NPFC-2025-TWG CMSA11-WP12

Standardized CPUE of Chub mackerel (*Scomber japonicus*) caught by the China's lighting purse seine fishery up to 2024

1. Introduction

公海围网渔业渔捞日志

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日期	网次	作业开始		作业结束		渔获量记录（Kg）											备　注（若有其他鱼种，可自行添加名称并
		时间	经纬度	时间	经纬度	鲳鱼	沙丁鱼	鲳鱼	鱿鱼	秋刀鱼	鲹鱼	竹筴鱼	无须鳕	鲭鱼	带鱼	杂鱼	合计	
10/7	2	20:19	151° 31′ 47″ E 42° 11′ 22″ N	22:54	151° 30′ 4″ E 42° 12′ 28″ N	18700	13200										31900	
10/8	4	19:36	151° 19′ 39″ E 42° 16′ 16″ N	23:23	151° 20′ 15″ E 42° 15′ 27″ N	12300	8300										20600	
10/9	2	19:58	151° 32′ 4″ E 42° 10′ 28″ N	22:38	151° 32′ 49″ E 42° 10′ 35″ N	16700	6600			1500							24800	
10/10	4	19:41	151° 8′ 33″ E 42° 11′ 38″ N	23:12	151° 8′ 38″ E 42° 11′ 52″ N	14500	10300										24800	
10/11			避风未作业														0	
10/12			避风未作业														0	
10/13			避风未作业														0	
10/14			避风未作业														0	
10/15	2	19:34	151° 13′ 7″ E 42° 14′ 9″ N	22:03	151° 14′ 28″ E 42° 15′ 43″ N	11600	9000										20600	
10/16	3	18:30	151° 19′ 8″ E 42° 17′ 10″ N	21:45	151° 17′ 12″ E 42° 16′ 12″ N	10600	9400										20000	
10/17	3	20:05	151° 16′ 59″ E 42° 6′ 51″ N	22:23	151° 17′ 27″ E 42° 7′ 31″ N	11300	11700			1000							24000	
合 计						95700	68500	0	0	2500	0	0	0	0	0	0	166700	

