheries and Marine Economics Statistical Services (n.d.); Number of catch-and-release charter boat operators was obtained from Government of Canada (n.d.); Estimated total gross revenue for the catch-and-release fishery was calculated based on the number of charter trips, as reported in Deonarine & Dalton (2019), and the average trip price.

Notes:

1. The number of participants and total gross revenue for the commercial fishery were reported as a total of PEI, Gulf Nova Scotia, and Eastern New Brunswick fleets.
2. The number of participants and estimated total gross revenue for the catch-and-release fishery were reported as a total of PEI and Gulf Nova Scotia. As indicated earlier, PEI and Gulf Nova Scotia are the two consistently active fleets engaged in catch-and-release.
3. Due to limited data availability, the obtained data for the commercial fishery were for 2017 and 2019 for the catch-and-release fishery.

2.3.4 Bluefin Tuna Catch-and-Retain Potential Economic Benefits

The BFT charter catch-and-retain fishery remains a pilot project to date. Potential economic benefits to participating fishers include a reduction in fishing-related costs and an increase in gross revenue. Under catch-and-retain, charter boat operators are permitted to combine

their commercial and charter operations into a single fishing trip, catching their commercial allocation while having tourist fishers onboard. Consequently, catch-and-retain charter boat operators may reduce the overall number of trips conducted per season and associated fishing-related costs, such as fuel for fishing boat and bait. Furthermore, given the unique characteristic of catch-and-retain, where charter clients can take pictures with the caught BFT onboard the vessel, such a trip could command a higher price relative to a catch-and-release trip. Although catch-and-retain BFT charter fishing is a novel experience for Canada, this fishing activity type has already been practised in the U.S. (National Marine Fisheries Service, 2022b). Nonetheless, catch-and-retain BFT fishing in the Gulf Region could still attract tourists for various reasons, such as pleasant local sceneries and historic record catches.

Although there are various potential economic benefits associated with the catch-and-retain fishery, the dearth of available data due to the COVID-19 pandemic limits any conclusive findings. The paucity of information on the fishery highlights the importance of collecting new data to better understand the fishery's economic activities.

2.4 Summary

The highly migratory nature of BFT requires cooperative management of the fisheries at international and national levels. Internationally, ICCAT's continuous efforts in rebuilding the western BFT populations have yielded positive results in recent years, where the stock outlook has improved compared to previous assessments. As an ICCAT contracting party, Canada manages their share of the western BFT TAC through DFO legislation and regulations. Among the 4 DFO Atlantic regions receiving the Canadian BFT allocation, the Gulf Region holds the highest allocation and has the largest number of commercial licence holders.

Three types of BFT fisheries in the Gulf Region are studied, namely commercial, charter catch-and-release, and charter catch-and-retain. These fisheries are regulated by the DFO via licencing systems. Across all three fisheries, eligible and qualified licence holders must abide by management measures established to ensure careful monitoring of all fishing activities.

The BFT commercial and charter catch-and-release fisheries are economically important activities for fish harvesters in the Gulf Region. Compared to these two fisheries, little is known about the charter catch-and-retain fishery's economic activities and relative economic viability. This fact warrants further research, particularly an economic profile of the BFT charter fishing industry and a comparison of catch-and-retain trip expenditures with alternative BFT fishing activity types (i.e., commercial and catch-and-release) and across fleet regions (i.e., PEI versus Gulf Nova Scotia).

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Chapter 3 : ECONOMIC CHARACTERISTICS OF BLUEFIN TUNA CHARTER FISHING INDUSTRY IN THE ATLANTIC CANADIAN GULF REGION: A PILOT STUDY AND COMPARISON BY ACTIVITY TYPE AND FLEET REGION

3.0 Abstract

This preliminary study explored key economic characteristics of the Bluefin Tuna charter fishing industry, including catch-and-release and catch-and-retain fisheries, in the Atlantic Canadian Gulf Region. Compared to the catch-and-release fishery, which has become a well-established industry since its introduction in 2009, the catch-and-retain fishery in the region was first piloted in 2020. Its relatively recent introduction and the disruptive impacts of COVID-19 on data collection mean that more research is needed to understand the economic characteristics of the catch-and-retain fishery. Understanding the catch-and-retain fishery relative to the catch-and-release fishery, and how the two fisheries differ by fleet regions (i.e., Prince Edward Island versus Gulf Nova Scotia) are essential for current and future fisheries management and policy decision-making. This study assessed and compared important economic characteristics of the Bluefin Tuna charter fishing industry in the Atlantic Canadian Gulf Region based on charter boat operators' survey data for the 2022 fishing season. Thirteen BFT charter boat operators completed an online survey administered in 2022. Survey data included charter operators' socio-economic characteristics, charter fishing operations, and respondents' perspectives on the catch-and-retain fishery. Survey findings revealed that almost all respondents (92.31%) were employed in other occupations outside the Bluefin Tuna fisheries. Additionally, the charter fishing industry's total gross revenues were CA\$ 508,749, 15% of which was from catch-and-retain fishing. Most importantly, all charter boat operators supported continuing the Bluefin Tuna catch-and-retain fishery in future seasons.

3.1 Introduction

The Atlantic Bluefin Tuna (*Thunnus thynnus*) supports economically important commercial (Fromentin & Ravier, 2005; Porch, 2005; Sumaila & Huang, 2012) and recreational fisheries (Bohnsack et al., 2002; Hutt et al., 2014; Versloot, 2021; Maar, 2022) in the North Atlantic Ocean, with significant economic impacts to Canada's Atlantic provinces (Ecology Action Centre, 2014). Prior to 2020, Bluefin Tuna (BFT) for-hire (charter) fishing in Canada was limited to catch-and-release only. Since its introduction in 2009, the catch-and-release fishery has become a well-established industry and an economically important activity for licensed commercial BFT fishers (Ecology Action Centre, 2014; Deonarine & Dalton, 2019). In the Atlantic Canadian Gulf Region, the fishery attracted approximately 57 licence holders in 2019 (Government of Canada, n.d.) and conducted an average of 812 day trips per fishing season between 2015 and 2018 (Deonarine & Dalton, 2019). The catch-and-release fishery also generates more revenue per tonne for Canadian BFT fishers relative to the commercial fishery. For every tonne of BFT caught, charter catch-and-release BFT fishing was estimated to secure six times the revenue of commercial BFT fishing (Ecology Action Centre, 2014). Thus, the BFT catch-and-release fishery can increase economic benefits of the Canadian BFT fisheries. Participation in the catch-and-release fishery presents an additional revenue stream for BFT commercial fishers.

In 2020, the Canadian Department of Fisheries and Oceans (DFO) introduced a catch-and-retain charter fishery to diversify and potentially increase economic opportunities for licensed commercial BFT fishers. Catch-and-retain fishing allows fishers to bring the hooked BFT onto the boat and retain it as part of the commercial fishery's quota allocation. These special features may allow such a fishing trip to command a higher charter fee than a catch-and-release trip. Higher fishing fees could translate into increased income for BFT commercial fishers, assuming an equal

or greater customer demand for catch-and-retain trips relative to catch-and-release trips. The Gulf Region is currently the only region piloting the catch-and-retain fishery among the four DFO Atlantic regions. This selection is primarily due to the prevalence of BFT charter fishing activities in the Gulf Region compared to other regions (Fisheries and Oceans Canada, 2019).

The Ecology Action Centre (2014) compared the economic returns for Atlantic Canada's commercial BFT fishery with the charter catch-and-release BFT fishery in 2012. Whereas the commercial fishery generated just over CA\$ 17,000 in landed value for every tonne of BFT caught, the catch-and-release charter fishery was estimated to bring over CA\$ 100,000 in gross revenue per tonne. Additionally, PEI and Gulf Nova Scotia catch-and-release charter vessels operated approximately 1,000 trips in 2012, earning an estimated CA\$ 1.8 million. In comparison to commercial fishing, charter fishing provided higher economic benefits to Canadian BFT charter boat operators for the 2012 season. Given the current piloting phase of the charter catch-and-retain fishery, it is imperative to understand the economic activities of this fishery relative to the BFT charter fishing industry. Prior to the present study, no studies have assessed and described important economic characteristics of the BFT charter fishing industry, including the recent addition of catch-and-retain activity, in the Atlantic Canadian Gulf Region. Information on BFT charter boat operators' socio-economic characteristics, charter fishing operations, and perspectives on the catch-and-retain fishery is an essential consideration for management actions and policy decisions. The data collected in this study provide information to address these knowledge gaps. In addition to serving as a benchmark study of the BFT charter fishing industry in the Atlantic Canadian Gulf Region, this study hopes to produce a better understanding of charter fishing in other fisheries of managerial interests.

The purpose of this study was to assess and describe important economic characteristics of the BFT charter fishing industry in the Atlantic Canadian Gulf Region using charter operators' survey data in 2022. The first objective was to examine and compare BFT charter boat operators' socio-economic characteristics by charter fishing activity type (i.e., catch-and-release versus catch-and-retain) and by fleet region (i.e., PEI versus Gulf Nova Scotia). Charter boat operators were asked to report their years of fishing experience, education level, income, and income diversification. The second objective was to assess and compare BFT charter fishing operations by activity type and by fleet region. Selected characteristics of the industry operations evaluated included the number of fishing trips, number of tourist fishers per trip, proportion of trips that were half-day versus full-day, and charter fishing fees charged per trip. The third objective was to evaluate and compare charter boat operators' perspectives on the pilot catch-and-retain BFT charter fishery. Respondents' perspectives were elicited through their levels of (dis)agreement with a series of short statements about the economic benefits of catch-and-retain fishing based on a five-point Likert scale.

The following section presents a review of the scholarly literature on the economic activities of a recreational fishery. The review section starts with a survey of existing studies on the economic aspects of recreational fishing for BFT. Then, it focuses on investigating survey-based analyses of charter boat operators that delivered an economic profile of a charter fishery. The study methods, including sampling frame and procedures, are described in section 3.3. Results are discussed in section 3.4. Section 3.5 provides a summary and conclusions.

3.2 Literature Review

3.2.1 Bluefin Tuna Recreational Fishing

Recreational fishing for BFT can generate direct benefits to tourist fishers and charter boat operators (Goldsmith et al., 2018), while also contributing to regional and local economic development (Bohnsack et al., 2002; Hutt et al., 2014; Marr et al., 2022; Versloot, 2021). For example, the catch-and-release BFT fishery in Hatteras, North Carolina, contributed to the local tourism sector, where about 84% of participating tourist fishers were non-local residents, and charter fishing trips outnumbered private fishing trips by almost a factor of three (Bohnsack et al., 2002). As a result of anglers' expenditures, the BFT fishery generated about US\$ 4.6 million to the local Hatteras economy, and US\$ 5 million to the economy of North Carolina, respectively. In a study of the regional economic contribution of Atlantic highly migratory species (HMS) (i.e., tunas, billfish, swordfish, and sharks), Hutt et al. (2014) estimated that anglers' expenditures generated US\$ 266 million in total economic impacts in the region between Maine and North Carolina. On average, an HMS angler spent significantly more money on their fishing trip (US\$ 10,410) than an average marine angler (US\$ 1,312). This finding suggests that HMS anglers can generate more economic benefits to local economies than other anglers on a per-trip basis.

In Canada, the Ecology Action Centre (2014) estimated that the catch-and-release BFT fishery generated up to six times more revenue per tonne than its commercial counterpart in 2012. The study also noted the increasing demand for and growth potential of BFT charter catch-and-release fishing activities. As with the recreational BFT fishery in North Carolina (Bohnsack et al., 2002), Canada's catch-and-release fishery has the potential to generate additional economic benefits for local communities through spending by anglers in restaurants, hotel accommodations and lodgings, and other retail services.

The economic activities from BFT recreational fishing are also documented in other countries bordering the North Atlantic Ocean, including Denmark and Norway. The findings of studies conducted in these countries are comparable to those of the U.S. studies. In an analysis of spending by recreational BFT anglers in Denmark, Maar et al. (2022) reported that BFT angling had higher associated costs than the average angling activity, which is similar to the finding of Hutt et al. (2014) that an HMS angler incurred more fishing trip costs than an average marine angler. Additionally, anglers who participated in the Danish recreational BFT fishery were predominantly (92%) non-locals, presenting a comparable finding as that of Bohnsack et al. (2002) for the North Carolina fishery. Moreover, Maar et al. (2022) found that non-local anglers could generate more new revenue in the local economy, contrary to local anglers who were likely to shift their expenditures from one fish species sector to another. Recreational BFT fishing was also found to be of great economic importance in Norway (Versloot, 2021). Both Denmark and Norway studies reached a similar conclusion that economic activity levels of the recreational BFT fisheries would increase in future seasons (Maar et al., 2022; Versloot, 2021). Meanwhile, the absence of an established charter fleet was the major barrier to their recreational fisheries' development.

Overall, the studies demonstrate that recreational BFT fishing contributes significantly to the local and regional economies near where the fisheries operate. Apart from the analysis by the Ecology Action Centre (2014) on the Canadian BFT catch-and-release fishery, all other studies share similar methodologies, utilizing data based on recreational anglers' survey responses. As such, their data analysis methods might not be applicable to the present study, which used data based on charter boat operators' survey responses. This reason motivates a review of the recreational fisheries literature employing data from charter boat operators.

3.2.2 Recreational Fishing based on Charter Operator Survey Data and Implications for Fisheries Management

While there were no studies assessing the recreational BFT fishery based on charter boat operators' survey data prior to the present study, there is a small body of literature that analyzes the impacts of recreational fisheries other than BFT using charter boat operators' survey data (Ditton et al., 1978; Hilger & Lovell, 2017; Howard et al., 2021). Various location-specific studies indicate that charter fishing businesses and operators can contribute to the overall recreational and tourism economy of the rural and local regions.

Social and economic studies of charter fishing operations may be grouped according to research methodology. While qualitative analyses typically identify and characterize charter boat fishing industries for specific locations and regions (Ditton et al., 1975; Ditton et al., 1978; Coughenower, 1986; Ditton et al., 2001; Lichtkoppler, 2003; Pistis & Lichtkoppler, 2003; Hilger & Lovell, 2017; Howard et al., 2021), quantitative studies primarily apply various mathematical modelling techniques to quantify a fishery's economic contributions to a regional economy (Holland et al., 2012; Steinback & Brinson, 2013; Hutt & Silva, 2015). Because the purpose and objectives of the present study are comparable to those of qualitative research studies, the following review focused on surveying selected qualitative analyses, particularly highlighting their implications for fisheries management.

Studies using qualitative methods include descriptive analyses of selected fisheries sector's economic profile and economic performance measures. Key dimensions of a fishery's economic profile include profitability, productivity, demographics, and challenges (Ditton et al., 1975; Ditton et al., 1978; Coughenower, 1986; Ditton et al., 2001; Lichtkoppler, 2003; Pistis & Lichtkoppler, 2003; Hilger & Lovell, 2017; Howard et al., 2021). Ditton et al. (1978) examined

the characteristics of the Texas charter fishing industry and its implications for fisheries management through in-person interviews with charter boat operators in 1975. They found that the industry was integral to coastal tourism in small communities, facilitated by the informal cooperation between charter businesses and other tourism elements, such as hotels and restaurants. Nonetheless, due to significantly high operating expenses, the Texas charter fishing industry did not yield sufficient income to keep most charter boat operators in business full-time.

In a longitudinal study of the social and economic characteristics of the U.S. Gulf of Mexico charter boat industry, Ditton et al. (2001) observed that the number of charter boats had increased between 1987 and 1997, despite the increasingly restrictive management environment. Greater harvest restrictions on bag and size limits for coastal pelagic and reef fish fisheries were implemented sporadically, limiting the stability charter businesses required to maintain their customers. Ditton et al. (2001) also found that charter operators relied on pricing charter fishing fees to remain in business. Excluding Florida, where a significant presence of boats limited their ability to increase prices, charter operators from the other four Gulf states increased their average trip fees by roughly 40% between 1987 and 1997. Such longitudinal study design can help demonstrate the extent of change in parameters of interest between multiple time points.

In a more recent survey-based study of charter boat operators, Howard et al. (2021) investigated the economic dimensions of the charter fishing industry in Western Australia in 2019. The online survey collected charter operators' socio-economic backgrounds and involvement in charter fishing, activity levels (e.g., region fished, number of clients), expenditures incurred to operate the charter fishing business, and views towards factors influencing industry performance. Howard et al. (2021) supplemented the survey results with logbook data to estimate aggregate values for revenue, expenditure, and employment. In terms of revenue, scaling the average price

per day of AU\$ 522 to the logbook data of 71,792 days per year provided an estimate of roughly AU\$ 37.6 million in gross revenue in 2019. Similarly, scaling the average expenditure per trip of AU\$ 3,907 to the logbook data of 7,843 trips per year gave an estimated gross expenditure of about AU\$ 30.6 million for the calendar year 2019. Including all full-time, part-time, casual, and seasonal employment, in 2019 the fishing charter industry in Western Australia employed an estimated 556 persons. Additionally, a large number of charter operators reported holding the catch-and-keep fishing licence. One explanation for this finding was the industry's general understanding that clients chose charter fishing services mainly to catch and keep.

In summary, the studies provide a qualitative and descriptive overview of the survey results on various charter fishing industries. Similar to existing studies, the present study used survey data and applied a qualitative and descriptive approach to investigate important economic characteristics of the BFT charter fishing industry in the Atlantic Canadian Gulf Region in 2022. Survey summary statistics were estimated based on the number of complete responses and used to assess and describe important economic characteristics of the BFT charter fishing industry.

3.3 Research Methods

3.3.1 Sampling Frame and Sampling Procedures

Primary data for the analysis were based on responses from BFT charter boat operators in the Atlantic Canadian Gulf Region, who were actively involved in BFT catch-and-release and catch-and-retain fishing during 2022. Before a fishing season commences, charter boat operators are required to obtain a Section 52 Scientific and Experimental licence to participate in BFT charter fishing. During the season, licensed charter boat operators can choose to: i) participate in the catch-and-release fishery; ii) participate in the catch-and-release and catch-and-retain fisheries; or iii)

not participate in any charter fisheries. The study's target population excluded those who did not participate in any charter fisheries in 2022 (i.e., inactive in charter fishing) because surveying this group would not provide additional helpful information for the study objectives.

