Analysis for tuna catches of the Taiwanese southern bluefin tuna longline fishery

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要約

台湾はえ縄データは有益なミナミマグロの資源指数を提供するものとして期待されている。資源指標のターゲッティングの問題を検討するため、台湾はえ縄漁業によるミナミマグロに関連する他のマグロ類の漁獲を記述した。ビンナガおよびメバチ、キハダ、メカジキの漁獲は使用釣鈎数の単純な反映であった。ビンナガとメバチ、また TArea2 ではキハダも、ターゲッティング問題でさらに検討すべき種であると示唆された。

Abstract

Taiwanese longline data are expected to provide a useful abundance index of southern bluefin tuna. In order to examine the targeting issue for the index, we described catch of other tunas by Taiwanese longline fleet in relation to SBT. Catches of albacore, bigeye, yellowfin and swordfish were simple reflections of being proportional to the amount of hooks used. Results suggested that albacore and bigeye, and maybe yellowfin in TArea 2, are species to be further considered in targeting issues.

1. Introduction

Taiwanese longline fleet increased catch of southern bluefin tuna *Thunnus maccoyii* (SBT) in the 1980s. The fishery statistic data has been accumulated and thus it is expected to provide an abundance index useful for the stock assessment in the CCSBT. This index would be highly valuable as index for young fish of age 3-5.

Our aim is to develop an abundance index from Taiwanese longline data. Based on the CPUE standardization for Taiwanese SBT longline fishery and the description for the characteristics of Japanese SBT longline fishery (Itoh et al. 2013; Wang et al. 2013), we found several points: (1) Data collection of catch, effort and size for SBT was reformed and improved in 2002; (2) Taiwanese longline SBT fishing area in the southeast Indian Ocean is unique and has little overlap with Japanese longline SBT fishing ground; (3) SBT caught was mainly for age 3 or 4, sometimes age 5; (4) Little variation in age composition by longitude, latitude or month; (5) SBT was caught mainly between April and September.

We suggested using new statistical area for Taiwanese longline fleet (named as TArea) instead of the CCSBT statistical Areas based on consideration for the effort distribution of this fleet. TArea1 is 25.0S-39.9S and 60.0E-109.9E in the southeastern Indian Ocean. TArea2 is 20.0S-44.9S and 20.0E-59.9E in the southwestern Indian Ocean. Note that these boundaries are tentative and are subject to be modified by further examination.

It was suggested to consider the catch of other tunas, including bigeye tuna and yellowfin tuna, for the Taiwanese longline abundance index in the 2013 ESC. Such a suggestion was reasonable because SBT is not necessarily the target species in the Taiwanese longline fleet. Thus, in this document we will describe catch of other tunas in relation to SBT in the Taiwanese longline fleet.

2. Materials and methods

We used the dataset (Interim_CCSBT_DataCD_2014_Revised.mdb) in the CCSBT data exchange process where Secretariat compiled data files submitted from all Members. Datasets, including catch-and-effort and non_sbt_catches, were extracted. Taiwanese data were chosen by specifying COUNTRY_CODE as “TW”.

3. Results and discussion

The numbers of fish, as well as hooks used, by year are shown in Table 1 for top five fish species caught, southern bluefin tuna *Thunnus maccoyii* (SBT), albacore *T. alalunga* (ALB), bigeye tuna *T. obesus* (BET), yellowfin tuna *T. albacares* (YFT) and swordfish

Xiphias gladius (SWO).

It should be noted that the data analyses were divided into two time periods by year of 2002 because Taiwanese SBT statistics system was reformed in 2002. The logbook was only source to produce the data report before 2001, and the SBT weekly report system was introduced in 2002 to the measurement monitoring and thus the reporting rate of SBT catch has substantially improved since then (Anon, 2014).

It also should be noted that SBT catch data become available immediately by the weekly report system, but catch data of other species do not become available unless logbooks were reported and its data were compiled. Therefore, catch data of other species in 2013 are incomplete and that in 2012 may be tentative.

Regardless of the change in SBT statistics system, albacore has been dominated as 92.7% in the total over 1981-2013 period. It was followed by bigeye (4.1%), yellowfin (1.5%), swordfish (1.0%) and SBT (0.7%).

Species compositions were also calculated for TArea1 and TArea2, respectively (Table 2, Fig. 1, Fig. 2). Albacore also dominated the catch composition in both areas. SBT has been the second dominated species since 2004 in TArea1. In TArea2, SBT composition increased after 2005 and exceeded 10% in the following years.

The Taiwanese data submitted to CCSBT covered largely in the southern hemisphere of Indian Ocean. Distributions of effort and catch by month, latitude and longitude in all areas are shown in Fig. 3. Those in TArea 1 and TArea 2 are shown in Fig. 4 and Fig .5, respectively. Catches of albacore, bigeye, yellowfin and swordfish were simple reflections of being proportional to the amount of hooks used. This suggests that no particular operation pattern for targeting any one of the four species exists. Horizontal and vertical distributions or temperature preference were different by these species.

If Taiwanese longline fleet had a specialized strategy for targeting one species in a specific area and/or season, it would be happened that catch of this species was large but other species were not. If such an apparent pattern were observed, we should be careful very much for the targeting issue in CPUE standardization of SBT. If such a pattern was not observed, as in the present case, we could believe that SBT CPUE was not *strongly* affected by targeting issue. However, it does not deny the possibility of existence of targeting influence, and we need to consider how we check in the next step.

Nominal CPUE, annual total catch / annual total hooks x 1000, in TArea1 and TArea2 are shown in Table 3 and Fig. 6. The largest CPUE has been of albacore. Because we will use data of from 2002 onward to develop SBT abundance index for Taiwanese fleet,

CPUEs after 2002 are of our interest. In TArea 1, CPUE of SBT was the second highest in most of years. Bigeye CPUE was much lower, except 2002-2003 and 2010 and 2011 when SBT CPUE was low. CPUEs of yellowfin and swordfish were further lower than that of SBT. In TArea 2, the second highest CPUE was recorded by SBT, bigeye or yellowfin in this area.

CPUE correlation between SBT and other tunas are shown in Fig. 7. No strong correlation was observed between any two species.

We have not reached a conclusion of how targeting affects SBT CPUE and how we should deal with it. Our analysis suggests that albacore and bigeye, (and maybe yellowfin in TArea 2) are species to be further considered in targeting issues, and tables and figures in this document are useful to facilitate discussion for next step.

5. References

Anon. (2014) Preparation of Taiwan's Southern bluefin tuna catch and effort data submission for 2014. CCSBT-ESC/1409/45.

Itoh, T. S. P. Wang, and N. Takahashi (2013) Progress in analysis of historical fishery data for Taiwanese southern bluefin tuna fleet. CCSBT-ESC/1309/38.

Wang, S. P., S. T. Chang and S. L. Lin (2013) CPUE analysis for southern bluefin tuna caught by Taiwanese longline fleet. CCSBT-ESC/1309/37

Table 1. Total numbers by year for five species and hooks by Taiwanese longline.

