Further investigation of the difference in two datasets, raised by the Second CPUE modeling workshop, used for CPUE analyses of SBT

第2回CPUEモデリングワークショップで提起された、ミナミマグロのCPUE解析に使用するための2つのデータセットの違いに関する更なる検討

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要約：　我々は、2007年の第2回CPUEワークショップでの解析に使用したショットバイショットデータから作成した2つのデータセットA、Bの違いについて検討した。CPUEトレンドは1990年代初め、特に1993年、1994年で違いが大きかった。ノミナルと標準化したCPUEを詳細に検討した結果、違いは4海区と9海区におけるCPUEが両データセットで違うことに起因すると思われた。ショットバイショットデータと5度x5度月集計データとで作成したデータにおいてノミナルCPUEにほとんど違いがなかったことから、集計データによるさらなる解析は、ESCのメンバーの誰もが行い得る。標準化したCPUEの年トレンドは、GLMの説明変数とモデルの仮定にある程度依存する。簡単なバリデーションの結果、データセットBの方が、Aよりも統計学的に頑健だった。

Abstract:　We mainly checked the difference of two datasets (Dataset-A and Dataset-B) made by shot-by-shot data used for CPUE analyses in the 2nd CPUE Workshop held in 2007. We obtained the different year trends of CPUE in the early 1990s, especially 1993-1994. As a result of investigation about nominal and standardized CPUE in detail, the difference seems to be mainly attributed the gap of CPUE values of area 4 and 9 in two datasets. Because there is little difference of nominal CPUE between the datasets made by shot-by-shot data and 5x5 month data, these and further investigation using the aggregated data (by 5x5/month) is also available for any of the ESC members. Year trend of standardized CPUE is dependent on the explanatory factors included into the GLM and its model assumption to some degree or another. Our result of a simple validation shows that the dataset-B is statistically more robust and stable than dataset-A.

Introduction

We mainly checked the difference of two datasets (Dataset-A and B) used for CPUE analyses of southern bluefin tuna from the viewpoints of nominal CPUE, standardized CPUE and statistical modeling for CPUE analyses etc. There datasets used in the 2nd CPUE workshop of CCSBT were defined as:
Dataset-A: Year(1992-2005), Area(4-9), Month(4-9) (past agreed definition)
Dataset-B: Year(1992-2005), Area(4,7,8,9), Month(Japanese fishing season)
Remark) Area and month defined in the dataset-B was annually changed (See Table 4 of p.11, CCSBT-ESC/0709/SBT-Fisheries/Japan)
The two datasets is different from "LL1", which is the past agreed and using in the annual calculation of CPUE indices regarding some points in Table A0.

Spatio-temporal coverage and Nominal CPUE

Spatio-temporal coverages of the datasets were compared in the number of hooks (Table A1). There were several area/month unique to either of the datasets. In addition to Area 5 and Area 6, Area 4 in April, July and August from 1991 to 1997, Area 7 in July from 1993 to 1996, and Area 9 in April, August and September from 1991 to 2005, were unique to the dataset–A. Area 8 in October, November and December from 1993 to 2005 were unique to the dataset-B.

Nominal CPUEs by Area are shown in Fig. A1. Large differences in the nominal CPUE between the dataset-A and B (CPUE_A< CPUE_B) were observed in Area 4 from 1993 to 1994 and in Area 9 from 1993 to 1994. Opposite difference (CPUE_A> CPUE_B) was observed in Area 8 from 1998 to 2000.

The nominal CPUE by Area, year and month for the dataset-A were very low in April, July and August of Area 4, and in April, August and September of Area9 (Fig. A2). These Area/month were outside of the fishing season for SBT and had effect to the nominal CPUE of all Areas in the dataset-A much lower than that of the dataset-B. Because the nominal CPUE in Area 7 in July was as high as that in the SBT fishing season, there were little difference in the nominal CPUE by both the datasets.

The nominal CPUE by Area, year and month for the dataset-B were slightly lower during October to December than in September in Area 8 (Fig, A3). The Area/month had effect to the nominal CPUE of all Areas in the dataset-B slightly lower.

Therefore, it can be point out the basic differences between the two datasets. The dataset-A included a number of longline operations NOT for SBT, as a consequence provides lower nominal CPUE of SBT than in the dataset-B. The dataset-B included later half period of the Area 8 which is the one of the major fishing ground, and the dataset-B consisted mainly of longline operations for SBT.

By the way, similar results can be obtained using the 5x5, month data. Results by the 5x5, month data are attached in the Appendix.

Several CPUE standardizations

In Figure B0, the following ANOVA model (i.e. explanatory variables) in Equation (1) was used in both datasets (A and B). Two CPUE trends seem to be different in Figure B0 (See Figure 12 of p.30, Report of the second CPUE modeling workshop).

log(CPUE+0.1)=intercept+year+area+month+VesselID+HPB+observer+year *observer+error, error～N(0, σ^2) (1)

However, in Figure B0, selected “Core-Vessels” were only used and the LSMENAS (least square means) of the year*observer without observer (i.e. in the case that scientific observers are not on board) were extracted as the estimated CPUE year trend. (Remark) This is an apparent mistake statistically and LSMEANS of the year effect should be extracted.)

Thus, since the starting point of discussion was wrong, we modified this point and used all vessels because which include more information. We also extracted the LSMEANS of year effect as the standardized year trend of CPUE for SBT using same Equation (1) in Figure B1.

CPUE year trends in Figure B1 are rather different from those in Figure B0 and the CPUE trends in two datasets in Figure B1 seem to be still different.

Next, we computed the standardized CPUE year trends using Eqn.(2), in which the main effect of observer and observer-related interactions (year*observer) are deleted from Equation (1). Formula (2) becomes a simple model using only main effects.

log(CPUE+0.1)=intercept+year+area+month+Vessel-ID+HPB+error (2)

In Figure B2, the year trends of standardized CPUE in both datasets are still different especially 1993-1994. Therefore, we check the CPUE trends deleting the data for 1992-1995 in Formula (2) (See Figure B3). As a result, we obtained the similar trends from 1996 to 2005. Figure B4 shows the year trends of nominal CPUE in two datasets, where the gap of CPUE for 1993-1994 is seen as well as in Figure B2 and the year trends of nominal and standardized CPUE in the dataset-A (shown in Figure B2 and B4) is similar and those in the dataset-B is quite different.

At last, we applied more complicated model by Equation (3) with some interactions including the random effect because it seems not to be performed the corrections by CPUE standardization through the simple model using only main effects.

log(CPUE+0.1)=intercept+year+area+month+Vessel-ID+HPB+observer+
(year*observer)+(year*area)+(year*area*month)+error, error $\sim N(0, \sigma^2)$ (3)

where year*area*month is a random effect and other factors are fixed effect.

Estimated CPUE year trends obtained from the Equation (3) in two both datasets are shown in Figure B5 and those two trends seem to be different. The reason why the range of the confidence interval is wider than that in other figures is considered that the random effect is included into the model.

Reliability check of two datasets by the validation

We checked the reliability of both datasets (Dataset-A and B), which datasets has better performance from the statistical viewpoint, based on the simple validation. The procedure of the calculation applied for each datasets (A and B) is as follow:

1. Divided the all records (in both datasets) into two sub-datasets randomly, 80 percent of training data and 20 percent of the data for verification.
   (Remark) We regarded the latter sub-dataset as missing data in this step)
2. After estimating unknown parameter by Equation (ANOVA model) only using the training data set, we computed the goodness of fit using the sub dataset for verification, which shows the difference between observed CPUEs and the corresponding predicted (i.e. obtained from the Equation (1)) ones, based on the mean absolute error (MAE) and Pearson's correlation coefficient.

