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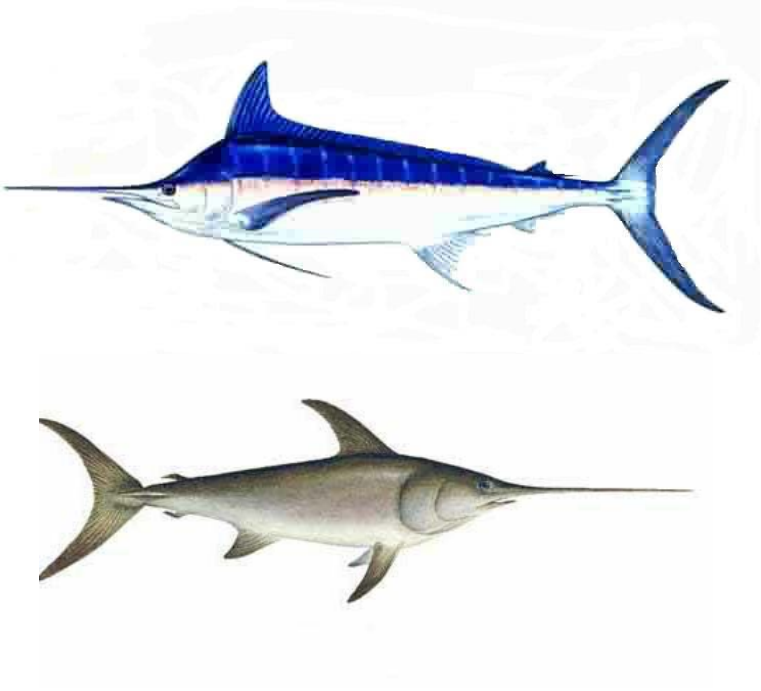
The evaluation of removing hook adjacent to floats for catch amount

Minoru Kanaiwa
Tokyo University of Agriculture
196 Yasaka, Abashiri, Hokkaido, 099-2493, Japan

Keith Bigelow
NOAA National Marine Fisheries Service
Pacific Islands Fisheries Science Center
2570 Dole St., Honolulu, Hawaii 96822 USA

Kotaro Yokawa
National Research Institute of Far Seas Fisheries
5-7-1 Orido, Shimizu, Shizuoka, 424-8633 Japan



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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, Blue marlin, Sword fish, Bigeye tuna, Yellowfin tuna and Albacore) 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 get precise estimates of the effect of loss of 1st and 2nd hooks adjacent to float on the catch ability on major tunas and billfishes. By this analysis, for billfishes this method will reduce more catch amount rather than tunas. However if removing both 1st and 2nd hooks make 10-20% reduction of catch amount. In same time, the reduction ratio of each operation has big differences and there is the probability the size composition of catch affect to the reduction ratio. Future studies are required.

Introduction

The issue 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. In this paper we try to evaluate the removing hook adjacent to float as the method applied on the data of the Japanese training vessel by using simple numerical calculation.

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. Separated area by 20N degree latitude because of operation pattern (Kanaiwa et. al. 2008a) is used for this analysis.

Methods

Following calculation is applied for each operation.

$R_{i,j,k}$ = the catch by the 1st- *i*th hooks adjacent to float of the *j*th operation for species *k*.

$T_{j,k}$ = total catch by the *j*th operation for species *k*

$r_{i,j,k}$ = reduction ratio by removing the 1st - *i*th hooks adjacent to float of the *j*th

operation for species *k*: $r_{i,j,k} = \frac{R_{i,j,k}}{T_{j,k}}$. In other word, $r_{i,j,k}$=1 means 100% percentage of catch was reduced by this method and $r_{i,j,k}$=0 means there is no effect to the catch amount by this method.

The reduction ratio is used to evaluate the efficiency. Considered species are Striped marlin, Blue marlin, Sword fish, Bigeye tuna, Yellowfin tuna and Albacore.