Year	Hook	SBT	ALB	BET	YFT	SWO	Total
1981	106,163	2,071	1,009,503	39,640	6,709	3,416	1,061,339
1982	217,181	3,523	2,127,407	75,483	11,041	5,674	2,223,128
1983	245,369	3,505	1,831,747	77,515	16,130	5,539	1,934,436
1984	150,587	4,033	1,025,076	55,948	6,081	3,905	1,095,043
1985	2,204,169	2,763	23,920,949	500,821	47,368	56,843	24,528,744
1986	4,304,234	5,267	60,585,549	867,149	308,673	132,086	61,898,724
1987	337,034	17,619	2,549,241	198,966	69,519	16,804	2,852,149
1988	576,521	15,866	3,303,128	213,824	60,077	32,118	3,625,013
1989	317,720	30,635	1,127,946	99,063	22,128	21,942	1,301,714
1990	314,331	23,656	1,415,527	108,129	18,950	24,772	1,591,034
1991	1,307,629	32,645	6,037,559	399,642	72,710	190,997	6,733,553
1992	626,457	32,274	3,808,686	141,043	46,705	221,607	4,250,315
1993	357,960	30,697	2,653,939	126,383	44,808	34,910	2,890,737
1994	237,204	25,930	1,315,740	100,765	67,268	51,856	1,561,559
1995	333,715	38,838	2,286,942	145,135	50,642	53,098	2,574,655
1996	500,310	50,422	1,151,054	151,690	87,614	30,707	1,471,487
1997	582,604	29,106	1,255,876	272,849	91,675	66,317	1,715,823
1998	745,390	45,557	1,445,442	248,320	135,561	49,668	1,924,548
1999	1,008,635	52,895	1,622,673	279,769	164,702	53,657	2,173,696
2000	671,736	44,465	1,108,560	171,286	68,597	29,829	1,422,737
2001	633,240	53,631	1,265,478	207,145	103,502	27,346	1,657,102
2002	757,267	34,841	796,500	414,590	221,210	87,976	1,555,117
2003	1,133,134	31,606	854,928	618,251	283,479	126,396	1,914,660
2004	333,391	42,151	286,245	44,725	21,793	6,805	401,719
2005	138,537	33,321	173,113	11,417	8,606	1,511	227,968
2006	130,693	30,667	138,735	16,552	6,271	3,027	195,252
2007	187,958	33,776	134,516	16,476	6,196	4,937	195,901
2008	208,000	35,144	372,245	18,582	5,950	5,331	437,252
2009	280,559	31,801	398,848	22,508	8,329	8,610	470,096
2010	321,924	33,407	593,074	21,406	12,234	9,989	670,110
2011	205,611	15,156	435,991	15,154	4,814	6,317	477,432
2012	121,965	17,578	453,102	8,781	2,327	1,821	483,609
2013	159,937	34,800	298,975	3,594	1,410	1,577	340,356
Total	19,757,166	919,646	127,784,294	5,692,601	2,083,079	1,377,388	137,857,008

SBT CPUE after 2002 will be used for abundance index.

Table 2. Numbers by year and area for five species and hooks by Taiwanese longline.

Year	T.Area	Hook	SBT	ALB	BET	YFT	SWO	Total
1981	1	31,047	629	288,031	14,437	2,055	770	305,922
1982	1	75,127	2,912	835,834	39,272	3,041	1,398	882,457
1983	1	138,044	1,325	1,089,046	29,912	6,639	1,963	1,128,885
1984	1	93,898	3,885	607,083	32,302	2,394	1,503	647,167
1985	1	165,069	0	1,952,270	43,322	1,184	3,850	2,000,626
1986	1	501,721	479	10,650,806	123,467	16,271	957	10,791,980
1987	1	176,562	14,414	1,307,690	107,154	15,519	12,427	1,457,204
1988	1	166,459	11,781	1,034,927	70,693	3,111	7,506	1,128,018
1989	1	250,047	30,359	791,831	76,417	20,260	10,190	929,057
1990	1	60,193	9,253	129,775	14,966	2,934	2,374	159,302
1991	1	301,854	10,238	1,879,144	78,401	21,821	8,790	1,998,394
1992	1	312,755	19,801	1,775,269	67,221	11,461	13,709	1,887,461
1993	1	137,740	25,422	719,819	51,398	8,100	5,071	809,810
1994	1	112,440	23,984	477,684	60,517	28,965	14,614	605,764
1995	1	74,812	14,693	391,046	27,392	6,640	5,639	445,410
1996	1	172,448	33,784	439,124	30,732	6,090	4,944	514,674
1997	1	137,329	20,632	451,831	39,518	2,913	4,555	519,449
1998	1	191,069	27,649	583,725	44,545	10,640	7,059	673,618
1999	1	224,454	28,353	371,397	51,882	18,616	6,649	476,897
2000	1	250,255	35,689	462,140	41,811	7,645	6,612	553,897
2001	1	231,717	37,186	365,384	46,021	20,255	12,584	481,430
2002	1	176,655	32,426	244,567	54,395	10,935	10,586	352,909
2003	1	199,799	25,235	351,154	63,000	9,572	4,851	453,812
2004	1	249,885	37,731	184,013	31,594	9,604	4,857	267,799
2005	1	105,158	31,406	95,872	6,996	3,413	849	138,536
2006	1	65,160	26,555	91,705	11,772	4,156	1,481	135,669
2007	1	51,307	27,216	93,592	10,038	3,411	1,076	135,333
2008	1	90,287	26,989	183,272	11,482	3,208	2,170	227,121
2009	1	65,516	23,869	117,481	7,572	1,597	2,404	152,923
2010	1	154,901	25,238	263,751	12,669	6,107	4,283	312,048
2011	1	54,103	10,496	88,424	8,533	1,043	2,224	110,720
2012	1	18,931	15,886	43,598	3,062	640	424	63,610
2013	1	55,513	32,528	26,316	1,567	199	337	60,947
1981	2	28,874	480	238,488	11,130	3,506	1,024	254,628
1982	2	67,072	354	512,926	17,995	5,319	2,172	538,766
1983	2	53,175	1,307	352,353	33,793	6,255	1,644	395,352
1984	2	36,239	61	236,100	20,059	2,840	1,849	260,909
1985	2	487,011	1,086	3,083,780	144,276	30,690	13,717	3,273,549
1986	2	1,094,483	1,436	7,592,338	310,106	84,226	75,613	8,063,719
1987	2	50,446	153	327,017	21,939	9,487	2,401	360,997
1988	2	341,272	3,579	1,849,929	133,487	49,577	21,618	2,058,190
1989	2	4,909	92	22,310	1,346	398	612	24,758
1990	2	155,972	14,046	590,246	51,086	13,777	13,371	682,526
1991	2	563,156	18,058	1,378,994	234,341	41,423	51,275	1,724,091
1992	2	75,646	11,964	133,787	37,490	28,063	142,200	353,504
1993	2	96,057	2,200	549,156	23,045	16,976	24,302	615,679
1994	2	37,424	949	208,513	18,924	21,977	27,781	278,144
1995	2	85,077	8,215	378,699	30,864	12,214	34,335	464,327
1996	2	88,407	15,979	211,056	19,577	14,307	7,947	268,866
1997	2	89,387	6,385	152,177	50,025	12,725	15,225	236,537
1998	2	184,688	17,022	344,365	42,693	16,140	13,510	433,730
1999	2	170,949	23,820	244,738	38,109	18,450	21,637	346,754
2000	2	112,888	8,152	141,080	37,277	11,158	10,588	208,255
2001	2	144,353	10,256	375,353	32,197	7,856	6,190	431,852
2002	2	79,300	1,442	149,307	26,628	21,440	13,980	212,797
2003	2	36,761	498	96,989	9,712	3,618	330	111,147
2004	2	50,271	3,897	59,441	8,857	9,241	1,207	82,643
2005	2	17,014	1,830	13,834	2,333	3,982	352	22,331
2006	2	56,247	4,105	13,234	3,505	1,762	1,399	24,005
2007	2	131,329	6,480	27,749	5,939	2,458	3,777	46,403
2008	2	98,932	8,044	60,373	5,247	2,433	2,974	79,071
2009	2	178,962	7,770	93,943	9,803	5,535	5,623	122,674
2010	2	115,961	7,974	39,877	5,998	4,659	5,073	63,581
2011	2	88,932	4,336	28,757	4,064	1,347	3,363	41,867
2012	2	28,232	1,260	6,369	2,049	365	562	10,605
2013	2	58,499	1,791	4,538	600	413	761	8,103

SBT CPUE after 2002 will be used for abundance index.

Table 3. Nominal CPUE by year and area for five species by Taiwanese longline.

