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STOCK ASSESSMENTS ON KAWAKAWA (*EUTHYNNUS AFFINIS*) AND LONGTAIL TUNA (*THUNNUS TONGGOL*) RESOURCES IN THE SE ASIA (SEAFDEC) WATERS

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SEAFDEC / MFRDMD
ZON LARANGAN MEROKOK
SEAFDEC
SWEDEN
asean
SEAFDEC
ASSP
The Special Training/Workshop on
STOCK ASSESSMENTS OF LONGTAIL TUNA
AND KAWAKAWA IN THE SOUTHEAST ASIAN REGION
17-25 April 2016, SEAFDEC/MFRDMD, Kuala Terengganu, Malaysia

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FUNDING AGENCY

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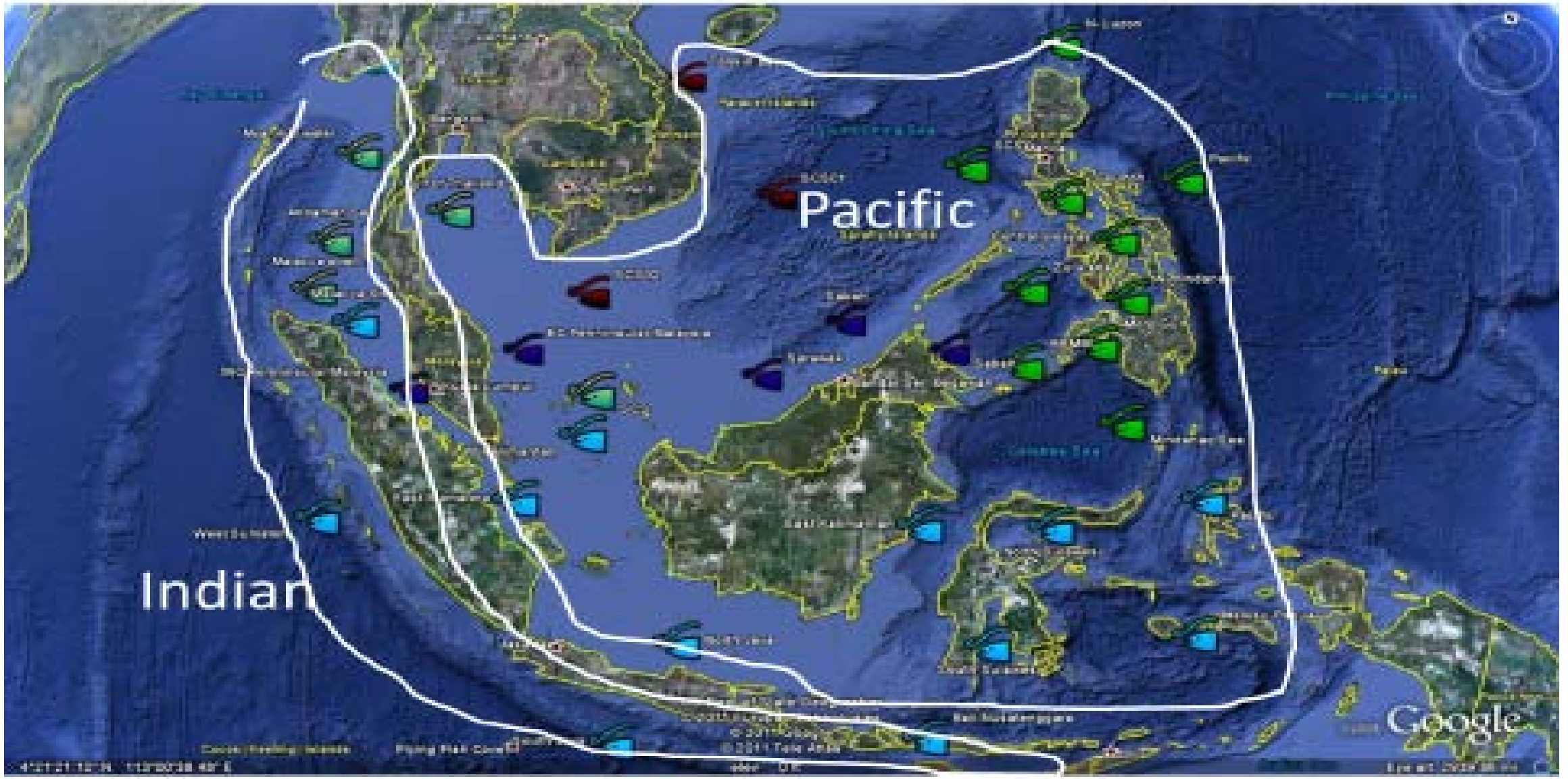
2. OUTLINE

As explained in Introduction, we (7 core persons and the resources person on stock assessments) will report the results of CPUE standardization, stock assessments by ASPIC and Kobe plot in this document, which also demonstrates our progress of the training and workshop.

2.1 Stock structure

In stock assessments, we assume **two stocks** for Kawakawa and Longtail tuna in the SE Asia, i.e., Pacific and Indian Ocean stock (Fig. 1). Thus we conducted **4 stock assessments (2 species for 2 stocks)** and show results in this document.

2 stock hypothesis



2.2 DATA

In ASPIC, for each species, we need the **global catch** by country and CPUE (catch and Effort) by country, gear and area. We now describe how to collected these data.

(1)Historical nominal Catch

- **data coordinators assigned in each country.**
- published catch data **from IOTC, FAO and SEAFDEC**.
- we made the most plausible catch data sets.

(1)CPUE

- Thailand and Philippines provided nominal CPUE for PS (Purse Seine) and multi gears respectively.
- After we examined the CPUE data, we realized that **CPUE data form Thailand** satisfied following conditions for CPUE standardization stated in BOX 1.

Box 1. Conditions to select plausible nominal CPUE for CPUE standardization

(a) data series should be more than 10 years;
(b) compositions of 0 (zero) catch should be less than 30%; and
(c) nominal CPUE trends should be smooth (no sudden jumps nor extreme values).

Table 1 shows the structure of the Thai nominal CPUE. There are data in three periods, i.e.,

(a) 1991-1994 (4 years) Annual CPUE (DOF)

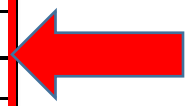
(b) 1995-2013 (17 years) monthly CPUE (DOF)

(c) 2011-2015 (5 years) Set by set CPUE (AFDEC).

As the data (a) is the annual basis and we cannot standardize, hence we decided not to use. Regarding the data (b) and (c), there data are collected by different offices and these are not same quality**. Thus we decided to use CPUE data for (b) basically.**

Table 1 Specification of Thai CPUE

	DOF/HQs (Praewpan)		DOF/AFDEC (Chalit)	
	Gulf of Thailand	Andaman Sea	Gulf of Thailand	Andaman Sea
1990				
1991	PS CE data by year and area (GOT and Andaman Sea) (can not use for CPUE standardization).			
1992				
1993				
1994				
1995	PS CE data by area, year and month (to be used CPUE standardization)			
1996				
1997				
1998				
1999				
2000				
2001				
2002				
2003				
2004				
2005				
2006				
2007				
2008				
2009				
2010				
2011			PS set by set CE data by area, year, month, day and boats (to be used for CPUE standardization)	
2012				
2013				
2014				
2015				



Note

Thailand (Chalit) send additional AFDEC Catch and effort data (2006-2013) recently. But all the stock assessments have completed thus we could not use these CPUE. We may them use in the future

Philippines CPUE data

Box 1. Conditions to select plausible nominal CPUE for CPUE standardization

(a) data series should be more than 10 years (OK);
(b) Compositions of 0 (zero) catch should be less than 30% (some Problem)
(c) nominal CPUE trends should be smooth (no sudden jumps nor extreme values) (some problem).

Some possibility for Philippines CPUE

- Use other model than GLM
  (negative binominal, 0 inflated model, GAM etc.)
- Statistical treatment (transformation)
- Combining CPUE to make robust (reliable) CPUE

Take tremendous time to explore
(in the long future)
(Not this time)

(1)RESULTS

We conducted 4 stock assessments in the SE Asia, i.e.,
(i) Kawakawa (Indian Ocean stock),
(ii) Kawakawa (Pacific Ocean stock),
(iii) Longtail tuna (Indian Ocean stock)
(iv) Longtail tuna (Pacific Ocean stock).

In each stock assessment, we present results as stated in BOX 2.

Box 2 Presentation of ASPIC Results

(1) Historical catch by country;

(2) Nominal CPUE and relations with catch;

(3) CPUE standardization (ANOVA Table, plots of standardized CPUE, residual analyses and QQ plots) and relations with catch;

(4) ASPIC results by Kobe plots (Stock status trajectory); and

(5) Stock status and Management advice.

We use excel (data process) and 3 menu driven software

Note : CPUE standardization software has been improved (output) and circulated to all the participants

Contents

(1) Catch

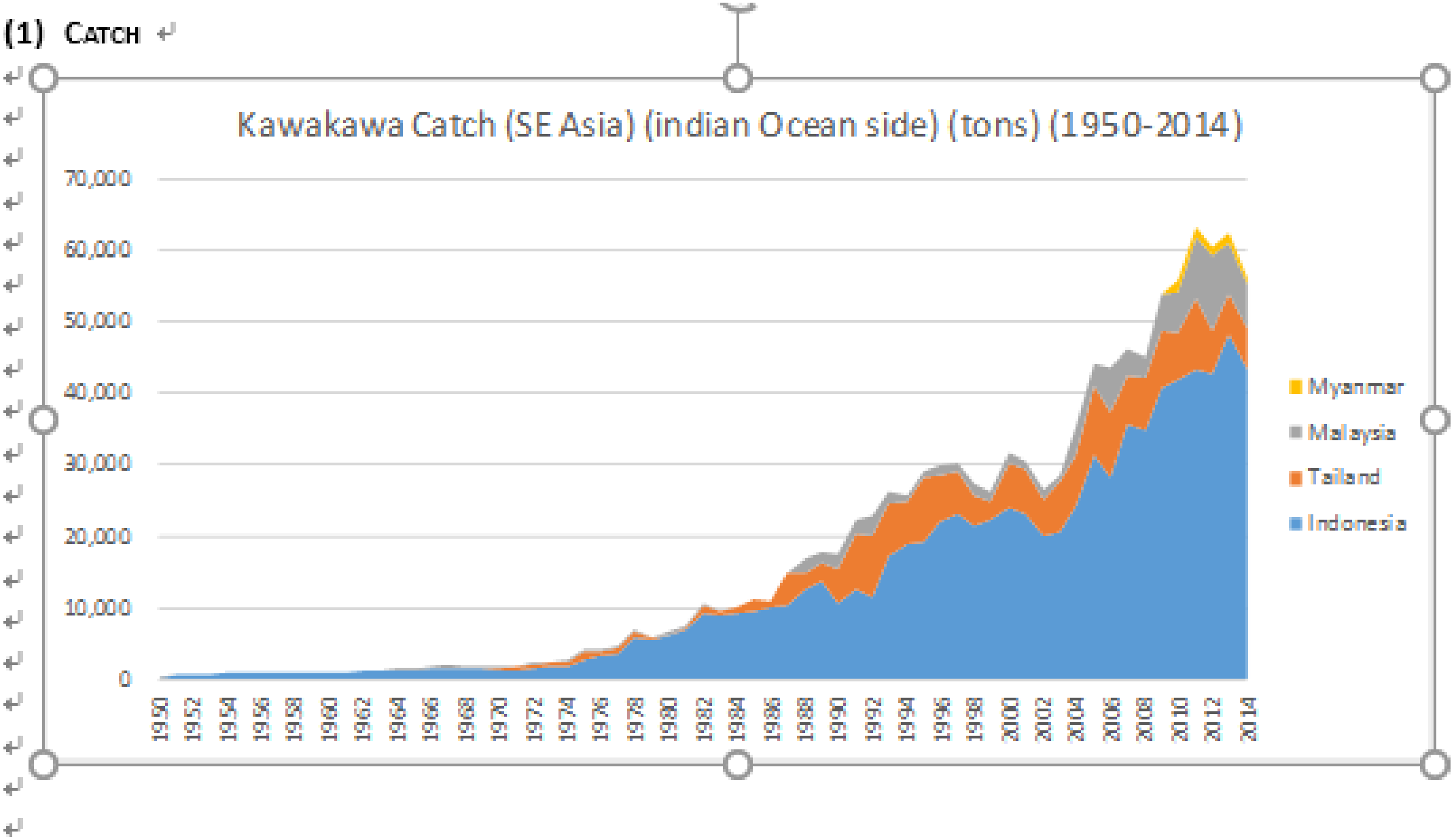


Fig 3. Kawakawa catch trend by country (SE Asia water in the Indian Ocean SEAFDEC water)

- (2) NOMINAL CPUE AND RELATION WITH CATCH

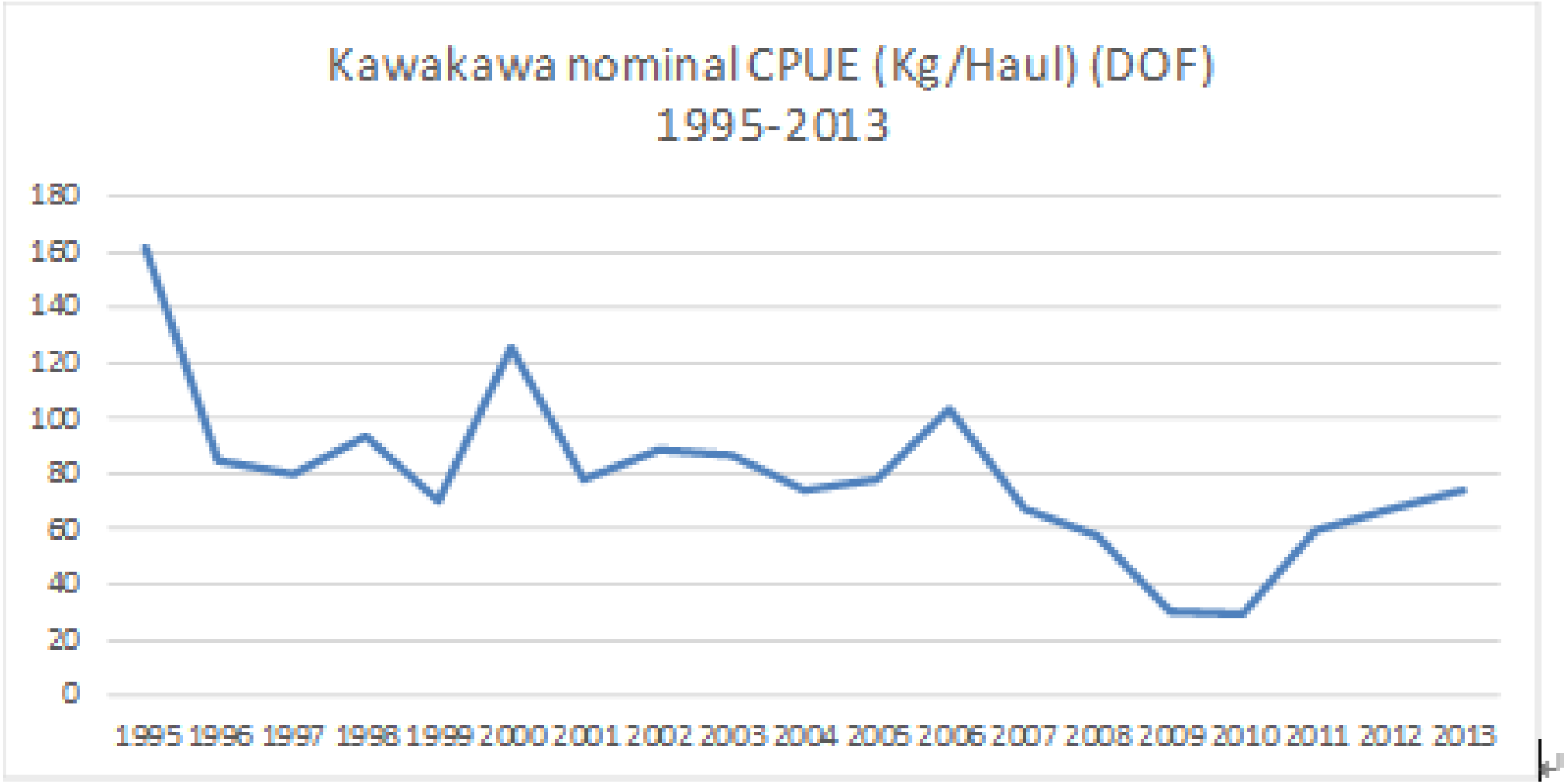
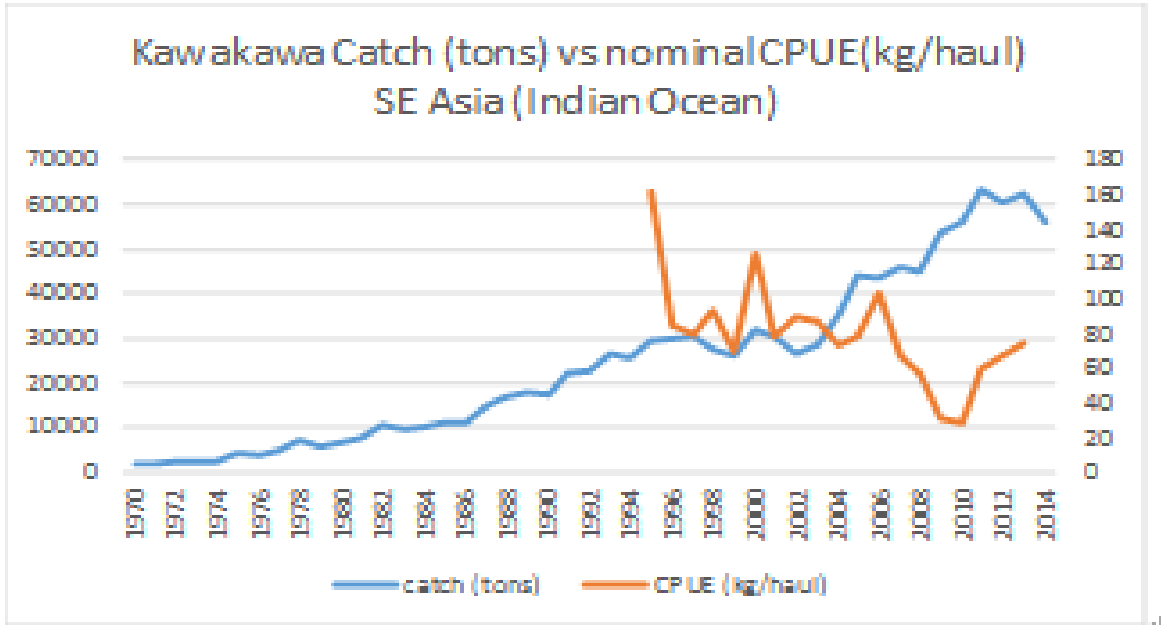


Fig. 4 Trend of nominal CPUE



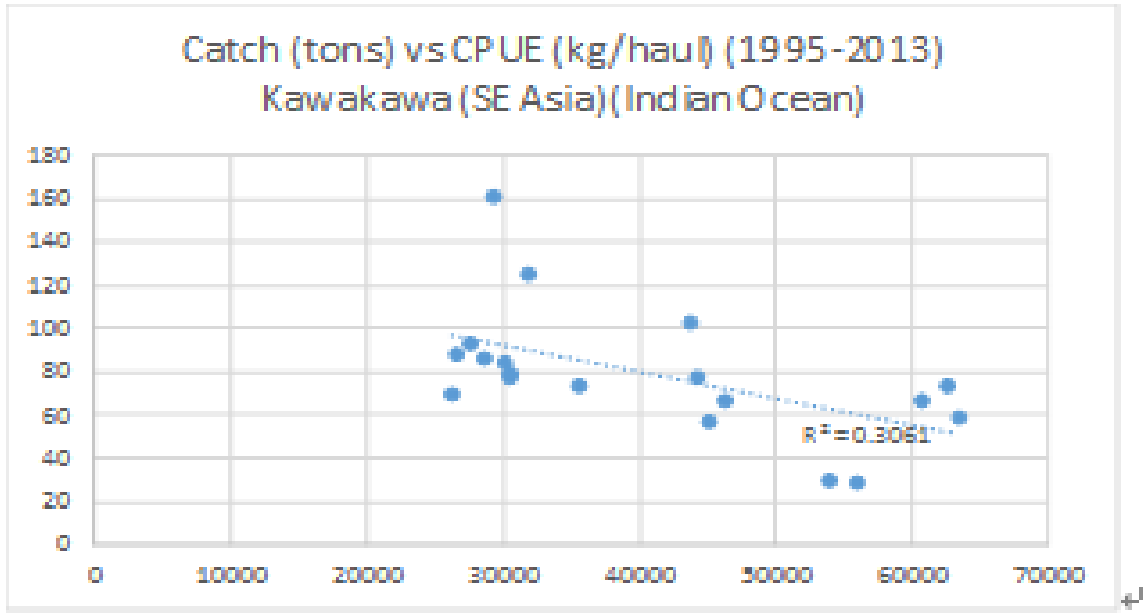


Fig. 5 Relations between catch vs. nominal CPUE

- (3) CPUE standardization (Table 3 and Figs 6-8)

Table 3

ANOVA (Analysis Of Variance) Table					
Adjusted R2 = 0.4819					
Factors	DF (Degrees of Freedom)	Type III SS (Sum of Squares)	MSE (Mean Squared Error)	F value	Pr(>F)
YR	18	34.39	1.91	2.14	0.00
Q	3	294.08	98.03	109.98	0
area	1	1.20	1.20	1.34	0.25
Residuals	352	313.75	0.89		