Table B1 shows the values of mean absolute error and Pearson's correlation coefficient between observed and the corresponding estimated CPUE in the part of data for verification in two datasets. In addition, the plots of observed and the corresponding predicted CPUE are shows in Figure

B6. Judging from these values, the dataset-B is more robust/stable than dataset-A statistically.

Discussion

Temporary conclusions obtained from nominal and standardized CPUE are as follows:

- Differences between the two datasets in terms of the spatio-temporal coverage and nominal CPUE were observed in Area4 (April, July and August), Area 9 (April, August and September) and Area 8 (October-December).
- Both the datasets would have different merits and demerits in terms of reflecting the state of the stock abundance to CPUE. Using data only operations targeting for SBT seems to be a concern. Including a number of operations where and when few SBT were caught such as northern half of Area 4 also seems to be a concern. It should be investigated more comprehensively and in detail what kind of spatio-temporal range to be chosen is appropriate.
- Results from the shot-by-shot data were similar to that from the 5x5, month data. Further investigation based on 5x5, month data is possible and seems appropriate at least to some extents.
- The gap of year trends between the dataset A and B in the early 1990s especially for 1993-1994 seems to be still large in the standardized CPUE.
- Extracted year trends of standardized CPUE is dependent upon the model (i.e. explanatory factors included into the ANOVA model) utilized.
- The difference of the year trend between nominal and standardized CPUE seems to be rather similar in the dataset-A (area4-9 and month4-9) and quite different in the dataset-B (Japanese fishing season and zone).
- As a result of model validation, the dataset-B is more robust and stable than dataset-A statistically.

Acknowledgement

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—Tables and Figures—

Table A0 Difference of the characteristic between datasets (A & B) and LL1

	Two datasets (A and B)	LL1 (used in the CCSBT)
Data resolution	Shot-by-shot	Aggregated by 5x5/month
Age configuration	All included	4plus (4+)
Joint venture vessels*	Not included	Included

*Data from the vessels of Joint venture between Japan and Australia or NZ.

Table A1 Spatio-temporal coverage of the dataset A and B made by shot-by-shot data

Number of hooks in thousands

		DatasetA									DatasetB												
		Month						a			Month									b	c	d=(a-b)/a	e=(a-c)/a
Area	Year	4	5	6	7	8	9	Sum	Area	Year	4	5	6	7	8	9	10	11	12	sum	sum (Apr-Sep)	Excess A	Excess A (Apr-Sep)
4	1991	438	1172	1422	1802	840	151	5824	4	1991		703	1422	1802						3927	3927	33%	33%
	1992	580	1428	1978	2516	763	194	7458		1992		919	1978	2516						5413	5413	27%	27%
	1993	2150	2176	2522	2397	1238	86	10568		1993		978	2522							3499	3499	67%	67%
	1994	1640	3492	2660	1263	942	106	10103		1994			1778							1778	1778	82%	82%
	1995	1747	2292	2758	2138	1050	343	10328		1995		1756	2077							3833	3833	63%	63%
	1996	1822	3960	4031	2076	1173	350	13413		1996		2634	3446							6079	6079	55%	55%
	1997	2769	3745	3372	2088	708	82	12763		1997	1261	3745	3372	782						9159	9159	28%	28%
	1998	1070	1752	4230	3679	987	38	11757		1998	308	1752	4230	3679						9969	9969	15%	15%
	1999	666	693	1495	2803	648		6305		1999	393	693	1495	2803	478					5862	5862	7%	7%
	2000	562	1358	2057	1979	262	66	6283		2000	145	1358	2057	1979	16					5555	5555	12%	12%
	2001	421	339	1627	1932	493	100	4912		2001	47	339	1627	1443						3456	3456	30%	30%
	2002	311	238	2751	3056	413	13	6780		2002	54	238	2751	2376						5418	5418	20%	20%
	2003	305	949	2888	3368	657	295	8462		2003	26	949	2888	3343						7205	7205	15%	15%
	2004	424	1108	2972	2959	1079	229	8771		2004	64	1108	2972	2959						7102	7102	19%	19%
	2005	31	2073	3188	2033	3		7328		2005	31	2073	3188	2033						7325	7325	0%	0%
5	1991	114	62	1458	2872	529	231	5266	5	1991												100%	100%
	1992		242	1936	1429	182	48	3837		1992												100%	100%
	1993		9	220	277	3		510		1993												100%	100%
	1994			59				59		1994												100%	100%
	1995		6	36	39	13		95		1995												100%	100%
	1996	53	6	4	137			200		1996												100%	100%
	1997			35	76			111		1997												100%	100%
	1998			52	147	76		274		1998												100%	100%
	1999				27	560	168	756		1999												100%	100%
	2000					92	124	216		2000												100%	100%
	2001			10	148	204	143	504		2001												100%	100%
	2002			6	9	6	6	28		2002												100%	100%
	2003	4			40	154	140	337		2003												100%	100%
	2004				9	267	24	300		2004												100%	100%
	2005				20			20		2005												100%	100%
6	1991	2511	2795	537	37			5881	6	1991												100%	100%
	1992	1232	1535	198	288			3253		1992												100%	100%
	1993	840	726	162	66			1794		1993												100%	100%
	1994	58	165	53				276		1994												100%	100%
	1995	117	267	256	59			699		1995												100%	100%
	1996									1996													
	1997	30	89	45				164		1997												100%	100%
	1998	9	223	159				392		1998												100%	100%
	1999	99	173	159	60			491		1999												100%	100%
	2000	18	18		25			61		2000												100%	100%
	2001		107	90	3			200		2001												100%	100%
	2002	25	91	54	3			173		2002												100%	100%
	2003	52	105	88				245		2003												100%	100%
	2004	22	105	107	18			251		2004												100%	100%
	2005									2005													
7	1991		1563	2589	1078	14	80	5324	7	1991		1563	2589	1078						5230	5230	2%	2%
	1992		808	1303	649	23	32	2815		1992		808	1303	649						2760	2760	2%	2%
	1993		1224	1087	126			2438		1993		1224	1087							2312	2312	5%	5%
	1994			1909	983	3		2895		1994			1003							1003	1003	65%	65%
	1995	86	988	1343	280			2697		1995		943	1051							1994	1994	26%	26%
	1996		950	1102	358	197	86	2694		1996		946	950							1897	1897	30%	30%
	1997	569	3117	1749	164			5599		1997	569	3117	1749	164						5599	5599	0%	0%
	1998	1331	3685	1180	33		6	6235		1998	1328	3685	1180	33						6226	6226	0%	0%
	1999	2209	4789	2951	271		364	10584		1999	2209	4789	2951	271						10220	10220	3%	3%
	2000	1943	2811	1699	37		63	6553		2000	1943	2811	1699	37						6490	6490	1%	1%
	2001	2693	5081	3085	429		195	11482		2001	2693	5081	3085	429						11287	11287	2%	2%
	2002	2298	4608	1538	101			8545		2002	2298	4608	1538	101						8545	8545	0%	0%
	2003	1918	3120	764			140	5941		2003	1918	3120	764							5802	5802	2%	2%
	2004	1361	1631	6				2997		2004	1358	1631	6							2994	2994	0%	0%
	2005	1738	1127	10				2874		2005	1738	1127	10							2874	2874	0%	0%
8	1991			15	91	2440	3747	6293	8	1991					2401	3747				6148	6148	2%	2%
	1992				66	1639	2730	4435		1992					1639	2730	518			4887	4369	-10%	1%
	1993					625	1158	1783		1993						415				415	415	77%	77%
	1994			18	67	833	3780	4699		1994						3780	412			4192	3780	11%	20%
	1995			33	245	726	4387	5390		1995						4387	2824	1224		8435	4387	-56%	19%
	1996		7	19	3		4549	4578		1996						4549	4382	5488		14419	4549	-215%	1%
	1997						4370	4370		1997						4370	3550	4418	1896	14233	4370	-226%	0%
	1998		14		2251	4919	3509	10694		1998						3496	3893	4346	747	12483	3496	-17%	67%
	1999			10	2457	4630	3328	10425		1999						3328	2069	2271		7668	3328	26%	68%
	2000						4340	4340		2000						4340	3988	4629	2793	15751	4340	-263%	0%
	2001					38	3974	4012		2001						3974	4065	3849		11888	3974	-196%	1%
	2002				3	86	3637	3726		2002						3637	2022	893		6553	3637	-76%	2%
	2003						2802	2802		2003						2802	2407	2357	917	8483	2802	-203%	0%
	2004		1173	312			1338	2824		2004						1338	1672	2503	1666	7180	1338	-154%	53%
	2005		1887	38			1610	3534		2005						1610	1993	2363	1420	7386	1610	-109%	54%
9	1991	3954	6373	6596	6144	997	519	24581	9	1991	3626	6373	6596	6144						22738	22738	7%	7%
	1992	3446	5796	7380	6660	3058	1140	27481		1992	3213	5796	7380	6660						23049	23049	16%	16%
	1993	3354	6578	7738	5207	2373	577	25827		1993	3006	6578	7738	777						18098	18098	30%	30%
	1994	1063	4386	6523	3854	1603	861	18290		1994		3818	6114							9932	9932	46%	46%
	1995	1417	7768	6692	1623	888	396	18784		1995		4292	6325							10617	10617	43%	43%
	1996	581	7860	6840	5515	911	637	22344		1996		7860	6840	5515						20215	20215	10%	10%
	1997	598	7429	6899	5950	1882	1338	24096		1997		7429	6899	5950						20278	20278	16%	16%
	1998	440	6429	6467	5062	2205	1443	22045		1998		6429	6467	5062	1285					19242	19242	13%	13%
	1999	257	6221	6246	4267	1423	264	18678		1999		6221	6246	4267	747					17480	17480	6%	6%
	2000	33	5007	4883	4744	1629	302	16598		2000		5007	4883	4744	28					14661	14661	12%	12%
	2001	54	6596	6945	5499	892	347	20333		2001		6596	6945	5499	130					19170	19170	6%	6%
	2002		5681	5886	824			12392		2002		5681	5886	818						12386	12386	0%	0%
	2003		7341	7795	1720			16856		2003		7341	7795	1717						16853	16853	0%	0%
	2004	48	6219	7564	7539	1520	14	22904		2004		6219	7564	7539	1495					22817	22817	0%	0%
	2005		5492	7275	7737	3499		24004		2005		5492	7275	7737	3499					24004	24004	0%	0%

