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The 2009 Canadian North Pacific Albacore Troll Fishery[1]

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INTRODUCTION

Canadian fishermen have been fishing for albacore tuna (*Thunnus alalunga*) since the mid-1930s. The Canadian fishery started in the coastal waters of British Columbia and is a troll fishery using jigs to targets albacore tuna in the surface waters of four areas of the Pacific Ocean in which the fleet operates: (1) British Columbia coastal, (2) British Columbia/United States coastal, (3) high seas north Pacific ocean, and (4) high seas south Pacific ocean. Although the Canadian fleet will follow albacore tuna concentrations into offshore waters, in recent years the majority of effort and catch has occurred in the coastal waters of Canada and the United States and this trend continued in 2008. Access by Canadian vessels to waters in the U.S. Exclusive Economic Zone (EEZ) is governed by a bilateral Canada-United States albacore tuna treaty, which enables Canadian and U.S. fishers to catch north Pacific albacore in each other's EEZ, and land albacore tuna at designated ports in Canada and the United States.

Canada is committed to providing detailed catch and effort statistics, logbook data, and fishing vessel information, as is required under the Highly Migratory Species Convention. Management regulations for Canadian vessels fishing albacore tuna in 2009 are documented in the Pacific Region Integrated Fisheries Management Plan: Tuna - April 1, 2009 to March 31, 2010, which is available at: http://www.dfo-mpo.gc.ca/Library/336239.pdf. These regulations specify that Canadian fishers must obtain a license to fish for albacore tuna and that they must maintain accurate records of daily harvest operations in the Canadian Pacific Albacore Tuna Logbook. Logbooks are purchased from the Canadian Highly Migratory Species Foundation (http://www.canadianalbacoretuna.com/) and fishers are required to submit their logbooks within 7 days of their final landing or mid-November, whichever is first. The Canadian tuna fishery in Pacific Ocean waters was open from 01 April 1 2009 to 31 March 2010, but all catch and effort in the North Pacific Ocean occurred between 15 June and 31 October 2009 when albacore availability to the fleet in coastal waters was highest.

The present report summarizes Category I (total annual catch and effort, catch per unit of effort (CPUE)), Category II (logbook catch and effort data summarized on 1° x 1° grid), and Category III (catch length frequencies) data for the Canadian North Pacific albacore troll fishery in 2009. Similar summaries for the 1995 to 2008 fisheries are presented by Shaw (1997, 1999), Shaw and Argue (1999, 2000), Argue and Shaw (2000), Shaw and Stocker (2002), Stocker and Shaw (2004a, 2004b, 2005), Stocker (2006, 2007a), and Holmes (2008, 2009). Historical catch data from 1945 to 1990 provided by Ware and Yamanaka (1991) are based on sales slip records, which capture total landings of albacore in Canadian ports but not ports in the United States. Effort associated with these catch data is not available, except when enhanced catch reporting occurred through the operation of experimental logbook programs in 1948-1950 and 1968-1974 (e.g., see Partlo 1951 and Ketchen 1980).

DATA SOURCES

Data on albacore tuna catch and effort are compiled from hailing records, logbooks, and sales slips from processing plants and stored in the Canadian Albacore Tuna Catch and Effort Relational Database (Stocker et al. 2007). This database contains all fishery-related scientific data from 1995 to the present and provides the best estimate of total annual catch and effort by

vessel and geographic area. All fishing vessels are required to hail out when they intend to start fishing and hail in when fishing ceases. Hail data from vessels fishing in Canadian waters are obtained from Marine Communications and Traffic Services, Canadian Coast Guard, and hail data for vessels fishing in U.S. waters are obtained from Ship.com. The hail data are used to estimate the total number of unique vessels fishing (Stocker et al. 2007). Canadian vessels must also carry logbooks while fishing for highly migratory species in any waters of the Pacific Ocean. Daily catch and effort data at the highest temporal and spatial scales are obtained from completed copies of the logbooks submitted at the end of the fishing season. Shaw and Argue (1999) and Stocker et al. (2007) provide a full description of the type of information recorded in the logbooks. Sales slips records of landings provide the most accurate estimates of albacore landings (weight), although they underestimate total annual landings because they do not fully account for international sales, domestic public sales or take-home totals (Stocker et al. 2007). Logbooks, sales slips and at-sea trans-shipment slips, completed at the time fish are landed and sold, must be returned to Fisheries and Oceans Canada (DFO) for entry into the albacore catch database (Argue et al. 1999; Stocker et al. 2007). Port samplers in American ports designated by the Canada-United States albacore tuna treaty collect length-frequency data from the Canadian albacore tuna catch landed in those ports. Canada implemented an on-board sampling program by harvesters in 2009. Participating harvesters were asked to measure the first 10 albacore landed on a daily basis and record these data in their logbooks. Thirty-eight vessels or 28% of the 2009 fleet participated in this program.

