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Tini a Tangaroa

Characterisation of the New Zealand skipjack tuna fishery

New Zealand Fisheries Assessment Report 2019/34

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Langley, A.D. (2019). Characterisation of the New Zealand domestic skipjack tuna purse seine fishery.

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The domestic catch of skipjack tuna (*Katsuwonus pelamis*) is almost exclusively caught by the target purse seine fishery. The fishery primarily occurs during January–March around the northern coast of the North Island from the Bay of Plenty to North Taranaki Bight. Since 2009/10, significant catches of skipjack tuna have intermittently been taken off the west coast of the South Island.

Since the early 2000s, the purse seine fleet has been comprised of two classes of vessel: smaller (overall length about 35 m) domestic vessels and the larger (60–80 m) super seiners. Three of the larger purse seine vessels have ceased fishing in recent years, while one vessel has continuously operated in the fishery since 2000/01. The fleet of smaller vessels is comprised of 4–5 vessels based in Tauranga. Both sectors of the fleet are reliant on spotter planes to locate schools of skipjack tuna and direct fishing activity. The catch from the Bay of Plenty was dominated by the smaller vessels, while catches from the west coast of North and South Islands were predominantly taken by the larger vessels.

Annual catches from the fishery have fluctuated considerably over the last two decades. Relatively large catches were taken in 1999/2000, 2003/04–2007/08 and 2010/11–2014/15, while catches were lower during the intervening years (2000/01–2002/03 and 2008/09) and in the three most recent years (2015/16–2017/18). Some of the variation in annual catches is attributable to the number of larger purse seine vessels operating in the fishery over the period which varies from year to year.

Length compositions of the skipjack tuna catch were derived from sampling by fisheries observers monitoring the purse seine fishery. The observers monitored approximately 5–10% of the annual skipjack tuna catches during 2004/05–2017/18. The length compositions tended to be comprised of several strong modes at about 40 cm, 45–48 cm and 52 cm, although the presence and strength of the individual modes varied amongst fishery areas and years. There was no appreciable trend in the length composition of the fish sampled from each area during 2004/05–2017/18.

The magnitude of the annual catch taken by the domestic purse seine fishery is likely to be strongly influenced by the availability of skipjack tuna in New Zealand waters. The oceanographic conditions that influence the availability of skipjack tuna are not well understood. The recent (2015/16–2017/18) period of lower catches of skipjack tuna followed a period of El Niño (negative Southern Oscillation Index SOI) conditions. Further, there is a weak positive correlation between the annual catches of skipjack tuna and the Southern Oscillation Index (from 1989/90 onwards). This suggests that the oceanographic conditions that prevail during El Niño conditions may limit the availability of skipjack tuna to the New Zealand fishery.

1 INTRODUCTION

A domestic purse seine fishery for skipjack tuna (*Katsuwonus pelamis*) has operated in New Zealand waters since the mid 1970s. The fishery principally operates around the northern North Island in summer and autumn. During the late 1970s–early 1980s, the United States purse seine fleet was seasonally active in New Zealand waters and annual catches from the fishery averaged about 9000 t (West 1991). In the 1990s, the fishery was the domain of a fleet of smaller domestic, coastal purse seine vessels and catches were considerably lower, averaging about 4000 t per annum (Fisheries New Zealand 2018).

In the early 2000s, the domestic fishery expanded following the purchase of four large purse seine vessels ("super seiners") by New Zealand fishing companies in 2001 (Langley 2011). These vessels principally operated in the equatorial waters of the western and central Pacific Ocean (WCPO) and intermittently operated in New Zealand waters during the summer fishing season. This increase in fishing capacity contributed to an increase in the annual catches of skipjack tuna in New Zealand waters during the 2000s (Langley 2011).

The skipjack tuna caught in New Zealand waters are considered to belong to a single western Pacific stock (Argue & Kearney 1984, Wild & Hampton 1994). However, the relationship between the New Zealand domestic fishery and the wider western Pacific stock is unclear (West 1991). Recent catches from the New Zealand domestic fishery represent 0.55% of the total WCPO skipjack tuna catch (average for 2011–2017) (Western and Central Pacific Fisheries Commission 2018).

This report summarises recent trends in the domestic skipjack tuna fishery, including trends in catch, fishing effort and the size (length) composition for the 1989/90–2017/18 fishing years. The study was funded by Fisheries New Zealand (Project SKJ2018-01).

2 FISHERY DATA SETS

Commercial catch and effort data from the NZ domestic skipjack tuna fishery were sourced from the Ministry for Primary Industries (MPI) databases (Data Extract 12001). The data set included all catch and effort data from any fishing trip that recorded a catch of skipjack tuna within the EEZ during 1989/90–2017/18. The data set was supplemented by data from any additional fishing trips that conducted purse seine fishing targeting skipjack tuna.

The catch of skipjack tuna is almost exclusively taken by the purse seine method. From 1989/90, the domestic purse seine vessels exclusively reported catch and effort data via the Catch Effort Landing Return (CELR). The reporting of fishing effort and associated (estimated) catches by the purse seine fleet was predominantly reported by fishing location (latitude and longitude) for individual purse seine sets, although multiple purse seine sets (and associated catches) were frequently reported when fishing occurred at the same location (i.e., multiple fishing events per CELR record).

The final destination of the catches from a trip were recorded in the Landings section of the CELR form following the discharge of catch from the vessel. Records which did not represent the final destination of the skipjack catch taken in New Zealand waters were excluded from the landings data set (records with Destination Codes T, F, R, D, B, P, Q), while records of domestic catches landed outside of New Zealand were retained (Destination Code O). The domestic landings of skipjack tuna caught outside of the EEZ (Fishstock Code SKJET) were also excluded.

The catch and effort data sets were processed following the methodology described in Starr (2007). For each trip, the landed catch of skipjack tuna was apportioned amongst the fishing records in proportion to the estimated catches of skipjack tuna. For the purse seine fishery, a trivial proportion (0.003%) of the effort records were from trips with no corresponding estimated catches. For these trips, the landed catches were distributed amongst the effort records in proportion to fishing effort (i.e., the number of sets).

Total annual catches of skipjack tuna under the Quota Management System (QMS) were compiled from Monthly Harvest Returns (MHR) submitted by fishing permit holders (Fisheries New Zealand 2018). The total annual estimated and landed catches included in the skipjack tuna catch and effort data sets approximated the QMS annual catches (Figure 1).

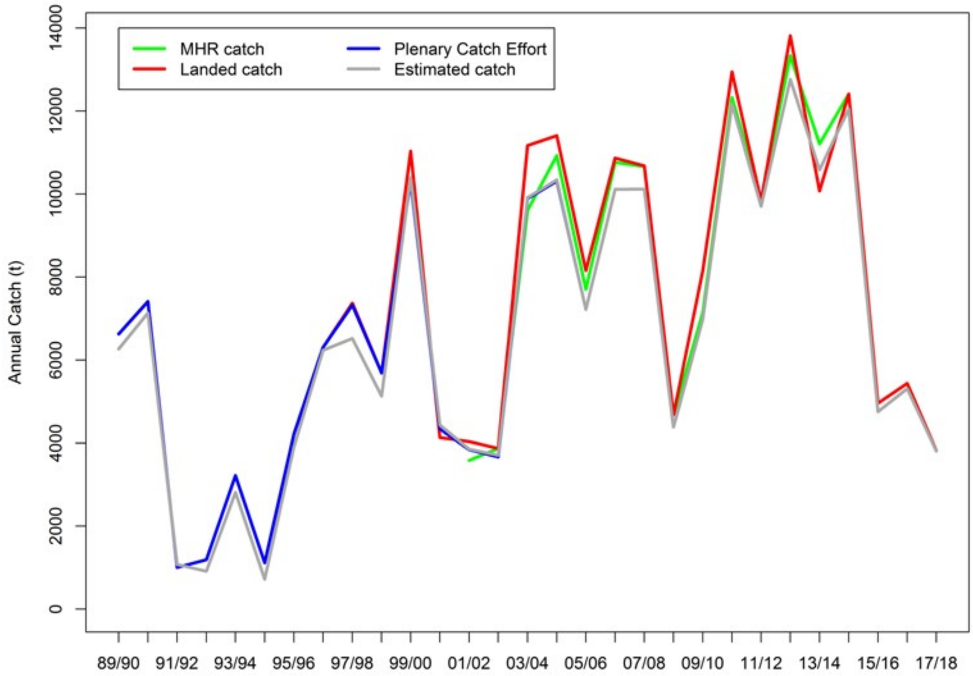

Figure 1: A comparison of total annual skipjack tuna estimated and landed catches (t) by fishing year from the catch and effort returns and the total reported landings (t) to the QMS (MHR).

Since 2004/05, Fisheries Observers have monitored the skipjack tuna purse seine fishery, including sampling of the length composition of the skipjack tuna catches. The corresponding fishing event, catch and length frequency data from the fishery were provided as an extract from the Centralised Observer Database (*cod*) (Sanders & Fisher 2010).

3 FISHERY CHARACTERISATION

The CELR based catch and effort data set was used to characterise the main trends in the skipjack tuna catch during 1989/90–2017/18. Annual catches fluctuated during the period with relatively large catches taken in 1999/2000, 2003/04–2007/08 and 2010/11–2014/15 (Figure 1). By contrast, catches were relatively low during the intervening years (2000/01–2002/03 and 2008/09) and in the three most recent years (2015/16–2017/18).

Skipjack tuna were almost exclusively caught by the target purse seine fishery which accounted for 97–99% of the annual catches over the study period. Most of the catch was taken during January–March (Figure 2). In years of higher catch, the fishing season tended to extend into April and, in some years, May.

The operation of the purse seine fishery is reliant on spotter planes to locate schools of skipjack tuna. Over the last decade, almost all purse seine sets were conducted in association with spotter plane flights. During that period, the aerial sightings were dominated by five planes (identified by international call sign). The analysis of the aerial sightings data collected by the spotter planes was beyond the scope of the current study.

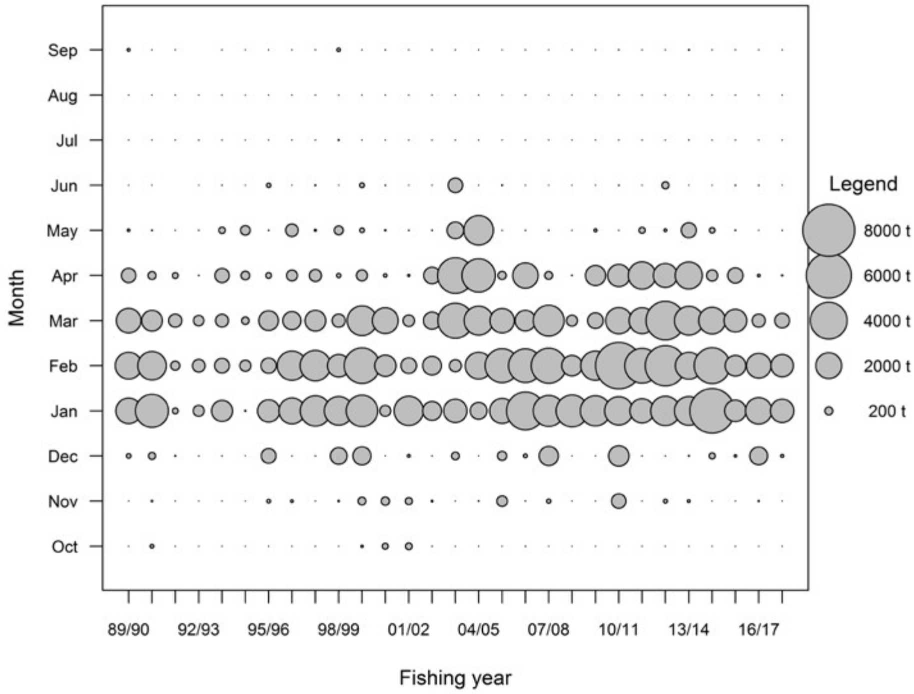

Figure 2: Landed catch of skipjack tuna by month and fishing year.

