

## UPDATED SEX- AND AGE-SPECIFIC CPUE FROM THE CANADIAN SWORDFISH LONGLINE FISHERY, 2002-2011

Irene Andrushchenko<sup>1</sup>, Alex R. Hanke, and John D. Neilson

### SUMMARY

*Sex- and age-specific nominal indices of relative abundance for North Atlantic swordfish caught by the Canadian pelagic longline fishery are updated with 2011 data, as well as partial year 2012 information. The trend in CPUE indicates that relative abundance for 2011 has decreased slightly from 2010 levels, but remains above levels seen throughout the 1990s and early 2000s.*

### RÉSUMÉ

*Des indices nominaux de l'abondance relative spécifiques du sexe et de l'âge pour l'espadon de l'Atlantique Nord capturé par la pêcherie palangrière pélagique du Canada sont actualisés avec les données de 2011, ainsi qu'avec des informations partielles au titre de 2012. La tendance de la CPUE indique que l'abondance relative au titre de 2011 a légèrement chuté par rapport aux niveaux de 2010, mais qu'elle demeure au-dessus des niveaux observés tout au long des années 1990 et au début des années 2000.*

### RESUMEN

*En este documento se actualizan los índices nominales de abundancia relativa específicos de la edad y el sexo para el pez espada del Atlántico norte capturado por la pesquería de palangre pelágico canadiense con los datos de 2011, así como con información parcial para el año 2012. La tendencia en la CPUE indica que la abundancia relativa para 2011 ha descendido ligeramente desde los niveles de 2010, pero sigue situándose por encima de los niveles observados durante los noventa y primeros años de la década del 2000.*

### KEYWORDS

*Catch/effort, logbooks, commercial fishing, pelagic fisheries, tunas*

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<sup>1</sup> Fisheries and Oceans Canada, St. Andrews Biological Station, 531 Brandy Cove Road, St. Andrews, New Brunswick, E5B 2L9, Canada; Email: Irene.Andrushchenko@dfo-mpo.gc.ca

## 1. Introduction

The last assessment of North Atlantic swordfish by the International Commission for the Conservation of Atlantic Tunas (ICCAT) was done in 2009, and presented age-specific catch rate indices (ages 2 to 5+) from the Canadian pelagic longline fleet between 1988 and 2008 (Anon. 2010). This manuscript reports the nominal catch rates for the unisex population, as well as gender and age (2-9+, 5+) specific rates, for the same fleet using data from 2002 to 2012. We also provide an account of recent trends in the Canadian fishery, as well as an overview of recent size changes in the two main gear sectors (longline and harpoon).

## 2. Description of the fishery

Between 1988 and 2011, catches of swordfish by the Canadian longline fleet ranged from 800 to 2,200 mt, with 39 to 77 vessels actively fishing in a given year. In 2011, 44 longliners landed 1,343 mt of swordfish. The number of vessels landing swordfish has been relatively consistent since 2002.

The Canadian longline fishery typically operates in waters from Georges Bank to the Flemish Cap (**Figure 1**). The fishing distribution of swordfish catches has shifted since 2006, with fewer trips going east of the Grand Banks as compared with the 2002-2005 period (**Figure 2**). This shift has been attributed to unfavourable water conditions and the high cost of fuel. Seasonally, fishing activity begins in May, starting south of the Scotian Shelf and along the edge of the Gulf Stream and continues until July, when it shifts to the edge of the continental shelf and encompasses Georges Bank, Scotian Shelf and the Grand Banks (**Figure 3**). Industry has noted that swordfish CPUE is typically higher in September and October, as they often target tropical tunas earlier in the fishing season.

Historically, changes in management measures have coincided with changes in fishing patterns of the pelagic longline fishery. The traditional competitive fishery changed to an Individual Transferable Quota (ITQ) system in 2002, following time closures, trip limits and mandatory discarding due to subsequent quota reductions in the late 1990s and early 2000s. Prior to the implementation of ITQ management, longliners targeted other tunas in the spring and fall, generally filling their annual swordfish quota during the summer months. Under the current ITQ system, the swordfish season extends from May until November, rather than May to September, and longliners can either direct for swordfish or target other tunas while catching swordfish as bycatch. Paul and Neilson (2010a) reported that Canadian longline fishermen primarily direct for other tunas throughout the season, as the swordfish-directed quota is quite low. Consequently, swordfish are targeted on the last sets of a fishing trip, or on fishing trips occurring at the end of the fishing season.

