16th Meeting of the
International Scientific Committee
for Tuna and Tuna-Like Species in the North Pacific Ocean
Sapporo, Hokkaido, Japan
13-18 July 2016

Canadian Tuna and Tuna-like Fisheries in the North Pacific Ocean in 2015[1]

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July 2016

[1] Prepared for the Sixteenth Meeting of the International Scientific Committee on Tuna and Tuna-like Species in the North Pacific Ocean (ISC), 13-18 July 2016, Sapporo, Hokkaido, Japan. Document not to be cited without permission of the author.

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SUMMARY

Canada has one fishery for highly migratory species in the Pacific Ocean, a troll fishery targeting juvenile north Pacific Albacore Tuna (*Thunnus alalunga*). Category I, II, and III data from the 2015 fishing season are summarized in this report. The Canadian fleet consisted of 164 vessels and operated exclusively within the eastern Pacific Ocean. Provisional 2015 estimates of catch and effort are 4,334 metric tonnes (t) and 5,197 vessel-days, respectively, which represent a 9% decrease in catch and 9.5% increase in effort relative to 2014. Catch and effort were split primarily between Canadian waters (67% of the catch and 73% of the effort) and US waters (33% of the catch and 27% of the effort) while the remaining catch and effort occurred in adjacent high seas waters. About 97% of the catch occurred in a sea surface temperature band of 15-18 °C. Fifty-nine (59) vessels measured 13,228 fork lengths on 139 trips in 2015 for a sampling rate of 1.76% of the reported catch. Fork lengths (FL) were dominated by a single mode single mode at 64-68 cm FL in all three fishing zones corresponding to 2-year old fish. There was a distinct shift in the size composition of the catch towards fish smaller than 69 cm in 2015. The Canadian troll fishery continues to be largely coastal in its operations, occurring almost exclusively within the Canada and United States exclusive economic zones. Very little catch and effort occurred outside the Canadian and United States EEZs in 2015.

1.0 INTRODUCTION

The Canadian fishery for highly migratory species uses troll gear with jigs to target juvenile north Pacific Albacore (*Thunnus alalunga*) in the surface waters of the Pacific Ocean. The majority of catch and effort by the Canadian fleet occurs within the exclusive economic zones (EEZ) of Canada and the United States. Access to the United States EEZ is permitted through a bilateral Treaty, which provides for access by Canadian-flagged and licensed vessels to fish for Albacore and to land Albacore catches at designated ports. Some of the larger Canadian vessels follow Albacore Tuna concentrations into offshore waters and may occasionally fish in the central and western Pacific Ocean. Management regulations for Canadian vessels fishing Albacore Tuna for a 3 year period from 01 April 2015 to 31 March 2017 are documented in the Albacore Tuna Integrated Fisheries Management Plan (IFMP) http://www.pac.dfo-mpo.gc.ca/fm-gp/mplans/2015/tuna-thon-sm-2015-eng.pdf. Historically the majority of catch and effort for north Pacific Albacore Tuna has occurred from early July to the end of October**.**

This report summarizes Category I (annual catch and effort), Category II (annual 1° x 1° catch and effort data), and Category III (bycatch, catch size composition) data for vessels active in the Canadian north Pacific Albacore Tuna troll fishery in 2015. This report also provides information on scientific research conducted by Fisheries and Oceans Canada (DFO) in support of resource conservation and management both domestically and internationally, including stock assessment, biological and oceanographic studies.

2.0 DATA SOURCES

Data on Albacore Tuna catch and effort from 1995 through to the present are compiled from hail records, logbooks, and sales slips and stored in the Canadian Albacore Tuna Catch and Effort Relational Database (Stocker et al. 2007). This database generates the best available estimates of total annual catch and effort by geographic zone (Canadian, US, and high seas waters) for the Canadian fishery. All Canadian fishing vessels are required to hail (call) a third party service provider when they intend to start fishing and stop fishing, and when they change fishing zones. Canadian vessels must also carry logbooks in which daily position, catch and effort (latitude, longitude, number of fish, estimated weight) are recorded for Albacore Tuna and non-target species. These data have the highest temporal and spatial resolution and are obtained when logbooks are returned in November after the fishing season is completed. The third data source, sales slips, record the weight of Albacore Tuna landed and bought by domestic buyers and provide the most accurate estimates of Albacore Tuna catch in weight since these data are the basis for payment to harvesters (Stocker et al. 2007). Logbooks and sales slips from domestic buyers (plus trans-shipment slips if applicable) are forwarded for entry into the Albacore Tuna catch database (Stocker et al. 2007).

Fork length data are collected by fishermen through an on-board sampling program initiated in 2009, with a sampling goal of 1% of the reported catch. Harvesters record the lengths of the first 10 Albacore Tuna landed on a daily basis in their logbooks to randomize measurements. Size composition data were collected by US port samplers from a portion of the Canadian catch landed in United States ports specified in the bilateral Canada-United States Albacore Tuna Treaty between 1981 and 2008. Fork length data reported by Canada since 2009 to the present are from the domestic on-board sampling program only.

