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# Standardized CPUE for skipjack caught by Japanese offshore pole and line fishery in the northern region of the western and central Pacific Ocean.

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**H. Kiyofuji[1], K. Uosaki[1], M. Ogura[1], A. Langley[2], S. Hoyle[3]**

[1] National Research Institute of Far Seas Fisheries, Japan
[2] Consultant, Secretariat of the Pacific Community, Noumea, New Caledonia
[3] Secretariat of the Pacific Community, Noumea, New Caledonia

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[1] National Research Institute of Far Seas Fisheries
[2] Consultant, Secretariat of the Pacific Community
[3] Secretariat of the Pacific Community

**Summary**

We attempted to standardize a catch per unit effort (CPUE) for a skipjack tuna caught by Japanese offshore pole and line fishery in the northern region of northwestern Pacific Ocean (northern part of 20ºN). We applied same method as proposed by Langley et al. (2010) which was only for distant water pole and line fishery. As a result, CPUE indices show different results from the sharp increase of indices after 1990 that was used for the stock assessment in 2008. This indicates that effects of vessel ID (good or poor catchability) were highly considerable.

## Introduction

Skipjack tuna (*Katsuwonus pelamis*) appears wide area within whole of Pacific Ocean and believed to migrate seasonally from tropical to subtropical oceans and near the Japanese coastal waters. Recent stock status of skipjack tuna is not overfishing and its stock keeps still safe level according to the last skipjack stock assessment in 2008 even though total catch has been increasing. However, recent skipjack catches near Japanese water has been decreasing and its catches caught by both of the Japanese pole and line and purse seine fisheries in 2009 recorded the lowest catches since the logbook data are available. This is one issue to clarify whether recent stock status in the WCPO is still safe level or not.

Standardized CPUE from both of Japanese pole and line distant-water and offshore fisheries were employed to the skipjack stock assessment in 2008. The same method was used to derive the indices as Shono and Ogura (1999) at the assessment in 2008. Derivation of the skipjack CPUE indices was reviewed at the pre-assessment workshop in April 2010 and revised CPUE indices were recommended to include in the 2010 skipjack stock assessment. Collaborative research between SPC and NRIFS was conducted to provide revised skipjack CPUE indices in May 2010 and detailed description of analysis including methodology are shown in Langley et al. (2010). In this document, we applied same method as Langley et al. (2010) to the Japanese offshore pole and line fisheries and discuss about applicability of this methodology for derivation of CPUE indices.

## Data and Methods

The operational level of catch and effort data for Japanese pole and line during 1972 and 2009 with noon position in equidistant 1° x 1° grid cells was used. Date, number of poles, catch in weight and vessel size in gross register tonnage (GRT) were employed. Japanese pole and line fishery are categorized three licenses, which are inshore (< 20 GRT), offshore (from 20 to 200 GRT) and distant-water (> 200 GRT) (Ogura and Shono, 1999). There is no necessarily for the inshore fishery to submit logbook, therefore this data were excluded from this analysis. The overview of the Japanese pole and line fisheries were described in details by Ogura and Shono (1999). Individual vessel number are identified by the license number and detail description of creating vessel ID are also shown in Langley et al. (2010).

Spatial structure to create a single northern region (Fig.1(b)) has been determined to combine the old MFCL region 1 -3 (Fig.1(a)) for stock assessment in 2010 (Harley and Hoyle, 2010). Japanese offshore pole and line fishing activity near Japanese water (old MFCL region 1 and 2; Fig.1 (a)) mainly occurs during April – September, targeting both of skipjack and albacore. The absence of skipjack in the catch from targeting albacore trips is unlikely to be suitable for representing the relative abundance of skipjack. This is also critical issues for derivation of relative abundance of albacore (e.g. Kiyofuji and Uosaki, 2010). To exclude such data from the analysis, those fishing trips that skipjack represented 75% of the combined skipjack and albacore were removed. The data set was limited to individual vessels that completed a minimum of 10 days fishing each year for a minimum of five years.

A generalized linear model was applied for only MFCL new defined region 1 (Fig.1(b)) and the basic GLM model formulation applied in this study is shown as follows. Definition of the predictor variables are shown in Table 1.

CPUE= YearQtr + vesselid + Latlong + NumPoles + BaitTank+NOAA+Sonar + BirdRadar + Error.

The continuous variable of number of poles (NumPoles) was included as a third order polynomial function. All other variables were categorical; however, devices information for the offshore pole and line fisheries has not been completed yet and hence device information is excluded from this analysis.