＜ -30%	>60%
	>20%

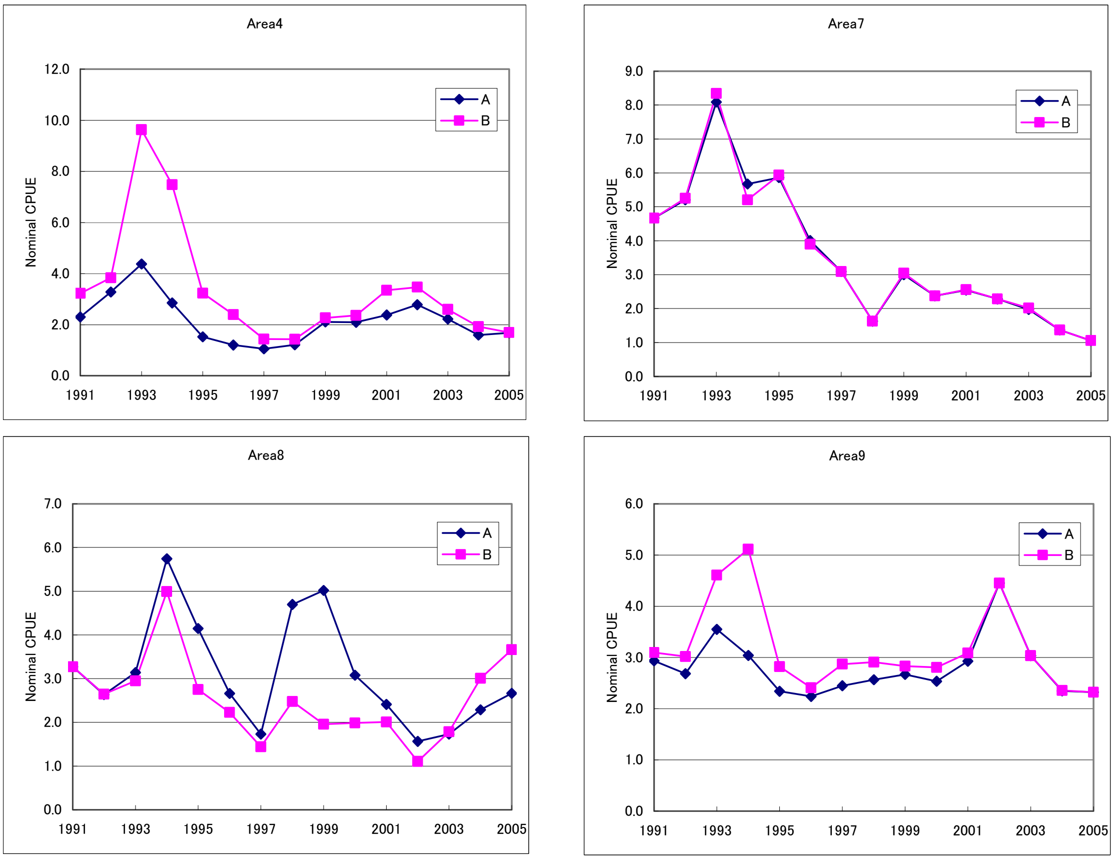


Fig. A1 Nominal CPUE by Area with the dataset A and B made by shot-by-shot data

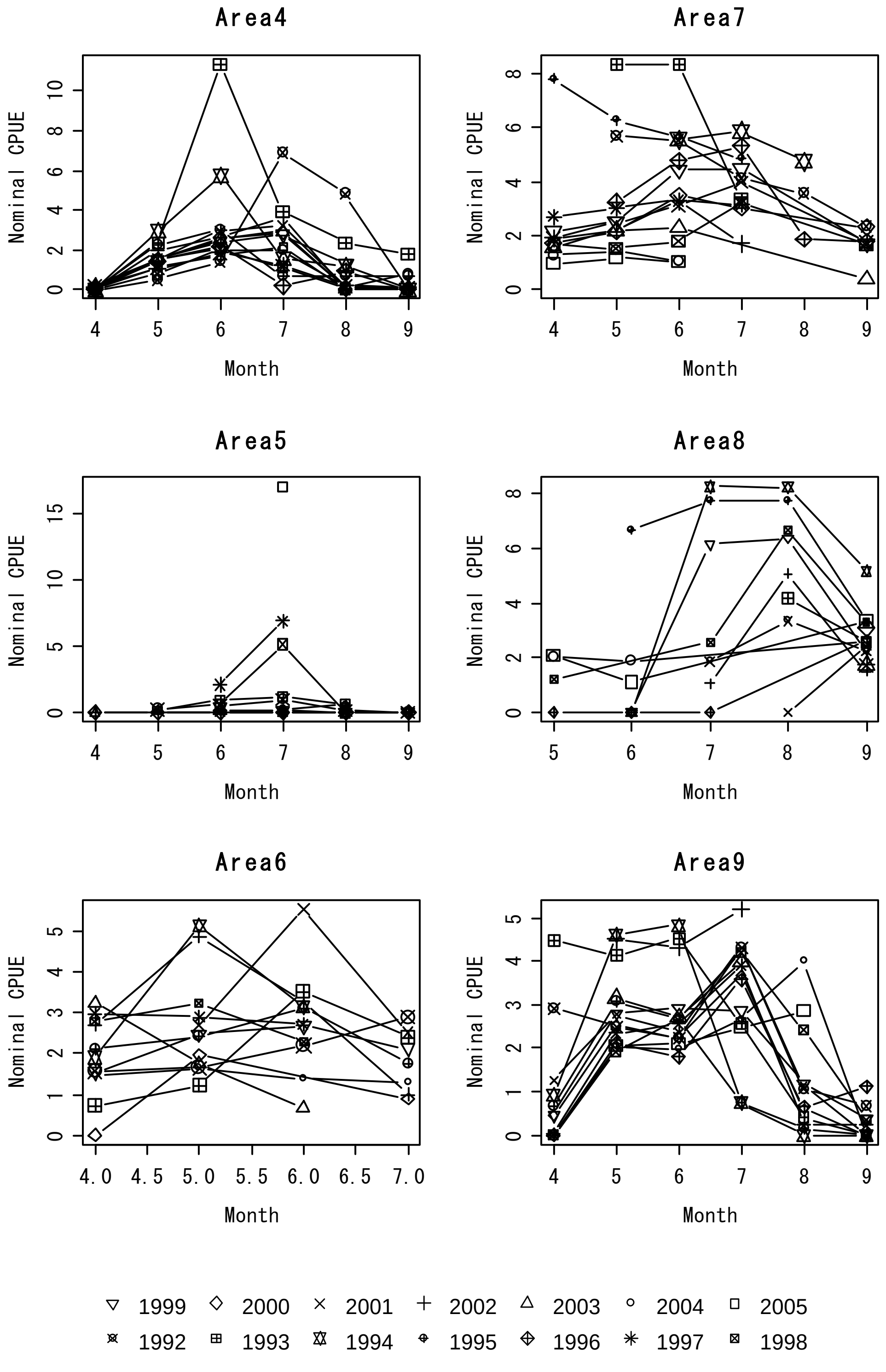


Fig. A2 Nominal CPUE by year, month and Area in the dataset A made by shot-by-shot data

Sizes of plots are proportional to the ratio of the effort in an area, year and month to the total efforts of the area.

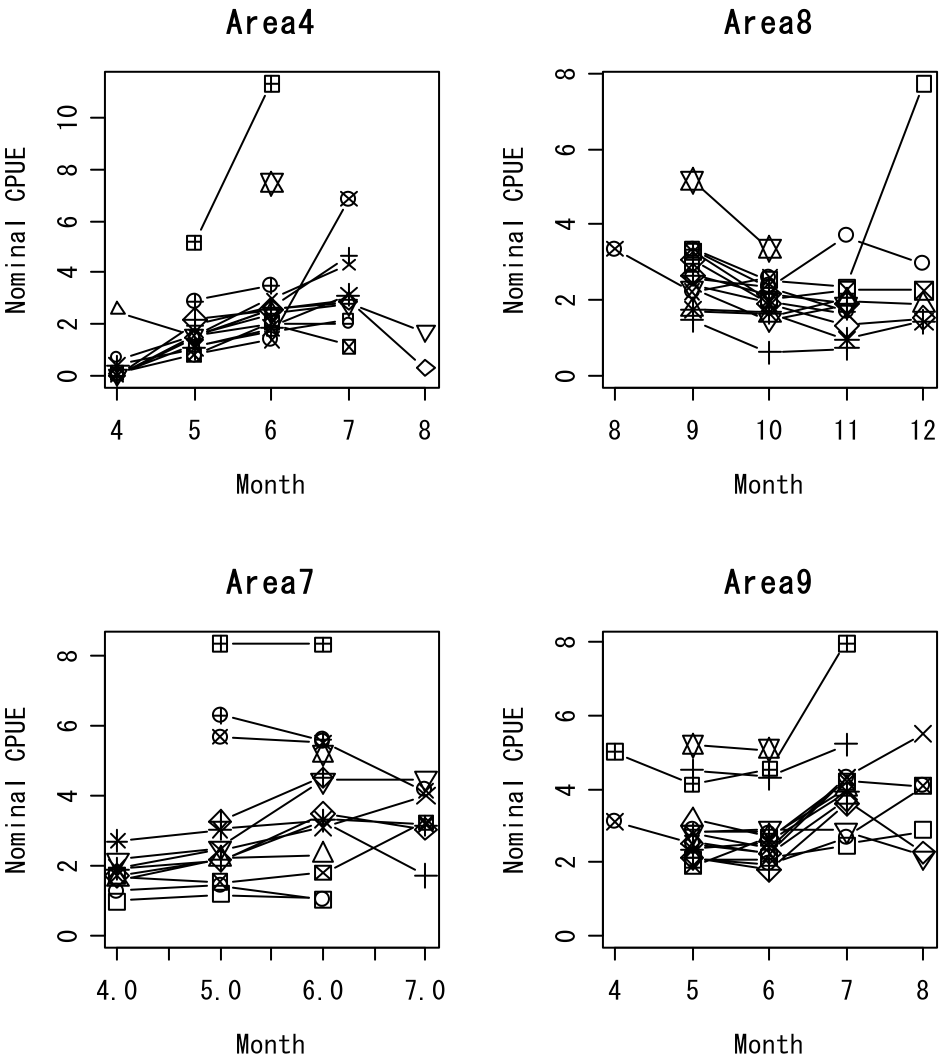


