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Update standardized CPUE for North Pacific albacore caught by the Japanese pole and line data

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Introduction

In this document, updated abundance index for the NPALB caught by the Japanese distant water pole and line fisheries were described and key points from the data preparatory meeting and email discussion s whether catchability changes around the late 1980's and early 1990's.

Data and Method

Data used same as the data preparatory meeting held in Shimizu in November 2013. To investigate searching device (low temperature bait tank, sonar, NOAA receiver and bird radar) introduction during the analysis period, equipped percentage of each device were calculated.

Simple analysis to investigate each vessel effect on CPUE was conducted by GLM compared with results both without vessel ID and added vessel ID in explanatory variables.

Estimating abundance indices after separating at certain year was described in the previous document (See Kiyofuji and Ijima, 2013). Following model configurations were applied.

Delta-lognormal (Lo *et al.*, 1992)

- 1st Step: estimate non-zero catch rate
  $$log(rate) = year + qtr + latlong + VesselID + \epsilon,\ \epsilon \sim binominal$$
- 2nd Step: estimate positive catch
  $$log(CPUE) = year + qtr + latlong + VesselID + \epsilon,\ \epsilon \sim (0, \sigma^2)$$

An unbiased relative abundance indices can be calculated as follows;

$$Indices = \frac{exp(\hat{\alpha})}{1+exp(\hat{\alpha})} \times exp(\hat{\beta} + \hat{\sigma}^2/2)$$

where $\hat{\alpha}$ is the estimate year factor for the binomial GLM, $\hat{\alpha}$ and $\hat{\sigma}^2$ are the estimated year factor for the positive catch (lognormal) GLM and the standard error of $\hat{\alpha}$, respectively.

Results and Discussion

Table 1 represent NPALB catch by the JPN DW PL (ton) in each quarter in area for estimating standardized CPUE, indicating that main season likely shift after late 1980's from quarter 2 to quarter 3. Figure 1 shows ratio of equipment (black: low temperature live bait tank, br1: bird radar, br2: high-powered bird radar, sonar and noaa: noaa satellite meteorological information receiver). One significant changes of catch was that catch in quarter 3 increased after 1990 and this was due to changes of fishing area (Kiyofuji, 2013) for targeting albacore with more fat. Low temperature biattank was first equipped on 1981 with keeping lots of baits and high survival rate for long period. The 1st generation bird radar was developed in 1987, that was radar adjusted to show a bird and birds school around 15 miles of rada. The 2nd generation bird radar was introduced in 1991 with being searching area about 25 miles. NOAA receiver began to use for searching fishing ground in 1988. Sonar has been started to develop and introduced in 1980's. After introducing these devices, ratio increased and almost all vessels have every device after 1992.

Figure 2 shows that abundance indices from GLM with year+qtr+latlong (black) and year+qtr+latlong+vesselID (red) and ratio of indices without vesselID to with vesselID. Ratio of indices has been increasing through analysis period, indicating that vessel has increased their catchability.

Summary of this document is as follows;

- ✓ Searching device on JPN DW PL has been developed from early 1980's to early 1990's. This would changed their fishing manner and cathability.
- ✓ Decadal and spatial changes of fishing ground formation were observed from 1980's to 1990's. Catch in quarter 3 increased from 1990. These could be due to change of demand of albacore with more fat.
- ✓ Simple analysis to examine vessel effect on CPUE indicate that vessel itself increased their catchability.

From these summaries, it is still difficult to determine the actual turning point (year) with changing their chatchability, however it is likely changes their fishing manner with introducing searching device or demand of fish market. 1989 is one candidate for separating JPN DW PL taking into consideration of fishing manner or catchability changes.

Figure 3 shows that relative abundance index of NPALB caught by the Japanese DW PL (dashed gray: presented by the data preparatory meeting; solid black and red: separated index before and after 1989). Both trends were similar to that presented at the data preparatory meeting, but their level were slightly changed. Table 2 – 6 represent each GLM diagnostics and estimated abundance indices.

Reference

Kiyofuji, H. and Ijima, H. (2013) Standardized CPUE for albacore caught by the Japanese pole and line fishery in the northwestern North Pacific Ocean. ISC/13/ALBWG-03/03.

