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Update standardized CPUE for North Pacific albacore caught by the Japanese pole and line from 1972 to 2018[1]

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Summary

This document shows spatial size distributions and the index of Standardized CPUE (i.e., relative abundance index) of north Pacific albacore caught by Japanese pole-and-line distant water (JPN DWPL). By revisiting decadal changes in the size distributions, it was confirmed that the size has been getting smaller since 2000s in north of 30°N compared to those caught before that period. It was used the same methodologies as the 2017 albacore tuna stock assessment for the analysis of CPUE standardization but the data period was extended to include the end of 2018. Recent trends (2016-2018) calculated in the updated JPN DWPL CPUE stay at the historically low level.

Introduction

Standardized CPUE is essential as an input data for stock assessment with the stock synthesis model. Japanese distant water pole-and-line (JPN DWPL) fishery has caught albacore in the off Japan areas and its fishery locations are associated with seasonal movements of albacore. Before updating the CPUE, we describe the characteristics of JPN DWPL that are to be used in the 2019 stock assessment by looking at trends in fishery locations and the spatial size distributions through the years from 1972 to 2018. The same model was used for JPN DWPL CPUE standardization as the previous stock assessments (Kinoshita et al. 2017), and only the change in the data was addition of recent data extended until 2018, thereby brief descriptions of the CPUE processing are provided in this document.

Data and Methods

Japanese pole-and-line logbooks contained gross register tonnage (GRT), fishery locations, daily catch of albacore, effort (number of poles), and approximate weight of caught individuals for each vessel from 1972-2018. To investigate trends in fishery locations and spatial size distributions, we firstly checked whether the approximate weight contained blank data (i.e., “NA”) to remove them from the calculation. Subsequently, catch weighted average was calculated in each grid to observe the size of caught fish in the fishery locations with all available pole-and-line data. Lastly, spatial size distributions for distant water pole-and-line (DWPL) were prepared for CPUE standardization as described below and compared among each decade from 1970s to 2010s to confirm consistency of target size through the period.

CPUE standardization

Data process and model for CPUE standardization (Tables 1 and 2) was the same as it was used in the last stock assessment (Kinoshita et al. 2017), and calculation steps are briefly explained below.

DWPL for CPUE data was extracted by

- Gross register tonnage (>199 t) and types of fishery (“Enyo”)
- Vessels that has searching devices (bait tank, NOAA receiver, bird radar)
- Operational areas (5°× 5° in 30-45N, 140-180E)
- Operational seasons (quarters 2 and 3)
- Sufficient operational days (>10 days in each year) AND operational years (>five years)

Model descriptions for CPUE standardization were delta-lognormal model (Lo et al. 1992) and its standard error was derived from the method described by Shono (2008).

Log (albacore catch rate) = year + latlong + Vessel ID ~binominal

Log (CPUE) = year + latlong + Vessel ID ~ gaussian

Nominal CPUE was also provided as comparisons.

Nominal CPUE = catch (albacore) / effort (poles),

Results and Discussion

Albacore size caught by pole-and-line

The decrease in large individuals in the recent decades was found, while the size range had also become narrow (Mainly occupied by 10 kg, **Figs 1 and 2**). When the approximate weight in pole-and-line catch records were compared through years (**Figs. 1 and 2**), there are a few individuals larger than 20kg before 1997. In the 1972-1982, although unknown size data is included, catch derived from individuals (>15 kg, shown in yellow in **Fig 1**) consisted high proportion of the catch compared to recent two decades.

These historical size trends would be explained by the change in fishery locations (**Figs. 3-8**). Overall trend of albacore size caught in pole-and-line (**Fig. 3**) is that large individual distributed in subtropical areas, whereas small individuals distributed in temperate areas. Fishery locations in the 1970s-1990s ranged from 25 to 45N and 140E to 180E, but the southern boundary has been gradually shrank toward north (**Figs. 4-8**), which would be one of the reasons recent size was small.

It should be mentioned that historical change in catch have some peaks as observed in long-line data after 1990 (Fujioka et al., 2019). In particular, some peaks were found in 1994, 1997, 1999, 2002, 2007, 2009, 2012. Interestingly, there were also some peaks consisting small individuals around 5kg in 1997, 2003, 2005, 2007, 2010.