Year	T.Area	SBT	ALB	BET	YFT	SWO
1981	1	0.020	9.277	0.465	0.066	0.025
1982	1	0.039	11.126	0.523	0.040	0.019
1983	1	0.010	7.889	0.217	0.048	0.014
1984	1	0.041	6.465	0.344	0.025	0.016
1985	1	0.000	11.827	0.262	0.007	0.023
1986	1	0.001	21.229	0.246	0.032	0.002
1987	1	0.082	7.406	0.607	0.088	0.070
1988	1	0.071	6.217	0.425	0.019	0.045
1989	1	0.121	3.167	0.306	0.081	0.041
1990	1	0.154	2.156	0.249	0.049	0.039
1991	1	0.034	6.225	0.260	0.072	0.029
1992	1	0.063	5.676	0.215	0.037	0.044
1993	1	0.185	5.226	0.373	0.059	0.037
1994	1	0.213	4.248	0.538	0.258	0.130
1995	1	0.196	5.227	0.366	0.089	0.075
1996	1	0.196	2.546	0.178	0.035	0.029
1997	1	0.150	3.290	0.288	0.021	0.033
1998	1	0.145	3.055	0.233	0.056	0.037
1999	1	0.126	1.655	0.231	0.083	0.030
2000	1	0.143	1.847	0.167	0.031	0.026
2001	1	0.160	1.577	0.199	0.087	0.054
2002	1	0.184	1.384	0.308	0.062	0.060
2003	1	0.126	1.758	0.315	0.048	0.024
2004	1	0.151	0.736	0.126	0.038	0.019
2005	1	0.299	0.912	0.067	0.032	0.008
2006	1	0.408	1.407	0.181	0.064	0.023
2007	1	0.530	1.824	0.196	0.066	0.021
2008	1	0.299	2.030	0.127	0.036	0.024
2009	1	0.364	1.793	0.116	0.024	0.037
2010	1	0.163	1.703	0.082	0.039	0.028
2011	1	0.194	1.634	0.158	0.019	0.041
2012	1	0.839	2.303	0.162	0.034	0.022
2013	1	0.586	0.474	0.028	0.004	0.006
1981	2	0.017	8.260	0.385	0.121	0.035
1982	2	0.005	7.647	0.268	0.079	0.032
1983	2	0.025	6.626	0.636	0.118	0.031
1984	2	0.002	6.515	0.554	0.078	0.051
1985	2	0.002	6.332	0.296	0.063	0.028
1986	2	0.001	6.937	0.283	0.077	0.069
1987	2	0.003	6.483	0.435	0.188	0.048
1988	2	0.010	5.421	0.391	0.145	0.063
1989	2	0.019	4.545	0.274	0.081	0.125
1990	2	0.090	3.784	0.328	0.088	0.086
1991	2	0.032	2.449	0.416	0.074	0.091
1992	2	0.158	1.769	0.496	0.371	1.880
1993	2	0.023	5.717	0.240	0.177	0.253
1994	2	0.025	5.572	0.506	0.587	0.742
1995	2	0.097	4.451	0.363	0.144	0.404
1996	2	0.181	2.387	0.221	0.162	0.090
1997	2	0.071	1.702	0.560	0.142	0.170
1998	2	0.092	1.865	0.231	0.087	0.073
1999	2	0.139	1.432	0.223	0.108	0.127
2000	2	0.072	1.250	0.330	0.099	0.094
2001	2	0.071	2.600	0.223	0.054	0.043
2002	2	0.018	1.883	0.336	0.270	0.176
2003	2	0.014	2.638	0.264	0.098	0.009
2004	2	0.078	1.182	0.176	0.184	0.024
2005	2	0.108	0.813	0.137	0.234	0.021
2006	2	0.073	0.235	0.062	0.031	0.025
2007	2	0.049	0.211	0.045	0.019	0.029
2008	2	0.081	0.610	0.053	0.025	0.030
2009	2	0.043	0.525	0.055	0.031	0.031
2010	2	0.069	0.344	0.052	0.040	0.044
2011	2	0.049	0.323	0.046	0.015	0.038
2012	2	0.045	0.226	0.073	0.013	0.020
2013	2	0.031	0.078	0.010	0.007	0.013

SBT CPUE after 2002 will be used for abundance index.

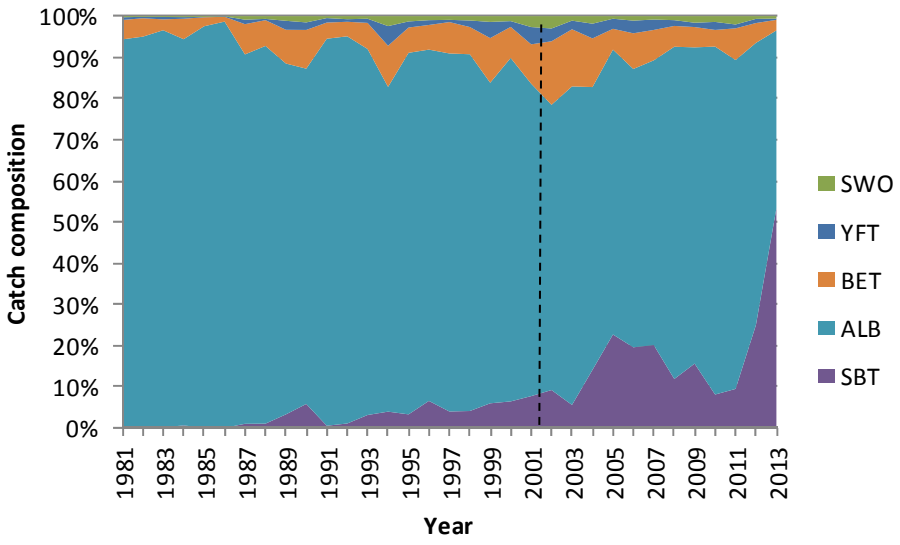

Fig 1. Species composition of five species for Taiwanese longline in TArea 1.

Years between 2001 and 2002 were marked because SBT CPUE after 2002 will be used for abundance index.

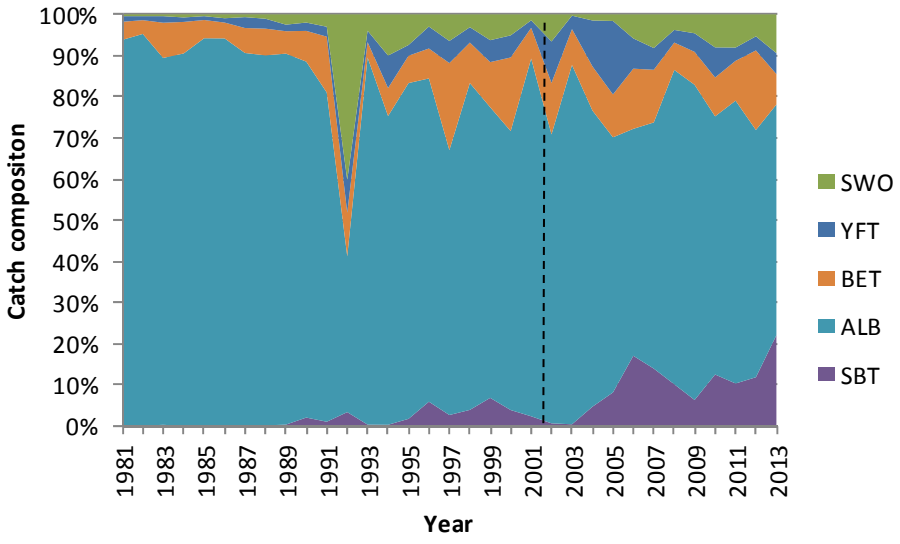

Fig 2. Species composition of five species for Taiwanese longline in TArea 2.

Years between 2001 and 2002 were marked because SBT CPUE after 2002 will be used for abundance index.