### 2.1 Data

Catch and effort data for the Canadian longline swordfish fishery were obtained from mandatory logbook submissions made to the Department of Fisheries and Oceans. The logbook database provides specific information about each species caught, such as total weight, number of fish caught and effort (number of hooks) for each set. Tally sheets obtained from the Dockside Monitoring program provides individual fish weights for approximately 90% of the landed swordfish catch. These individual data were used to generate the numbers caught at length, against which the gender proportions were applied. Incomplete data for the current (2012) fishing season was included in the analysis, though these are subject to revision following the completion of the season. The detailed data for effort calculations spanned the years 2002 to 2012, and no filters were applied in this update.

### 2.2 Age and gender keys

The sex ratio at length key developed by Ortiz et al. (2000) was used to separate the unisex population into its male and female components. The growth curves for males and females developed by Ehrhardt et al. (1996) provided ages for swordfish by gender, month and aggregated lower jaw fork length (LJFL). Lower jaw fork lengths (cm) were derived from individual dressed weights (kg) using the relationship provided by Turner (1987).

### 2.3 CPUE

The catch per unit effort (CPUE, number of fish per 1000 hooks) was determined for the longline fleet only, as no measure of effort is available for the harpoon fleet. In addition, the activity of harpoon vessels is weather-dependent, making it difficult to distinguish trends due to changes in abundance from those caused by weather

conditions. The offshore fleet was also excluded from the analysis, as this fleet primarily targets other tunas. Finally, vessels within the longline fishery are able to use combinations of gears on a given trip (including harpoon and tended line), and these are all recorded as ‘longline’ catches in the log system. This issue was addressed by separating fishing sets based on the number of hooks, where sets with fewer than 300 hooks were considered a mixture of tended line and harpoon, while those with an effort greater than 300 hooks were strictly longline (Hanke et al., 2012). Sets with one hook were considered to be harpoon, unless more than one species was identified or the total swordfish weight for the set exceeded the maximum weight of a single fish (537 kg).

The annual nominal CPUE was calculated for males and females aged 2 to 9+ and 5+, as well as for the combined unisex population caught by longline gear. The nominal annual CPUE was derived by taking the mean of all set-level CPUEs for a given year.

### 3. Results and Discussion

#### 3.1 Distribution of fishing and relative abundance

As noted earlier, during the early 2000s, the Canadian longline fishery had some activity east of 50 degrees W. longitude but, in recent years, fishing in this area has declined in favor of closer fishing grounds (**Figure 2**). Industry has commented that this shift in recent years reflects a lower emphasis on the tropical tuna component of the fishery, due high fuel prices, high bait costs and low tuna prices. Industry has also noted that, as tuna prices rise in 2012, the distribution of fishing activity will likely shift back to the southerly area.

The seasonal fishing pattern of the longline fishery shows activity off the southern Scotian Shelf in May and June, moving north towards the Scotian Shelf, Emerald Basin and the Grand Banks for July through October (**Figure 3**). Activity generally reaches its maximum spatial extent in September, tapering off by December, while catch rates tend to peak throughout September and October at 75 fish per 1000 hooks (**Figure 3**). This is consistent with industry comments that swordfish CPUE is typically higher in September and October, as the fishing vessels often target tropical tunas early in the fishing season.

#### 3.2 Catch characteristics

The LJFL frequency distribution from 1999 to 2010 is skewed to the right and ranges from 100 to 300 cm (**Figure 4**). Swordfish caught in the Canadian longline fishery showed some variation in lower jaw fork length (LJFL) prior to 2006, but have since remained generally close to the series median (177 cm, **Figure 5**). In 2011, however, the catch had a considerably larger component of fish longer than 177 cm, as compared to the probability density distribution for the 1999-2010 data (**Figures 4 and 5**). Preliminary analyses of the most recent data indicate that the 2012 catch is consistent with pre-2011 sizes (**Figures 4 and 5**). Swordfish from the Canadian harpoon fishery have remained slightly smaller than the series median since experiencing a drop in LJFL in 2006 (**Figure 5**).

#### 3.3 CPUE

The nominal catch rates (number per 1000 hooks) for the composite swordfish catch from the Canadian longline fishery peaked in 2010, with values comparable to the series maximum in 1990 (**Figures 6 and 7**). The nominal CPUE showed a decrease in 2011, but remained above the levels observed throughout the early 2000s (**Figure 6**). In the current fishing season (2012), truncated on September 18<sup>th</sup>, the catch rate increases slightly from the 2011 value<sup>2</sup> (**Figure 7**). After truncating each year to match the length of the 2012 season, the increase in 2012 is accentuated (**Figure 7**).