Fig. A3 Nominal CPUE by year, month and Area in the dataset B made by shot-byshot data

Sizes of plots are proportional to the ratio of the effort in an area, year and month to the total efforts of the area. Refer to the legend in Fig. 2A.

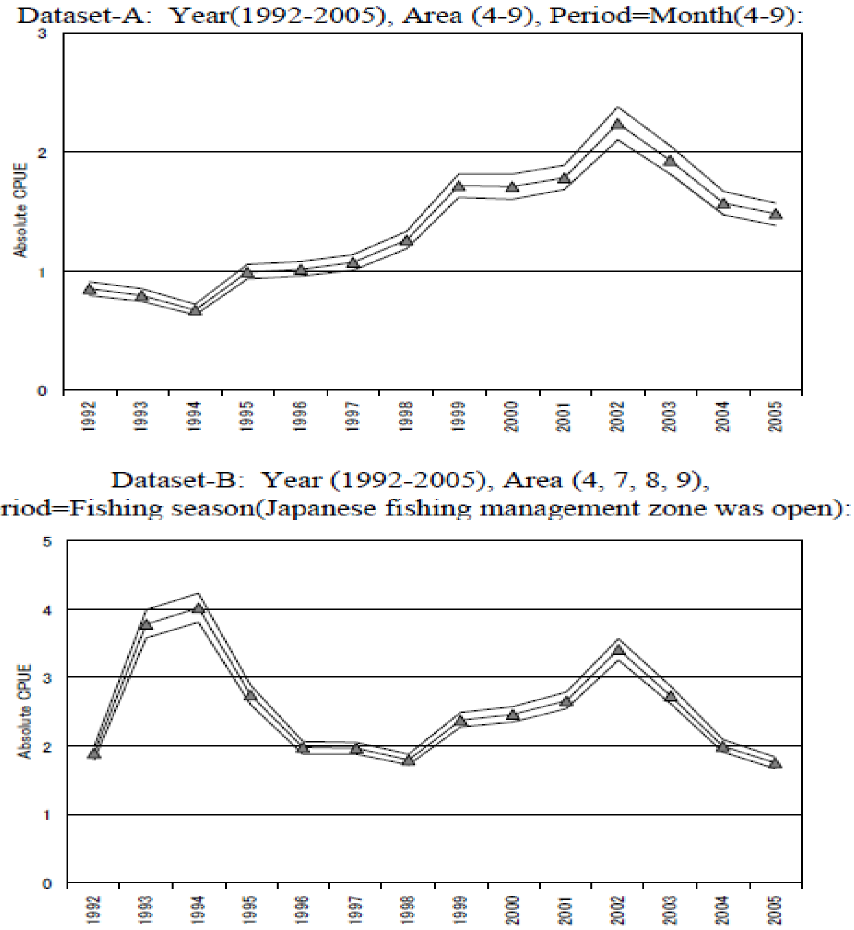


Figure 12. Comparison of model runs with core-vessels and different definitions of areas and times (Datasets A and B).