Research ethics approval for the study was obtained in October 2022 (Dalhousie Research Ethics Board (REB) file number 2022-6259). Potential respondents completed the online survey between November and December 2022. As the federal agency responsible for licensing fishers in Canada, the Department of Fisheries and Oceans (DFO) has information on BFT commercial fishers licensed to participate in the charter fishery before a fishing season commences. DFO area office managers of Eastern New Brunswick, Gulf Nova Scotia, and PEI emailed BFT charter boat operators and invited them to participate in the survey.

DFO typically determines the number of active charter boat operators only after the season ends, when licence holders submit logbooks recording their fishing activities. Thus, all licensed BFT charter boat operators were invited to participate because, a priori, it was not possible to identify active BFT charter operators.

Inactive charter boat operators were screened out from participating in the study if they had attempted to take the online questionnaire. The first survey question served this purpose by asking respondents to indicate the activities participated during 2022. Respondents were asked to select one of the two options available, namely "catch-and-release only," or "both catch-and-release and catch-and-retain." Because respondents were required to answer this question before moving on to subsequent questions, a respondent who did not participate in BFT charter fishing in 2022 would be unsuccessful in continuing to take the survey. Consequently, the sample frame included only charter boat operators who actively participated in BFT charter fishing during 2022.

A total of 37 BFT charter boat operators in the Atlantic Canadian Gulf Region were licensed to participate in the catch-and-release and catch-and-retain fisheries in 2022. Of these, none was based in Eastern New Brunswick, 14 in Gulf Nova Scotia, and 23 in PEI. In Gulf Nova Scotia, 2 fishers could not participate because of missing and inaccurate email contact information. Among the 12 licensed charter boat operators of Gulf Nova Scotia who received the survey link, 8 (66.67%) were active in BFT charter fishing during the 2022 season. For PEI, 14 (60.87%) of the 23 licensed charter boat operators participated in BFT charter fishing in 2022. Details of the number of administered and completed surveys by fleet region are summarized in Table 3.1.

In consultation with DFO collaborators, the following steps were taken to deliver the survey to potential respondents.

1. Each of the three DFO area office managers were asked to email the link to the online survey to the list of all licensed BFT charter boat operators in their area. The email text to the area office managers is provided in Appendix B.
2. When the charter boat operator logged in to the online survey, they were prompted to review a cover letter detailing the purpose of the survey, and the researcher contact information. In addition, participants were informed about the consent process, including that participation in the study was voluntary and privacy and confidentiality of their responses. The text of the cover letter is provided in Appendix C.
3. Area office managers were also asked to distribute reminder emails to charter boat operators after two weeks from the initial mailing. Details of the reminder email are provided in Appendix D.

3.3.2 Survey Instrument

The questionnaire was available in English and French and comprised four sections. Parts 1 and 2 elicited information on charter fishing operations, such as the number of commercial tags used for catch-and-retain fishing, the number and length of trips by charter activity, the number of clients (or tourist fishers), charter fees, and variable costs incurred on an individual trip basis. Part 3 elicited perspectives on the catch-and-retain fishery using a series of short statements about the economic benefits associated with catch-and-retain. Respondents were asked to indicate their level of agreement (or disagreement) with each statement based on a five-point Likert scale ranging from 1=strongly agree to 5=strongly disagree. The last section of the online survey collected information on various socio-economic variables, including number of years involved in BFT fishing, engagement in occupations outside the BFT fisheries, education, and annual household income. The complete questionnaire for the charter boat operators is available in Appendix A.

3.4 Results and Discussion

3.4.1 Response Rate

An overall effective response rate was determined by dividing the number of usable responses received by the number of active BFT charter boat operators (Table 3.1). The overall response rate was 59.09%. This response rate was below the desired response, particularly considering the small sample size. However, the overall response is reasonable, given local conditions with COVID-19 and Hurricane Fiona. The response rates were 62.50% for Gulf Nova Scotia and 57.14% for PEI.

Table 3.1 Survey Sampling Administration and Response Rate

Fleet Region	Total Number of Licensed Charter Operators	Number of Emails Not Delivered	Effective Email Invitations Delivered	Total Number of Active Charter Operators*	Number of Usable Responses Received	Response Rate (%)
Gulf Nova Scotia	14	2	12	8	5	62.50
PEI	23	0	23	14	8	57.14
All Respondents	37	2	35	22	13	59.09

*This number refers to the total number of active charter boat operators who received the invitation email to participate the survey.

The overall response rate of 59.09% is higher in comparison to similar other economic profiles of a charter fishery. Selected studies conducting face-to-face interviews reported response rates of 21% (Holland et al., 2012), 44.90% (Ditton et al., 1975), and 46.59% (Ditton et al., 1978). Response rates for mailed survey studies ranged between 49% (Lichtkoppler et al., 2003) and 59% (Lichtkoppler, 2003). On the other hand, the response rate for this study is lower than Hilger and Lovell’s (2017), who reported a response rate of 84% based on a unique survey sampling method consisting of two data collection phases. Phase 1 involved in-person interviews, and phase 2 administered a combination of in-person, telephone, and mail-in options. Hilger and Lovell (2017) also attributed their high response rate to a high level of outreach prior to the start of the survey.

In an economic profile study of the Western Australian charter fishing industry, Howard et al. (2021) reported a response rate of 56% using an online questionnaire. The response rate received by Howard et al. (2021) is suitable for comparison with the present study because both administered an online survey. In addition, both studies had a relatively small sample size ($n < 30$).

Despite the small number of respondents, the 59.09% response rate for this study has the potential to generate useful empirical results as a pilot study. Nonetheless, the results could be

impacted by non-response bias, as not all charter boat operators who were active in BFT charter fishing during 2022 responded to the online survey.

3.4.2 Comparison of Socio-Economic Characteristics

BFT charter boat operators' socio-economic characteristics considered in this study include years of fishing experience, education level, income, and income diversification. Their socio-economic profiles are presented and examined with respect to difference between fishing activity types (catch-and-release versus catch-and-retain) and fleet regions within the Atlantic Canadian Gulf Region (Gulf Nova Scotia versus PEI).

Years of Bluefin Tuna Fishing Experience: Respondents reported fishing BFT as part of commercial and charter fishing activities in the Atlantic Canadian Gulf Region for an average of 21 years (Table 3.2). Gulf Nova Scotia charter operators' BFT fishing involvement averaged about 17 years compared to 23 years for PEI charter operators. The number of years spent BFT fishing for Gulf Nova Scotia respondents varied between 5 and 35. By comparison, the range was 14 to 35 years among respondents from PEI. For both fleet regions, the considerable time spent in BFT fishing indicates the respondents were experienced and had received economic and non-economic benefits to sustain their business. Economic benefits could include monetary returns from selling tuna to buyers for export, while non-economic benefits could include the recreational pleasure or enjoyment of fishing BFT.

The average years of fishing experience among BFT charter boat operators in Atlantic Canada's Gulf Region (21 years) were higher than those in other regions. Texas charter operators had been in business for an average of 11.5 years (Ditton et al., 1978), and Western Australian

charter operators reported operating a charter fishing business for an average of 15.8 years (Howard et al., 2021). The U.S. South Atlantic charter operators had been operating a charter boat for 17.5 years on average (Holland et al., 2012). On the other hand, the average years of fishing experience for this study are lower than Hilger and Lovell’s (2017), who reported an average of 33 years of experience among California charter operators.

Table 3.2 Socio-Economic Profile of Bluefin Tuna Charter Boat Operators, 2022 Fishing Season

	Gulf Nova Scotia	PEI	Total
a) Years of Fishing Experience (<i>AVG, STD; N₁ = 5, N₂ = 8, N = 13</i>)			
	17.2 (11.19)	23.25 (7.85)	20.92 (9.33)
b) Education Completed (<i>number, %; N₁ = 5, N₂ = 8, N = 13</i>)			
Did not complete high school	0 (0)	1 (12.5)	1 (7.69)
Completed high school	2 (40)	4 (50)	6 (46.15)
Completed trade school or community college	1 (20)	2 (25)	3 (23.08)
Completed university	2 (40)	1 (12.5)	3 (23.08)
Completed post-graduate degree (masters or doctorate)	0 (0)	0 (0)	0 (0)
c) Household Income for 2021 tax year (<i>number, %; N₁ = 5, N₂ = 8, N = 13</i>)			
Under CA\$ 10,000	0 (0)	0 (0)	0 (0)
CA\$ 10,000 – 19,999	0 (0)	0 (0)	0 (0)
CA\$ 20,000 – 29,999	0 (0)	0 (0)	0 (0)
CA\$ 30,000 – 39,999	0 (0)	0 (0)	0 (0)
CA\$ 40,000 – 49,999	0 (0)	1 (12.5)	1 (7.69)
CA\$ 50,000 – 74,999	0 (0)	0 (0)	0 (0)
CA\$ 75,000 – 99,999	0 (0)	1 (12.5)	1 (7.69)
CA\$ 100,000 or above	5 (100)	6 (75)	11 (84.62)
d) Engagement in Jobs Outside Bluefin Tuna Fisheries (<i>number, %¹; N₁ = 5, N₂ = 8, N = 13</i>)			
No	1 (20)	0 (0)	1 (7.69)
Yes, during Bluefin Tuna season	1 (20)	4 (50)	5 (38.46)
Yes, outside Bluefin Tuna season	4 (80)	7 (87.5)	11 (84.62)

Notes: ¹The percentage indicates the proportion of the survey respondents accounted for by each category. Three categories include “No”, “Yes, during Bluefin Tuna season”, and “Yes, outside Bluefin Tuna season.”

Level of Education: Overall, nearly half of the respondents (46.15%) reported having completed high school (Table 3.2). Another respondent (7.69%) reported that they did not complete high school, while the remaining 6 respondents (46.16%) reported having completed some form of higher education, including trade school or community college (23.08%), and university (23.08%). The educational attainment of Canadian BFT charter boat operators was higher than that of Canadian farm operators at the high school and university levels. In 2016, for example, 28.7% of farm operators reported having completed high school, compared with 46.15% among BFT charter operators, while 10.6% of farm operators had a university education in comparison to 23.08% of BFT charter operators (Tran & Shumsky, 2019). On the other hand, farm operators placed a greater emphasis on trades and college-level education than BFT charter operators. While 35% of farm operators reported having completed trades and college-level education, only 23.08% of BFT charter operators attained such education level (Tran & Shumsky, 2019). As trades and college-level education reportedly equipped farm operators with the technical and managerial expertise necessary to operate a farm, perhaps BFT charter boat operators might find this education beneficial for the operations of a charter fishing business.

Income and Income Diversification: Most respondents (84.62%) reported receiving an annual household income of CA\$ 100,000 or more for the 2021 tax year (Table 3.2). 7.69% reported receiving between CA\$ 75,000 – 99,999 and another 7.69% reported receiving between CA\$ 40,000 – 49,999.

Almost all respondents (92.31%) were employed in other occupations outside of the BFT fisheries either during or outside of the 2022 BFT fishing season (Table 3.2). In contrast, only 1 respondent (7.69%) based in Gulf Nova Scotia reported that they were involved in only BFT

fishing. Among the 12 respondents who were engaged in non-BFT-fishing occupations, 4 (33.33%) reported activities both during and outside of the BFT fishing season, 7 (58.33%) reported activities off season, and 1 (8.33%) reported engaging only during the season. Table 3.2 also shows the pooled survey data disaggregated by fleet region (i.e., Gulf Nova Scotia and PEI). Of the 5 respondents from the Gulf Nova Scotia fleet, 1 respondent reported no other employment outside of the BFT fishery, accounting for 20% of the fleet survey population. Because the survey question allowed respondents to select all answers applicable to them, the sum of the column proportions would be greater than 100%. Nonetheless, the individual proportions could be interpreted as the prevalence of that option among the survey sample. For instance, the rate of non-BFT-fishing employment outside of the 2022 BFT fishing season was higher among PEI charter operators (87.5%) than among Gulf Nova Scotia charter operators (80%). Additionally, the proportion of non-BFT-fishing employment during the 2022 season was higher among PEI charter operators (50%) than among Gulf Nova Scotia operators (20%).

The high proportion of charter boat operators engaging in occupations other than BFT fishing outside of the season (84.62%) suggested the industry operated as a seasonal business. This high proportion also indicated that fishing BFT for commercial and charter purposes brought limited income during the 2022 season. Therefore, most charter boat operators engaged in occupations outside of the BFT fishery to help with financial stability over the year. Kasperski & Holland (2013) found that the U.S. West Coast and Alaska fishers diversified their income streams by engaging in multiple fishing and non-fishing activities. For example, fishers diversified their fishing revenues by targeting different species or species groups within a region, and by fishing in different regions (Kasperski & Holland, 2013). Their analysis demonstrates that increased diversification is correlated with a reduction in variation of revenues, thereby providing a financial

risk-reduction strategy for an individual fisher. The diversity in income streams may also compensate for seasonal downturns in charter fishing activities. For instance, the impacts of Hurricane Fiona forced the 2022 BFT charter fishing season in the Atlantic Canadian Gulf Region to end earlier than the scheduled dates.

3.4.3 Comparison of Bluefin Tuna Charter Fishing Activities

As noted earlier, active BFT charter boat operators in 2022 were involved in either catch-and-release alone or both catch-and-release and catch-and-retain fishing. However, a priori it was not known if there were any differences within and across fleet regions. While 54% of all BFT charter vessel operators reported participating in both charter fishery types, 46% reported participating in catch-and-release exclusively (panel a) of Table 3.3). Among the 7 respondents who participated in catch-and-retain, 4 were from Gulf Nova Scotia and 3 were from PEI. Among the catch-and-retain participants, 2 were relatively new entrants to this charter activity in 2022, while the remaining 5 participants already took part in catch-and-retain in previous seasons. Additionally, participation rate in both catch-and-release and catch-and-retain was higher among Gulf Nova Scotia charter operators (4/7 or 57%) than for PEI (3/7 or 43%). In contrast, participation rate in catch-and-release only was higher among PEI charter operators (5/6 or 83%) than for Gulf Nova Scotia (1/6 or 17%).

Table 3.3 Number of Bluefin Tuna Charter Fishing Participants, Number of Commercial Tags Received by Fleet Region, and Number of Commercial Tags Received by Catch-and-Retain Participants, 2022 Fishing Season

	Gulf Nova Scotia	PEI	Total
a) Number of Participants (<i>number, %; N₁ = 5, N₂ = 8, N = 13</i>)			
Catch-and-Release Only	1 (20)	5 (62.5)	6 (46.15)
Both Catch-and-Release and Catch-and-Retain	4 (80)	3 (37.5)	7 (53.85)
b) Commercial Tags Received (<i>number, STD; N₁ = 5, N₂ = 8, N = 13</i>)			
Total Number of Tags	19	25	44
Average Number of Tags ¹	4 (3.03)	3 (0.99)	3 (1.94)
c) Commercial Tags Received by Catch-and-Retain Participants (<i>number, %²</i>)			
Total Number of Tags	11	9	20
Number of Tags Used for Catch-and-Retain	4 (36.36)	9 (100)	13 (65)

Notes: ¹The average number of tags was rounded to the nearest integer. ²The percentages indicate the utilization rates (i.e., the proportions of commercial tags received by catch-and-retain participants that were used toward their catch-and-retain fishing operations).

Respondents were asked to report the total number of BFT commercial tags received in 2022, including tags issued during the initial quota allocation and any additional tags received during the season. The total and average number of tags received are summarized in panel b) of Table 3.3 by fleet region. BFT charter boat operators reported receiving a total of 44 BFT commercial tags in 2022. This total includes initial quotas and during-the-season allocation. Total commercial tags received were higher for PEI (25) than for Gulf Nova Scotia (19). In Gulf Nova Scotia, the commercial tags received by an individual charter operator ranged from a minimum of 1 tag to a maximum of 8 tags. By comparison, the range was between 2 and 5 tags for charter operators in PEI. On average, a Gulf Nova Scotia BFT fisher received 4 tags, compared with 3 tags for PEI during the 2022 season. Although PEI receives the highest quota allocation among the seven DFO Atlantic inshore fleet regions, it also has the highest number of commercial licence holders. As a result, an individual fisher in PEI fleet region may not receive as many tags compared

to a fisher from other fleet sectors, such as Gulf Nova Scotia, where the quota allocation and number of licence holders are relatively low.

Charter boat operators who participated in catch-and-retain during 2022 were asked to report the number of BFT commercial tags used toward catch-and-retain fishing. Across both fleet regions, 7 catch-and-retain charter boat operators reported receiving a total of 20 commercial tags (Table 3.3 panel c)). Among this total number of tags received, 13/20 were used for catch-and-retain purposes, representing a utilization rate of 65%. This finding indicates that many BFT charter boat operators operated the catch-and-retain fishery to combine their commercial and charter operations into a single fishing trip.

The 2022 BFT charter fishing season was announced to open between July 15 and October 31 in PEI, compared to July 1 to December 31 in Gulf Nova Scotia (Fisheries and Oceans Canada, 2022a; 2022b). However, the season was closed early on September 28 for both fleet regions due to the impacts of Hurricane Fiona. Figure 3.1 shows the total number of tags used each month in the season by fleet region. The survey results indicate that the tags were used in the peak season months between August and October, with the highest BFT fishing in September. Among the Gulf Nova Scotia respondents, the majority of catch-and-retain tags (i.e., 3/4) was utilized in October and the remaining 1/4 in September. In comparison, the catch-and-retain tags used in PEI were spread across three months, namely August (2/9), September (5/9), and October (2/9). The delayed BFT harvesting suggest that fishers recognize potential higher payoffs when they catch and sell tuna later in the season (Carroll et al., 2001; Martínez-Garmendia et al., 2000).