Kiyofuji, H. (2013) Reconsideration of CPUE for albacore caught by the Japanese pole and line fishery in the northwestern Pacific Ocean. ISC/13/ALBWG-1/10.

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.

Table 1. Total albacore catch by the JPN DWPL in the area for estimating standardized CPUE

Year	quarter			
	1	2	3	4
1972	1.0	11314.0	1307.0	27.2
1973	491.7	19643.0	2206.1	1.2
1974	19.7	29500.9	1779.7	70.0
1975	94.3	24907.3	951.2	1.0
1976	137.4	40027.8	201.4	4959.0
1977	82.1	15808.3	172.4	4213.8
1978	2.2	16735.0	14539.0	3490.8
1979	2.0	14917.7	8015.8	3191.4
1980	17.1	17941.9	2912.6	392.5
1981	20.8	8347.2	157.9	223.1
1982	73.0	7662.3	177.6	715.7
1983	42.0	10554.0	477.8	524.5
1984	1.0	16965.9	666.1	31.0
1985	6.4	10072.6	81.9	182.5
1986	2.5	6095.4	687.1	271.2
1987	–	43.4	76.1	7.1
1988	1.0	1028.1	8.7	1.7
1989	–	2962.3	493.5	2.8
1990	1.0	2158.5	2852.9	155.5
1991	1.0	158.4	2479.4	156.8
1992	–	312.8	899.8	1.0
1993	–	3006.7	3490.1	1.2
1994	1.0	3715.1	17025.4	46.0
1995	–	2627.4	13489.9	1512.6
1996	1.0	4383.8	6878.1	1.6
1997	1.0	5143.0	13975.6	3444.4
1998	1.0	114.2	12542.7	362.8
1999	–	12210.4	21116.7	6698.7
2000	1.0	4879.3	13258.5	1159.6
2001	1.0	6967.5	18187.9	694.6
2002	–	9532.4	31183.6	324.8
2003	–	7863.2	14858.0	5942.8
2004	25.0	14021.0	2271.9	1.0
2005	–	3651.0	8182.9	331.1
2006	–	4560.8	1650.2	844.4
2007	1.0	10836.8	1215.2	1.0
2008	–	4868.8	1347.4	1.0
2009	1.0	10881.3	1146.1	81.6
2010	–	6951.7	5312.8	67.6
2011	–	8739.8	2904.3	1.0
2012	–	9114.5	5920.3	39.4

Table 2. Definition of the predictor variables included in the model.

Variable	Data Type	Description
year	Categorical	unique year
qtr	Categorical	unique quarter 1. Jan.- June. 2. Jul. – Dec.
latlong	Categorical	5^{o} x 5^{o}
vesselID	Categorical	Unique vessel ID

Table 3. Anova for 1st step (a) and TYPE3 ANOVA for 2nd step (1972 – 1989).

(a)

Variable	DF	Chisq	Pr (>Chi)
year	17	4614.3	132815 < 2.2e-16 ***
qtr	1	14218.5	118597 < 2.2e-16 ***
latlong	39	11129.1	107467 < 2.2e-16 ***
vID	207	3891.7	103576 < 2.2e-16 ***

(b)

Variable	SS	Df	F	Pr (>F)
year	1795	17	5.5	< 2.2e-16 ***
qtr	843	1	682.7	< 2.2e-16 ***
latlong	2632	38	56.1	< 2.2e-16 ***
vID	2199	207	8.6	< 2.2e-16 ***

Table 4. Anova for 1st step (a) and TYPE3 ANOVA for 2nd step (1990 – 2012).

(a)

Variable	DF	Chisq	Pr (>Chi)
year	22	69743	89273 < 2.2e-16 ***
qtr	1	69742	85014 < 2.2e-16 ***
latlong	39	69703	76247 < 2.2e-16 ***
vID	79	69624	75232 < 2.2e-16 ***

(b)

Variable	SS	Df	F	Pr (>F)
year	1926	22	83.1	< 2.2e-16 ***
qtr	843	1	144.5	< 2.2e-16 ***
latlong	2632	36	28.5	< 2.2e-16 ***
vID	2199	614	7.6	< 2.2e-16 ***

Table 5. Abundance indices for NPALB caught by the Japanese distant water pole and line between 1972 and 1989 for quarter 1 and 2, and quarter 3 and 4.