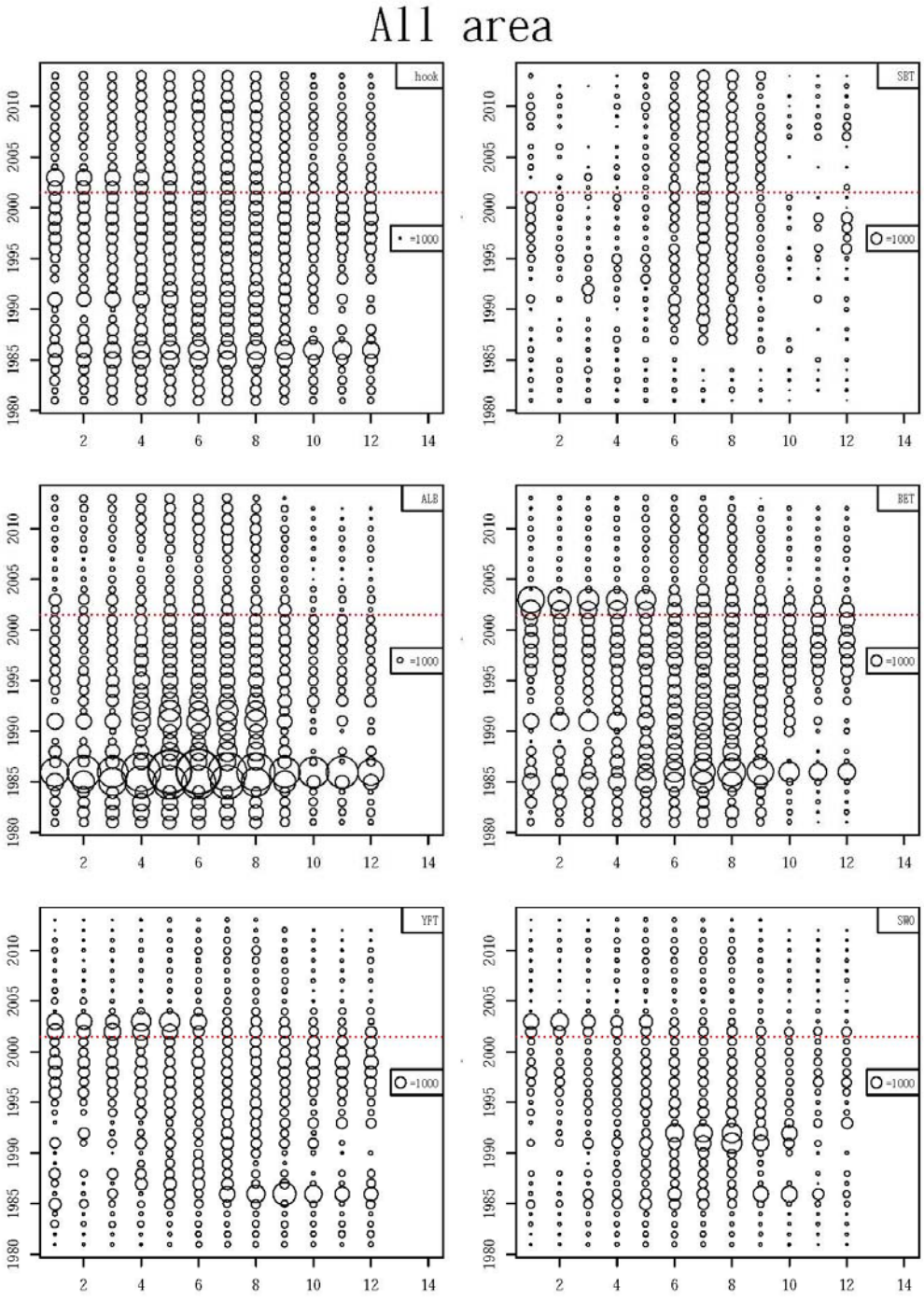

Fig 3. Distribution of numbers of hooks or species caught by month, latitude or longitude to year in Taiwanese longline for all area. (by Month)

Years between 2001 and 2002 were marked because SBT CPUE after 2002 will be used for abundance index.

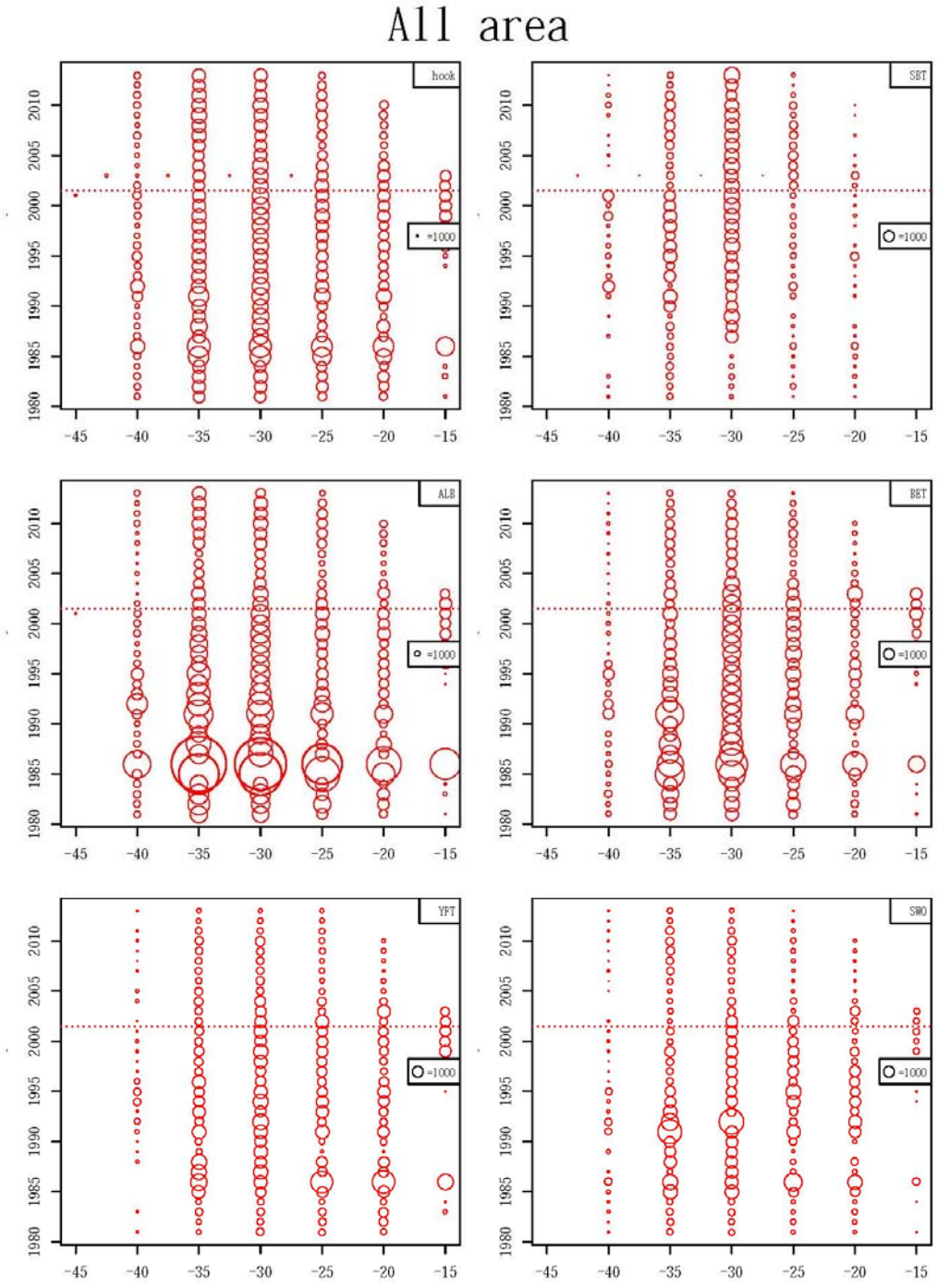

Fig 3. (cont'd) (by latitude)