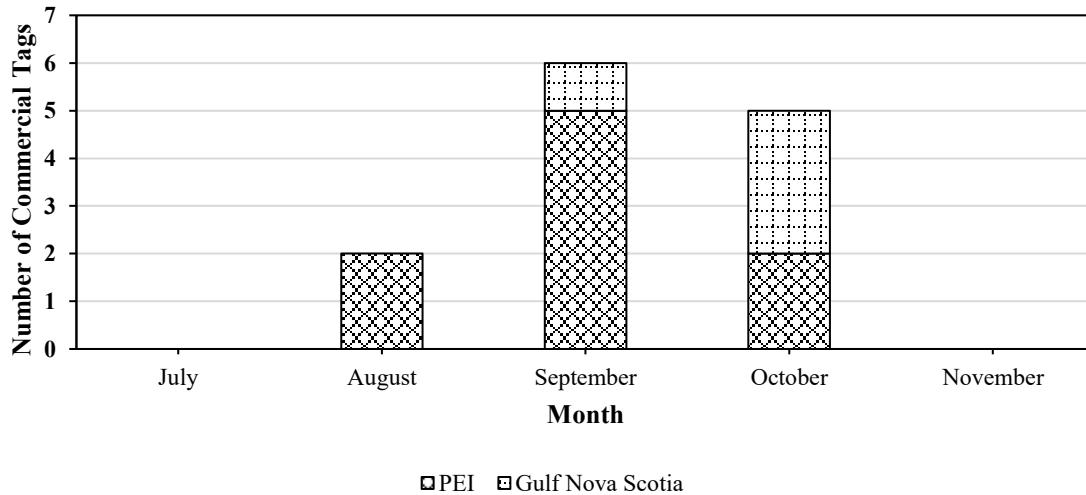


Figure 3.1 Months During which Bluefin Tuna Commercial Tags were Used in Catch-and-Retain Fishing in 2022 by Fleet Region

In general, respondents conducted more catch-and-release trips than catch-and-retain trips during the 2022 BFT fishing season (see panel a) of Table 3.4). In addition, there were more catch-and-release trips in Gulf Nova Scotia (133 or 57.83%) than in PEI (97 or 42.17%). By comparison, there were fewer catch-and-retain trips in Gulf Nova Scotia (8 or 32%) than in PEI (17 or 68%). The number of tags held by catch-and-retain harvesters in each fleet region could impact the number of catch-and-retain trips conducted. As Gulf Nova Scotia’s catch-and-retain participants received more tags than PEI’s (11 versus 9), this finding would imply that the Gulf Nova Scotia fleet would conduct more catch-and-retain trips than the PEI fleet. However, survey results indicated otherwise. The higher occurrence of catch-and-retain trips in PEI in 2022 suggests that tourist fishers patronized more in PEI than in Gulf Nova Scotia.

Of the total catch-and-release fishing trips, 91.31% were full-day trips and 8.69% were half-day trips (panel b) of Table 3.4). On the other hand, all catch-and-retain fishing trips were full-day trips (panel c) of Table 3.4). This finding suggests a higher demand among tourist fishers for full-day trips than half-day trips for both catch-and-release and catch-and-retain BFT charter

fishing. Additionally, charter boat operators may prefer offering full-day trips over half-day trips because full-day excursions could be more profitable.

Table 3.4 Number of Bluefin Tuna Charter Fishing Trips and Proportions of Trips that were Full-Day and Half-Day by Fleet Region, 2022 Fishing Season

	Gulf Nova Scotia	PEI	Total
a) Number of Charter Fishing Trips (<i>number, %; N₁ = 141, N₂ = 114, N = 255</i>)			
Catch-and-Release	133 (94.33)	97 (85.09)	230 (90.20)
Catch-and-Retain	8 (5.67)	17 (14.91)	25 (9.80)
b) Proportions of Charter Fishing Trips – Catch-and-Release (<i>%; N₁ = 5, N₂ = 7, N = 12</i>)			
Full-Day ¹	97.14	87	91.31
Half-Day ²	2.86	13	8.69
c) Proportions of Charter Fishing Trips – Catch-and-Retain (<i>%; N₁ = 4, N₂ = 3, N = 7</i>)			
Full-Day ¹	100	100	100
Half-Day ²	0	0	0

Notes: ¹A full-day trip takes 8 hours or more. ²A half-day trip takes 5 hours or less.

On average, BFT charter boat operators had an equal number of tourist fishers (4) on each catch-and-release and catch-and-retain trip (Table 3.5). These numbers were multiplied by the number of fishing trips an average operator conducted in the season (19 for catch-and-release and 4 for catch-and-retain) to determine the number of tourist fishers per charter operator. For the 2022 BFT fishing season, an individual charter operator had on average 76 catch-and-release customers and 16 catch-and-retain customers. Overall, BFT charter boat operators had 912 catch-and-release customers and 112 catch-and-retain customers in 2022.

Table 3.5 Number of Bluefin Tuna Tourist Fishers by Activity Type, 2022 Fishing Season

	Catch-and-Release	Catch-and-Retain
Number of Tourist Fishers per Fishing Trip	4	4
Number of Fishing Trips per Operator	19	4
Number of Tourist Fishers per Operator	76	16
Total Number of Tourist Fishers	912	112

Notes:

1. Raw data for the number of tourist fishers per trip were rounded to the nearest integer.
2. The number of fishing trips per operator was calculated by dividing the total number of fishing trips, presented in panel a) of Table 3.4, by the number of charter operators. The results were rounded to the nearest integer.
3. Among the 13 charter boat operators surveyed, 12 reported catch-and-release activities and 7 reported catch-and-retain activities.

The average charter fee per boat before taxes were higher for a BFT catch-and-retain trip than for a catch-and-release trip in 2022 (Table 3.6). In addition, as expected, the trip rates charged were higher for a full-day trip than for a half-day trip. On average, across the two fleet regions, charter boat operators charged CA\$ 3,075 per vessel for a catch-and-retain full-day trip, compared to CA\$ 1,920.83 per boat for a catch-and-release full-day trip, representing a 60.09% difference. This fare difference is lower when looking at only catch-and-retain charter operators. Among the 7 catch-and-retain participants of the two fleets, the average fee per boat for a full-day catch-and-release trip was CA\$ 2,141.67 compared to CA\$ 3,075 for a full-day catch-and-retain trip, indicating a 43.58% difference. This finding demonstrates that a charter operator who offered catch-and-retain trips tended to charge a higher price for all trip types than an average charter boat operator. For a half-day trip, average charter fees per boat were CA\$ 1,850 for catch-and-retain, compared to CA\$ 1,425 for catch-and-release, indicating a 29.83% difference.

The difference between trip rates also depends on the fishing fleet region. Average charter fees per boat for both catch-and-release and catch-and-retain activities were higher in Gulf Nova

Scotia than in PEI. For example, the average fee per boat for a full-day catch-and-release trip was CA\$ 2,490 in Gulf Nova Scotia compared to CA\$ 1,514.29 in PEI, representing a 64.44% rate difference. For a full-day catch-and-retain trip, charter boat operators in Gulf Nova Scotia charged an average rate of CA\$ 3,675 per boat, almost doubling PEI’s average rate of CA\$ 1,875 per boat. The large fare difference between the two fleet sectors for a full-day catch-and-retain trip may explain why the PEI fleet conducted more catch-and-retain trips than the Gulf Nova Scotia fleet in 2022 (17 versus 8).

Table 3.6 Average Charter Fees Per Boat Before Taxes for Bluefin Tuna Charter Fishing Activities During the 2022 Fishing Season by Fleet Region

Activity Type	Gulf Nova Scotia	PEI	Average
<i>Catch-and-Release (number, STD)</i>			
Full-Day Trip Rate ¹	\$2,490 (317.02)	\$1,514.29 (193.03)	\$1,920.83 (556.15)
Half-Day Trip Rate ²	\$2,350 (212.13)	\$962.50 (179.90)	\$1,425 (736.04)
<i>Catch-and-Retain (number, STD)</i>			
Full-Day Trip Rate ³	\$3,675 (1,299.70)	\$1,875 (176.78)	\$3,075 (1,372.50)
Half-Day Trip Rate ⁴	\$2,200 (N/A)	\$1,500 (N/A)	\$1,850 (494.98)

Notes:

1. The average full-day trip rates for catch-and-release were calculated based on 5 respondents in Gulf Nova Scotia and 7 respondents in PEI. The rate in the ‘Total’ column was calculated across 12 respondents.
2. The average half-day trip rates for catch-and-release were calculated based on 2 respondents in Gulf Nova Scotia and 4 respondents in PEI. The rate in the ‘Total’ column was calculated across 6 respondents.
3. The average full-day trip rates for catch-and-retain were calculated based on 4 respondents in Gulf Nova Scotia and 2 respondents in PEI. The rate in the ‘Total’ column was calculated across 6 respondents.
4. The average half-day trip rates for catch-and-retain were calculated based on 1 respondent in Gulf Nova Scotia and 1 respondent in PEI. The rate in the ‘Total’ column was calculated across 2 respondents.

Total revenues received from charter boat fees were calculated based on the number and type of fishing trips conducted as well as the average trip rates. Table 3.7 reports the total revenue by type of charter fishing activity. Overall, the BFT charter fishing industry brought CA\$ 508,749 in revenue in 2022. The total revenues were CA\$ 431,874 for the catch-and-release activity and CA\$ 76,875 for the catch-and-retain activity. While the catch-and-release fishery made a significant contribution (about 85%) to the total revenue of BFT charter fishing for the 2022 season, the catch-and-retain fishery contributed to only 15% of the total. This significant difference can be explained by the gap in the total number of fishing trips conducted between catch-and-release and catch-and-retain. The total number of catch-and-release fishing trips was almost tenfold that of catch-and-retain fishing trips (230 versus 25) for the 2022 season. The limited number of possible catch-and-retain trips can largely explain this gap. If all commercial tags that charter operators received during 2022 were used for catch-and-retain operations, there would still only be 44 trips.

Table 3.7 also shows revenues stratified by full-day fishing-trip based revenues and half-day fishing-trip based revenues. Across 13 charter boat operators surveyed, total revenues generated by the catch-and-release activity were CA\$ 403,374 for full-day trips and CA\$ 28,500 for half-day trips. All catch-and-retain fishing trips conducted were full-day trips, generating a total revenue of CA\$ 76,875.

Table 3.7 Total Revenues by Type of Bluefin Tuna Charter Fishing Activity

Type of Fishing Trip	Catch-and-Release	Catch-and-Retain
Full-Day		
Number of Trips*	210	25
Charter Fees per Trip	\$1,920.83	\$3,075
Subtotal	\$403,374.30	\$76,875
Half-Day		
Number of Trips*	20	0
Charter Fees per Trip	\$1,425	\$1,850
Subtotal	\$28,500	\$0
Total Revenues	\$431,874.30	\$76,875

Notes: *The number of full-day and half-day trips were calculated based on the total number of trips and the proportions of trips that were full-day and half-day.

3.4.4 Perspectives on Bluefin Tuna Catch-and-Retain Charter Fishing

To understand charter boat operators’ perspectives towards the recently introduced catch-and-retain BFT charter fishery, respondents were asked to indicate their levels of (dis)agreement with selected statements on a five-point Likert scale ranging from 1=strongly agree to 5=strongly disagree (Table 3.8).

A first statement explored the relative contributions of revenue from charter fishing trips versus sales from BFT landings to respondents’ annual household income, namely: “On average, income from taking tourists on charter fishing trips contributes more to my annual household income than income from landing BFT.” This statement was developed to gauge the economic importance of BFT charter fishing to charter boat operators for the 2022 season. Ecology Action Centre (2014) reported that the BFT charter catch-and-release fishery provided higher economic benefits to Canadian BFT fishers than its commercial counterpart in 2012. The introduction of catch-and-retain to BFT charter fishing activities in 2020 signifies the importance of understanding

its economic contribution to BFT charter fisheries. This information is critical for policy decision-making and BFT conservation management.

Income from taking tourists on charter fishing trips contributed more to charter boat operators' annual household income than income from commercial BFT landings (Table 3.8). Specifically, about 92.31% of the charter boat operators strongly agreed or agreed with the statement. This finding is consistent with Ecology Action Centre (2014) finding that BFT charter fishing generated more income than commercial fishing to operators.

Table 3.8 Charter Boat Operator Responses to Selected Statements on Catch-and-Retain Fishing

Level	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
Statement: "On average, income from taking tourists on charter fishing trips contributes more to my annual household income than income from landing Bluefin Tuna."					
Respondents (n=13)	76.92%	15.39%	7.69%	0%	0%
Statement: "Combining commercial and charter fishing trips under catch-and-retain reduces the overall number of trips and fishing-related costs."					
Respondents (n=13)	76.92%	15.39%	0%	7.69%	0%
Statement: "I would like to see the charter catch-and-retain fishery continuing in future Bluefin Tuna seasons."					
Respondents (n=13)	92.31%	7.69%	0%	0%	0%

A second statement explored whether: "Combining commercial and charter fishing trips under catch-and-retain reduces the overall number of trips and fishing-related costs." The majority of respondents (92.31%) strongly agreed or agreed that combining commercial and charter fishing trips under catch-and-retain reduces the overall number of trips and fishing-related costs, while 7.69% disagree (Table 3.8). The one respondent who disagreed operated catch-and-release only during 2022, and may neither recognize nor experience the economic benefits associated with catch-and-retain. More importantly, all 7 respondents who reported participation in the catch-and-retain fishery in 2022 strongly agreed with the statement.

This statement's purpose was to obtain a better understanding of whether respondents recognized the potential economic advantages attached to catch-and-retain. As charter boat operators were permitted to combine their commercial and charter operations into a single fishing trip under catch-and-retain, a possible economic advantage of this activity was a reduction in costs due to the decline of overall trips. Respondents acknowledging these economic advantages would be more likely to agree with the statement relative to their counterparts.

Another statement investigated whether respondents "would like to see the charter catch-and-retain fishery continuing in future Bluefin Tuna seasons." All respondents strongly agreed (92%) and agreed (8%) that they would like the charter catch-and-retain fishery to continue in future seasons (Table 3.8). Their indication implies a strong interest in catch-and-retain fishing.

This last statement was developed to gauge charter boat operators' interest in continuing the BFT charter catch-and-retain fishery in future seasons, particularly given that the fishery was a pilot program at the time. Although catch-and-retain was initially introduced as a pilot fishery in 2020, its status remained temporary in 2022 because the disruptive impacts of COVID-19 on data collection limited any conclusive findings on the fishery. Respondents supporting the decision to continue the BFT catch-and-retain fishery would be more likely to agree with the statement relative to their counterparts. Ultimately, charter boat operators' responses could partially influence the permanent implementation of the catch-and-retain fishery.

To gain further insights into the respondents' perceptions about catch-and-retain BFT charter fishing, the pooled survey data was disaggregated by fleet region (i.e., Gulf Nova Scotia versus PEI) (Table 3.9). Overall, Gulf Nova Scotia respondents held stronger perspectives towards the catch-and-retain fishery than respondents from PEI. For example, all 5 respondents in Gulf Nova Scotia indicated strong agreement with all three statements, compared with 62.5% for the

first and second statements and 87.5% for the third statement among PEI respondents. This finding suggests different perceptions across fleet regions. However, further study is needed to validate the findings from this pilot study involving a small sample.

Table 3.9 Comparison of Bluefin Tuna Charter Boat Operators Responses by Fleet Region

Level	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
Statement: “On average, income from taking tourists on charter fishing trips contributes more to my annual household income than income from landing BFT”					
Gulf Nova Scotia (n=5)	100%	0%	0%	0%	0%
PEI (n=8)	62.5%	25%	12.5%	0%	0%
Statement: “Combining commercial and charter fishing trips under catch-and-retain reduces the overall number of trips and fishing-related costs”					
Gulf Nova Scotia (n=5)	100%	0%	0%	0%	0%
PEI (n=8)	62.5%	25%	0%	12.5%	0%
Statement: “I would like to see the charter catch-and-retain fishery continuing in future Bluefin Tuna seasons”					
Gulf Nova Scotia (n=5)	100%	0%	0%	0%	0%
PEI (n=8)	87.5%	12.5%	0%	0%	0%

The pooled survey data was also disaggregated by type of charter fishing activity (i.e., catch-and-release versus catch-and-retain) (Table 3.10). Charter boat operators participating in catch-and-retain tended to hold more positive perspectives towards the catch-and-retain fishery than those who participated in catch-and-release only. All 7 catch-and-retain operators strongly agreed with all three statements. By comparison, answers to each of the three statements among respondents reported participation in catch-and-release varied. For instance, only 50% of the catch-and-release charter boat operators surveyed responded “Strongly Agree” for the first statement. This data indicates a stronger willingness to support the catch-and-retain fishery among respondents that participated in this activity than those that participated in catch-and-release only.

That catch-and-retain participants might have benefitted from the economic advantages associated with the fishery could explain the high support level among this group of participants.

Table 3.10 Comparison of Bluefin Tuna Charter Boat Operators Responses by Charter Fishing Activity Type

Level	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
Statement: “On average, income from taking tourists on charter fishing trips contributes more to my annual household income than income from landing BFT”					
Catch-and-release only (n=6)	50%	33.33%	16.67%	0%	0%
Both catch-and-release and catch-and-retain (n=7)	100%	0%	0%	0%	0%
Statement: “Combining commercial and charter fishing trips under catch-and-retain reduces the overall number of trips and fishing-related costs”					
Catch-and-release only (n=6)	50%	33.33%	0%	16.67%	0%
Both catch-and-release and catch-and-retain (n=7)	100%	0%	0%	0%	0%
Statement: “I would like to see the charter catch-and-retain fishery continuing in future Bluefin Tuna seasons”					
Catch-and-release only (n=6)	83.33%	16.67%	0%	0%	0%
Both catch-and-release and catch-and-retain (n=7)	100%	0%	0%	0%	0%

3.5 Summary and Conclusions

This chapter explored an economic profile of the BFT charter fishing industry in the Gulf Region for the 2022 season. Survey research methods were used to understand important economic characteristics of the BFT charter fisheries, including catch-and-release and catch-and-retain, and discuss possible management implications. An online survey was developed to elicit responses from BFT charter boat operators on their charter fishing operations, perspectives towards the

catch-and-retain fishery, and socio-economic backgrounds. Survey results were presented in a descriptive and qualitative format. An understanding of the characteristics of the BFT charter industry is useful to fisheries managers in determining if and how particular resources will be allocated to this fishing sector. For example, if BFT charter fishing is identified as an economically important fishery as reflected in its total revenue, more resources, such as revisions of management measures, will be required to further develop the fishery. Additionally, as an exploratory study, its findings can serve as a benchmark for future studies investigating the Gulf Region's BFT charter fishing industry.