Fisheries and Oceans Canada embarked on a program in March 1999 to reconcile past estimates of total Canadian catches of albacore from logbook, sales slip, phone-in and transhipment data, which culminated in the development and implementation of the Canadian Albacore Tuna Catch and Effort Relational Database (Stocker et al. 2007). During the process updates, based on new logbook and sales slip information, were made to catches and number of vessels as reported in earlier reports (Shaw and Argue 1999, Argue and Shaw 2000 and Argue et al. 1999).

The catch and effort data for 2009 in this report were taken from database version 10.03.07. Logbook coverage was estimated to be 99% of expanded catch and effort. The data in this report up to and including 2008 are considered definitive and are derived from a reconciliation of trip log (best estimates of effort, catch in pieces, and geographic location) and sales slip (best estimate of catch weight) data (S + X report described in Stocker et al. 2007).

CATEGORY I DATA

Catch

The preliminary estimate of north Pacific albacore tuna caught by the Canadian troll fishery in 2009 is 5,685 metric tons (t), which represents a 4% increase in catch relative to 2008 (Table 1). The total catch of north Pacific albacore tuna by the Canadian troll fishery has ranged from 1,763 t in 1995 to 7,856 t in 2004 and averaged 4,797 t for the 1995 to 2009 period. All but 1 t of the 2009 catch occurred in FAO Statistical Area 67 (Table 2) and was distributed in the Canadian EEZ (7%), the United States EEZ (92%), and the highseas (1%) (Figure 2). The Canadian fishery operated exclusively within the IATTC convention area north of the equator and was inactive in the WCPFC convention area, both north and south of the equator in 2009.

Effort

The Canadian albacore troll fleet consisted of 135 unique vessels in 2009, which is among the smallest fleet size, which has varied from 174 vessels in 2006 to 292 vessels in 1996 and averaged 213 vessels in the 1995-2009 period (Table 1). All Canadian vessels targeted the north Pacific albacore stock exclusively.

Fishing effort in the Canadian tuna fishery is measured as the number of vessel fishing days (v-d). The 2009 estimate of fishing effort expended in the north Pacific by the Canadian fleet is 6,631 v-d and is a 13 % increase in effort relative to effort in 2008 (Table 1). Annual fishing effort has ranged between 4,324 v-d in 1997 and 10,021 v-d in 2001, averaging 7,421 v-d since 1995. However, Canadian fishing effort for north Pacific albacore remains below the high levels recorded in the 2000-2002 period.

CPUE

The estimated catch per unit of effort (CPUE) of the Canadian fleet targeting north Pacific albacore tuna in 2009 was 857 kg/v-d and is well above the average value of 648 kg/v-d for the 1995 to 2009 period (Table 1; Figure 1). Historically Canadian CPUE for north Pacific albacore tuna has ranged between 297 kg/v-d in 1995 and 934 kg/v-d in 2006. Both catch and CPUE follow an increasing trend over the period 1995-2004, a drop in 2005 and then a leveling off from 2006 through 2009 (Figure 1). The inverse relationship between effort (measured either as the number of vessels or vessel-days) and CPUE in recent years may reflect increasing efficiency/experience of those fishers remaining in the fishery, i.e., less efficient fishermen have left the fishery leaving behind "highliners" who have better CPUEs. Since vessel and captain identifiers are recorded in the logbooks, this hypothesis can be tested through the use of GLM or other CPUE standardization methods.

