International Scientific Committee for Tuna and Tuna-like Species in the North Pacific Ocean

The Evaluation of Removing Hook Adjacent Floats for Catch Amount Using Generalized Linear Model (GLM)

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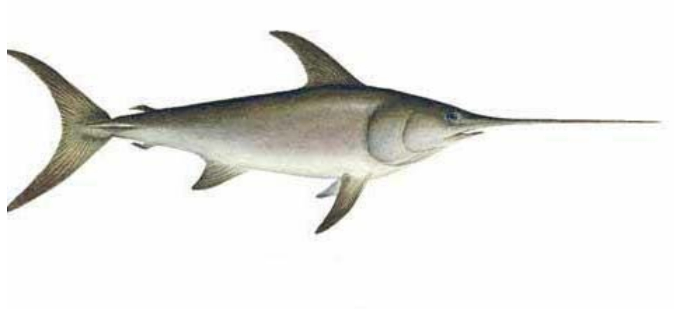

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Summary

The evaluation of the effects of removing hook adjacent to float on the catch of major tunas and billfishes (striped marlin, big-eye tuna and yellow-fin tuna) caught by the longline fishery as the selectable fisheries conducted. The Japanese training vessel data was used for this analysis. The information of the number of branch line hooked by tunas and billfishes, which is available in the data of Japanese training vessels, is enabled us to make statistical model to estimates of the effect of loss of 1st hooks adjacent to float on the catch ability on major tunas and billfishes. By this analysis, no interaction between branch number and environmental factors to explain catch was selected. For striped marlin this method can reduce about 50% of catch. For big-eye tuna there is relatively fewer effects were estimated. For yellow-fin tuna, 13% % of catch will be reduced by this method. As the result, tropical area in the northwestern Pacific in October and November are best area and season to do this method.

Introduction

The issue reduction of by-catch is the one of most important problem in longline fishery. Recently, the selectable fishing method, which decreases the catch ability for the by-catch species with minor effects on the catch of commercially important species, is receiving greater attentions by tuna's RFMOs in the world. Kanaiwa et al. (2009) shows the preliminary result of this method by using simple numerical simulation but there was no objective analysis that what factors affect on the catch amount of each branch line. Some statistical analysis was required from this result. In this paper we try to evaluate the removing hook adjacent to float removing 1st and 2nd shallowest hooks as the method applied on the data of the Japanese training vessel by using statistical model.

Materials and Methods

Data

Japanese training vessel's fishery data (2000-2006) which is operated in Pacific Ocean eastern side of 170E degree longitude is analyzed. We used the data of operation which used 13 branches between floats because of for the purpose of simplification of the analysis, and this operation style is the most frequency of operation number (Fig. 1).

Methods

The generalized linear model was used to estimate the efficiency of removing hooks. The initial model was below:

C ~ branch.no * (lon + lat + year + month + hook.no) + Poisson Error term.

Here, C is the catch number of each operation and each branch number, lon is longitude, lat is latitude and hook.no is hook's number of each operation, respectively. Both-direction step-wise method with BIC as evaluation criterion was used to find optimal model. The catch by each branch line was predicted by using optimal model and estimate the reduction ratio of catch by removing first hooks adjacent to floats. The reduction ratio is calculated the sum of the estimated catch number by first hooks divided by sum of reported catch in that operation. The reduction ratio is used to evaluate the efficiency. Considered species are striped marlin, big-eye tuna and yellow-fin tuna because Kanaiwa et al. (2009) shows these three species have different characteristic in habitat preferences.

Result and discussion

The number of operation with 13 hooks between floats was 2512. For striped marlin, Bigeye tuna and Yellowfin tuna, optimal models were below;

STM: C ~ branch.no + lat + year + month + hook.no + Poisson Error term,

BET: C ~ branch.no + lon + lat + year + month + hook.no + Poisson Error term and

YFT: C ~ branch.no + lat + year + month + hook.no + Poisson Error term, respectively.