1. Introduction

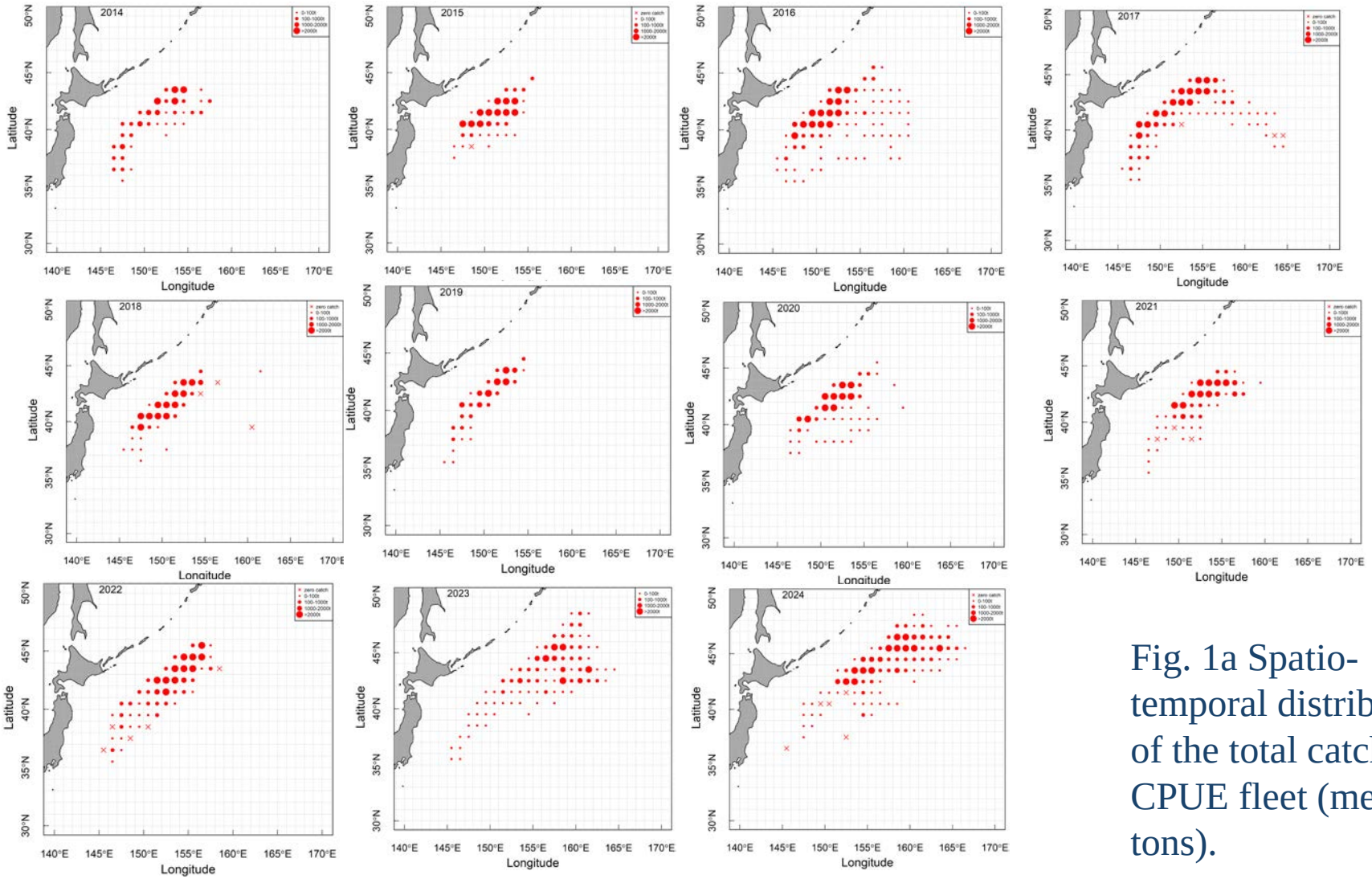


Fig. 1a Spatio-temporal distribution of the total catch of CPUE fleet (metric tons).