CPUE trends

Update of the CPUE was successfully processed (**Tables 2** and **3**) and showed drastic fluctuations in the long-term (yellow line in **Fig. 9**). The CPUE fluctuated within a range of 0.4-1.0 in 1972-1992, but it shifted toward high and stayed at a level around 1.5 in 1993-2003. On the other hand, it went back to the low level again within a range of 0.5-1.0. The latest years (2015-2018) of CPUE corresponded to the historically low level. As found in the catch after 1990 (**Fig. 1**), CPUE had peaks at 1994, 1999, 2002, 2007, 2009 2012, and some of them (2007, 2012) were consistent with peaks (1997, 2003, 2007, 2012, 2015) found in the long-line CPUE of immature albacore (Fujioka et al., 2019).

Reference

Ko Fujioka, Daisuke O., Hirotaka I., and Kiyofuji,H. (2019) Update standardized CPUE for North Pacific albacore caught by the Japanese longline data from 1976 to 2018. ISC/19/ALBWG-02/01.

Kinoshita, J., Ochi, D. and Kiyofuji, H. (2017) Revised of standardized CPUE for North Pacific albacore caught by the Japanese pole and line data from 1972 to 2015. ISC/17/ALBWG-02/05.

Lo, N. C.-h., Jacobson, L. D. and Squire, J. L. (1992) Indices of relative abundance from fish spotter data based on Delta-Lognormal Models. Can. J. Fish. Aquat. Sci., 49: 2515-2526.

Shono, H. (2008) Confidence interval estimation of CPUE year trend in delta-type two-step model. Fish. Sci., 74: 712-717.

Table 1. Summary of data for analysis of CPUE standardization

	Data for ISC DataPrep in 2019
Period (whole)	1972–2018
Region	see Figure 1
Model	delta-lognormal (no update)
Variables	year, latlong, vessel ID (qtr was used only 2nd in 1972-1989 and 2nd-3rd combined in 1990-2018)
Vessel ID	(Kinoshita et al. 2017, no update)

Table 2. Definition of explanatory variables included in the model

Variable	**Data type**	**Description**
Year	Categorical	unique year (1972–2018)
Latlong	Categorical	5°× 5°
vessel ID	Categorical	unique vessel identification

Table 3. ANOVA (1st step (a)) and TYPE III ANOVA (2nd step (b)) in the period 1972–1989.

(a) 1st step

Variable	***Df***	**Chisq** (χ^2)	***p*** (> Chi)
Year	17	2414.352	< 2.2e-16 ***
Latlong	23	9888.587	< 2.2e-16 ***
Vessel ID	204	4328.581	< 2.2e-16 ***

(b) 2nd step

Variable	**TYPE III SS**	***df***	***F***	***p*** (> *F*)
Year	1683.589	17	81.615	< 2.2e-16 ***
Latlong	2053.381	22	76.919	< 2.2e-16 ***
Vessel ID	1678.649	204	6.781	< 2.2e-16 ***

Table 4. ANOVA (1st step (a)) and TYPE III ANOVA (2nd step (b)) in the period 1990–2018.

(a) 1st step

Variable	***Df***	**Chisq** (χ^2)	***p*** (> Chi)
Year	28	8026.413	< 2.2e-16 ***
Latlong	23	5423.672	< 2.2e-16 ***
Vessel ID	78	846.870	< 2.2e-16 ***

(b) 2nd step

Variable	**TYPE III SS**	***df***	***F***	***p*** (> *F*)
Year	2343.971	28	79.238	< 2.2e-16 ***
Latlong	730.140	22	31.414	< 2.2e-16 ***
Vessel ID	519.256	77	6.383	< 2.2e-16 ***