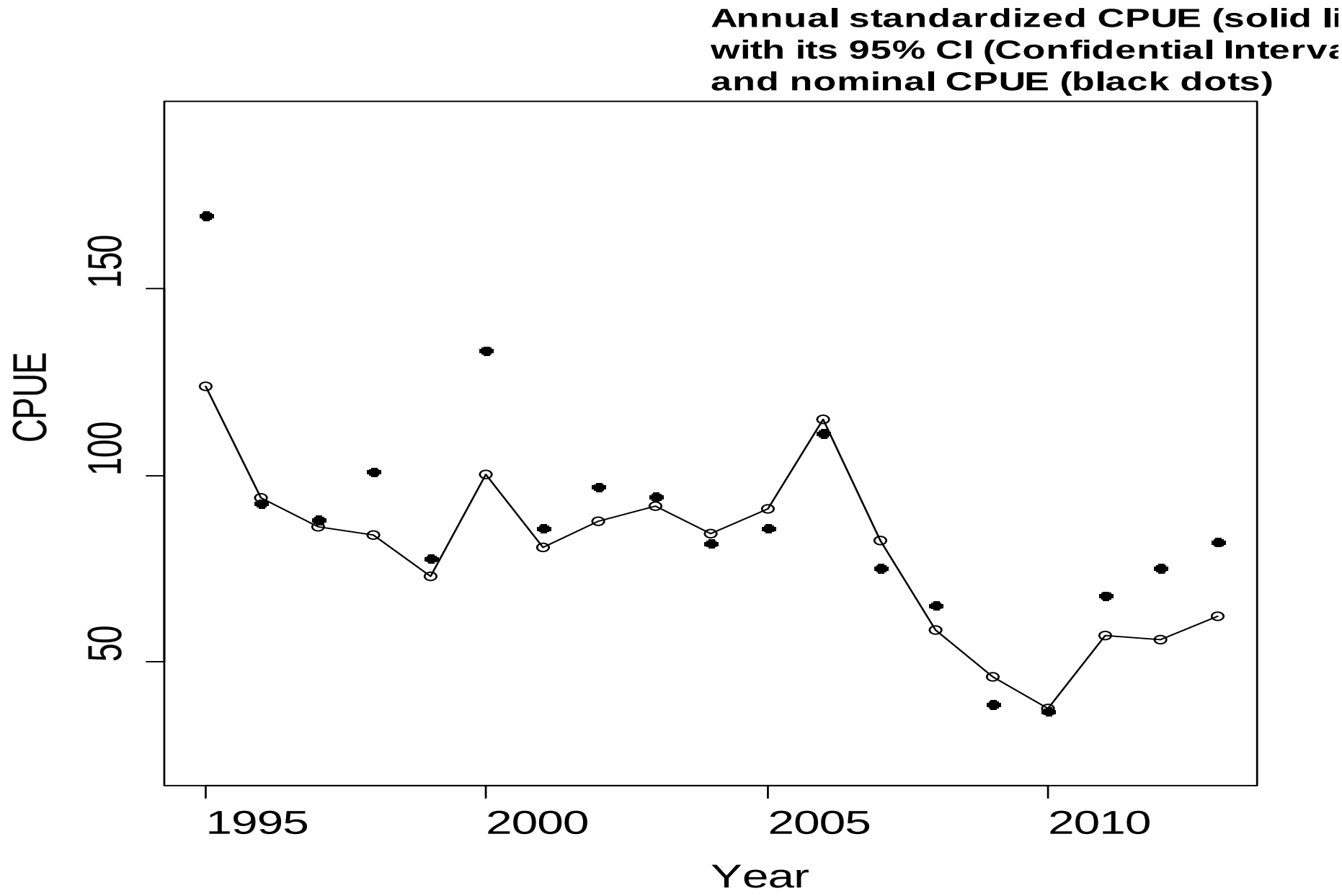
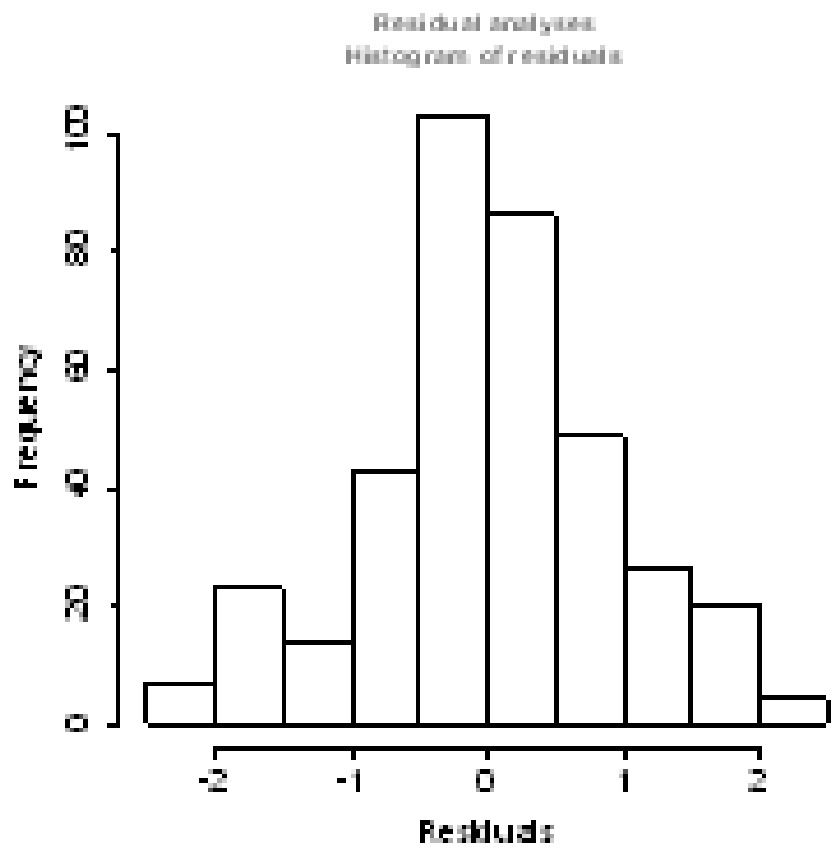

Annual standardized CPUE (solid li
with its 95% CI (Confidential Interva
and nominal CPUE (black dots)
CPUE
50
100
150
1995
2000
2005
2010
Year

Fig. 7.


Residual analysis
Histogram of residuals
Frequency
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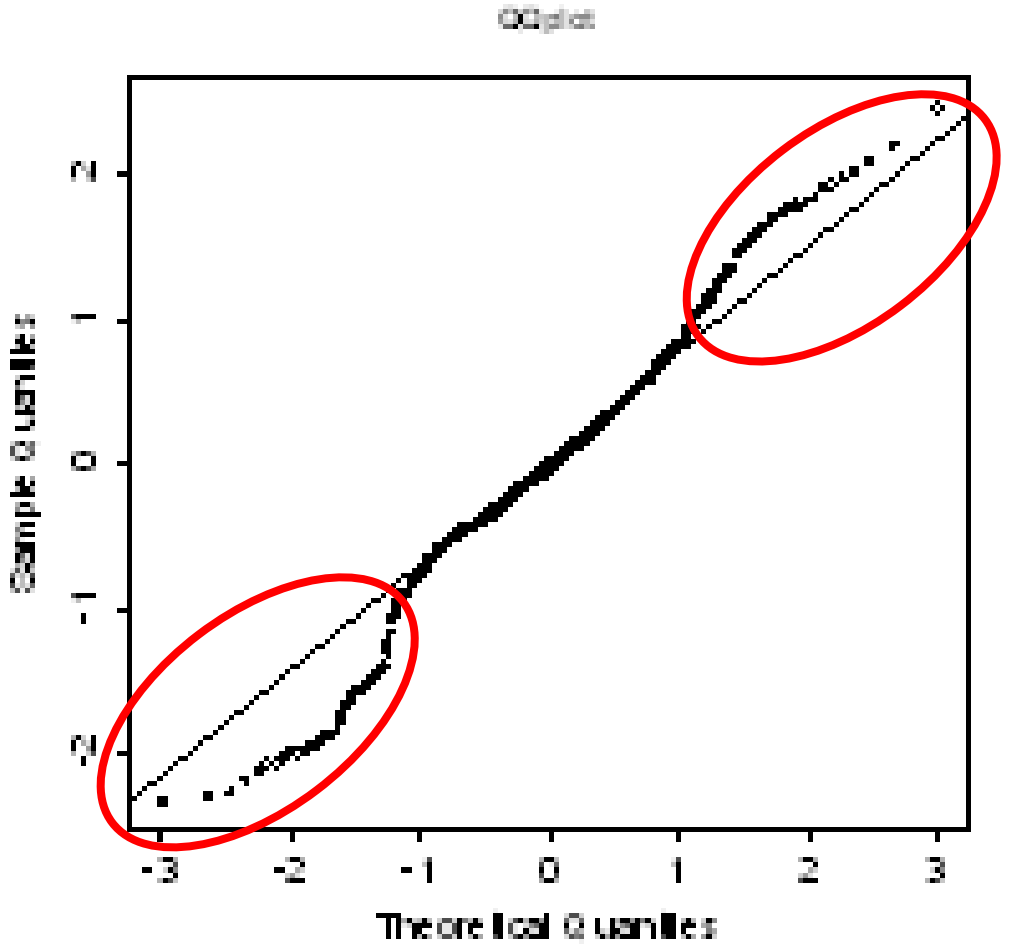
40
60
80
-2
-1
0
1
2
Residuals

Fig. 8.


QQplot
Sample Quantiles
-2
-1
0
1
2
-3
-2
-1
0
1
2
3
Theoretical Quantiles

(1)ASPIC RESULTS BY KOBE PLOTS (STOCK STATUS TRAJECTORY)

There were no convergences when we attempted to estimate all parameters. Then we assume B0/K=1 and we fixed plausible K values (100, 200 and 300,000 tons).

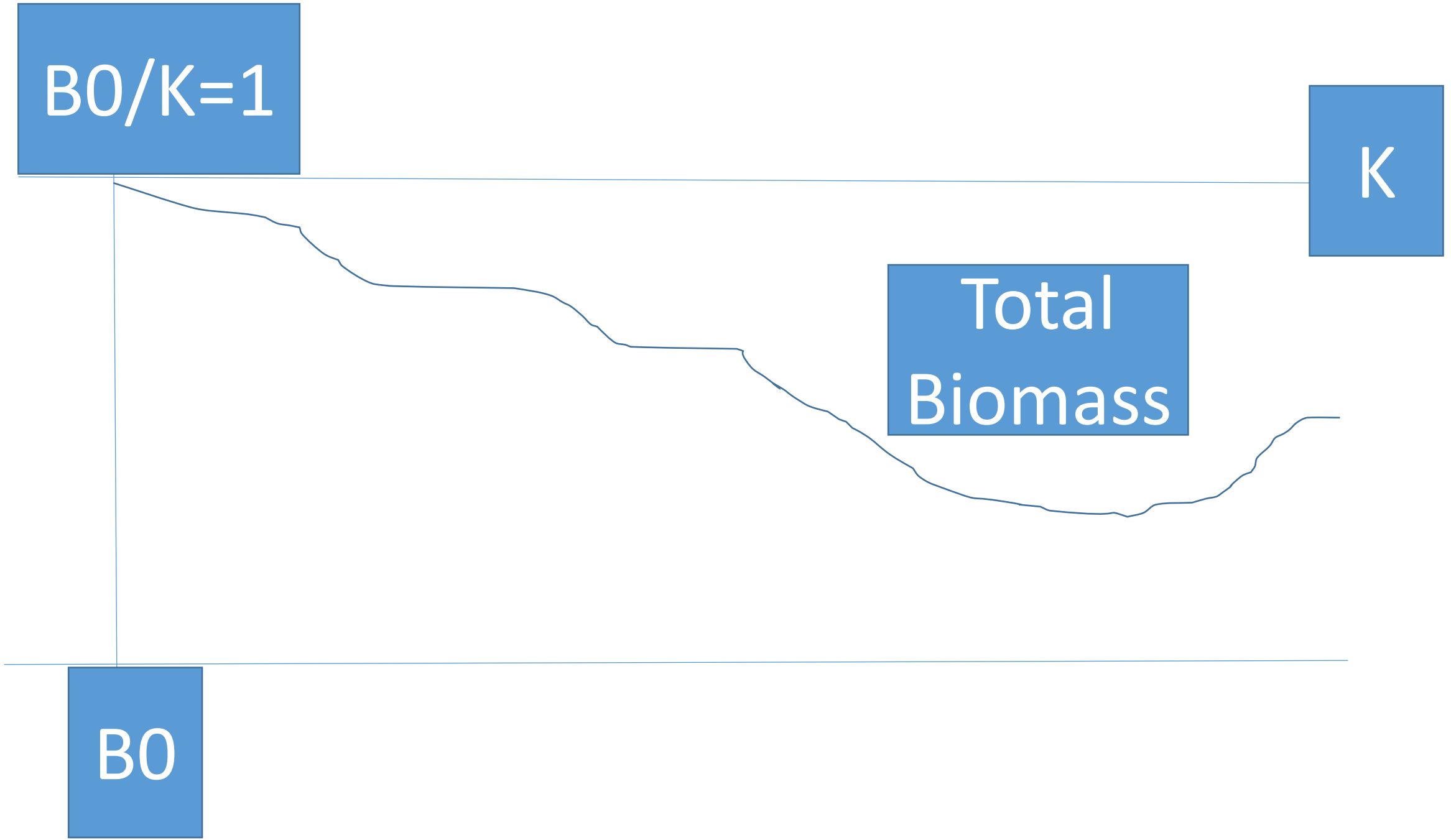
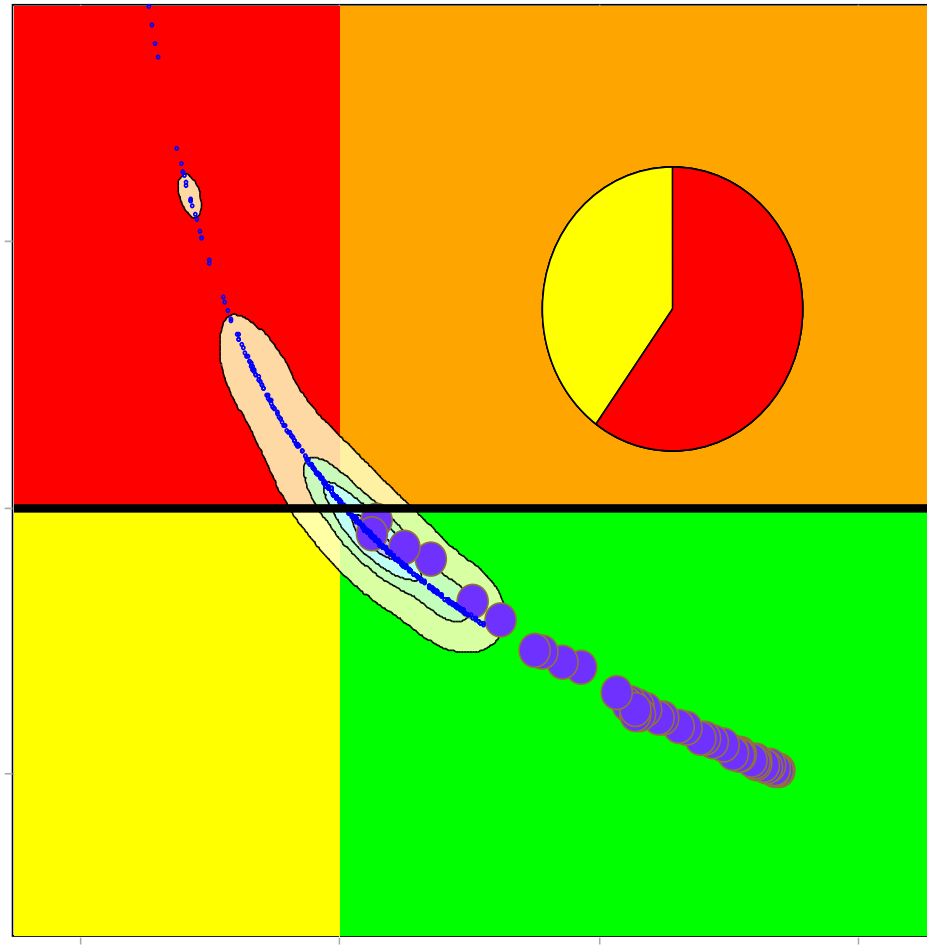
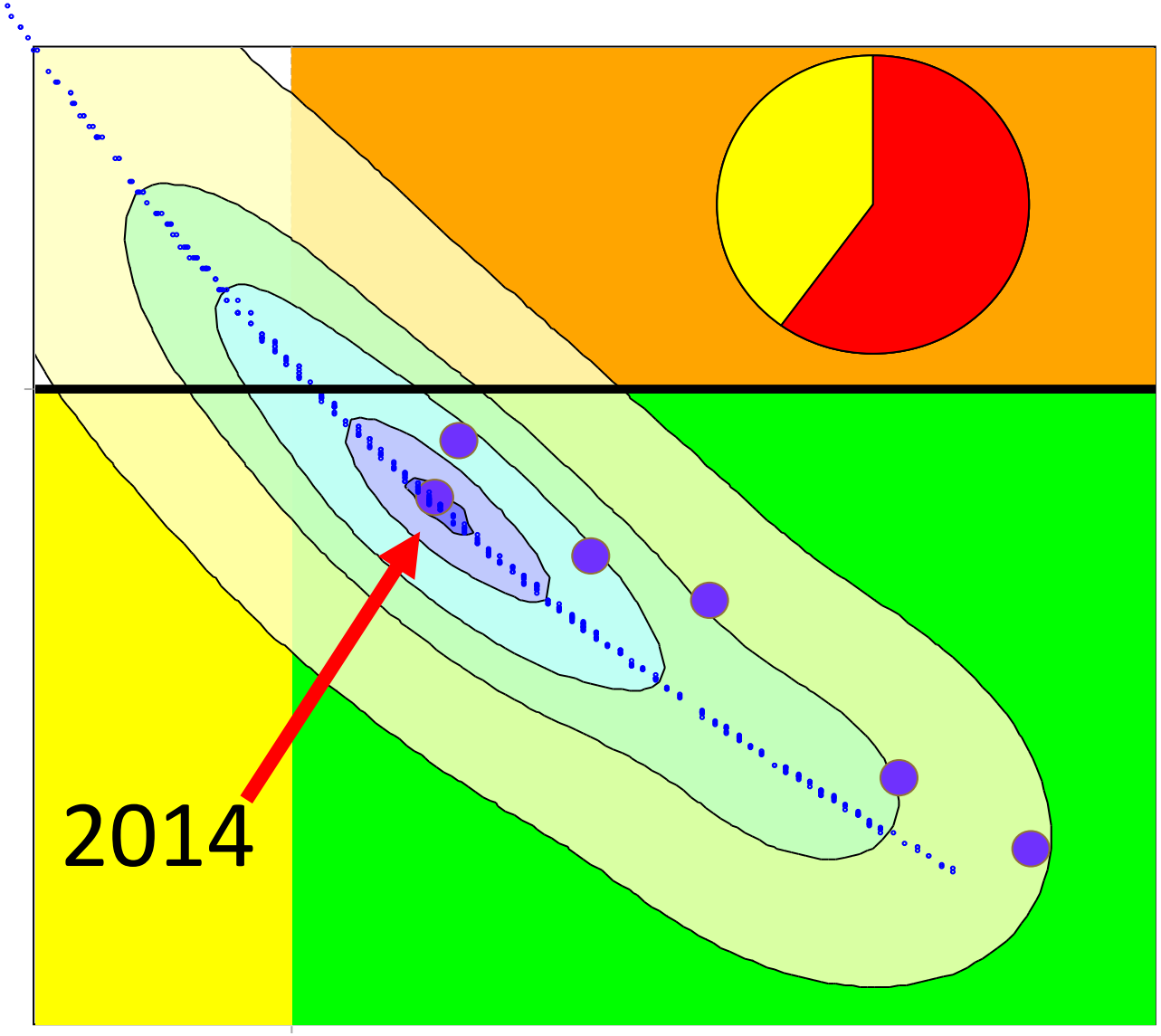

B0/K=1
K
Total Biomass
B0

Table 4 Results of ASPIC stock assessments on 5 scenarios

Model	K(fixed) (1,000t)	B0/K=1	r	MSY (1,000t)	TB/TBmsy	F/Fmsy	Bmsy	Fmsy	TB	R2	RMS
Fox	100	1	1.76 (too high)	65	1.43	0.61	37	1.45	50	0.23	0.36
Fox	200	1	0.80	59	1.28	0.75	74	0.80	94	0.24	0.37
Fox	300	1	0.48 (too low)	53	1.16	0.91	110	0.48	110	0.25	0.36
Fox	400	1	0.32 (too low)	47	1.07	1.09	147	0.32	167	0.27	0.36
Fox	500	1	0.23 (too low)	42	1.02	1.26	147	0.23	202	0.28	0.35

As r values are not realistic for100 and 300,000 tons, we selected parameters when K=200,000 tons.




2014

(1)STOCK STATUS AND MANAGEMENT ADVICE

Based on the Kobe plots, **the 2014 stock status of kawakawa** in the SE Asia (Pacific Ocean side) is **in the green zone** (F/Fmsy=0.75 and TB/TBmsy=1.28), i.e., F is 26% lower than MSY level and TB is 29% higher than its MSY level.

Although Kawakawa stock in the Indian Ocean stock is in the safe condition, it is recommended that **both fishing pressure and catch should not exceed the 2014 level** because uncertainties around the 2014 point **is 53% (Red, Orange and Yellow zone i**n the Kobe plot), while the **47% is in the safe (green) zone**.