The study's findings can be grouped into three categories: socio-economic characteristics, information on charter fishing activities, and perspectives towards the catch-and-retain fishery. Notable findings of respondents' socio-economic background include their years of BFT fishing experience and engagement in occupations outside of the BFT fisheries. In 2022, average years of experience fishing BFT for commercial and charter purposes illustrate that the charter boat operators were highly experienced with over 20 years in the industry. Moreover, almost all respondents were employed in other occupations outside of the BFT fisheries either during or outside of the fishing season. As BFT fishing is a seasonal activity, charter boat operators are likely to have additional income streams to help with financial stability over the year. Additionally, most charter boat operators (92.31%) received formal education. Compared to an average farm operator, an average BFT charter boat operator attained a higher level of education at the high school and university levels, though lower at the trades and college levels. As trades and college-level education reportedly equipped farm operators with the technical and managerial expertise to operate a farm, perhaps BFT charter boat operators might find this education helpful for the operations of a charter fishing business.

More than half (7/13) of the charter operators surveyed participated in catch-and-retain during 2022. Among these participants, 5/7 used all their BFT commercial tags for catch-and-retain, indicating that most fishers took advantage of the catch-and-retain fishery to combine their commercial and charter operations into a single fishing trip. In 2022, catch-and-retain charter fishing activities were most concentrated in September, as reflected in the highest number of tags utilized during the season. The number of catch-and-retain trips conducted for 2022 were modest compared to catch-and-release (25 versus 230). The stark difference in the number of trips between the two charter activities can be explained by the fact that catch-and-release is already a well-established industry. Nonetheless, the number of catch-and-retain trips has the potential to increase as the fishery further develops in future seasons.

In 2022, the average charter fee per boat before taxes for a BFT catch-and-retain trip were higher relative to a BFT catch-and-release trip. For a full-day excursion, the average charter fee of catch-and-retain was CA\$ 3,075 per boat compared to CA\$ 1,920.83 of catch-and-release, indicating a 60.09% fare difference. The add-on features of catch-and-retain allow such a trip to command a higher price than a catch-and-release trip. Nevertheless, the catch-and-retain fishery contributed to only 15% of the BFT charter fishing industry's total gross revenues in 2022 of CA\$ 508,749¹². This small contribution was largely due to the limited number of trips conducted during the season. Therefore, increasing the number of trips will allow the fishery to generate more revenue. Fisheries managers and charter boat operators must develop the catch-and-retain fishery such that it can attract more tourist fishers to participate. Considering its charter fee is relatively expensive, the add-on features of catch-and-retain must be attractive enough so that tourist fishers are willing to pay a premium to enjoy this type of excursion.

¹² This number was calculated based on the study's sample size of 13 respondents. Overall BFT charter industry revenues for the 2022 fishing season would be higher than this amount.

Most importantly, all charter boat operators surveyed indicated that they would like the BFT charter catch-and-retain fishery to continue in future fishing seasons in the Gulf Region. This profound interest among fishers has some implications. First, for the charter boat operators who participated in only catch-and-release in 2022, they are interested in experiencing the operations of catch-and-retain in upcoming BFT fishing seasons. Second, for the charter boat operators who engaged in catch-and-retain in 2022, while the fishery's economic success for the season was limited, they would like to enhance their catch-and-retain operations further to attract more tourist fishers in the future. Finally, positive responses among charter boat operators would likely to positively influence fisheries managers' decisions to continue the pilot catch-and-retain fishery and, ultimately, implement the fishery permanently.

Considering that the catch-and-retain fishery was recently introduced in 2020 and that the present study is the first exploratory study to assess the fishery's economic viability and impacts, it is critical that future studies continue building on the economic profile of the industry. Additionally, future analysis will explore more comparative results, such as whether the differences in fleet sector management between PEI and Gulf Nova Scotia translate into differences in the industry's economic profile. Analyzing the perspectives of charter clients will also be critical to understanding the demand for catch-and-retain relative to catch-and-release.

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Chapter 4 : COMPARISON OF BLUEFIN TUNA FISHING EXPENSES FOR CATCH-AND-RETAIN VERSUS ALTERNATIVE FISHING ACTIVITY TYPES, AND BY FLEET REGIONS USING SURVEY DATA

4.0 Abstract

Fishing trip costs are important for assessing the economic viability of BFT fisheries. Using statistical hypothesis testing and survey data, this study evaluated and compared differences in average fishing trip expenses of catch-and-retain Bluefin Tuna fishing with commercial and catch-and-release fishing in the Atlantic Canadian Gulf Region. The study also assessed and compared how catch-and-retain Bluefin Tuna fishing trip expenses differ between Gulf Nova Scotia and Prince Edward Island (PEI) fleet regions. Important fishing trip costs evaluated included hired equipment, fuel, repairs and maintenance, wages, tackle costs, meals, ice, and bait. The two-tailed paired samples t-test and Wilcoxon signed rank test were applied to test significant differences in fishing trip expenses between fishing activities. The two-tailed two-sample t-test and Mann-Whitney U test were used to compare the fishing trip costs of catch-and-retain between fleet regions. The results indicate significant differences in fishing trip expenses for meals, tackle costs, and repairs and maintenance between catch-and-retain and commercial. In contrast, no significant differences across fishing trip expense categories considered were observed between catch-and-retain and catch-and-release. Similarly, there were no significant differences in all expense categories of catch-and-retain between Gulf Nova Scotia and PEI.

4.1 Introduction

Economic data on fishing trip costs are important considerations for effective fisheries management and decision-making. Fishing trip cost data have been used in the commercial fisheries literature to analyze the economic performance of fisheries (Anderson et al., 2015; Lam et al., 2011; Sala et al., 2018) and potential economic impacts from alternative protection and management measures (Prellezo, 2019; Seung & Waters, 2006; Sumaila et al., 2012; Chan, 2021). In the recreational fisheries literature, fishing trip costs have been used as supplementary data to estimate the economic contributions of fisheries to regional economies (Holland et al., 2012; Steinback & Brinson, 2013; Hutt & Silva, 2015). Trip costs are expenses that are usually incurred during a fishing trip, as opposed to annual costs, which include all expenses that fishing vessel owners incur whether or not a fishing trip is conducted (Das, 2013). Trip expenses that are frequently assessed in the literature on recreational fisheries include hired equipment, fuel, repairs and maintenance, wages paid to the vessel workers, tackle costs, meals, ice for onboard fish storage, and bait (Ditton et al., 1978; Hilger & Lovell, 2017; Deloitte Access Economics, 2013). These expenses are also sometimes referred to as variable costs (Chan, 2021).

Previous research has applied mathematical modelling techniques to quantify the economic contributions to a region's economy from recreational fishing expenses (Seung & Waters, 2006). The most extensively used technique to estimate the regional economic impacts of recreational fisheries is the input-output (I-O) model (Seung & Waters, 2006). However, an I-O analysis of the catch-and-retain fishery's economic contributions to Atlantic Canada's Gulf Region would be incomplete because the 2022 BFT charter fishing season was cut short due to the incidence of Hurricane Fiona. Instead of investigating the regional economic impacts of catch-and-retain, this study explored its relative trip variable costs among alternative BFT fishing activity types and

across fleet regions. Statistical hypotheses were developed and tested to determine and compare cost disparities for fishing trips.

The purpose of this study was to evaluate and compare the trip expenses of catch-and-retain with other BFT fishing activity types (i.e., commercial and catch-and-release), and how catch-and-retain fishing trip variable costs differ by fleet regions (i.e., PEI versus Gulf Nova Scotia). The first objective was to evaluate and compare differences in trip expenses between pairs of BFT fishing activities, namely commercial versus catch-and-retain, and catch-and-release versus catch-and-retain. The second objective was to evaluate and compare differences in trip expenses of catch-and-retain BFT fishing between PEI and Gulf Nova Scotia. Trip expenses data for each fishing activity were obtained using an online survey administered in 2022 to active BFT charter boat operators in the Atlantic Canadian Gulf Region. Important fishing trip expenses evaluated included hired equipment, fuel, repairs and maintenance, wages, tackle costs, and meals.

The following section surveys the recreational fisheries literature using charter boat operators' survey data on fishing trip expenses. Section 4.3 describes the study methods, including survey design, normality assessment, and data analysis. Section 4.4 discusses the results, and section 4.5 provides a summary and conclusions.

4.2 Literature Review

This section presents a review of selected recreational fisheries studies analyzing charter boat operators' fishing trip expenses. Discussion of the studies is grouped based on two methodologies: hypothesis testing and mathematical modelling. The present study used hypothesis testing to evaluate the relative trip costs of catch-and-retain fishing in comparison to alternative BFT fishing activity types and across fleet regions. The application of hypothesis testing in

comparative cost analyses has been surprisingly neglected, as the majority of the literature on charter boat operators' fishing trip expenses has focused on estimating regional economic impacts. Thus, this study contributes to the body of recreational fisheries literature that uses hypothesis testing to analyze fishing trip cost data.

4.2.1 Hypothesis Testing

A few applied recreational fisheries studies analyze cost data using statistical hypothesis testing. Notably, in an economic profile study of the charter fishing fleet in California, Hilger & Lovell (2017) stratified fishing expenses data by large and small vessel categories¹³, and tested for significant differences in the expenses among the two groups. Using the two-tailed two-sample t-test, Hilger & Lovell (2017) found significant differences in most expenses between large and small vessels, apart from expenses for ice and U.S. taxes, government fees, and vessel permits. For example, fuel expenses of small vessels were statistically different from large vessels at 1% significance level. In particular, fuel costs were the highest average expense for small vessels (US\$ 17,250) and the second highest expense for large vessels (US\$ 86,790). Overall, hypothesis testing of fishing trip expense data can help assess whether any cost difference among groups represents an actual difference.

4.2.2 Mathematical Modelling

Mathematical modelling is another methodology that uses fishing trip expense data to quantify the economic contributions of a recreational fishery to a regional economy. Among

¹³ Hilger & Lovell (2017) classified vessels 50 ft (15.24 m) or larger as “Large” and vessels less than 50 ft as “Small.”

different modelling methods¹⁴, the input-output (I-O) technique is well used in most fisheries economic impact studies (Seung & Waters, 2006). The IMPLAN (Impact Analysis for Planning) system is among the three most widely employed, ready-made I-O models for economic impact assessment (Rickman & Schwer, 1995).¹⁵

Several existing studies have applied the IMPLAN model to measure the economic contributions of various charter fishing industries in different U.S. regions (Holland et al., 2012; Steinback & Brinson, 2013; Hutt & Silva, 2015; Stoll et al., 2002; Grado et al., 2003). For example, Hutt & Silva (2015) conducted an economic contribution analysis of the Atlantic highly migratory species charter fishing industry for the Northeast, Southeast, and the Gulf of Mexico regions. They found that expenses from charter operations contributed to US\$ 51.3 million in total economic output, US\$ 13.1 million in labour income, and 1,131 full and part-time jobs in 2013. A few other studies have used the multi-region IMPLAN model to measure the economic contributions inside and outside the investigated region. For instance, Rollins & Lovell (2019) explored the spillover and feedback effects of the Hawaiian charter fishing industry with U.S. mainland states.

A limitation of the IMPLAN modelling method is that additional datasets, such as region-specific data at the industry and commodity levels, are required along with fishing trip costs to estimate the regional economic impacts of a recreational fishery. For example, Steinback & Brinson (2013) purchased the IMPLAN county-level data sets of 440 distinct business sectors to quantify the recreational fishing industry's economic contributions to the Northeastern U.S.

¹⁴ Different methods include input-output (I-O) modelling, social accounting matrices (SAM) modelling, integrated econometric input-output (EC-IO) modelling, fishery economic assessment model (FEAM), and computable general equilibrium (CGE) models. Each of these techniques has its merits and demerits, which have been well documented in the literature (Loveridge, 2004; Seung & Waters, 2006).

¹⁵ The REMI (Regional Economic Models, Inc.) and RIMS-II (Regional Input-Output Modelling System) are the other two widely used models for economic impact assessment (Rickman & Schwer, 1995).

economy. Regional IMPLAN datasets specific to the Atlantic Canadian Gulf Region were also not available at the time of writing this report (Slovachek, 2022).

The present study used hypothesis testing to investigate the relative trip costs of catch-and-retain to alternative BFT fishing activity types (i.e., commercial and catch-and-release) and across fleet sectors (i.e., Gulf Nova Scotia versus PEI). This information is among the important considerations for fisheries managers to assess the success or otherwise of this pilot fishery.

4.3 Research Methods

4.3.1 Survey Design

Two questions in the survey elicited information on charter boat operators' fishing trip variable costs. The expenses that were compiled for BFT charter boat operators in the Atlantic Canadian Gulf Region involved in three BFT fishing activity types in 2022: commercial, catch-and-release, and catch-and-retain (Appendix A). The variable cost categories were developed based on existing literature (Ditton et al., 1978; Hilger & Lovell, 2017; Deloitte Access Economics, 2013). Important variable costs evaluated included hired equipment (excluding boat-related costs), fuel for fishing vessel(s), repairs and maintenance, wages paid to vessel crew, tackle costs, meals, ice for onboard fish storage, and bait.

Primary data were collected to determine each activity's average cost per fishing trip. Pair-wise comparisons of disaggregated average costs by BFT fishing activity type (e.g., commercial versus catch-and-retain) and across fleet regions (e.g., Gulf Nova Scotia versus PEI) provide more meaningful insights than those obtained from the total cost question. For example, although the total costs may be similar between fishing activity types, the average costs for each activity may be different depending on the number of fishing trips conducted.

Additionally, the study focused on variable costs rather than fixed costs (e.g., licence fees, insurance, and purchase cost of a fishing vessel). While variable costs vary with the amount of fishing effort or catch, fixed costs are still incurred irrespective of the level of fishing activity (Pascoe et al., 2015; Dichmont et al., 2009). Thus, information on fishing trip variable costs can help charter boat operators with short-term operations management of the BFT fisheries.

An open-ended question asked respondents who participated in catch-and-release and catch-and-retain BFT fishing during 2022 to describe any differences in expenses between the two charter fishing activity types. Catch-and-retain fishing differs from catch-and-release in that tourist fishers could take the hooked BFT onto the boat, and the fish would be retained and counted towards the commercial fishery's quota allocation. However, it was not known whether any additional costs were incurred for catch-and-retain fishing compared with catch-and-release fishing. For example, catch-and-retain BFT fishing may have some costs associated with storing the fish onboard, such as expenses for ice for cold storage, which do not apply to catch-and-release BFT fishing. Responses to this question would help gain insights to any cost changes between catch-and-release and catch-and-retain BFT fishing.

4.3.2 Normality Assessment

The first step in the analysis involved investigating whether the fishing trip expense data were normally distributed. Assessing normality is important in deciding between parametric versus nonparametric statistical procedures, especially for analyzing small sample datasets (Ghasemi & Zahediasl, 2012). Visual (or graphical) methods and statistical significance tests are two widely used methods to assess normality (Ghasemi & Zahediasl, 2012). Among various graphical

inspection techniques¹⁶, the quantile-quantile (Q-Q) plot was applied in this study because it is the most commonly used and effective diagnostic tool (Razali & Wah, 2011). The Q-Q plot is a scatterplot generated by plotting the sample quantiles against the theoretical quantiles, which are the quantiles from the standard Normal distribution with mean = 0 ($\mu = 0$) and standard deviation = 1 ($\sigma = 1$) (Das & Imon, 2016). All the sample quantile points lie along a straight line $y = x$ representing perfect quantile matching when the sample data follow a normal distribution (Das & Imon, 2016). However, graphical assessments, considered alone, may not ascertain the data distribution and are less precise compared to formal statistical significance tests (Ghasemi & Zahediasl, 2012; Razali & Wah, 2011; Yap & Sim, 2011). Thus, statistical significance tests were conducted to validate the conclusions using the graphical method.

Among the various significance diagnostic tests¹⁷, the Shapiro-Wilk and Anderson-Darling tests are ideal for small sample sizes ($N \leq 30$) (Razali & Wah, 2011). In this study, the Anderson-Darling test (Razali & Wah, 2011) was used to check the distribution of the data using Minitab statistical software package (Minitab Inc., 2023). The two hypotheses tested were:

$$H_0: \mu_i \sim N(0, \sigma^2)$$

$$H_a: \mu_i \neq N(0, \sigma^2)$$

H_0 implies that the sample data follow a normal distribution, whereas H_a indicates that the sample data do not follow a normal distribution. H_0 and H_a are evaluated by comparing the p -values of the Anderson-Darling test with the chosen 5% level of significance (i.e., $\alpha = 0.05$). If $p > 0.05$,

¹⁶ Visual inspection is commonly accomplished using a histogram (of frequency distributions), stem-and-leaf plot, box-and-whisker plot, P-P plot (probability-probability plot), and Q-Q plot (quantile-quantile plot) (Ghasemi & Zahediasl, 2012; Razali & Wah, 2011).

¹⁷ Statistical significance tests commonly used to check normality assumption include the Kolmogorov-Smirnov (K-S) test, Lilliefors corrected K-S test, Shapiro-Wilk test, Anderson-Darling test, Cramer-von Mises test, D'Agostino skewness test, Anscombe-Glynn kurtosis test, D'Agostino-Pearson omnibus test, and the Jarque-Bera test (Ghasemi & Zahediasl, 2012). Each is a goodness-of-fit test, comparing the scores in the observed data to a normally distributed set of scores with the same mean and standard deviation (Ghasemi & Zahediasl, 2012).

H_0 is not rejected and the data are assumed to have a normal distribution. In contrast, if H_0 is rejected in favor of H_a , the data are assumed to have a non-normal distribution ($p \leq 0.05$).