Year	qtr	non-zero rate		positive catch			Relative	by Shono (2008)	
		estimat	SE	estimat	SE	adjusted	abundance Index	⍰[CPUE]	⍰[logCPUE]
1972	2	0.42808	0.0265	0.15178	0.0315	0.151856	0.581715574	0.00305	0.157632557
1973	2	0.60099	0.0239	0.13936	0.0221	0.139395	0.749667555	0.00213	0.242341986
1974	2	0.61372	0.0235	0.19867	0.0210	0.198717	1.091334035	0.00291	0.249208928
1975	2	0.60946	0.0236	0.16441	0.0207	0.164447	0.896854095	0.00238	0.246843005
1976	2	0.57341	0.0243	0.17581	0.0181	0.175845	0.902300302	0.00226	0.227191705
1977	2	0.49407	0.0256	0.09096	0.0209	0.090988	0.402276323	0.00131	0.187025191
1978	2	0.67325	0.0210	0.12296	0.0164	0.122982	0.740921815	0.00146	0.282596112
1979	2	0.52943	0.0250	0.12554	0.0176	0.125561	0.594863417	0.00158	0.204324198
1980	2	0.50975	0.0254	0.13841	0.0201	0.138438	0.631494734	0.00192	0.194665596
1981	2	0.47557	0.0261	0.08202	0.0263	0.082054	0.349192693	0.00143	0.178779047
1982	2	0.38370	0.0259	0.13690	0.0312	0.136975	0.470315453	0.00268	0.138117423
1983	2	0.50753	0.0261	0.14543	0.0280	0.145488	0.660758963	0.0027	0.194542655
1984	2	0.49237	0.0259	0.19684	0.0249	0.196901	0.867542651	0.00328	0.186689947
1985	2	0.62474	0.0245	0.18297	0.0320	0.183070	1.023450737	0.00395	0.256445629
1986	2	0.49034	0.0266	0.14044	0.0326	0.140518	0.61657317	0.00297	0.186881541
1987	2	0.46316	0.0293	0.19092	0.0497	0.191156	0.792269968	0.00598	0.17797751
1988	2	0.35306	0.0397	0.15866	0.1348	0.160114	0.505858361	0.01266	0.181433007
1989	2	0.30195	0.0257	0.17664	0.0527	0.176891	0.477964247	0.00547	0.113330044
1990	2-3	0.31189	0.0254	0.23133	0.0461	0.231583	0.646334555	0.00633	0.114062078
1991	2-3	0.22675	0.0239	0.40862	0.0783	0.409878	0.831681087	0.01798	0.106151179
1992	2-3	0.19513	0.0217	0.37941	0.0753	0.380499	0.664425523	0.01582	0.096523431
1993	2-3	0.29200	0.0253	0.35435	0.0555	0.354898	0.927352579	0.01149	0.111246159
1994	2-3	0.58930	0.0256	0.43411	0.0357	0.434391	2.290708551	0.0103	0.237681253
1995	2-3	0.45588	0.0272	0.38839	0.0386	0.388684	1.585629593	0.00952	0.171812938
1996	2-3	0.64599	0.0242	0.27281	0.0370	0.273001	1.578129584	0.0068	0.268980179
1997	2-3	0.67438	0.0218	0.26838	0.0292	0.268499	1.620319768	0.00536	0.284280948
1998	2-3	0.66601	0.0227	0.27585	0.0367	0.276038	1.645137326	0.00685	0.280330024
1999	2-3	0.67028	0.0221	0.40779	0.0283	0.407956	2.446929207	0.00791	0.28181794
2000	2-3	0.64324	0.0231	0.18335	0.0292	0.183437	1.055870286	0.00364	0.266457105
2001	2-3	0.74912	0.0179	0.20417	0.0256	0.204241	1.369128212	0.00364	0.328822587
2002	2-3	0.80953	0.0143	0.35353	0.0259	0.353657	2.561915528	0.00644	0.367252353
2003	2-3	0.67705	0.0219	0.28515	0.0296	0.285279	1.728406337	0.00578	0.285881555
2004	2-3	0.54213	0.0261	0.24150	0.0311	0.241624	1.172189098	0.00498	0.212369486
2005	2-3	0.48026	0.0263	0.16193	0.0297	0.162006	0.696238145	0.00314	0.181542564
2006	2-3	0.35947	0.0264	0.17222	0.0425	0.172385	0.554525615	0.00446	0.131164592
2007	2-3	0.47662	0.0272	0.25737	0.0365	0.257544	1.098444878	0.00603	0.181053071
2008	2-3	0.35205	0.0264	0.20960	0.0454	0.209826	0.661024996	0.00576	0.129181797
2009	2-3	0.40473	0.0274	0.37885	0.0423	0.379194	1.373347123	0.00994	0.14995657
2010	2-3	0.52481	0.0267	0.26641	0.0365	0.266591	1.251997564	0.00634	0.204500225
2011	2-3	0.38728	0.0271	0.35093	0.0431	0.351259	1.217333065	0.00931	0.142784552
2012	2-3	0.59553	0.0252	0.25517	0.0320	0.255309	1.360576687	0.00548	0.240504407
2013	2-3	0.46250	0.0272	0.27991	0.0363	0.280102	1.159249776	0.0065	0.174383474
2014	2-3	0.46858	0.0277	0.25449	0.0394	0.254689	1.06793139	0.0064	0.17789881
2015	2-3	0.30002	0.0250	0.17244	0.0463	0.172626	0.463466997	0.00471	0.109828112
2016	2-3	0.31390	0.0256	0.16838	0.0483	0.168577	0.473521825	0.00482	0.115701505
2017	2-3	0.34962	0.0266	0.21906	0.0444	0.219282	0.686056089	0.00588	0.127862452
2018	2-3	0.27826	0.0254	0.18312	0.0581	0.183437	0.456774523	0.00616	0.107977748