CATEGORY II DATA

Distribution of Catch

Canadian vessels fishing for North Pacific albacore in 2009 operated within a latitudinal range of 37 to 52 °N and from the west coast of North America to 142° W and (Figure 2), which is approximately the same area of ocean fished in 2008 (between 40 to 53° N and as far west as 141° W). As in previous years, the majority of Canadian catch (92 % by weight) occurred in the United States EEZ, particularly in the coastal waters of Oregon, which accounted for 48% of the catch (by weight). About 7% of the total catch occurred in Canadian waters in 2009, which is lower than the 16% average for the 2000-2008 period. The remaining 1% of catch occurred in highseas waters adjacent to the USA and Canadian EEZs. The increased catch and effort (see below) in the EEZ of the USA reflect an increase in the number of vessels permitted to enter and fish these waters from 94 in 2008 (and 2006 and 2007 as well) to 110 in 2009. This increase in vessels is the result of the implementation of new terms in a renegotiated Canada-United States Pacific Albacore Tuna Treaty.

Distribution of Effort

The majority of the fishing effort (98%) by the Canadian troll fleet occurred in the coastal waters of Canada and the United States, as defined by the EEZs shown in Figure 3. This effort was primarily located off of the west coast of Washington and Oregon, and to a lesser extent the

southwest coast of Vancouver Island. Minor amounts of effort and catches were reported north of Brooks Peninsula on the west coast of Vancouver Island (Figures 2 and 3). The remaining effort (2%) occurred in highseas areas adjacent to the United States and Canadian EEZs.

CATEGORY III DATA

Bycatch

Reported bycatch in 2009 consisted of 59 yellowtail *Seriola lalandi* (averaging 2.93 kg in size) and 9 Pacific bluefin tuna (*Thunnus orientalis*) averaging 6.42 kg in size. A total of 4,289 skipjack tuna (*Katsuwonus pelamis*) were also reported by a single vessel. However these reports may be a misidentification of bonito (*Sarda chiliensis lineolata*) since skipjack were not reported by other vessels in the same area at the same time. All by-catch was retained.

Biological

After a successful pilot program in 2008, Canada implemented an on-board length sampling program in 2009. Harvesters were asked to measure and record the fork lengths (rounding down to the lowest whole number) of the first 10 fish landed on a daily basis, or as often as possible. Thirty-eight vessels participated and turned in 11,717 fork length measurements (Figure 4), which represents 1.46% of the total catch (804,781 fish) in 2009. Canadian catch landed in designated ports in Washington and Oregon may be sampled by the port sampling program collecting size composition from the USA troll fleet. Canadian size composition data from the USA port sampling program are not yet available, but are likely few in number since little catch was landed in these ports in 2009.

Based on the data submitted by the Canadian fleet, albacore in the Canadian catch ranged from 50 cm (2.63 kg) to 90 cm (15.25 kg) in size (Figure 4). One mode is present in the length frequency data at 64-66 cm (5.76 kg), corresponding to 3-yr old fish. Weights were estimated from the length-weight relationship for both sexes reported by Clemens (1961):

$$\hat{W} = 4.936 \times 10^{-8} \cdot L^{2.99},$$

where $\hat{W}$ is weight in pounds (lbs x 0.4536 = kg) and L is fork length in mm.

RESEARCH ACTIVITIES

The American Fishermen's Research Foundation tagged approximately 200 albacore off the coast of Washington with conventional dart tags in July and August 2009. Heads, dorsal fins, gonads, and stomach contents were sampled from approximately 50 specimens and stored in freezers at the Alaska Fishery Science Centre in Seattle. A contractor to Fisheries and Oceans Canada removed the otoliths from the heads of 49 fish and forwarded the otoliths and dorsal fin rays to the Sclerochronlogy Lab in Nanaimo, Canada, for aging, which began in June 2010. These structures represent a pilot project to determine appropriate techniques and assess the utility of these structures for aging albacore. Since only one otolith is required, the remaining unused otoliths will be shipped to the Southwest Fishery Science of NOAA/NMFS in La Jolla, CA, and a comparison with the Nanaimo lab will be attempted at a future date.

Nominal Canadian CPUE has risen consistently since 1995 and this increase is believed to be related to the increasing experience/adoption of satellite technology for targeting areas to fish based on SST and ocean colour, and the retirement of inexperienced/undercapitalized vessels. A small project was initiated to standardize the Canadian CPUE time series using generalized linear Bayesian models to remove this effect on CPUE were promising, but further work, based on feedback from the ALBWG, is ongoing at present.