Contents

(1) CATCH BY COUNTRY

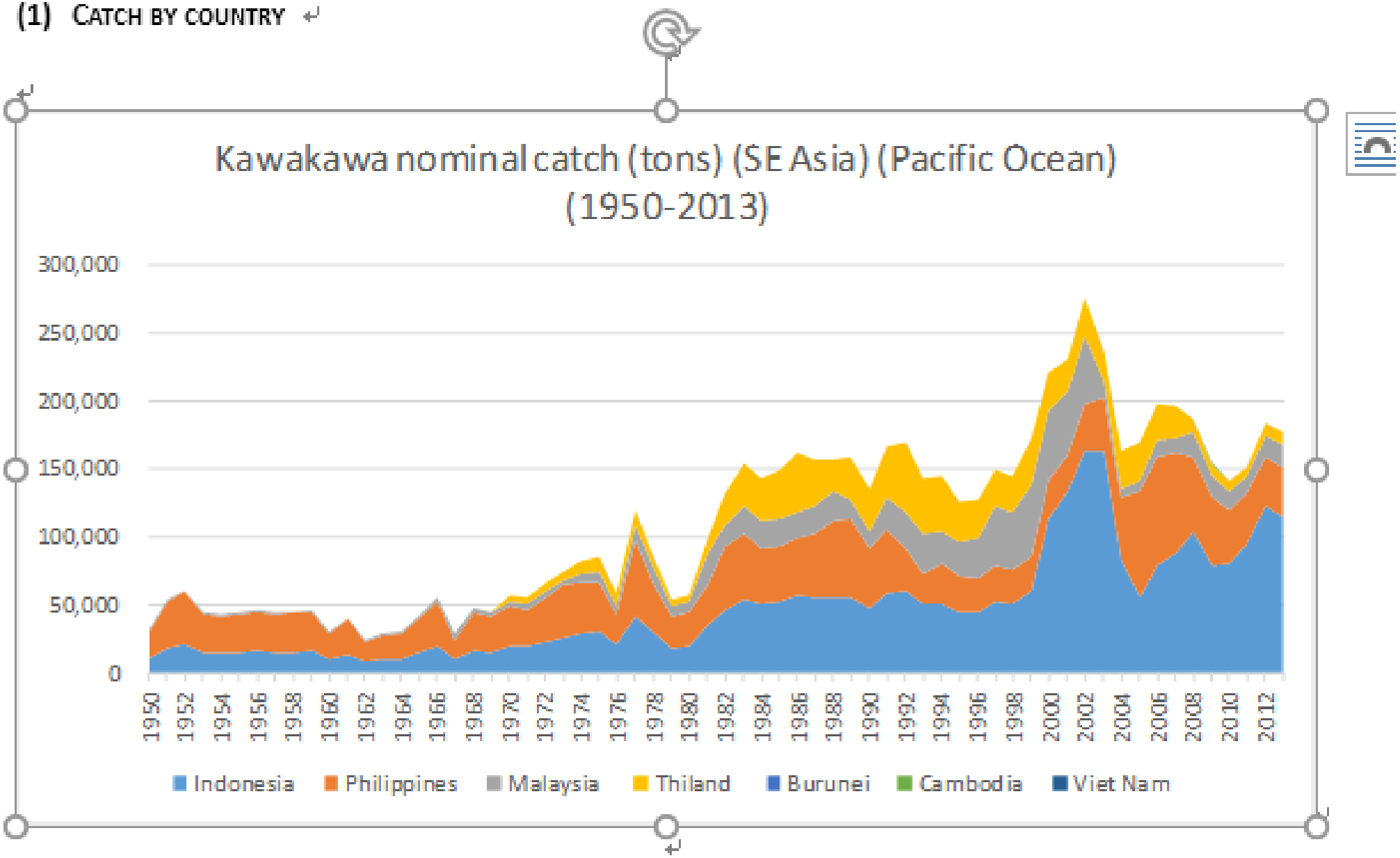


Fig. 10 Kawakawa catch trend by country

(SE Asia water in the Pacific Ocean SEAFDEC water)

(2) Nominal CPUE

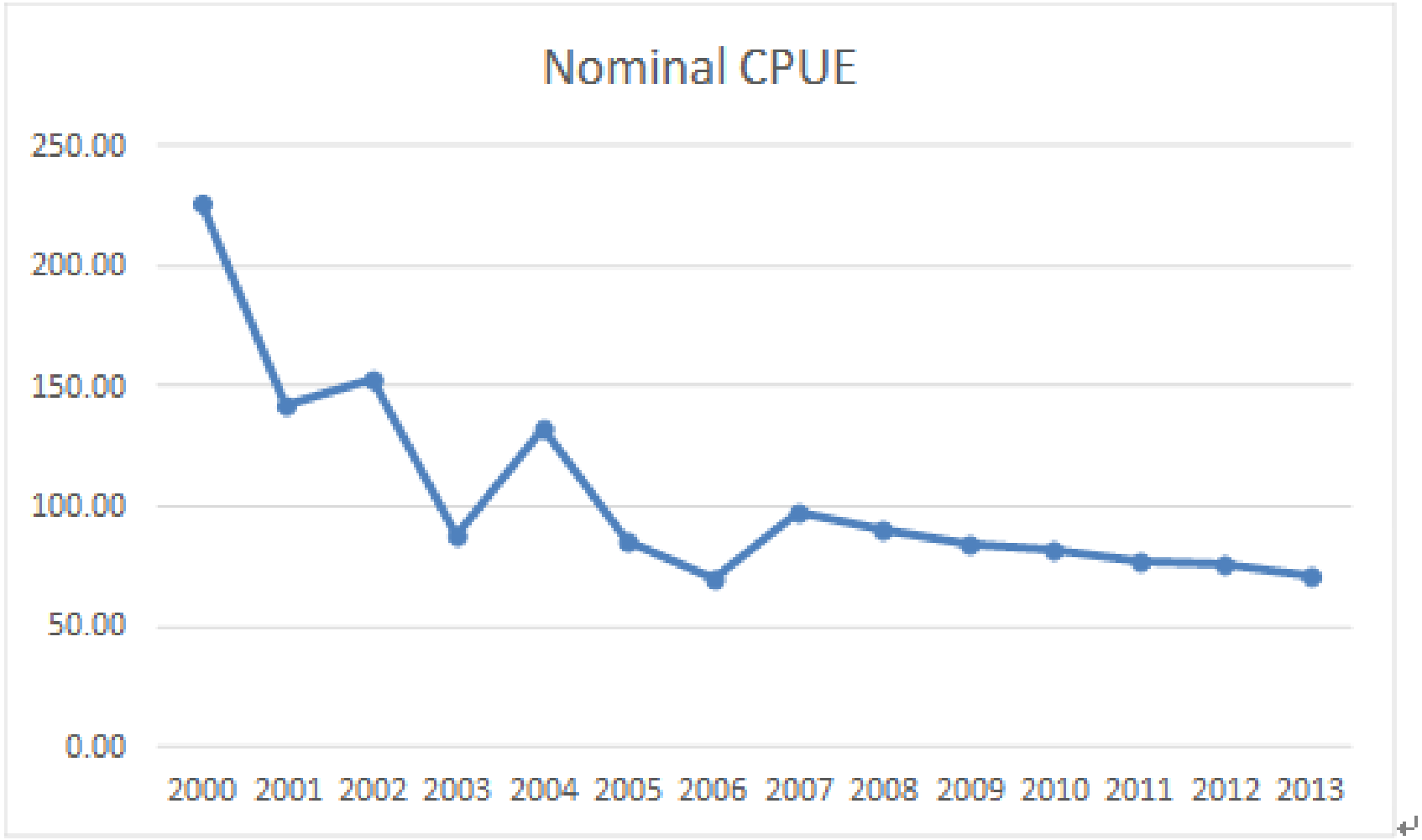


Fig 11 Nominal CPUE

- (3) STANDARDIZED CPUE AND RELATION WITH CATCH (TABLE 6 AND FIGS 12-14)

Table 6

ANOVA (Analysis Of Variance) Table					
Adjusted R2 = 0.6535					
Factors	DF (Degrees of Freedom)	Type III SS (Sum of Squares)	MSE (Mean Squared Error)	F value	Pr(>F)
YR	13	91.52	7.04	11.49	0
Q	3	13.73	4.58	7.47	0.00
area	6	1059.19	176.53	288.14	0
Residuals	974	596.74	0.61		

Fig. 12

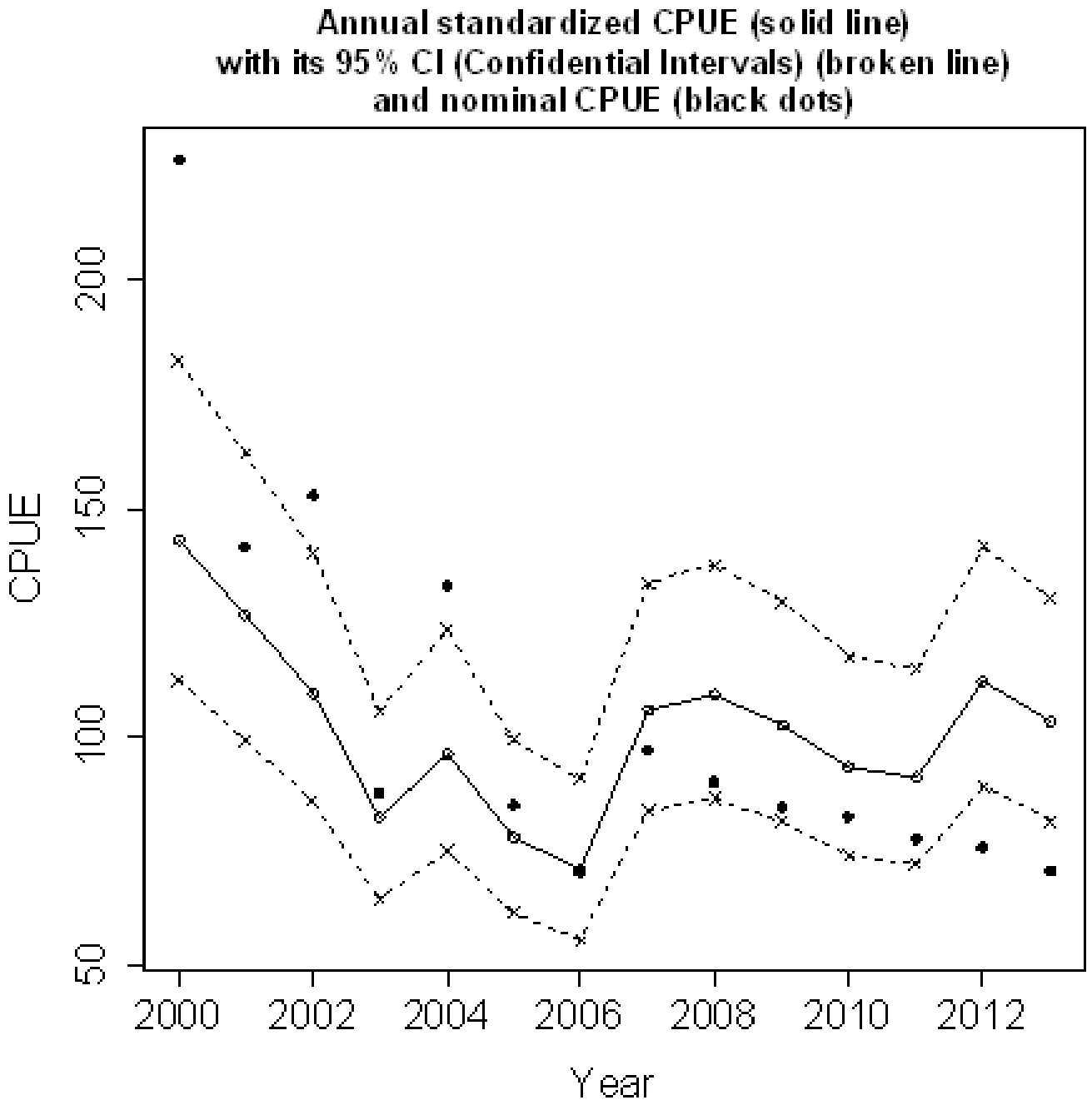
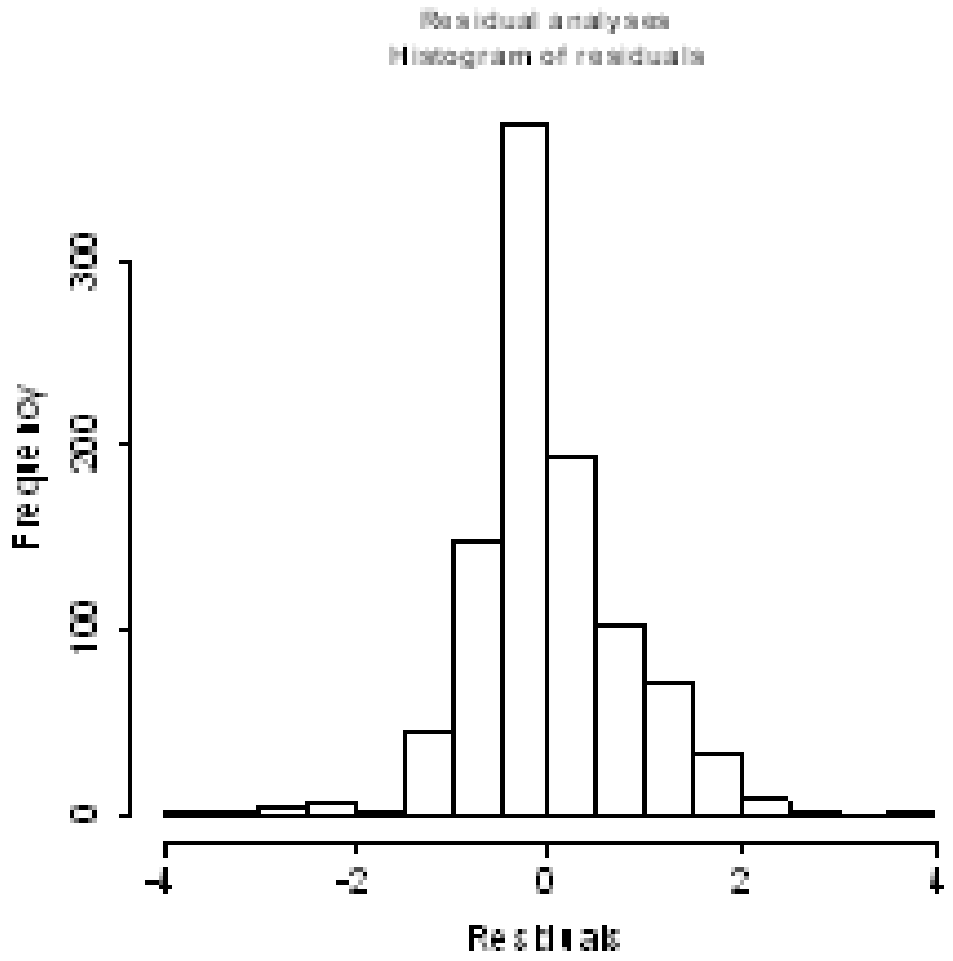

Annual standardized CPUE (solid line)
with its 95% CI (Confidential Intervals) (broken line)
and nominal CPUE (black dots)
CPUE
50
100
150
200
2000
2002
2004
2006
2008
2010
2012
Year

Fig. 13.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Histogram of residuals
Frequency
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300
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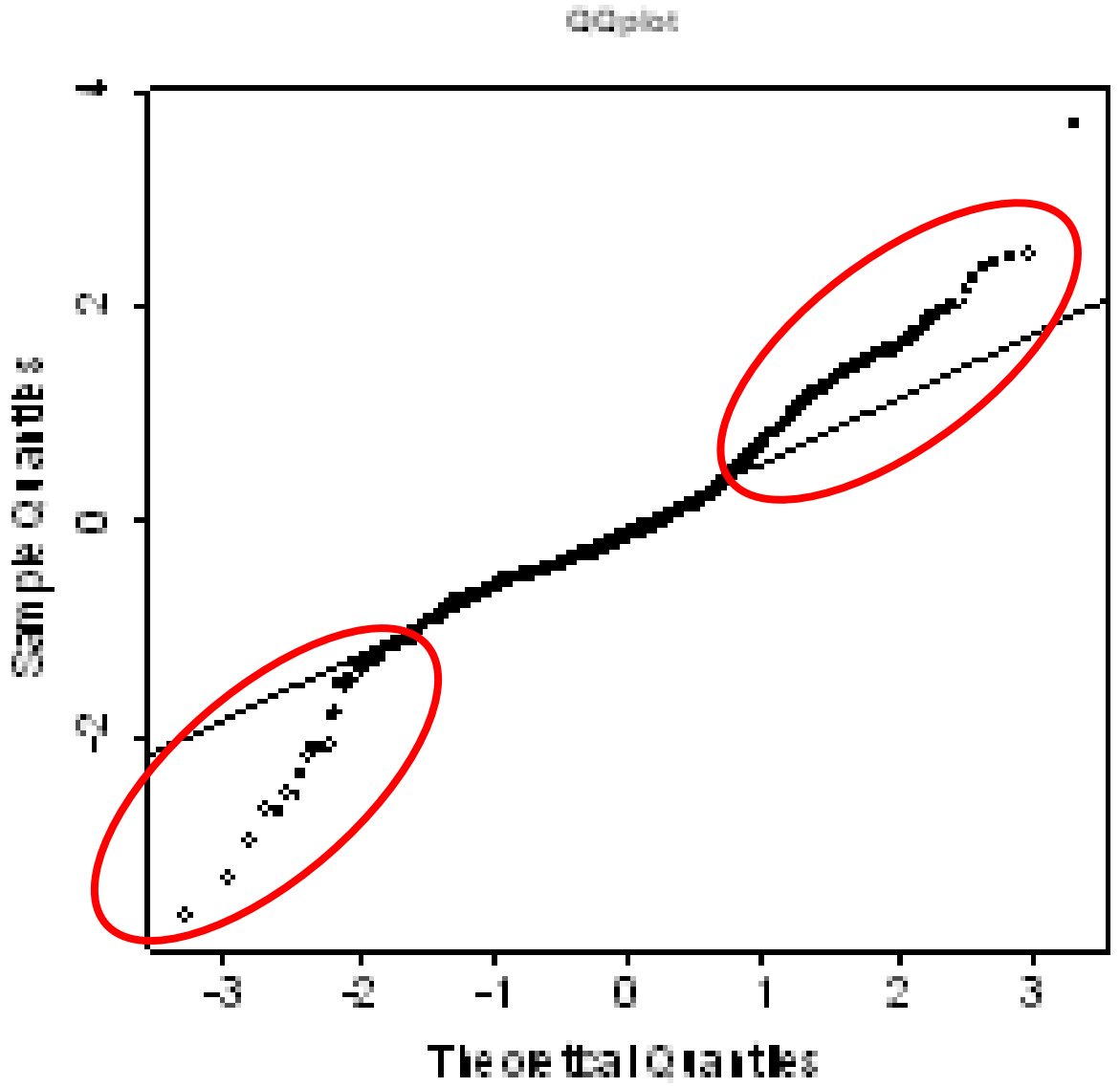
4
Residuals

Fig. 14.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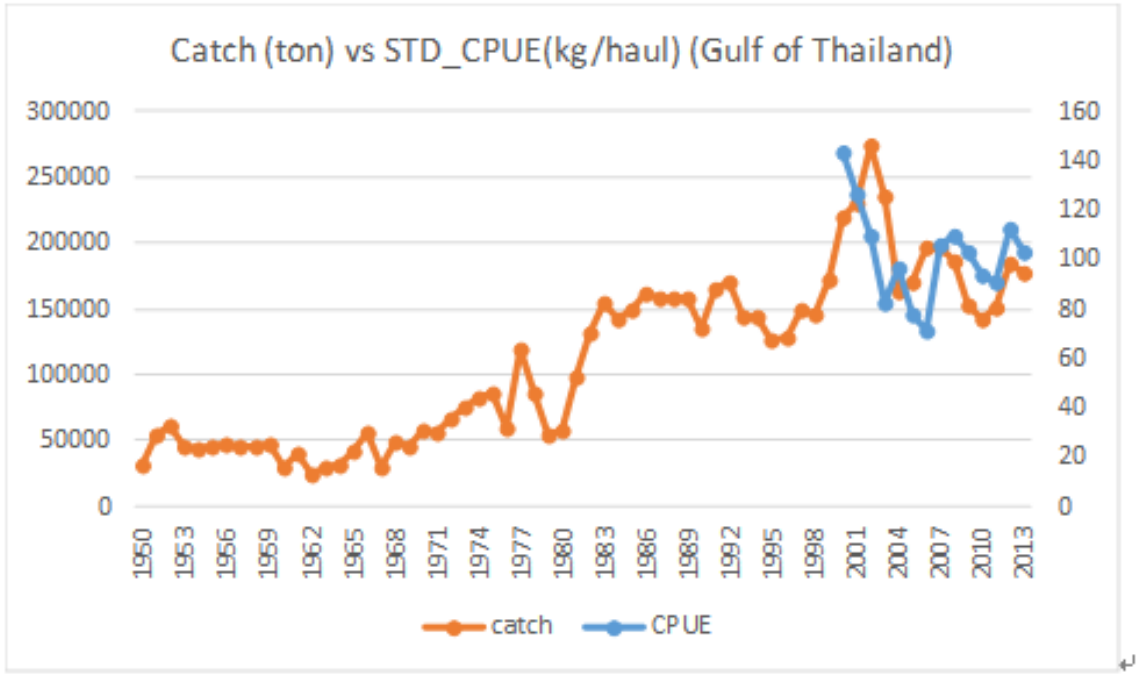
2
3
Theoretical Quantiles