Figure B0 Estimated CPUE year trend using the LSMEANS of Year*Observer without observer and Core-vessels in the two datasets (A&B).

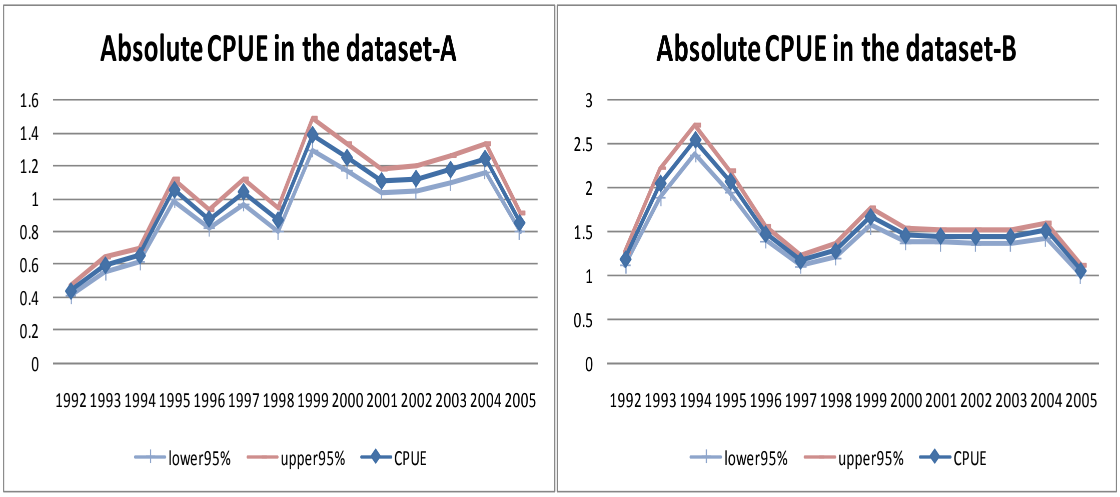


Figure B1 Estimated CPUE trend using LSMEANS of "Year" and all vessels.

Table B1 Values of mean absolute error and Pearson's correlation coefficient.

Dataset	MAE (Smaller is better)	Correlation (Larger is better)
Dataset-A	1.861	0.241
Dataset-B	1.618	0.349

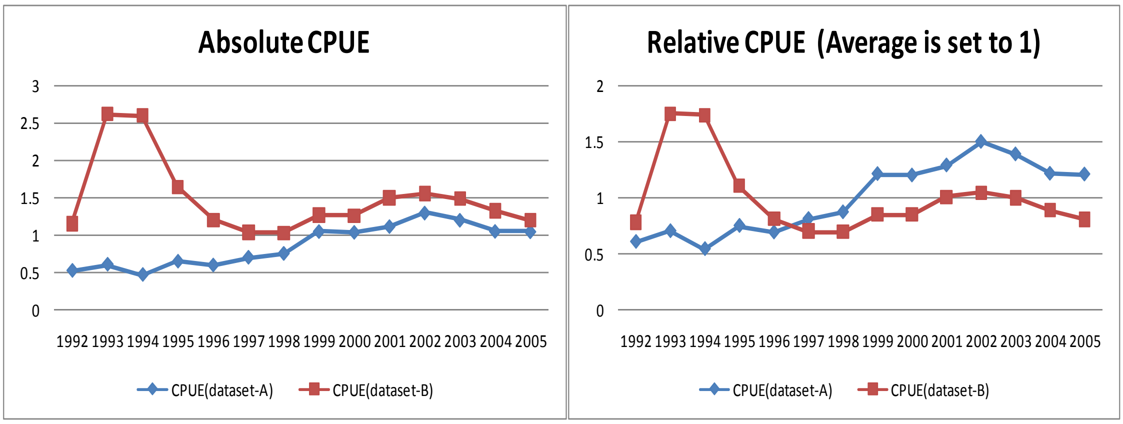
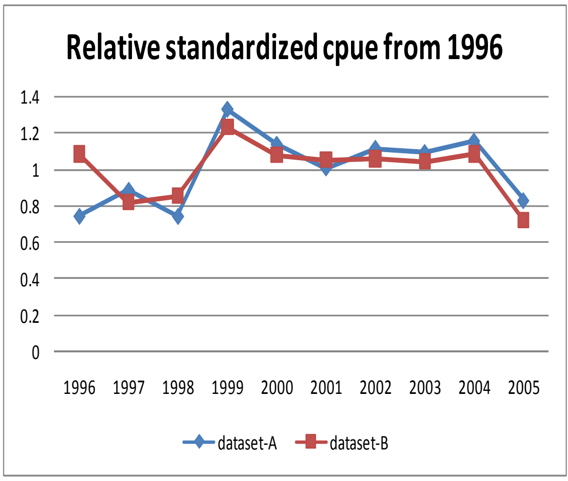


Figure B2 CPUE year trends in both datasets obtained from the Eqn.(2).



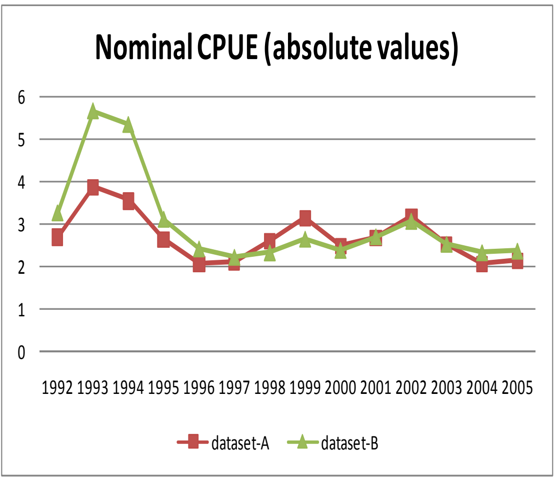


Figure B3 CPUE from 1996 in Eqn.(2). **Figure B4** Year trend of nominal cpue

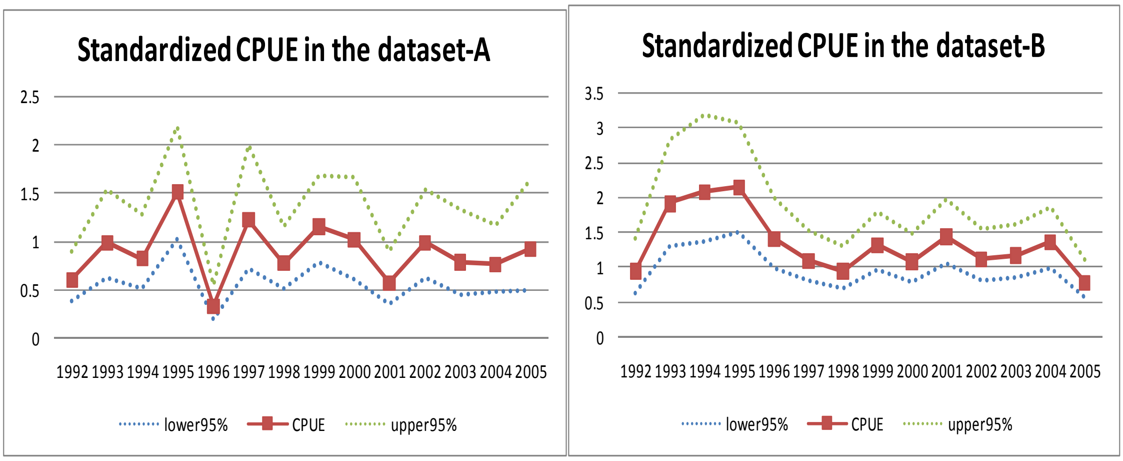


Figure B5 CPUE year trends in both datasets obtained from the Eqn.(3).