Research in conjunction with a contractor (Marc Labelle) to model the distribution and abundance of juvenile albacore along the west coast of North America based on fishing (catch, effort latitude, longitude) and environmental data (salinity, SSH, SST, temperature at depth, temperature gradients, oxygen, lunar phase, mixed layer depth, PDO, NOI, upwelling intensity) using daily 1° x 1 ° strata was initiated. The goal is to develop a tool that uses near real-time environmental data to make short-term forecasts of the relative densities of albacore tuna in various regions. The initial model, based on GLM analysis, has shown promise, explaining 75% of the variability in reported catch (Figure 5). Further work will focus on model validation, increasing the size of the dataset for parameter estimation purposes with pooled records from both the USA and Canadian vessels (1995-2009 only), and improving the model structure for predictive and forecasting purposes with new variables such as time-lagged NOI, UPWI and PDO indices, thermocline depth, satellite data on chlorophyll concentrations and temperature fronts (gridded), actual measurements of ocean conditions during fishing activities (not OGCM predictions), and information on collaborative search practices (if any). One product from this work may be a tool that can be used to provide preseason forecasts of albacore availability within Canadian waters as a contribution to annual State of the Ocean reporting for the Pacific coast of Canada (e.g., see Crawford and Irvine 2009).

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Table 1. Annual fishery statistics for the Canadian north Pacific albacore tuna fishery, 1995-2009.

Fishing Season	Total Catch (metric tonnes)	Effort (vessel-days)	Total Unique Vessels	CPUE (kg/v-d)	Logbook Coverage[2]
1995	1,763	5,930	284	297	22%
1996	3,316	8,151	292	407	28%
1997	2,168	4,324	197	501	38%
1998	4,177	6,018	213	694	51%
1999	2,734	6,969	233	392	74%
2000	4,531	8,769	238	517	70%
2001	5,248	10,021	244	524	81%
2002	5,379	8,323	228	646	81%
2003	6,861	8,429	192	814	98%
2004	7,856	9,943	220	790	95%
2005	4,845	8,565	213	566	94%
2006	5,832	6,243	174	934	99%
2007	6,075	7,113	198	854	96%
2008	5,478	5,881	134	931	96%
2009[1]	5,685	6,631	135	857	99%
Mean	4,797	7,421	213	648	75%
Maximum	7,856	10,021	292	934	99%
Minimum	1,763	4,324	134	297	22%

[1] 2009 data are preliminary based on Ver.10.03.07 of the *Canadian Albacore Tuna Catch and Effort Relational Database* and v09.12.30 of the codebase.

[2] (Reported Catch/Expanded Catch) x 100

Table 2. Total Canadian catch (t) of north Pacific albacore tuna in FAO Statistical Areas.

	Year							
FAO Area	2002	2003	2004	2005	2006	2007	2008	2009[1]
NE Pacific (67)	5,089	6,429	7,696	4,834	5,832	6,074	5,478	5,684
NW Pacific (61)	152	341	44	11	0	0	0	0
EC Pacific (77)[2]	138	91	102	0	0	1	0	1
Total	5,379	6,861	7,842	4,845	5,832	6,075	5,478	5,685

[1] Preliminary 2008 data obtained with codebase Version 09.12.30 and Version 10.03.07 of the *Canadian Albacore Tuna Catch and Effort Relational Database*.

[2] Excludes catch data from south of the equator.