The fishery data provided in this report were taken from Canadian tuna database version 16.05.25. Figures up to and including 2014 are considered definitive and are derived from a reconciliation of logbook data (best estimates of effort, catch in pieces, and geographic location) and sales slip (best estimate of catch weight) data (Stocker et al. 2007). The 2015 catch and effort data are preliminary at this time.

3.0 AGGREGATED CATCH AND EFFORT DATA

3.1 Catch

The preliminary estimate of the Canadian Albacore Tuna catch in 2015 is 4,334 metric tons (t) and is a 9% decrease relative to catch in 2014 (Table 1; Figure 1). The total catch by the Canadian troll fishery has ranged from 1,761 t in 1995 to 7,857 t in 2004 and averaged 5,474 ± 1,306 (± sd) t since 2003, the period when logbook coverage has exceeded 90% of all vessels participating in this fishery. The 2015 catch was distributed among Canadian coastal waters (66.6%) and United States coastal waters (33.3%), while catch in adjacent high seas waters was minimal (0.1%). Forty-five (45) Canadian vessels were permitted to fish in the coastal waters of the United States in 2015, but only 43 vessels entered the US EEZ and fished.

The number of Albacore released has increased since 2013 (Table 2) to an estimated 14.6 t in 2015. These figures are not included in Table 1, which records retained catch only. Released Albacore are fish below a threshold size of about 3.18 kg (7 lbs), which is considered too small to be marketable. Releases of Albacore have been recorded for this fishery historically, but these releases have usually amounted to 20-50 kg in a year and have been reported by vessels operating within the US EEZ off of California. The releases reported since 2013 are larger and are occurring off of Oregon, Washington and British Columbia, i.e., further north than in the past.

3.2 Effort

The Canadian Albacore Tuna troll fleet consisted of 164 unique vessels in 2015, a increase of about 2.5% in participation relative to 2014, but below the average participation rate of 177 vessels since 2003 (Table 1). The 2015 estimate of fishing effort is 5,197 v-d and is a 9.5% increase in effort relative to 2014 (Table 1; Figure 1). Fishing effort in 2015 was split between Canadian coastal waters (73%), United States coastal waters (26.6%), and adjacent high seas waters (0.3%). Annual fishing effort has ranged between 4,320 v-d in 1997 and 10,021 v-d in 2001, averaging 6,971 ± 1,517 v-d since 2003.

4.0 SPATIAL DISTRIBUTION OF CATCH AND EFFORT DATA

The Canadian troll fleet operated within a 10° latitudinal band between 44 and 54°N and primarily within the EEZs of Canada and the United States in 2015 (Figures 2 and 3). This coastal oriented spatial distribution is consistent with the pattern of operation observed in the last decade. The Canadian fishery operated exclusively within the Inter-American Tropical Tuna Commission (IATTC) convention area east of 150°W and north of the equator. No effort or catch were made in the Western and Central Pacific Fisheries Commission (WCPFC) convention area west of 150°W in 2015, continuing a trend that began in 2005 of concentrating effort and catch in the eastern Pacific Ocean (EPO). More than 99% of the 2015 fishing effort and catch occurred within the coastal waters of Canada and the United States, although the proportion of effort and catch occurring within United States waters continues to decline (26.6% and 33.4%, respectively) than average (66% of effort and catch) for the 1995 to 2011 period. This decline in fishing effort and catch relative to historical levels prior to 2012 is the result of the fishing regime in the bilateral Albacore Tuna treaty negotiated for 2013 and adopted for a three-year period beginning in 2014.

Monthly effort and catch shifted from waters in the US EEZ south of 47°N in June to predominately north of 48°N in the Canadian EEZ and remained distributed throughout the Canadian EEZ until the fishery terminated in October (Figures 2 and 3).

Albacore were caught in waters with sea surface temperatures ranging between 13 and 21 °C in 2015, but 97% of the fish were harvested in waters within the15-18 °C temperature band (Figure 4).

Nominal catch rates in 2015 peaked well above average in mid-July and then exhibited a consistent decline through August and September and were below average just before the fishery terminated in October (Figure 5). The 2015 CPUE pattern is similar to the pattern in 2014, except for a secondary peak in mid-September 2014 due to a northward shift in catch and effort near the BC-Alaska border. Both the 2014 and 2015 CPUE patterns are compressed relative to the average CPUE, reflecting a reduction in fishing season length and both exhibit catch rates well above average for extended periods of time during the primary fishing months (July, August, September) for the Canadian fleet.

5.0 BIOLOGICAL DATA

5.1 By-Catch

Reported by-catch was 24 fish and seven species in 2015 (Table 3), of which 58% were retained. Yellowtail (*Seriola lalandi*) was the most commonly retained species followed by Yellowfin Tuna (*T. albacares*). Shortfin Mako Shark (*Isurus oxyrinchus*) and Silky Shark (*Carcharhinus falciformis*) were the most commonly released species. Other by-catch species include Blue Shark (*Prionace glauca*), Bonito (*Sarda chilensis*), and Pacific Bluefin Tuna (*T. orientalis*). Total weight of all retained by-catch is estimated to be approximately 85 kg and total estimated weight of released by-catch is 252 kg, of which the Blue, Shortfin Mako and Silky Sharks accounted for 95% of the released biomass.