The age-specific CPUE for females aged 2 to 8 showed an increase from 2002 to 2010, with a short-term decrease in 2011 notable for ages 3, 4 and 5 (**Figure 8**). Males constituted a smaller fraction of the overall population and their trend in relative abundance was less evident by comparison. Females aged 9+ declined in relative abundance from 2002 to 2006 and increased again through 2011, while the 9+ males showed an increasing trend across the entire time series (**Figure 8**). The males lag the females in size by about 3 years and, consequently, the patterns in the 9+ male CPUE resembles the age 6 female CPUE more so than the 9+ pattern.

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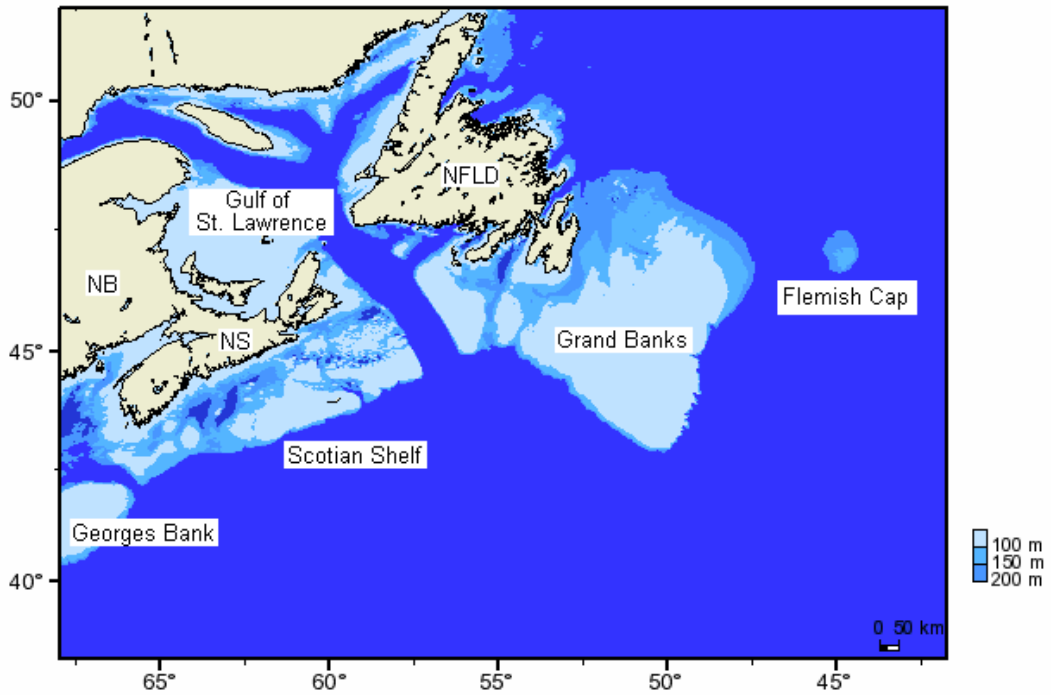
<sup>2</sup> At the time of publication, the end of the fishing was yet to be realized.

#### 4. Conclusions

- The fishing domain is contracting, with fewer sets observed east of 60°W longitude.
- There is a decline in fishing south of the Scotian Shelf due to incurred high costs of bait and fuel, but industry noted that as the price of tuna rises in 2012, this shift may reverse.
- High catch rates have been observed close to the coast (“inshore”), and throughout September and October.
- The 2011 season saw an unexpected increase in the median size of the fish, despite remaining constant in the previous six years. So far, there is no evidence of this change persisting through the 2012 season.
- Nominal catch rates suggest increasing trends in the relative abundance of the entire population and by gender, as compared to the early 2000 levels.