1. Introduction

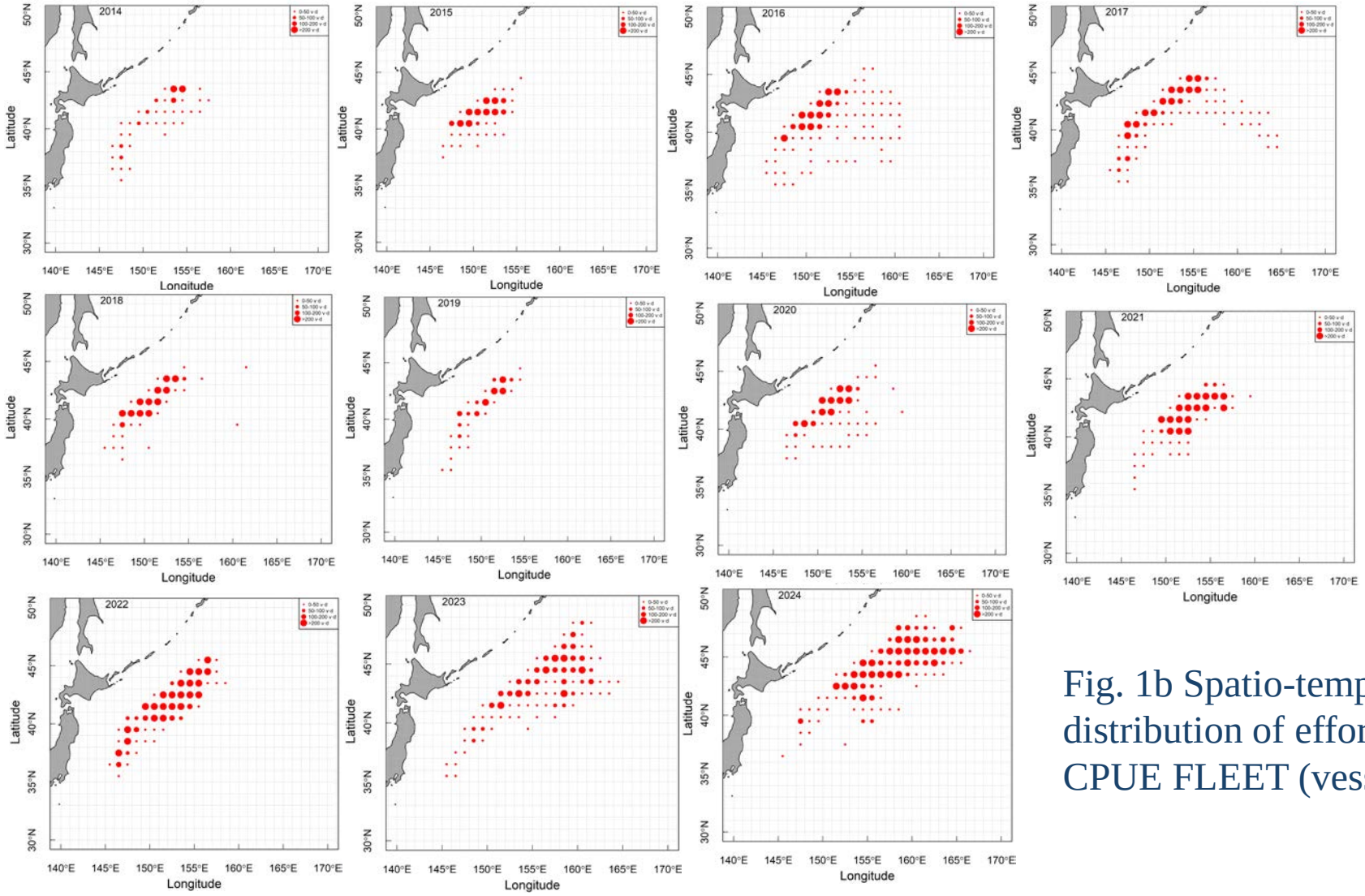


Fig. 1b Spatio-temporal distribution of efforts by CPUE FLEET (vessel•day)