All estimated co-efficients and standard errors are shown in Tables 1 - 3 and all estimated relative catch are shown in Figs. 2 - 4. Estimated reduction ratios were 0.50, 0.03 and 0.13 for striped marlin, big-eye tuna and yellow-fin tuna, respectively. For whole three species, no interaction term were selected. This means reduction ratio by removing hook adjacent to floats is not significantly different among year, season and area. This at least partially can be attributed to the fact that the area and season of the operation of Japanese training vessels with 13 hooks between floats is limited. The reduction ratio is calculated by only relative difference in catch among branch-lines but values of catch amount were actually different between area and season. If this method was applied on the area and season with high catch amount, larger number of catch reduction can be obtained than on the area and season with lower catch amount. For striped marlin, lower latitude around 5 degree has three times larger catch than higher latitude around 40 degree and in April, October and December, there is higher catch than other months (Fig. 2). It is suggested that the removing hooks adjacent floats, therefore, is more efficient on Southern area in spring and autumn season where CPUE of striped marlin becomes larger. For big-eye tuna, this method has few efficient so does not change the catch amount. In addition, in southern western area has lower catch than other areas (Fig. 3). For yellow-fin tuna, in a similar with striped marlin, lower latitude has larger catch than higher latitude (Fig. 4). On February there is highest catch and on October and December the catch is middle.

In summary conclusion, removing hook adjacent to float should be useful especially in Southern Western area in North Pacific in October and November with estimated redaction ratio of 50% reduce 50% of striped marlin's catch. In this way, the total catch of bigeye and yellow-fin would only have fewer damages.

References

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	Estimate	Std. Err.	z value	P
(Intercept)	0.06	0.17	0.37	0.71
as.factor(branch.no)2	−0.69	0.05	−15.34	0.00
as.factor(branch.no)3	−1.31	0.06	−23.25	0.00
as.factor(branch.no)4	−1.96	0.07	−26.47	0.00
as.factor(branch.no)5	−2.27	0.09	−26.70	0.00
as.factor(branch.no)6	−2.68	0.10	−26.09	0.00
as.factor(branch.no)7	−2.71	0.10	−26.01	0.00
as.factor(branch.no)8	−2.68	0.10	−26.09	0.00
as.factor(branch.no)9	−2.30	0.09	−26.69	0.00
as.factor(branch.no)10	−1.90	0.07	−26.35	0.00
as.factor(branch.no)11	−1.54	0.06	−24.85	0.00
as.factor(branch.no)12	−0.86	0.05	−18.02	0.00
as.factor(branch.no)13	0.07	0.04	1.90	0.06
lat	−0.05	0.00	−9.56	0.00
as.factor(year)2001	0.20	0.05	4.41	0.00
as.factor(year)2002	−0.17	0.05	−3.17	0.00
as.factor(year)2003	0.08	0.05	1.75	0.08
as.factor(year)2004	−0.40	0.05	−7.35	0.00
as.factor(year)2005	−0.14	0.05	−2.65	0.01
as.factor(year)2006	0.17	0.05	3.43	0.00
hooks	0.00	0.00	3.79	0.00
as.factor(month)2	−0.21	0.05	−4.09	0.00
as.factor(month)3	−0.19	0.14	−1.43	0.15
as.factor(month)4	0.42	0.12	3.52	0.00
as.factor(month)5	−0.13	0.06	−2.09	0.04
as.factor(month)6	−0.44	0.07	−6.54	0.00
as.factor(month)7	−1.72	1.00	−1.71	0.09
as.factor(month)9	0.21	0.11	1.87	0.06
as.factor(month)10	0.52	0.08	6.68	0.00
as.factor(month)11	0.50	0.07	6.65	0.00