The skipjack tuna catch from the purse seine fishery was predominantly taken off the northern coast of the North Island. The Bay of Plenty (Statistical Areas 008–010) and east Northland coast (Statistical Areas 003 and 004) areas consistently yielded significant catches of skipjack tuna (Figure 3), although the relative importance of these areas varied between years. From 2002/03, a significant proportion of the catch was taken from the North Taranaki Bight (Statistical Areas 041 and 042), primarily by the larger purse seine vessels. Catches of skipjack tuna have also been intermittently taken off the west coast of the South Island (WCSI) (Statistical Areas 034–036). These four areas formed the basis for summarising regional trends in skipjack catch and purse seine fishing effort (Figure 4).

The spatial distribution of the annual catches varied considerably over the study period. In some years, the catch was predominantly taken from a single fishery area; annual catches from 2003/04–2005/06 and 2010/11–2012/13 were dominated by catches from the WCNI area, while annual catches from 2006/07 and 2014/15 were dominated by the East Northland area (Figure 5 and Table A1). In years of lower overall catch, the catches were more evenly distributed among the three main areas of the fishery (BPLE, ENLD and WCNI). The WCSI area accounted for a significant proportion of the total catch in 2013/14 (Figure 5).

The timing of the fishery varies between the regions; the fishery generally commences in the ENLD and BPLE areas and is followed by the WCNI fishery from mid February. The catches from the WCSI are primarily taken during March and April (Figure 6).

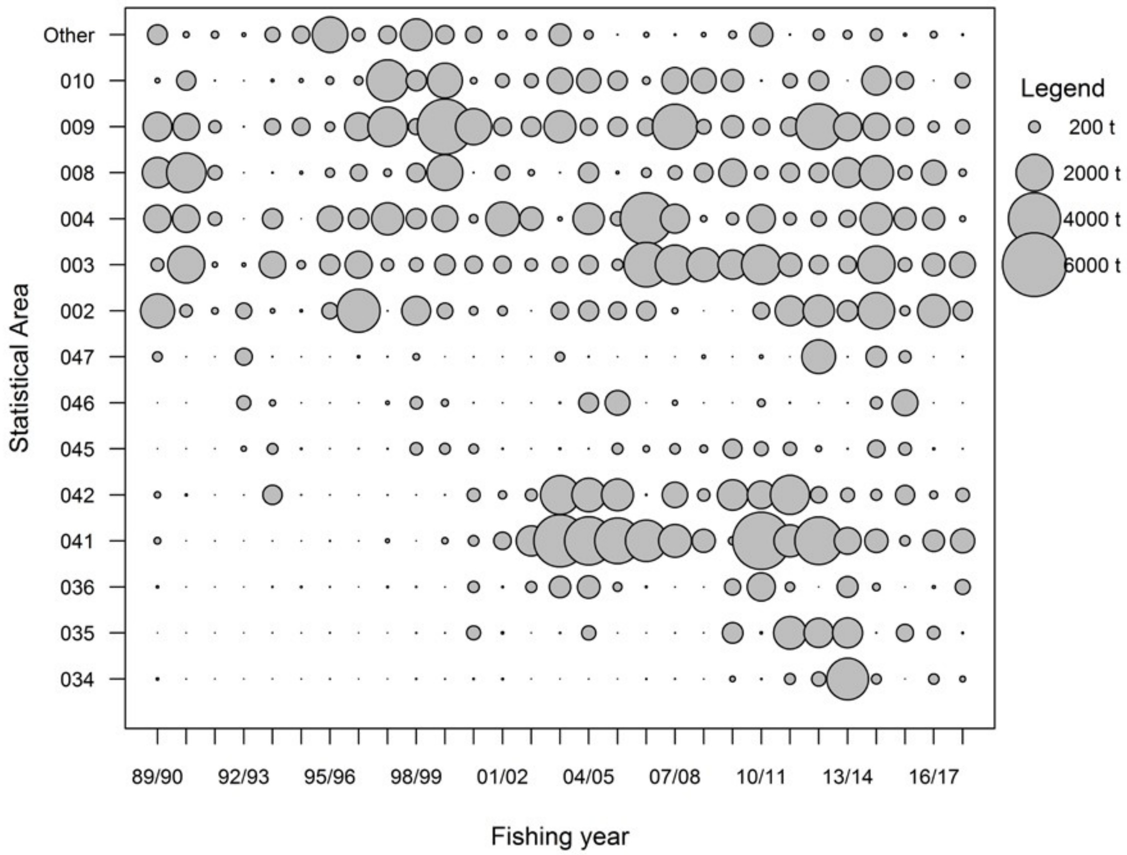

Figure 3: Landed catch of skipjack tuna by Statistical Area and fishing year.

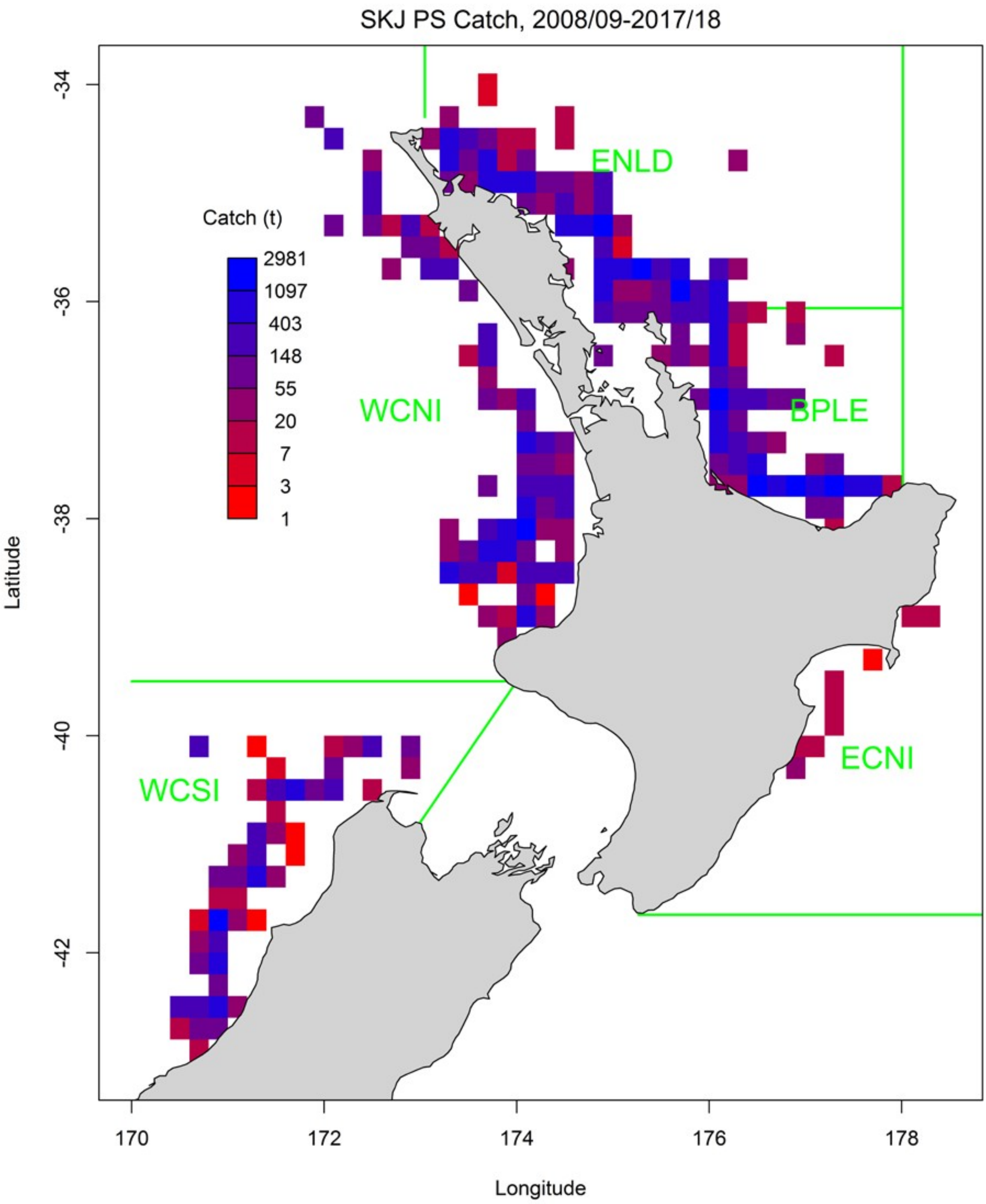

Figure 4: Total skipjack tuna purse seine catch by 0.2 degree latitude/longitude, aggregated for 2008/09–2017/18 (logarithmic scale).

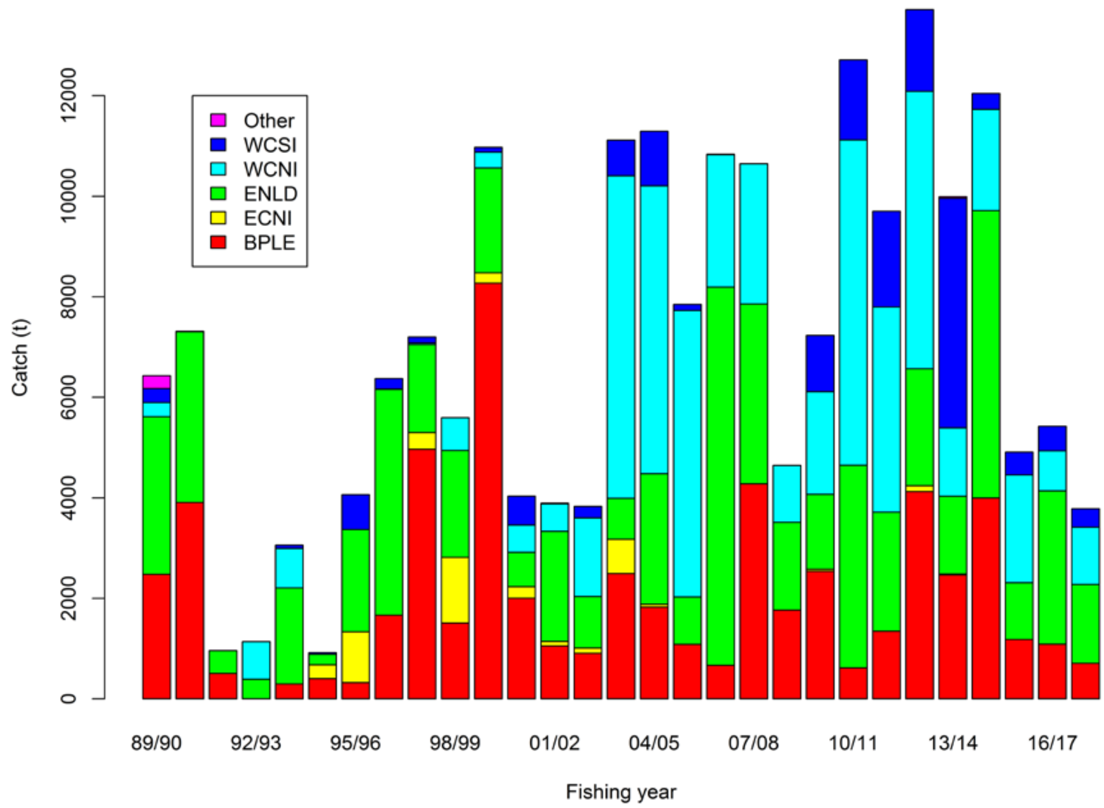

Figure 5: Annual catches of skipjack tuna catch from the target purse seine fishery by fishery area.