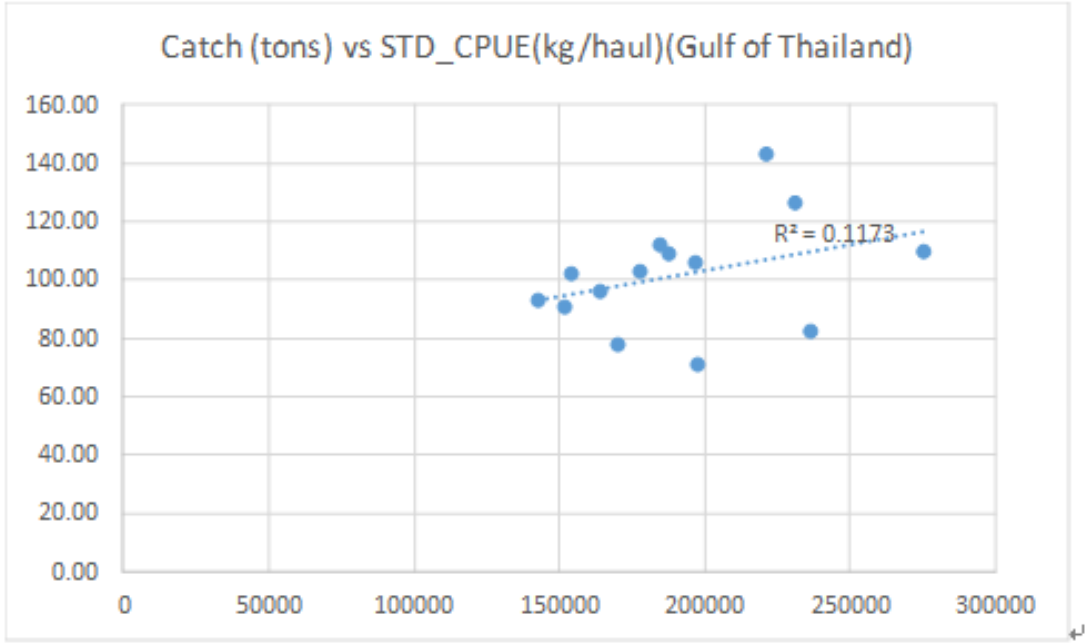


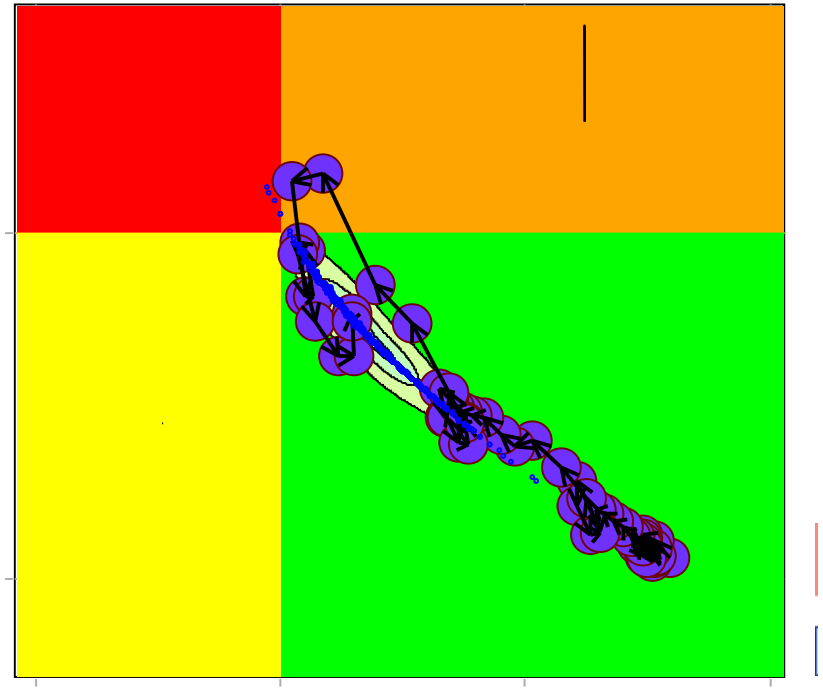
Fig 15 Relation between catch vs standardized CPUE

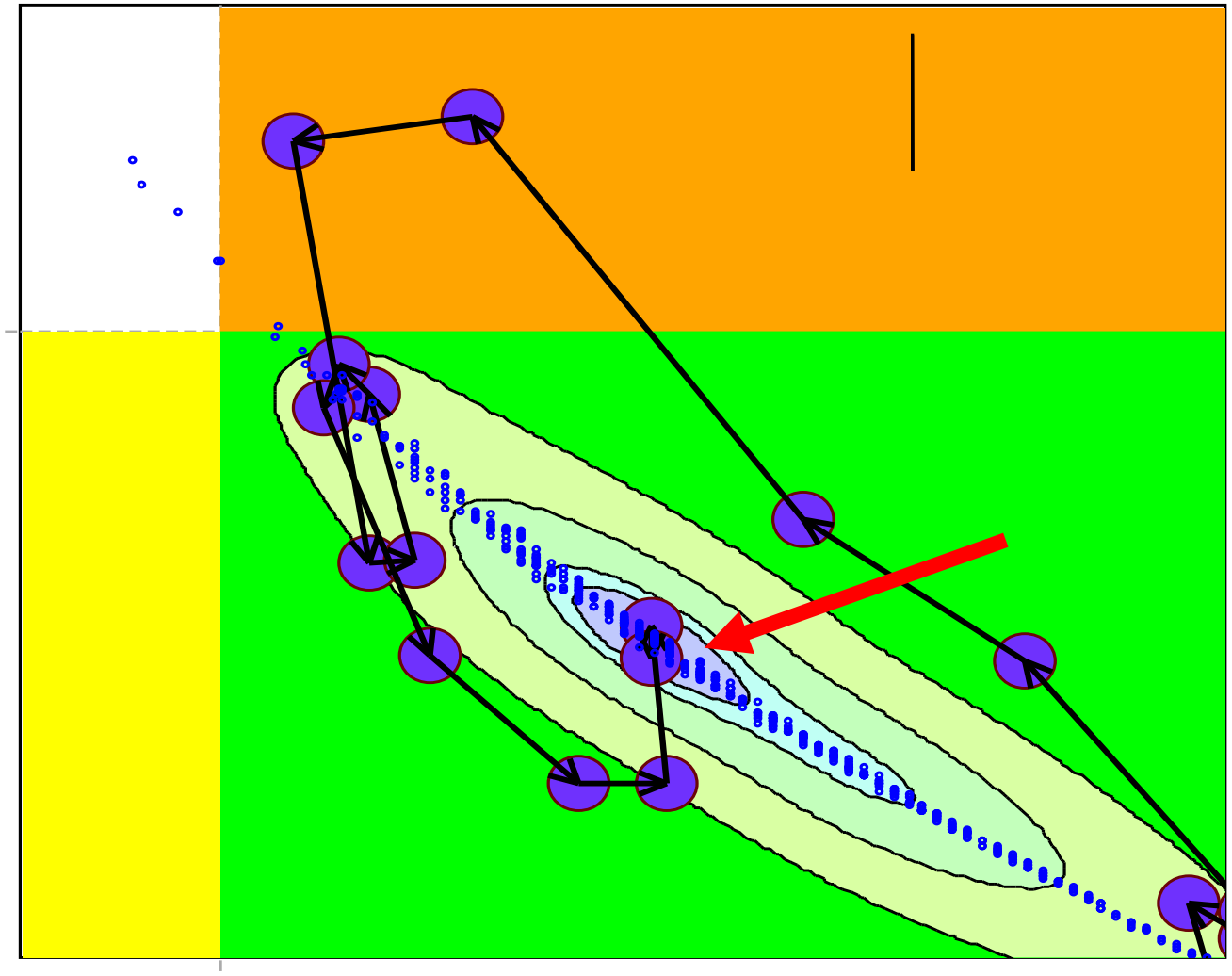
(4) ASPIC results using the Kobe plots (Stock status trajectory)

All parameters are estimated without any conversion problems.

Table 7 Results of ASPIC stock assessments

Model	K	B0/K=1	R	MSY (1,000t)	TB/TBmsy	F/Fmsy	Bmsy	Fmsy	TB	R2	RMS
Fox	117	0.96	0.42	185	1.29	0.74	43	0.43	56	0.57	0.15





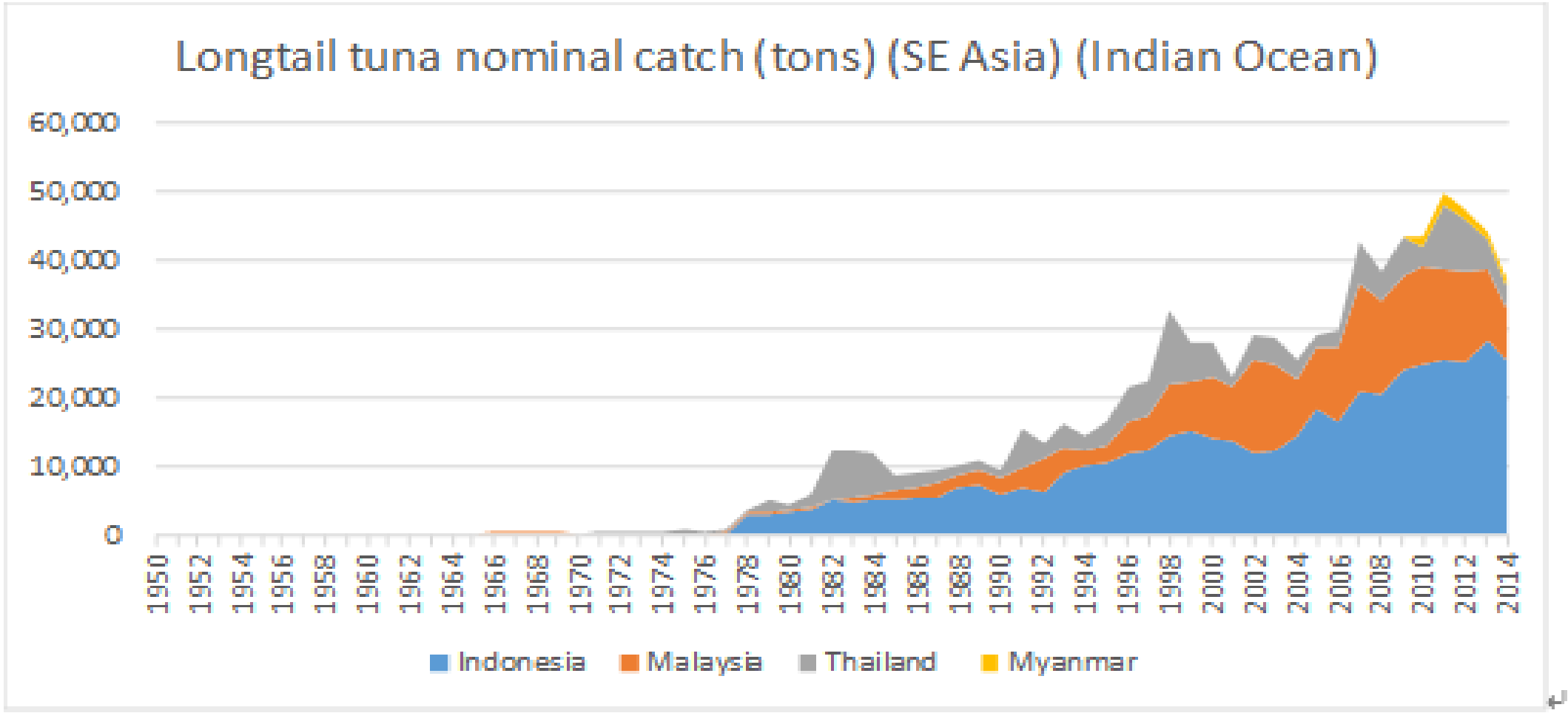
(5) STOCK STATUS AND MANAGEMENT ADVICE

The current stock status is in **the safe zone (Green in the Kobe plot),** i.e., TB/TBmsy=1.29 and F/Fmsy=0.74 implying that TB is the 29% higher than the MSY level and F is 26% lower than the MSY level. This is because there was significant catch decrease after 2002 (peak level) and the current catch level is low. In addition, the Kobe plot shows that there **is no probability** that uncertainties in the 2013 estimates fall in the unsafe zone (red, orange and yellow zone in the Kobe plot).

Thus **there are no problems to maintain the current catch and F (fishing pressure) levels**, but both catch and F (fishing pressure) should be kept under their MSY levels (185,000 tons and 0.43 respectively)

Contents

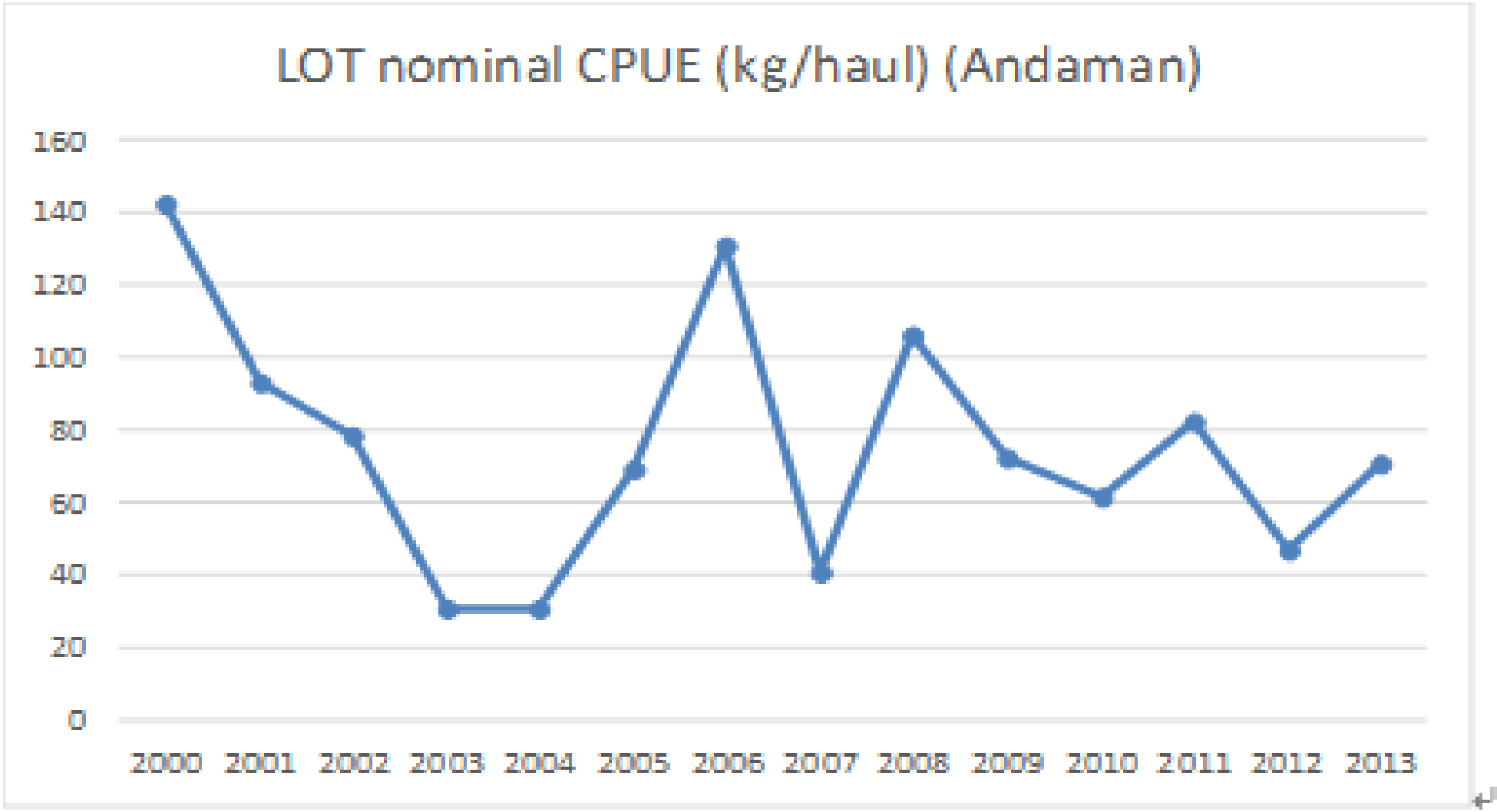
(1) Catch



Note: *Based on IOTC and data coordinators.*
We used the data from 1970 for stock assessments as the data before 1970 is nil.

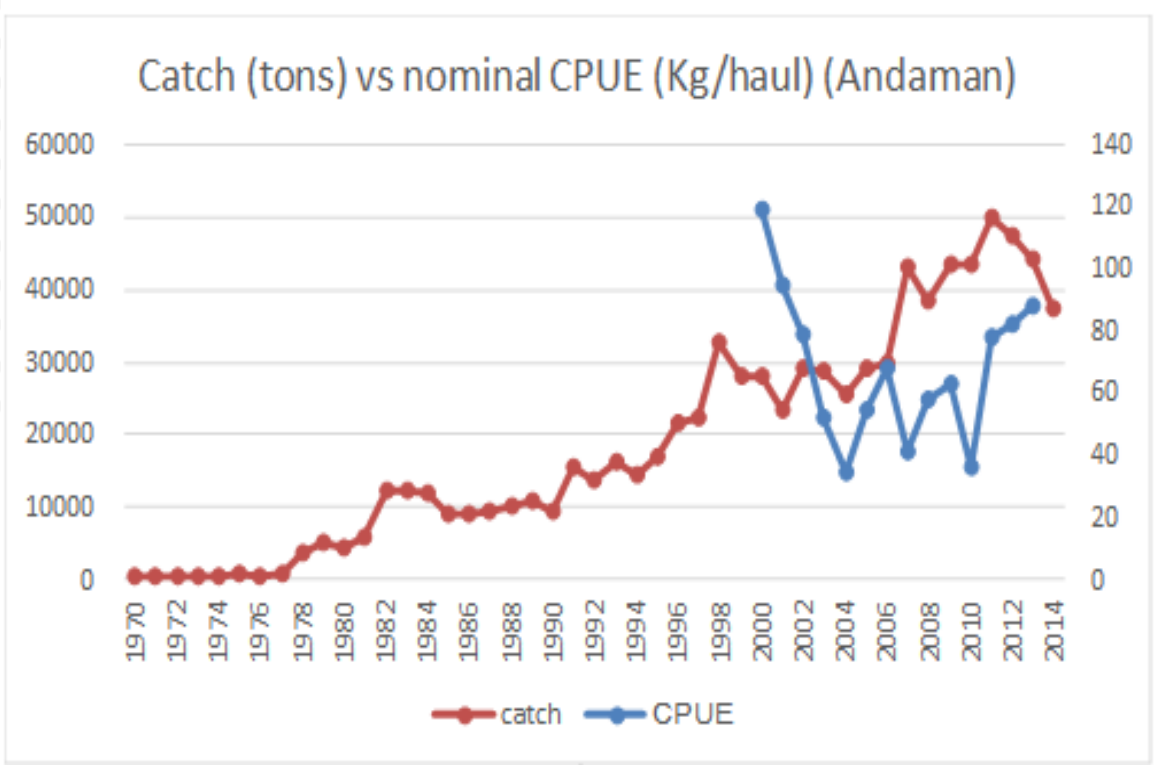
Fig. 17 Longtail tuna catch trend by country (SEAFDEC SE Asia water in the Indian Ocean)

(2) Nominal CPUE (DOF) (Area 6 + C+D) (2000-2013) (n=343 n(0)=101)



(Note) Outliers (too low values) (1995-1999) and Area 6 (no realistic) are not used.

Fig 18 Trends of nominal Thai LOT CPUE (Andaman Sea)



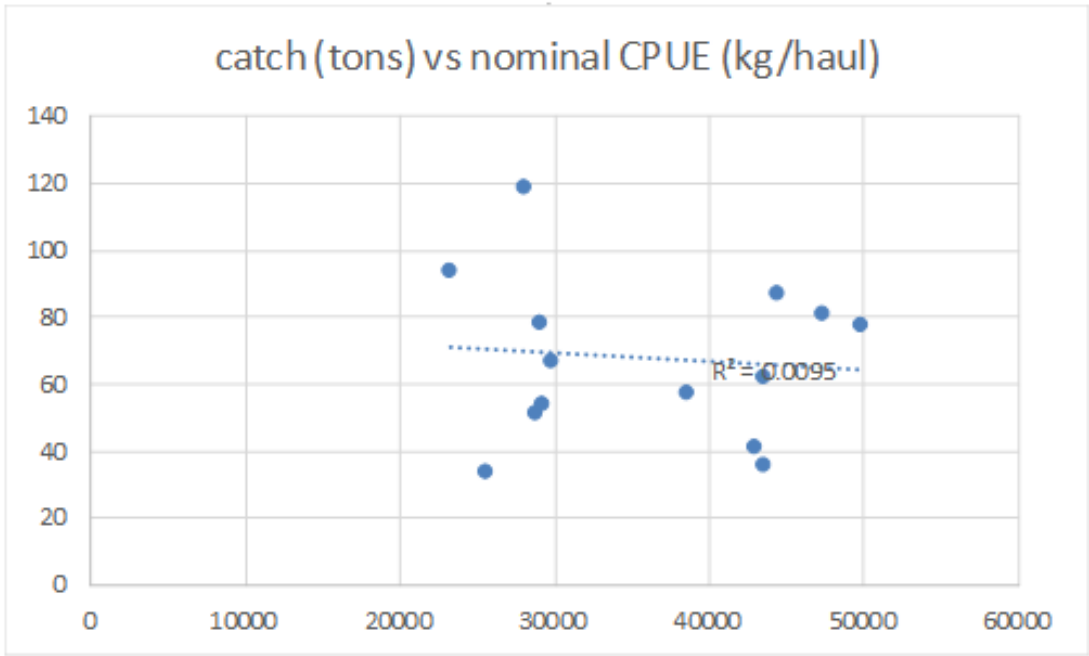


Fig 19 Realtion between LOT catch and nominal CPUE (Indian Ocean side)

- (4) CPUE standardization (Table 9 and Figs 20-22)

n=282 and n (0 data) = 84 (35%)