1. Introduction

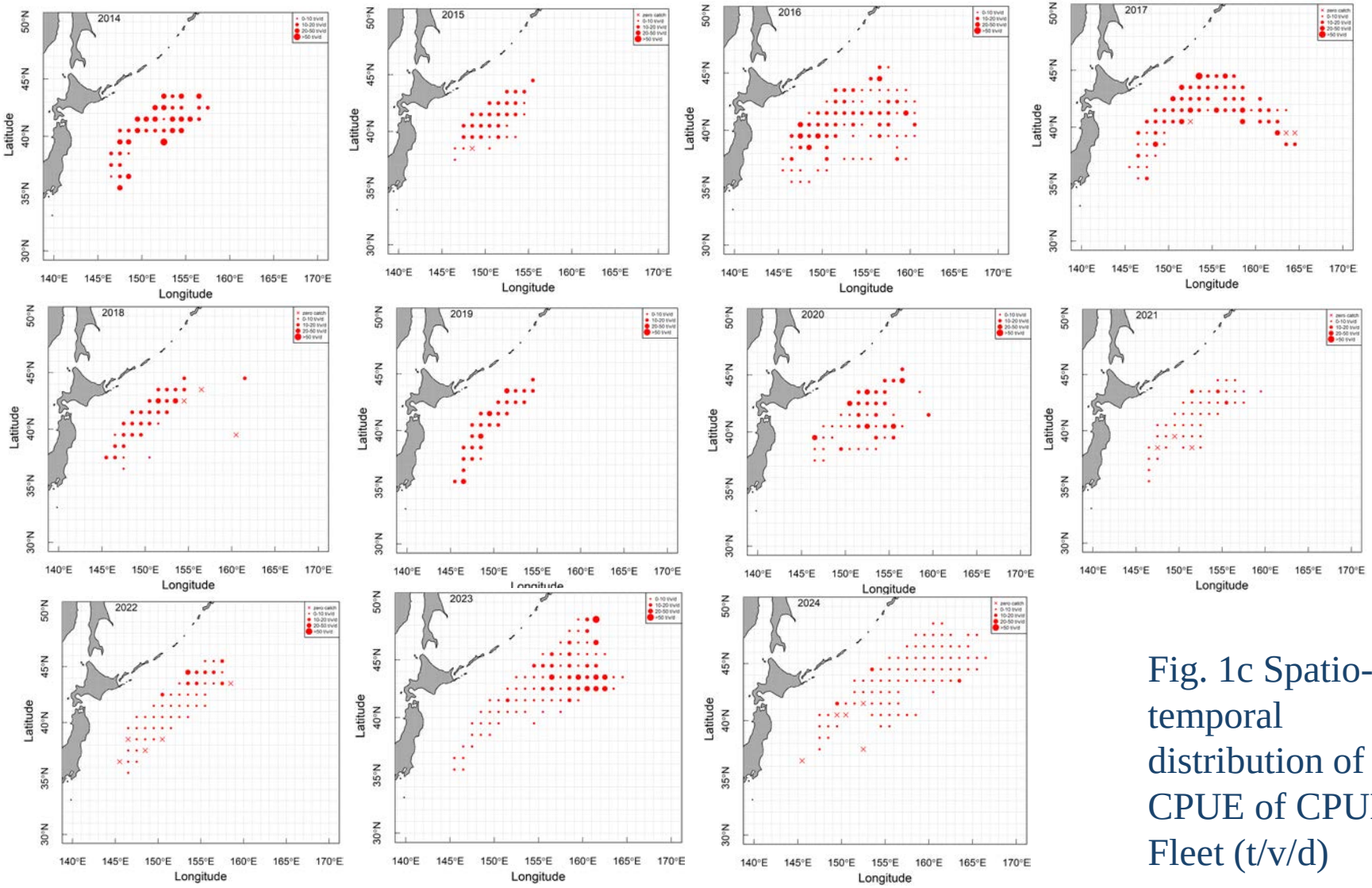


Fig. 1c Spatio-temporal distribution of CPUE of CPUE Fleet (t/v/d)

2. Material and Methods

Oceanographic Data

Fishery Data

Sea surface temperature (SST)

Chlorophyll-a concentration (Chla)

2. Material and Methods

Table 1. Catch and effort information by CPUE Fleet						
Year	Number of observations	% Coverage of CPUE FLEET(catch).	% Coverage of CPUE FLEET(effort).	Total Catch CPUE FLEET (MT)	Total Effort for CPUE FLEET and unit	Percentage of overall catch by member (across all fleets/gears)
2014	1477	80%	75%	30030.48	1477 vessel days	71%
2015	5605	74%	85%	93884.49	5605 vessel days	67%
2016	6644	82%	89%	98131.64	6644 vessel days	69%
2017	9578	92%	95%	133363.19	9578 vessel days	86%
2018	6617	81%	90%	98140.26	6617 vessel days	75%
2019	2504	81%	90%	43363.81	2504 vessel days	67%
2020	5158	82%	94%	69542.5	5158 vessel days	75%
2021	14239	93%	96%	88550.22	14239 vessel days	82%
2022	13723	70%	90%	75340.71	13723 vessel days	68%
2023	14075	98%	95%	46133	14075 vessel days	94%
2024	13830	98%	95%	67835	13830 vessel days	93%

2. Material and Methods

Variables	Cases	Categorical or continuous	Details	Note
Year	Year	11 categories	11 years from 2014 to2024	
Month	Month	10 categories	10 months from March to December	
Longitude	Longitude	22 categories	145°≤Longitude＜146° ; 146°≤Longitude ＜147°; 147°≤Longitude＜148°;…, 166°≤Longitude＜167°	at intervals of 1°
Latitude	Latitude	14 categories	35°≤Latitude＜36°; 36°≤Latitude＜37°; …, 48°≤Latitude＜49°	at intervals of 1°
Sea surface temperature	SST SST_c	spline 20 categories	3℃≤SST＜4℃;4℃≤SST＜5℃; 5℃≤SST ＜6℃; …, 25℃≤SST＜26℃	at intervals of 1℃
Chlorophyll-a concentration	Chla	continues （spline）		
Vessel length	Vessellength _c	10 categories	45m≤Vessellength＜47m; 47m≤Vessellength＜49m …, 61m≤Vessellength＜63m	at intervals of 2m

2. Material and Methods

Statistical model and model selection strategy

GLM and GAM were used to standardize the CPUEs.

Full GLM $log(CPUE+1) = Year + Month + Longitude + Latitude + Sst + Chla + Vessellength + interaction + \varepsilon$

Full GAM $log(CPUE+1) = Year + Month + Longitude + Latitude + s(Sst) + s(Chla) + s(Vessellength) + interaction + \varepsilon$

2. Material and Methods

The way to calculate the yearly standardized CPUE :

Expanded grid function in R was used to generate a series of spatial homogeneous explanatory variables and the area of each 1°×1° grid cell was considered the same. Then, annual values of ln(*CPUE*) for each area (1°×1°) were predicted. Finally annual standardized CPUE were calculated as the mean of CPUEy:

$$\overline{CPUE}_y = \frac{1}{n_y} \times \sum_{k=1}^{n_y} CPUE_k^{fitted}$$

3. Results

Optimal Model

Best model in GLM	R^2	BIC	Explained deviance
Ln(CPUE+1)~Intercept+Year+Month+Longitude+Latitude+Sst_c+Chla +Vl_c+Year:Month+ε	0.4398	59664.33	43.58%

Best model in GAM	R^2	BIC	Deviance explained
Ln(CPUE+1)~Intercept+Year+Month+Longitude+Latitude+s(Sst)+s(Chla)+Vl_c+Year:Month +ε	0.4366	59560.93	44.04%

The optimal model was selected using the Bayesian information criterion (BIC) based on the forward selection.