Table 5. Abundance indices for NPALB caught by the JPN DWPL

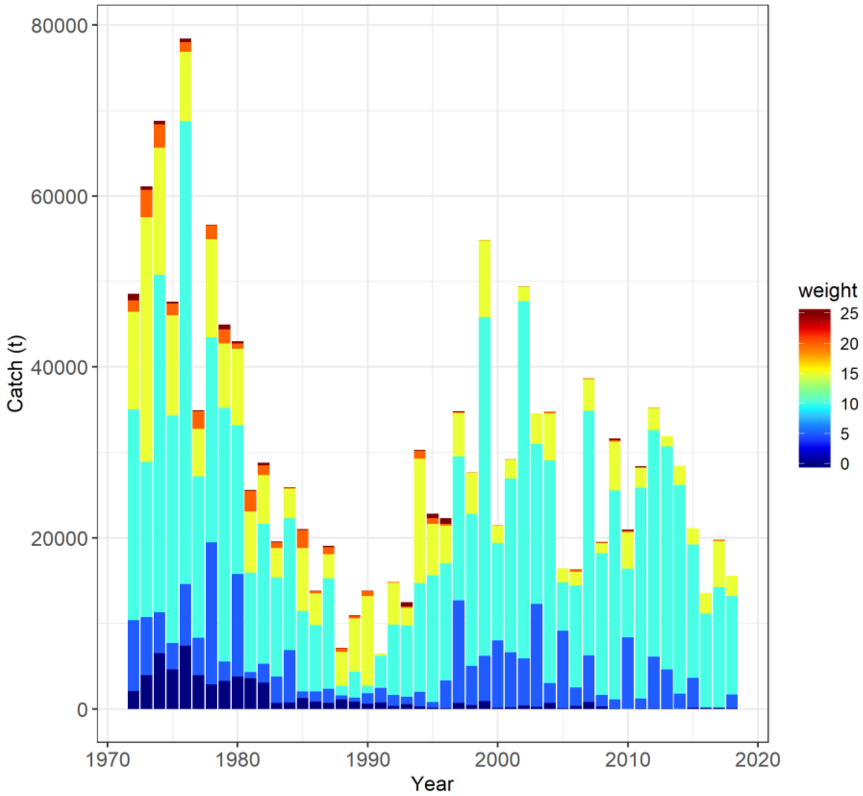

Figure 1. Catch by JPN PL from 1972 to 2018 and its weight composition.

