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Update standardized CPUE for North Pacific albacore caught by the Japanese pole and line from 1972 to 2022[1]

Makoto Nishimoto, Naoto Matsubara, Hirotaka Ijima, and Yuichi Tsuda

Highly Migratory Resources Division, Fisheries Resources Institute,
Japan Fisheries Research and Education Agency (FRA)

2-12-4, Fukuura, Kanazawa-ku, Yokohama,
Kanagawa 236-8648, JAPAN

Email: nishimoto_makoto44@fra.go.jp

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Summary
This document describes the location of operations and spatial changes in standardized CPUE for the Japanese albacore fishery CPUE was updated to include the most recent data, including the year 2022, to update the results. The CPUE was standardized using the same methodology as last year's albacore tuna stock assessment, but a program code error regarding data aggregation was discovered and corrected. The results of the analysis showed that the estimated standardized CPUE showed almost the same trend as the nominal CPUE. Recent standardized CPUE (2015-2022) was highly variable, with 2022 being the lowest historically.

Introduction
At the last ISC Albacore Working Group Assessment Improvement Meeting on December 6-12, 2022, we gave the presentation on the overview of JPPL fishery and the CPUE calculated by GLM using delta-log normal method (Matsubara et al. 2022). This document describes an update of the analysis using the same method for the JPPL data for Q2 and Q3 as before, with the addition of data for the latest year (2022). In the course of the update, a code error was discovered in which the data aggregation process for the 5-degree grid was not applied properly, and we corrected so that the number of captures and effort were aggregated as annual totals. In this report, we present the updated results as well as our outlook for future modeling.

Data and Methods
Logbook data for JPPL fishery were included daily catch of albacore, gross register tonnage (GRT), fishery locations (Latitude and Longitude), effort (number of poles), vessel ID from 1972-2022. We removed the data that the approximate weight contained blank data (i.e., "NA") from the calculation. Subsequently, total catch was calculated in each grid (5 by 5), in order to confirm the spatial change of fishery locations with all available Japanese distant water pole-and-line data.

CPUE standardization
The statistical model for CPUE standardization (Tables 1 and 2) was the same as previous JPPL CPUE in the last stock assessment (Matsubara et al. 2023). Data filtering process and calculation steps including formula for standardization are described below.

DWPL for CPUE data was extracted by

- Gross register tonnage (>199 t) and types of fishery ("Enyo") for extracting DWPL
- Vessels with 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).

The model for CPUE standardization was a delta-lognormal model (Lo et al. 1992). This method is used for data containing many zeros, which are frequently found in fishery data. In the first step, the binomial distribution model was used to standardize the zero catch rate, and in the second step, a normal distribution model was used to analyze log CPUE for corrected data with a non-zero catch sets.

log(albacore catch rate) = year + latlong +Vessel ID + error1 (1st step).

log(CPUE) = year + latlong + Vessel ID + error2 (2nd step).

All covariates were cosideerd as fixed effect. Standard error was derived from the method described by Shono (2008).

Nominal CPUE was also provided as comparisons.

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

Results and Discussion

We calculated the updated CPUE for the JPPL by adding the new 2022 data and modifying the aggregation method to the appropriate method (Tables 2 and 3). The estimated updated standardized CPUE showed a fluctuating trend similar to the nominal CPUE (Figure 2): compared to the pre-1990s, the CPUE remained high from 1993-2003 and showed a tendency to decline again from 2004 onward. In particular, CPUE in recent years (2015-2022) has also been highly variable, with 2022 being the lowest CPUE in history. The CPUE of the pole and line fishery fluctuates widely over time, and the causes of this have been uncleared. The current model uses latitude/longitude and year information, but it is hoped that incorporating environmental factors that may affect albacore density (e.g., sea surface temperature and ocean current information) into the model in the future will elucidate the mechanisms that cause the large fluctuations.

Reference

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.

Matsubara, N., Matsubayashi, J., Aoki, Y., Tsuda, Y., and Ijima, H. (2022) Update standardized CPUE for North Pacific albacore caught by the Japanese pole and line from 1972 to 2021. ISC/22/ALBWG-02/07.