Table 1, estimated co-efficients for striped marlin

	Estimate	Std.Err.	z value	P
(Intercept)	−4.02	0.10	−38.45	0.00
as.factor(branch.no)2	0.93	0.04	24.21	0.00
as.factor(branch.no)3	1.51	0.04	42.00	0.00
as.factor(branch.no)4	1.85	0.04	52.66	0.00
as.factor(branch.no)5	2.04	0.03	58.92	0.00
as.factor(branch.no)6	2.07	0.03	60.07	0.00
as.factor(branch.no)7	1.98	0.03	57.12	0.00
as.factor(branch.no)8	1.94	0.03	55.81	0.00
as.factor(branch.no)9	1.85	0.04	52.90	0.00
as.factor(branch.no)10	1.66	0.04	46.60	0.00
as.factor(branch.no)11	1.26	0.04	34.20	0.00
as.factor(branch.no)12	0.72	0.04	18.06	0.00
as.factor(branch.no)13	−0.07	0.05	−1.55	0.12
bn	0.01	0.00	16.51	0.00
lat	0.01	0.00	6.77	0.00
as.factor(year)2001	0.08	0.02	5.19	0.00
as.factor(year)2002	0.25	0.02	16.73	0.00
as.factor(year)2003	−0.03	0.02	−1.49	0.14
as.factor(year)2004	0.36	0.02	23.73	0.00
as.factor(year)2005	−0.17	0.02	−9.93	0.00
as.factor(year)2006	0.08	0.02	5.08	0.00
hooks	0.00	0.00	26.16	0.00
as.factor(month)2	0.00	0.02	−0.02	0.99
as.factor(month)3	−0.13	0.05	−2.73	0.01
as.factor(month)4	−1.24	0.09	−13.69	0.00
as.factor(month)5	0.00	0.02	−0.13	0.90
as.factor(month)6	−0.36	0.02	−15.27	0.00
as.factor(month)7	−0.75	0.22	−3.40	0.00
as.factor(month)9	−0.30	0.04	−8.50	0.00
as.factor(month)10	−0.24	0.03	−7.92	0.00
as.factor(month)11	−0.24	0.03	−7.97	0.00
as.factor(month)12	−2.05	1.00	−2.05	0.04

Table 2, estimated co-efficients for big-eye tuna

	Estimate	Std. Err.	z value	P
(Intercept)	−0.73	0.09	−7.93	0.00
as.factor(branch.no)2	0.37	0.06	5.97	0.00
as.factor(branch.no)3	0.51	0.06	8.35	0.00
as.factor(branch.no)4	0.32	0.06	5.14	0.00
as.factor(branch.no)5	0.26	0.06	4.04	0.00
as.factor(branch.no)6	0.03	0.07	0.47	0.64
as.factor(branch.no)7	0.02	0.07	0.24	0.81
as.factor(branch.no)8	−0.07	0.07	−1.07	0.28
as.factor(branch.no)9	0.12	0.07	1.87	0.06
as.factor(branch.no)10	0.18	0.06	2.78	0.01
as.factor(branch.no)11	0.23	0.06	3.51	0.00
as.factor(branch.no)12	0.32	0.06	5.05	0.00
as.factor(branch.no)13	0.06	0.07	0.93	0.35
lat	−0.02	0.00	−5.67	0.00
as.factor(year)2001	−0.08	0.05	−1.66	0.10
as.factor(year)2002	0.71	0.04	17.58	0.00
as.factor(year)2003	−0.36	0.06	−6.03	0.00
as.factor(year)2004	0.20	0.05	4.42	0.00
as.factor(year)2005	0.05	0.05	1.08	0.28
as.factor(year)2006	0.08	0.05	1.70	0.09
as.factor(month)2	0.03	0.04	0.79	0.43
as.factor(month)3	−0.07	0.11	−0.60	0.55
as.factor(month)4	−0.32	0.10	−3.03	0.00
as.factor(month)5	−0.36	0.05	−7.04	0.00
as.factor(month)6	−0.34	0.05	−6.15	0.00
as.factor(month)7	−1.85	0.71	−2.61	0.01
as.factor(month)9	−0.72	0.12	−5.97	0.00
as.factor(month)10	−0.67	0.08	−8.38	0.00
as.factor(month)11	−0.57	0.07	−8.43	0.00