quarter 1 and quarter 2								
year	non0rate	SE1	lsmean	SE2	adjINDEX	abnIndex	sigmaCPUE	sigmalogCPUE
1972	0.598	0.033	0.134	0.038	0.134	1.001	0.003	0.24
1973	0.703	0.028	0.134	0.030	0.134	1.178	0.003	0.30
1974	0.674	0.030	0.183	0.029	0.183	1.537	0.004	0.28
1975	0.632	0.031	0.154	0.028	0.154	1.212	0.003	0.26
1976	0.669	0.030	0.156	0.026	0.156	1.303	0.003	0.28
1977	0.612	0.032	0.092	0.027	0.092	0.701	0.002	0.25
1978	0.734	0.026	0.119	0.025	0.119	1.086	0.002	0.32
1979	0.681	0.029	0.125	0.026	0.125	1.062	0.002	0.29
1980	0.581	0.033	0.135	0.028	0.135	0.979	0.003	0.23
1981	0.566	0.033	0.081	0.031	0.081	0.574	0.002	0.22
1982	0.535	0.034	0.132	0.035	0.132	0.881	0.003	0.21
1983	0.596	0.033	0.124	0.034	0.124	0.920	0.003	0.24
1984	0.596	0.033	0.172	0.032	0.172	1.279	0.004	0.24
1985	0.641	0.032	0.162	0.035	0.162	1.295	0.004	0.27
1986	0.557	0.034	0.128	0.038	0.128	0.888	0.003	0.22
1987	0.348	0.050	0.121	0.221	0.124	0.539	0.016	0.25
1988	0.407	0.038	0.122	0.083	0.123	0.623	0.006	0.17
1989	0.467	0.036	0.161	0.052	0.162	0.941	0.005	0.18

quarter 3 and quarter 4								
year	non0rate	SE1	lsmean	SE2	adjINDEX	abnIndex	sigmaCPUE	sigmalogCPUE
1972	0.233	0.029	0.084	0.040	0.084	0.968	0.002	0.08
1973	0.331	0.033	0.085	0.033	0.085	1.378	0.002	0.12
1974	0.301	0.032	0.115	0.032	0.115	1.701	0.002	0.10
1975	0.262	0.030	0.097	0.031	0.097	1.244	0.002	0.09
1976	0.295	0.031	0.098	0.029	0.098	1.428	0.002	0.10
1977	0.245	0.029	0.058	0.029	0.058	0.695	0.001	0.08
1978	0.368	0.033	0.075	0.026	0.075	1.353	0.001	0.13
1979	0.308	0.031	0.079	0.027	0.079	1.191	0.001	0.11
1980	0.221	0.028	0.085	0.030	0.085	0.921	0.002	0.08
1981	0.210	0.027	0.051	0.033	0.051	0.527	0.001	0.07
1982	0.188	0.026	0.083	0.037	0.083	0.770	0.002	0.07
1983	0.232	0.028	0.078	0.035	0.078	0.887	0.002	0.08
1984	0.231	0.028	0.108	0.034	0.108	1.233	0.002	0.08
1985	0.269	0.031	0.102	0.037	0.102	1.350	0.002	0.10
1986	0.203	0.027	0.080	0.040	0.080	0.803	0.002	0.07
1987	0.093	0.024	0.076	0.221	0.078	0.358	0.009	0.22
1988	0.119	0.021	0.077	0.084	0.077	0.450	0.003	0.09
1989	0.148	0.023	0.102	0.053	0.102	0.741	0.003	0.07

Table 6. Abundance indices for NPALB caught by the Japanese distant water pole and line between 1990 and 2012 for quarter 1 and 2, and quarter 3 and 4.