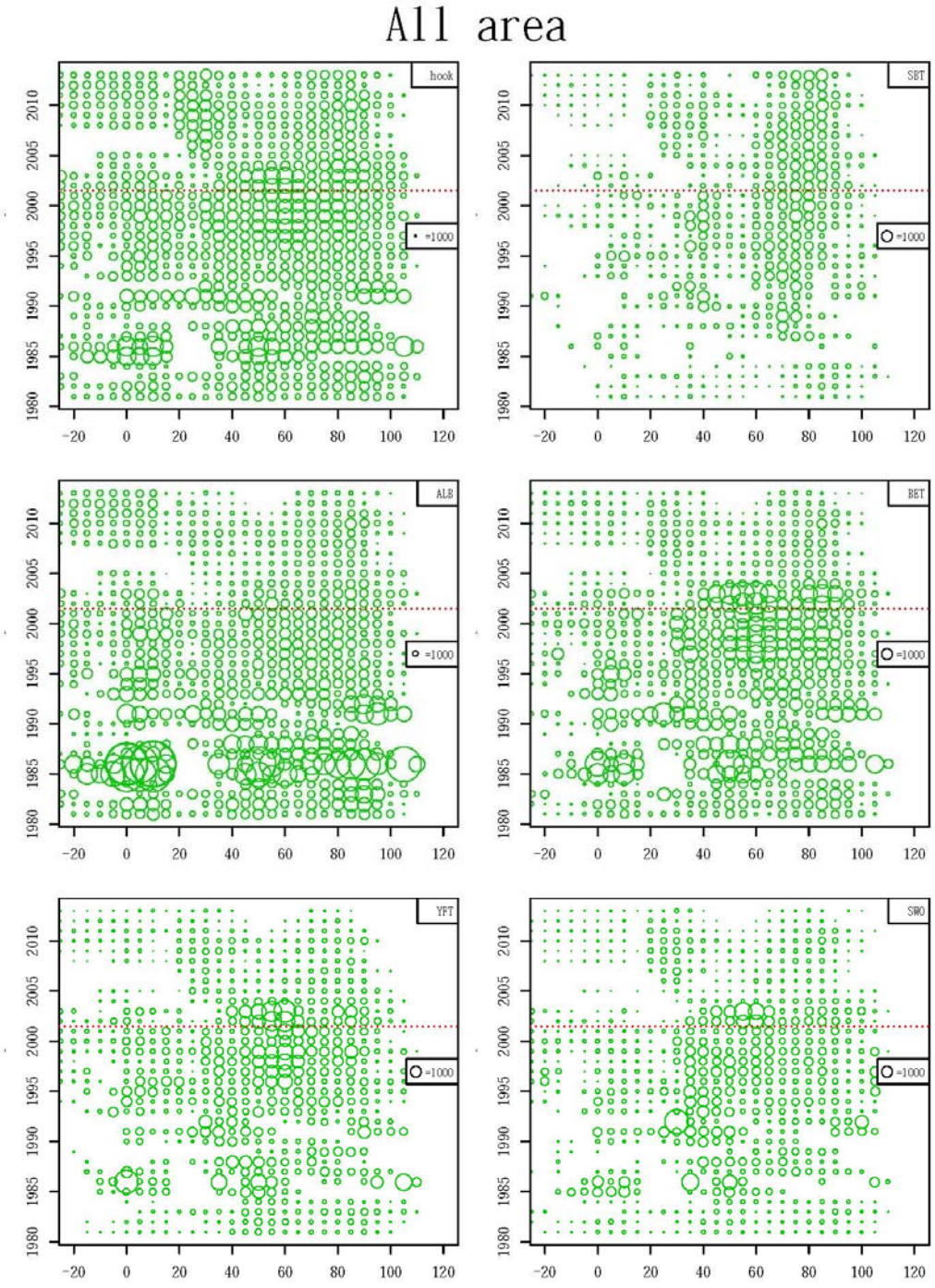

Fig 3. (cont'd) (by longitude)

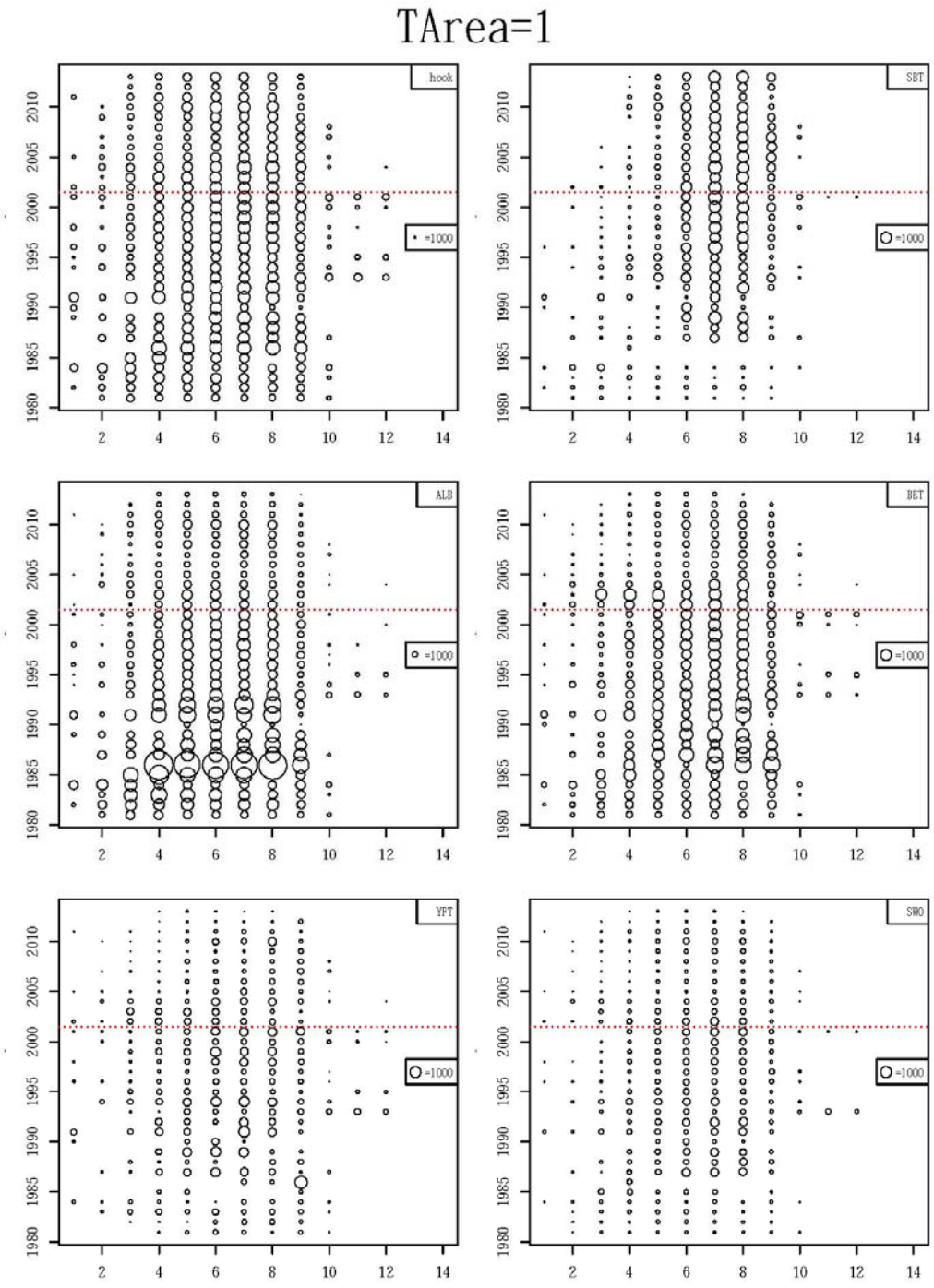

Fig 4. Distribution of numbers of hooks or species caught by month, latitude or longitude to year in Taiwanese longline in TArea 1. (by Month)

Years between 2001 and 2002 were marked because SBT CPUE after 2002 will be used for abundance index.

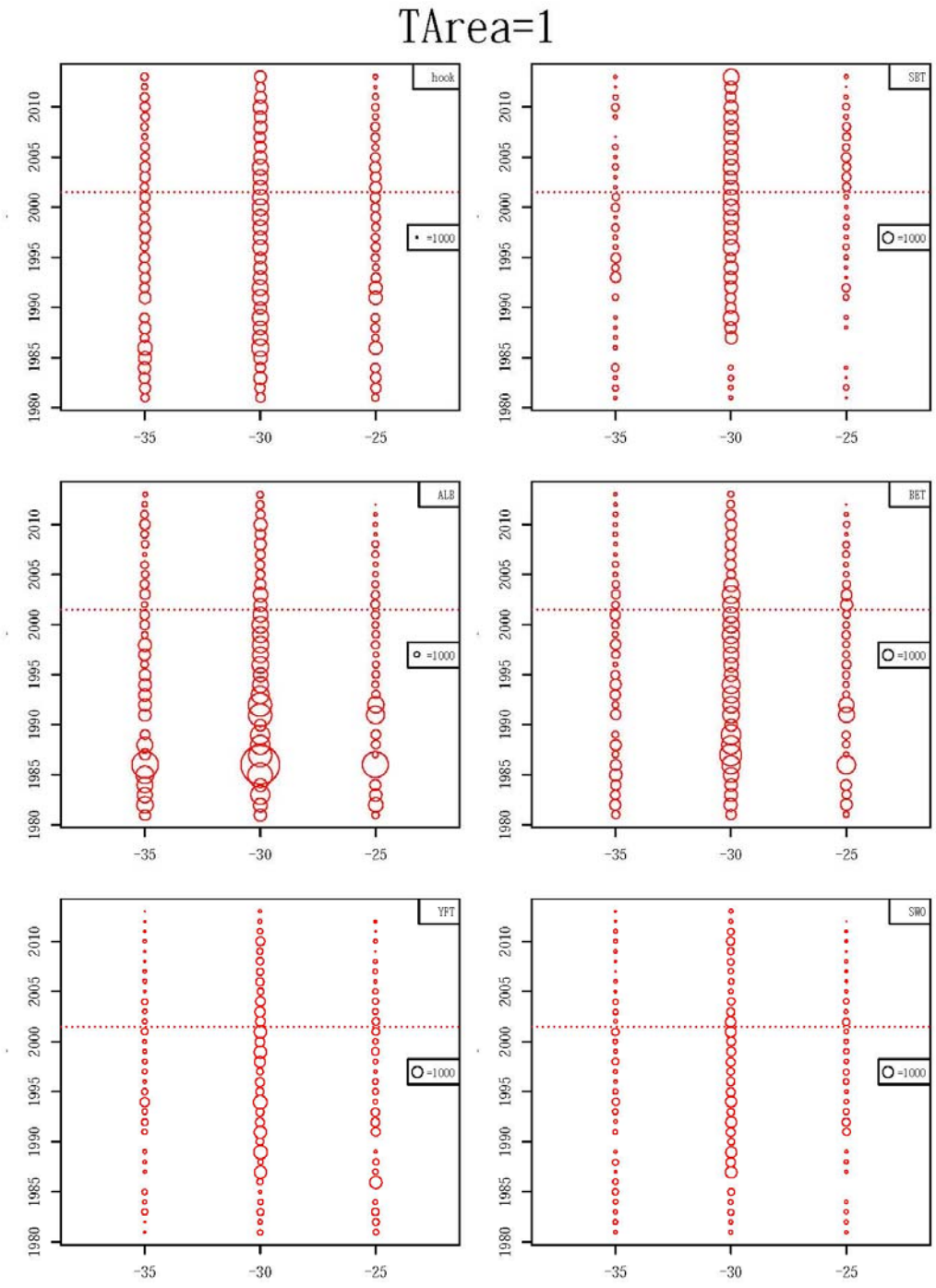

Fig 4. (cont'd) (by latitude)