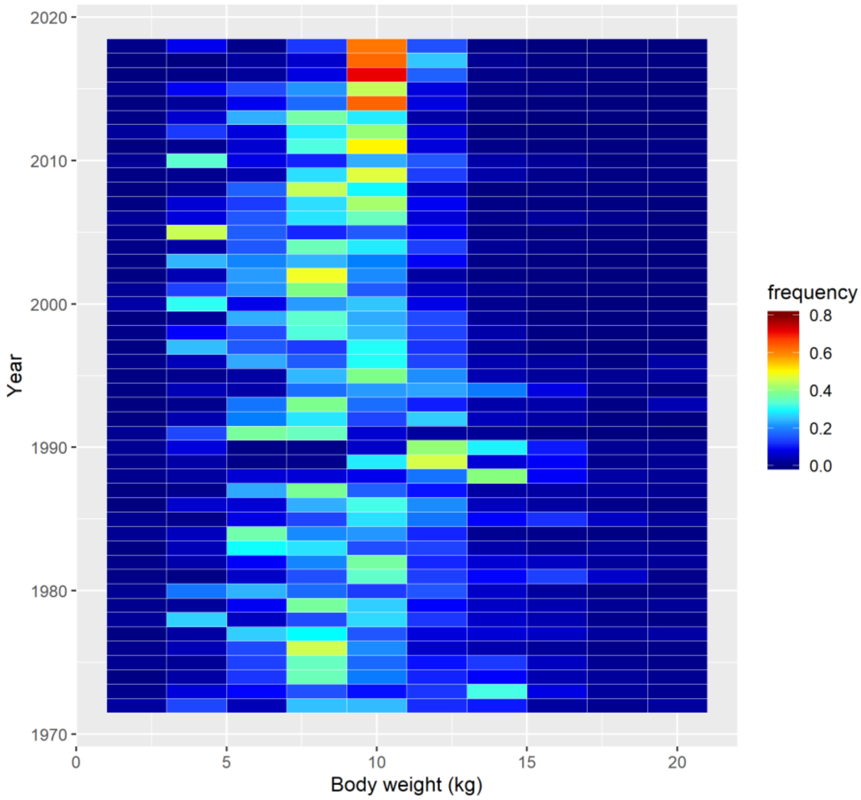

Figure 2. Weight composition ratio of albacore caught by JPN PL from 1972 to 2018.

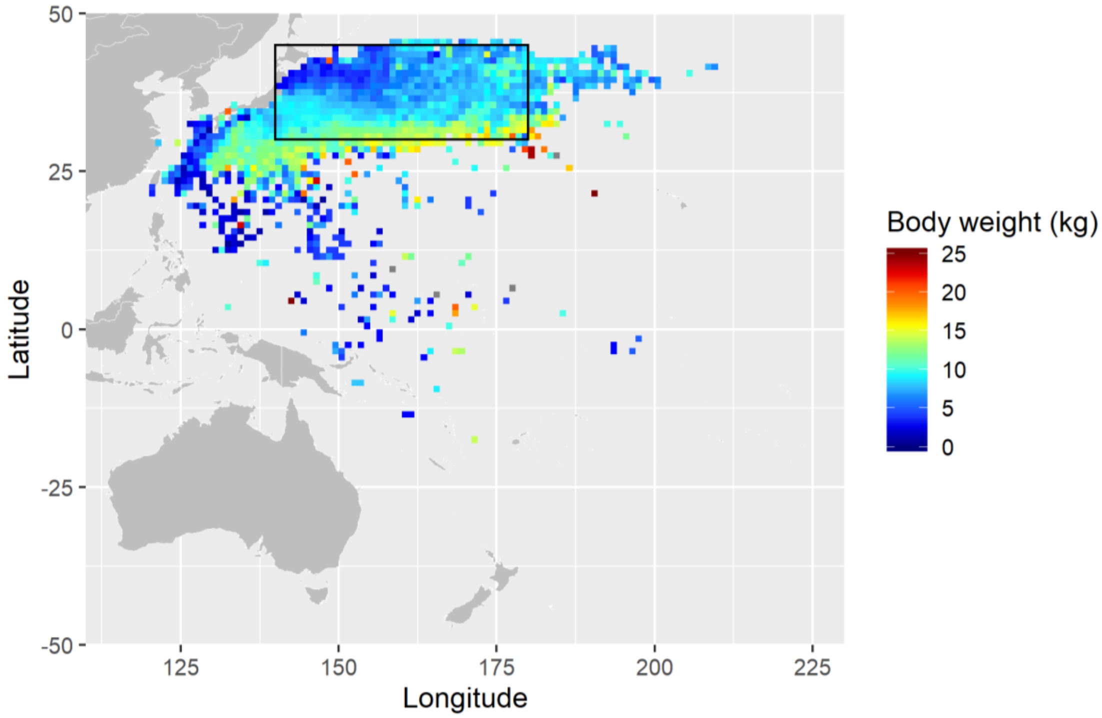

Figure 3. Spatial distribution of albacore body weight caught by the Japanese pole and line (JPN PL). Black square indicated the definition area of the previous study and this study.