Table 3, estimated co-efficients for yellowfin tuna

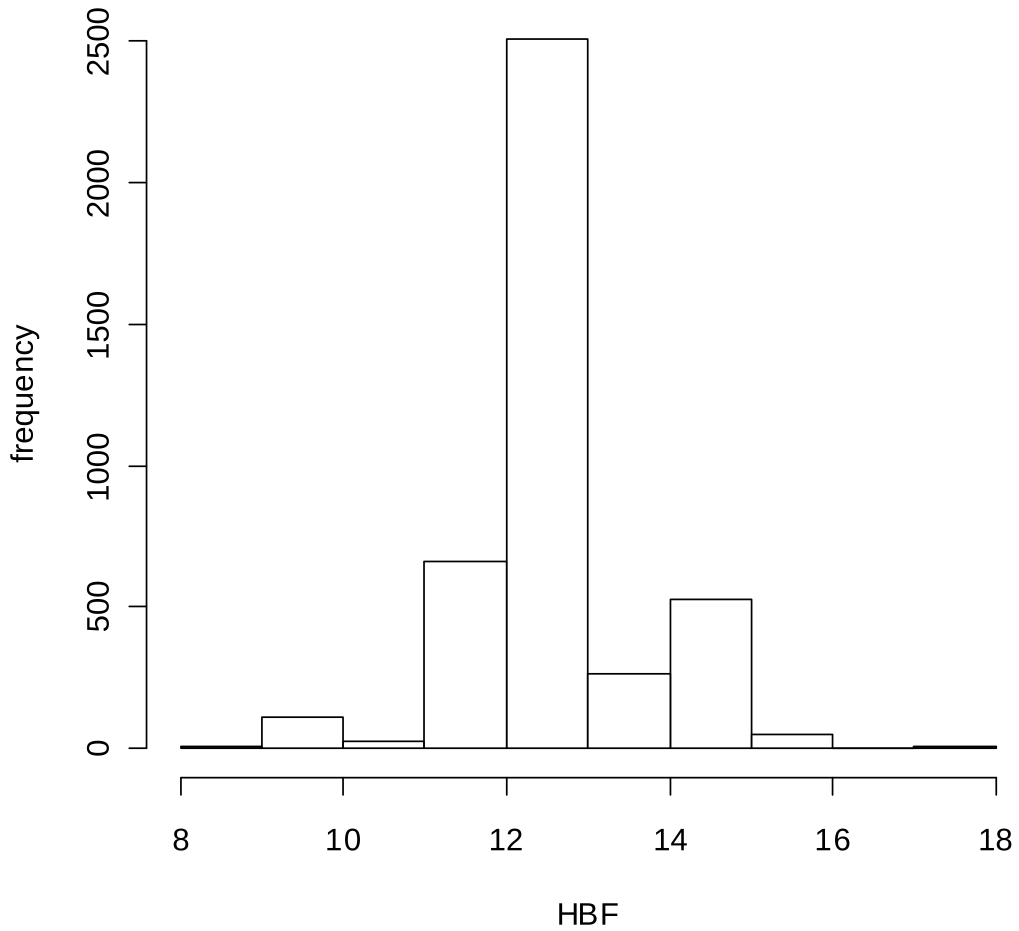

Fig. 1 The histogram of hooks between floats (HBF).