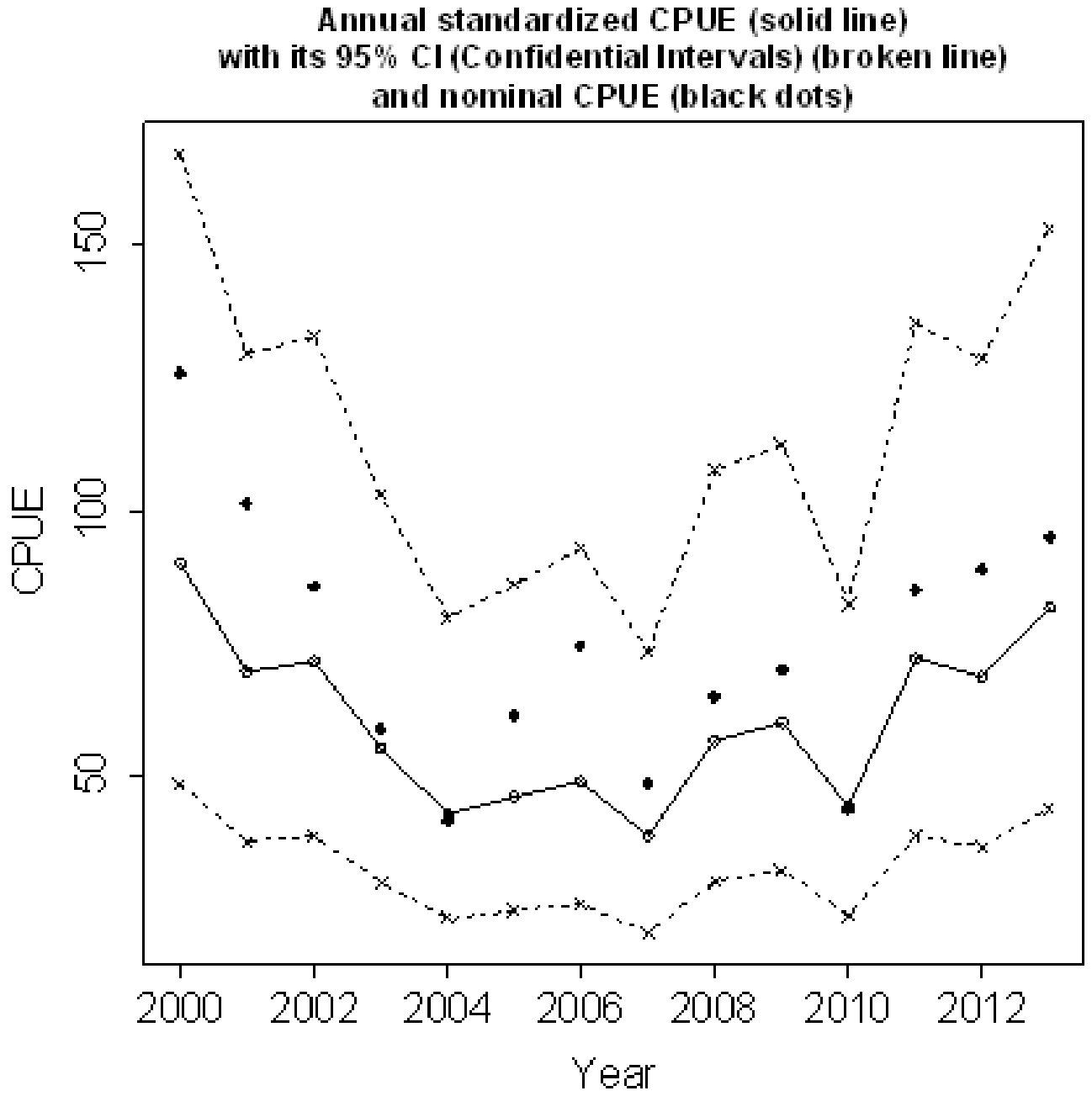
Very poor fit

Table 9

ANOVA (Analysis Of Variance) Table					
Adjusted R2 = 0.1161					
Factors	DF (Degrees of Freedom)	Type III SS (Sum of Squares)	MSE (Mean Squared Error)	F value	Pr(>F)
YR	13	17.87	1.37	0.86	0.60
Q	3	68.52	22.84	14.26	0.00
area	1	0	0	0	1.00
Residuals	264	422.97	1.60		

NG

Fig. 20


Annual standardized CPUE (solid line)
with its 95% CI (Confidential Intervals) (broken line)
and nominal CPUE (black dots)
CPUE
50
100
150
2000
2002
2004
2006
2008
2010
2012
Year

NG

Fig. 21

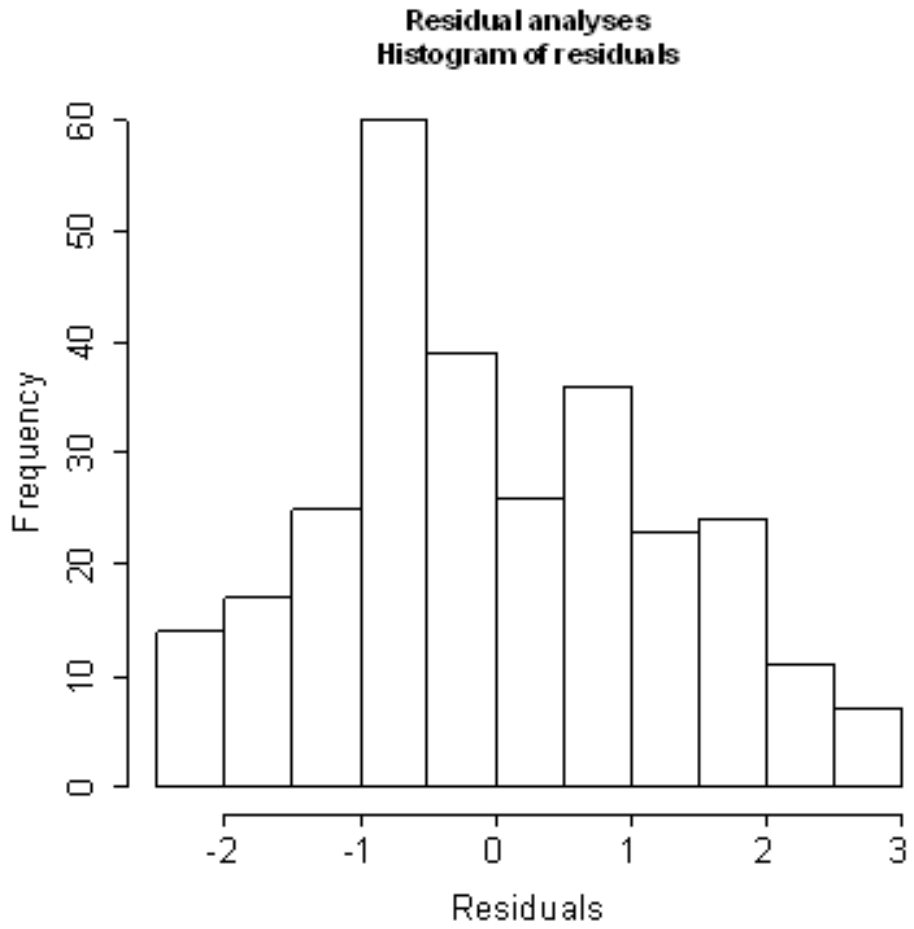
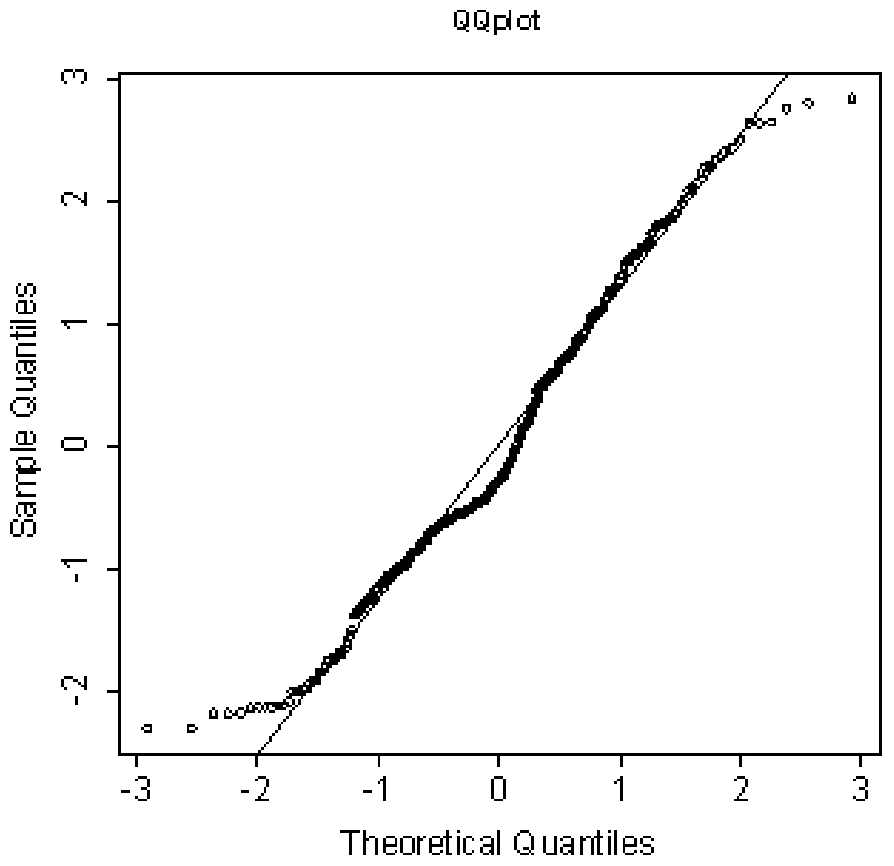


Fig. 22



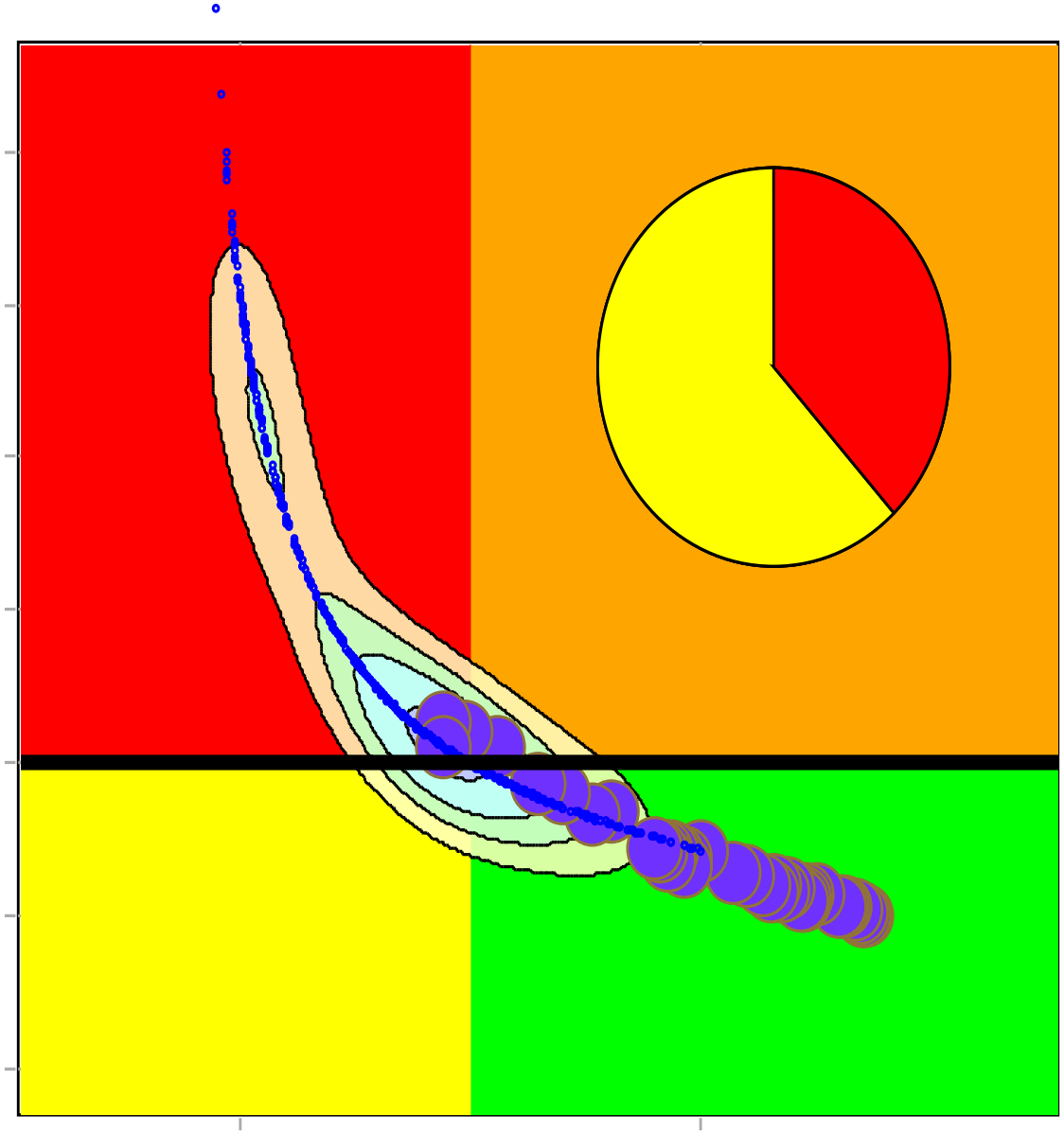
(4) ASPIC RESULTS USING THE KOBE PLOTS (STOCK STATUS TRAJECTORY)

In the first attempt using the standardized CPUE, we could not get the convergence, even we fixed some parameters. **Hence we changed to the nominal CPUE for the 2nd ASPIC run.**

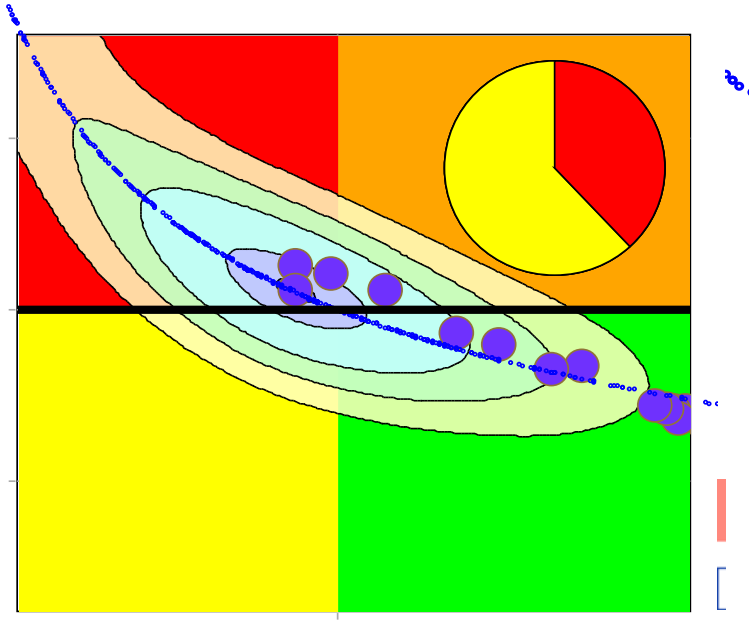
We set 4 scenarios using K=100,150,200 and 250,000 tons with B0/K=1. After ASPIC runs, we found that parameters with K=200,000 produced most plausible results**, although r is a bit low value. Thus the results should be looked up carefully.**

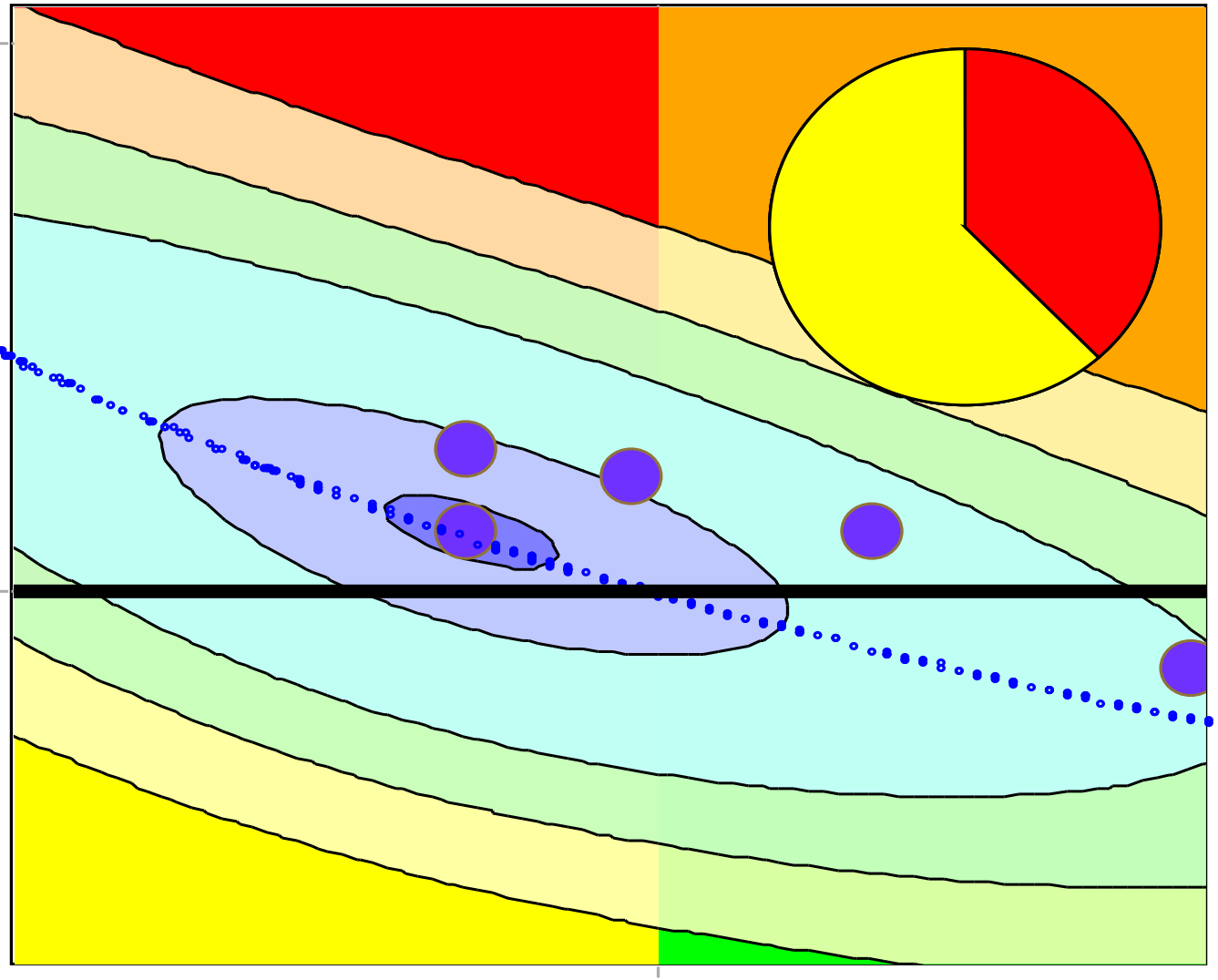
Table 10 Estimated parameters in three scenarios

Model	K(fixed) (1,000t)	B0/K=1	r	q	MSY (1,000t)	TB/TBmsy	F/Fmsy	TBmsy	Fmsy	TB	R2	RMS
Fox	100	1	1.15	0.11E-6	42	1.00	0.89	37	1.15	33 (Too low)	0.13	0.56
Fox	150	1	0.75	7.40E-6	40	0.96	0.99	55	0.73	50 (low)	0.14	0.56
Fox	200	1	0.51	5.00E-6	37	0.89	1.11	66	0.51	66	0.15	0.56
Fox	250	1	0.38 (too low)	4.59E-6	35	0.85	1.23	92	0.38	80	0.17	0.56



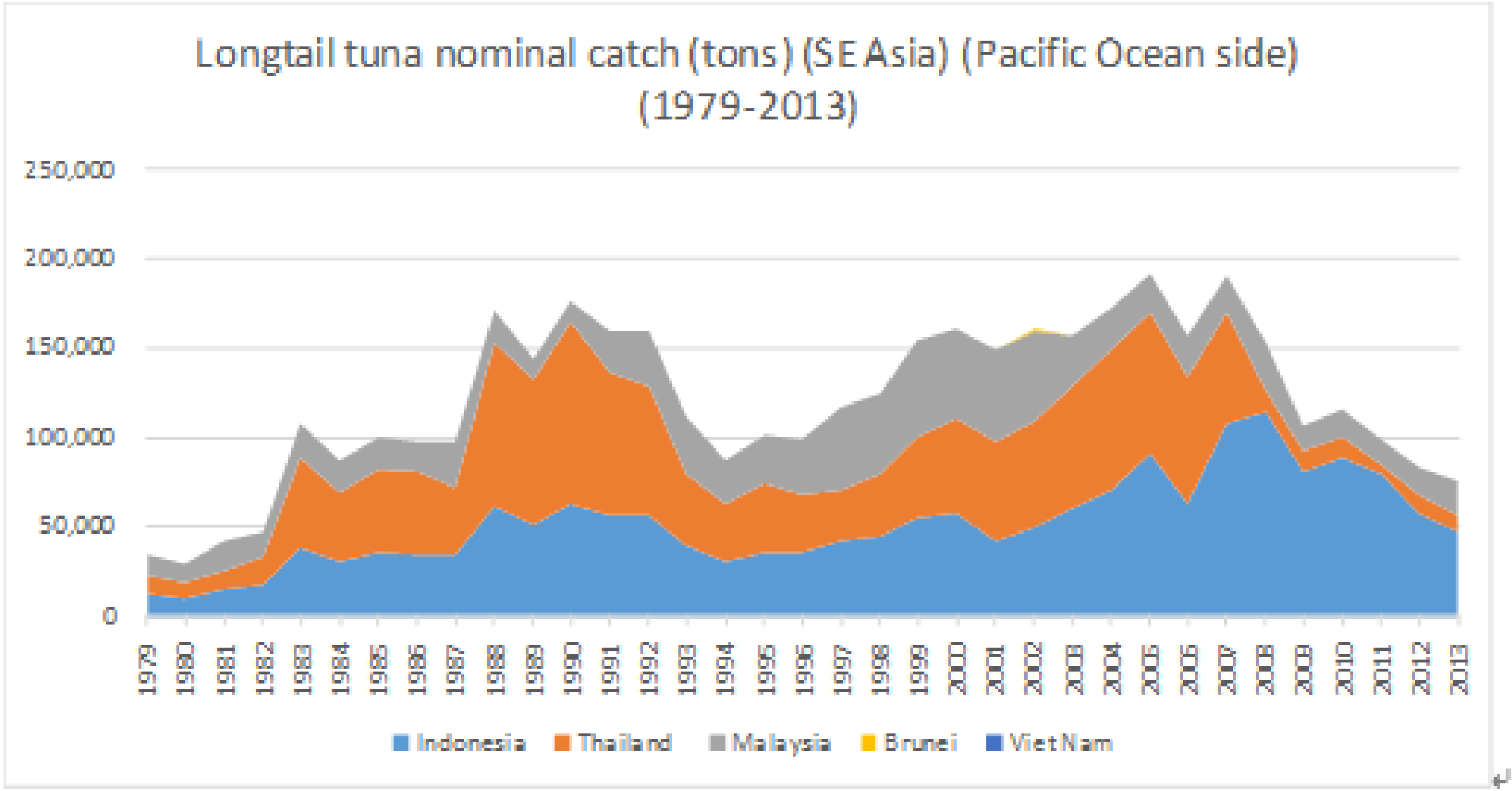
Kobe·plot Software (2015)





Contents

(1) CATCH



Note: Based on FAO and data coordinators.