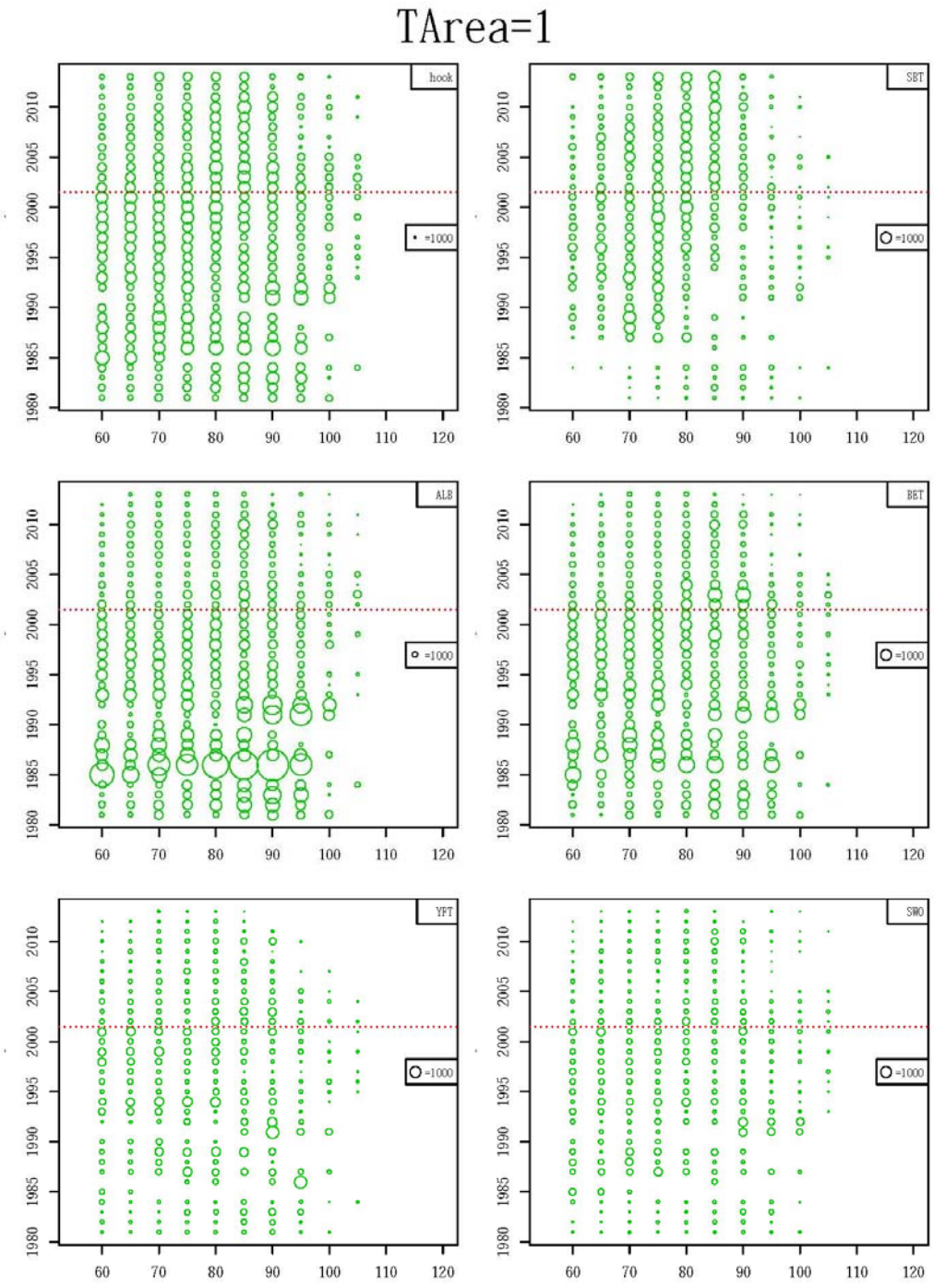

Fig 4. (cont'd) (by longitude)

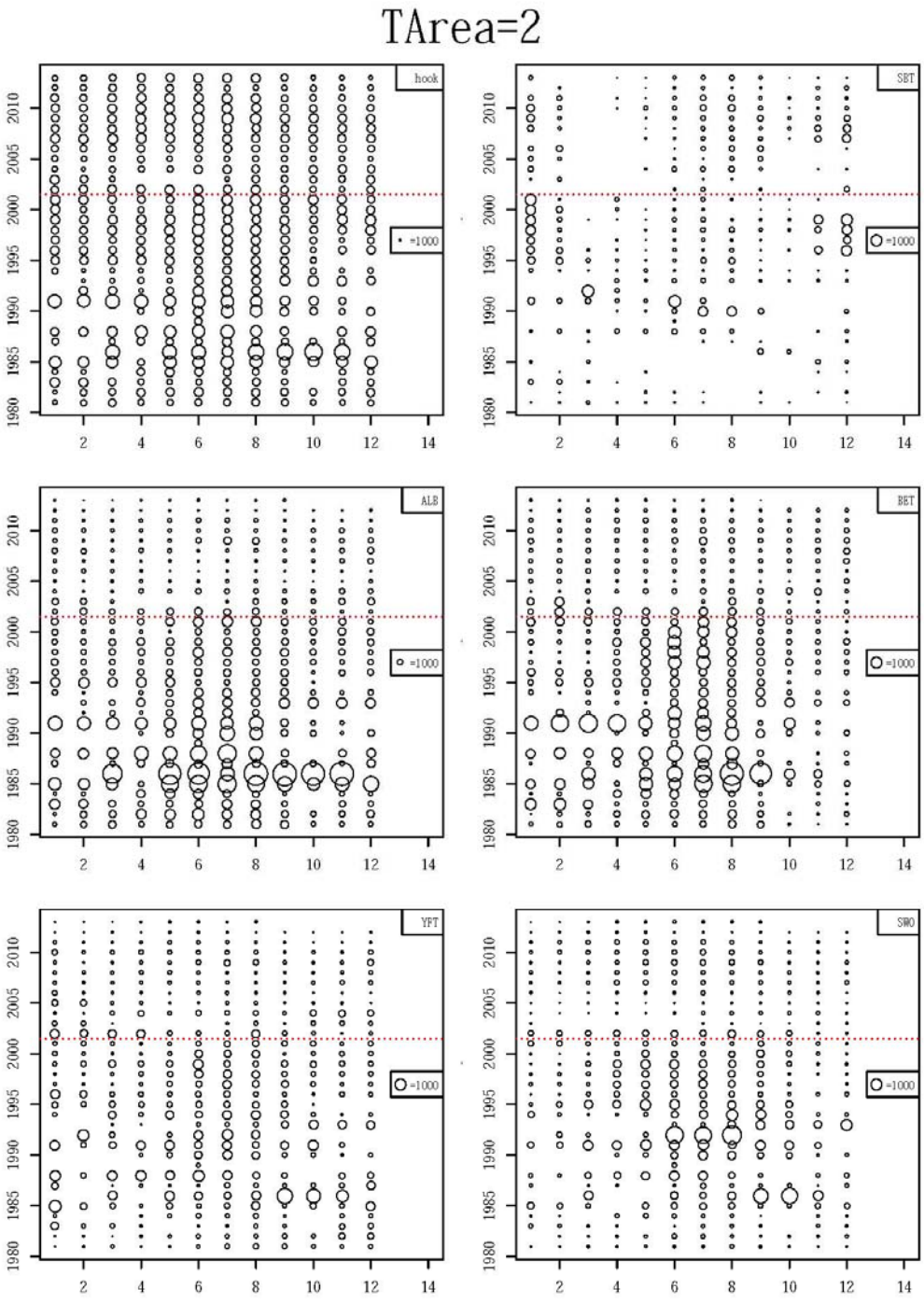

Fig 5. Distribution of numbers of hooks or species caught by month, latitude or longitude to year in Taiwanese longline in TArea 2. (by Month)

Years between 2001 and 2002 were marked because SBT CPUE after 2002 will be used for abundance index.