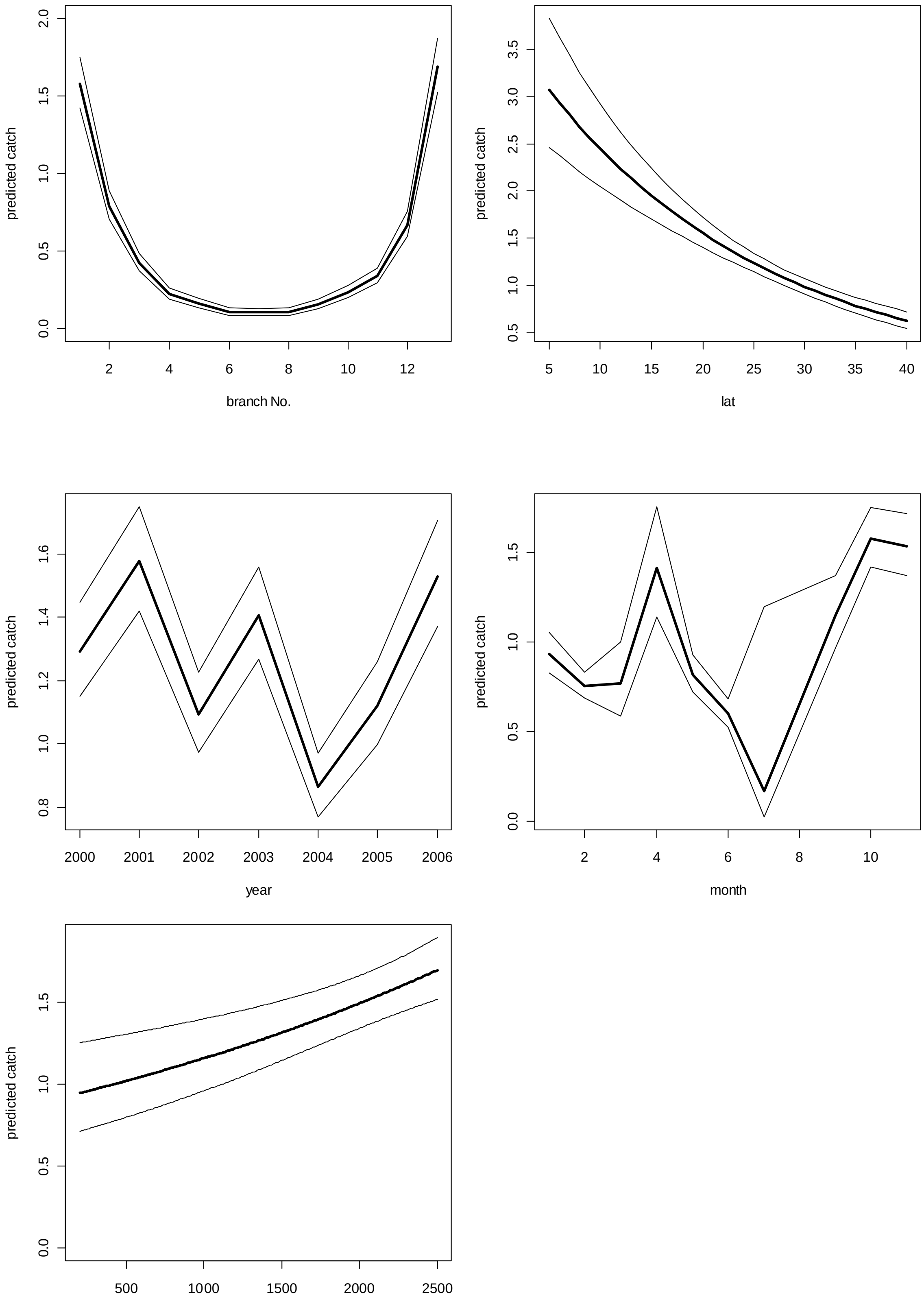

Fig. 2. Estimated relative catch for each explaining variables of striped marlin.