1. The presence/absence of skipjack catches for a fishing day. The dependent variable was modeled using a binomial error structure to estimate probability of non-zero catch of skipjack for a fishing day.
2. Skipjack catch for a fishing day with the additional of a small constant. The dependent variable was modeled assuming a lognormal error structure. Zero catch records were assigned a nominal catch of 1kg.
3. Non-zero skipjack catch for a fishing day and zero catch records were excluded. Lognormal error structure.

From each model, the year/quarter CPUE indices were derived by exponentiations of the individual year/quarter factorial coefficients. Delta-lognormal indices were derived by combining the binomial and the non-zero lognormal indices and are calculated by multiplying the two sets of indices.

## Results and Discussion

Figure 2 shows catch, effort (number of poles) and nominal CPUE in the new MFCL region1 (north of 20ºN), respectively. Catch has been likely decreasing since 1984 and significant decreasing of effort is identified from 1982 until 1990 because of the decrease of fleet number. However, nominal CPUE (skipjack catch/pole-day) kept slightly higher level after 1990.

Figure 3 shows summary of data for the new MFCL region 1. The Japanese offshore pole and line vessel operates mainly between April and August about latitude 30ºN – 33ºN from 1972 and 1990. They shifted slightly north between 33ºN and 35ºN after 1991 until 2009. Significant changes were not identified in longitude, however, fishing ground seems to be extended to wider area between 1972 and 1983. Size of vessel was around 100 GRT from 1972 to 1995, but they became larger after 1996. This is due to decrease of smaller size of vessels.

Each GLM analysis shows different from the current standardized CPUE analysis used in the last stock assessment. Their trends were similar pattern and especially between the zero-inflated lognormal model and the non-zero lognormal model (Fig.4). There are unlikely any patterns or correlations between short and long range of participating years and vessel effects on the probability of catching skipjack (Fig.5). One large difference was that the sharp increase after 1990 were not identified in each year/quarter indices. Although delta-lognormal index also shows no sharp increase after 1990, indicating that abundance levels keep similar level as that before 1990, their seasonal changes are likely larger than that before 1990 (Fig. 6).

The nature of zero catch data issues has been discussed in several articles (e.g. Lo *et al.*, 1992 and Shono, 2008) and it is very difficult to put any meanings to zero catch data from the logbook. This is one of limitation to use logbook data set which record only one record per day as representative information. Because the pole and line fishery fishes several times a day, this information should be incorporated. Since device information for the offshore pole and line has not completed yet, these also should be also solved.

In future analysis for standardizing catch per unit effort for skipjack caught by the Japanese offshore pole and line are as follows.

1. Additional and fine scale data such as number of operations per day and successive operations of skipjack catch should be incorporated. This would lead to estimating particularly fishing effort more appropriately.
2. Device information should be completed and how they are used during the fishing. This is also related to No.1. It is necessary to conduct device effects experiments during the actual fishing activities in some cases, how they effect on their catchability. For example, comparing successive operations of skipjack catch with and without any devices.
3. A list of captain would be useful as an alternative way to identify the vessel ID (poor and good catchability).

In conclusion, this analysis is same approach as Langley et al. (2010) and results were different from indices used in the last stock assessment in 2008. Abundance estimated by the offshore pole and line in the northern region might not increased sharply after 1990. This indicates that the individual vessel effects on catchability of skipjack, which is consistent with results from the distant-water pole and line fishery. Additional analysis listed above will be next step for improving abundance index appropriately.

**Acknowledgement**

We thank to Dr Hiroshi Shono for providing useful comments on model configuration.

## References

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**Table 1.** Definition of the predictor variables included in the model.

| Variable | Data type | Description |
|---|---|---|
| YearQtr | Categorical | Unique year and quater |
| LatLong | Categorical | 5º of latitude and longitude spatial strata (midday position) |
| VesselID | Categorical | Unique vessel category |
| NumPoles | Continuous | Number of poles |
| BaitTank | Categorical (3) | 0. Unknown if vessel has LTLBT. |
| | | 1. Vessel does not have LTLBT. |
| | | 2. Vessel has LTLBT. |
| NOAA | Categorical (3) | 0. Unknown if vessel has NOAA receiver. |
| | | 1. Vessel does not have NOAA receiver. |
| | | 2. Vessel has NOAA receiver. |
| Sonar | Categorical (3) | 0. Unknown if vessel has sonar. |
| | | 1. Vessel does not have sonar. |
| | | 2. Vessel has sonar. |
| BirdRadar | Categorical (4) | 0. Unknown if vessel has bird radar |
| | | 1. Vessel does not have bird radar |
| | | 2. Vessel has 1st generation bird radar. |
| | | 3. Vessel has 2nd generation bird radar. |