5.2 Biological

Fifty-nine (59) vessels measured 13,228 fork lengths on 139 trips in 2015 (Figure 6), representing a sample rate of 1.76% of the reported catch. This sampling rate is above the target of 1.0% of the reported catch. The amount of length sampling in the three fishing zones (Canada - 80%; United States waters - 19%; high seas - 1%) was not proportional to the fishing effort in each zone.

Albacore in the Canadian catch ranged from 45 cm to 107 cm fork length (FL) in size (Figure 6), which is slightly larger than the size range reported in previous years (see Holmes 2011, 2012, 2013, 2014, 2015). The size data are dominated by a single mode at 64-68 cm FL in all three fishing zones corresponding to 2-year old fish. There was a distinct shift in the size composition of the catch towards smaller fish in 2015 as shown by the proportion of fish smaller than 69 cm in 2015 relative to 2014 (Figure 5). This shift is consistent with the increase in releases of small Albacore in 2015 (Table 2), which occurred about equally in the Canadian and United States zones, and anecdotal reports from fishermen on the abundance of small fish that were not marketable.

6.0 DISCUSSION

The 2015 Canadian troll fishery fished almost exclusively within the Canadian and United States EEZs. In addition, there was pronounced northward shift in Albacore Tuna distribution within Canadian waters in the latter part of the fishing season (Figures 2 and 3), assuming that the distribution of effort and catch is somewhat representative of the underlying fish distribution. The hypothesis of a northward change in fish distribution is supported the increase in releases of small non-marketable albacore since 2013 (Table 2) especially in waters of Washington and Canada, and by a distinct shift towards smaller fish in the size frequency data sampled from the Canadian catch.

The terms of the fishing regime in the Canada-United States bilateral Pacific Albacore Tuna Treaty continue to influence Canadian fishery operations. The fishing regime currently in effect limits the number of Canadian vessels in US waters to 45 from June 15 to September 15 annually for 2014 to 2017. As a result, fishing operations have shifted, with increasing proportion of effort and catch in Canadian waters relative to the period prior to 2012. This increased emphasis on fishery operations in Canadian waters appears to have coincided with a northward shift in fish distribution into Canadian waters. Hypotheses to address this distributional change are under investigation.

A recreational fishery for Albacore Tuna is developing off the west coast of Vancouver Island. This fishery consists of both charter-boat and private boat components. Two methods have been used in attempts to collect information on recreational catch and effort: (1) a logbook program for the major charter-boat operators and fishing lodges along the west coast of Vancouver Island, and (2) a web-based survey of recreational anglers that purchased a licence to fish in tidal waters (e.g., see DFO 2015). The estimated catches and effort for 2013 to 2015 are under investigation to resolve differences between methods. The majority of fishing effort and catch appear to occur in the June to September period (consistent with the commercial fishery) and most of the effort occurs on the seaward side of the continental slope off the southwest coast of Vancouver Island. The recreational catch and effort data are

not included in the tables and figures in this report because they are highly uncertain. Once the differences in methodology and resulting estimates are resolved satisfactorily, these data will be incorporated into Canada's data reporting.

7.0 RESEARCH

Canadian highly migratory species research in the Pacific Ocean has focused on improving understanding of the biology and ecology of north Pacific Albacore Tuna to enhance assessments of the effects of fishing and the environment on stock dynamics and status. The studies highlighted below have recently been completed or are ongoing and are conducted largely in cooperation with stakeholders and in collaboration with both Canadian and international colleagues.

A simple modeling exercise was conducted to evaluate the potential effects of anthropogenically caused warming on Albacore Tuna thermal habitat (defined by logbook data) in Canadian waters of the north Pacific Ocean. Potential new habitat is about half a million km^2 even under a moderate mitigation scenario. Estimates are smaller for some months of the year in which the fishery is conducted, but as well as opening up habitat that is currently not exploited by Albacore, there is considerable scope for extending the length of season in which the fishery is active in the northern part of the range. However, much of the potential new habitat is in oceanic waters with relatively low productivity. Our estimated area of potential habitat is based on the fish's thermal niche and assumes that other biologically important factors such as food will not be limiting.

Publications

Christian, J.R., and Holmes, J.A. Expansion of albacore tuna habitat in the northeast Pacific Ocean under anthropogenic warming. Fish. Oceanogr. (*Accepted for publication 13 May 2016*).

Chen, E., and Holmes, J.A. 2015. Manual of best practices for age determination of north Pacific Albacore Tuna. Can. Tech. Rep. Fish. Aquat. Sci. 3145: v + 28 p. http://waves-vagues.dfo-mpo.gc.ca/Library/360625.pdf

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Kleiber, P., and Perrin, C. 1991. Catch-per-effort and stock status in the U.S. north Pacific albacore fishery: reappraisal of both. Fish. Bull., US. 89: 379-386.