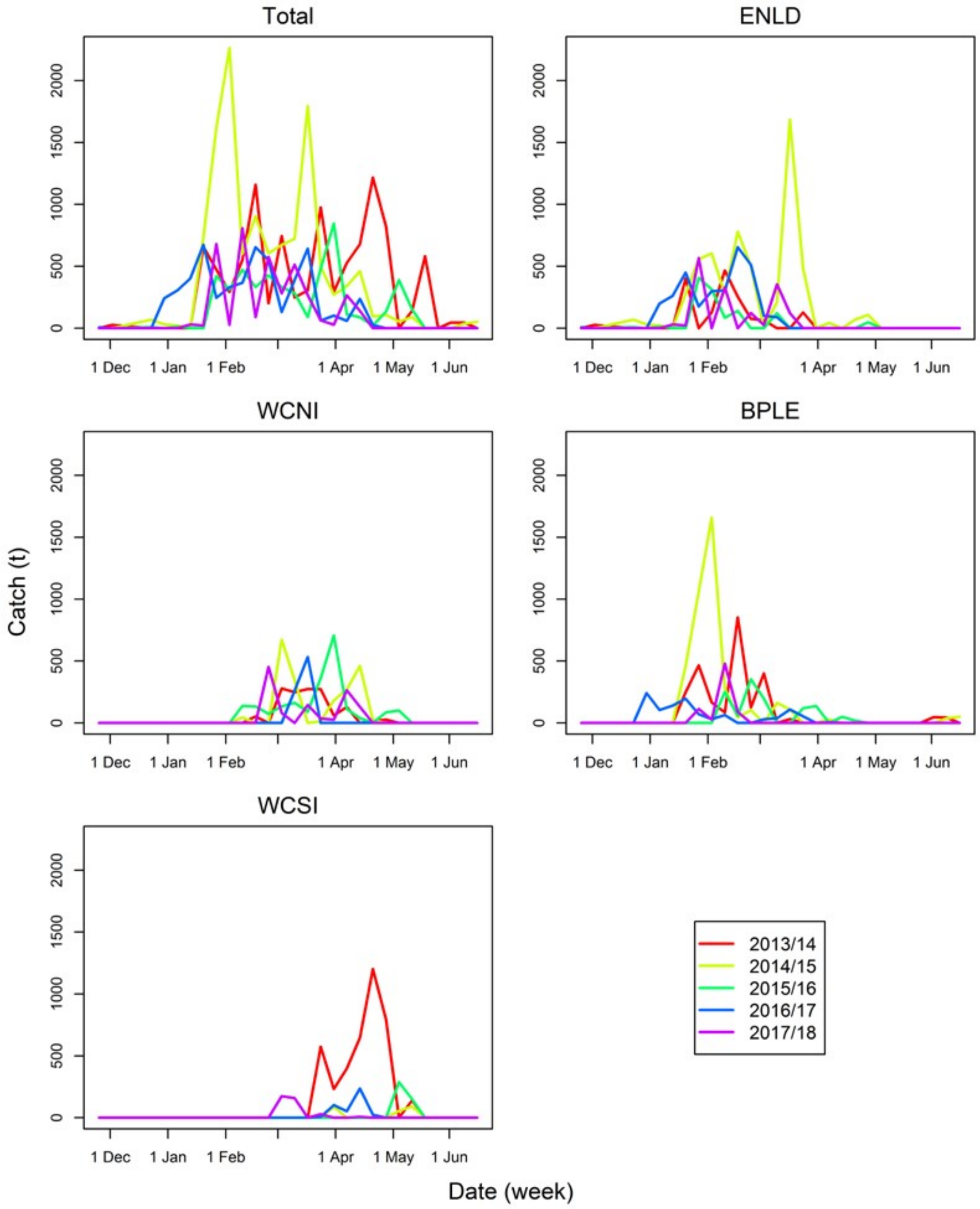

Figure 6: Weekly catches of skipjack tuna by fishery area by fishing year from 2013/14 to 2017/18.

Since the early 2000s, the purse seine fishery has been comprised of two classes of vessel: the smaller (overall length about 35 m) domestic vessels and the larger (60–80 m) super seiners. Four of the smaller vessels operated continuously in the fishery from the early 1990s, while three other vessels have retired from the fishery over the last decade (Figure 7). A single large vessel operated continuously in the fishery from 2000/01. Three other larger purse seine vessels operated intermittently from the early 2000s but ceased fishing in recent years (Figure 7 and Figure 8).

Since the early 2000s, the domestic skipjack catch has been relatively evenly distributed between the two components of the purse seine fleet, although the spatial distribution of the catch differs between the two sectors (Figure 9). The catch from the Bay of Plenty was dominated by the smaller domestic vessels, while catches from the west coast of North and South Islands were predominantly taken by the larger vessels.

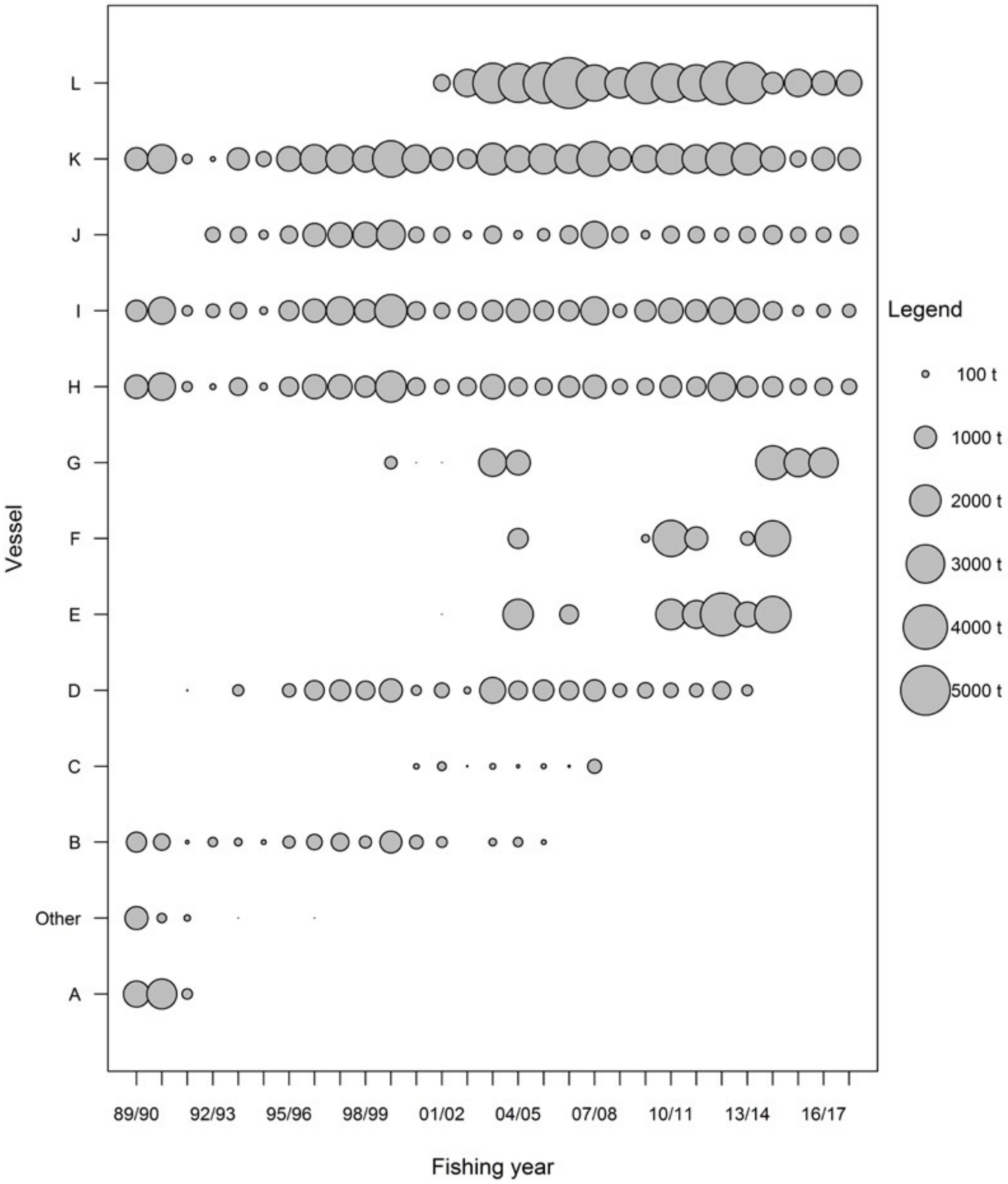

Figure 7: Distribution of skipjack tuna catch from the purse seine fishery by vessel and fishing year.

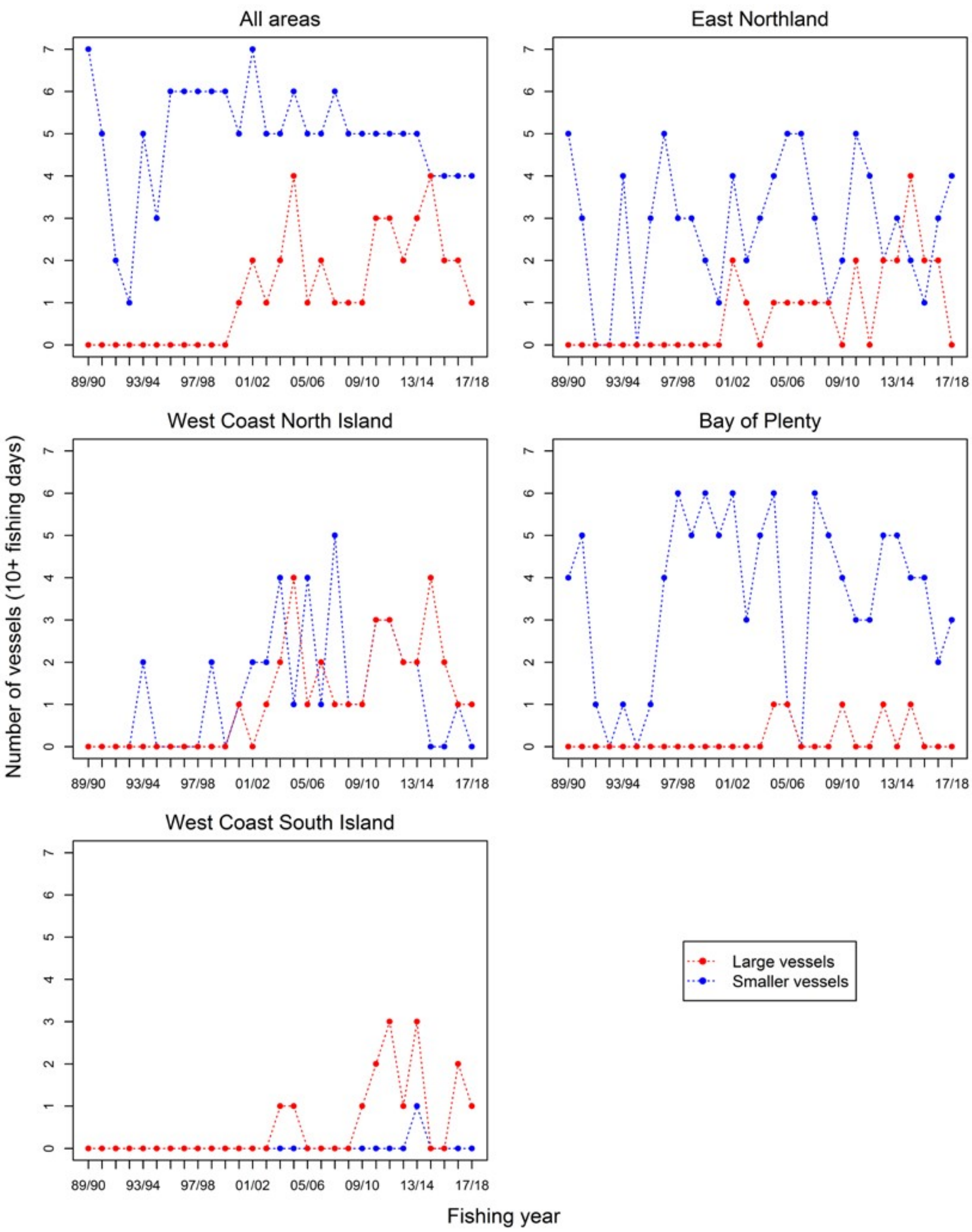

Figure 8: Number of vessels operating in each area for the two components of the target skipjack tuna purse seine fishery.