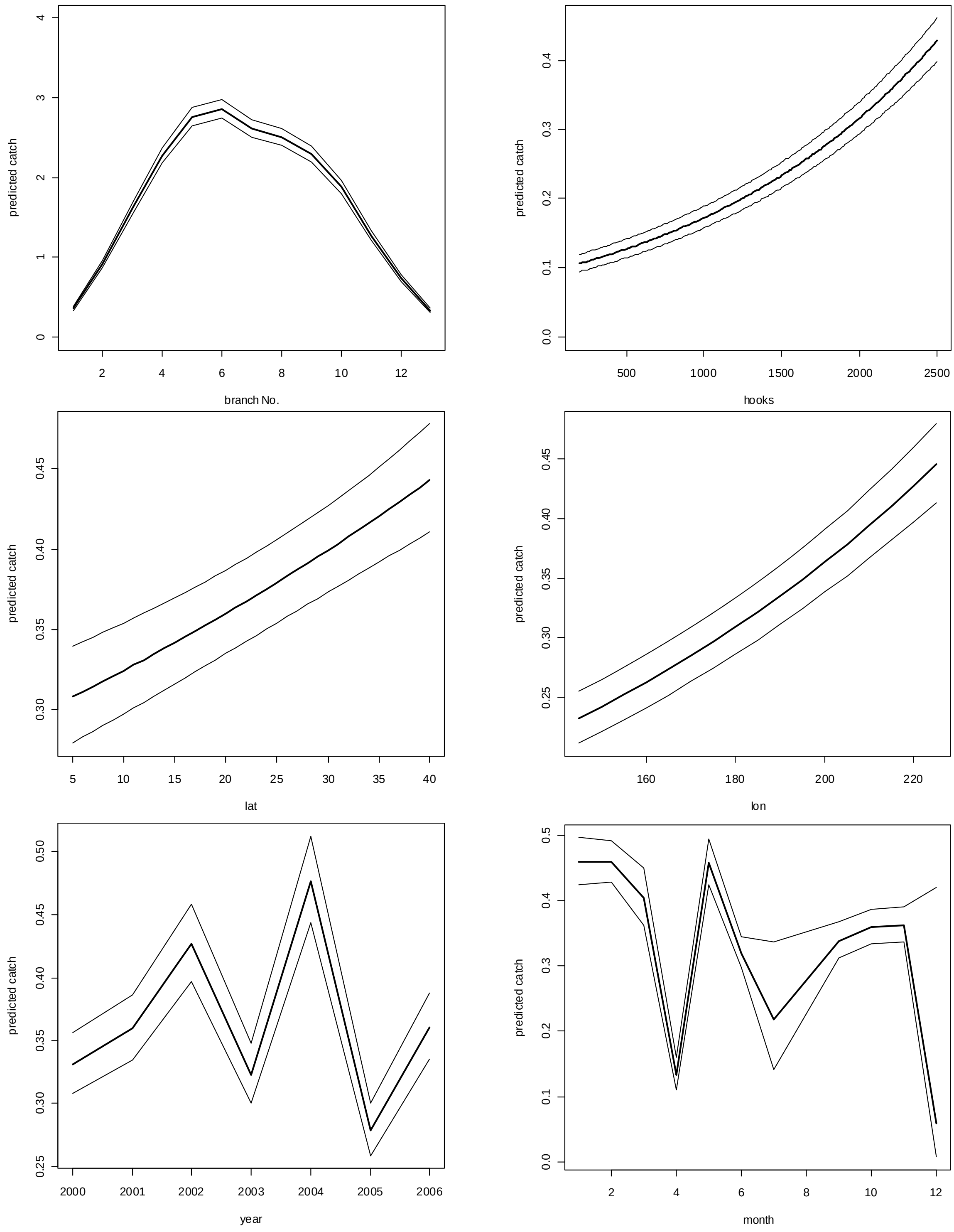

Fig. 3. Estimated relative catch for each explaining variables of big-eye tuna