Stocker, M., H. Stiff, W. Shaw, and A.W. Argue. 2007. The Canadian albacore tuna catch and effort relational database. Canadian Technical Report of Fisheries and Aquatic Sciences 2701: vi+76 p.

Table 1. Fishery statistics from the Canadian troll fishery for north Pacific Albacore Tuna, 1995-2015. Catch and effort data are expanded or raised to account for vessels that do not report logbook data. The level of expansion can be determined by the logbook coverage figures.

Year	Total Catch (t)	Effort (vessel-days)	Total Vessels	Logbook Coverage[2] (%)
1995	1,761	5,923	287	18%
1996	3,321	8,164	295	24%
1997	2,166	4,320	200	30%
1998	4,177	6,018	214	50%
1999	2,734	6,970	238	71%
2000	4,531	8,769	243	68%
2001	5,249	10,021	248	81%
2002	5,379	8,323	232	74%
2003	6,847	8,428	193	96%
2004	7,857	9,942	221	92%
2005	4,829	8,564	213	94%
2006	5,833	6,243	174	95%
2007	6,040	6,902	207	92%
2008	5,464	5,774	137	93%
2009	5,693	6,540	138	97%
2010	6,527	7,294	161	96%
2011	5,385	8,556	176	99%
2012	2,484	5,974	174	100%
2013	5,088	6,465	183	99%
2014	4,780	4,745	160	100%
2015[1]	4,332	5,194	164	99%

1. 2015 data are preliminary based on Ver.16.05.25 of the *Canadian Albacore Tuna Catch and Effort Relational Database*. See Stocker et al. (2007) for a description of the database.
2. Logbook coverage = Number of vessels reporting logbooks/Total number of vessels fishing based on all data sources (sales slips, logbooks, hail records) in database Ver. 15.02.17 for 1995-2014.

Table 2. Releases of Albacore below marketable size (3.18 kg) reported by the Canadian Albacore fishery.

Year	Number of Fish	Total Weight (kg)
2013	289	918
2014	2,214	7,153
2015	42283	14,550

Table 3. Reported catch of non-target species (by-catch) by the Canadian Albacore Tuna troll fishery in 2015.

			Catch (Number of fish)	
Month	Common name	Scientific Name	Retained	Released
July	Pacific Bluefin Tuna	*Thunnus orientalis*		1
	Shortfin Mako Shark	*Isurus oxyrinchus*		3
	Yellowtail	*Seriola lalandi*	1	
August	Bonito	*Sarda chiliensis*	1	1
	Shortfin Mako Shark	*Isurus oxyrinchus*		3
	Silky Shark	*Carcharhinus falciformis*		1
	Yellowfin Tuna	*Thunnus albacares*	2	
	Yellowtail	*Seriola lalandi*	4	
September	Blue Shark	*Prionace glauca*		1
	Pacific Bluefin Tuna	*Thunnus orientalis*	1	
	Yellowtail	*Seriola lalandi*	5	
		TOTALS	14	10