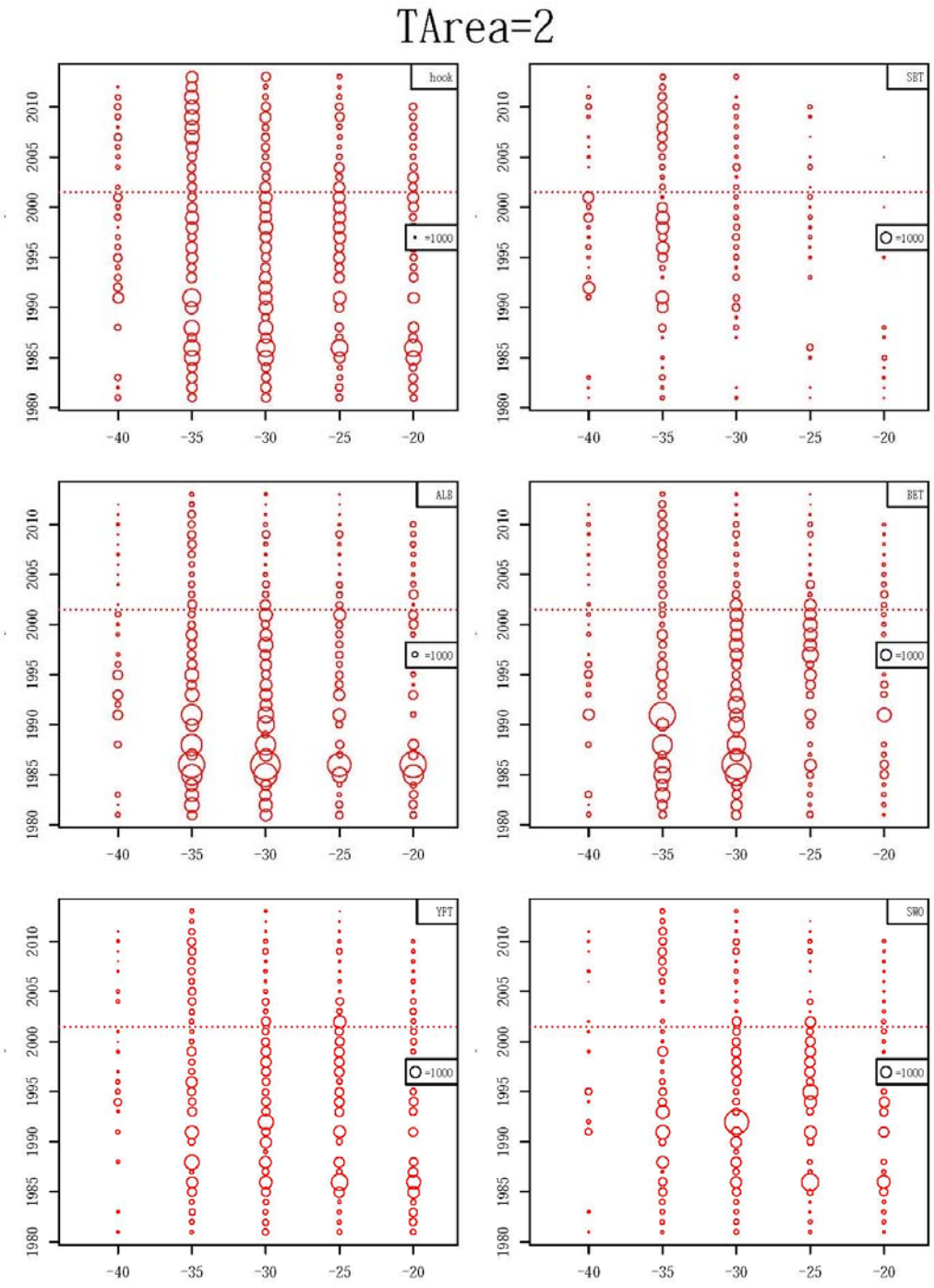

Fig 5. (cont'd) (by latitude)

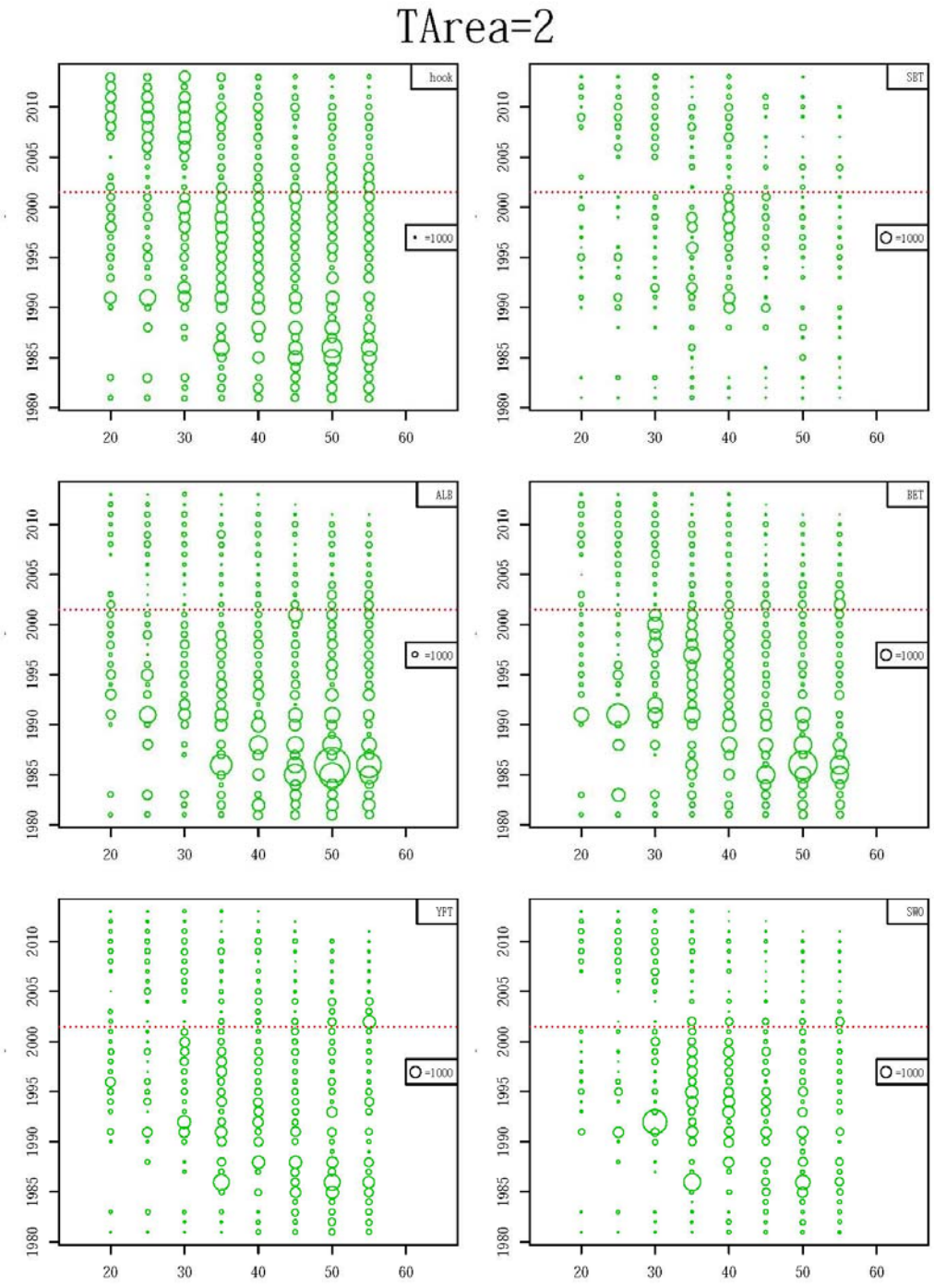

Fig 5. (cont'd) (by longitude)