Two scenarios, i.e. removing only 1st hook adjacent to float and 1st and 2nd hooks adjacent to float are evaluated.

Result and discussion

The operation numbers are 1672 and 2177 for North and South, respectively and the hook's numbers are 3553594 and 4617055 for North and South, respectively.

For Striped marlin, about 45% of the total catch can be decreased by removing 1st hook adjacent to float, averagely. There is not big annual and seasonal different but slightly higher reduction ratio is in northern area rather than southern area (Table 1a). By removing both 1st and 2nd hook, the removing ratio becomes about 70% (Table 2a). For Blue marlin and Sword fish, the trends of results are similar with the one for Striped marlin (Table 1d,f and 2d,f). For Yellowfin Tuna and Albacore, by removing only 1st hook, there is almost no effect to their catch amount but by removing both 1st and 2nd hook, the reduction ratios become between about 10-20%. For Bigeye Tuna, there is almost no effect by both scenarios. These results is quite match with the results of previous studies on the vertical distribution patterns or vertical CPUE pattern of tunas and billfishes (e.g., Kanaiwa et al. 2008b).

The average reduction ratio of Striped marlin is high but the distribution of reduction ratio is not normal distribution (Table 3a) i.e. some operation will be able to reduce all of their catch but others cannot reduce any catch. This should suggest that the multiple hooking patterns of striped marlin in the season/area analyzed. The factorial analysis will be required.

Especially, the interaction effect between spatial and seasonal factors should be analyzed. To apply this method actually, the analysis which is included habitat environmental factors is required. There is a study which shows the habitat preference may change by individual's size in same species (Shimose, et al. 2006). In such a case, the evaluation of this method should be included the size distribution of catch. These are future works.

References

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Table 1a annual and seasonal trend of reduction ratio for Striped Marlin by removing 1st hook

year	total	north	south
2000	0.471	0.507	0.447
2001	0.558	0.537	0.577
2002	0.427	0.538	0.380
2003	0.437	0.508	0.354
2004	0.492	0.541	0.412
2005	0.467	0.500	0.414
2006	0.490	0.545	0.455

month	total	north	south
1	0.387	0.486	0.382
2	0.438	0.404	0.439
3	0.391	−	0.391
4	0.404	0.489	0.310
5	0.459	−	0.459
6	0.509	−	0.509
7	0.286	−	0.286
9	0.602	0.602	−
10	0.528	0.529	0.391
11	0.471	0.477	0.429
12	0.474	0.500	0.444

Table 1b annual and seasonal trend of reduction ratio for Yellowfin Tuna by removing 1st hook

year	total	north	south
2000	0.179	0.325	0.157
2001	0.151	0.206	0.143
2002	0.114	0.204	0.109
2003	0.142	0.191	0.129
2004	0.119	0.199	0.104
2005	0.131	0.207	0.112
2006	0.135	0.276	0.112

moth	total	north	south
1	0.111	0.211	0.109
2	0.111	0.149	0.110
3	0.167	−	0.167
4	0.159	0.273	0.121
5	0.128	−	0.128
6	0.151	−	0.151
7	0.119	−	0.119
9	0.286	0.286	−
10	0.231	0.239	0.121
11	0.154	0.189	0.121
12	0.147	0.083	0.182

Table 1c annual and seasonal trend of reduction ratio for Albacore by removing 1st hook

year	total	north	south
2000	0.064	0.072	0.054
2001	0.048	0.065	0.047
2002	0.072	0.037	0.082
2003	0.055	0.032	0.070
2004	0.039	0.057	0.037
2005	0.030	0.108	0.021
2006	0.055	0.114	0.053

month	total	north	south
1	0.040	0.041	0.040
2	0.043	0.024	0.045
3	0.091	–	0.091
4	0.039	0.014	0.051
5	0.067	–	0.067
6	0.056	–	0.056
7	0.000	–	0.000
9	0.072	0.072	–
10	0.095	0.097	0.050
11	0.057	0.055	0.063
12	0.018	0.000	0.024