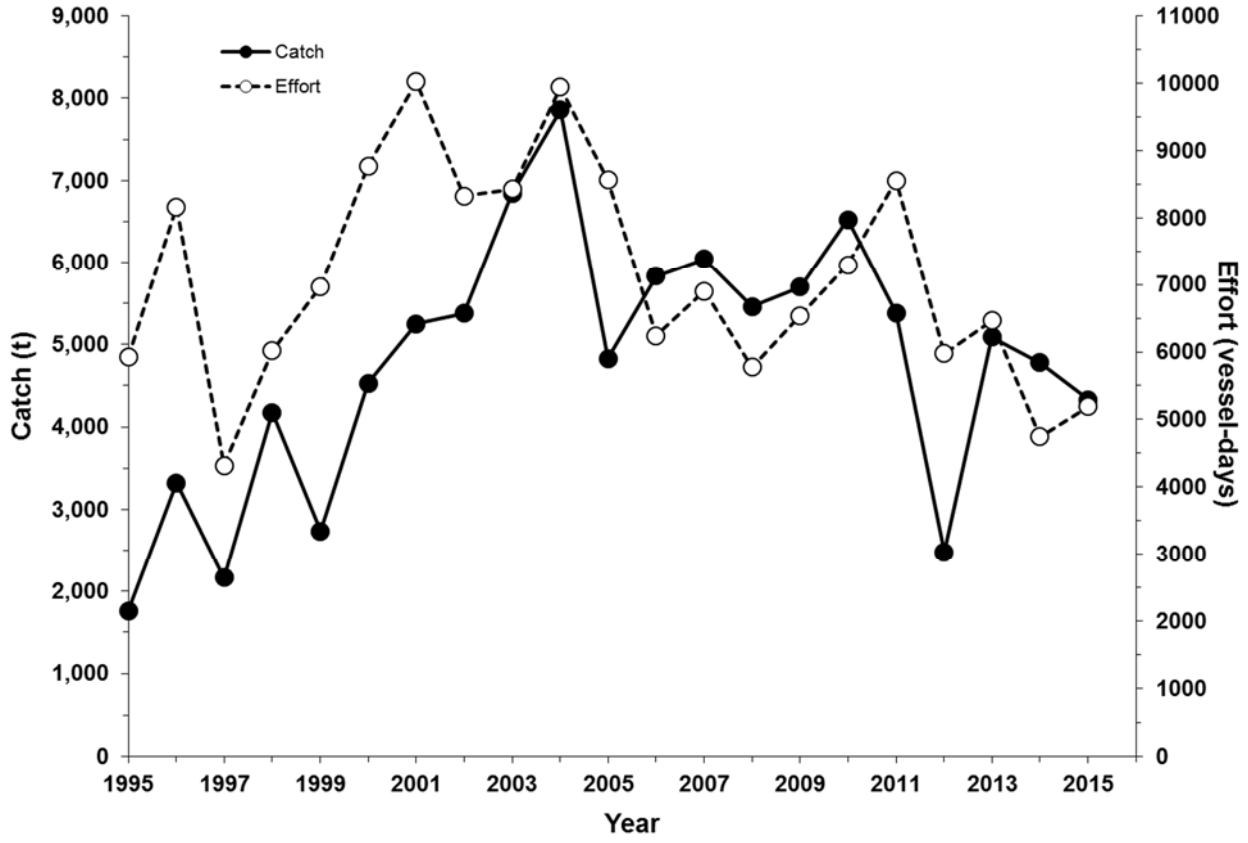

Figure 1. Historical trends in expanded catch and effort in the Canadian troll fishery for north Pacific Albacore Tuna from 1995 to 2015.

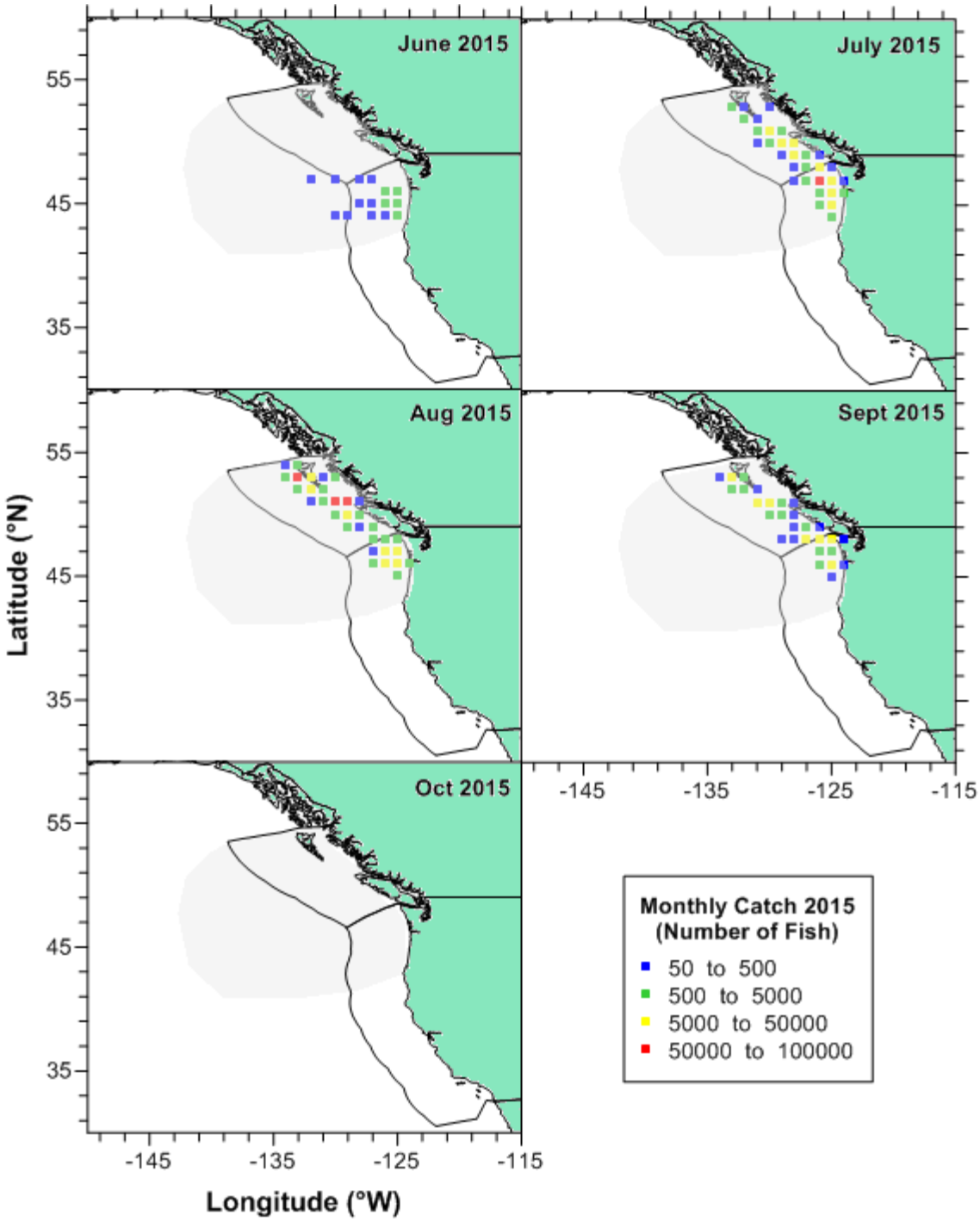

Figure 2. Monthly spatial distribution of reported catch in Canadian Albacore Tuna troll fishery in 2015. Data are plotted on a 1° x 1° strata with symbols located on the bottom-right corner of each stratum. Strata in which fewer than three vessels reported are not shown. Grey area is the approximate operational area of the Canadian fishery in 2015.