(a)

(b)

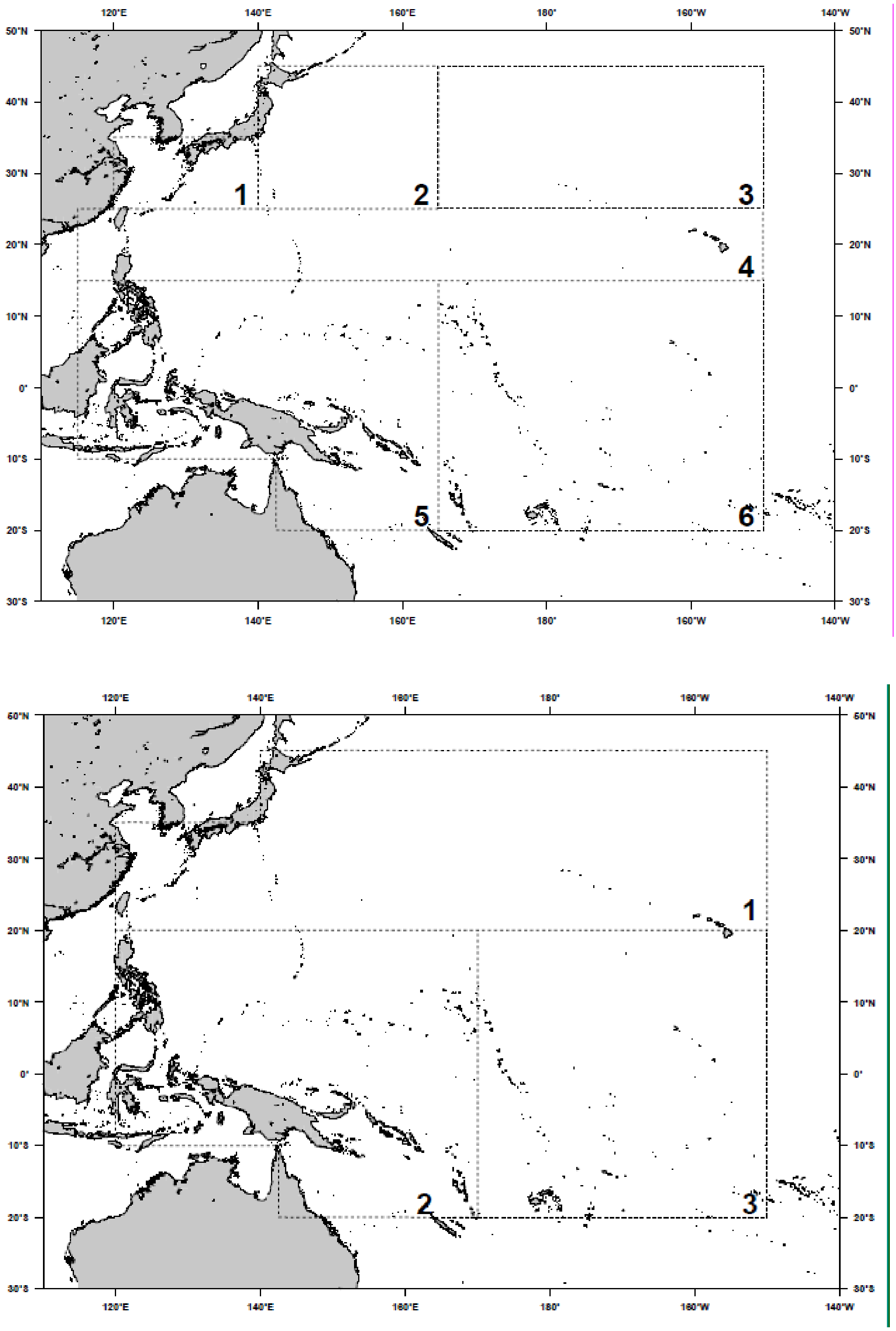


**Figure 1.** Spatial structure of the (a) previous and (b) new MFCL skipjack assessment model.

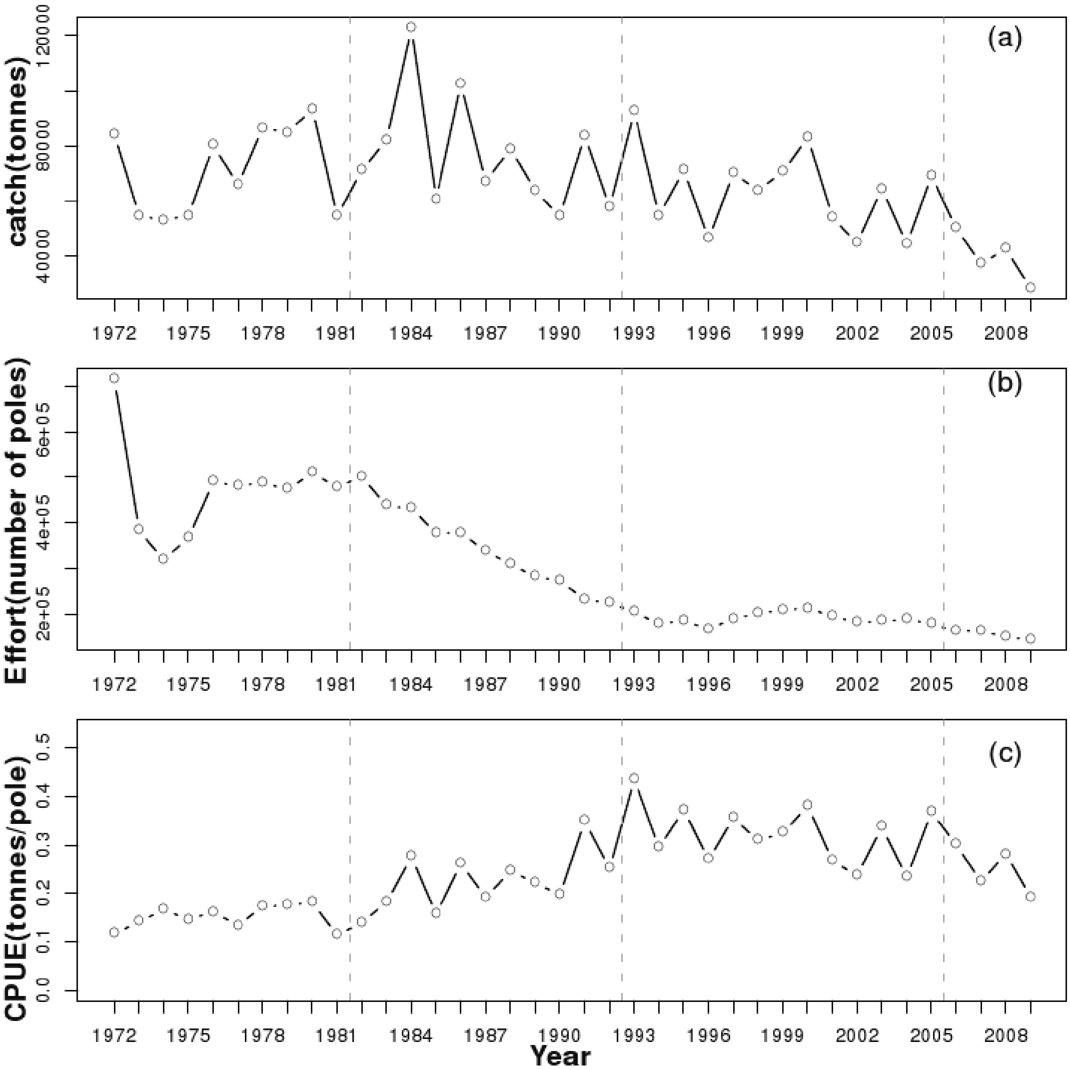


**Figure 2.** (a) Catch, (b) effort (number of poles), (c) nominal CPUE (tonnes/number of poles) of the Japanese offshore pole and line in the new MFCL region 1 (Figure 1 (b)).