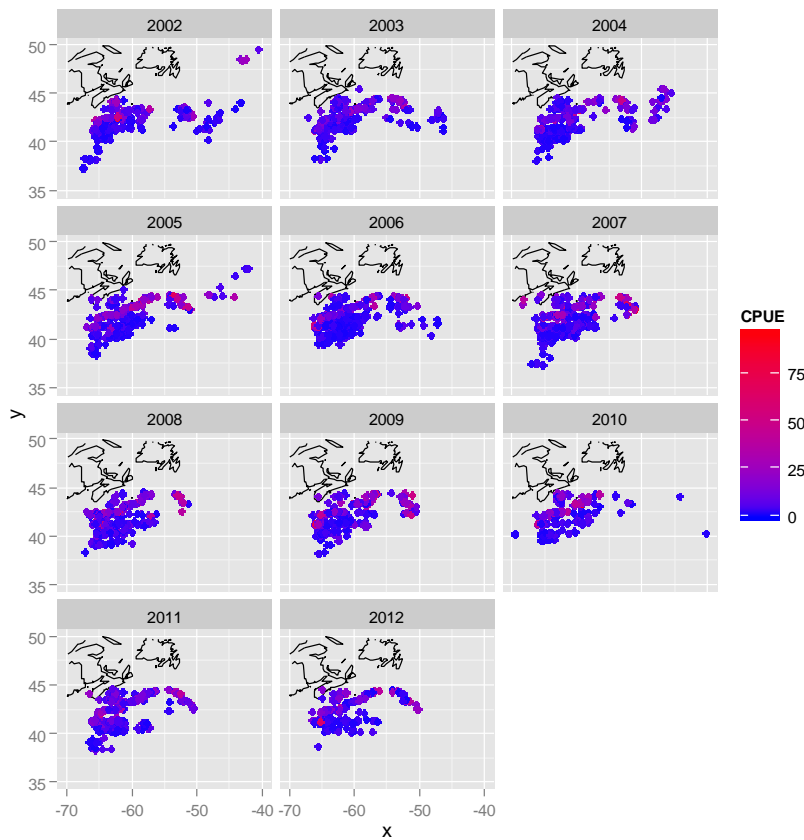
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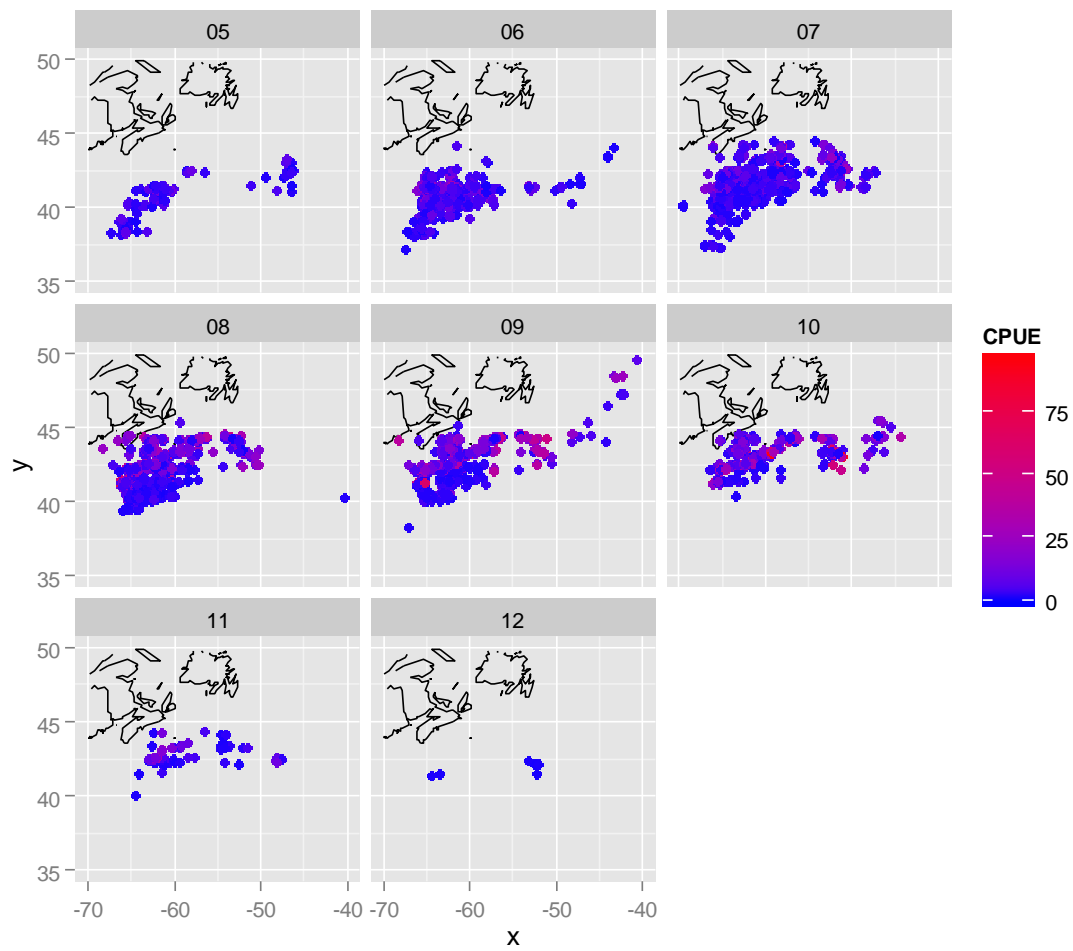