When the distribution of the data is non-normal as indicated by the Anderson-Darling test results, the data may require a transformation to better follow a normal distribution. Empirical selection of a transformation entails trying some of the power family transformations in order of increasing strength, such as square root ($y^{1/2}$), cubic root ($y^{1/3}$), natural log ($\ln(y)$), reciprocal square root ($y^{-1/2}$), and reciprocal (y^{-1}), respectively (Montgomery, 2013). Strength of a transformation implies the amount of curvature it induces (Montgomery, 2013). In this study, the transformations that were applied to non-normally distributed data include square root and cubic root transformations. Based on conclusions from the normality assessment, parametric tests (such as the t-test) and non-parametric test (such as the Wilcoxon test) were used to compare variable trip expenses across fishing activity types and fleet regions.

4.3.3 Data Analysis

The second step in analyzing the cost data involved using statistical hypothesis testing methods to evaluate and compare average trip expenses of catch-and-retain with other BFT fishing types (i.e., commercial and catch-and-release), and how catch-and-retain BFT fishing expenses differ by fleet regions (i.e., Gulf Nova Scotia versus PEI).

4.3.3.1 Pair-Wise Comparison by Fishing Activity Type

Average fishing trip expenses for commercial, catch-and-release, and catch-and-retain BFT fishing activities were collected from the same group of respondents with equal number of responses. This characteristic suggests two types of statistical methods most applicable to compare

the average fishing trip expenses of catch-and-retain BFT fishing with commercial and catch-and-release BFT fishing, respectively. If the differences data were normally distributed, the paired samples t-test was applied. On the other hand, the Wilcoxon signed rank test was applied if the distribution of differences were non-normal. Under the paired samples t-test, the two hypotheses tested for each fishing trip expense category between commercial and catch-and-retain fishing activities were:

$$H_0 = \mu_{\text{Commercial}} - \mu_{\text{Catch-and-Retain}} = 0$$

$$H_a = \mu_{\text{Commercial}} - \mu_{\text{Catch-and-Retain}} \neq 0$$

H_0 implies that for each fishing trip expense category, there is no difference between its population mean under the commercial activity ($\mu_{\text{Commercial}}$) and its population mean under the catch-and-retain activity ($\mu_{\text{Catch-and-Retain}}$). On the other hand, H_a indicates that for each fishing trip expense category, there are differences between its population mean under the commercial activity ($\mu_{\text{Commercial}}$) and its population mean under the catch-and-retain activity ($\mu_{\text{Catch-and-Retain}}$).

In contrast, the Wilcoxon signed rank test was applied if the differences between the means of cost for commercial and catch-and-retain fishing were non-normally distributed. Unlike the paired samples t-test, which is focused on population means, the Wilcoxon signed rank test is directed toward hypotheses concerning the median of the population. The two hypotheses tested for each fishing trip expense category between commercial and catch-and-retain BFT fishing activities were:

$$H_0 = \eta_{\text{Commercial}} - \eta_{\text{Catch-and-Retain}} = 0$$

$$H_a = \eta_{\text{Commercial}} - \eta_{\text{Catch-and-Retain}} \neq 0$$

H_0 implies that for each fishing trip expense category, there is no difference between its population median under the commercial activity ($\eta_{\text{Commercial}}$) and its population median under the catch-

and-retain activity ($\eta_{\text{Catch-and-Retain}}$). On the other hand, H_a indicates that for each fishing trip expense category, there are differences between its population median under the commercial activity ($\eta_{\text{Commercial}}$) and its population median under the catch-and-retain activity ($\eta_{\text{Catch-and-Retain}}$). Similar procedures were applied for comparison of fishing trip expenses between catch-and-release and catch-and-retain BFT fishing.

For each statistical hypothesis test described, H_0 was accepted if $p > 0.05$. In contrast, if $p \leq 0.05$, H_0 was rejected in favor of H_a . Statistical software package Minitab (Minitab Inc., 2023) was used to conduct statistical hypothesis testing.

4.3.3.2 Comparison by Fleet Region

To compare differences in average fishing trip expenditures of catch-and-retain BFT fishing between PEI and Gulf Nova Scotia, statistical tests for two independent groups were considered, because the expense data were collected from two different geographic regions with different costs of fishing trip expenses. A parametric or non-parametric test was applied depending on the data distribution. If the distributions of two populations were normal, the two-sample t-test was applied. Normality assumptions and equal variances are important conditions for the two-sample t-test (Montgomery, 2013). When the variances of two populations are equal, the results of the two-sample t-test are exact. In contrast, the results are approximate when the variances of two populations are unequal. Under the two-sample t-test, the two hypotheses tested for each fishing trip expense category of catch-and-retain between PEI and Gulf Nova Scotia were:

$$H_0 = \mu_{\text{PEI}} - \mu_{\text{Gulf Nova Scotia}} = 0$$

$$H_a = \mu_{\text{PEI}} - \mu_{\text{Gulf Nova Scotia}} \neq 0$$

H_0 implies that for each fishing trip expense category under the catch-and-retain fishery, there is no difference between its population mean in PEI (μ_{PEI}) and its population mean in Gulf Nova Scotia ($\mu_{Gulf\ Nova\ Scotia}$). On the other hand, H_a indicates that for each fishing trip expense category under the catch-and-retain fishery, there are differences between its population mean in PEI (μ_{PEI}) and its population mean in Gulf Nova Scotia ($\mu_{Gulf\ Nova\ Scotia}$).

If the distribution of populations were non-normally distributed, the Mann-Whitney U test (also known as the Wilcoxon rank sum test) was applied as the non-parametric alternative to the two-sample t-test. Application of the Mann-Whitney U test does not require equal variances between populations (Zimmerman, 1987). The two hypotheses tested for each fishing trip expense category of the catch-and-retain BFT fishery between PEI and Gulf Nova Scotia were:

$$H_0 = \eta_{PEI} - \eta_{Gulf\ Nova\ Scotia} = 0$$

$$H_a = \eta_{PEI} - \eta_{Gulf\ Nova\ Scotia} \neq 0$$

H_0 implies that for each fishing trip expense category under the catch-and-retain fishery, there is no difference between its population median in PEI (η_{PEI}) and its population median in Gulf Nova Scotia ($\eta_{Gulf\ Nova\ Scotia}$). On the other hand, H_a indicates that for each fishing trip expense category under the catch-and-retain fishery, there are differences between its population median in PEI (η_{PEI}) and its population median in Gulf Nova Scotia ($\eta_{Gulf\ Nova\ Scotia}$).

For each statistical hypothesis test described, H_0 was accepted if $p > 0.05$. In contrast, if $p \leq 0.05$, H_0 was rejected in favor of H_a . Statistical software package Minitab (Minitab Inc., 2023) was used to conduct statistical hypothesis testing.

4.4 Results and Discussion

4.4.1 Response Rate

Primary data for the analysis were based on 13 usable responses from BFT charter boat operators. Among these, 6 (46.15%) participated in only catch-and-release fishing, while the remaining 7 (53.85%) participated in both catch-and-release and catch-and-retain fishing. Given the research interest on catch-and-retain BFT fishing, the 7 survey responses from catch-and-retain participants were relevant for the comparative analysis between fishing activity types and across fleet regions. Nonetheless, only 6 of the 7 catch-and-retain respondents provided answers to the questions on fishing trip variable costs. Thus, further analysis utilized these 6 survey responses. Fishing trip expense categories were compared for catch-and-retain versus commercial and catch-and-retain versus catch-and-release. Variable cost items assessed for the pair-wise comparisons included hired equipment, fuel, repairs and maintenance, wages, meals, tackle costs, ice, and bait.

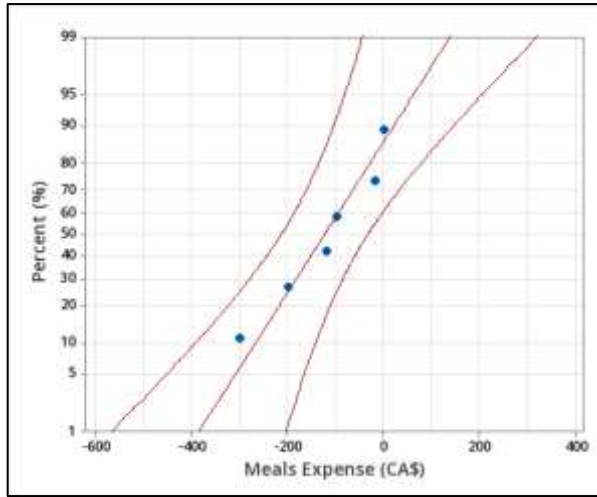
Data on catch-and-retain fishing trip variable costs were disaggregated by fleet regions to compare differences in expenses between PEI and Gulf Nova Scotia. Among the 6 catch-and-retain charter boat operators, 4 (66.67%) were from Gulf Nova Scotia and 2 (33.33%) were from PEI. Catch-and-retain fishing trip variable cost items assessed across fleet regions included hired equipment, fuel, repairs and maintenance, wages, meals, tackle costs, ice, and bait.

4.4.2 Comparison of Fishing Costs: Commercial versus Catch-and-Retain

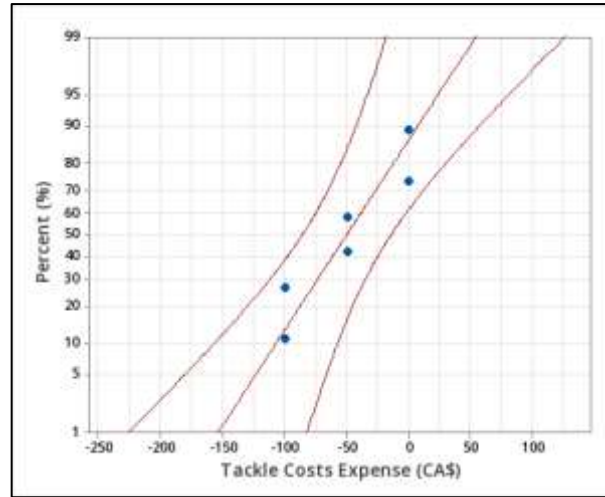
4.4.2.1 Normality Test Results

Results of the Q-Q plots are reported for commercial versus catch-and-retain in Figures 4.1 and 4.2, while the Anderson-Darling test results are summarized in Table 4.1. The Q-Q plots for meals, tackle costs, repairs and maintenance, fuel, hired equipment, and wages expenses indicate

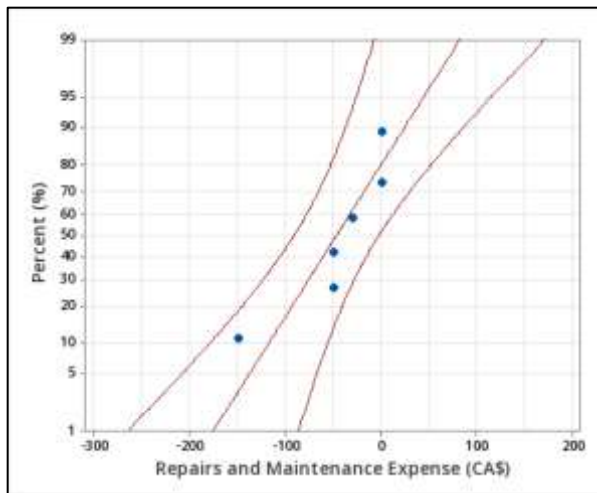
that the distributions of sample quantiles lie mainly along the straight diagonal line with a few minor deviations (Figure 4.1). These reported expenses are consistent with a normal distribution based on the Q-Q plots. Additionally, the Anderson-Darling test results (Table 4.1) are consistent with the visual assessment results (Figure 4.1) as $p > 0.05$.



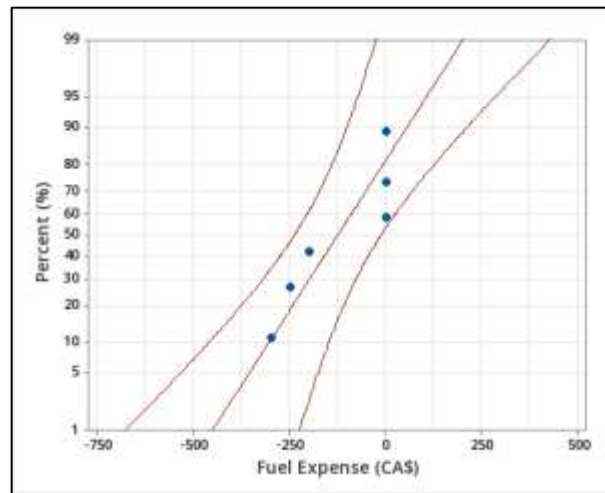
(a)



(b)



(c)



(d)

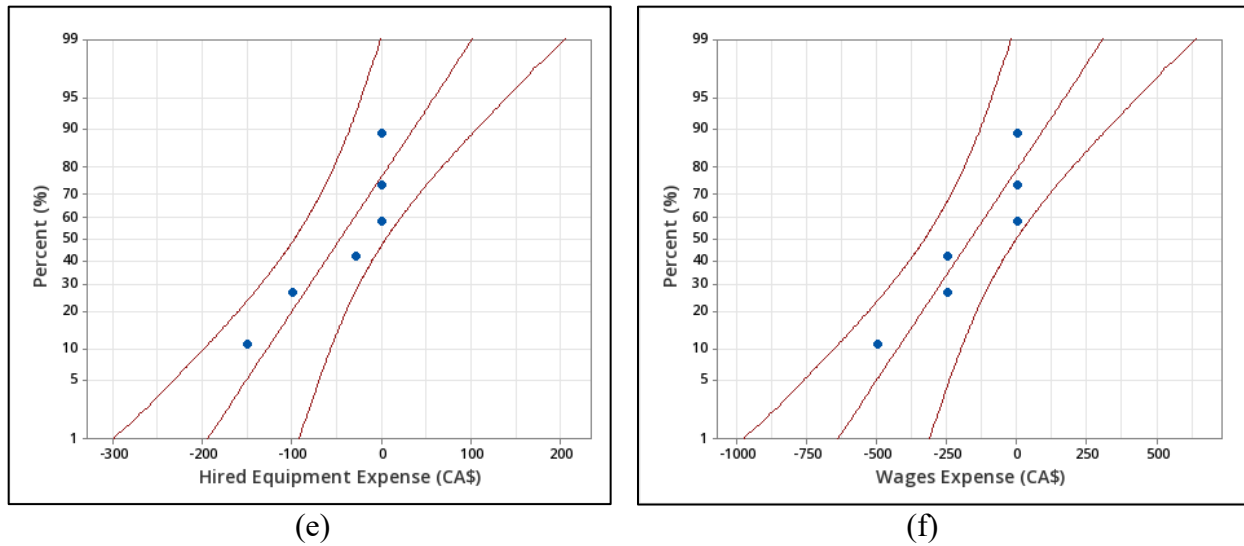


Figure 4.1 Q-Q Plots of Expenses for (a) Meals, (b) Tackle Costs, (c) Repairs and Maintenance, (d) Fuel, (e) Hired Equipment, and (f) Wages, Commercial versus Catch-and-Retain Bluefin Tuna Fishing

Notes: Normality assumption was checked using raw data for all cost categories.

Table 4.1 Summary Results of Anderson-Darling Test for Selected Fishing Trip Expenses, Commercial versus Catch-and-Retain Bluefin Tuna Fishing

Variable Cost Item	Mean (CA\$)	Standard Deviation	Number of Replications	Anderson-Darling test	
				statistic	<i>p</i> -value
Meals	-123.3	112.7	6	0.218	0.714
Tackle Costs	-50	44.72	6	0.417	0.215
Repairs and Maintenance	-46.67	55.38	6	0.530	0.101
Hired Equipment	-46.67	63.77	6	0.607	0.060
Fuel	-125	140.5	6	0.599	0.064
Wages	-166.7	204.1	6	0.544	0.092
Bait	-50	83.67	6	0.905	0.008
Bait (Square Root Transformed)	-4.024	6.370	6	0.934	0.007
Bait (Cubic Root Transformed)	-1.748	2.735	6	0.972	0.005
Ice	-10.83	20.10	6	1.026	<0.005
Ice (Square Root Transformed)	-1.824	3.001	6	0.901	0.008
Ice (Cubic Root Transformed)	-1.025	1.634	6	0.921	0.007

Notes: Negative mean values for each of the variable cost items indicate that its expenses under commercial BFT fishing are less than its expenses under catch-and-retain BFT fishing.

The Q-Q plots for bait and ice expenses indicate that most quantile points are positioned away from the theoretical normal line, suggesting a non-normal distribution (Figure 4.2). For example, four out of seven sample quantile points had values of 0, for each expense category. This observation implies that there were no differences in fishing trip expenses between commercial and catch-and-retain BFT fishing among these paired samples. The Anderson-Darling test results (Table 4.1) are consistent with the visual assessment results (Figure 4.2). Data for bait and ice costs were non-normally distributed as $p \leq 0.05$. Because the raw data were non-normally distributed and contained many zero values, square root and cubic root transformations were applied to investigate if the transformations would yield a normal distribution. However, the transformations resulted in even smaller p -values of the Anderson-Darling test, except for the square root transformation of ice expense (Table 4.1). Thus, transforming the raw data for normality was not applicable in these scenarios.