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 2022
Period (whole)	1972–2022, Quarter 1 and 2
Region	Lat: 30-45, Lon:140-180 (5-degree grid)
Model	delta-lognormal (no update)
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 (1972–2022)
latlong	Categorical	5°× 5°
vessel ID	Categorical	unique vessel identification

Table 3. Abundance indices for NPALB caught by the JPN DWPL. Relative abundance Index is the standard CPUE for each year divided by the annual average.

Year	qtr	non-zero rate		Std. CPUE			Relative	by Shono (2008)	
		estimat	SE	estimat	SE	adjusted	abundance Index	σ[CPUE]	σ[logCPUE]
1972	2-3	0.58432	0.060	0.09878	0.068	0.099014	0.787199814	0.00455	0.242148217
1973	2-3	0.73741	0.047	0.12718	0.050	0.127348	1.277743603	0.00458	0.324605956
1974	2-3	0.71519	0.049	0.15772	0.045	0.157895	1.53648789	0.00516	0.310436315
1975	2-3	0.76263	0.044	0.12933	0.041	0.129447	1.343207451	0.00388	0.338844351
1976	2-3	0.67500	0.052	0.13311	0.039	0.133219	1.223504343	0.00384	0.285923463
1977	2-3	0.57779	0.058	0.06624	0.042	0.066305	0.521257221	0.00201	0.23270766
1978	2-3	0.72228	0.047	0.08895	0.035	0.089016	0.874807804	0.00233	0.313343635
1979	2-3	0.64681	0.054	0.08158	0.037	0.081639	0.718470509	0.00226	0.269542026
1980	2-3	0.59481	0.057	0.08661	0.043	0.086698	0.701659673	0.00269	0.241947606
1981	2-3	0.59794	0.058	0.05493	0.053	0.055015	0.447596208	0.00203	0.245538013
1982	2-3	0.56324	0.059	0.07252	0.052	0.072627	0.556584344	0.00262	0.227214118
1983	2-3	0.67523	0.053	0.07668	0.053	0.076798	0.705573367	0.00289	0.288363157
1984	2-3	0.63917	0.055	0.12356	0.050	0.123724	1.075988118	0.0044	0.267434704
1985	2-3	0.63956	0.057	0.13253	0.065	0.132825	1.155855822	0.00597	0.270918181
1986	2-3	0.57514	0.059	0.07435	0.064	0.074509	0.583072056	0.00323	0.23631873
1987	2-3	0.58884	0.065	0.13352	0.104	0.134257	1.075653588	0.00919	0.256930261
1988	2-3	0.44700	0.087	0.06191	0.243	0.063768	0.387840438	0.00927	0.292794294
1989	2-3	0.40274	0.063	0.09955	0.105	0.100113	0.548596194	0.00647	0.177657704
1990	2-3	0.36885	0.060	0.12598	0.093	0.126533	0.635029834	0.00717	0.158295838
1991	2-3	0.21646	0.051	0.16644	0.177	0.169090	0.498007037	0.01651	0.190079361
1992	2-3	0.21091	0.050	0.29172	0.170	0.295983	0.849405566	0.02768	0.182532669
1993	2-3	0.32914	0.060	0.07825	0.128	0.078910	0.353385819	0.00598	0.170328189
1994	2-3	0.60528	0.060	0.19319	0.083	0.193876	1.596683974	0.0108	0.257646512
1995	2-3	0.54561	0.062	0.19543	0.084	0.196124	1.455973086	0.01079	0.227954135
1996	2-3	0.64056	0.059	0.22110	0.086	0.221940	1.93434352	0.01292	0.277266307
1997	2-3	0.73227	0.049	0.16661	0.063	0.166956	1.663454405	0.00737	0.323717217
1998	2-3	0.51305	0.064	0.16805	0.096	0.168837	1.178585989	0.01041	0.217625904
1999	2-3	0.66483	0.056	0.23755	0.075	0.238222	2.154917896	0.01217	0.287246647
2000	2-3	0.69195	0.053	0.11456	0.069	0.114845	1.081251652	0.00548	0.301230918
2001	2-3	0.69805	0.053	0.16162	0.069	0.162014	1.538785782	0.00775	0.304790776
2002	2-3	0.76802	0.046	0.25623	0.069	0.256845	2.683976602	0.01237	0.346638802
2003	2-3	0.83934	0.036	0.22517	0.069	0.225711	2.577672059	0.01102	0.392190204
2004	2-3	0.61710	0.060	0.14339	0.078	0.143844	1.207769061	0.0076	0.262329532
2005	2-3	0.62246	0.058	0.08603	0.069	0.086242	0.730416862	0.00407	0.262585589
2006	2-3	0.51365	0.064	0.07177	0.093	0.072089	0.503828863	0.00435	0.216929095
2007	2-3	0.60733	0.061	0.09283	0.089	0.093205	0.770203584	0.00555	0.260758969
2008	2-3	0.50880	0.065	0.08034	0.109	0.080823	0.559535406	0.00561	0.221828936
2009	2-3	0.57206	0.063	0.17127	0.094	0.172044	1.339130382	0.01069	0.244885902
2010	2-3	0.54029	0.063	0.11386	0.088	0.114309	0.840323296	0.00657	0.226993416
2011	2-3	0.51747	0.065	0.16432	0.097	0.165112	1.162532316	0.01039	0.220471423
2012	2-3	0.70955	0.054	0.15621	0.081	0.156728	1.513109149	0.00871	0.314294829
2013	2-3	0.61066	0.061	0.14758	0.085	0.148117	1.23068403	0.0084	0.260904303
2014	2-3	0.64842	0.060	0.16763	0.092	0.168346	1.48525272	0.01041	0.283259969
2015	2-3	0.44371	0.066	0.04842	0.115	0.048749	0.294312148	0.00348	0.198432312
2016	2-3	0.39295	0.063	0.10355	0.113	0.104220	0.557223584	0.00718	0.179039401
2017	2-3	0.47235	0.064	0.12011	0.098	0.120705	0.775771587	0.00755	0.201277973
2018	2-3	0.42067	0.064	0.08386	0.106	0.084341	0.48274159	0.00555	0.184893218
2019	2-3	0.32717	0.059	0.02763	0.113	0.027810	0.123798643	0.00187	0.15850082
2020	2-3	0.55878	0.064	0.17482	0.099	0.175683	1.335707546	0.01134	0.240172692
2021	2-3	0.41839	0.065	0.05550	0.116	0.055879	0.31810503	0.004	0.189972701
2022	2-3	0.08100	0.029	0.04073	0.301	0.042626	0.046982538	0.0064	0.302373417