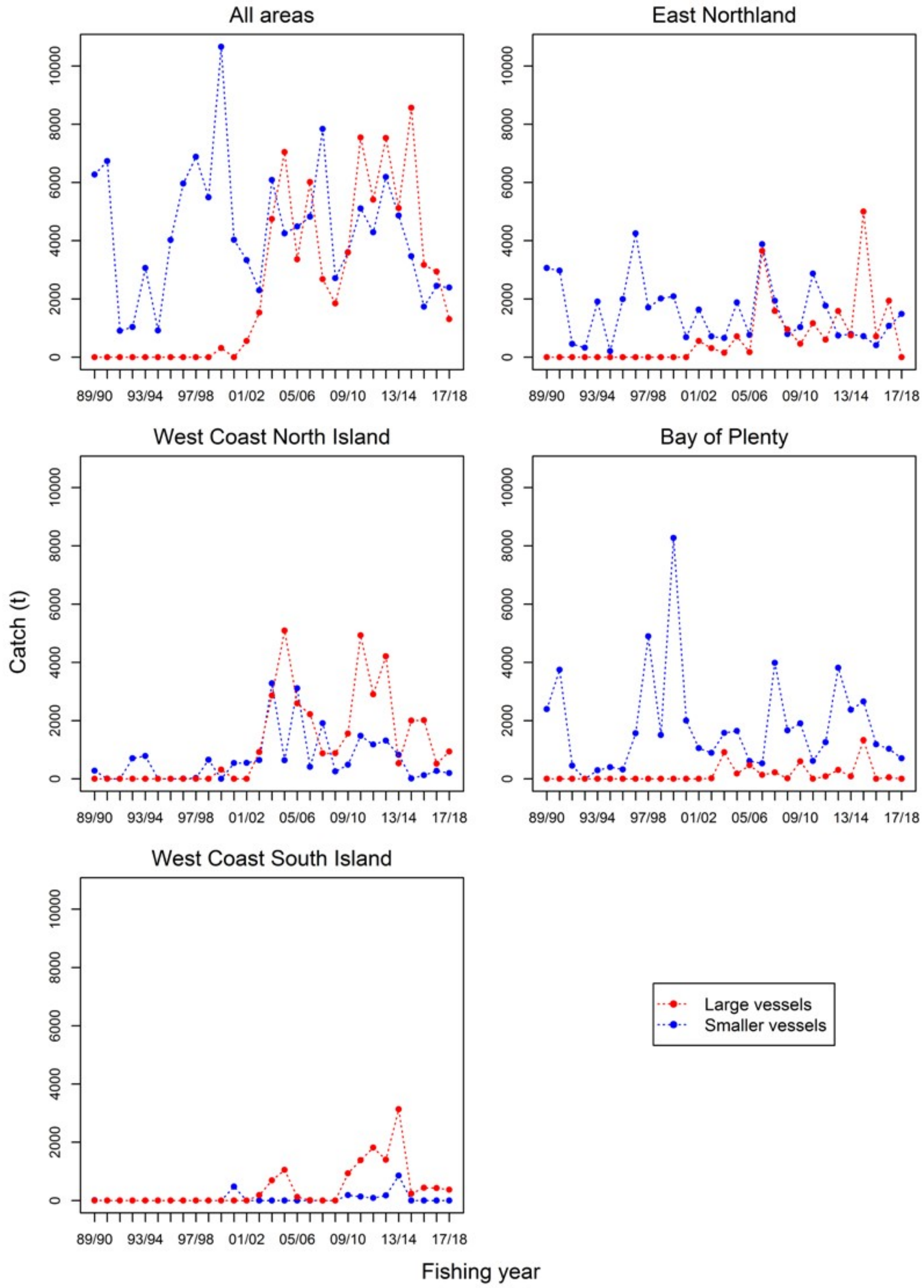

Figure 9: Annual catches of skipjack tuna catch by area for the two components of the target purse seine fishery.

The annual distribution of fishing effort, expressed as number of purse seine sets, closely approximates the relative distribution of catch amongst the fishery areas (Figure 10). The smaller domestic vessels conducted considerably fewer sets in 2015/16–2017/18 compared to the previous years. Similarly, there was a decline in the number of sets conducted by the larger vessels over the recent period, partly due to the recent retirement of several vessels from the fishery (Figure 10).

The purse seiners typically conducted two purse seine sets per fishing day (defined as a day when fishing occurred) (Figure 11). Smaller vessels typically undertake trips of a relatively short duration (Inter Quartile Range 2–6 days) and fishing is conducted on most days. In contrast, the larger vessels conduct trips of a much longer duration (IQR 7–30 days) and may conduct fishing on a lower proportion of those days (IQR 51–89% of days fished per trip).

For the smaller vessels, median skipjack tuna catch per set was relatively stable over the last decade, largely due to the performance of the Bay of Plenty fishery area (Figure 12). Annual catch rates tended to be more variable in the other areas of the fishery. For the larger vessels, overall catch rates (catch per set) were lower in 2013/14–2017/18 compared to the preceding years (2004/05–2012/13) primarily due to the lower catch rates from the WCNI and ENLD fishery areas from the latter period (Figure 12). Similar trends are also apparent in the average catch per fishing day (Figure 13).

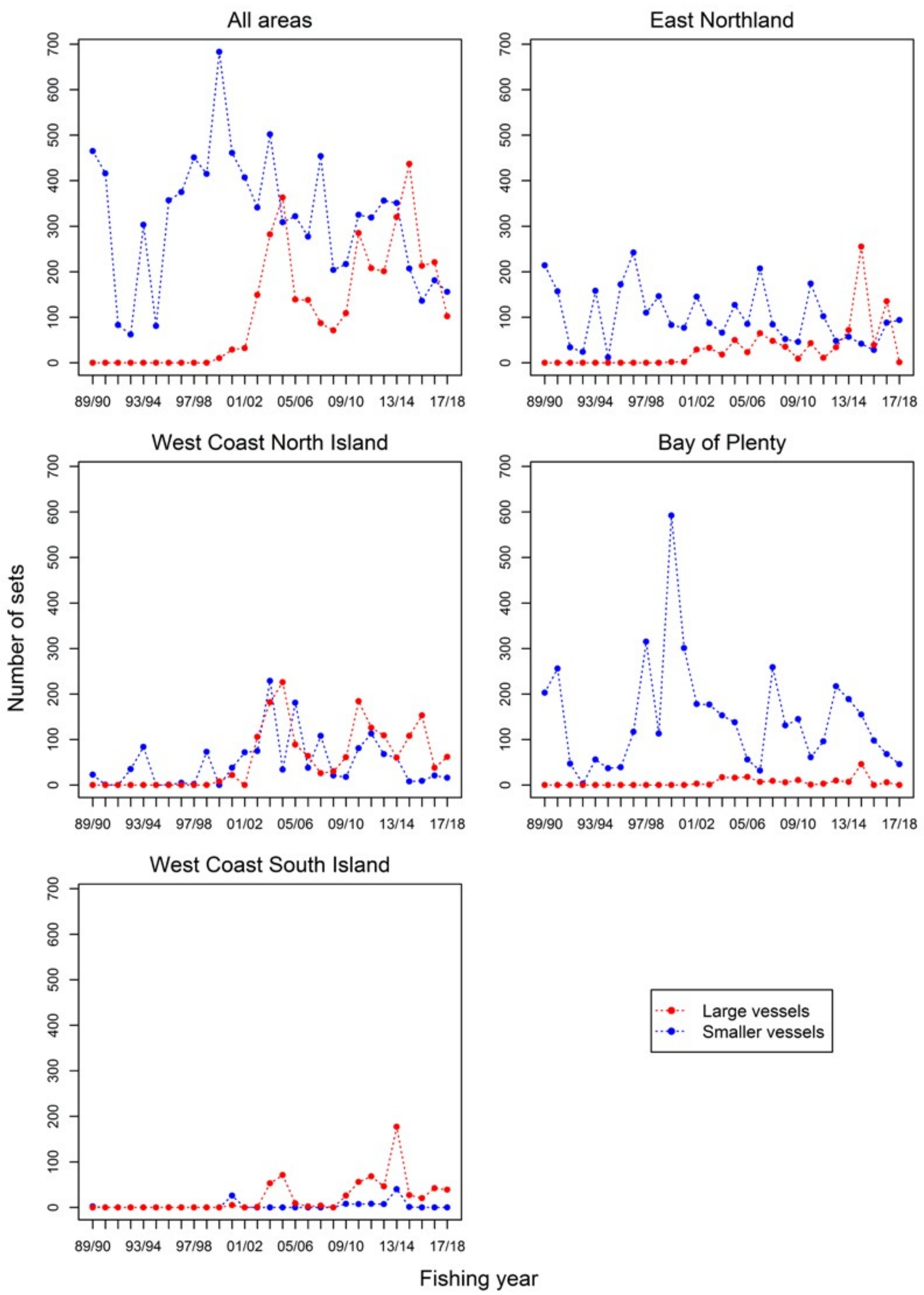

Figure 10: Distribution of sets by area for the two components of the target skipjack tuna purse seine fishery.

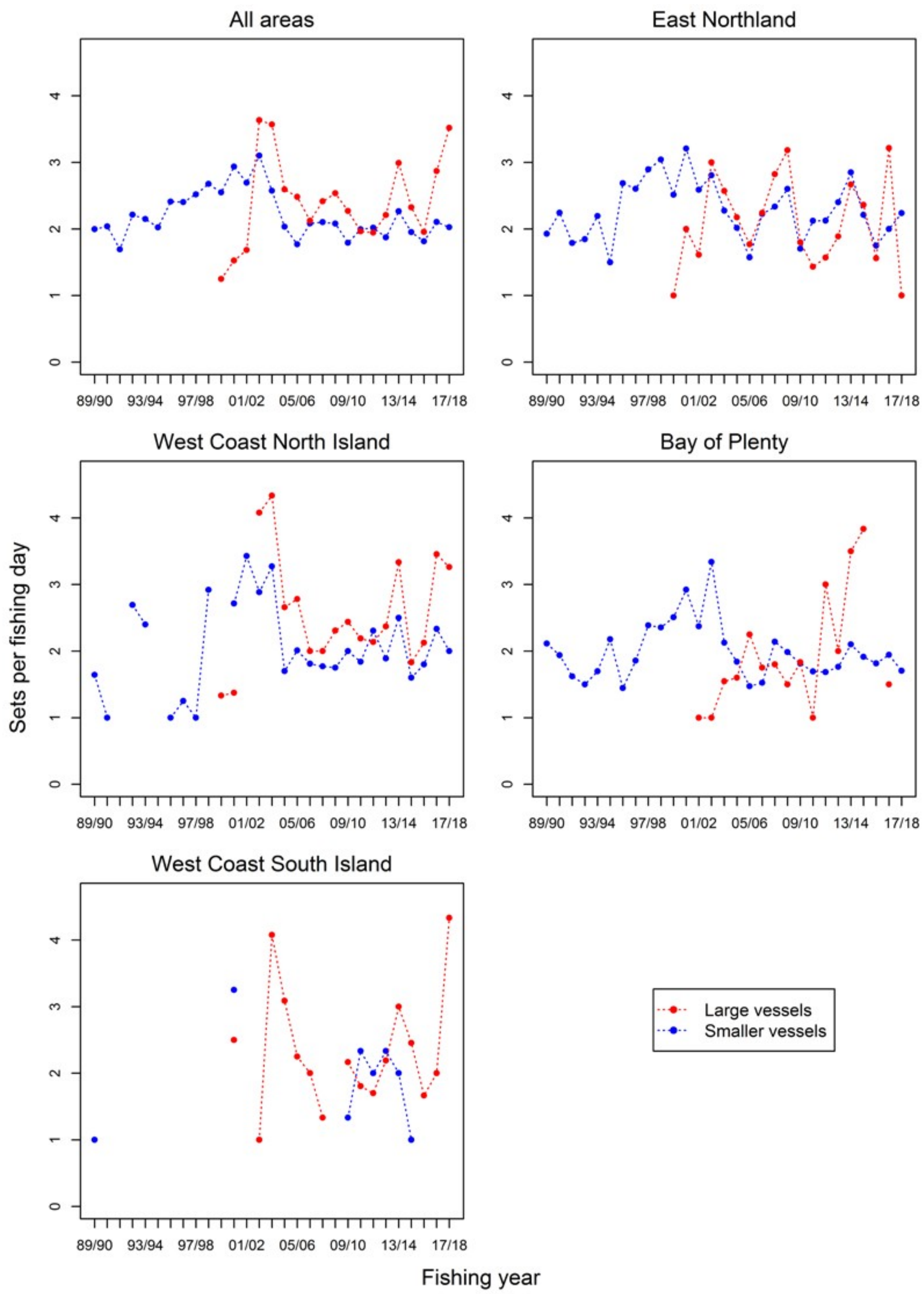

Figure 11: Average number of sets conducted per fishing day by area for the two components of the target skipjack tuna purse seine fishery.