quarter 1 and quarter 2								
year	non0rate	SE1	lsmean	SE2	adjINDEX	abnIndex	sigmaCPUE	sigmalogCPUE
1990	0.441	0.039	0.179	0.064	0.179	0.736	0.007	0.17
1991	0.334	0.036	0.279	0.085	0.280	0.871	0.014	0.14
1992	0.320	0.039	0.349	0.126	0.352	1.050	0.026	0.17
1993	0.399	0.038	0.264	0.070	0.265	0.985	0.011	0.16
1994	0.546	0.039	0.298	0.056	0.299	1.521	0.011	0.22
1995	0.510	0.039	0.287	0.057	0.288	1.369	0.011	0.20
1996	0.637	0.038	0.210	0.058	0.211	1.250	0.008	0.27
1997	0.633	0.037	0.195	0.053	0.195	1.152	0.007	0.26
1998	0.568	0.039	0.216	0.057	0.216	1.144	0.008	0.23
1999	0.626	0.038	0.249	0.052	0.250	1.458	0.009	0.26
2000	0.570	0.038	0.141	0.053	0.141	0.750	0.005	0.23
2001	0.610	0.038	0.145	0.052	0.145	0.824	0.005	0.25
2002	0.635	0.037	0.241	0.052	0.241	1.427	0.008	0.27
2003	0.650	0.037	0.169	0.053	0.169	1.025	0.006	0.27
2004	0.542	0.039	0.172	0.056	0.172	0.870	0.006	0.22
2005	0.473	0.038	0.114	0.054	0.115	0.504	0.004	0.18
2006	0.452	0.038	0.137	0.060	0.137	0.575	0.005	0.18
2007	0.544	0.039	0.174	0.060	0.175	0.884	0.007	0.22
2008	0.408	0.037	0.142	0.067	0.142	0.541	0.006	0.16
2009	0.512	0.039	0.267	0.061	0.268	1.277	0.01	0.20
2010	0.448	0.038	0.163	0.057	0.163	0.680	0.006	0.17
2011	0.458	0.039	0.242	0.062	0.243	1.035	0.009	0.18
2012	0.595	0.039	0.193	0.057	0.193	1.071	0.007	0.24

quarter 3 and quarter 4								
year	non0rate	SE1	lsmean	SE2	adjINDEX	abnIndex	sigmaCPUE	sigmalogCPUE
1990	0.150	0.020	0.145	0.063	0.146	0.603	0.005	0.08
1991	0.093	0.015	0.227	0.085	0.228	0.584	0.01	0.09
1992	0.086	0.016	0.284	0.126	0.286	0.685	0.019	0.13
1993	0.125	0.018	0.215	0.071	0.215	0.745	0.008	0.08
1994	0.228	0.027	0.243	0.056	0.243	1.534	0.008	0.09
1995	0.198	0.024	0.234	0.058	0.234	1.283	0.008	0.08
1996	0.322	0.034	0.171	0.058	0.171	1.527	0.006	0.12
1997	0.317	0.033	0.159	0.053	0.159	1.394	0.005	0.12
1998	0.248	0.028	0.175	0.057	0.176	1.207	0.006	0.10
1999	0.310	0.032	0.203	0.053	0.203	1.741	0.006	0.12
2000	0.250	0.028	0.115	0.054	0.115	0.794	0.004	0.10
2001	0.291	0.031	0.118	0.053	0.118	0.949	0.004	0.11
2002	0.320	0.033	0.196	0.053	0.196	1.738	0.006	0.12
2003	0.339	0.034	0.137	0.053	0.138	1.290	0.004	0.13
2004	0.224	0.027	0.140	0.057	0.140	0.870	0.005	0.09
2005	0.170	0.022	0.093	0.055	0.093	0.439	0.003	0.08
2006	0.156	0.021	0.111	0.060	0.111	0.481	0.004	0.08
2007	0.225	0.027	0.142	0.061	0.142	0.886	0.005	0.09
2008	0.130	0.018	0.115	0.068	0.116	0.416	0.004	0.08
2009	0.199	0.025	0.217	0.062	0.218	1.200	0.008	0.09
2010	0.154	0.020	0.132	0.058	0.132	0.565	0.004	0.07
2011	0.160	0.021	0.197	0.062	0.197	0.876	0.007	0.08
2012	0.275	0.031	0.157	0.057	0.157	1.194	0.005	0.11