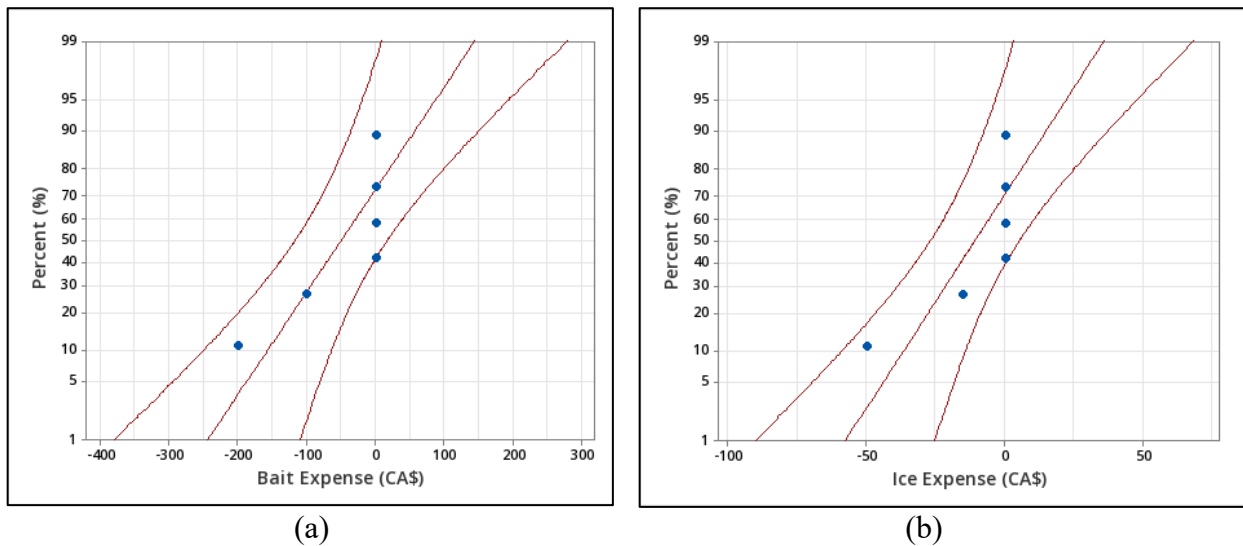


Figure 4.2 Q-Q Plots of Expenses for (a) Bait, and (b) Ice, Commercial versus Catch-and-Retain Bluefin Tuna Fishing

Notes: Normality assumption was checked using raw data for all cost categories.

In summary, the graphical assessment and statistical significance test results indicate that data on expenses for meals, tackle costs, repairs and maintenance, fuel, hired equipment, and wages were normally distributed. In contrast, expense data on bait and ice were non-normally distributed. The following cost data analysis applied a parametric or a non-parametric test depending on the data distribution.

4.4.2.2 Cost Data Analysis

Given that the differences were normally distributed for meals, tackle costs, repairs and maintenance, fuel, hired equipment, and wages expenses, a two-tailed paired samples t-test was applied to compare trip variable costs for catch-and-retain with commercial BFT fishing (Table 4.2 panel (a)). In contrast, given that the distributions were non-normal for reported expenditures for bait and ice, a two-tailed Wilcoxon signed rank test was applied to compare trip variable costs between catch-and-retain and commercial BFT fishing (Table 4.2 panel (b)).

The results suggest that meals expenses for catch-and-retain were statistically different from commercial BFT fishing ($p = 0.044$) (Table 4.2). Differences in meals expenses are consistent with the observation that the commercial fishing activity does not have tourist clients onboard, thus requiring no meals for recreational anglers. On the contrary, because catch-and-retain BFT fishing is a full-day charter activity, such trips typically include lunch and light refreshments for tourist fishers. Similarly, average expenses for tackle costs, and repairs and maintenance for catch-and-retain were statistically different from commercial BFT fishing, as both p -values are less than the 0.05 significance level ($p = 0.041$ and $p = 0.040$, respectively) (Table 4.2). Differences in repairs and maintenance expenses are consistent with the observation that to

be eligible for operating charter services, BFT commercial licence holders must have their fishing vessel(s) certified by Transport Canada. This additional requirement indicates that more repairs and maintenance expenses may be required for catch-and-retain relative to commercial fishing.

In contrast to the findings for meals, tackle costs, and repairs and maintenance expenses, no significant differences were observed between catch-and-retain and commercial BFT fishing for hired equipment, fuel, wages, bait, and ice expenses; all p -values are greater than the 0.05 significance level (Table 4.2). This overall finding is consistent with the observation that commercial and catch-and-retain BFT fishing are relatively similar activities. An important difference between the two fishing activities is that catch-and-retain allows fishers to capture their commercial quota allocation with charter clients on board, whereas commercial prohibits such an action. Expenses for hired equipment, fuel, wages, bait, and ice may still incur in each fishing trip independent of charter clients' participation.

Table 4.2 Summary Results of Paired Samples t-Test and Wilcoxon Signed Rank Test for Selected Fishing Trip Expenses, Commercial versus Catch-and-Retain Bluefin Tuna Fishing

(a) Paired Samples t-Test				
Variable Cost Item	Mean (CA\$)	Standard Deviation	t-statistic	p -value
Meals	-123.3	112.7	-2.68	0.044
Tackle Costs	-50	44.7	-2.74	0.041
Repairs and Maintenance	-5.31	4.71	-2.76	0.040
Hired Equipment	-46.7	63.8	-1.79	0.133
Fuel	-125.0	140.5	-2.18	0.081
Wages	-166.7	204.1	-2.00	0.102
(b) Wilcoxon Signed Rank Test				
	Median	Sample Size Used for Test	Wilcoxon statistic	p -value
Bait	-50	2	0.00	0.371
Ice	-7.5	2	0.00	0.371

4.4.3 Comparison of Fishing Costs: Catch-and-Release versus Catch-and-Retain

As with the comparison between commercial and catch-and-retain BFT fishing, data used for comparing average fishing trip expenses of catch-and-retain with catch-and-release were based on 6 paired samples. An assessment of the raw data reveals no differences between the two fishing activities for all trip expense categories, including hired equipment, fuel, repairs and maintenance, wages, tackle costs, meals, ice, and bait. This finding was further corroborated by respondents' answers to an open-ended question, which asked for a description of any differences in trip expenses between catch-and-release and catch-and-retain BFT fishing in the Gulf Region. All respondents answered that most fishing expenses for a catch-and-release trip were similar to a catch-and-retain trip. This finding is consistent with the observation that both charter fishing activities typically offer excursions for the same duration (i.e., full-day trips of at least 8 hours). An important difference between catch-and-release and catch-and-retain BFT fishing is that the former activity restrains charter boat operators and tourist fishers from retaining any fish caught, whereas the latter permits such an action. Retaining BFT onboard may require some expenses on ice to keep the fish staying fresh, while this expense type is not applicable for catch-and-release. Thus, it is a surprising finding that there were no differences in ice expenses between catch-and-release and catch-and-retain BFT fishing.

Additionally, 2 respondents from Gulf Nova Scotia further indicated that the monitoring costs of landing fish and the cost of utilizing commercial tags were additional expenses incurred under the catch-and-retain fishing activity. Moreover, charter boat operators mentioned how engaging in catch-and-retain fishing helped eliminate the unnecessary duplication of expenses. For example, a Gulf Nova Scotia respondent noted that:

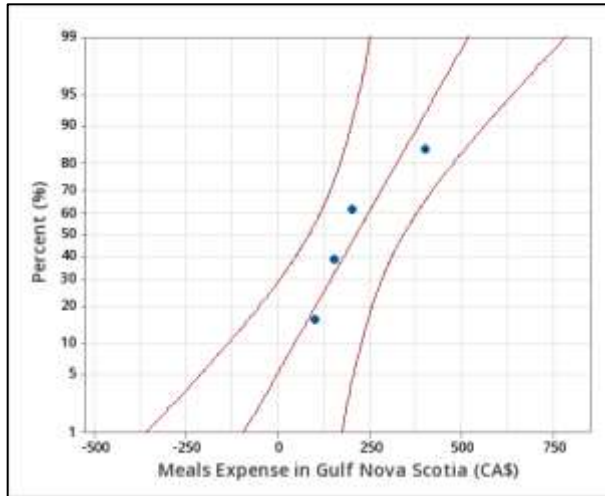
“[Fishing trip] expenses [between catch-and-release and catch-and-retain BFT fishing] are usually very similar. The most significant difference is that by doing a catch-and-retain trip, [fishers] are usually able to eliminate expenses by not having to go out and repeat everything [they] did the day before.”

Overall cost reductions were possible because charter operators were allowed to catch their commercial allocation with charter clients onboard under catch-and-retain, instead of undertaking separate commercial fishing trips.

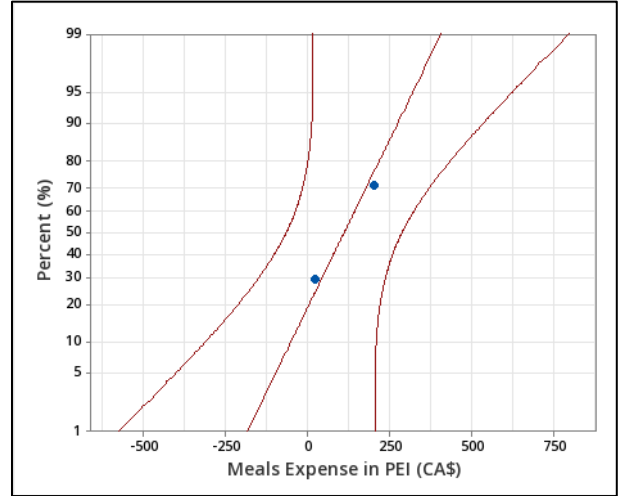
4.4.4 Comparison of Catch-and-Retain Fishing Costs: Gulf Nova Scotia versus PEI

Given that the expense data were collected from different fleet regions, the normality test was assessed separately for the distribution of each cost category for Gulf Nova Scotia and PEI. Among the 6 survey responses used for the comparative analysis, 4 (66.67%) were from Gulf Nova Scotia and 2 (33.33%) were from PEI. Because the values reported for repairs and maintenance and wages expenses were identical among PEI survey responses, comparisons of these two cost categories between the fleet regions were not conducted.

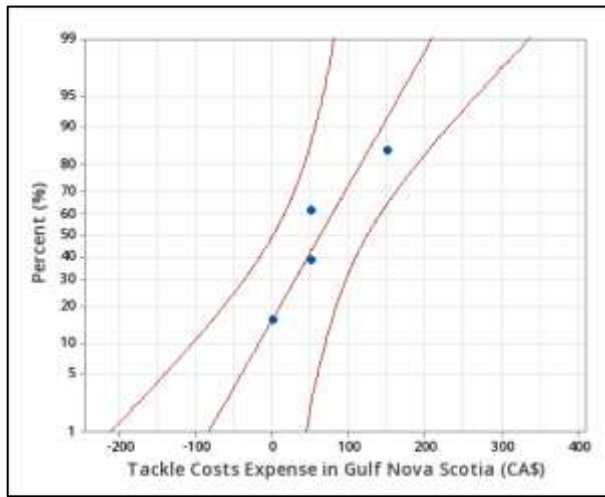
Results of the Q-Q plots (Figure 4.3) indicate that the raw data for expenses on meals, tackle costs, fuel, and bait lie evenly along the straight diagonal line, suggesting the data were normally distributed. The Anderson-Darling test results are consistent with the conclusions using the visual assessment method ($p > 0.05$) (Table 4.3). Consequently, the two-tailed two-sample t-test was used in the further analysis.



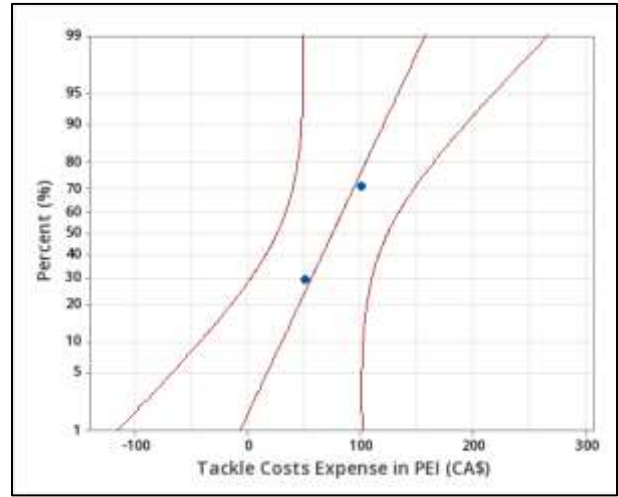
(a1)



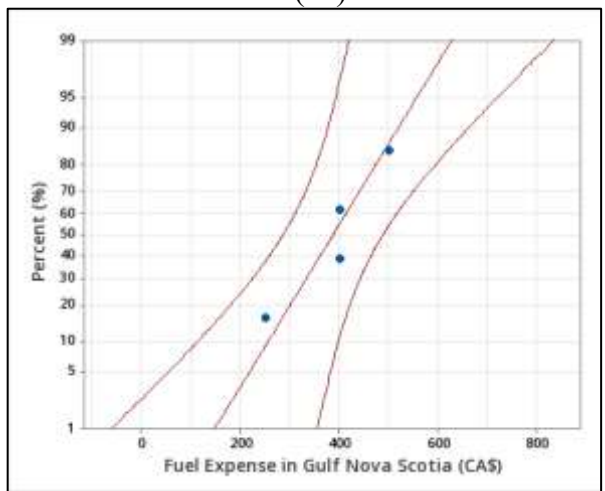
(a2)



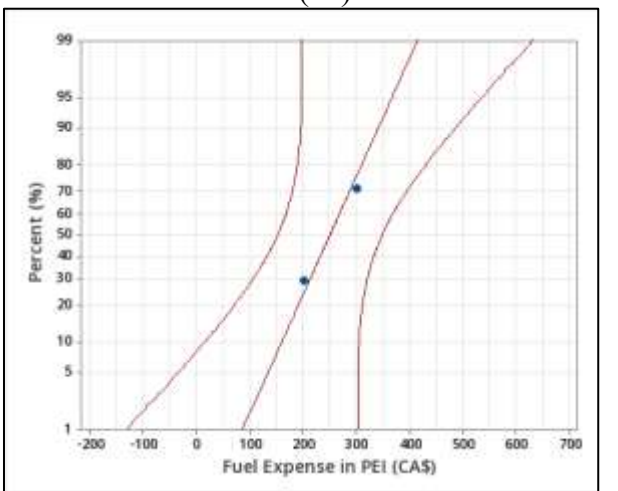
(b1)



(b2)



(c1)



(c2)

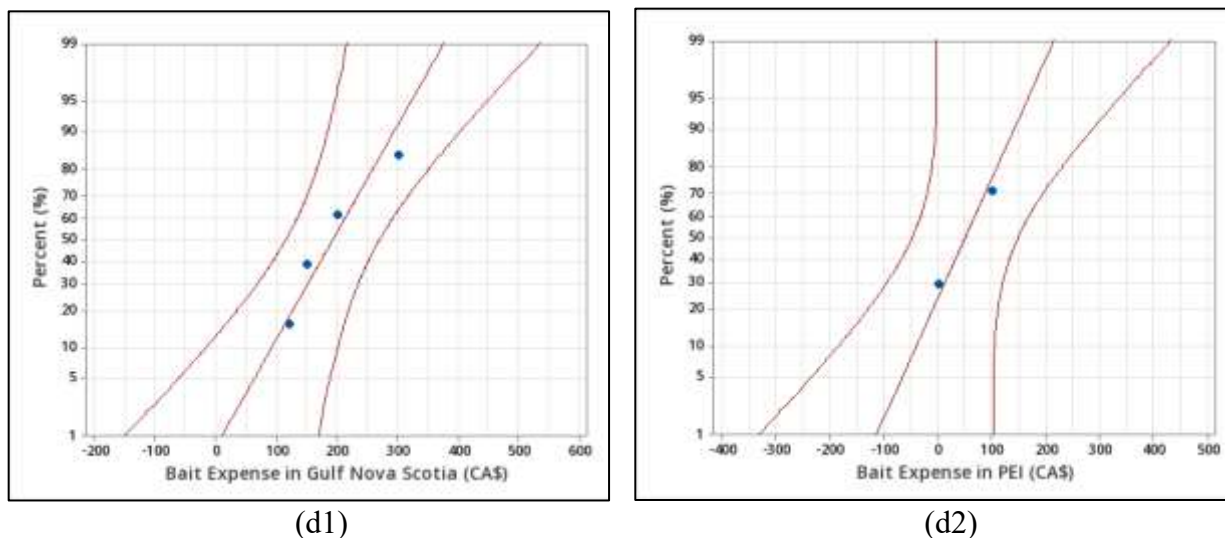


Figure 4.3 Q-Q Plots of Expenses of Bluefin Tuna Catch-and-Retain Fishing for (a1; a2) Meals, (b1; b2) Tackle Costs, (c1; c2) Fuel, and (d1; d2) Bait, Gulf Nova Scotia versus PEI

Notes: Normality assumption was checked using raw data for all cost categories.