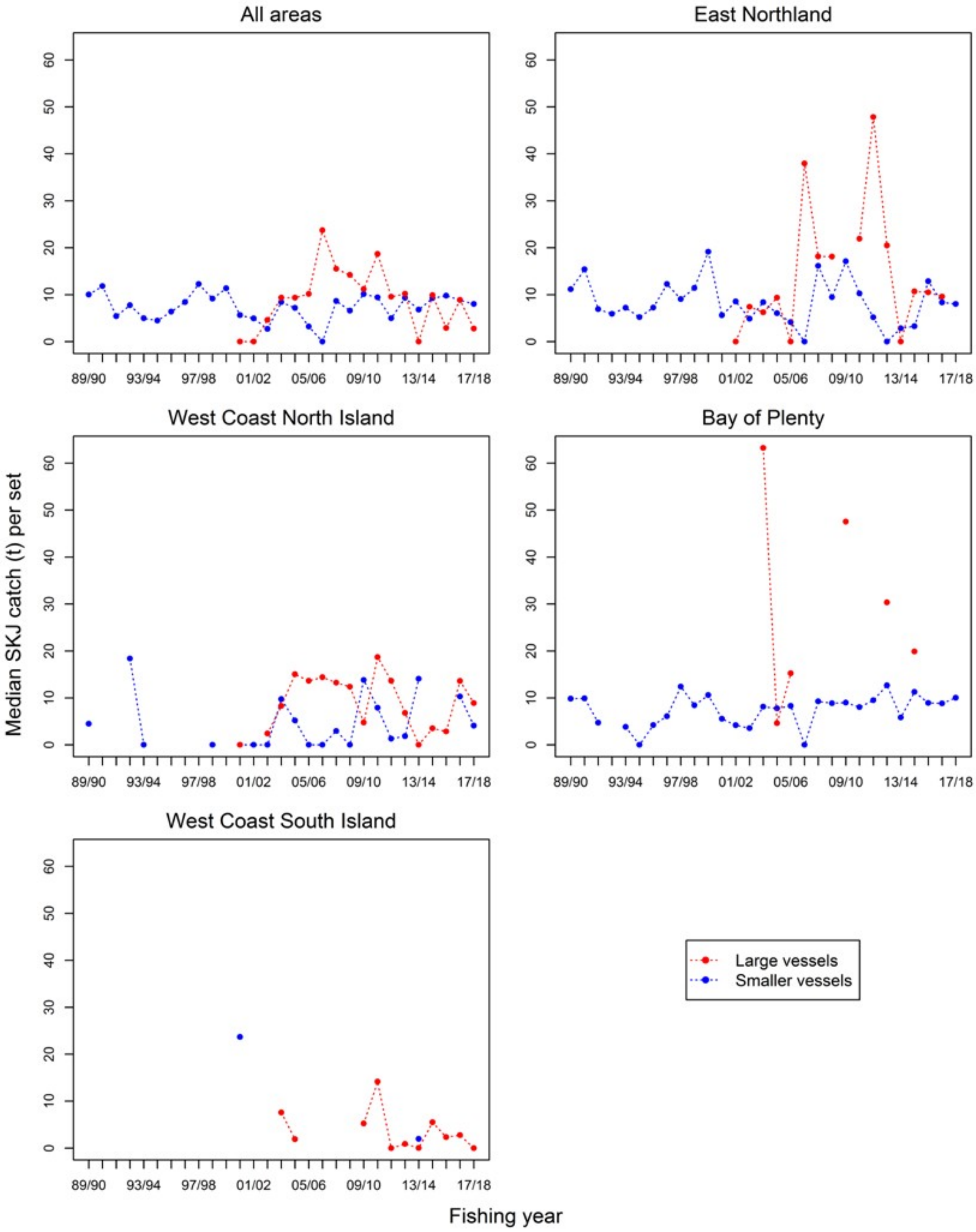

Figure 12: Annual trends in the median skipjack tuna catch per set by area for the two components of the target skipjack tuna purse seine fishery.

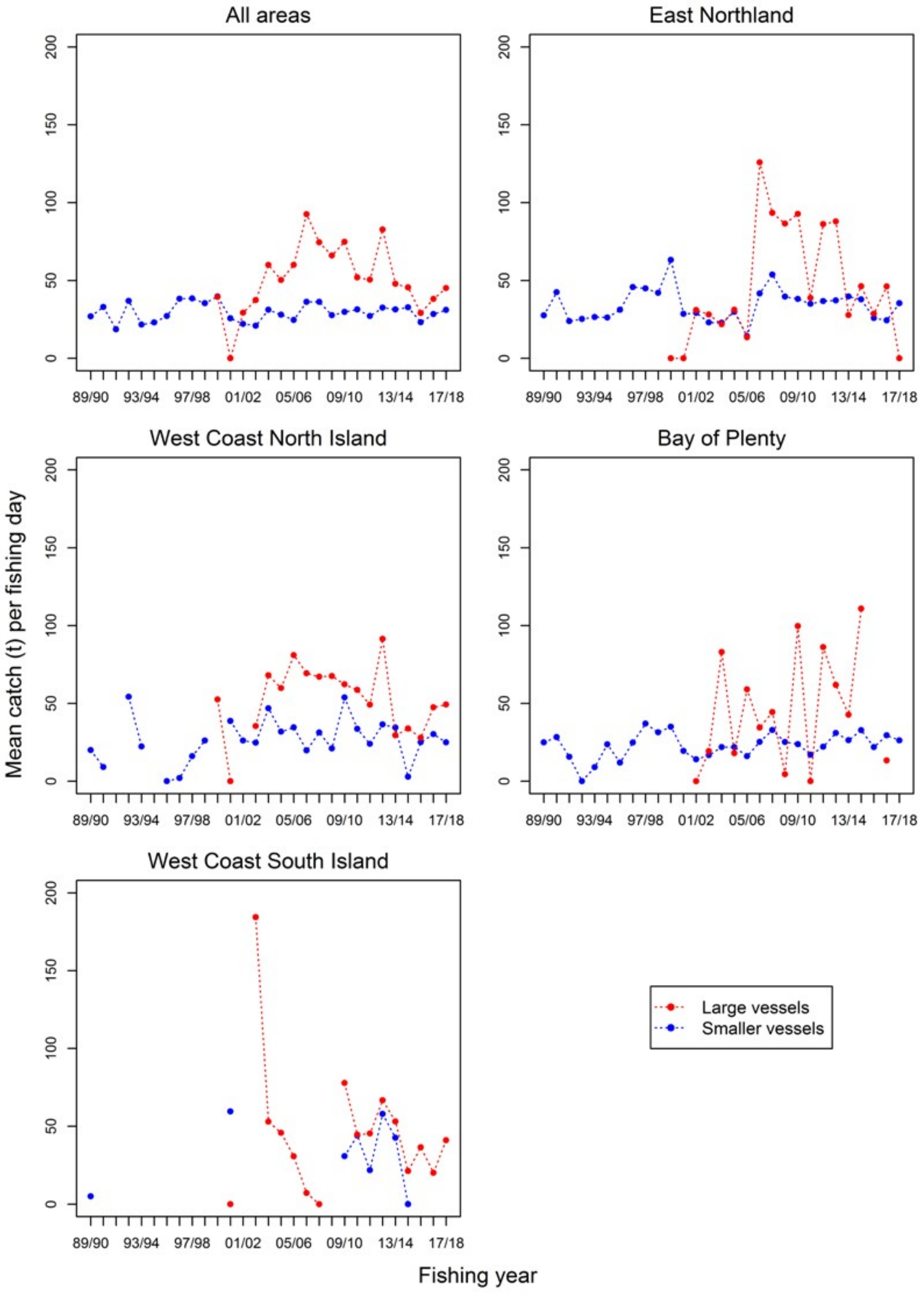

Figure 13: Annual trends in the average skipjack tuna catch (t) per fishing day by area for the two components of the target skipjack tuna purse seine fishery.

4 LENGTH COMPOSITION

Since 2004/05, fishery observers from the Observer Programme (OP) have been routinely deployed to the skipjack tuna purse seine fishery (Table 1). In most years, the observer coverage was distributed amongst the main areas of the fishery and monitored about 5–10% of the total catch (Table 2 and Table 3). The coverage of the fishery was distributed across the purse seine fleet, encompassing the main vessels operating in the fishery (vessels L, K, J, H, G, D, F and E, see Figure 7).

The OP monitored the catches from the fishery and sampled the length composition of the skipjack tuna catch. Catch sampling involved the measurement of the length (fork length, in centimetres) of approximately 100 fish from each set. For most samples, the sex of the fish was not determined.

Annual length compositions were derived for each fishery area (with a minimum of 100 fish sampled) (Table 4) by combining the individual length samples weighted by the relative size of catch (in number of fish) of the sampled sets.

The length compositions tended to be comprised of several modes at about 40 cm, 45–48 cm and 52 cm (fork length), although the presence and strength of the individual modes varied amongst fishery areas and years (Figure 14 – Figure 17). The modal structure of the length compositions is not consistent with the length of annual cohorts based on the growth of skipjack tuna in the equatorial WCPO (47 cm at 1 year; 72 cm at 2 years) (McKechnie et al. 2016). However, the modes could represent modes from multiple spawning events in one year (47 cm at 1 year; 53 cm at 1.25 year).

Overall, fish sampled from the East Northland area were smaller than in the other areas (Figure 18), corresponding to the dominance of fish from the two smaller length modes in the sampled catch (Figure 15). Conversely, the length composition of fish sampled from the WCNI and WCSI fishery areas were predominantly comprised of fish in the larger length mode (Figure 16 and Figure 17). There was no appreciable trend in the length composition of the fish sampled from each area during the period 2004/05–2017/18 (Figure 18).

Table 1: Number of purse seine sets sampled for length of the skipjack tuna catch by the Observer Programme by fishery area and year.

Fishing year	Fishery area					Total
	BPLE	ENLD	WCNI	WCSI	Other	
2004/05	6	5	-	-	3	14
2005/06	-	3	17	-	-	20
2006/07	5	19	11	-	2	37
2007/08	21	8	11	-	-	40
2008/09	4	7	12	-	1	24
2009/10	20	9	4	-	-	33
2010/11	18	23	12	8	-	61
2011/12	19	9	11	13	-	52
2012/13	7	8	17	4	2	38
2013/14	24	12	2	8	1	47
2014/15	13	22	16	1	-	52
2015/16	15	5	15	-	-	35
2016/17	2	4	12	9	-	27
2017/18	1	4	10	6	-	21

Table 2: Catch (t) of skipjack tuna sampled for length from the purse seine fishery by the Observer Programme by fishery area and year.

Fishing year	Fishery area					Total
	BPLE	ENLD	WCNI	WCSI	Other	
2004/05	87.6	95.9	0.0	0.0	31.0	214.5
2005/06	0.0	25.0	782.2	0.0	0.0	807.2
2006/07	94.1	329.2	249.0	0.0	74.9	747.2
2007/08	311.9	303.0	323.6	0.0	0.0	938.6
2008/09	31.1	55.2	185.2	0.0	32.0	303.5
2009/10	265.2	165.2	20.9	0.0	0.0	451.3
2010/11	191.1	303.8	292.5	168.6	0.0	955.9
2011/12	292.1	143.0	187.5	427.1	0.0	1,049.7
2012/13	68.1	196.5	366.7	101.4	50.0	782.7
2013/14	302.2	186.4	15.0	212.0	2.5	718.1
2014/15	252.7	361.0	89.2	12.5	0.0	715.4
2015/16	148.5	68.0	146.2	0.0	0.0	362.8
2016/17	26.0	54.0	197.5	106.4	0.0	383.9
2017/18	35.0	71.0	348.2	31.3	0.0	485.4

Table 3: Percentage of the purse seine skipjack tuna catch sampled for length by the Observer Programme by fishery area and year.