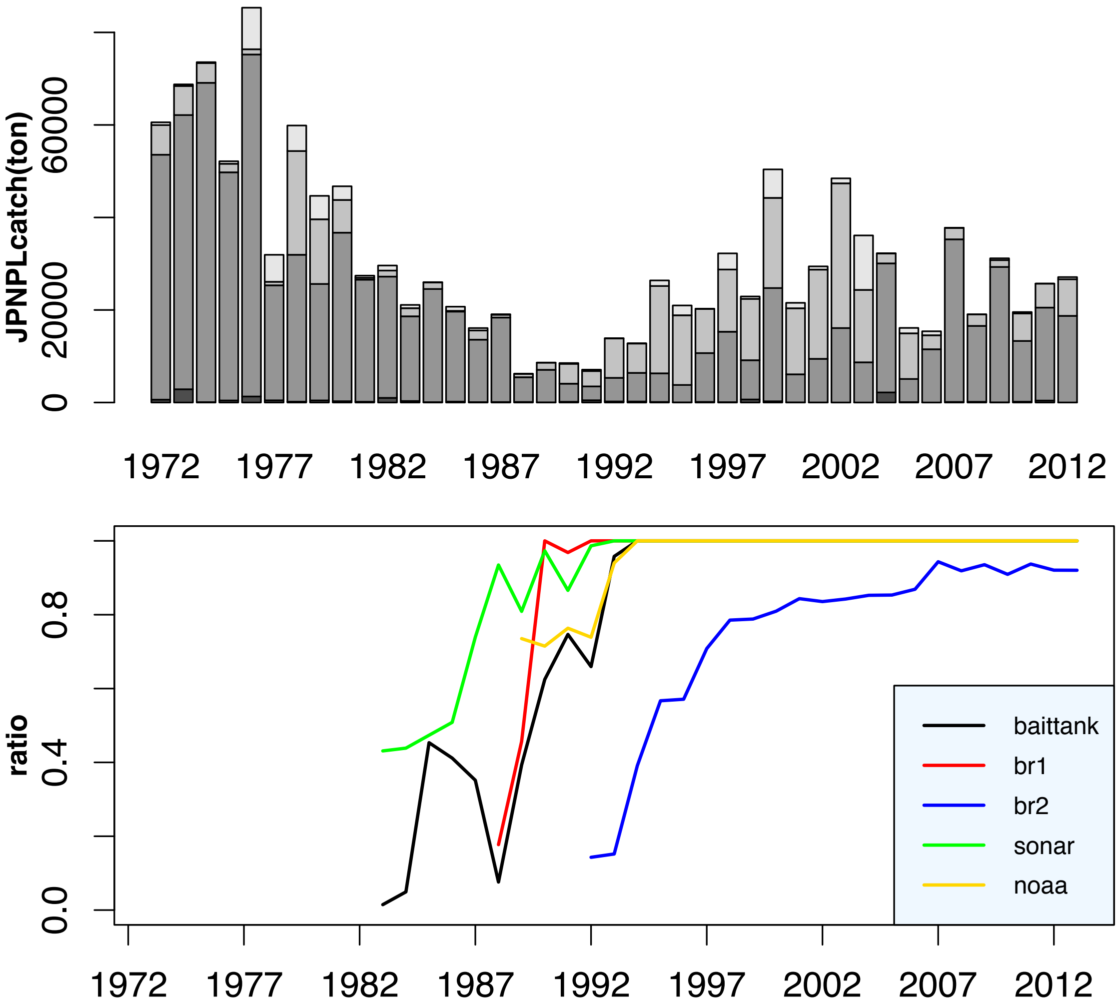

Figure 1. Catch from catch table by the JPN PL (ton) and ratio of equipment (black: low temperature live bait tank, br1: bird radar, br2: high-powered bird radar, sonar and noaa: noaa satellite meteorological information receiver.