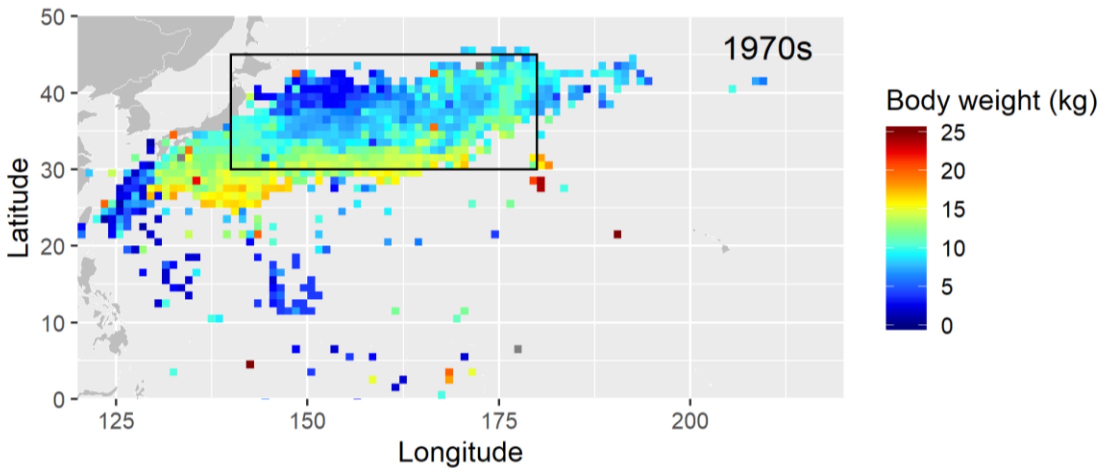

Figure 4. Spatial distribution of weight composition in 1970s.

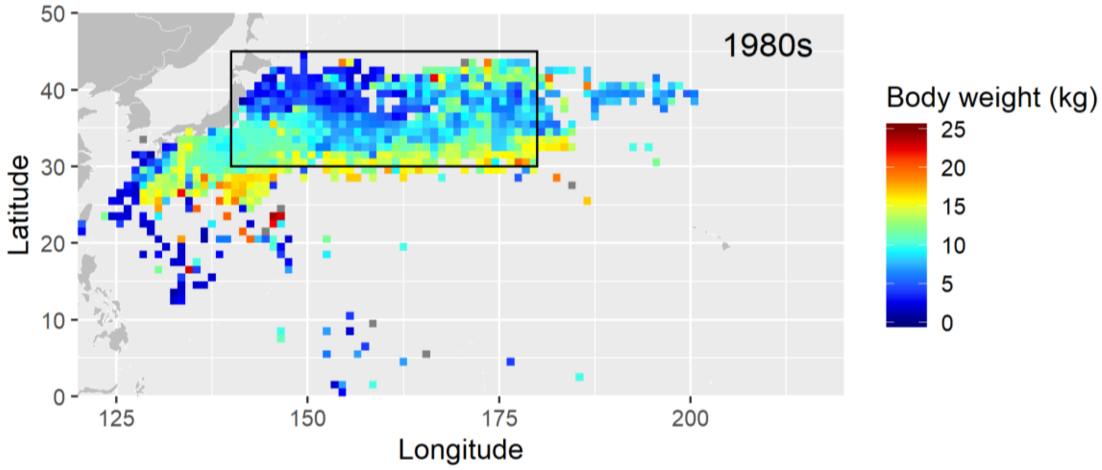

Figure 5. Spatial distribution of weight composition in 1980s.