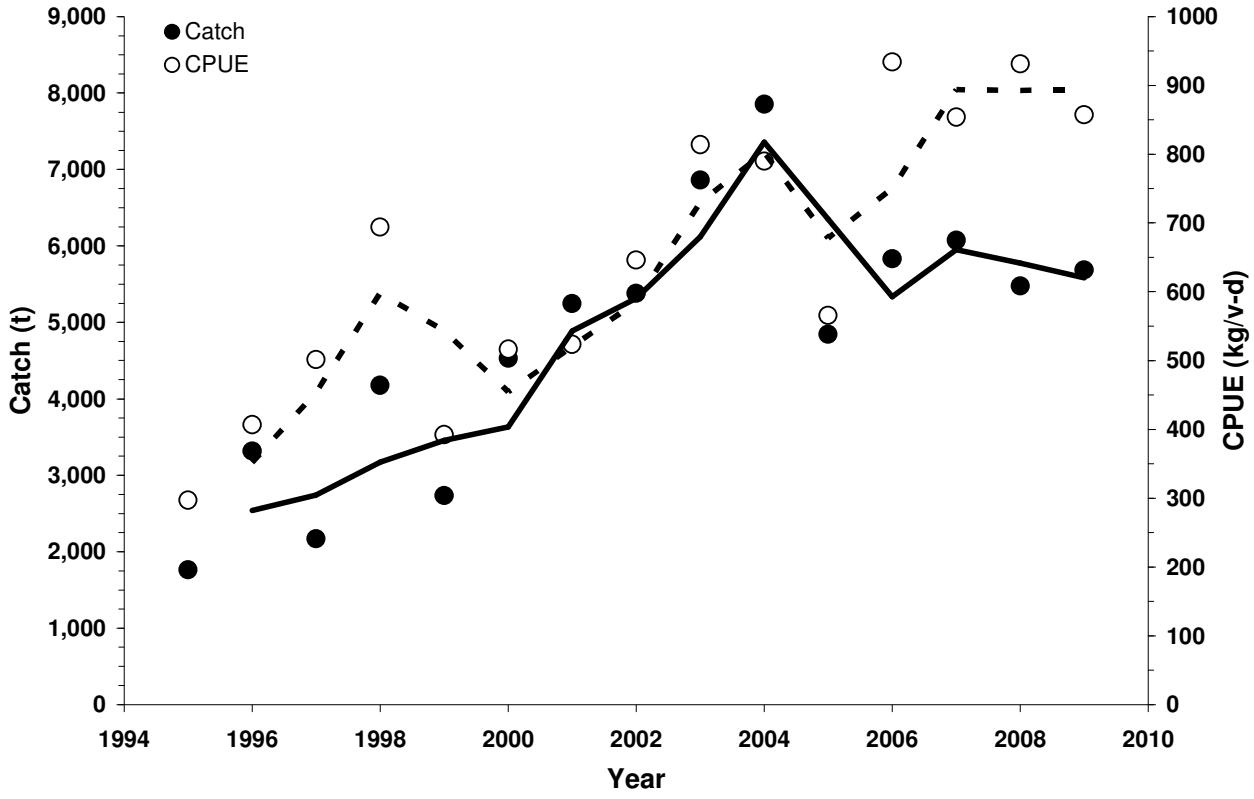

Figure 1. Canadian north Pacific albacore troll catch (●) and catch-rates (CPUE) (○) from 1995 to 2009. Lines are 2-yr moving averages of catch (▬) and CPUE (– –).