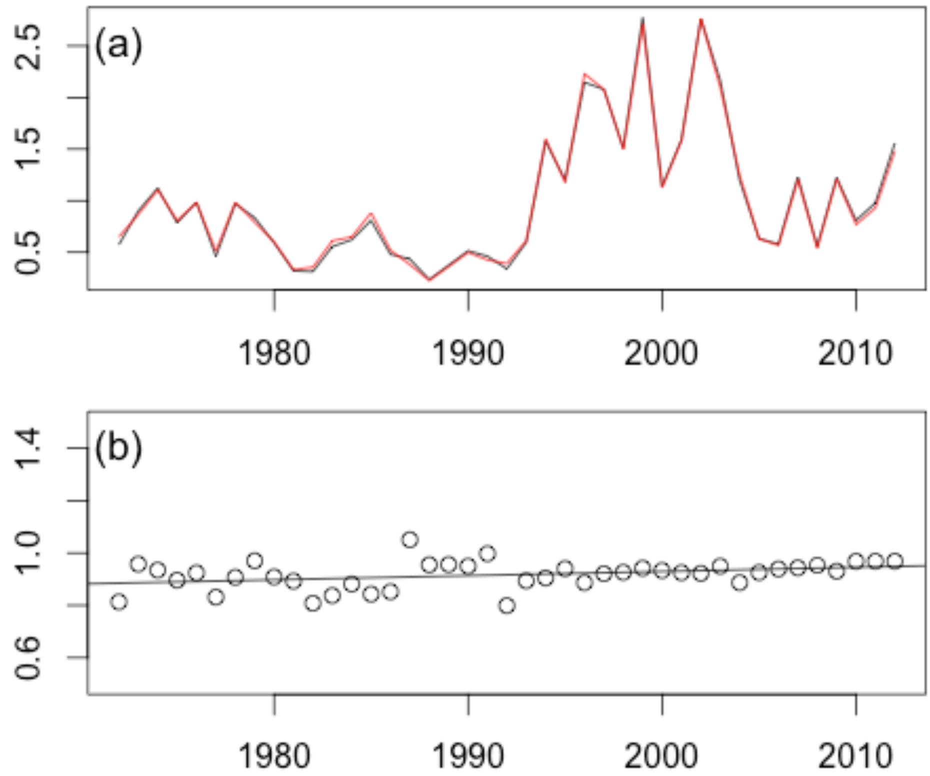

Figure 2. (a) Abundance indices from GLM with year+qtr+latlong (black) and year+qtr+latlong+vesselID (red). (b) Ratio of indices without vesselID to with vesselID

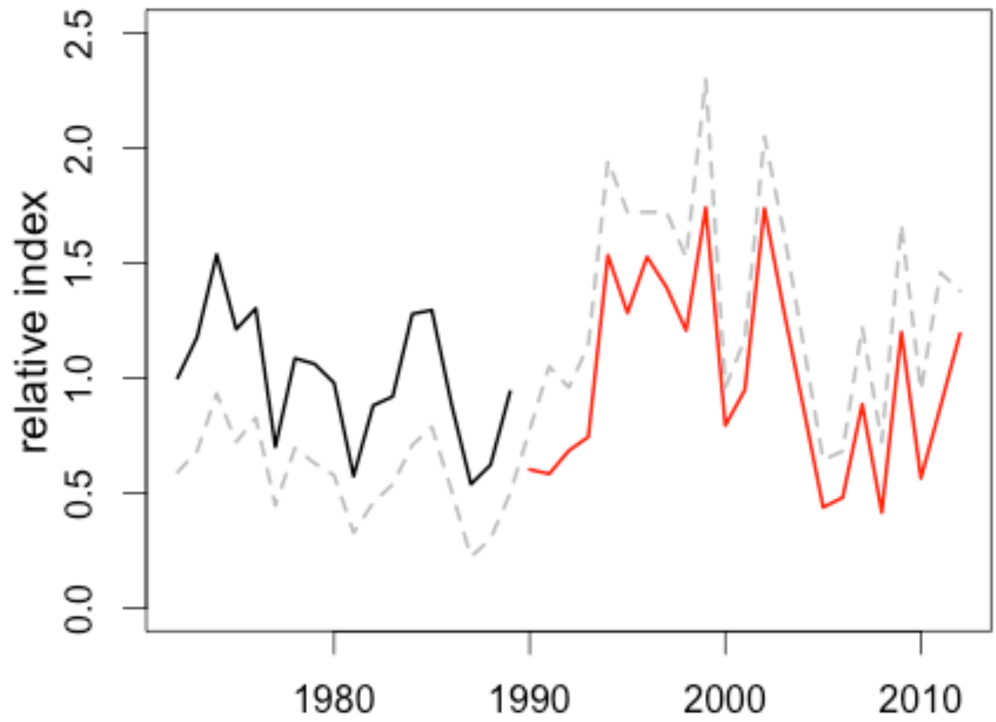

Figure 3. Relative abundance index of NPALB caught by the Japanese DW PL (dashed gray: presented by the data preparatory meeting; solid black and red: separated index before and after 1989).