Appendix　Results made by 5x5 month data

Table A1　Spatio-temporal coverage of the dataset A and B by the 5x5 month data

Number of hooks in thousands

DatasetA

		Month						a
Area	Year	4	5	6	7	8	9	Sum
4	1991	440	1273	1485	1920	840	180	6137
	1992	634	1517	2095	2774	1087	312	8418
	1993	2499	2176	2531	2714	1580	193	11692
	1994	1999	3997	2754	1277	1252	380	11659
	1995	1662	2476	2997	1943	939	343	10359
	1996	1822	4181	4417	2076	1173	350	14021
	1997	2702	3884	3507	2076	667	82	12917
	1998	1011	1888	4665	3891	896	3	12353
	1999	594	735	1663	2842	650		6483
	2000	412	1284	1816	1833	26		5370
	2001	319	337	1662	1855	332	36	4541
	2002	269	249	3031	3153	651	14	7365
	2003	259	976	2987	3368	570	264	8425
	2004	378	1246	3303	3155	1015	196	9294
	2005	84	2075	3192	2046	245		7642
7	1991		1586	2612	1101	14	86	5399
	1992		800	1373	714	32	35	2954
	1993		1221	1060	201			2482
	1994			1552	648			2200
	1995	86	1003	1350	280			2719
	1996		989	1157	408	261	114	2929
	1997	600	3337	1862	167			5967
	1998	1566	4313	1410	33		6	7328
	1999	2363	5108	3200	271		365	11307
	2000	2032	3062	1916	49		69	7127
	2001	2737	5179	3132	444		195	11687
	2002	2603	5172	1744	134			9653
	2003	1955	3213	778			143	6089
	2004	1512	1814	6				3332
	2005	1744	1127	10				2880
8	1991			15	95	2575	4102	6788
	1992				68	1939	3010	5017
	1993					543	1129	1672
	1994			18	92	958	3760	4828
	1995			33	267	809	4779	5887
	1996		7	19	3		4956	4984
	1997						4610	4610
	1998		20		2555	5584	3985	12143
	1999		3	7	2781	5312	3449	11552
	2000					59	4610	4669
	2001					38	4150	4188
	2002				3	138	4341	4482
	2003						2801	2801
	2004		1176	312			1402	2890
	2005		1887	38			1610	3534
9	1991	4119	6624	6882	6578	1014	519	25735
	1992	3673	5961	7551	6761	3058	1140	28144
	1993	3651	6990	8372	5383	2613	601	27611
	1994	1099	4511	6762	4166	1858	1179	19576
	1995	1417	8402	7148	1626	888	396	19877
	1996	581	8346	7245	5862	914	637	23585
	1997	598	8031	7417	6343	1882	1338	25609
	1998	440	7239	7370	5768	2299	1344	24460
	1999	201	7170	7085	4864	1314	262	20896
	2000	33	5649	5405	5126	1185	302	17699
	2001	25	7277	7554	5974	875	299	22003
	2002		7032	7177	994			15202
	2003		7794	8211	1806			17811
	2004	48	6888	8445	8418	1334	3	25136
	2005		5495	7275	7737	3516		24023

DatasetB

		Month									b	c	d=(a−b)/a	e=(a−c)/a
Area	Year	4	5	6	7	8	9	10	11	12	sum	sum (Apr−Sep)	Excess A	Excess A (Apr−Sep)
4	1991		1273	1485	1920						4678	4678	24%	24%
	1992		1517	2095	2774						6386	6386	24%	24%
	1993		2176	2531							4707	4707	60%	60%
	1994			2754							2754	2754	76%	**76%**
	1995		2476	2997							5473	5473	47%	47%
	1996		4181	4417							8599	8599	39%	39%
	1997	2702	3884	3507	2076						12168	12168	6%	6%
	1998	1011	1888	4665	3891						11454	11454	7%	7%
	1999	594	735	1663	2842	650					6483	6483	0%	0%
	2000	412	1284	1816	1833	26					5370	5370	0%	0%
	2001	319	337	1662	1855						4172	4172	8%	8%
	2002	269	249	3031	3153						6701	6701	9%	9%
	2003	259	976	2987	3368						7590	7590	10%	10%
	2004	378	1246	3303	3155						8083	8083	13%	13%
	2005	84	2075	3192	2046						7397	7397	3%	3%
7	1991		1586	2612	1101						5299	5299	2%	2%
	1992		800	1373	714						2887	2887	2%	2%
	1993		1221	1060							2281	2281	8%	8%
	1994			1552							1552	1552	29%	29%
	1995		1003	1350							2353	2353	13%	13%
	1996		989	1157							2146	2146	27%	27%
	1997	600	3337	1862	167						5967	5967	0%	0%
	1998	1566	4313	1410	33						7322	7322	0%	0%
	1999	2363	5108	3200	271						10943	10943	3%	3%
	2000	2032	3062	1916	49						7058	7058	1%	1%
	2001	2737	5179	3132	444						11491	11491	2%	2%
	2002	2603	5172	1744	134						9653	9653	0%	0%
	2003	1955	3213	778							5947	5947	2%	2%
	2004	1512	1814	6							3332	3332	0%	0%
	2005	1744	1127	10							2880	2880	0%	0%
8	1991					2575	4102				6677	6677	2%	2%
	1992					1939	3010	1304			6253	4949	−25%	1%
	1993						1129				1129	1129	33%	33%
	1994						3760	531			4291	3760	11%	22%
	1995						4779	3115	1906		9800	4779	**−66%**	19%
	1996						4956	4769	5741		15465	4956	**−210%**	1%
	1997						4610	3831	4677	1946	15064	4610	**−227%**	0%
	1998						3985	4402	5031	879	14296	3985	−18%	**67%**
	1999						3449	2097	2398		7944	3449	31%	**70%**
	2000						4610	4236	4868	2917	16631	4610	**−256%**	1%
	2001						4150	4266	4019		12436	4150	**−197%**	1%
	2002						4341	2364	965		7670	4341	**−71%**	3%
	2003						2801	2413	2360	917	8492	2801	**−203%**	0%
	2004						1402	1675	2624	1851	7552	1402	**−161%**	51%
	2005						1610	1993	2363	1420	7386	1610	**−109%**	54%
9	1991	4119	6624	6882	6578						24202	24202	6%	6%
	1992	3673	5961	7551	6761						23946	23946	15%	15%
	1993	3651	6990	8372	5383						24397	24397	12%	12%
	1994		4511	6762							11273	11273	42%	42%
	1995		8402	7148							15550	15550	22%	22%
	1996		8346	7245	5862						21453	21453	9%	9%
	1997		8031	7417	6343						21790	21790	15%	15%
	1998		7239	7370	5768	2299					22677	22677	7%	7%
	1999		7170	7085	4864	1314					20434	20434	2%	2%
	2000		5649	5405	5126	1185					17364	17364	2%	2%
	2001		7277	7554	5974	875					21679	21679	1%	1%
	2002		7032	7177	994						15202	15202	0%	0%
	2003		7794	8211	1806						17811	17811	0%	0%
	2004		6888	8445	8418	1334					25085	25085	0%	0%
	2005		5495	7275	7737	3516					24023	24023	0%	0%