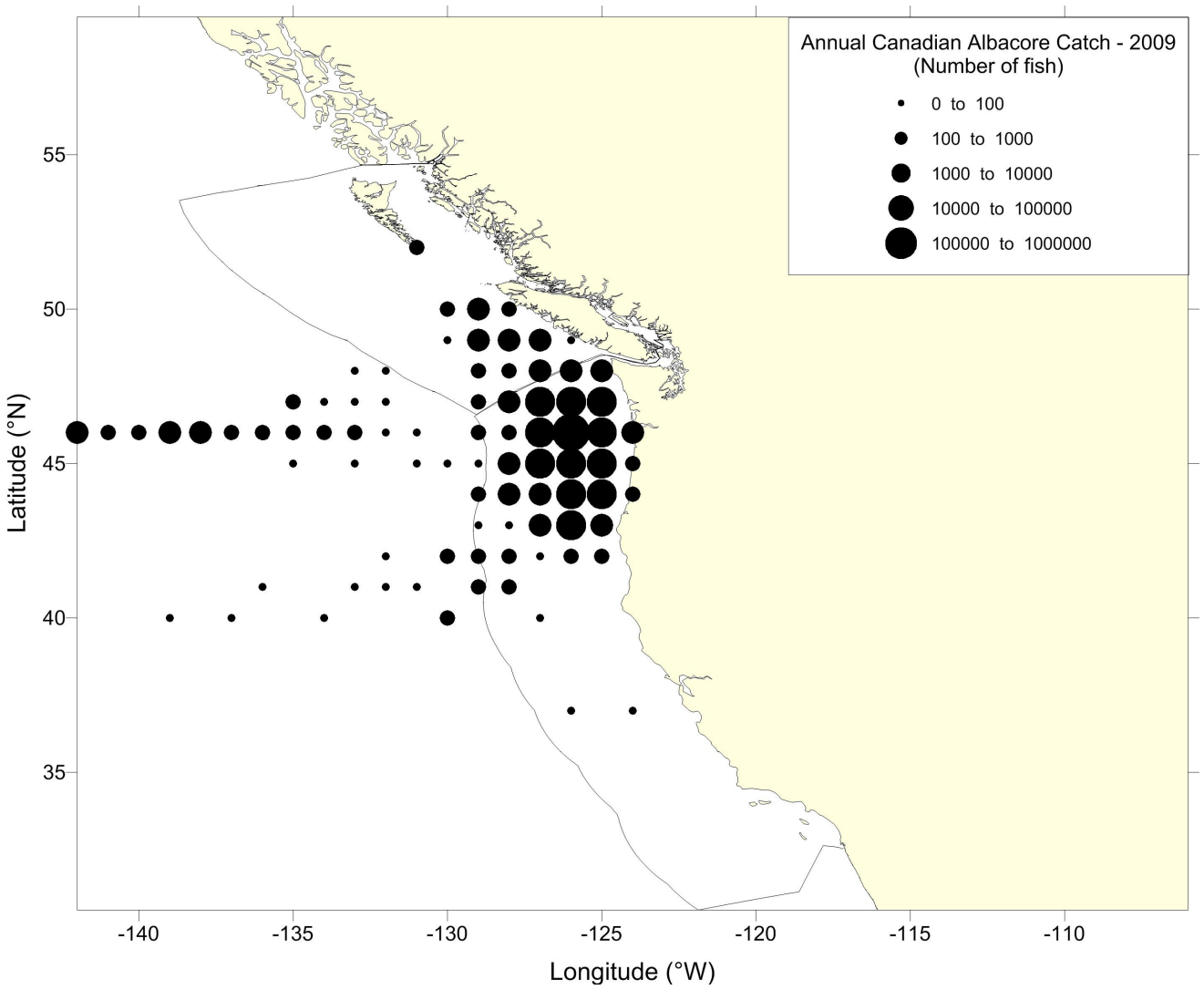

Figure 2. Distribution of the Canadian north Pacific albacore tuna troll fishery catch (Number of fish) in 2009. Data are plotted on a 1° x 1° grid with symbols located on the bottom-right corner of each grid cell. Size of the symbol is proportional to the catch. The plot also shows the boundaries of the Canadian and United States exclusive economic zones (200-mile limit).