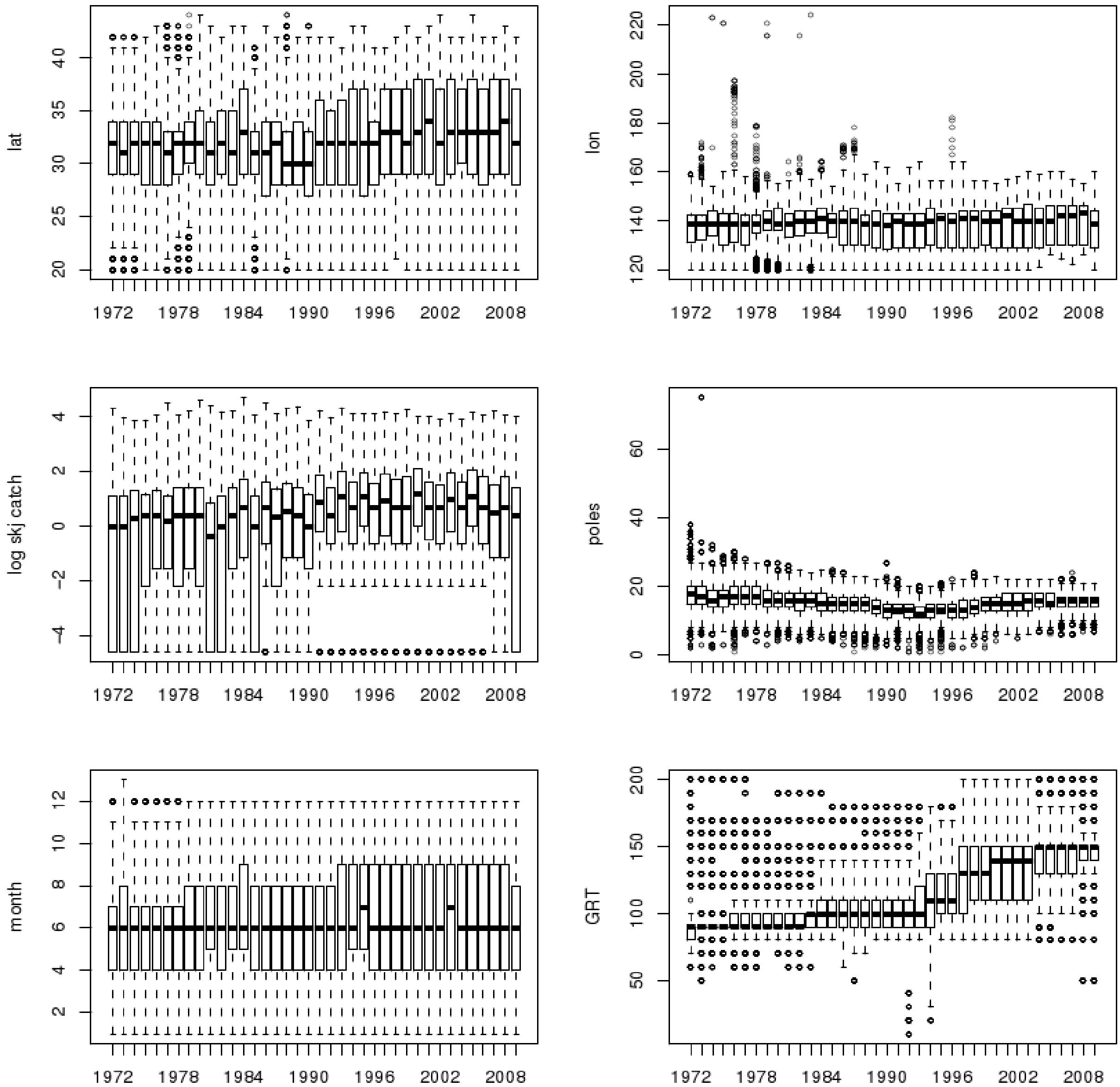


**Figure 3.** Summary of data for the new MFCL region 1 (Fig. 1(a)).

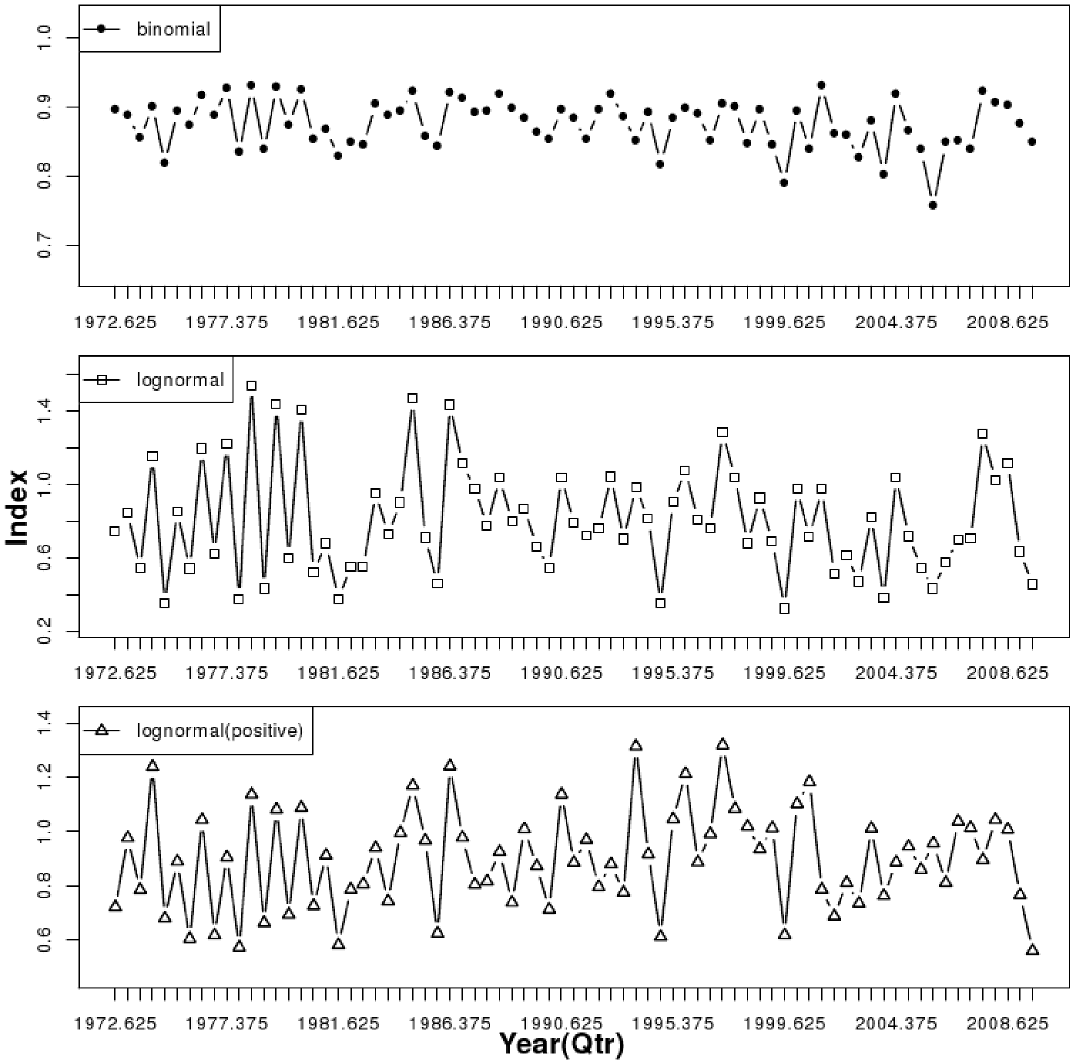


**Figure 4.** Each CPUE index by the Japanese offshore pole and line fishery in the new MFCL region2.

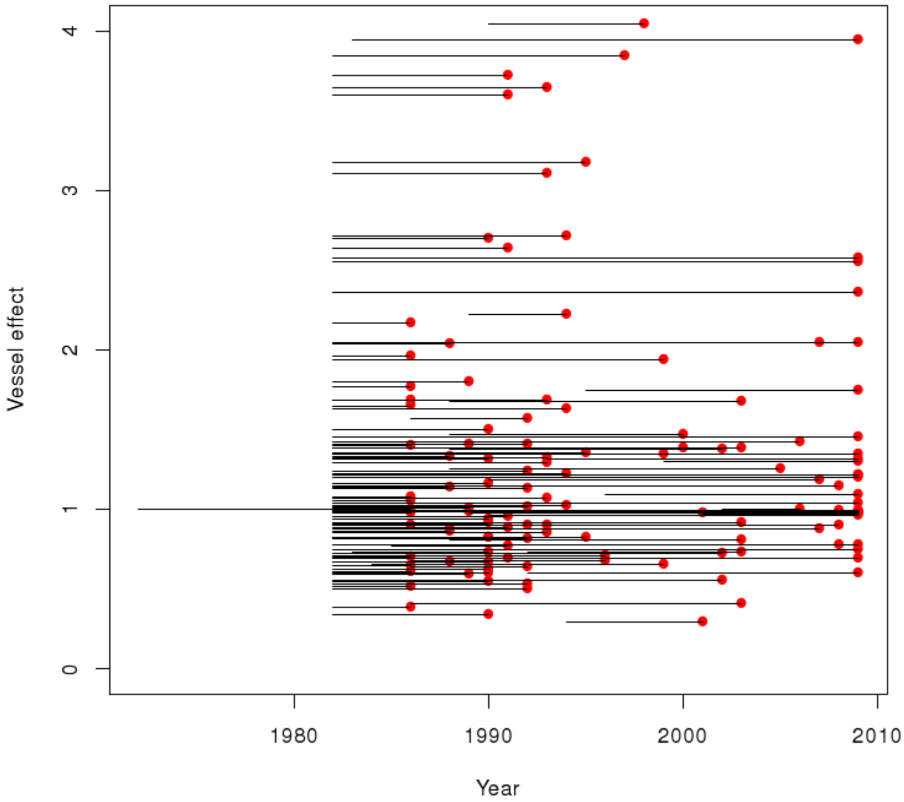