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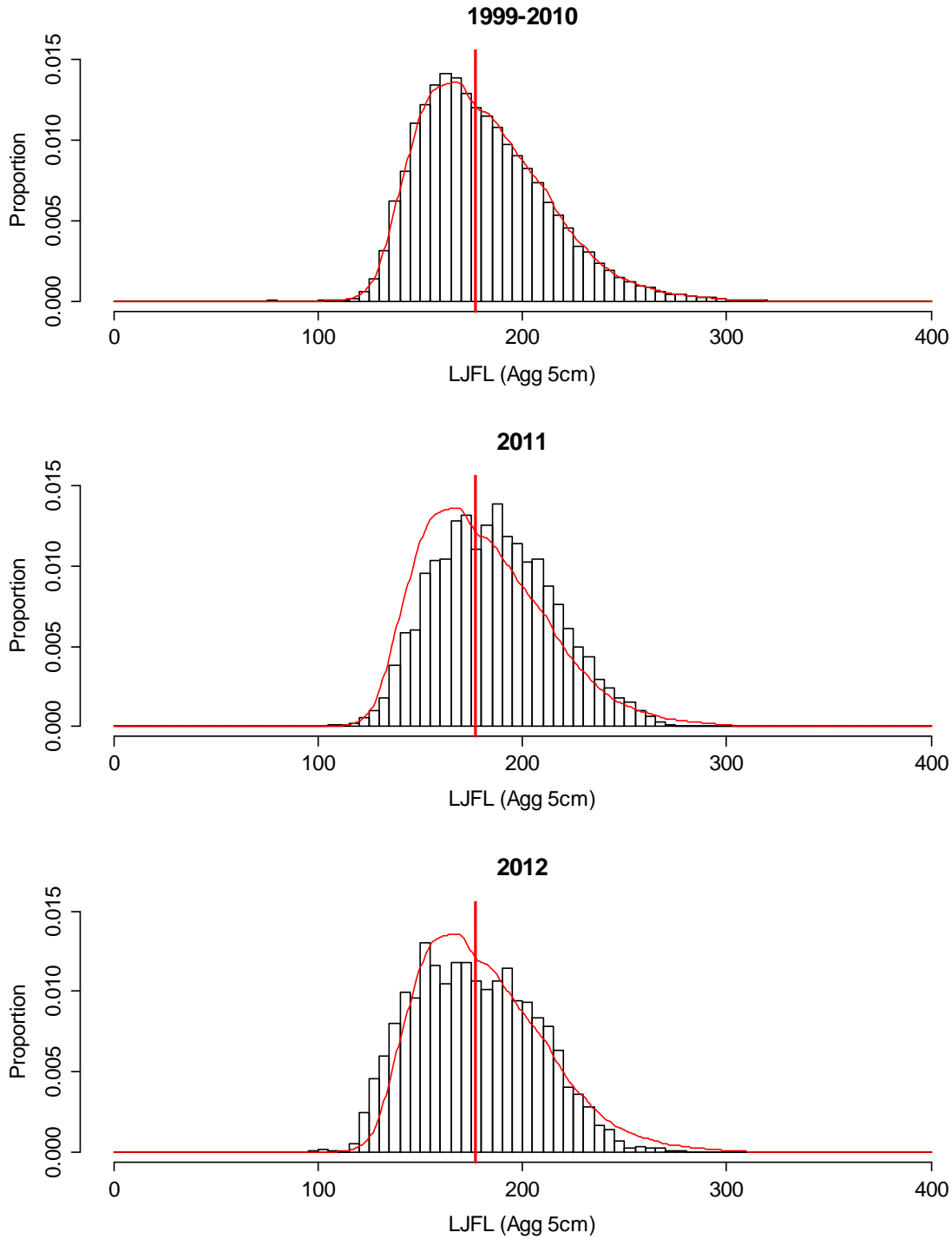
**Figure 1.** Geographic locations off the Canadian Atlantic coast spanning the longline swordfish fishery.