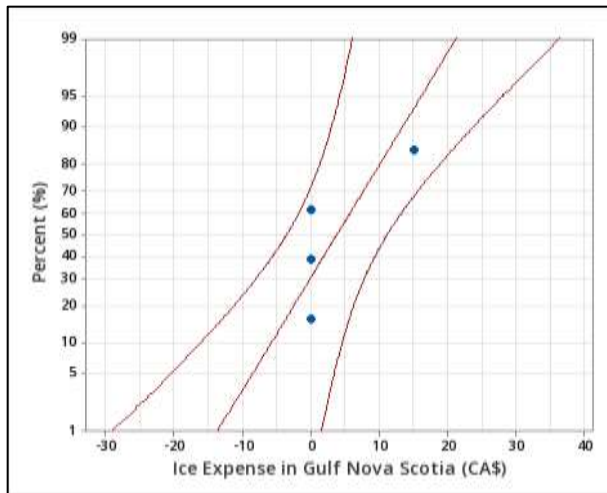
Table 4.3 Summary Results of Anderson-Darling Test for Selected Bluefin Tuna Catch-and-Retain Fishing Trip Expenses, Gulf Nova Scotia versus PEI

Variable Cost Item	Mean (CA\$)	Standard Deviation	Number of Replications	Anderson-Darling test	
				statistic	<i>p</i> -value
Meals (Gulf Nova Scotia)	212.5	131.5	4	0.339	0.276
Meals (PEI)	110	127.3	2	0.250	0.227
Tackle Costs (Gulf Nova Scotia)	62.50	62.92	4	0.361	0.234
Tackle Costs (PEI)	75	35.36	2	0.250	0.227
Fuel (Gulf Nova Scotia)	387.5	103.10	4	0.312	0.335
Fuel (PEI)	250	70.71	2	0.250	0.227
Bait (Gulf Nova Scotia)	192.5	78.90	4	0.252	0.508
Bait (PEI)	50	70.71	2	0.250	0.227
Ice (Gulf Nova Scotia)	3.75	7.5	4	0.827	0.007
Ice (PEI)	25	35.36	2	0.250	0.227
Ice (Gulf Nova Scotia) (Square Root Transformed)	0.9683	1.937	4	0.827	0.007
Ice (PEI) (Square Root Transformed)	3.536	5.000	2	0.250	0.227
Hired Equipment (Gulf Nova Scotia)	7.5	15	4	0.827	0.007
Hired Equipment (PEI)	125	35.36	2	0.250	0.227

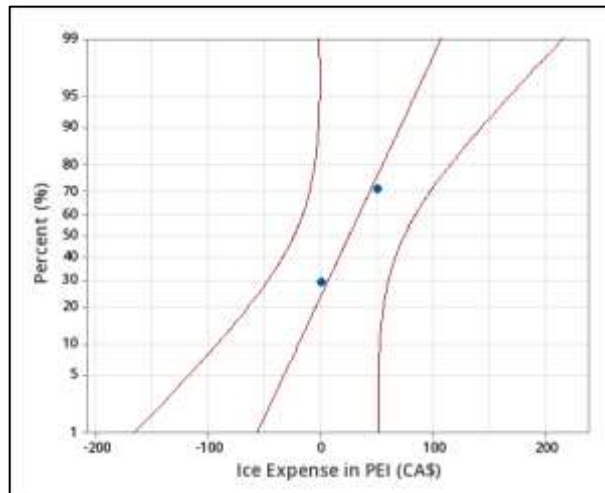
Table 4.3 (Continued) Summary Results of Anderson-Darling Test for Selected Bluefin Tuna Catch-and-Retain Fishing Trip Expenses, Gulf Nova Scotia versus PEI

Variable Cost Item	Mean (CA\$)	Standard Deviation	Number of Replications	Anderson-Darling test	
				statistic	<i>p</i> -value
Hired Equipment (Gulf Nova Scotia) (Square Root Transformed)	1.369	2.739	4	0.827	0.007
Hired Equipment (PEI) (Square Root Transformed)	11.12	1.589	2	0.250	0.227

The Q-Q plots for expenses on ice and hired equipment in Gulf Nova Scotia (Figure 4.4 panels (a1) and (b1)) indicate that most quantile points are positioned away from the theoretical normal line, suggesting the data were non-normally distributed. The Anderson-Darling test results (Table 4.3) are also consistent with the visual test results ($p \leq 0.05$). On the other hand, expense data for ice and hired equipment in PEI were assumed to be normally distributed based on their Q-Q plots (Figure 4.4 panels (a2) and (b2)) and Anderson-Darling test results ($p > 0.05$) (Table 4.3). Given that the distribution of the raw data for Gulf Nova Scotia were non-normal, square root transformations were applied to examine whether the outcomes would yield a normal distribution. However, the transformations resulted in similar *p*-values of the Anderson-Darling test (Table 4.3). Consequently, the Mann-Whitney U test was applied to the raw data as the non-parametric alternative to the two-sample t-test in the further analysis.



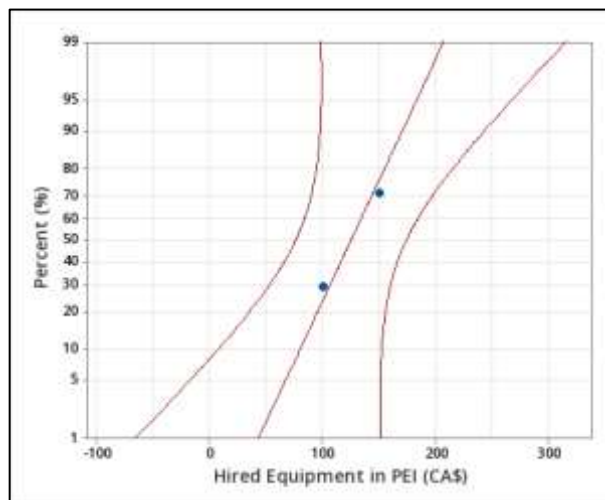
(a1)



(a2)



(b1)



(b2)

Figure 4.4 Q-Q Plots of Expenses of Bluefin Tuna Catch-and-Retain Fishing for (a1; a2) Ice, and (b1; b2) Hired Equipment, Gulf Nova Scotia versus PEI

Notes: Normality assumption was checked using raw data for all cost categories.

Results of the two-tailed two-sample t-test suggest no significant differences in expenses on meals, tackle costs, fuel, and bait for catch-and-retain fishing between Gulf Nova Scotia versus PEI, as the respective p -values are quite large ($p > 0.05$) (Table 4.4 panel (a)). Similarly, results of the Mann-Whitney U test indicate no significant differences in expenses on ice and hired equipment of catch-and-retain fishing between Gulf Nova Scotia and PEI ($p > 0.05$) (Table 4.4

panel (b)). In summary, no significant differences in all BFT catch-and-retain fishing trip variable costs were observed between Gulf Nova Scotia and PEI. This finding is surprising given that different purchasing powers across geographic locations may imply differences in some fishing trip variable costs between the two fleet regions. The finding may have resulted from the lower statistical power associated with small sample sizes, thus implying the need for further study to validate the conclusions from this pilot study.

Table 4.4 Summary Results of Two-Sample t-Test and Mann-Whitney U Test for Selected Bluefin Tuna Catch-and-Retain Fishing Trip Expenses, Gulf Nova Scotia versus PEI

(a) Two-Sample t-test				
Variable Cost Item	Mean (CA\$) and Standard Deviation (Gulf Nova Scotia)	Mean (CA\$) and Standard Deviation (PEI)	t-statistic	<i>p</i> -value
Meals	213 (131)	110 (127)	0.92	0.455
Tackle Costs	62.5 (62.9)	75.0 (35.4)	-0.31	0.776
Fuel	388 (103)	250.0 (70.7)	1.91	0.151
Bait	192.5 (78.9)	50.0 (70.7)	2.24	0.155
(b) Mann-Whitney U Test				
Variable Cost Item	Median (CA\$) and Sample Size (Gulf Nova Scotia)	Median (CA\$) and Sample Size (PEI)	Wilcoxon statistic ¹	<i>p</i> -value
Ice	0 (4)	25 (2)	12.50	0.643
Hired Equipment	0 (4)	125 (2)	10.00	0.105

Notes: ¹The Wilcoxon statistics reported were not adjusted for ties.

4.5 Summary and Conclusions

This study evaluated and compared the average fishing trip expenses of catch-and-retain BFT fishing with its commercial and catch-and-release counterparts and how catch-and-retain BFT fishing trip expenses differ between Gulf Nova Scotia and PEI for the 2022 fishing season. Survey research methods were used to elicit information on BFT charter boat operators' variable fishing trip costs for each fishing activity type. Important variable costs evaluated included hired equipment, fuel, repairs and maintenance, wages paid for the vessel crew, tackle costs, meals, ice for onboard fish storage, and bait. The two-tailed paired samples t-test and Wilcoxon signed rank test were applied to test for significant differences in fishing trip expenses between catch-and-retain BFT fishing and commercial and catch-and-release BFT fishing. The two-tailed two-sample t-test and Mann-Whitney U test were conducted to compare the fishing trip expenses of catch-and-retain BFT fishing between Gulf Nova Scotia and PEI. Understanding the relative costs of BFT catch-and-retain fishing is useful to fisheries managers for comparing costs across fleet regions and among fishing activity types. Additionally, findings from this exploratory study can serve as a benchmark for future studies evaluating the cost data of catch-and-retain BFT fishing.

The results indicate significant differences in expenses for meals, tackle costs, and repairs and maintenance between catch-and-retain and commercial BFT fishing. Differences in meals expenses are consistent with the observation that the commercial BFT fishing activity does not have tourist clients onboard, thus requiring no meals for recreational anglers. On the contrary, because catch-and-retain BFT fishing is a full-day charter activity, such trips typically include lunch and light refreshments for tourist fishers. Similarly, differences in repairs and maintenance expenses between catch-and-retain and commercial fishing may be partly explained by the fact that BFT commercial licence holders must have their fishing vessel(s) certified by Transport

Canada to be eligible for charter operations. This additional requirement may require more repairs and maintenance expenses for the catch-and-retain BFT fishery relative to its commercial counterpart. In contrast, the study found no significant differences in expenses on hired equipment, fuel, wages, bait, and ice between catch-and-retain and commercial BFT fishing. This finding is consistent with the observation that commercial and catch-and-retain fishing are relatively similar activities, where the only difference is that catch-and-retain allows fishers to capture their commercial quota allocation with charter clients on board. Expenses for hired equipment, fuel, wages, bait, and ice may still incur in each fishing trip independent of charter clients' participation.

Additionally, there were no significant differences in trip expenses between catch-and-retain and catch-and-release BFT fishing, consistent across all cost categories. This finding was further supported by charter boat operators' responses to the open-ended question. All respondents reported that most fishing expenses under catch-and-release were similar to catch-and-retain. Specific additional costs that catch-and-retain BFT charter boat operators incurred during the 2022 fishing season included monitoring costs of landing fish and the cost of utilizing commercial tags. Most importantly, charter boat operators noted that catch-and-retain fishing helped eliminate the unnecessary duplication of effort and expenses. Catch-and-retain participants can combine their commercial and charter operations into a single fishing trip, catching their commercial allocation while having tourist fishers onboard.

The study also found no significant differences in all expense categories of catch-and-retain BFT fishing between Gulf Nova Scotia and PEI. This finding may have resulted from the lower statistical power associated with small sample sizes. Further study is needed to validate the conclusions from this exploratory study.

The findings are a first attempt at exploring comparative cost data analyses for the BFT fisheries in Atlantic Canada's Gulf Region. Further research is needed to validate the findings from this pilot study of BFT catch-and-retain charter boat operators in the region to include a larger sample. For example, it is important that research explore the relationship between a specific fishing trip expense and important dependent variables, such as the trip length and vessel type.

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Chapter 5 : SUMMARY AND CONCLUSIONS

5.1 Background

The Atlantic Bluefin Tuna (*Thunnus thynnus*) is economically important to commercial and recreational fisheries in the North Atlantic region, especially Atlantic Canada. In 2020, the federal Department of Fisheries and Oceans (DFO) introduced a charter catch-and-retain fishery to complement existing Bluefin Tuna (BFT) commercial and charter catch-and-release fisheries in the Atlantic Canadian Gulf Region. Unlike catch-and-release, the catch-and-retain fishery allows any BFT caught to be retained and counted towards the commercial fishery's quota allocation.

Little is currently known about the economic activities of the catch-and-retain fishery, given its relatively recent introduction and the disruptive impacts of the COVID-19 pandemic on data collection. Before the present study, an analysis by the Ecology Action Centre (2014) was the only study that evaluated the economic returns for Atlantic Canada's BFT charter fishing industry. Given the current piloting phase of catch-and-retain, it is imperative to understand the fishery's economic activities relative to the BFT charter fishing industry to assess its success or otherwise. The paucity of information highlights the importance of collecting and analyzing primary data to better understand the catch-and-retain fishery in Atlantic Canada's Gulf Region.

The main focus of this study was to provide technical information on the economic activities of the catch-and-retain BFT fishery to government fishery resource managers and policy analysts, local economic development officials, and BFT charter boat operators. The study also discussed some implications for BFT fisheries management and decision-making. Data for the analysis were based on an online survey administered to active BFT charter boat operators in Atlantic Canada's Gulf Region following the 2022 fishing season.

5.2 Summary of Major Results

This section presents a summary of major findings according to specific objectives of the study.

Objective 1: To assess and describe important economic characteristics of the Bluefin Tuna charter fishing industry in the Atlantic Canadian Gulf Region using charter boat operators' survey data for the 2022 fishing season.

An online survey was administered following the 2022 BFT fishing season to elicit responses from charter boat operators on their socio-economic characteristics, charter fishing operations, and perspectives on the catch-and-retain fishery. Data for the analysis were based on 13 responses from BFT charter boat operators, representing an overall response rate of 59.09%. Survey data were analyzed using qualitative research methods, as presented in Chapter 3.

Charter boat operators were highly experienced, with an average of over 20 years (per respondent) in the BFT fishing industry. Additionally, almost all respondents (92.31%) reported engaging in other occupations outside the BFT fisheries, either during or outside the 2022 fishing season. As BFT fishing is a seasonal activity, it is not surprising that charter boat operators engaged in non-BFT-fishing occupations to help with financial stability over the year.

More than half (53.85% or 7/13) of the charter boat operators surveyed participated in catch-and-retain BFT fishing in 2022. Among these participants, 71.43% (or 5/7) used all their BFT commercial tags for catch-and-retain fishing, suggesting that most fishers used the catch-and-retain fishery to combine their commercial and charter operations into a single fishing trip. Additionally, the average charter fees per boat before taxes for a BFT catch-and-retain trip were 60% higher than a BFT catch-and-release trip. However, the catch-and-retain fishery contributed

to only 15% of the BFT charter fishing industry's total gross revenues in 2022 of CA\$ 508,749¹⁸. This relatively small contribution may be partly explained by the limited number of commercial tags available during the season capped the number of possible catch-and-retain trips. Thus, the DFO's quota allocation decisions are among the exogenous factors that will affect the future performance of the Gulf Region's BFT catch-and-retain fishery.

Most importantly, all charter boat operators indicated a preference for continuing the pilot BFT catch-and-retain fishery in future fishing seasons in the Gulf Region. This interest among fishers is useful information for fisheries managers' decisions and planning of the BFT catch-and-retain fishery.

Objective 2: To evaluate and compare differences in average fishing trip expenses of catch-and-retain Bluefin Tuna fishing with commercial and catch-and-release Bluefin Tuna fishing, and between Gulf Nova Scotia and PEI.

Survey research methods were used to elicit information on BFT charter boat operators' fishing trip variable costs for each fishing activity type: commercial, catch-and-release, and catch-and-retain. Important variable costs evaluated included expenses for hired equipment, fuel, repairs and maintenance, wages, tackle costs, meals, ice, and bait. The cost data analyses were detailed in Chapter 4 and based on survey results of 6 respondents, who reported actively engaging in all 3 BFT fishing activities during the 2022 season.

The two-tailed paired samples t-test and Wilcoxon signed rank test were applied to test for significant differences in average fishing trip expenses between catch-and-retain BFT fishing and commercial and catch-and-release BFT fishing. Among the variable costs evaluated, results

¹⁸ As noted earlier, this number was calculated based on the study's sample size of 13 respondents. Overall BFT charter industry revenues for the 2022 fishing season would be higher than this amount.

indicated significant differences in expenses on meals, tackle costs, and repairs and maintenance between catch-and-retain and commercial BFT fishing. For catch-and-retain and catch-and-release BFT fishing, there were no significant differences in all trip expense categories. This finding was further corroborated by charter boat operators' answers to an open-ended question, which asked for a description of any differences in fishing trip expenses between catch-and-release and catch-and-retain. All respondents reported that most fishing expenses for a catch-and-release trip were similar to a catch-and-retain trip. Most importantly, charter boat operators' responses emphasized how participating in catch-and-retain BFT fishing helped eliminate the unnecessary duplication of effort and expenses.

The two-tailed two-sample t-test and Mann-Whitney U test were conducted to compare average catch-and-retain BFT fishing trip expenses between Gulf Nova Scotia and PEI. Of the 6 respondents who participated in catch-and-retain in 2022, 4 (or 66.67%) were from Gulf Nova Scotia, and 2 (or 33.33%) were from PEI. No significant differences in all expense categories of catch-and-retain BFT fishing were observed between the two fleet regions. This finding may have resulted from the lower statistical power associated with small sample sizes.

5.3 Contributions of the Study

The contributions of this exploratory study based on responses from a small sample of BFT charter boat operators (13) are mainly empirical in nature. The study is the first to assess and describe important economic characteristics of the BFT charter fishing industry in the Atlantic Canadian Gulf Region. Previous studies on BFT charter fishing did not investigate the relative economic viability of the recently introduced catch-and-retain fishery compared to the catch-and-release fishery. Considering the current piloting phase of the catch-and-retain BFT fishery, it is

also imperative to understand the economic activities of this fishery relative to BFT charter fishing, particularly how much it contributes to the industry's total revenues per fishing season. Consequently, the findings from this exploratory study contribute to a better understanding of the economic implications of the catch-and-retain BFT fishery in Atlantic Canada's Gulf Region. The important economic characteristics of BFT charter fishing documented provides reference or benchmark information for future studies of other charter fisheries.

In addition, the study is the first to evaluate and compare differences in average fishing trip expenses of catch-and-retain with commercial and catch-and-release BFT fishing, and between Gulf Nova Scotia and PEI. The findings of the relative costs of catch-and-retain compared to other BFT fishing activity types and by fleet regions can assist fisheries managers in gauging whether any cost differences are reasonable. For example, it was found that there were no significant differences in all trip expense categories between catch-and-retain and catch-and-release BFT fishing. This finding may be partly explained by the observation that both charter fishing activities offer excursions for similar duration. Overall, while the estimates presented in this report can be taken as reasonably approximating current conditions of the BFT fisheries in Atlantic Canada's Gulf Region, its exploratory findings can provide a baseline for estimates for future years.

5.4 Recommendations for Further Research

As with most empirical analyses, the constraints of data availability, time, and resources influenced the approaches that could be effectively used in the present study. Nonetheless, the data gathered and analyzed for this study have arguably established a baseline for future research on the economic sustainability of the BFT catch-and-retain fishery in Atlantic Canada's Gulf Region.

The online survey was conducted when a significant number of charter fishing businesses resumed operations following the disruptive impacts of the COVID-19 pandemic. For example, the number of licence holders in the BFT charter fishing industry was lower in 2022 (37) compared to 2019 (57) (Government of Canada, n.d.). As charter boat operators have more time to adjust to local economic conditions, participation in BFT charter fishing, particularly the catch-and-retain activity, will likely increase in future seasons. Thus, it is important that follow-up studies investigate any changes to the economic viability of the pilot BFT catch-and-retain fishery in the Atlantic Canadian Gulf Region.

Additionally, it is important that future studies investigate the perspectives of charter clients to understand the demand for catch-and-retain relative to catch-and-release BFT fishing. For instance, investigating charter clients' willingness-to-pay (WTP) for a BFT catch-and-retain trip requires survey data on price premia for this fishing activity. The present study initially intended to collect this information from charter clients. However, the incidence of Hurricane Fiona (in September 2022) in Atlantic Canada resulted in an early closure of the 2022 BFT charter fishing season, disrupting the planned data collection.