Fishing year				Fishery area		Total
	BPLE	ENLD	WCNI	WCSI	Other	
2004/05	5%	4%	0%	0%	99%	2%
2005/06	0%	3%	14%	0%	-	10%
2006/07	14%	4%	9%	0%	-	7%
2007/08	7%	8%	12%	-	0%	9%
2008/09	2%	3%	16%	-	-	7%
2009/10	10%	11%	1%	0%	-	6%
2010/11	31%	7%	4%	11%	0%	7%
2011/12	22%	6%	5%	22%	-	11%
2012/13	2%	8%	7%	6%	100%	6%
2013/14	12%	12%	1%	5%	0%	7%
2014/15	6%	6%	4%	5%	0%	6%
2015/16	13%	6%	7%	0%	0%	7%
2016/17	2%	2%	25%	25%	0%	7%
2017/18	5%	5%	31%	8%	-	13%

Table 4: Number of fish sampled for length from the purse seine skipjack tuna catch by the Observer Programme by fishery area and year.

Fishing year				Fishery area		Total
	BPLE	ENLD	WCNI	WCSI	Other	
2004/05	591	503	-	-	245	1,339
2005/06	-	300	1,082	-	-	1,382
2006/07	421	1,562	770	-	97	2,850
2007/08	1,516	694	1,054	-	-	3,264
2008/09	280	678	655	-	71	1,684
2009/10	1,590	774	435	-	-	2,799
2010/11	1,638	2,226	1,159	779	-	5,802
2011/12	1,508	892	1,144	1,421	-	4,965
2012/13	583	689	1,533	413	200	3,418
2013/14	2,113	1,216	192	837	49	4,407
2014/15	1,195	1,908	1,049	100	-	4,252
2015/16	1,551	588	1,443	-	-	3,582
2016/17	172	401	1,242	762	-	2,577
2017/18	48	354	200	120	-	722

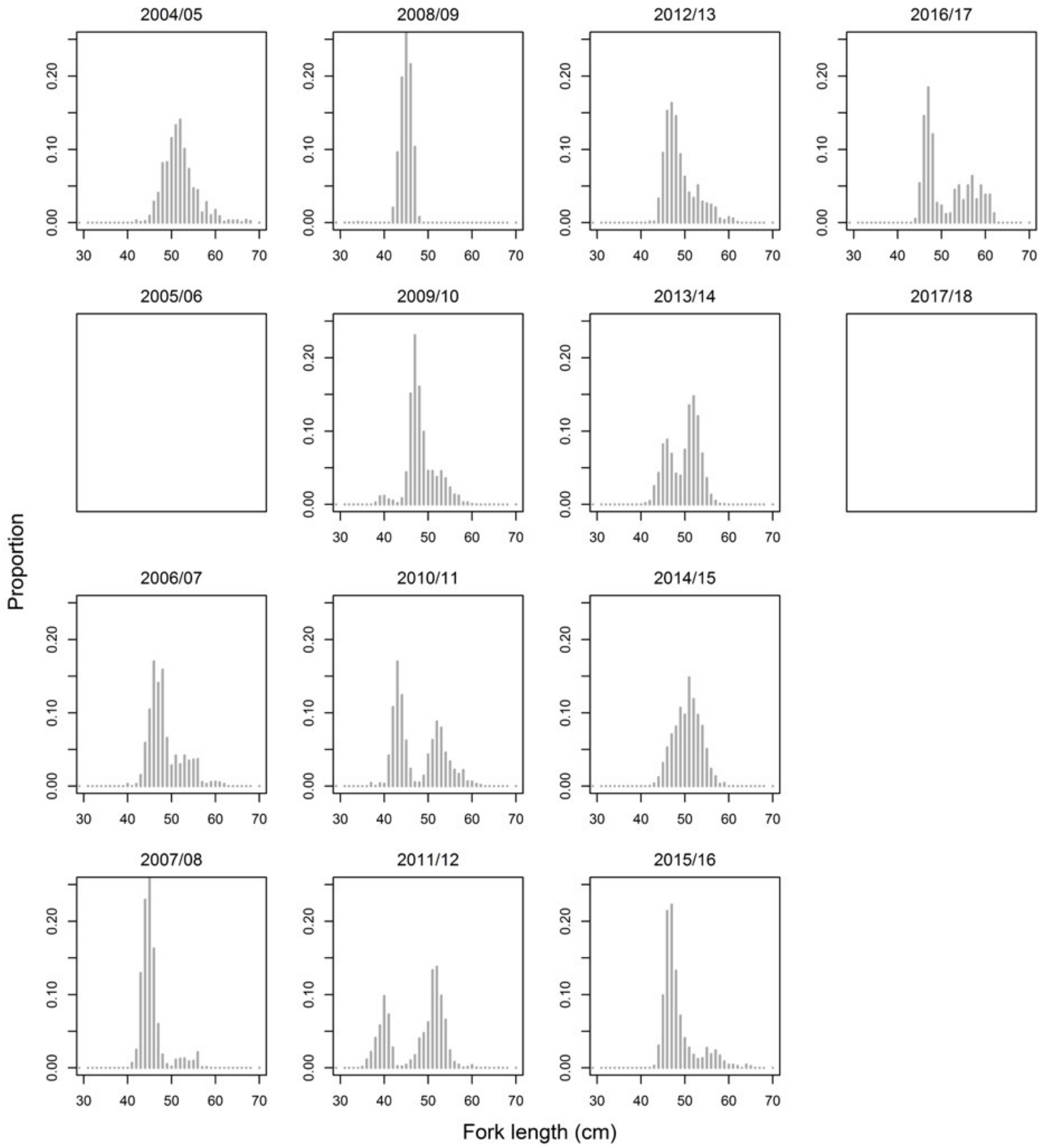

Figure 14: Length composition of skipjack tuna catch from the Bay of Plenty fishery area by fishing year.

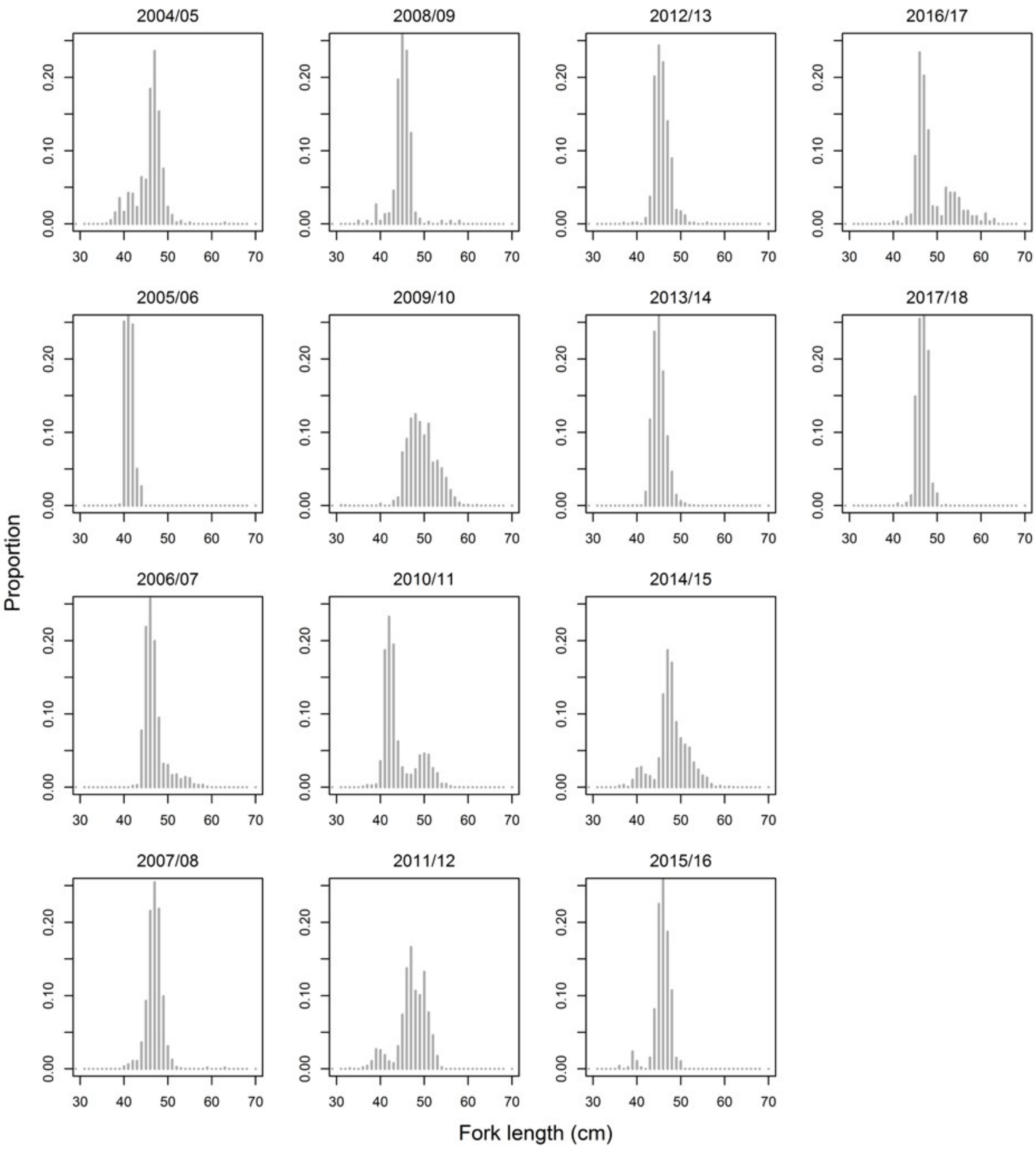

Figure 15: Length composition of skipjack tuna catch from the East Northland fishery area by fishing year.

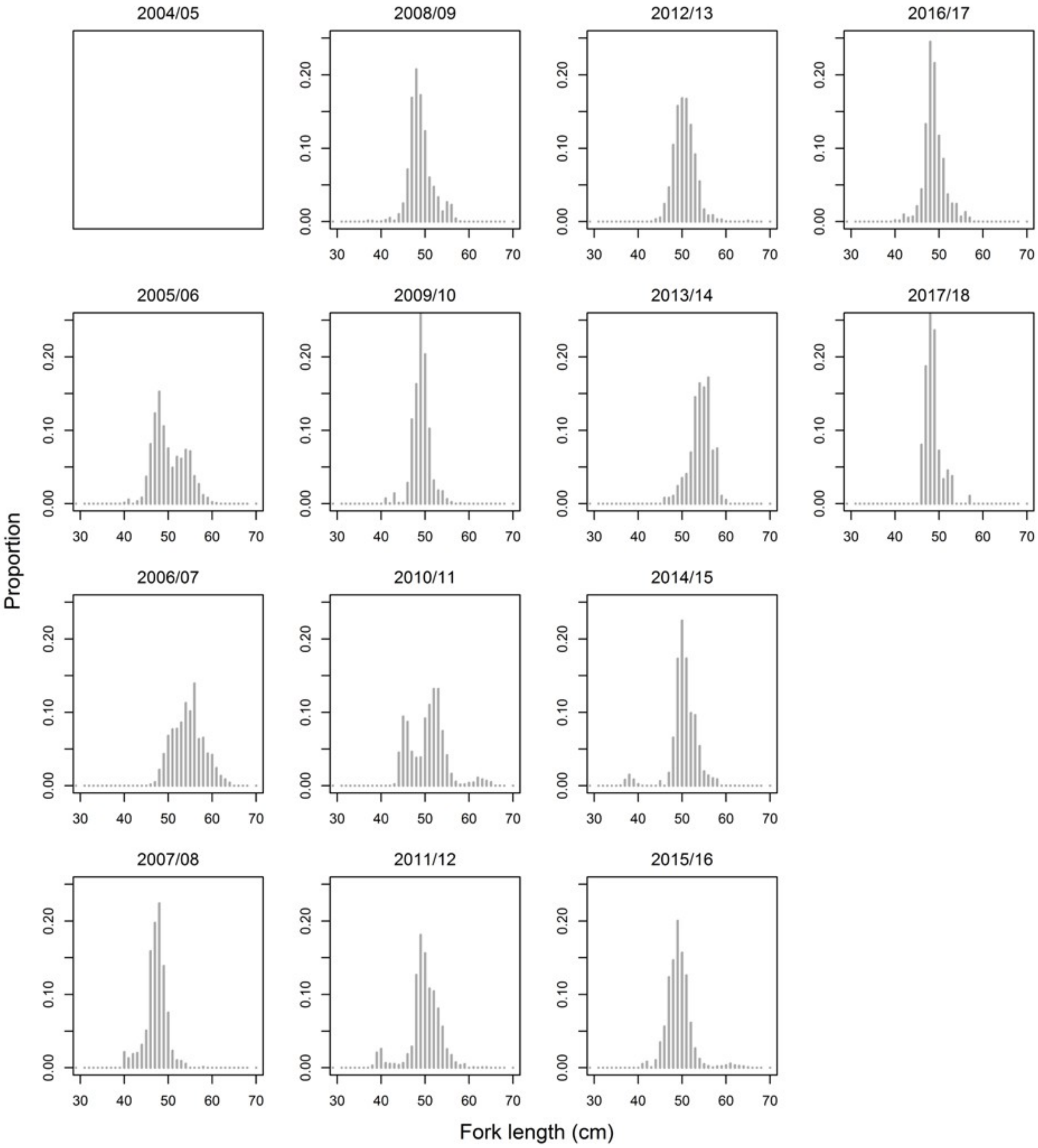

Figure 16: Length composition of skipjack tuna catch from the west coast North Island fishery area by fishing year.