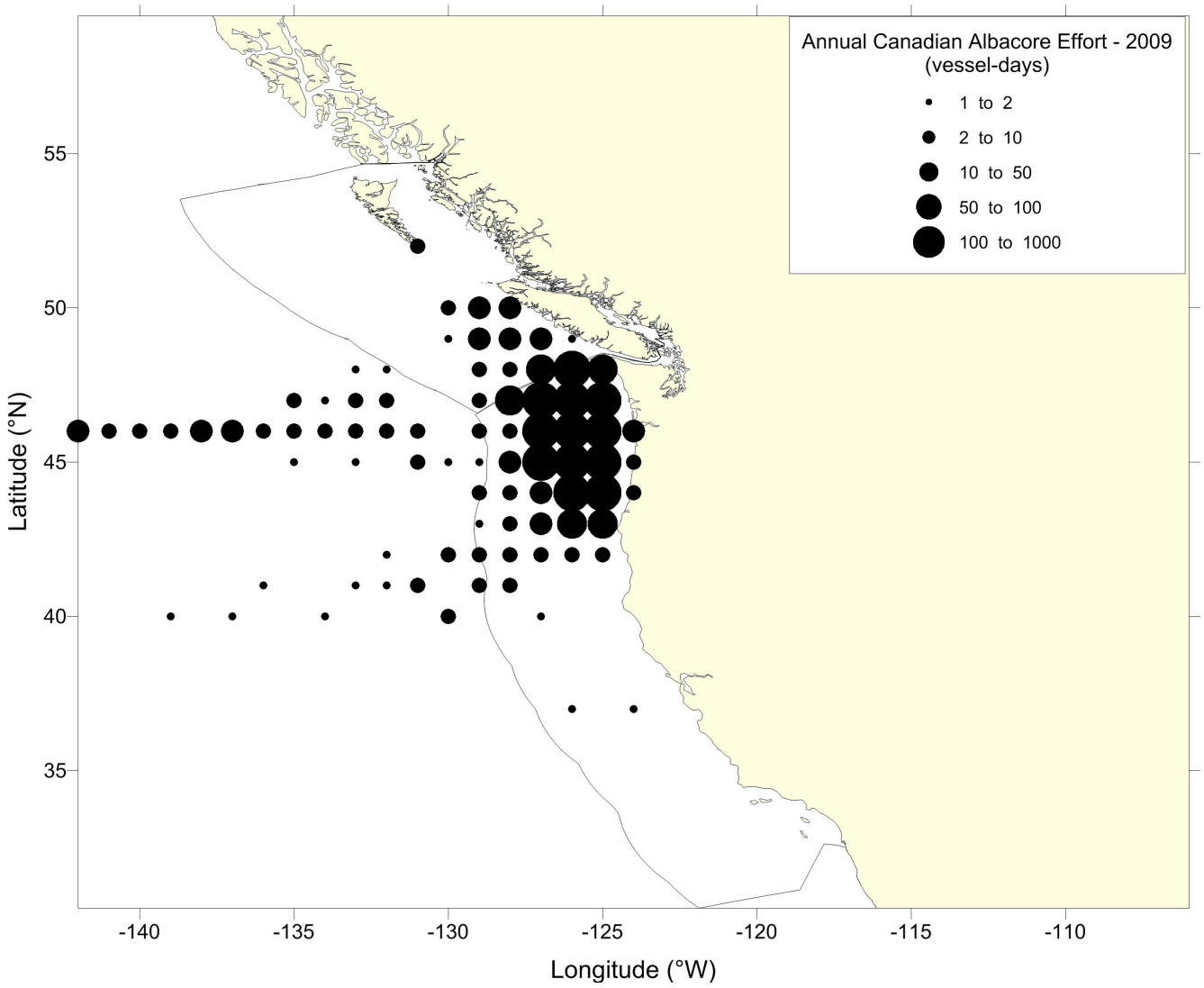

Figure 3. Distribution of the Canadian north Pacific albacore tuna troll fishery effort (vessel-days) in 2008. Data are plotted on a 1° x 1° grid with symbols located on the bottom-right corner of each grid cell. Size of the symbol is proportional to effort. The plot also shows the boundaries of the Canadian and United States exclusive economic zones (200-mile limit).