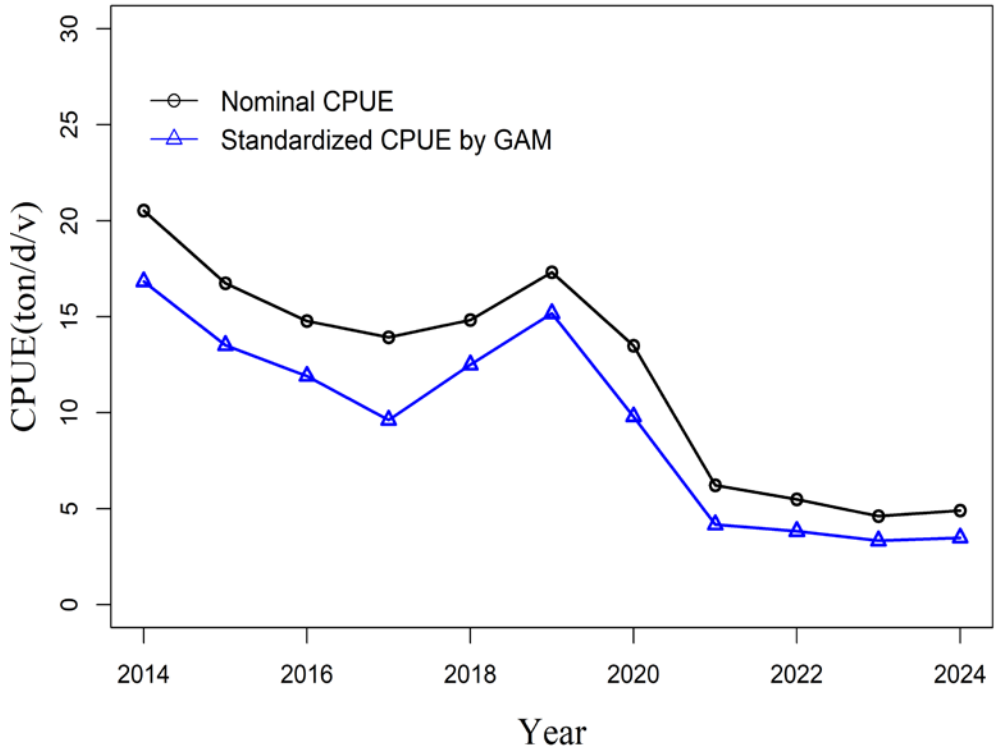
3. Results

The cross validation for the best GLM and GAM

case	cor_**GLM**	MSE_GLM
1	0.6441	0.7096
2	0.6540	0.7213
3	0.6421	0.7251
4	0.6401	0.7049
5	0.6435	0.7042

case	cor_**GAM**	MSE_GAM
1	0.6590	0.6878
2	0.6681	0.6780
3	0.6646	0.6922
4	0.6551	0.6791
5	0.6610	0.6776

3. Results



We prefer to choice the best GAM model to estimate standardized CPUE

3. Results

Nominal and standardized CPUEs of CPUE fleet from 2014 to 2024

Year	Nominal CPUE	Standardized CPUE by GAM	CV (%)	95% CI by GAM	
2014	22.33	16.83	6.57	[16.14	17.25]
2015	16.75	13.51	5.21	[12.72	13.81]
2016	14.77	11.91	5.98	[11.05	12.62]
2017	13.92	9.61	3.87	[9.07	10.24]
2018	14.83	12.50	5.25	[11.83	13.09]
2019	17.32	15.17	6.19	[14.21	15.85]
2020	13.48	9.79	6.68	[8.97	10.18]
2021	6.22	4.17	4.97	[3.57	4.70]
2022	5.49	3.82	4.73	[3.02	4.29]
2023	4.61	3.34	5.89	[2.88	3.89]
2024	4.90	3.48	6.41	[2.76	4.07]

Thank you for your attention!