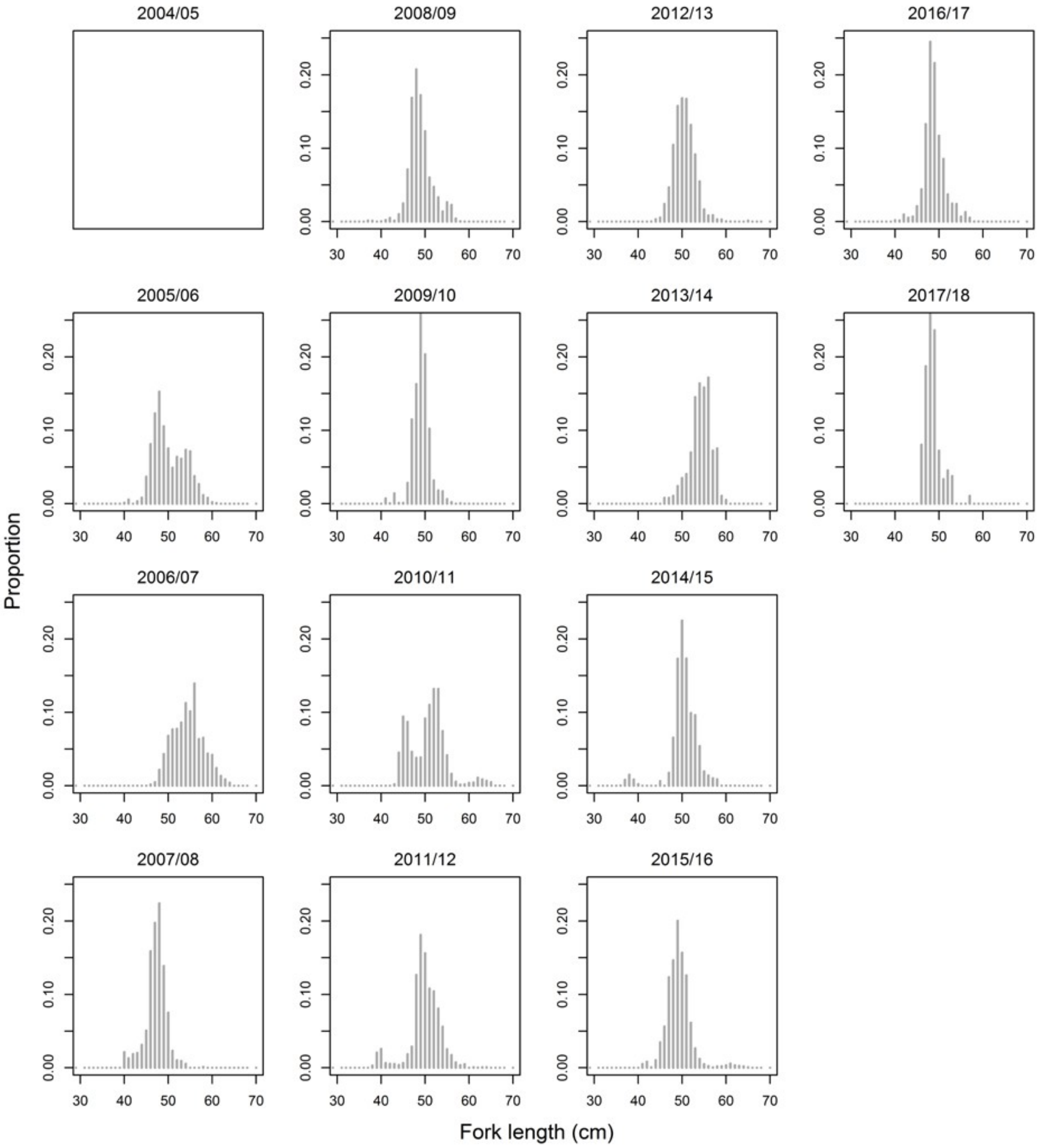

Figure 17: Length composition of skipjack tuna catch from the west coast South Island fishery area by fishing year.

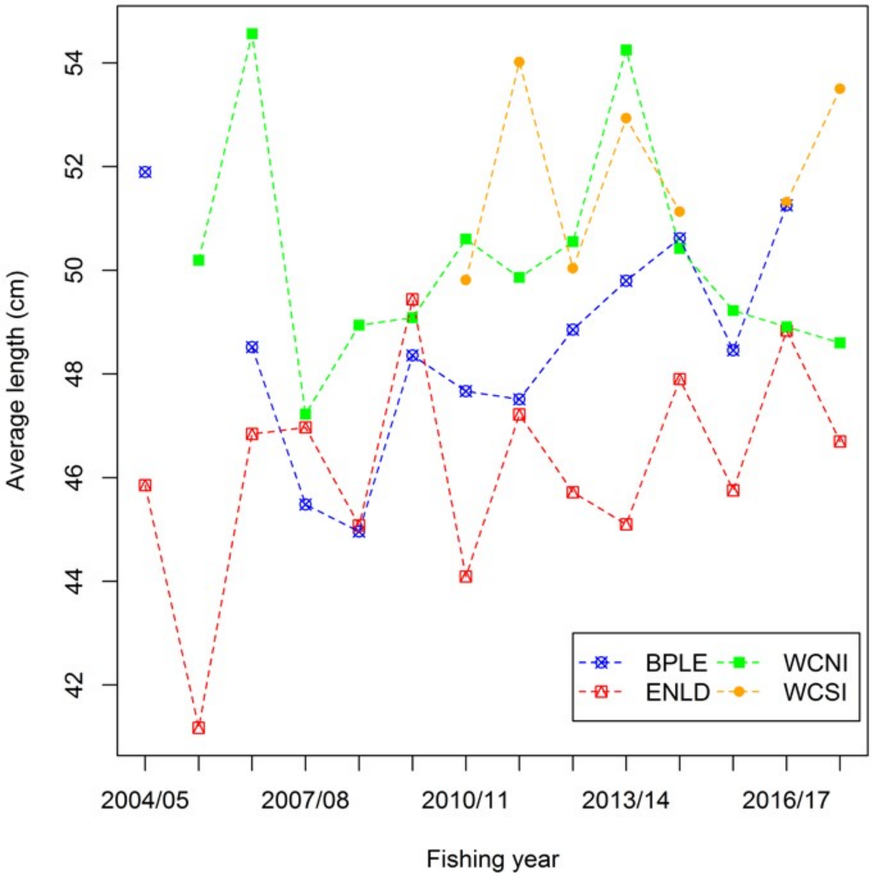

Figure 18: Annual trends in average fish length (fork length, cm) of skipjack tuna catch by fishery area.

5 ENVIRONMENTAL INDICATORS

Total annual skipjack tuna catch is weakly correlated (correlation coefficient 0.42) with the annual average Southern Oscillation Index (SOI) (Trenberth 1984) (Figure 19). Lower catches tended to occur during periods of persistent negative SOI (El Nino) (1991/92–1995/96 and 2000/01–2002/03), while higher catches tended to occur during periods of positive SOI (La Nina) (1998/99, 1999/2000, 2007/08, 2010/11–2012/13). The lower catches during the last few years (2015/16–2017/18) followed a period of negative SOI (Figure 19).

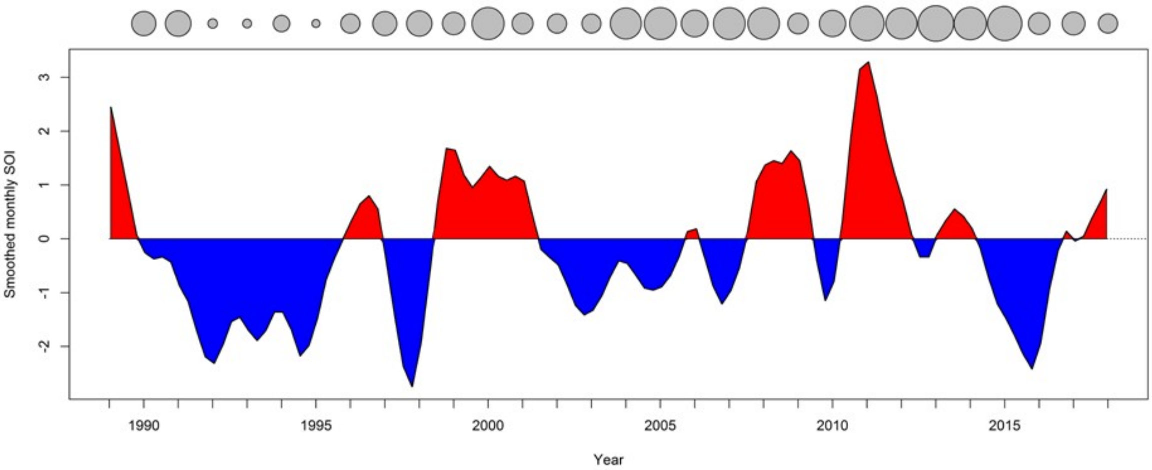

Figure 19: The Southern Oscillation Index (Standardized Tahiti - Standardized Darwin) compared to the annual skipjack tuna catches (grey circles). The area of the grey circles is proportional to the skipjack tuna catch (maximum annual catch = 12702 t). The SOI was sourced from http://http://www.cgd.ucar.edu/cas/catalog/climind/SOI.signal.txt

A simple GLM model was configured to further investigate the relationship between annual catch and recent environmental condition. The predictor variable was the natural logarithm of annual skipjack tuna catch ($lnSKJ_{year}$). The potential explanatory variables were fishing period (categorised as two time blocks 1989/90–2000/01 and 2001/02–2017/18) *FishingPeriod*, SOI (SOI_{year}) and SOI in the preceding year (SOI_{year-1}), the natural logarithm of skipjack tuna catch in the preceding year ($lnSKJ_{year-1}$), the annual sea temperature anomaly for the Tasman Sea (SST_{year}), and the skipjack tuna price index ($Price_{year}$). Fishing period was included in the GLM as a categorical variable and all other variables were included as linear functions. A Gaussian error structure was assumed. The variables included in the final model were selected based on the Akaike information Criteria (AIC).

The Tasman Sea SST anomalies were sourced from http://archive.stats.govt.nz/browse_for_stats/environment/environmental-reporting-series/environmental-indicators/Home/Atmosphere-and-climate/oceanic-sea-surface-temperature.aspx. The skipjack tuna price indices were sourced from https://atuna.com/pages/atuna-skipjack-tuna-price-index.