**Figure 5.** The individual vessel effects on the probability of caching skipjack (binomial model) for MFCL new region 1 plotter against the last year that the vessel was active in the fishery. The horizontal line represents the range of years that the individual vessel participated in the fishery. All vessel variables commence from 1982 onwards with the exception of the aggregate vessel category.

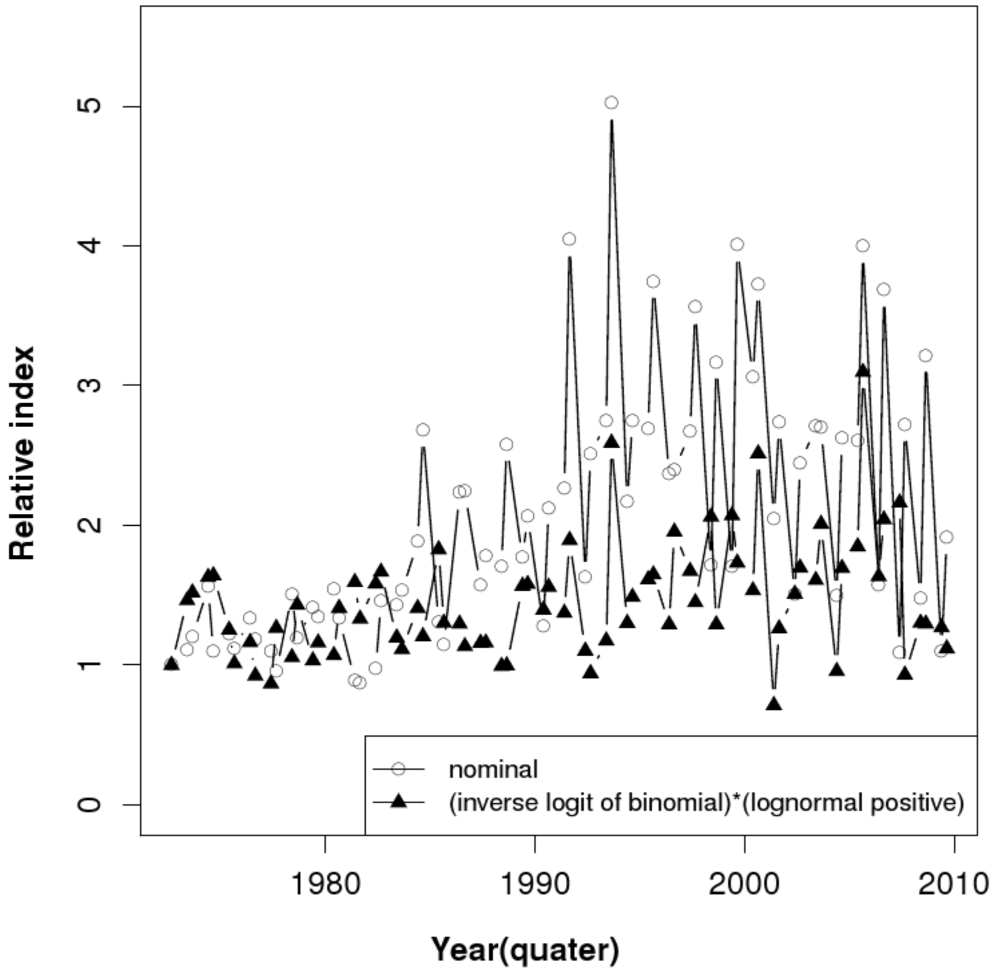


**Figure 6.** Relative indices derived from the (a) nominal (catches/pole-day; white circle) and (b) delta-lognormal (black traiangle) for the offshore pole and line fishery in new MFCL region 1 (Fig.1(b)).