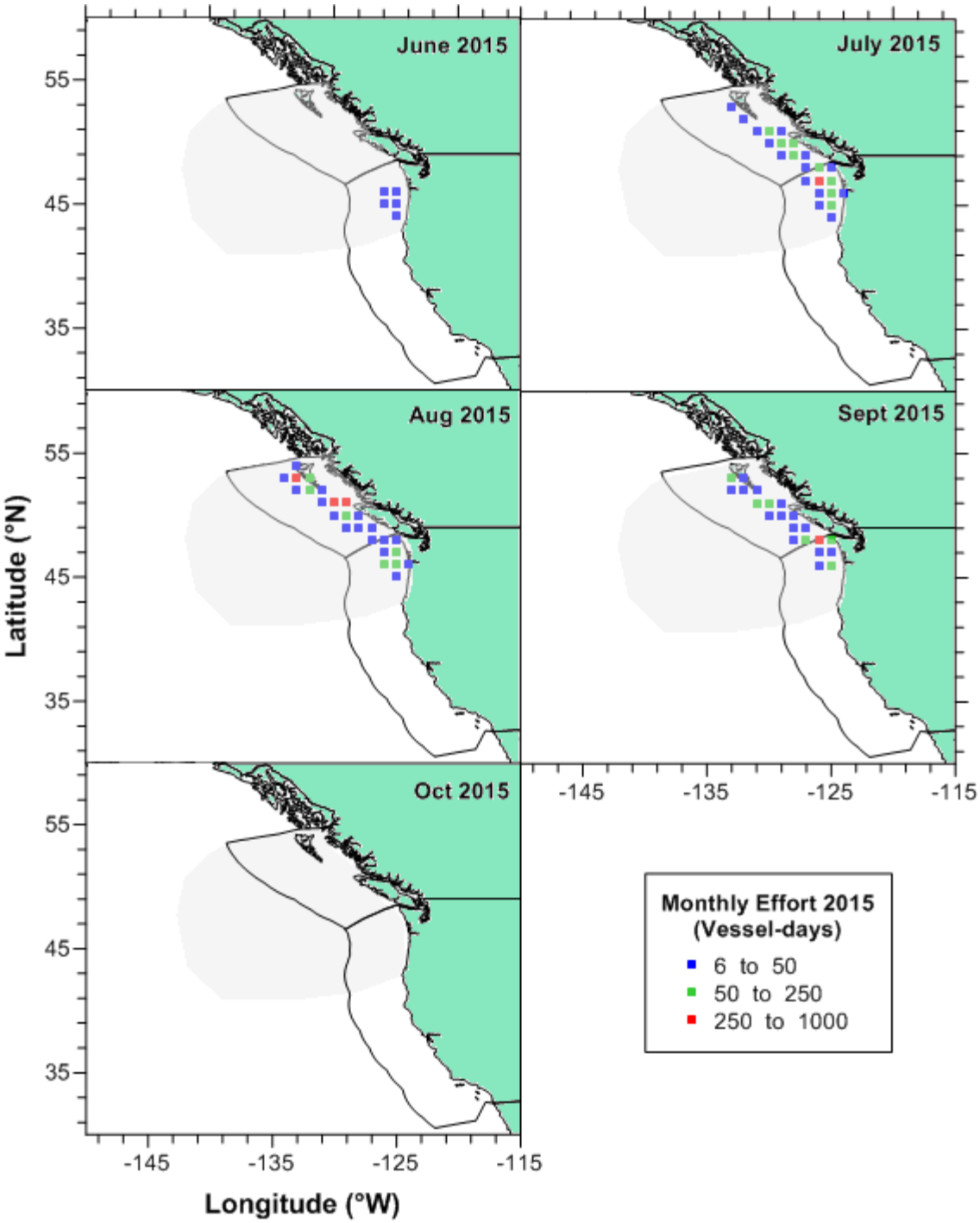

Figure 3. Monthly spatial distribution of effort by the Canadian Albacore Tuna troll fishery in 2015. Data are plotted on 1° x 1° strata with symbols located on the bottom-right corner of each stratum. Strata in which fewer than three vessels reported are not shown. Grey area is the approximate operational area of the Canadian fishery in 2015.