Finally, future research should estimate the extent of regional economic impacts brought on by the BFT catch-and-retain fishery. Such an assessment would require data on fishing trip costs from both charter boat operators and tourist fishers. Its findings would help to clarify if and how the catch-and-retain fishery may benefit rural outport communities in Atlantic Canada's Gulf Region. These inputs are important for the federal decision-making process to choose a fisheries management alternative that maximizes benefits to rural coastal communities and minimizes negative economic consequences.

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APPENDIX A: Survey Instruments Administered to Active Bluefin Tuna Charter Boat Operators, 2022 Fishing Season

APPENDIX A1: English Version of Survey Instrument

SECTION I: BLUEFIN TUNA CHARTER ACTIVITY DURING THE 2022 SEASON

1. For the 2022 Bluefin Tuna charter fishery season, did you participate in only catch-and-release, or both catch-and-release and catch-and-retain?

- Only catch-and-release
 Both catch-and-release and catch-and-retain

2. How many Bluefin Tuna tags did you have in total for the 2022 season? Please include tags received as part of the initial allocation and any additional tags that you received during the season.

3. If you engaged in catch-and-retain during the 2022 season, was the 2022 season your first season to participate in catch-and-retain?

- Yes
 No
 Not applicable: I participated in only catch-and-release.

4. If you engaged in catch-and-retain during the 2022 season, please indicate the number of tags used for each month for your catch-and-retain operations during the season. Please record 0 if you did not use any tags for any of the listed months.

	Number of used tags
July	
August	
September	
October	
November	

SECTION II: FREQUENCY OF OPERATION, TRIP RATES, AND VARIABLE EXPENSES DURING THE 2022 BLUEFIN TUNA SEASON

5. In which Canadian province is your charter business based?

- New Brunswick
- Nova Scotia
- Prince Edward Island

6. How many catch-and-release and catch-and-retain trips (including half-day and full-day trips) did you conduct in total during the 2022 Bluefin Tuna charter fishery season? Please record 0 if there were no trips conducted.

A full-day trip takes 8 hours or more, and a half-day trip takes 5 hours or less.

	Number of trips
Catch-and-release	
Catch-and-retain	

7. Thinking of this season's Bluefin Tuna catch-and-release and catch-and-retain charters, please specify how many persons (excluding the captain and mate), on average, you took on each fishing trip. If you participated in only catch-and-release during the 2022 season, please record 0 for catch-and-retain.

	Number of persons
Catch-and-release	
Catch-and-retain	

8. Thinking of the total number of Bluefin Tuna catch-and-release and catch-and-retain trips conducted during this season, please provide the proportions of trips that were full-day and half-day (e.g., 60% were full-day and 40% were half-day). Please record 0% if you did not offer any full-day/half-day trips.

A full-day trip takes 8 hours or more, and a half-day trip takes 5 hours or less.

	Proportion for full-day trips	Proportion for half-day trips
Catch-and-release		

Catch-and-retain		
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9. What were the daily rates (excluding sales tax) for a Bluefin Tuna catch-and-release trip and a catch-and-retain trip during the 2022 season? Please specify the rates, in Canadian dollars, for both full-day and half-day trips, and indicate whether these rates were per person or for the whole boat.

For example, if the daily rate was \$2,000 per boat for a catch-and-release trip, please fill out “2,000/boat” in the blank field. Please record 0 if you did not offer any full-day or half-day trips.

A full-day trip takes 8 hours or more, and a half-day trip takes 5 hours or less.

	Full-day trip rate	Half-day trip rate
Catch-and-release		
Catch-and-retain		

10. Thinking of your operations during the 2022 Bluefin Tuna season, which included commercial, catch-and-release, and/or catch-and-retain activities, please provide an estimate of the average cost per trip for each activity, in Canadian dollars, associated with each variable cost item listed in the table below. Please record 0 for no expense.

	Commercial	Catch-and-release	Catch-and-retain
Equipment hiring (excluding boat related)			
Fuel for fishing boat			
Repairs			
Wages			
Commissions			
Tackle			
Bait (Live and/or Artificial)			

Ice			
Food and Refreshments			
Accommodation/Lodging			
Other variable cost			

11. If you engaged in both catch-and-release and catch-and-retain during the 2022 season, please briefly describe if there were any differences in expenses between catch-and-release and catch-and-retain. Please respond “N/A” if you did not engage in both activities.

SECTION III: PERSPECTIVES TOWARDS THE CATCH-AND-RETAIN FISHERY

Please indicate your level of agreement or disagreement with each of the following statements.

Statements	Strongly Agree	Agree	Neither Agree Nor Disagree	Disagree	Strongly Disagree
12. On average, income from taking tourists on charter fishing trips contributes more to my annual household income than income from landing BFT.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
13. Combining commercial and charter fishing trips under catch-and-retain reduces the overall number of trips and fishing-related costs.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
14. I would like to see the charter catch-and-retain fishery continuing in future Bluefin Tuna seasons.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

SECTION IV: SOCIO-ECONOMIC BACKGROUND INFORMATION

15. Thinking of your commercial and charter fishing activities, how many years have you fished for Bluefin Tuna?

16. Are you engaged in occupations outside of the Bluefin Tuna fishery? Please select all that apply.

No

Yes, during the Bluefin Tuna season

Yes, outside of the Bluefin Tuna season

17. What is the highest level of education you have completed?

Did not complete high school

Completed high school

Completed trade school or community college

Completed university

Completed post-graduate degree (masters or doctorate)

18. Which of the following best describes your household income (before taxes and other deductions) for 2021?

Total household income refers to the sum of the total incomes of all household members 15 years of age and over.

Under CA\$ 10,000

CA\$ 10,000 – 19,999

CA\$ 20,000 – 29,999

CA\$ 30,000 – 39,999

CA\$ 40,000 – 49,999

CA\$ 50,000 – 74,999

CA\$ 75,000 – 99,999

CA\$ 100,000 or above

**SECTION I : ACTIVITÉ NOLISÉE DE THON ROUGE DE L'ATLANTIQUE
PENDANT LA SAISON 2022**

1. Pour la saison de pêche nolisée au thon rouge de l'Atlantique 2022, avez-vous participé uniquement à la pêche avec remise à l'eau, ou à la fois à la pêche avec remise à l'eau et à la pêche sans remise à l'eau?

- Seulement la pêche avec remise à l'eau
 La pêche avec remise à l'eau et la pêche sans remise à l'eau

2. Combien d'étiquettes de thon rouge de l'Atlantique avez-vous eues au total pour la saison 2022? Veuillez inclure les étiquettes reçues dans le cadre de l'allocation initiale et toutes les étiquettes supplémentaires que vous avez reçues pendant la saison

3. Si vous avez pratiqué la pêche sans remise à l'eau pendant la saison 2022, était-ce votre première fois?

- Oui
 Non
 Sans objet : Je n'ai participé qu'à la pêche avec remise à l'eau.

4. Si vous avez pratiqué la pêche sans remise à l'eau pendant la saison 2022, veuillez indiquer le nombre d'étiquettes utilisées pour chaque mois pour vos opérations de pêche avec conservation pendant la saison. Veuillez enregistrer 0 si vous n'avez utilisé aucune étiquette pour aucun des mois listés.

	Nombre d'étiquettes utilisées
Juillet	
Août	

Septembre	
Octobre	
Novembre	

**SECTION II: FRÉQUENCE D'OPÉRATION, TAUX DE FRÉQUENCE DES VOYAGES,
ET DÉPENSES VARIABLES AU COURS DE LA SAISON D'EXPLOITATION DU
THON ROUGE DE L'ATLANTIQUE 2022**

5. Dans quelle province canadienne votre entreprise nolisée est-elle basée?

- Nouveau-Brunswick
 Nouvelle-Écosse
 Île-du-Prince-Édouard

6. Combien de sorties de pêche avec remise à l'eau et de pêche sans remise à l'eau (y compris les sorties d'une demi-journée et d'une journée) avez-vous effectuées au total pendant la saison de pêche nolisée au thon rouge de l'Atlantique 2022? Veuillez enregistrer 0 si aucun voyage n'a été effectué.

Une excursion d'une journée entière dure huit heures ou plus, et une excursion d'une demi-journée dure cinq heures ou moins.

	Nombre de voyages
Pêche avec remise à l'eau	
Pêche sans remise à l'eau	

7. En ce qui concerne les bateaux nolisés de pêche au thon rouge de l'Atlantique avec remise à l'eau et sans remise à l'eau de cette saison, veuillez préciser combien de personnes (à l'exclusion du capitaine et du second), en moyenne, vous avez emmenées à chaque sortie de pêche. Si vous n'avez pratiqué que la pêche avec remise à l'eau pendant la saison 2022, veuillez enregistrer 0 pour la pêche sans remise à l'eau.

	Nombre de personnes
Pêche avec remise à l'eau	
Pêche sans remise à l'eau	

8. En considérant le nombre total de sorties de pêche au thon rouge de l'Atlantique avec remise à l'eau et sans remise à l'eau effectuées au cours de cette saison, veuillez indiquer

les proportions de sorties d'une journée complète et d'une demi-journée (par exemple, 60 % d'une journée complète et 40 % d'une demi-journée). Veuillez inscrire 0 % si vous n'avez proposé aucun voyage d'une journée ou d'une demi-journée.

Une excursion d'une journée entière dure huit heures ou plus, et une excursion d'une demi-journée dure cinq heures ou moins.

	Proportion de voyages d'une journée complète	Proportion de voyages d'une demi-journée
Pêche avec remise à l'eau		
Pêche sans remise à l'eau		

9. Quels étaient les tarifs journaliers (hors taxe de vente) pour une sortie de pêche au thon rouge de l'Atlantique avec remise à l'eau et une sortie de pêche sans remise à l'eau pendant la saison 2022? Veuillez préciser les tarifs, en dollars canadiens, pour les excursions d'une journée et d'une demi-journée, et indiquer si ces tarifs sont par personne ou pour l'ensemble du bateau.

Par exemple, si le tarif journalier est de 2 000 \$ par bateau pour une sortie de pêche avec remise à l'eau, veuillez inscrire « 2 000/bateau » dans le champ vide. Veuillez enregistrer 0 si vous n'avez proposé aucun voyage d'une journée ou d'une demi-journée.

Une excursion d'une journée entière dure huit heures ou plus, et une excursion d'une demi-journée dure cinq heures ou moins.

	Prix d'un voyage d'une journée	Tarif d'une demi-journée
Pêche avec remise à l'eau		
Pêche sans remise à l'eau		

10. En pensant à vos opérations pendant la saison 2022 du thon rouge, qui comprenaient des activités commerciales, de pêche avec remise à l'eau et de pêche sans remise à l'eau, veuillez fournir une estimation du coût moyen par voyage pour chaque activité, en dollars canadiens, en lien avec chaque élément de coût variable figurant dans le tableau ci-dessous. Inscrivez 0 pour aucune dépense.

	Commerciale	Pêche avec remise à l'eau	Pêche sans remise à l'eau
Location d'équipements (à l'exception de ceux liés aux bateaux)			
Carburant pour bateau de pêche			
Réparations			
Salaires			
Commissions			
Outillage de chargement			
Appâts (vivants et/ou artificiels)			
Glace			
Alimentation et rafraîchissements			
Hébergement/logement			
Autre coût variable			

- 11.** Si vous avez participé à la fois à la pêche avec remise à l'eau et sans remise à l'eau pendant la saison 2022, veuillez décrire brièvement s'il y avait des différences dans les dépenses entre la pêche avec remise à l'eau et la pêche avec conservation. Veuillez répondre « S. o. » si vous n'avez pas participé aux deux activités.

SECTION III: PERSPECTIVES ENVERS LA PÊCHE SANS REMISE À L'EAU

Veillez indiquer votre niveau d'accord ou de désaccord avec chacune des déclarations suivantes.

Déclarations	Tout à fait d'accord	D'accord	Ni d'accord ni en désaccord	En désaccord	Fortement en désaccord
12. En moyenne, le revenu tiré de l'accompagnement de touristes lors de voyages de pêche nolisée contribue davantage au revenu annuel de mon ménage que le revenu tiré du débarquement du thon rouge d'Atlantique.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
13. Le fait de combiner les voyages de pêche commerciale et nolisée dans le cadre de la pêche sans remise à l'eau réduit le nombre total de voyages et les coûts liés à la pêche.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
14. J'aimerais que la pêche nolisée sans remise à l'eau se poursuive lors des prochaines saisons de pêche au thon rouge de l'Atlantique.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

SECTION IV: INFORMATIONS DE FOND SOCIO-ÉCONOMIQUES

15. En pensant à vos activités de pêche commerciale et nolisée, depuis combien d'années pêchez-vous le thon rouge de l'Atlantique?

16. Exercez-vous une activité professionnelle en dehors de la pêche au thon rouge de l'Atlantique? Veuillez cocher toutes les réponses qui s'appliquent.

- Non
- Oui, pendant la saison du thon rouge de l'Atlantique
- Oui, en dehors de la saison du thon rouge de l'Atlantique

17. Quel est votre niveau de scolarité le plus élevé?

- Pas de diplôme d'études secondaires
- Diplôme d'études secondaires
- Diplôme d'école professionnelle ou de collège communautaire
- Diplôme universitaire
- Diplôme d'études supérieures (maîtrise ou doctorat)

18. Laquelle des propositions suivantes décrit le mieux le revenu de votre ménage (avant impôts et autres déductions) pour 2021?

Le revenu total du ménage correspond à la somme des revenus totaux de tous les membres du ménage âgés de 15 ans et plus.

- Moins de 10 000 \$ CA
- 10,000 – 19,999 \$ CA
- 20,000 – 29,999 \$ CA
- 30,000 – 39,999 \$ CA
- 40,000 – 49,999 \$ CA
- 50,000 – 74,999 \$ CA
- 75,000 – 99,999 \$ CA
- 100,000 \$ CA ou plus

**APPENDIX B: Support/Cooperation Correspondence to Department of Fisheries and
Oceans Area Office Manager**

Dear FULL NAME:

My name is Khanh Tran, and I am a Master of Development Economics student at Dalhousie University. I am currently conducting a collaborative study with the Fisheries and Marine Economics group at the Department of Fisheries and Oceans to assess the socio-economic benefits associated with the catch-and-retain Atlantic Bluefin Tuna charter fishery in the Canadian Gulf Region. This study falls under the federal Research Affiliate Program (RAP) and forms part of my Master's degree requirements.

As part of the study, an online survey questionnaire for Bluefin Tuna commercial fish harvesters active in charter fishing (charter boat operators) was developed. Insights from charter operators are invaluable and will provide a better understanding of the economic importance and demand for the catch-and-retain Atlantic Bluefin Tuna charter fishery in the Gulf Region for the 2022 fishing season.

I will appreciate your help with distributing the survey link via email to the list of all Bluefin Tuna commercial fish harvesters active in charter fishing in your area. The URL to the online survey is <https://surveys.dal.ca/opinio/s?s=70380> and the survey closes on December 31, 2022, at 11:59 PM Atlantic Time.

If you have any questions or comments, you can contact me by email at khanh.tran@dal.ca or by phone number at 902-580-1989.

Thank you for your help.

Sincerely,
Khanh Tran

APPENDIX C: Invitation/Cover Letter to Bluefin Tuna Charter Boat Operator

Dear charter boat operator:

My name is Khanh Tran, and I am a Master of Development Economics student at Dalhousie University. I am currently conducting a collaborative study with the Fisheries and Marine Economics group of the federal Department of Fisheries and Oceans to assess the socio-economic benefits associated with the catch-and-retain Atlantic Bluefin Tuna charter fishery in the Canadian Gulf region. This study falls under the federal Research Affiliate Program (RAP) and forms part of my Master's degree requirements.

Please accept my invitation to participate in this important research study on the economic value of the catch-and-retain Atlantic Bluefin Tuna charter fishery in the Gulf region. Knowledge about the economic benefits of the catch-and-retain fishery is important for assessing the success of this pilot fishery. The study is conducted by a research team including myself, my two thesis supervisors at Dalhousie University, and Fisheries and Oceans Canada collaborators.

Completing the survey will take about 15 minutes of your time. Your participation in this survey is entirely voluntary. Even once you begin participating, you can withdraw from the study simply by no longer answering questions and closing your browser. If you submitted the survey and then decide to withdraw, your data will not be removed since it is impossible to identify which data are yours due to anonymity. However, your response to the survey is important to ensure that the findings of the research represent a more complete picture of the catch-and-retain fishery. Findings from this research will be shared in the thesis report and may be submitted to a peer-reviewed journal and/or conference proceedings.

Your consent to participate in the study is implied by answering the online survey questionnaire. The responses provided in the survey will be treated confidentially to protect your personal identity. Responses will be analyzed and reported in group form only. Thus, individual responses will not be apparent.

Although you may not gain directly from participating in this study, your participation will provide important information and useful insights to government and policymakers, and inform their future development decisions related to the catch-and-retain charter fishery.

If you have any questions about this survey, please contact Khanh Tran by email at khanh.tran@dal.ca. If you have any concerns with the ethical aspects of this research project, please contact the Dalhousie Research Ethics Board, by phone number at 902-494-3423 or by email at ethics@dal.ca.

Thank you for your support of this research study.

Sincerely,
Khanh Tran

APPENDIX D: Reminder Email to Bluefin Tuna Charter Boat Operator

Dear charter boat operator,

You were recently invited to complete a short survey on the Bluefin Tuna catch-and-retain fishery. If you operated only catch-and-release during the 2022 season, you are encouraged to participate in the survey, as there are questions that can capture your views towards the catch-and-retain fishery.

The survey takes approximately 15 minutes to complete. Most importantly, your answers will provide important information and valuable insights to government and policymakers and inform their future development decisions related to the Bluefin Tuna catch-and-retain fishery.

You can complete the online survey [here](#) if you have not yet provided your input. The survey will be open until December 31, 2022, and is voluntary and confidential.

Thank you for your support of this research study.

Sincerely,
Khanh Tran