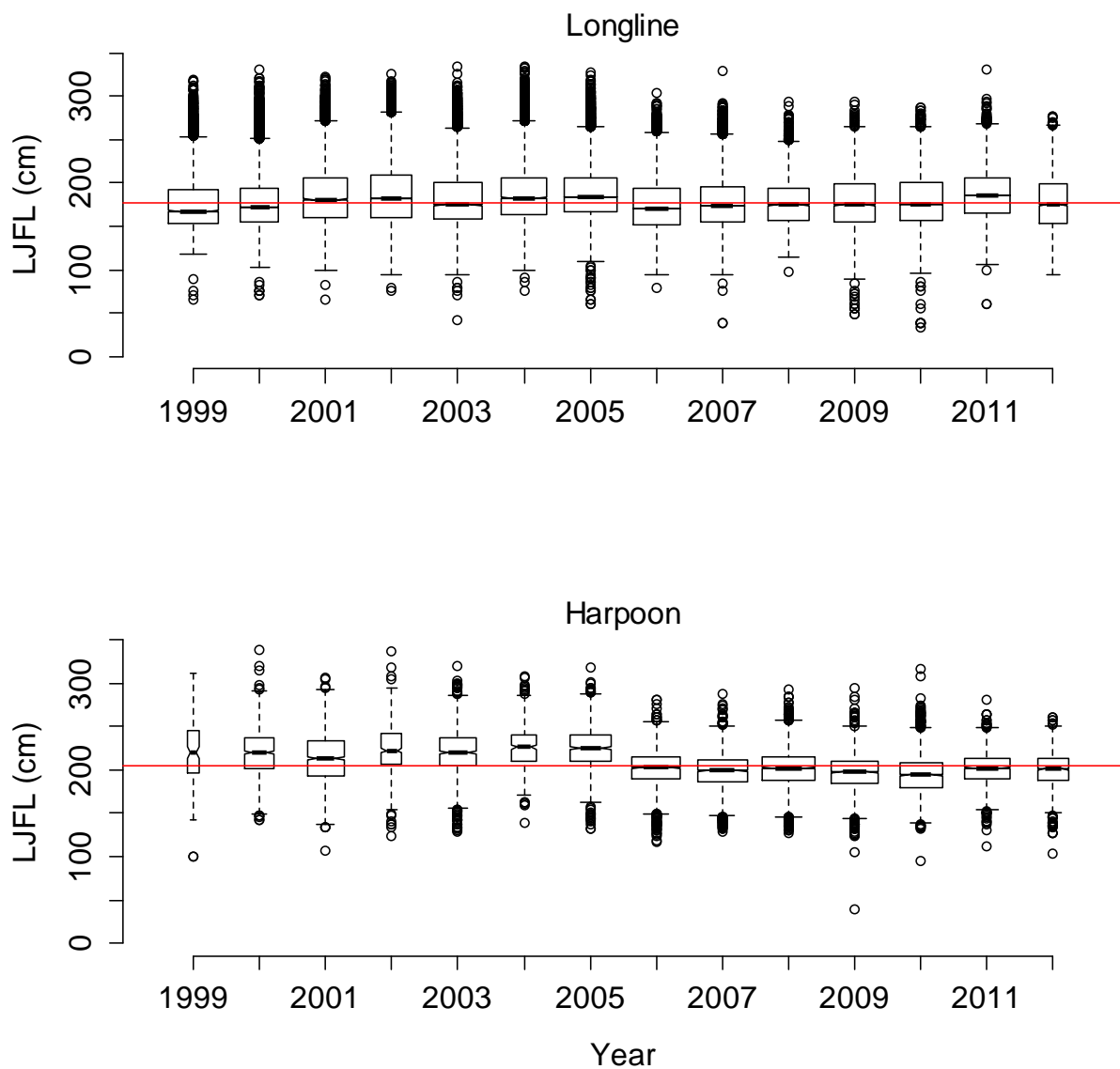
**Figure 2.** Annual distribution of Canadian pelagic longline sets between 2002 and 2012. Points represent fishing set locations and color represents nominal CPUE. Note that the dataset used for 2012 is incomplete, as the fishing season was ongoing at the time of the analysis.



**Figure 3.** Seasonal distribution and CPUE of catches in the Canadian swordfish longline fishery from 2002 to 2012, aggregated by month. Color is indicative of CPUE.