Fishing effort (or capacity) is difficult to quantify for the purse seine fleet as effort will be correlated with fish abundance; i.e., a larger number of fishing days and sets will tend to occur when skipjack tuna are more abundant. Nonetheless, the entrance of the larger purse seine vessels in the fishery in the early 2000s increased the overall capacity of the domestic fleet. This was accounted for in the GLM by partitioning the time-series into the two periods (*FishingPeriod*).

The final model included the variables *FishingPeriod* and SOI_{year}. The model accounted for 42.7% (adjusted R^2) of the variance in annual catch. Annual catches were predicted to be approximately double in the more recent period; i.e., during the period since the entry of the larger purse seine vessels. The SOI variable accounted for approximately 40% of the explained variance in annual catches. The SOI variable fluctuated between -2.0 and +2.0 during the study period. The model predicted a strong positive relationship between SOI and annual catches; annual catches were predicted to vary by over three-fold across the range of SOI observations (Figure 20). However, the model predictions were highly uncertain at the upper range of SOI observations.

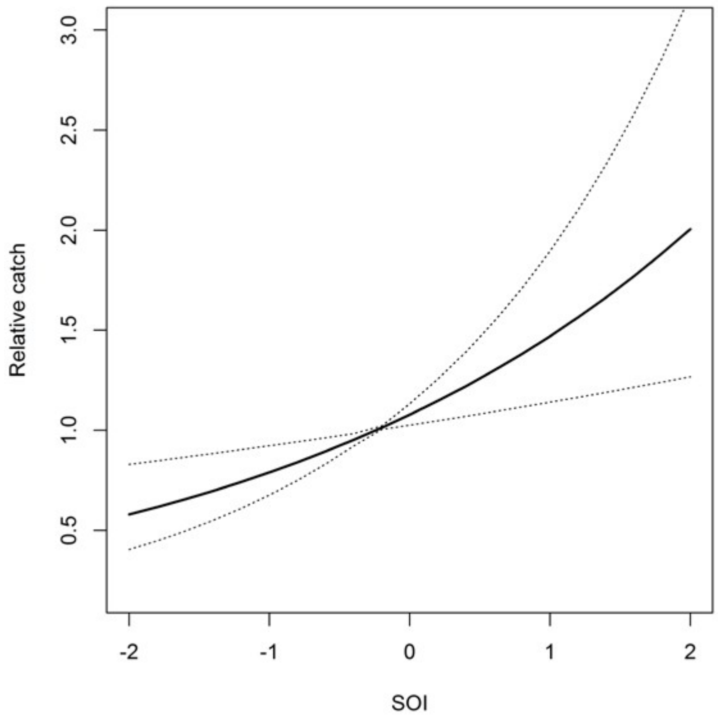

Figure 20: Predicted relationship between the Southern Oscillation Index and the scale of the annual skipjack tuna catch from the GLM model. The dashed lines represent the 95% confidence interval.

Overall, the model predicted the general trend in annual catches although the individual annual catches were poorly predicted by the model (Figure 21). Most notably, the model substantially over-estimated the annual catch in 2001/02, 2008/09 and 2017/18 (positive SOI years) and under-estimated catch in 1999/2000, 2003/04, 2004/05, 2006/07, and 2012/13–2014/15 (generally negative SOI years).

While the variation in SOI accounts for some of the observed variation in annual catch, the model does not provide a reliable prediction of skipjack tuna catch based on the SOI (either in the year when the fishery occurred or in the previous year). The SOI is simply a coarse index of oceanographic conditions in the Pacific Ocean and does not necessarily directly correlate with the abundance and/or availability of skipjack tuna to the purse seine fleet operating in New Zealand waters.

The analysis of local scale oceanographic conditions may provide insights into the key factors influencing the inter-annual variation in skipjack tuna catches. However, simple comparisons of seasonal sea surface temperatures in each of the fishery areas did not provide any explanation of the magnitude of catch taken in the respective area.

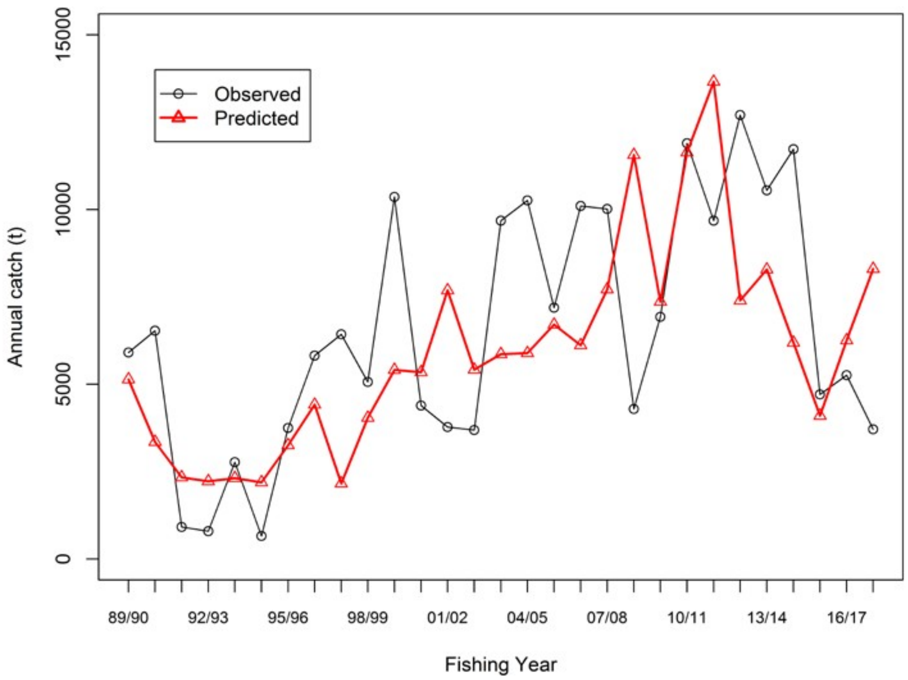

Figure 21: A comparison of the annual skipjack tuna catches and catch predicted from the simple predictive model.

6 DISCUSSION

The performance of the purse seine fishery is reliant on the ability to locate surface schools of skipjack tuna. The domestic purse seine fishery operates in conjunction with spotter planes which assist in the location of surface schools and directs fishing activity accordingly. The aerial sightings data provided by spotter pilots tend to be well correlated with the daily catches of skipjack tuna in the main fishery areas (Langley 2011). The previous study was not updated to include aerial sightings data from the more recent years (from 2009/10).

The searching component of the purse seine fishing operation, including spotter plane activity, is difficult to quantify and, hence, catch rates from the fishery are not considered to be indicative of fish abundance. The magnitude of the annual catch taken by the New Zealand domestic purse seine fishery probably provides a general indication of fish abundance (although catches will also be influenced by changes in fleet operation). Annual catches are likely to be strongly influenced by the availability of skipjack tuna within the EEZ. However, the oceanographic conditions that influence the availability of skipjack tuna in New Zealand waters are not well understood. Oceanographic models (SEAPODYM) have been developed for the Pacific skipjack tuna fishery (Senina et al. 2016), although the results of these models may not be directly applicable to the New Zealand fishery which operates at the periphery of the distribution of skipjack tuna.

The recent (2015/16–2017/18) period of lower catches of skipjack tuna from the domestic fishery followed a period of El Niño (negative SOI) conditions. Further, there is a weak positive correlation between the annual catches of skipjack tuna and the Southern Oscillation Index (from 1989/90 onwards). This suggests that the oceanographic conditions that prevail during El Niño conditions may limit the availability of skipjack tuna to the New Zealand fishery.

The skipjack tuna fishery represents an important seasonal fishery for the domestic purse seine fleet. However, annual catches represent a trivial component of the total catch from the western and central Pacific Ocean (WCPO) skipjack tuna stock (McKechnie et al. 2016). Research tagging of skipjack tuna occurred in New Zealand waters during 1979 and 1980 with subsequent recoveries of fish to the north of New Zealand (in the EEZs of New Caledonia, Fiji, Samoa, and French Polynesia) (Argue & Kearney 1984). A limited number of tagged skipjack tuna have also been recovered in New Zealand waters (Senina et al. 2016) from fish released 3–5 months earlier in Bismarck Sea and Solomon Sea (SPC- OFP TagDager on-line database http://www.spc.int/webtagging). These results provide considerable evidence to support the assumption that the fish in New Zealand waters belong to the wider western equatorial skipjack tuna stock. The current level of monitoring of the catch and length composition of the domestic skipjack tuna fishery appears adequate for the contribution to the WCPO stock assessment and the ongoing monitoring of the performance of the domestic fishery.

7 ACKNOWLEDGMENTS

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APPENDIX 1. SUMMARY OF CATCH AND FISHING EFFORT

Table A1: Skipjack tuna catch (t) from the purse seine target fishery by fishery area and year.

Fishing year	Fishery Area						Total
	BPLE	ECNI	ENLD	WCNI	WCSI	Other	
1989/90	2 477	-	3 138	281	10	525	6 431
1990/91	3 907	-	3 397	9	-	-	7 313
1991/92	507	-	454	-	-	-	961
1992/93	0	-	390	749	-	-	1 139
1993/94	297	-	1 911	782	-	69	3 060
1994/95	404	274	210	-	-	33	921
1995/96	323	1 013	2 034	-	-	694	4 063
1996/97	1 664	-	4 493	8	-	207	6 373
1997/98	4 967	330	1 750	32	-	122	7 201
1998/99	1 508	1 309	2 125	653	-	-	5 594
1999/2000	8 271	204	2 086	316	-	96	10 973
2000/01	2 003	227	685	543	476	97	4 032
2001/02	1 054	89	2 189	549	-	12	3 892
2002/03	909	103	1 025	1 565	184	44	3 830
2003/04	2 494	681	814	6 417	690	19	11 116
2004/05	1 825	56	2 600	5 726	1 053	31	11 292
2005/06	1 084	-	942	5 700	123	-	7 849
2006/07	669	-	7 525	2 635	7	-	10 835
2007/08	4 278	-	3 581	2 784	-	3	10 646
2008/09	1 766	-	1 746	1 131	-	-	4 643
2009/10	2 540	37	1 493	2 042	1 119	-	7 230
2010/11	615	-	4 034	6 472	1 516	78	12 713
2011/12	1 345	-	2 370	4 081	1 906	-	9 701
2012/13	4 124	117	2 326	5 521	1 575	50	13 712
2013/14	2 466	18	1 546	1 359	4 570	32	9 991
2014/15	3 996	-	5 718	2 014	235	81	12 043
2015/16	1 182	-	1 130	2 144	439	14	4 908
2016/17	1 088	-	3 051	795	424	67	5 423
2017/18	708	-	1 570	1 137	370	-	3 785

Table A2: Number of purse seine sets conducted by the skipjack tuna target fishery by area and year.

Fishing year	Fishery Area						Total
	BPLE	ECNI	ENLD	WCNI	WCSI	Other	
1989/90	203	1	214	23	2	22	465
1990/91	256	-	157	1	-	2	416
1991/92	47	-	34	-	-	2	83
1992/93	3	-	24	35	-	-	62
1993/94	56	-	158	84	-	5	303
1994/95	37	29	12	-	-	3	81
1995/96	39	98	172	1	-	47	357
1996/97	117	-	242	5	-	11	375
1997/98	315	14	110	2	-	10	451
1998/99	113	82	146	73	-	1	415
1999/2000	592	3	85	8	-	5	693
2000/01	301	12	79	60	31	7	490
2001/02	181	9	174	72	-	3	439
2002/03	178	6	120	181	1	4	490
2003/04	170	64	84	411	53	2	784
2004/05	154	9	177	260	71	1	672
2005/06	74	-	108	270	9	-	461
2006/07	39	-	272	102	2	-	415
2007/08	268	1	132	134	4	2	541
2008/09	137	-	87	51	-	-	275
2009/10	156	2	55	79	34	-	326
2010/11	62	-	217	265	63	3	610
2011/12	99	-	113	239	76	-	527
2012/13	227	12	82	177	53	6	557
2013/14	196	5	129	120	216	3	671
2014/15	201	-	297	116	28	2	644
2015/16	98	-	67	162	20	2	349
2016/17	74	-	223	59	42	4	402
2017/18	46	-	95	78	39	-	258