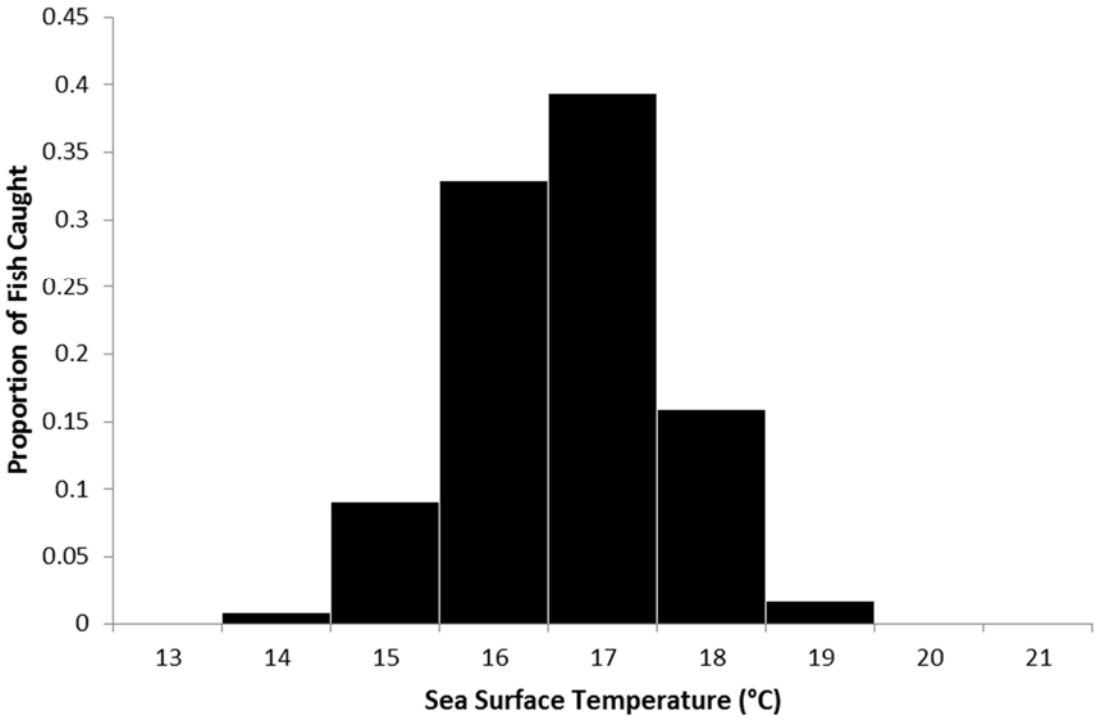

Figure 4. Sea surface temperatures at which Albacore Tuna were caught by the Canadian troll fishery in 2015. Plot is based on N = 671,123 fish with associated water temperature data reported in logbooks.