＜ −30%	>60%
	>20%

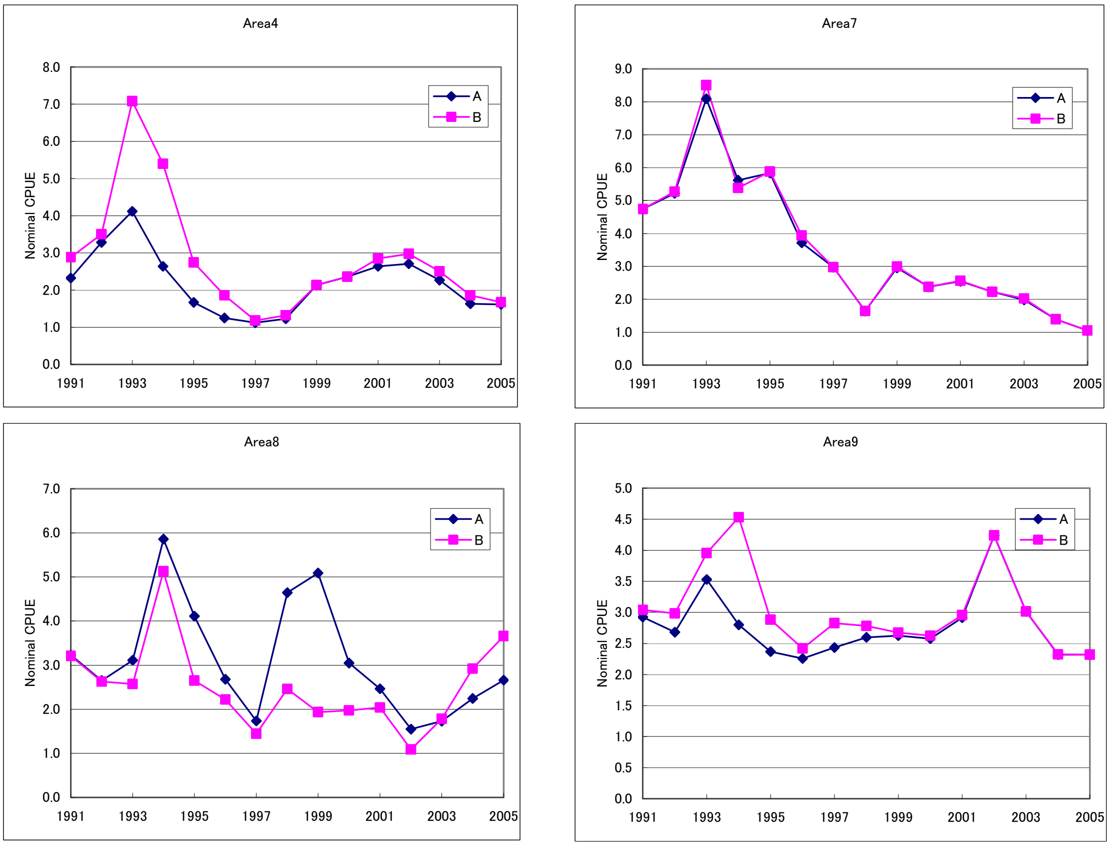


Fig. A1　Nominal CPUE by Area with the dataset A and B by the 5x5 month data

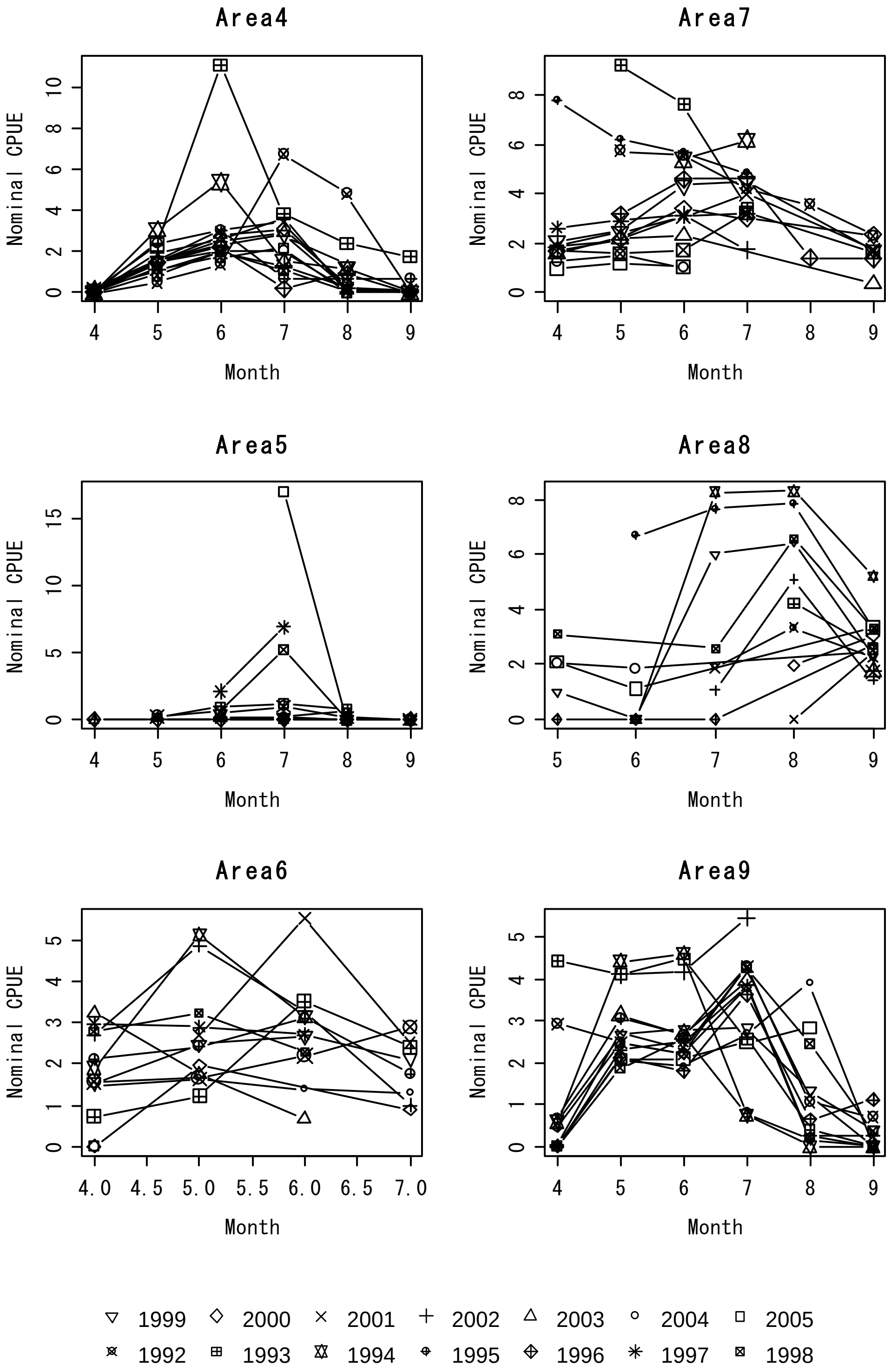


Fig. A2　Nominal CPUE by Area, year and month with the dataset A by the 5x5 month data

Sizes of plots are proportional to the ratio of the effort in an area, year and month to the total efforts of the area.