Table 1d annual and seasonal trend of reduction ratio for Blue Marlin by removing 1st hook

year	total	north	south
2000	0.357	0.633	0.339
2001	0.342	0.315	0.345
2002	0.332	0.432	0.325
2003	0.364	0.333	0.368
2004	0.314	0.271	0.317
2005	0.376	0.458	0.366
2006	0.375	0.500	0.365

month	total	north	south
1	0.409	1.000	0.403
2	0.352	0.333	0.352
3	0.333	–	0.333
4	0.407	0.333	0.412
5	0.340	–	0.340
6	0.339	–	0.339
7	0.231	–	0.231
9	0.404	0.404	–
10	0.394	0.396	0.385
11	0.305	0.405	0.284
12	0.571	–	0.571

Table 1e annual and seasonal trend of reduction ratio for Bigeye Tuna by removing 1st hook

year	total	north	south
2000	0.037	0.043	0.033
2001	0.037	0.034	0.039
2002	0.039	0.041	0.038
2003	0.036	0.040	0.033
2004	0.032	0.034	0.031
2005	0.029	0.039	0.018
2006	0.031	0.029	0.032

month	total	north	south
1	0.029	0.041	0.029
2	0.032	0.042	0.031
3	0.043	–	0.043
4	0.023	0.040	0.021
5	0.031	–	0.031
6	0.038	–	0.038
7	0.083	–	0.083
9	0.043	0.043	–
10	0.036	0.036	0.032
11	0.026	0.025	0.039
12	0.041	0.043	0.021

Table 1f annual and seasonal trend of reduction ratio for Swordfish by removing 1st hook

year	total	north	south
2000	0.115	0.195	0.098
2001	0.196	0.353	0.109
2002	0.170	0.339	0.110
2003	0.179	0.333	0.096
2004	0.096	0.305	0.045
2005	0.258	0.493	0.103
2006	0.177	0.269	0.128

month	total	north	south
1	0.092	0.000	0.093
2	0.111	0.333	0.109
3	0.167	–	0.167
4	0.500	0.000	1.000
5	0.064	–	0.064
6	0.094	–	0.094
7	0.000	–	0.000
9	0.336	0.336	–
10	0.335	0.343	0.258
11	0.241	0.293	0.118
12	–	–	–

Table 2a annual and seasonal trend of reduction ratio for Striped Marlin by removing 1-2nd hooks

year	total	north	south
2000	0.693	0.736	0.664
2001	0.750	0.752	0.748
2002	0.652	0.763	0.606
2003	0.683	0.748	0.608
2004	0.719	0.767	0.639
2005	0.679	0.727	0.603
2006	0.706	0.754	0.676

month	total	north	south
1	0.596	0.657	0.593
2	0.646	0.596	0.647
3	0.652	–	0.652
4	0.640	0.723	0.548
5	0.690	–	0.690
6	0.713	–	0.713
7	0.286	–	0.286
9	0.779	0.779	–
10	0.746	0.748	0.609
11	0.748	0.754	0.704
12	0.789	0.850	0.722

Table 2b annual and seasonal trend of reduction ratio for Yellowfin Tuna by removing 1-2nd hooks

year	total	north	south
2000	0.357	0.531	0.331
2001	0.345	0.423	0.334
2002	0.276	0.415	0.268
2003	0.340	0.404	0.322
2004	0.305	0.424	0.283
2005	0.293	0.391	0.267
2006	0.319	0.505	0.288

moth	total	north	south
1	0.268	0.421	0.265
2	0.275	0.276	0.275
3	0.383	–	0.383
4	0.352	0.545	0.288
5	0.298	–	0.298
6	0.356	–	0.356
7	0.286	–	0.286
9	0.536	0.536	–
10	0.430	0.441	0.276
11	0.361	0.408	0.315
12	0.353	0.417	0.318