We used the data from 1979 as the data before 1970are incomplete

(2) Nominal CPUE and relation with catch

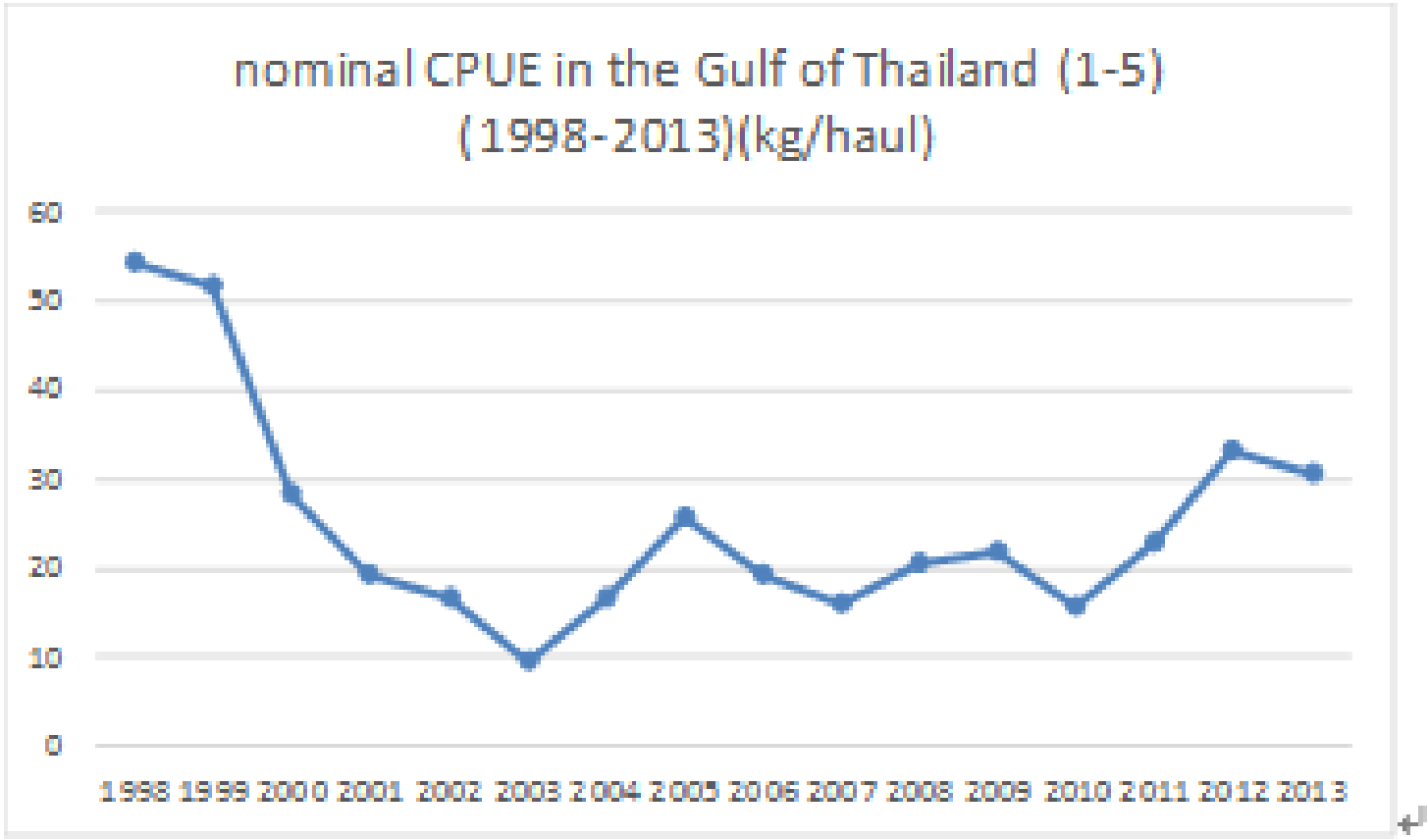
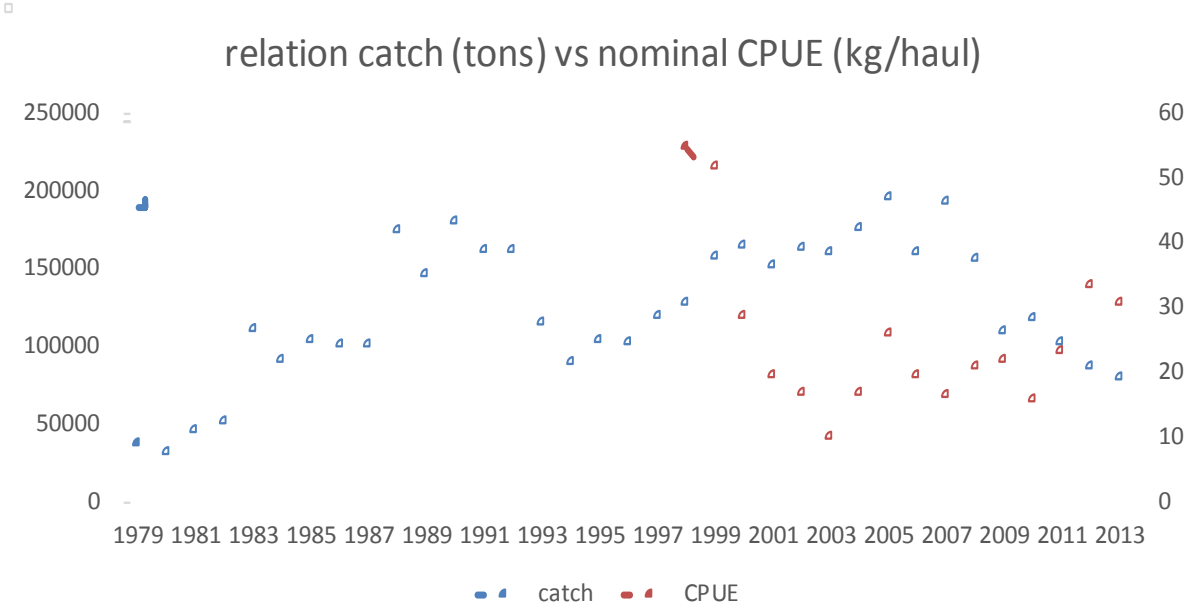


Fig. 26 Longtail tuna nominal CPUE
(SEAFDEC SE Asia water in the Indian Ocean)



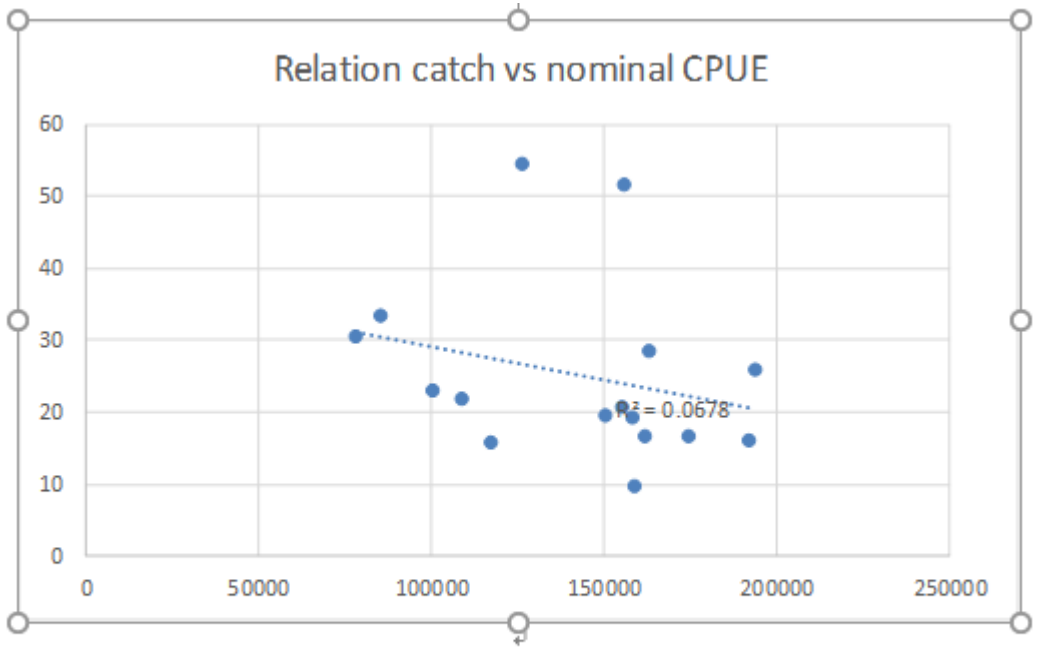


Fig. 27 Relation between Longtail tuna catch vs. nominal CPUE (SEAFDEC SE Asia water in the Indian Ocean)

- **(4) CPUE STANDARDIZATION AND RELATION WITH CATCH (TABLE 12 AND FIGS 28-30)**

Table 12

ANOVA (Analysis Of Variance) Table					
Adjusted R2 = 0.1563					
Factors	DF (Degrees of Freedom)	Type III SS (Sum of Squares)	MSE (Mean Squared Error)	F value	Pr(>F)
YR	15	118.87	7.92	6.20	0
Q	3	1.54	0.51	0.40	0.75
area	4	112.61	28.15	22.04	0
Residuals	844	1078.01	1.28		

Fig 28

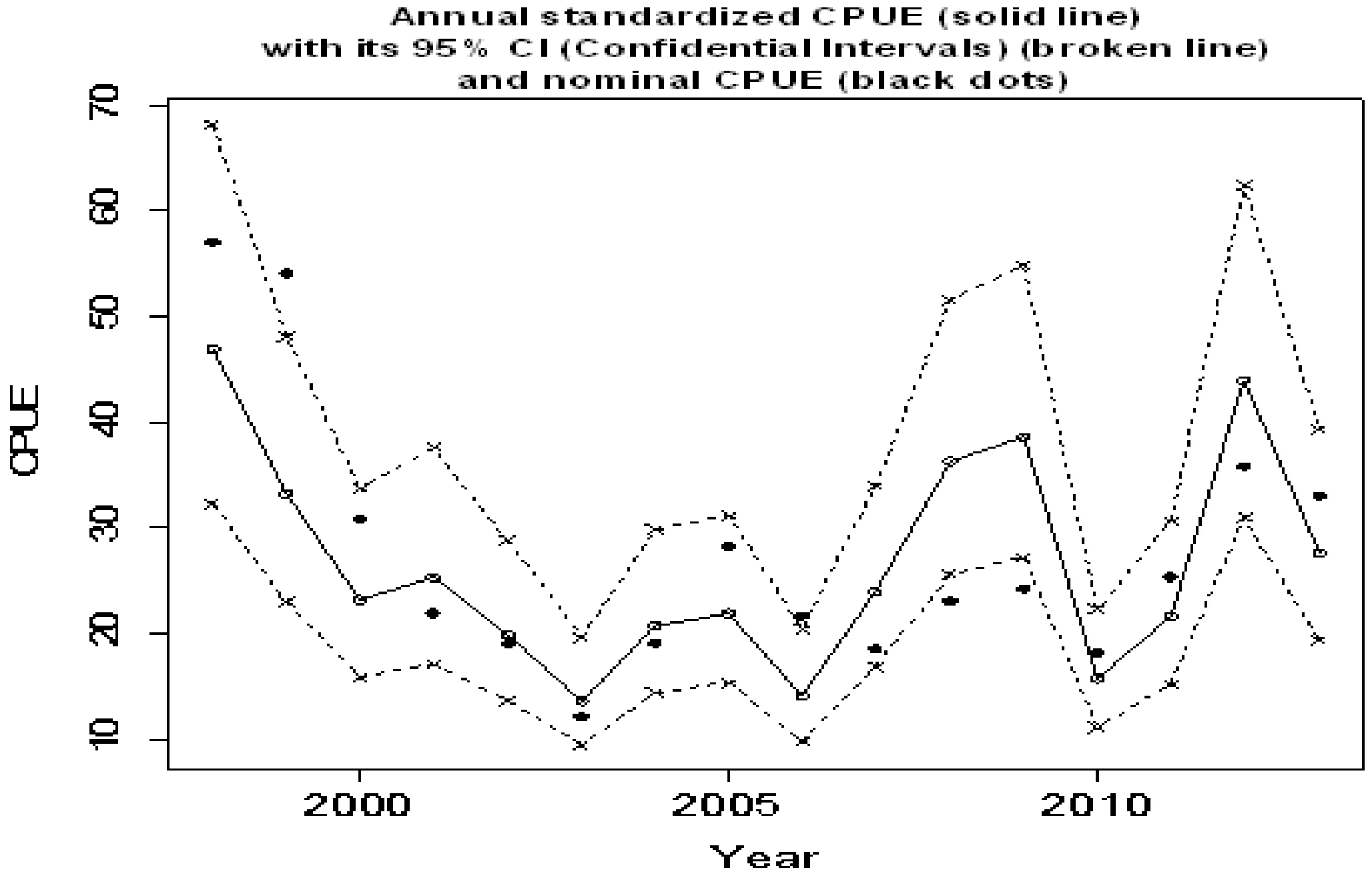

Annual standardized CPUE (solid line)
with its 95% CI (Confidential Intervals) (broken line)
and nominal CPUE (black dots)
CPUE
10
20
30
40
50
60
70
2000
2005
2010
Year

Fig 29

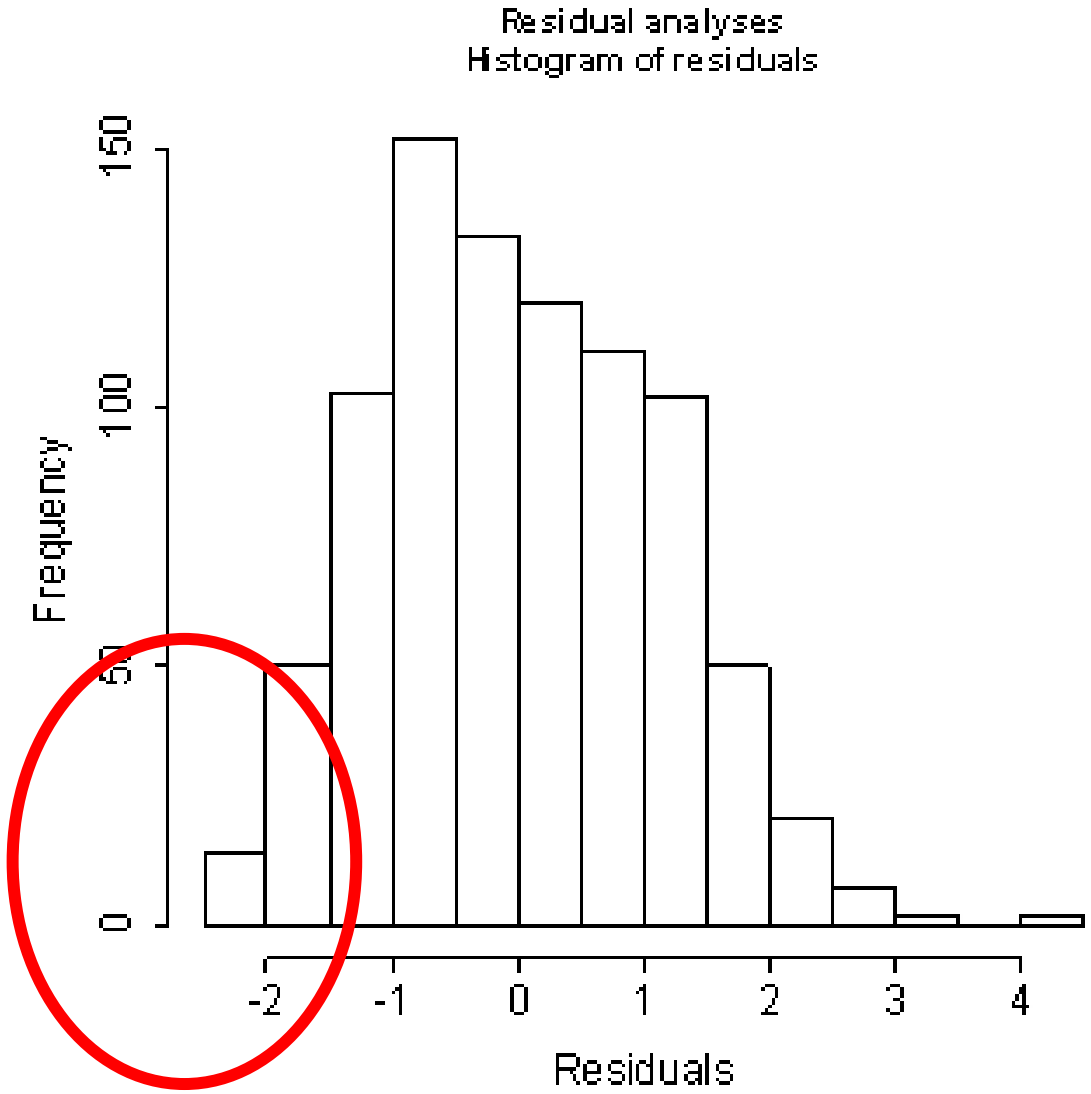
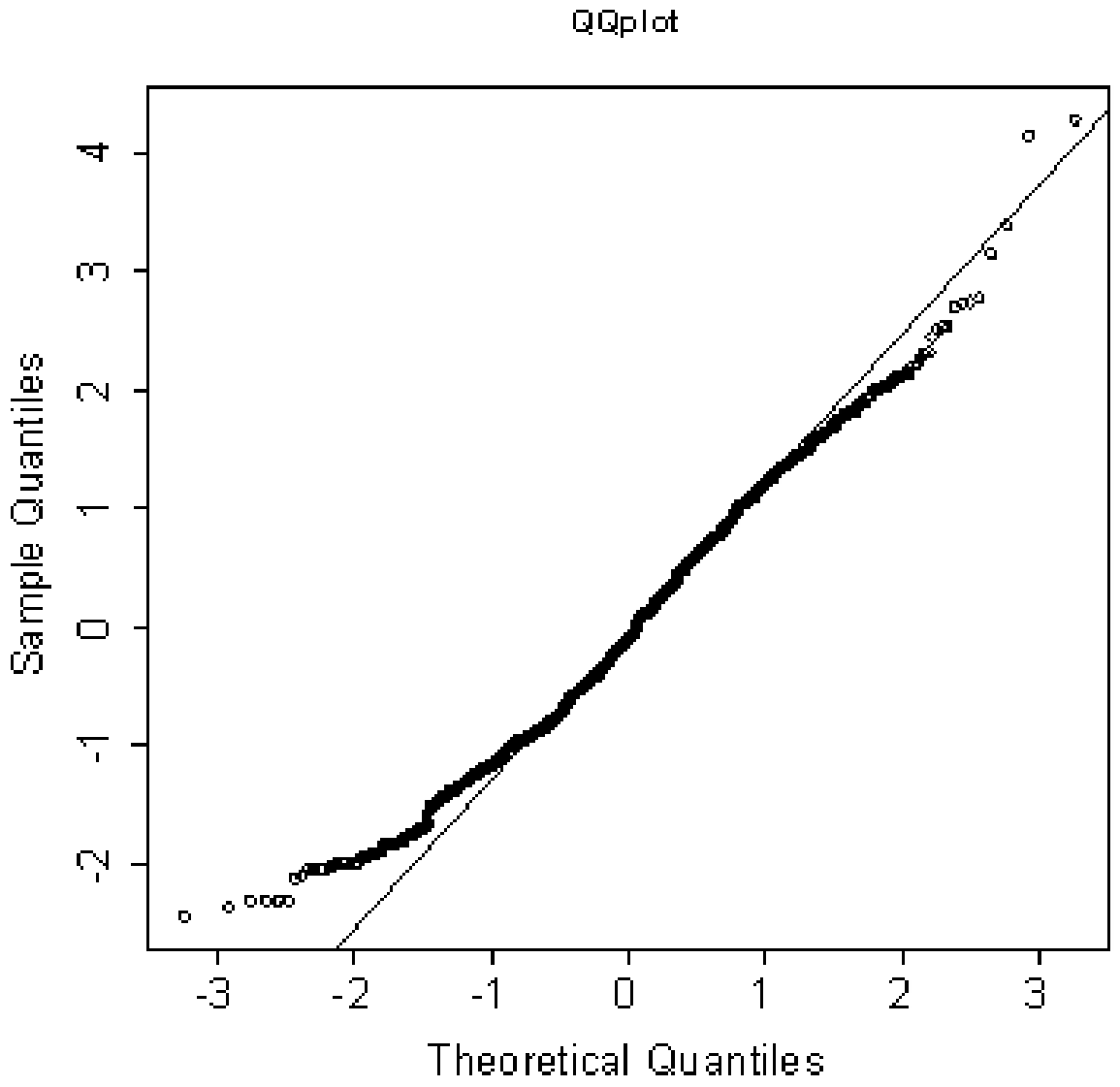

Residual analyses
Histogram of residuals
Frequency
0
50
100
150
-2
-1
0
1
2
3
4
Residuals