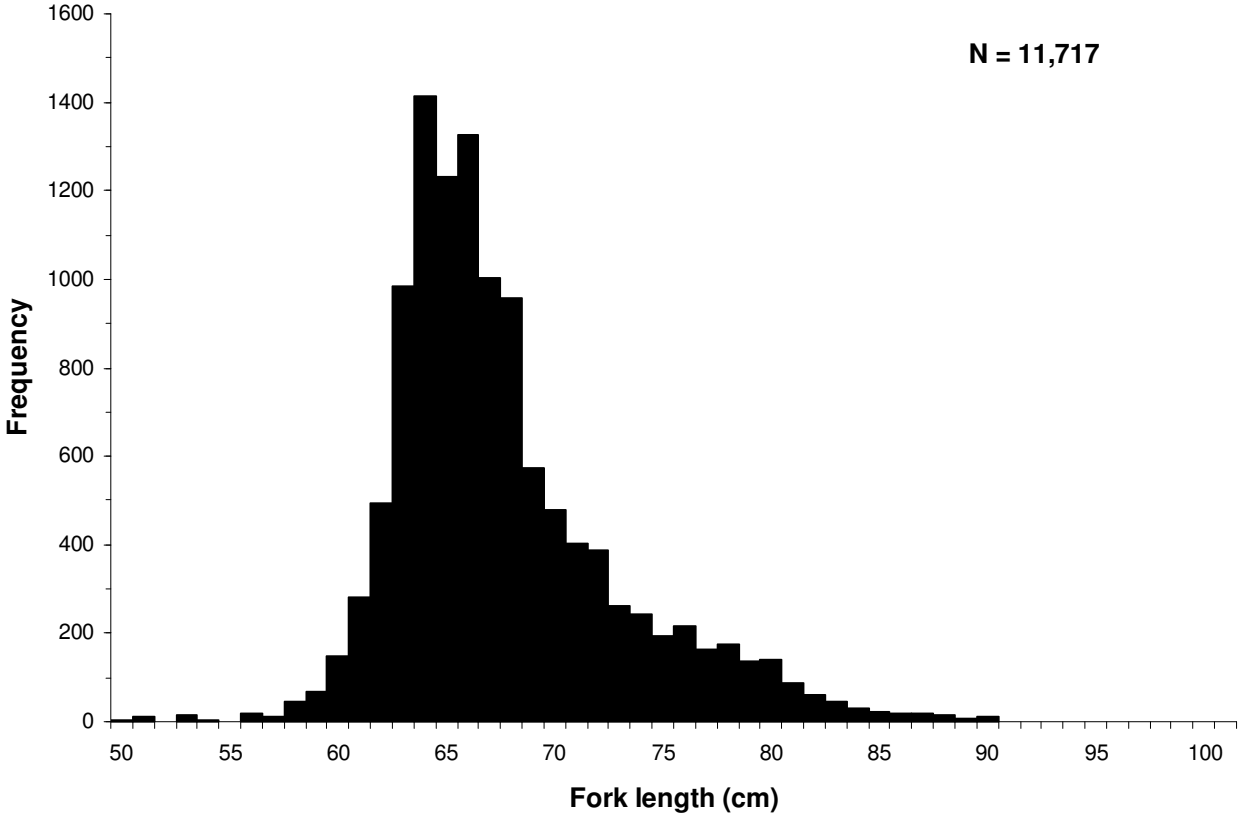

Figure 4. Fork lengths of North Pacific albacore harvested by the Canadian fishery in 2009 and recorded on board by harvesters.

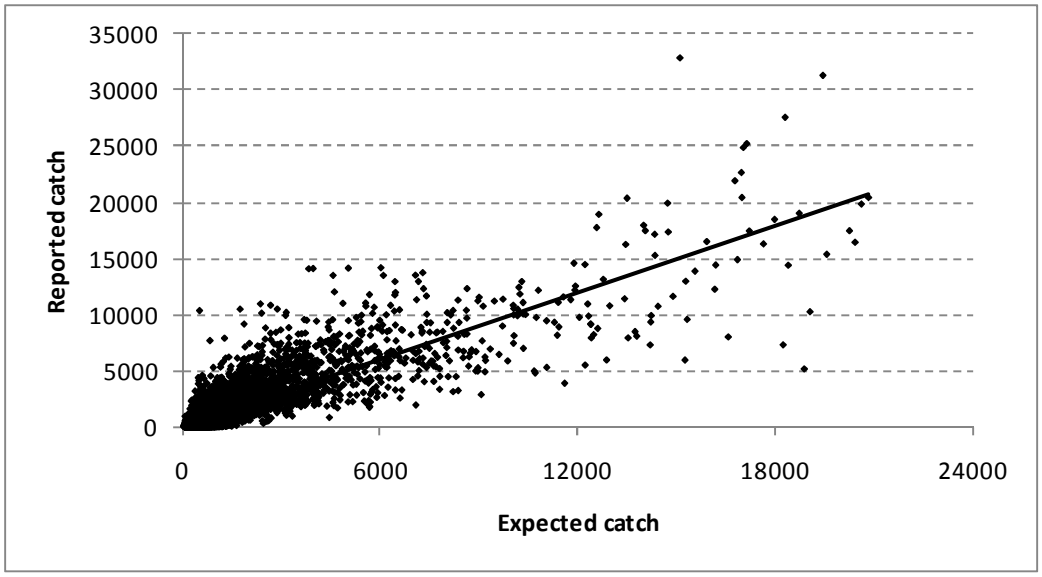

Figure 5. Reported versus expected catches (pooled by time/area stratum) based on the full GLM model. Linear regression line shown for reference purposes only. $R^2 = 0.7454$.