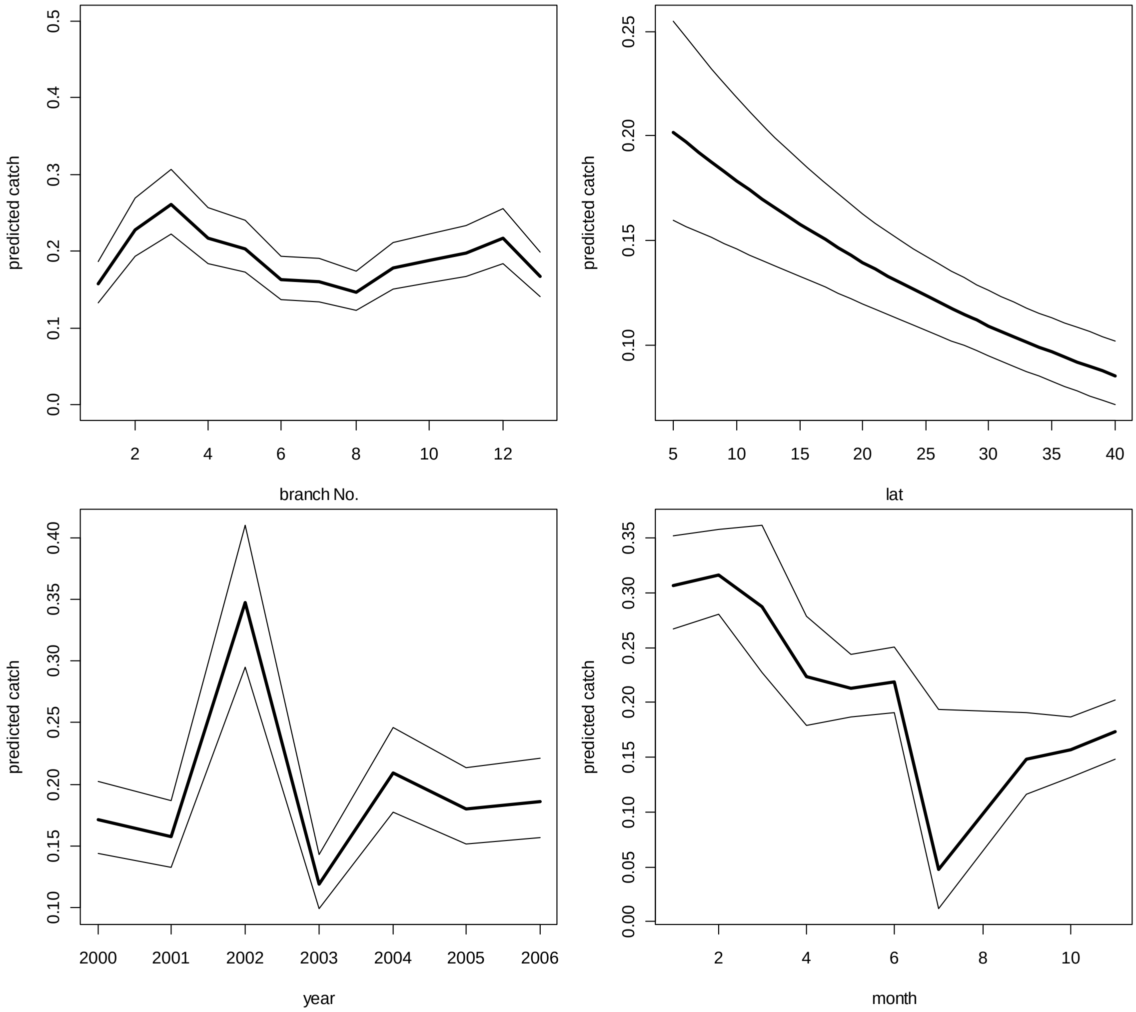

Fig. 4. Estimated relative catch for each explaining variables of yellow-fin tuna