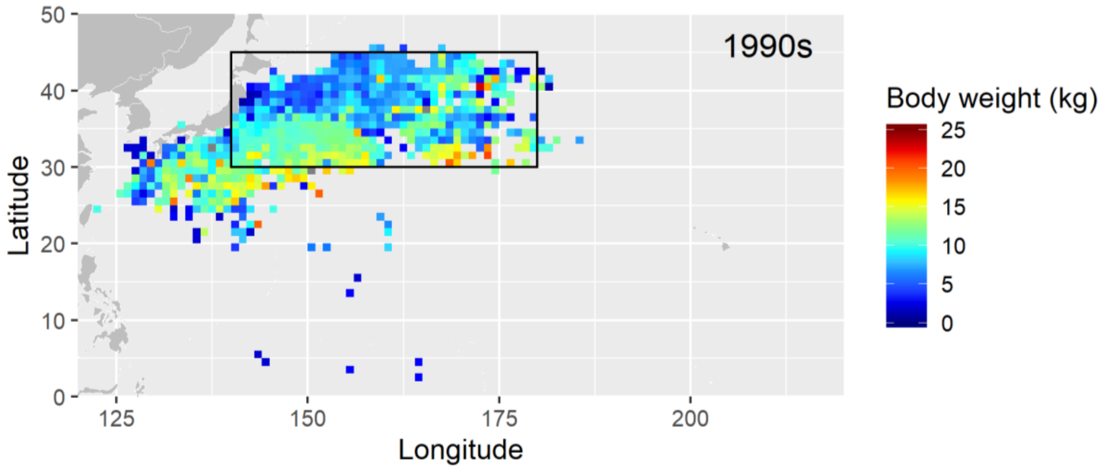

Figure 6. Spatial distribution of weight composition in 1990s.

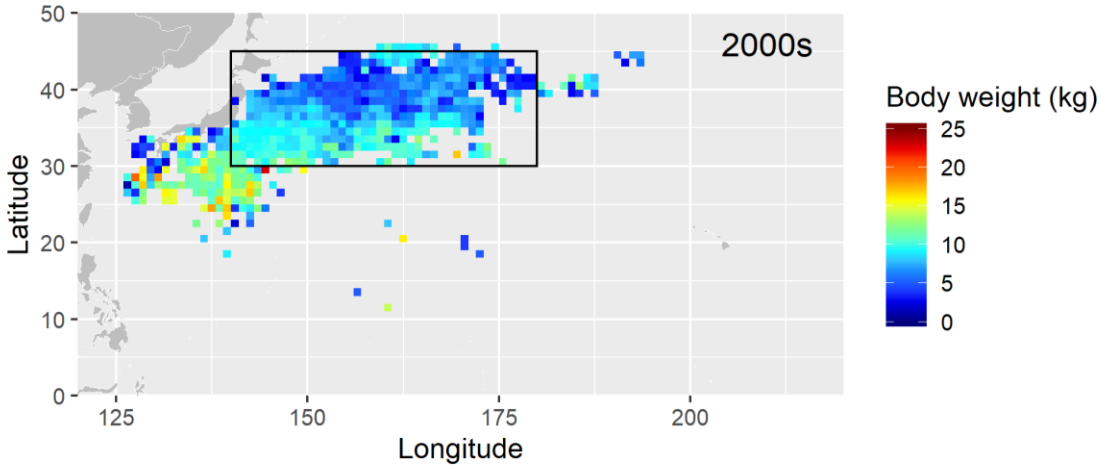

Figure 7. Spatial distribution of weight composition in 2000s.