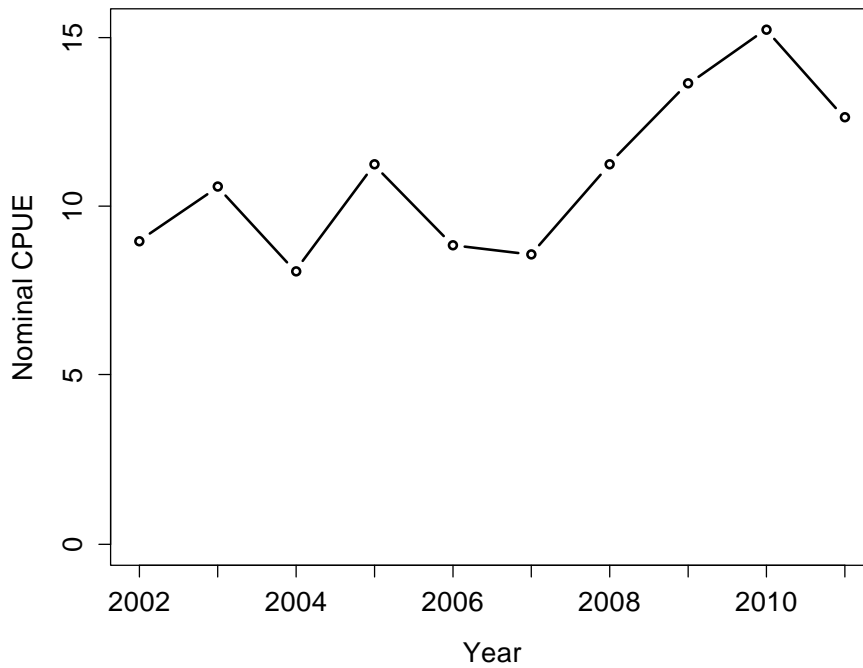


**Figure 4.** Composite catch at length for swordfish caught by the Canadian pelagic longline fishery. Vertical line and curve represent the median length and probability density distribution for the 1999 to 2011 data series. The 2012 plot only shows the fishing completed as of September 18<sup>th</sup> of 2012, as the season was not complete at the time of publication.

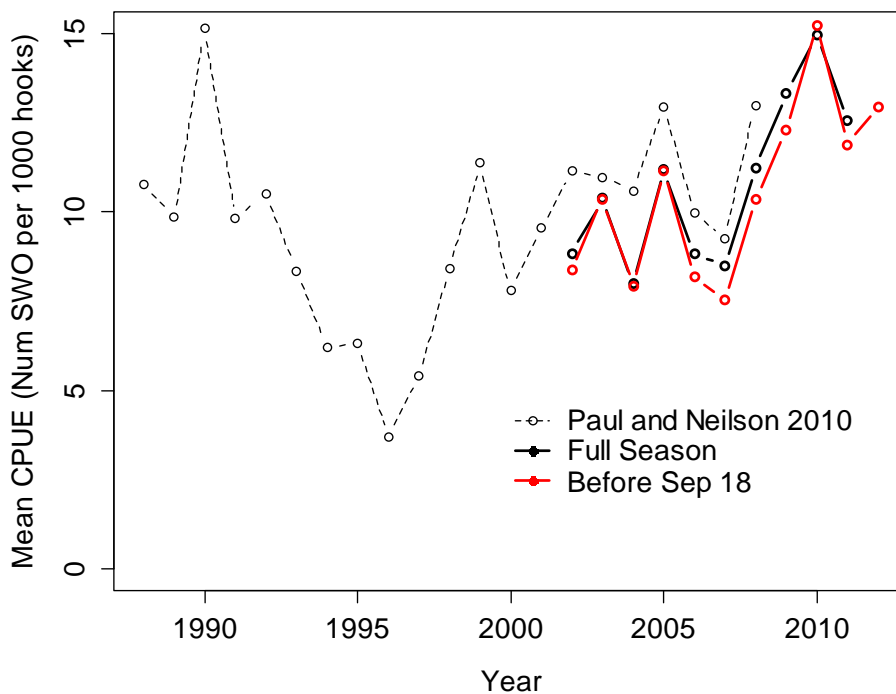


**Figure 5.** Box and whisker plots depicting the distribution of lower jaw fork lengths (LJFL) of fish caught in the Canadian longline (top) and harpoon (bottom) fisheries between 1999 and 2012. The median for each series is given as reference (177 cm for longline and 205 cm for harpoon). Note that the 2012 dataset is incomplete and is subject to revisions.