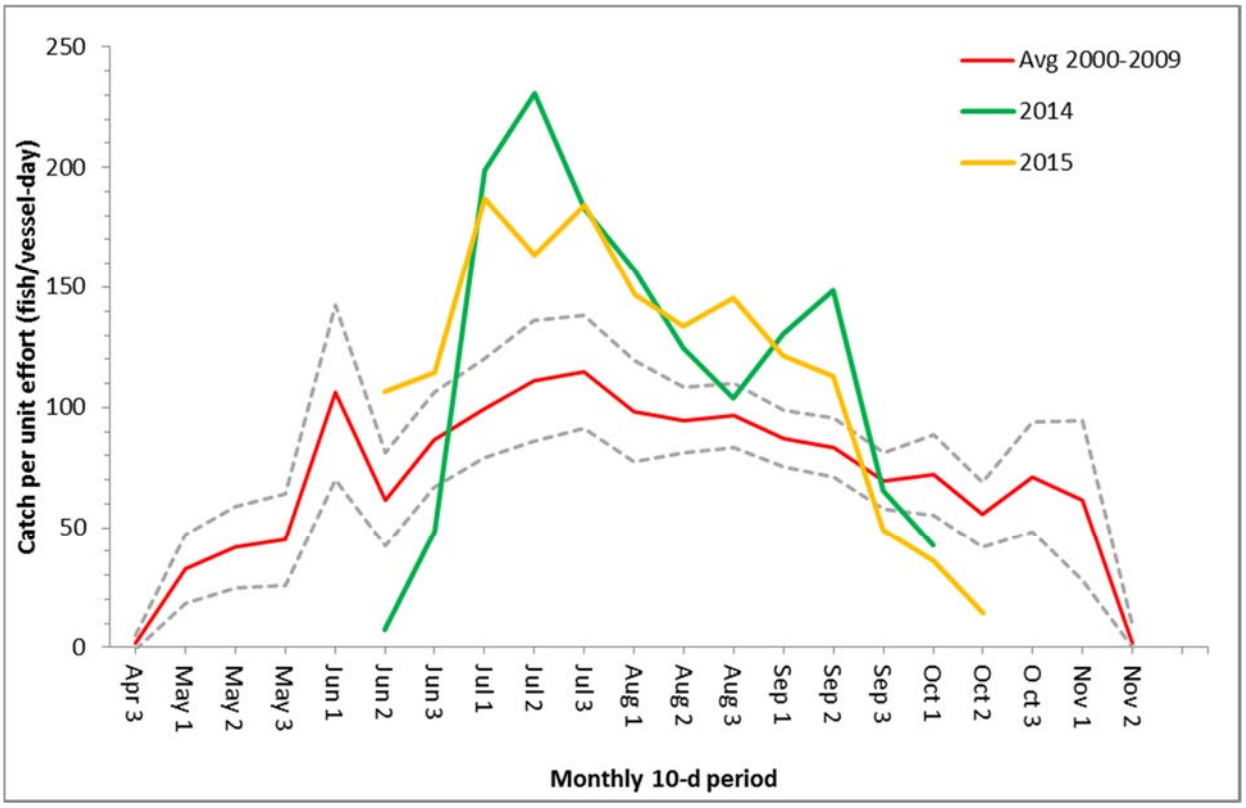

Figure 5. Nominal catch per unit effort for 10-day periods of the Canadian fleet averaged for 2000-2009 compared to the 2014 and 2015 fishing seasons. Each data point is the average of all 1°x1° spatial strata in which effort occurred during one of three 10-day periods in a month. The grey dashed lines are the lower and upper 95% confidence interval around the average CPUE "climatology". See Kleiber and Perrin (1991) for CPUE calculation details.

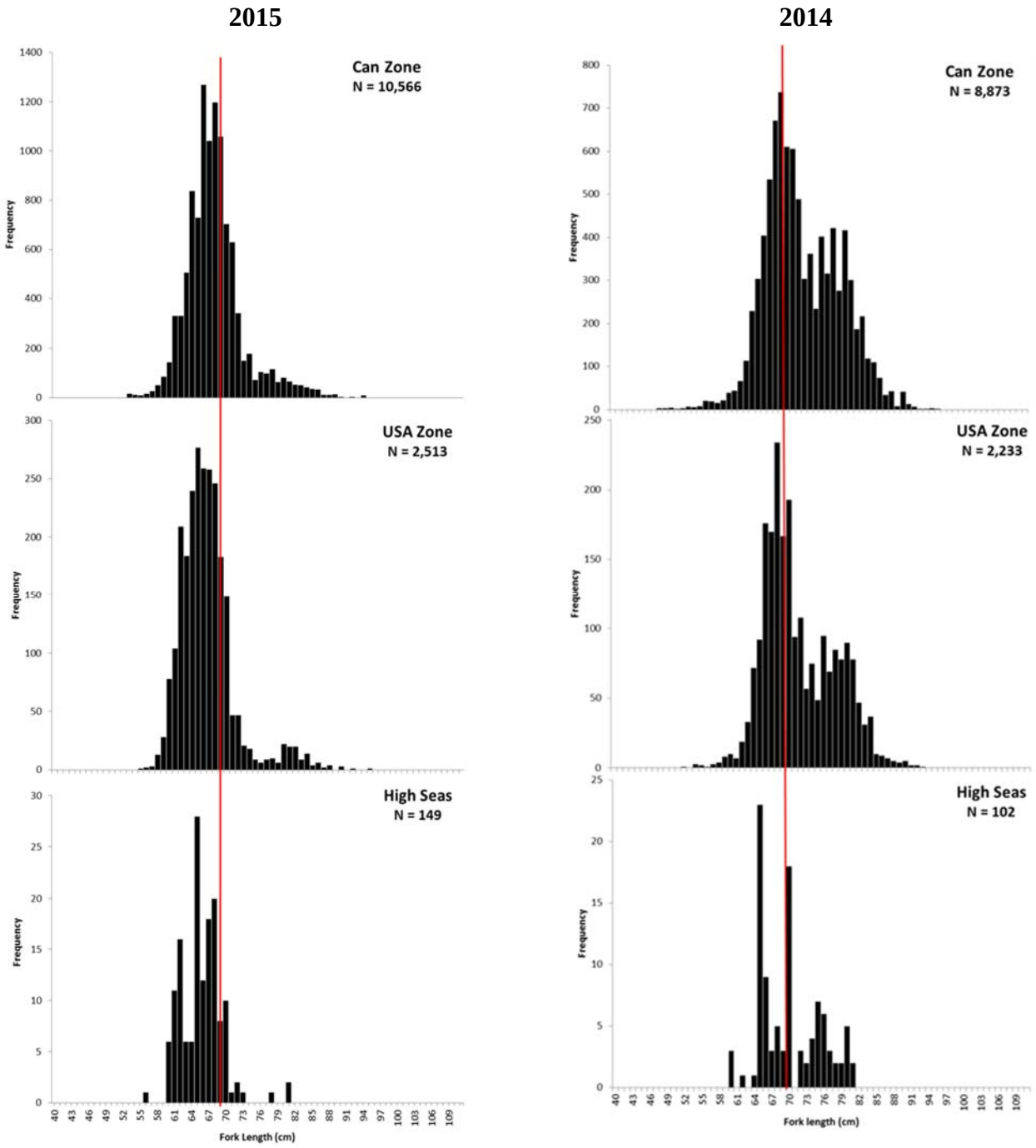

Figure 6. Fork lengths of North Pacific Albacore Tuna harvested by the Canadian troll fishery in 2014 and 2015. The vertical red line is placed at a fork length of 69 cm for comparison between years.