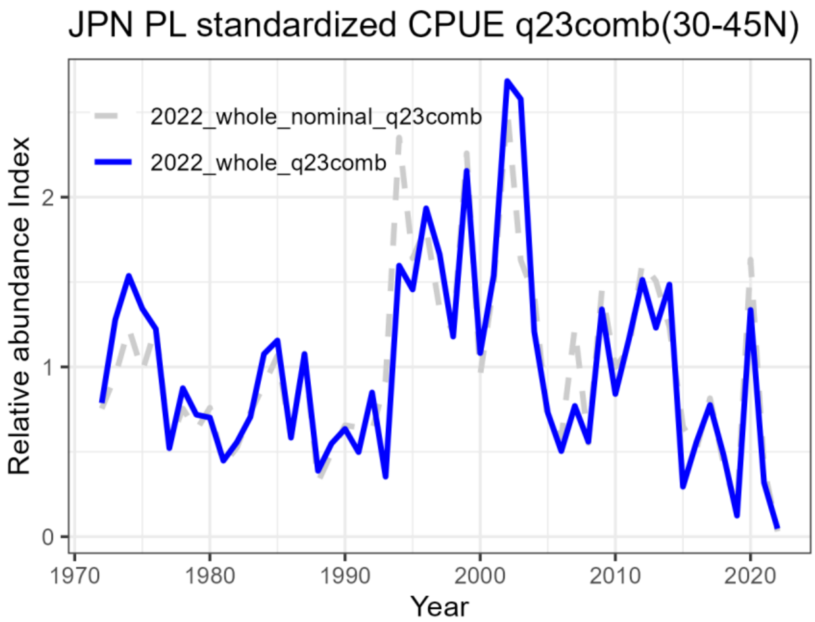

Figure 1. Relative abundance index of NPALB caught by Japanese distant water pole and line (JP DWPL) from 1972 to 2022. Blue line indicates standardized CPUE. Dashed grey line showed nominal CPUE.