Fig 30

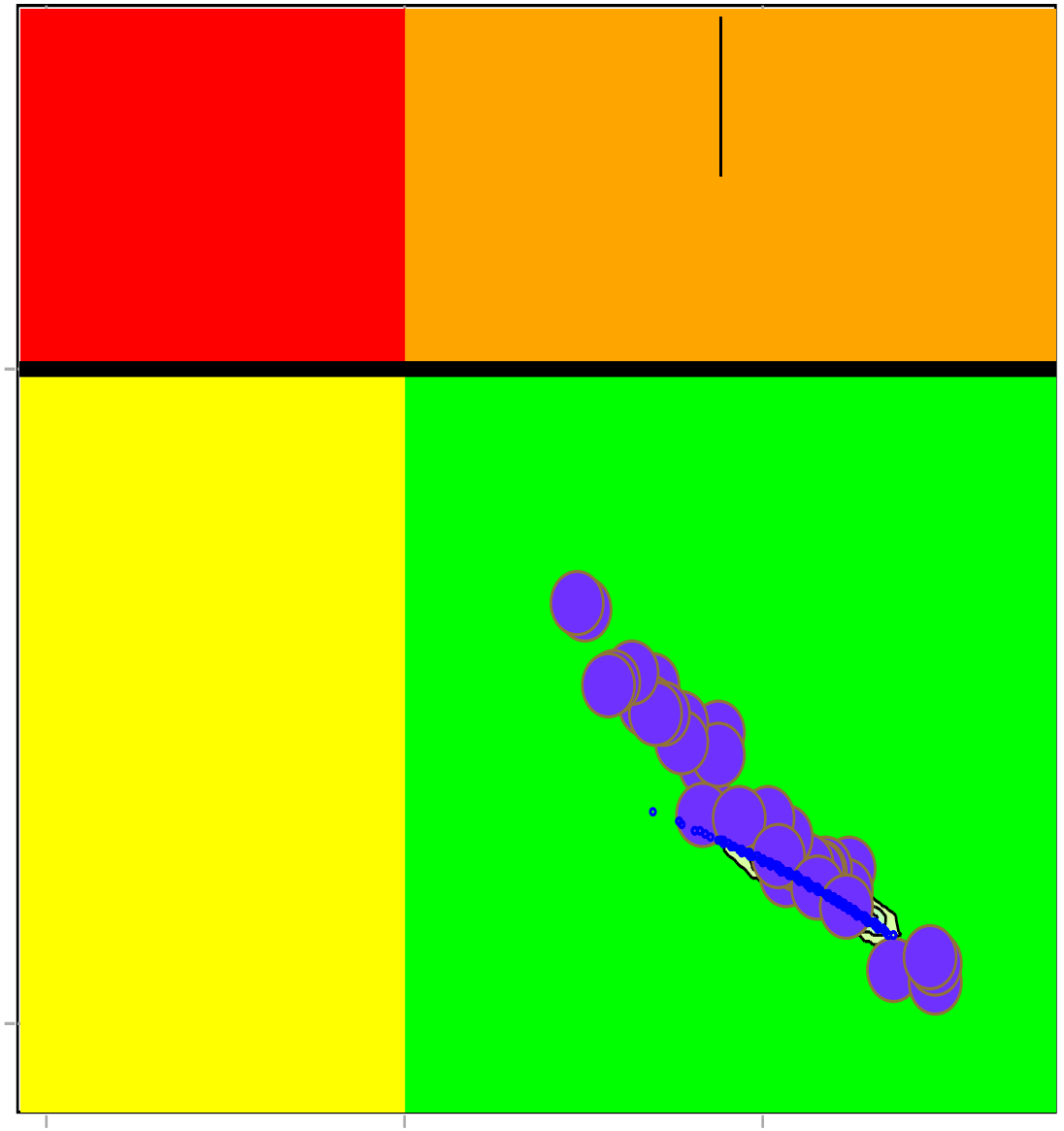

QQplot
Sample Quantiles
-2
-1
0
1
2
3
4
-3
-2
-1
0
1
2
3
Theoretical Quantiles

▪ (4) ASPIC RESULTS USING THE KOBE PLOTS (STOCK STATUS TRAJECTORY)

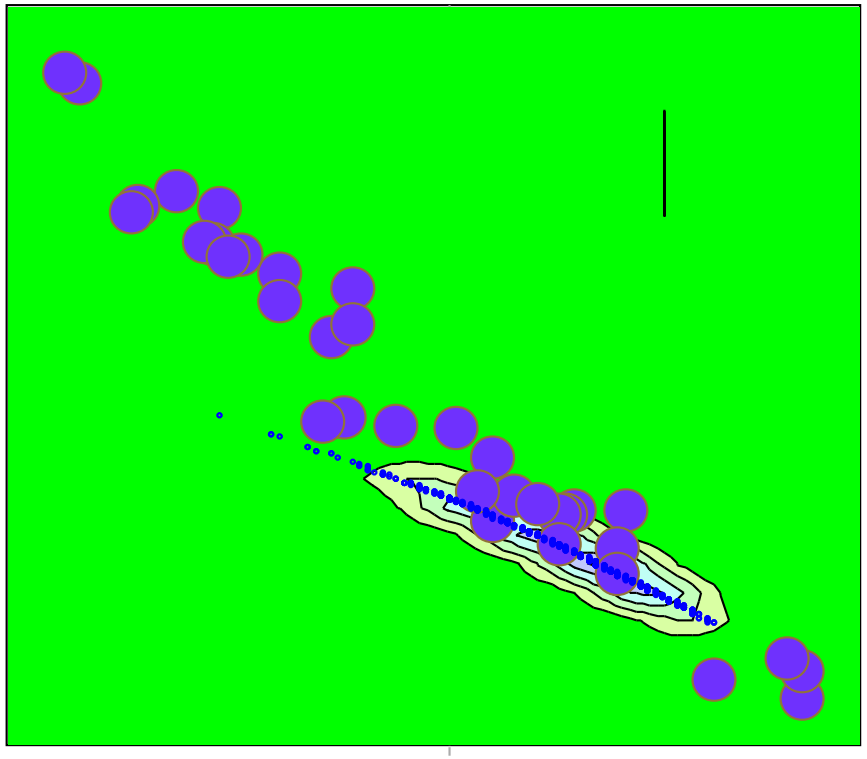
We could not get convergence when we attempted to estimate all parameter. Then we assumed that B0/K=1 and explored plausible K values (300, 400, 500, 600 and 700,000 tons). As a result, when K=500,000, we could get the most plausible parameters.

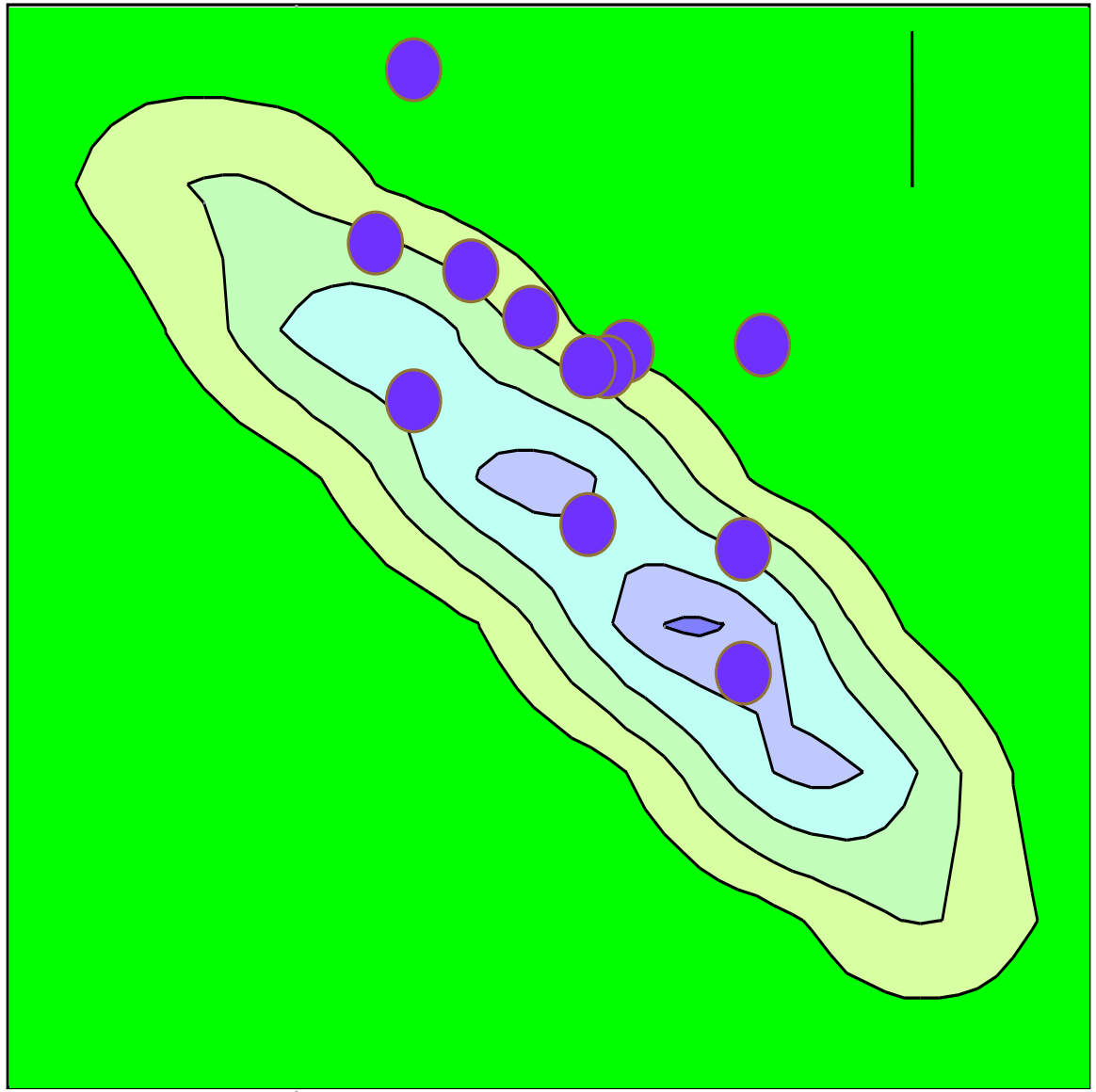
Table 13 Results of ASPIC stock assessments

model	K(fixed) (1,000t)	B0/K	r	MSY (1,000t)	TB/TBmsy	F/Fmsy	TBmsy	Fmsy	TB	R2	RMS
	300	Not converged									
Fox	400	1	1.34 Too high	200	2.25	0.18	150	1.34	320	0.130	0.3796
Fox	500	1	1.07	200	2.22	0.18	180	1.07	400	0.126	0.3800
Fox	600	1	0.89 low	200	2.21	0.18	220	0.89	470	0.120	0.3809
Fox	700	1	0.77 Too low	200	2.19	0.18	260	0.77	540	0.112	0.3821



Kobe·plot Software (2015)





(5) STOCK STATUS AND MANAGEMENT ADVICE

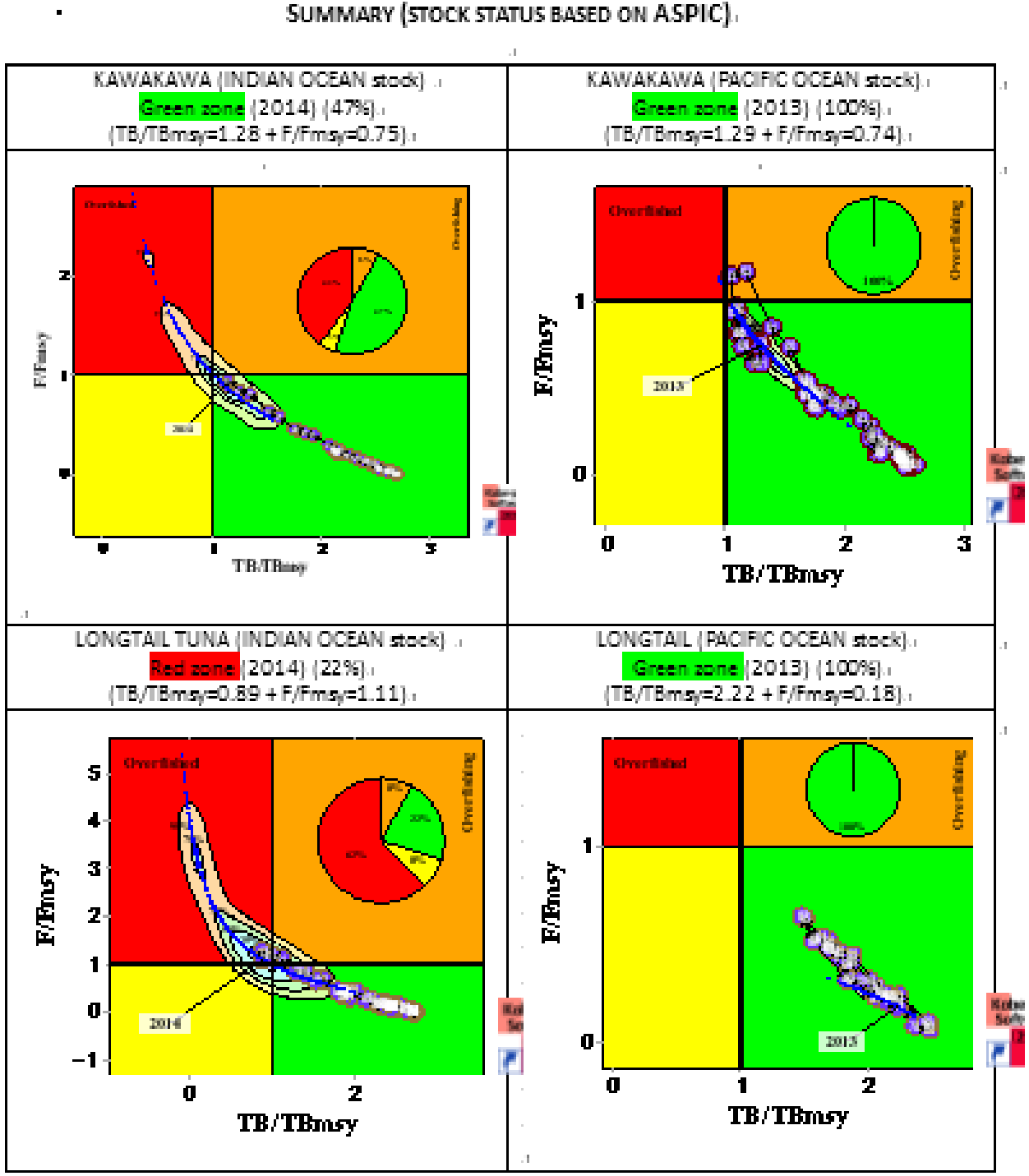
The current stock status (2013) is in the green (safe) zone the Kobe plot, i.e., TB/TBmsy=2.22 and F/Fmsy=0.18 implying that TB is the 222% higher than the MSY level and F is 92% lower than the MSY level. Catch in 2008 was the peak, but afterwards it sharply decreased to 2013 (193,000 tons, the lowest level since 1980's).

That is the reason why the stock status is very safe and the probability of uncertainties in the un-safe zone (red, orange and yellow) around the 2013 point is **none (0%).** Thus, **both catch and F (Fishing pressure) can be increased more, but should be less than their MSY and Fmsy levels, i.e., 200,000 tons and 1.07 respectively.**

Contents

Summary of 4. stock assessments.

Results are looked at very carefully as there are a number of constraints, limitations and uncertainties as shown in Box 3.



Box 3 Caveats in stock assessments results

- Stock structures are unknown which produce uncertainties in results.
- Catch are based on FAO, IOTC and data coordinators of the SEAFDEC neritic tuna project. This means that almost all data are basically national statistics which have wide range of uncertainties (see IOTC, FAO, BOBP and SEAFDEC publications).
- CPUE are based on Thai DOF information. As other plausible CPUE are not available, we cannot compare with others. This implies that results are mainly driven by Thai CPUE.
- CPUE series may not be long enough for the reliable stock assessments
- Some CPUE include 0 (zero) catch more than 30%. In such case, we need to use other suitable models than GLM such as negative binomial mode, 0 inflated model, GAM and etc.

- Although there are a number of Caveats, there are some positive evidences that results are likely plausible (realistic) as stated in Box 4

Box 4 Some evidences supporting plausible results of ASPIC stock assessments

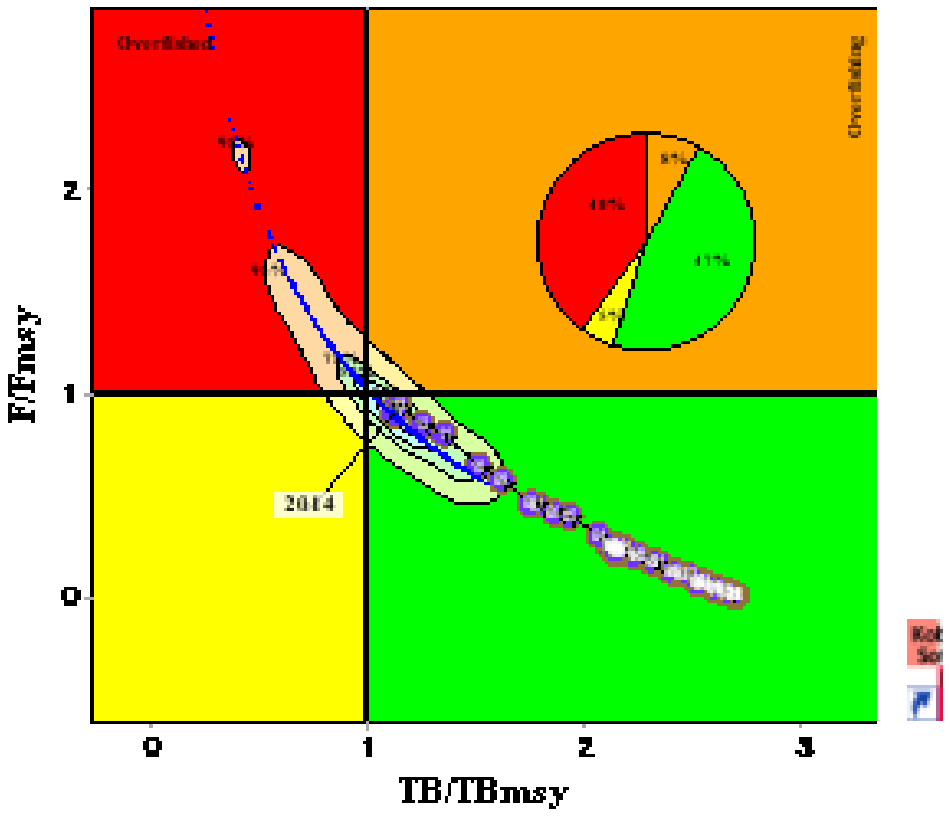
- Results of stock assessments are likely plausible (realistic) as they reflect catch and CPUE trends.
- Results of stock assessments (Indian Ocean stock) are similar to those in the whole Indian Ocean based on the stock assessments conducted by IOTC (Boxes 5-6 for Kawakawa and Boxes 7-8 for longtail tuna).

BOX 5 Comparison with IOTC assessment results (whole Indian Ocean)

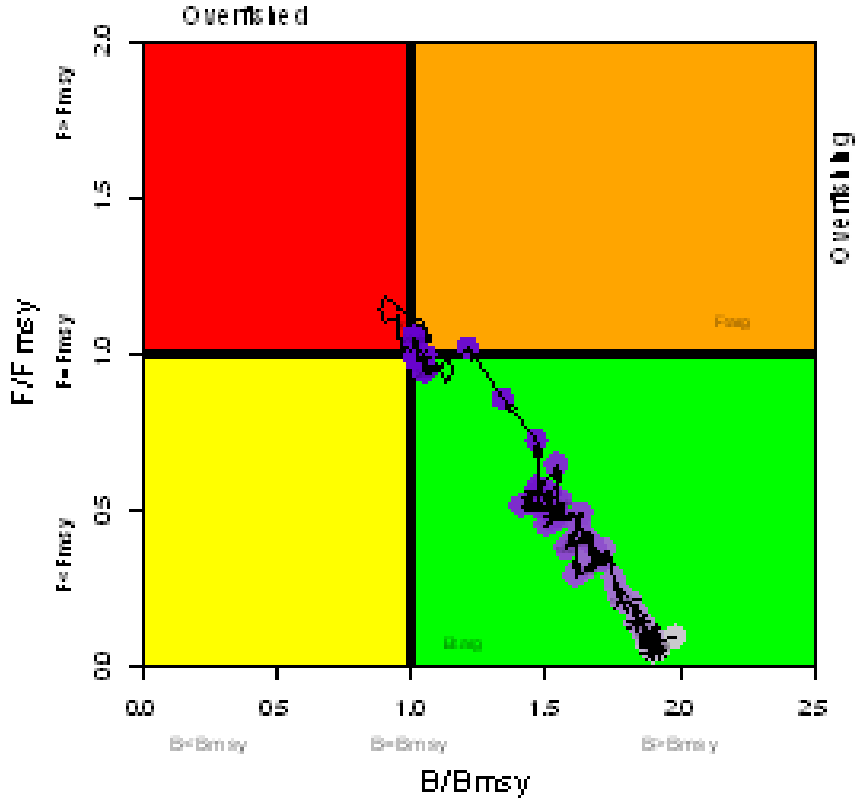
Kawakawa

Both results are very similar (green zone) but very close to MSY (TB and F). Both catch in the whole Indian Ocean and the SE Asia have been increasing, but the catch in SE Asia started to decrease in 2011 (see Box 6, next page).