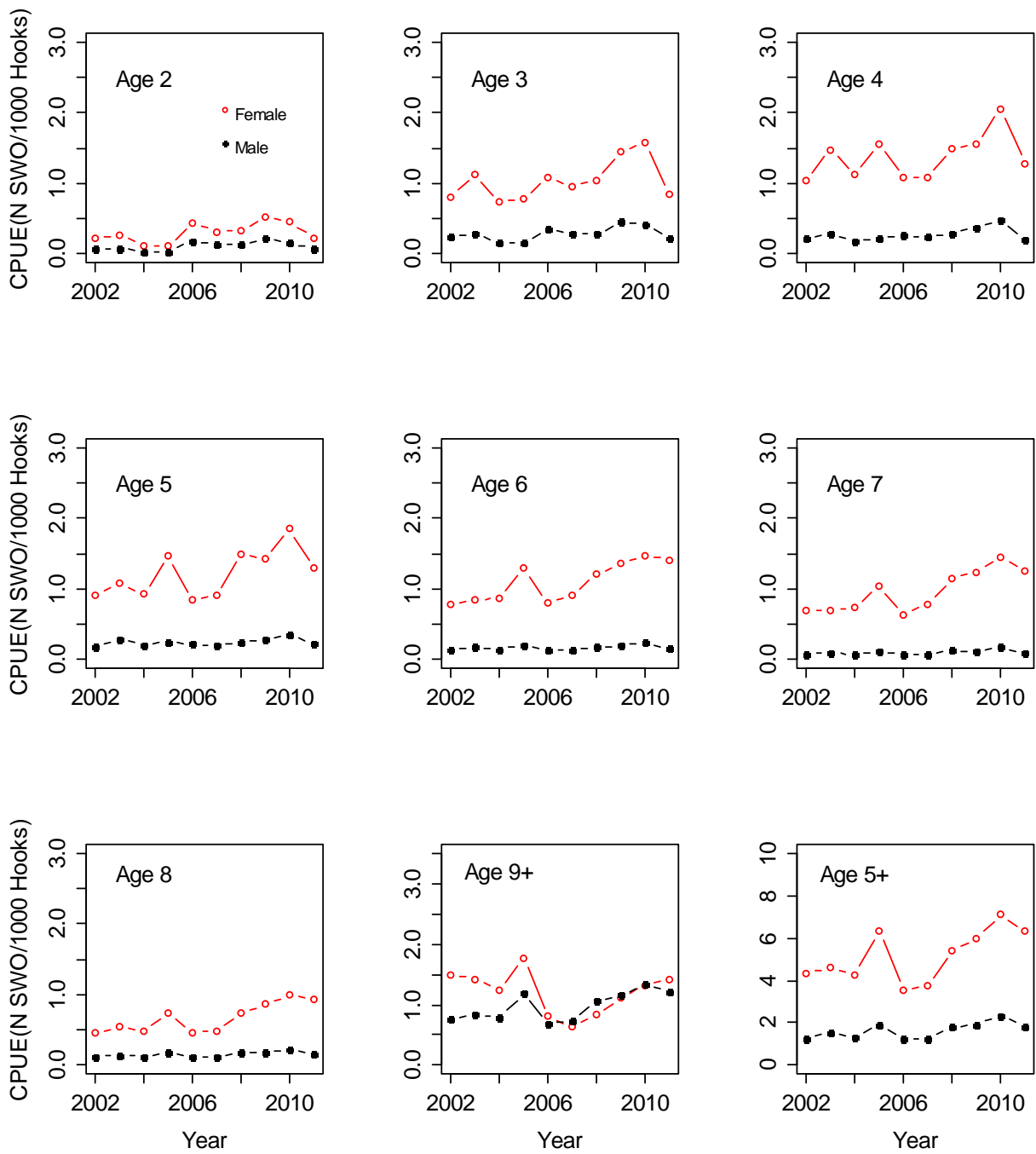




**Figure 6.** Nominal CPUE (number per 1000 hooks) for swordfish caught by the Canadian pelagic longline fishery from 2002 to 2011.



**Figure 7.** Nominal CPUE (number per 1000 hooks) for swordfish caught by the Canadian pelagic longline fishery from 2002 to 2011 (solid, upper). The lower solid line represents the nominal CPUE for 2002 – 2012, with the season in each year truncated to the same length as 2012. The dashed line shows nominal CPUE calculated in Paul and Neilson 2010b.



**Figure 8.** Sex- and age-specific nominal CPUE for swordfish (number of fish per 1000 hooks) for ages 2 – 9+ and 5+ from the Canadian pelagic longline fishery, 2002 – 2011. In each case the upper line represents the females and the lower the males.