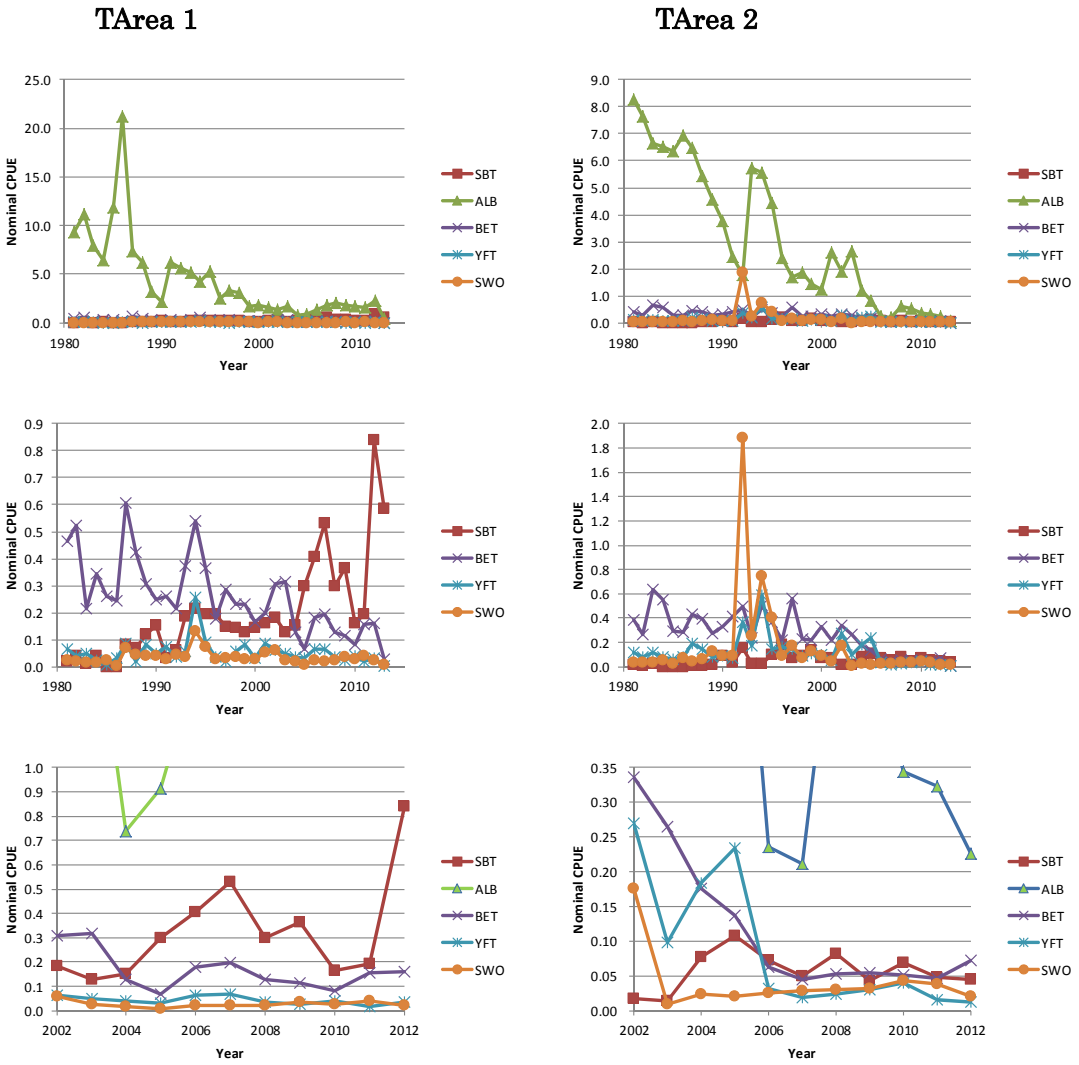

Fig 6. Nominal CPUE by year, area and species for Taiwanese longline.

Top panels are of five species for the period since 1981. Middle panels are of four species excluding albacore for the period since 1981. Bottom panels are of four species for the short period since 2002 corresponding to years for which SBT CPUE data will be used for abundance index. 2013 data were removed because logbook data of this year was tentative. Left and right panels are for TArea1 and TArea2, respectively.

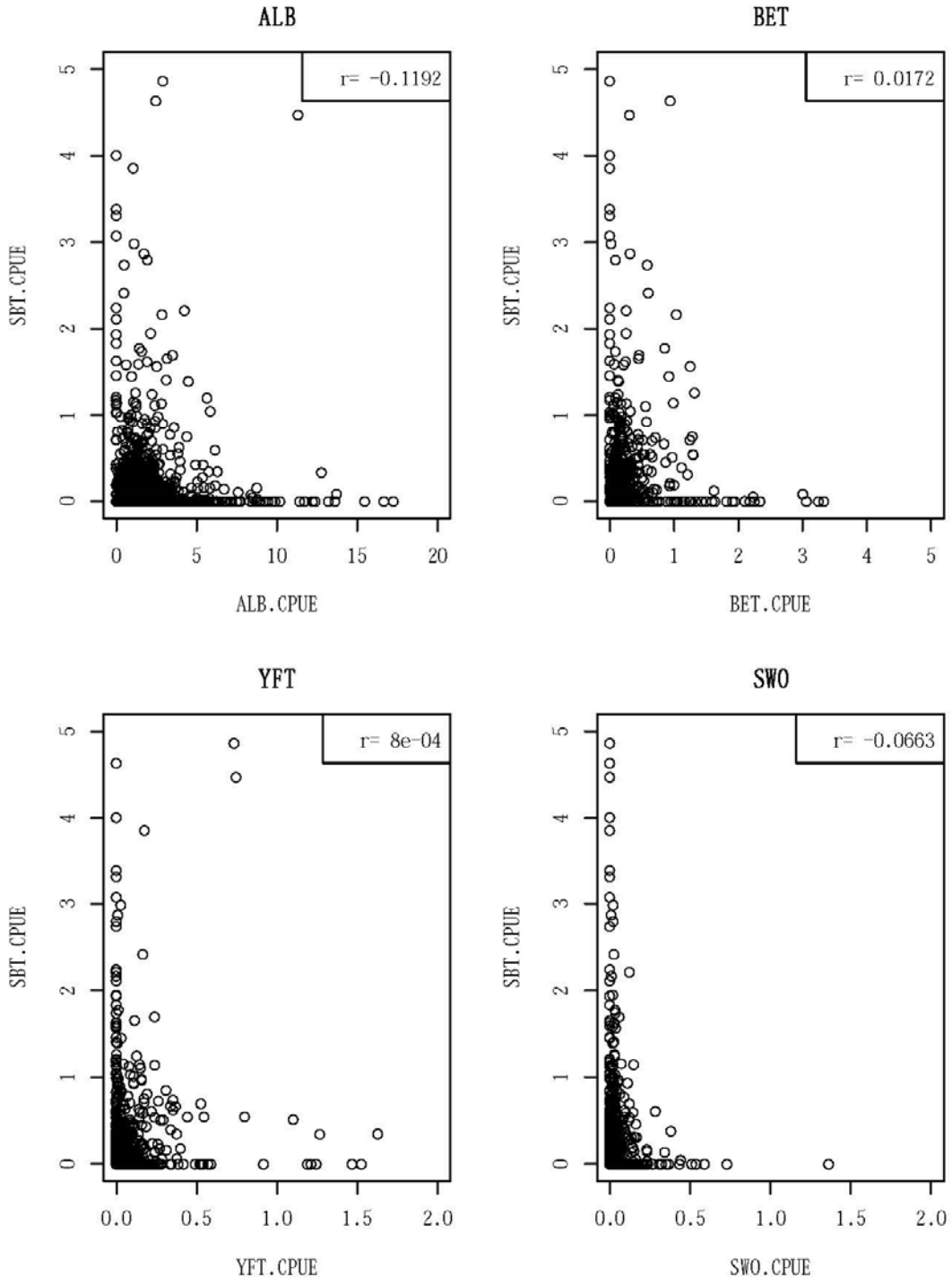

Fig 7. Plot of CPUE to SBT in TArea 1 in Taiwanese longline.

"r" is the Pearson`s correlation factor. Year in data are between 2002 and 2012.