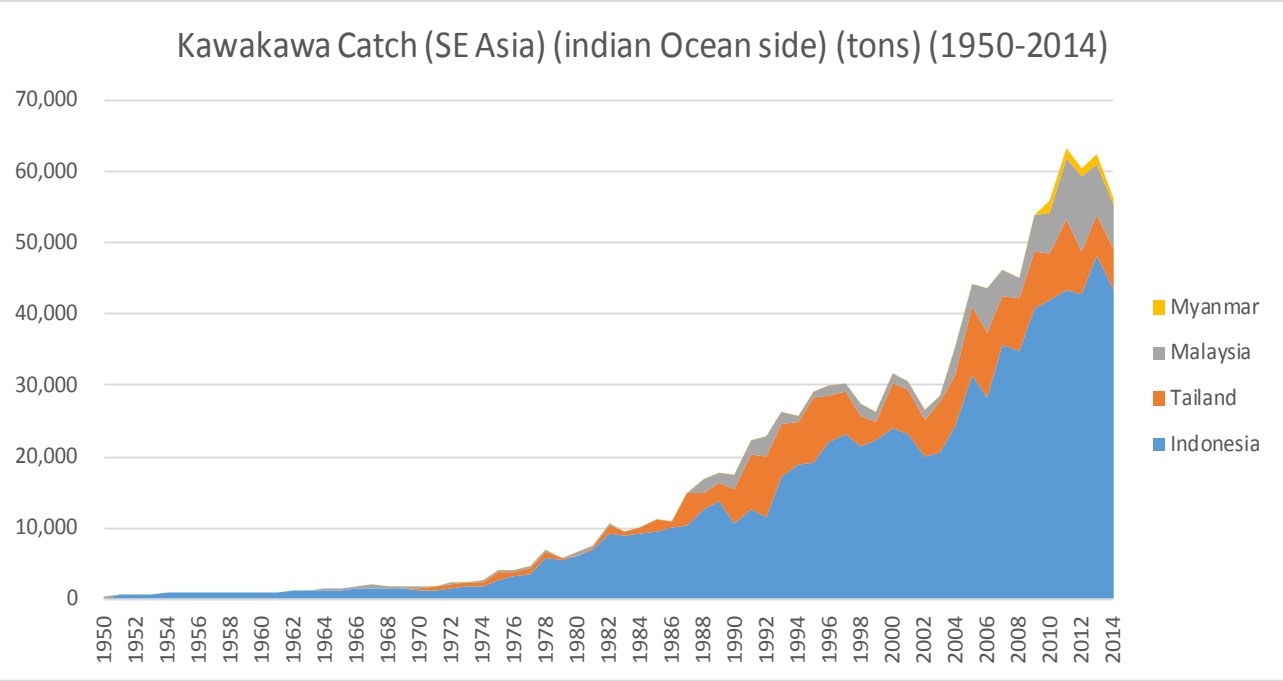
SE Asia region (This document) (Green)



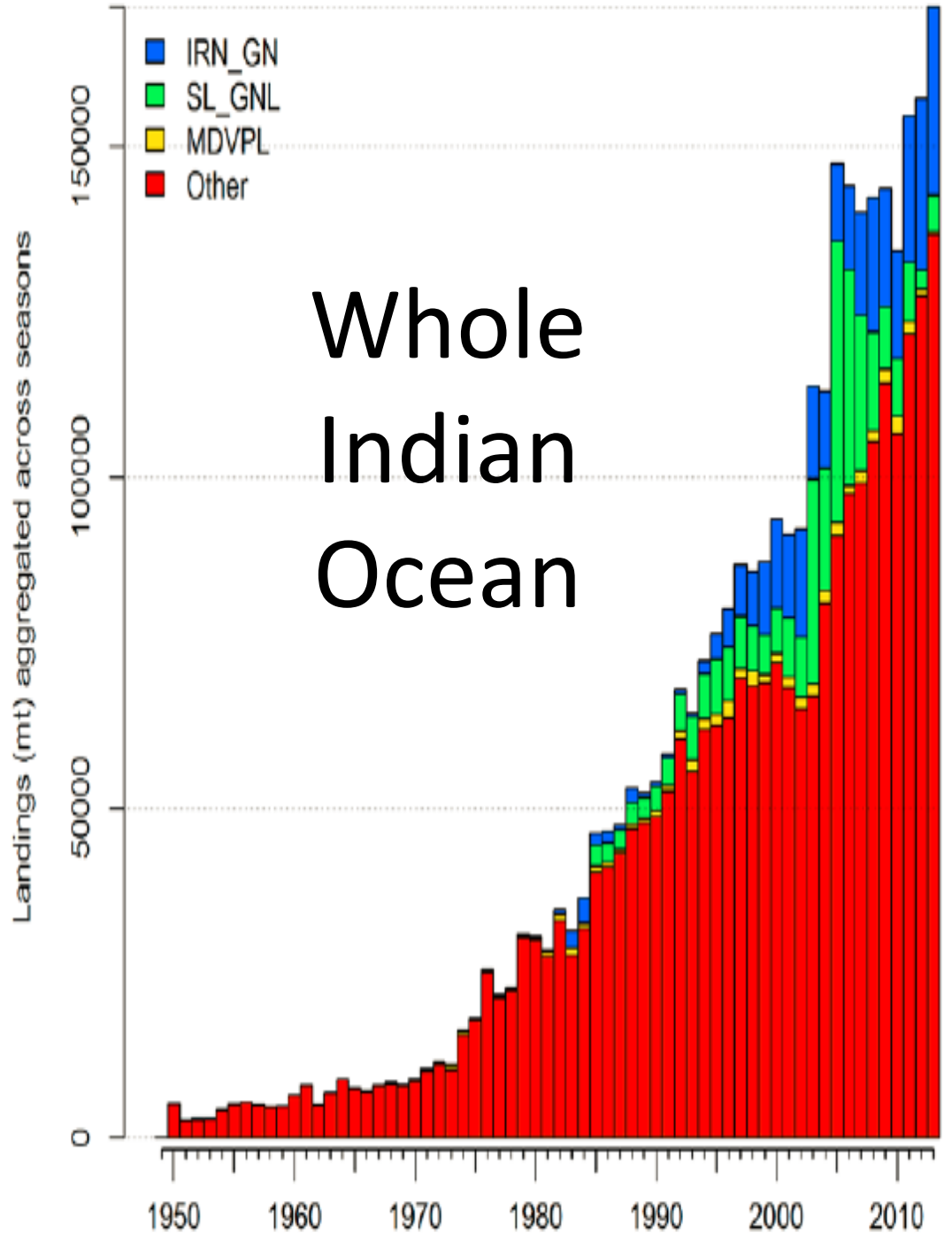
Whole Indian Ocean (IOTC, 2015) (IOTC-WPNT06-2015-21) (green)



SE Asia
(Indian Ocean side)
1/3 of whole IO



Whole Indian Ocean

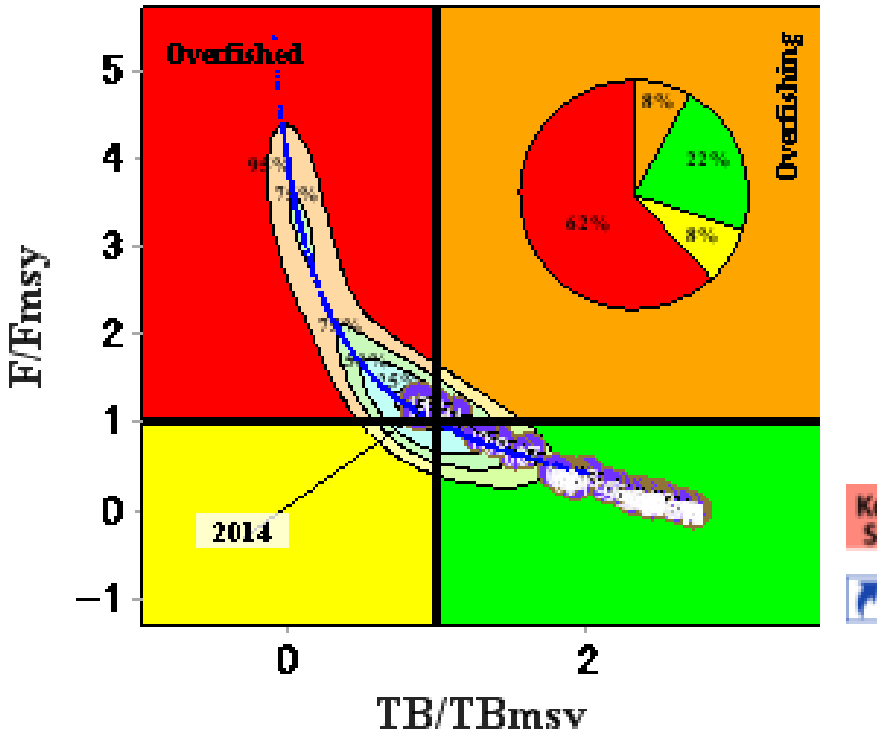


BOX 7 Comparison with IOTC assessment results (whole Indian Ocean)

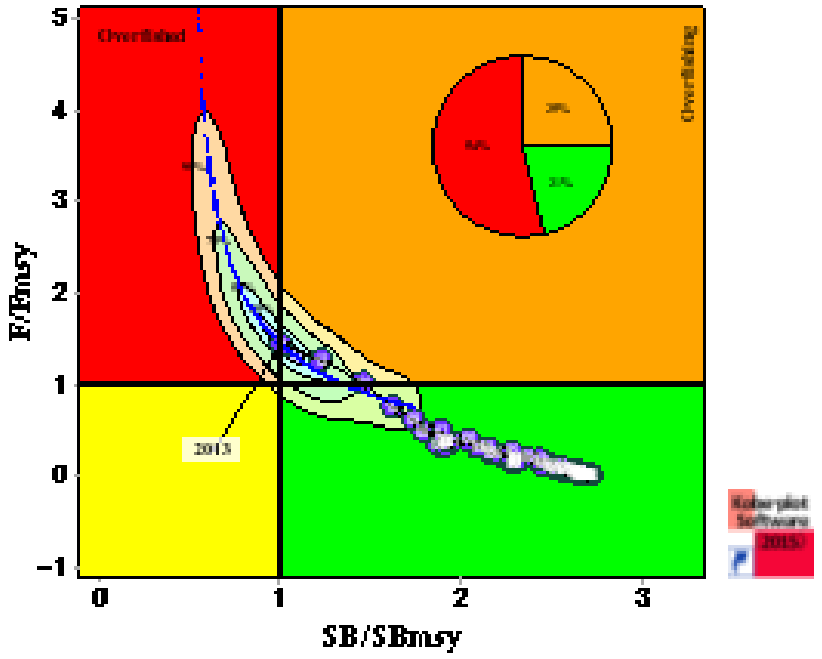
Longtail tuna

Both results are very similar (red zone) but the one in the whole Indian Ocean is more pessimistic because large catch are mainly from Middle east (especially Iran), which catch have been significantly increasing but started declined in last a few years. Same situation on the LOT in the SE Asia are observed (see Box 8 next page).

SE Asia region (This document)
(red zone)

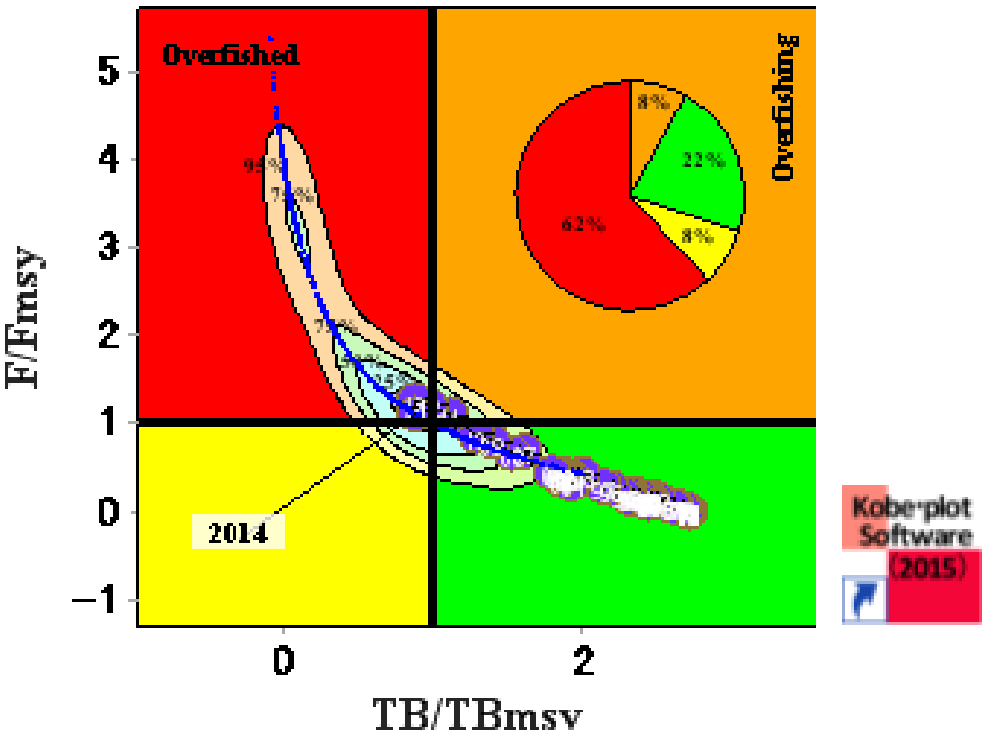


Whole Indian Ocean (Nishida and Iwasaki, 2015) (IOTC-WPNT06-2015-28 Rev_2)
(red zone)



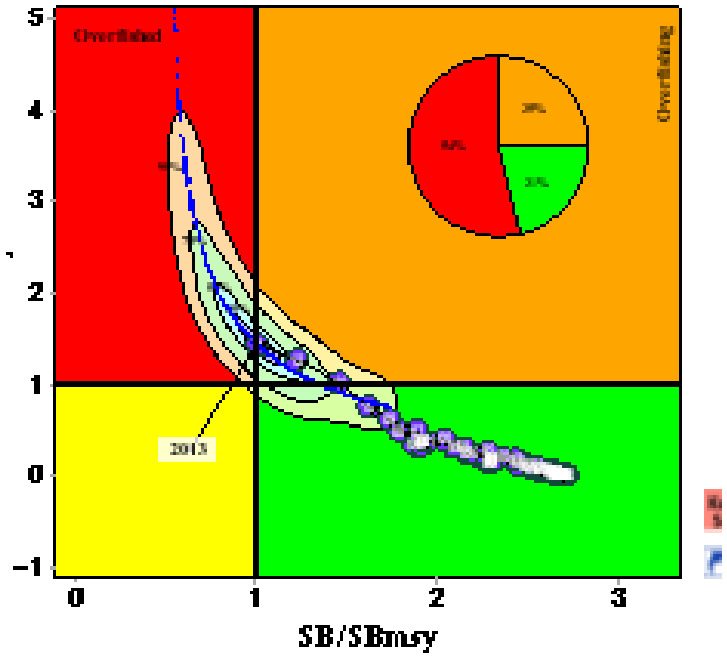
SE Asia region (This document)

(red zone)

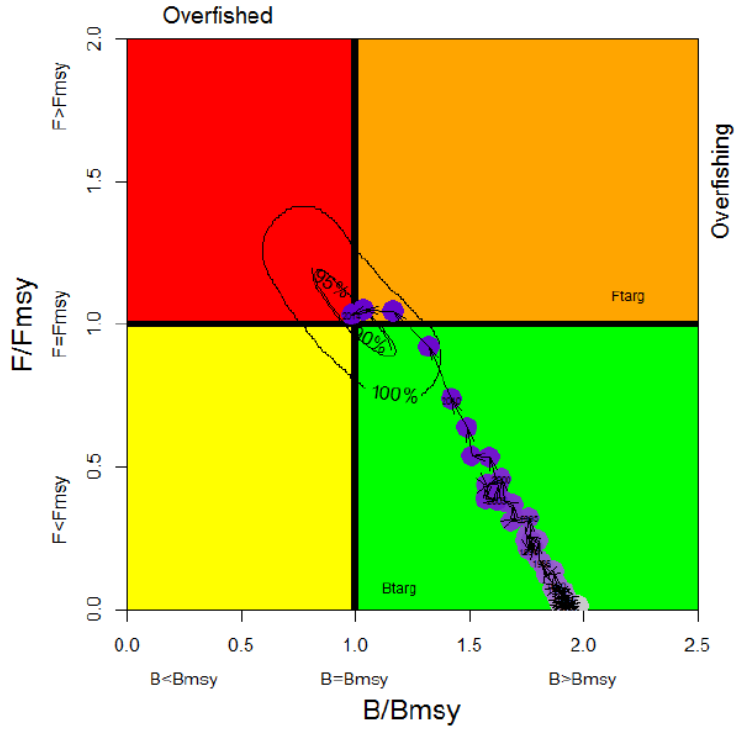


Whole Indian Ocean (Nishida and Iwasaki, 2015) (IOTC-WPNT06-2015-28 Rev_2)

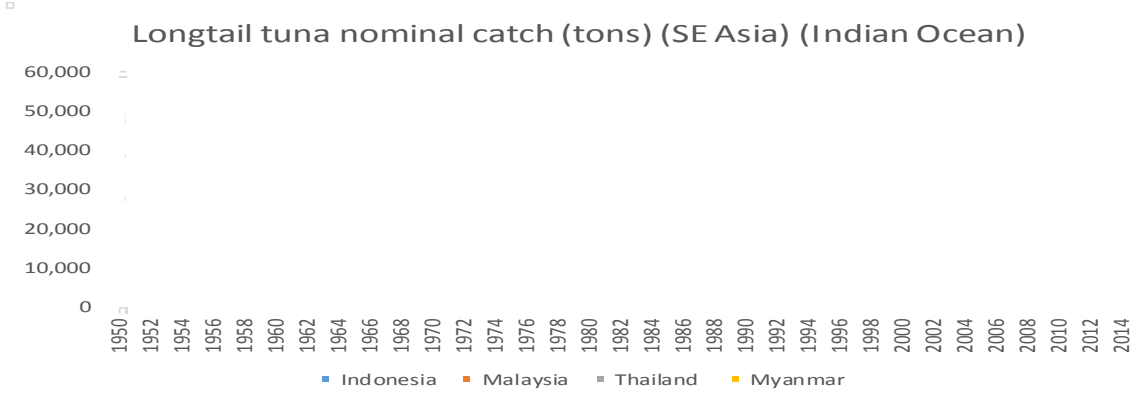
(red zone)



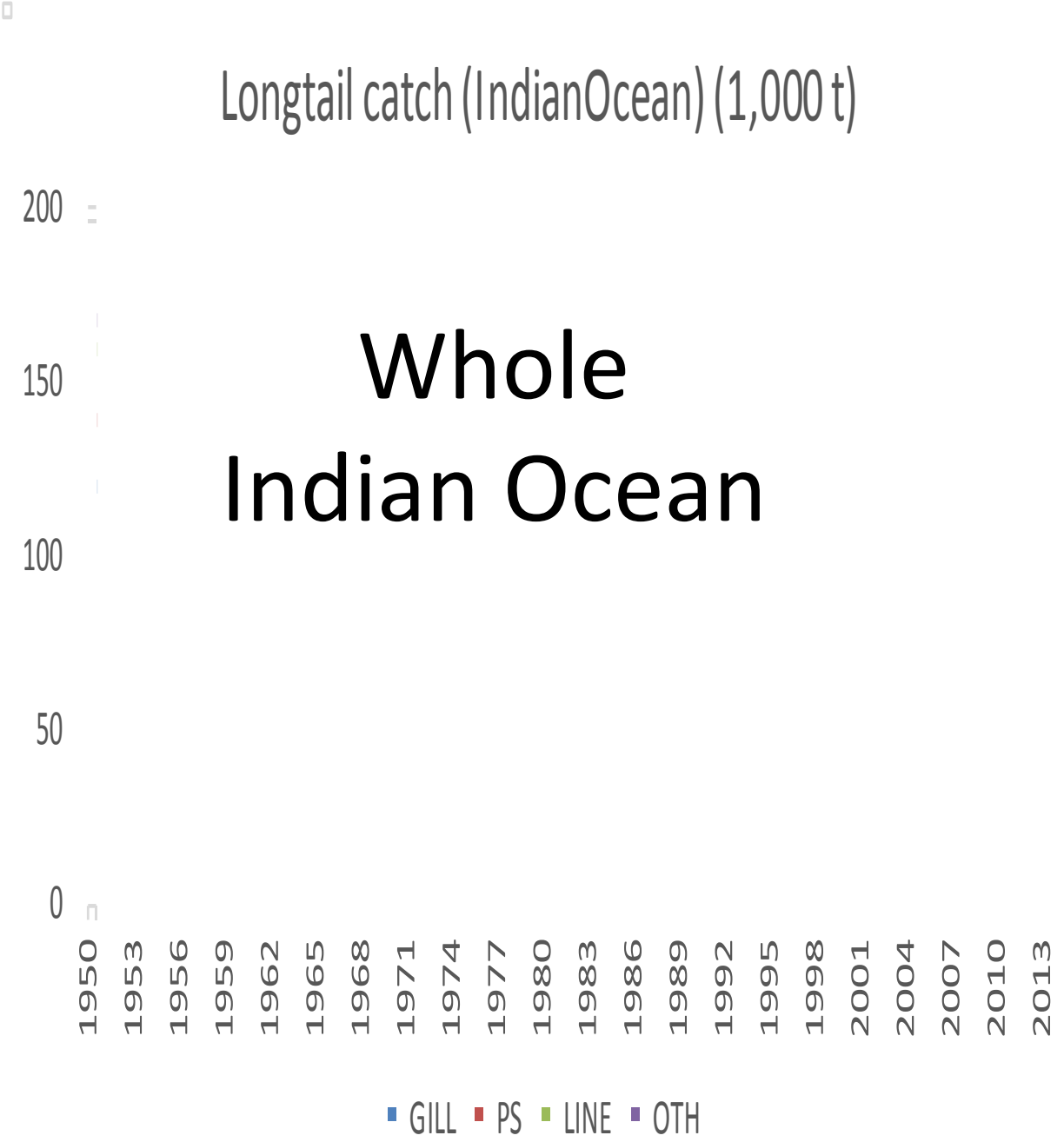
Whole Indian Ocean (2016) (IOTC) last week (red zone)



SE Asia
(Indian Ocean side)
1/3 of Whole IO



Whole
Indian Ocean



Management Advice

- SEAFDEC can make recommendation
- But SEAFDEC can not force recommendation as SEAFEC is not RFMO
- If stock status is not serious but in unsafe zone (red, orange or yellow)
  ➔ voluntarily reduction of catch and/or effort
- BUT If the stock status is **very serious (RED)**➔ ASEAN, IOTC etc. for mandatory reduction of catch or effort

Need periodical stock assessments

As stock status change

Risk assessment (future)

after we agree stock assessments

Using agreed parameters

Probability Risks violation MSY (TB and F)

in 3-10 years if the current catch level continue

Box 9 Future works

- Collect Catch and Effort data for ALL MEMBER COUNTIES.
- Reexamine catch data for ALL MEMBER COUNTIES.
- Explore other standardized CPUE models than GLM for those do not fits well.
- Explore Philippines catch and effort data. We may be able to find some plausible CPUE as data are so details hence some statistical treatment can produce feasible CPUE.
- Thailand (Chalit) send additional AFDEC Catch and effort data (2006-20013) recently. But all the stock assessments have completed by that time, thus we could not use these CPUE. We may need to use them in the next chance in the future
- Conduct age/size based stock assessments using biological data (for example Statistical-Catch-At-Age/Size) to compare results by ASPIC.
- Proceed genetic studies for Stock structure. Cooperate with on-going EU funded Stock structure project in the IOTC (for Indonesia, Thailand, Malaysia and Philippines).

Software

- CPUE standardization:
  - ➔ GLM (interaction)
  - ➔ add other CI : 80% and 90%
  - ➔ negative binominal + Poisson model (for many 0 catch situation)
- ASPIC ➔ add Graphic function
- SCAA ➔ Statistical-Catch-At-Age (integrated model)

  using biological data (growth, LW, maturity, fecundity)

  (already available) 6 input files

Thank you….