**Appendix 1** Nominal and Standardized CPUE calculated by the delta log-normal in new MFCL region 1.

| Year | Nominal | Delta-lognormal [ (logit inverse of binomial)*(lognormal positive) ] |
|---|---|---|
| 1972.625 | 0.1392 | 0.0752 |
| 1973.375 | 0.1532 | 0.1100 |
| 1973.625 | 0.1673 | 0.1142 |
| 1974.375 | 0.2168 | 0.1225 |
| 1974.625 | 0.1520 | 0.1235 |
| 1975.375 | 0.1700 | 0.0942 |
| 1975.625 | 0.1550 | 0.0760 |
| 1976.375 | 0.1853 | 0.0875 |
| 1976.625 | 0.1645 | 0.0695 |
| 1977.375 | 0.1523 | 0.0652 |
| 1977.625 | 0.1327 | 0.0951 |
| 1978.375 | 0.2093 | 0.0794 |
| 1978.625 | 0.1652 | 0.1076 |
| 1979.375 | 0.1959 | 0.0777 |
| 1979.625 | 0.1863 | 0.0873 |
| 1980.375 | 0.2145 | 0.0805 |
| 1980.625 | 0.1859 | 0.1059 |
| 1981.375 | 0.1239 | 0.1198 |
| 1981.625 | 0.1208 | 0.1001 |
| 1982.375 | 0.1359 | 0.1191 |
| 1982.625 | 0.2030 | 0.1254 |
| 1983.375 | 0.1990 | 0.0900 |
| 1983.625 | 0.2128 | 0.0837 |
| 1984.375 | 0.2616 | 0.1058 |
| 1984.625 | 0.3728 | 0.0907 |
| 1985.375 | 0.1815 | 0.1374 |
| 1985.625 | 0.1586 | 0.0979 |
| 1986.375 | 0.3102 | 0.0974 |
| 1986.625 | 0.3118 | 0.0853 |
| 1987.375 | 0.2178 | 0.0871 |
| 1987.625 | 0.2478 | 0.0872 |
| 1988.375 | 0.2375 | 0.0747 |
| 1988.625 | 0.3589 | 0.0750 |
| 1989.375 | 0.2456 | 0.1178 |
| 1989.625 | 0.2877 | 0.1188 |
| 1990.375 | 0.1769 | 0.1050 |
| 1990.625 | 0.2956 | 0.1172 |
| 1991.375 | 0.3144 | 0.1033 |
| 1991.625 | 0.5624 | 0.1424 |
| 1992.375 | 0.2262 | 0.0829 |

| | | |
|---|---|---|
| 1992.625 | 0.3488 | 0.0708 |
| 1993.375 | 0.3815 | 0.0884 |
| 1993.625 | 0.6985 | 0.1948 |
| 1994.375 | 0.3017 | 0.0978 |
| 1994.625 | 0.3825 | 0.1118 |
| 1995.375 | 0.3749 | 0.1212 |
| 1995.625 | 0.5213 | 0.1239 |
| 1996.375 | 0.3287 | 0.0970 |
| 1996.625 | 0.3333 | 0.1469 |
| 1997.375 | 0.3710 | 0.1258 |
| 1997.625 | 0.4950 | 0.1090 |
| 1998.375 | 0.2377 | 0.1551 |
| 1998.625 | 0.4408 | 0.0971 |
| 1999.375 | 0.2374 | 0.1558 |
| 1999.625 | 0.5572 | 0.1303 |
| 2000.375 | 0.4256 | 0.1154 |
| 2000.625 | 0.5186 | 0.1891 |
| 2001.375 | 0.2843 | 0.0536 |
| 2001.625 | 0.3807 | 0.0949 |
| 2002.375 | 0.2090 | 0.1135 |
| 2002.625 | 0.3400 | 0.1276 |
| 2003.375 | 0.3762 | 0.1209 |
| 2003.625 | 0.3753 | 0.1511 |
| 2004.375 | 0.2075 | 0.0719 |
| 2004.625 | 0.3648 | 0.1274 |
| 2005.375 | 0.3619 | 0.1390 |
| 2005.625 | 0.5558 | 0.2329 |
| 2006.375 | 0.2191 | 0.1230 |
| 2006.625 | 0.5123 | 0.1535 |
| 2007.375 | 0.1516 | 0.1626 |
| 2007.625 | 0.3786 | 0.0700 |
| 2008.375 | 0.2048 | 0.0979 |
| 2008.625 | 0.4475 | 0.0974 |
| 2009.375 | 0.1530 | 0.0955 |
| 2009.625 | 0.2658 | 0.0841 |