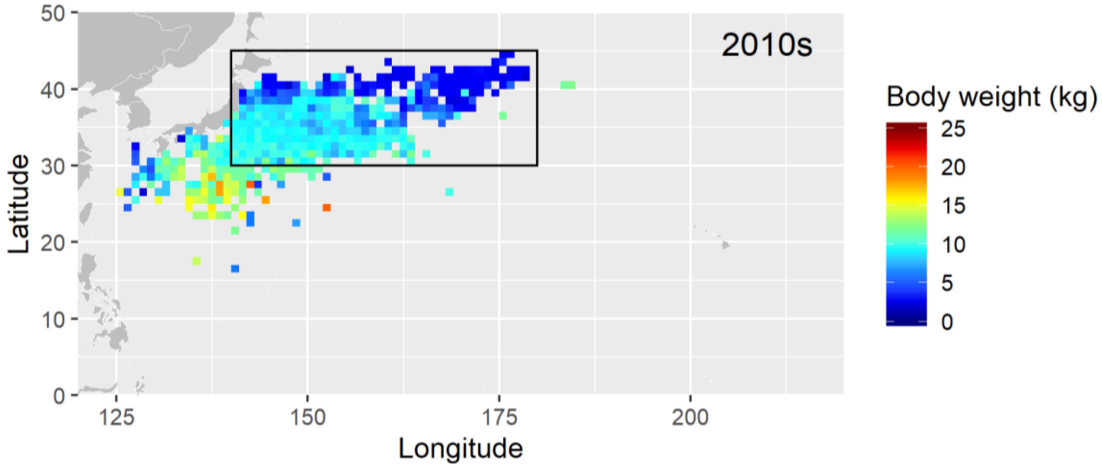

Figure 8. Spatial distribution of weight composition in 2010s.

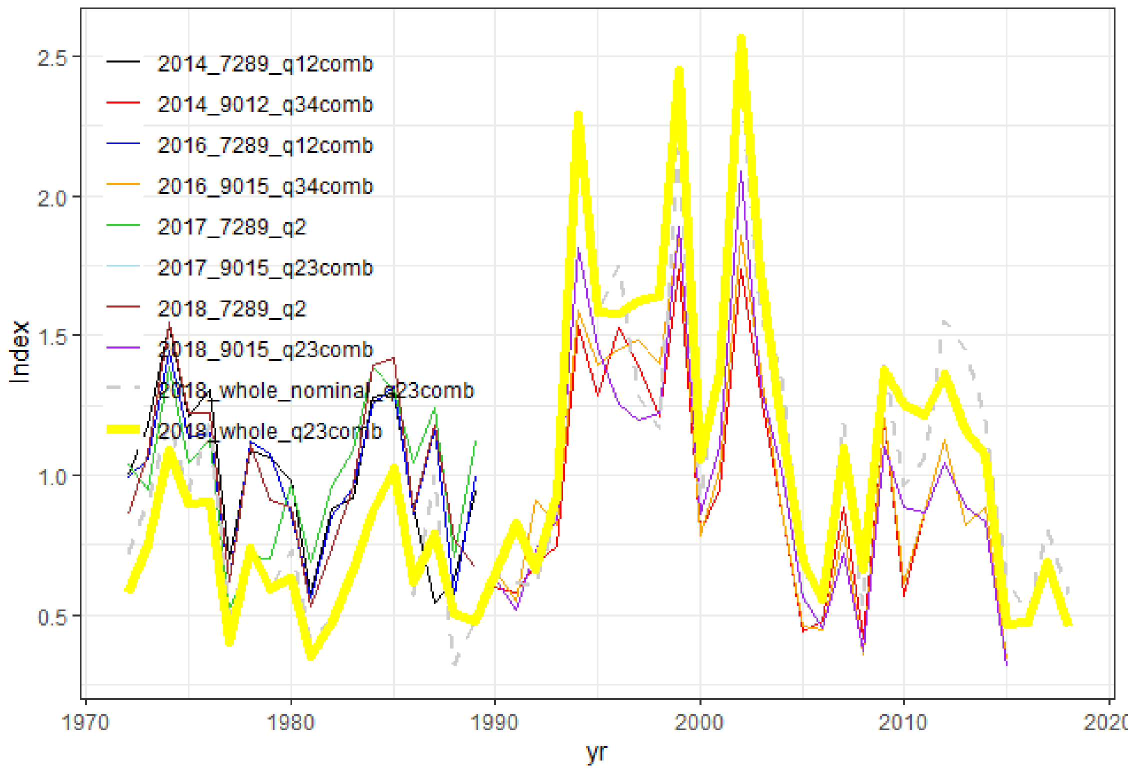

Figure 9. Relative abundance index of NPALB caught by Japanese distant water pole and line (JP DWPL) from 2014 to 2018. Dashed grey line showed nominal CPUE.