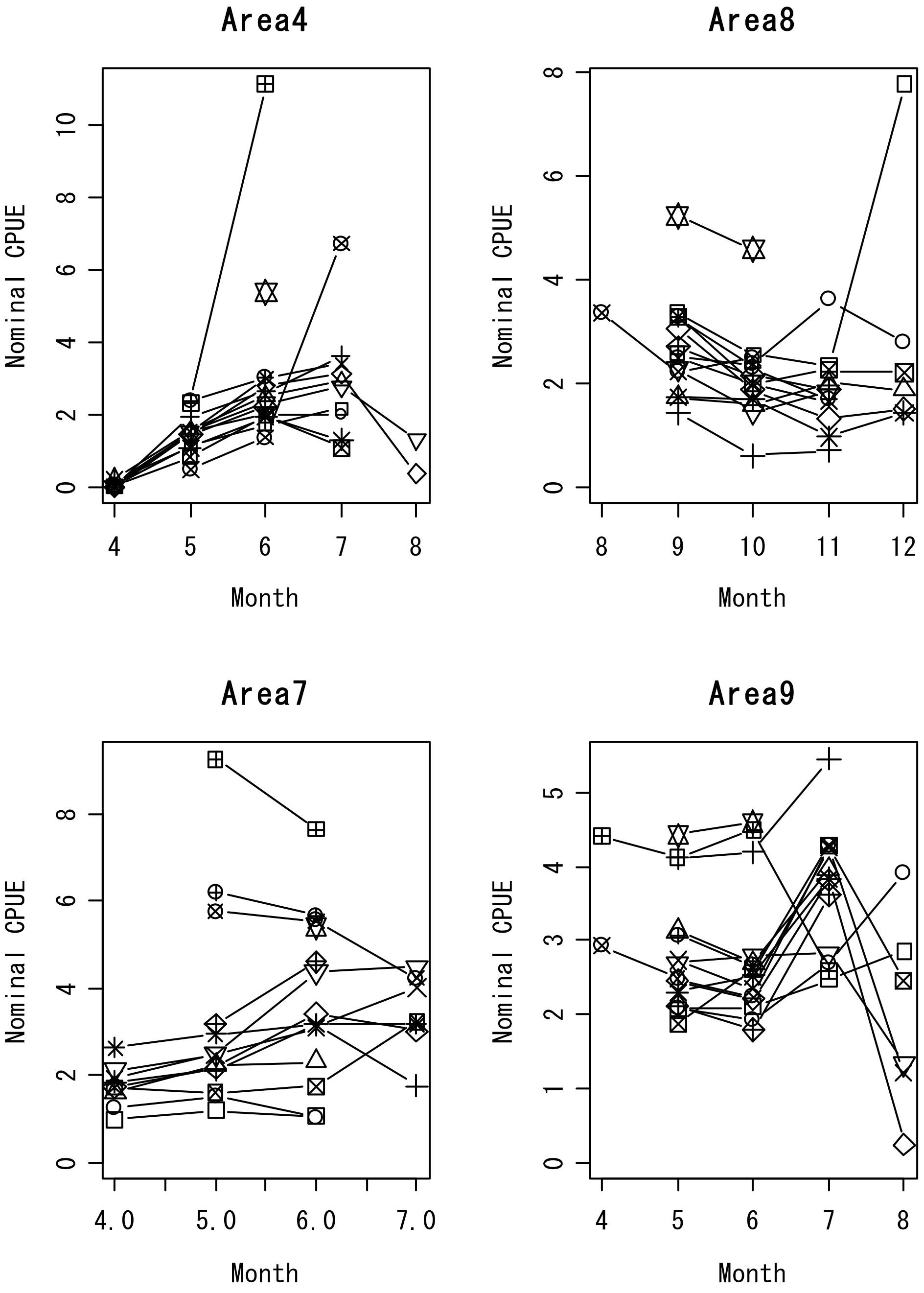
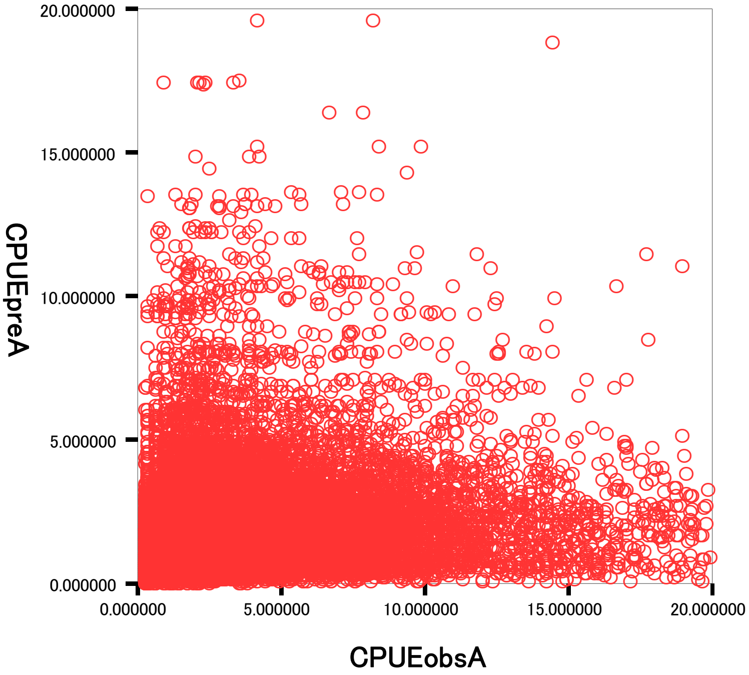


Fig. A3 Nominal CPUE by Area, year and month with the dataset B by the 5x5 month data

Sizes of plots are proportional to the ratio of the effort in an area, year and month to the total efforts of the area. See the legend in Fig. A3.



Dataset-A (Upper)　　　　　　　　　　Dataset-B (Lower)

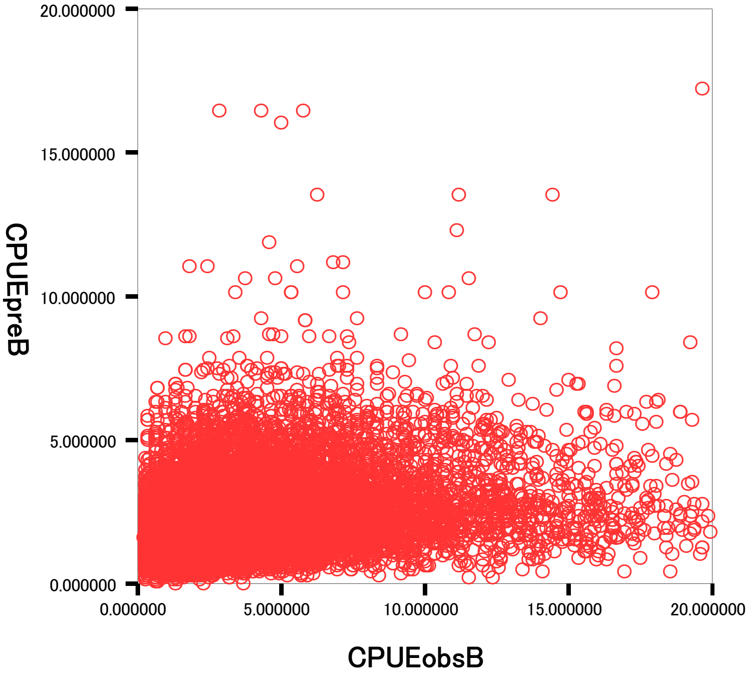


Figure B6 Plot of observed and corresponding predicted CPUE in two dataset