Table 2c annual and seasonal trend of reduction ratio for Albacore by removing 1-2nd hooks

year	total	north	south
2000	0.204	0.208	0.199
2001	0.150	0.278	0.142
2002	0.188	0.137	0.203
2003	0.170	0.140	0.190
2004	0.131	0.143	0.130
2005	0.112	0.229	0.097
2006	0.146	0.286	0.143

month	total	north	south
1	0.144	0.148	0.143
2	0.140	0.129	0.140
3	0.227	−	0.227
4	0.112	0.057	0.140
5	0.179	−	0.179
6	0.184	−	0.184
7	0.200	−	0.200
9	0.275	0.275	−
10	0.245	0.251	0.100
11	0.152	0.151	0.154
12	0.140	0.200	0.119

Table 2d annual and seasonal trend of reduction ratio for Blue Marlin by removing 1-2nd hooks

year	total	north	south
2000	0.544	0.733	0.532
2001	0.563	0.426	0.580
2002	0.535	0.649	0.528
2003	0.594	0.550	0.600
2004	0.570	0.521	0.574
2005	0.580	0.644	0.572
2006	0.569	0.700	0.559

month	total	north	south
1	0.597	1.000	0.594
2	0.562	0.667	0.562
3	0.667	−	0.667
4	0.593	0.333	0.608
5	0.568	−	0.568
6	0.564	−	0.564
7	0.487	−	0.487
9	0.577	0.577	−
10	0.570	0.573	0.538
11	0.498	0.667	0.462
12	0.857	−	0.857

Table 2e annual and seasonal trend of reduction ratio for Bigeye Tuna by removing 1-2nd hooks

year	total	north	south
2000	0.120	0.120	0.120
2001	0.115	0.105	0.122
2002	0.123	0.123	0.124
2003	0.119	0.136	0.109
2004	0.105	0.109	0.102
2005	0.093	0.113	0.071
2006	0.100	0.103	0.096

month	total	north	south
1	0.098	0.097	0.098
2	0.101	0.120	0.101
3	0.127	−	0.127
4	0.110	0.080	0.113
5	0.105	−	0.105
6	0.132	−	0.132
7	0.207	−	0.207
9	0.129	0.129	−
10	0.112	0.112	0.112
11	0.097	0.097	0.104
12	0.122	0.123	0.106

Table 2f annual and seasonal trend of reduction ratio for Swordfish by removing 1-2nd hooks

year	total	north	south
2000	0.238	0.366	0.211
2001	0.315	0.471	0.228
2002	0.315	0.500	0.249
2003	0.321	0.547	0.201
2004	0.199	0.475	0.132
2005	0.331	0.592	0.159
2006	0.260	0.403	0.184

year	total	north	south
1	0.204	0.000	0.206
2	0.181	0.333	0.180
3	0.333	−	0.333
4	0.500	0.000	1.000
5	0.160	−	0.160
6	0.199	−	0.199
7	0.400	−	0.400
9	0.455	0.455	−
10	0.504	0.516	0.387
11	0.431	0.463	0.353
12	−	−	−

Table 3 The histogram of operation number depend on reduction ratio by removing 1st hook. a: Striped Marlin, b: Yellowfin Tuna, c: Albacore, d: Blue Marlin, e: Bigeye Tuna, f: Swordfish

a. Striped Marlin

reduction ratio	operation number	the ratio of operation
0.9–1.0	618	0.252
0.8–0.9	44	0.018
0.7–0.8	84	0.034
0.6–0.7	199	0.081
0.5–0.6	391	0.160
0.4–0.5	93	0.038
0.3–0.4	190	0.078
0.2–0.3	131	0.053
0.1–0.2	40	0.016
0.0–0.1	660	0.269

b. Yellowfin Tuna

reduction ratio	operation number	the ratio of operation
0.9–1.0	170	0.076
0.8–0.9	0	0.000
0.7–0.8	5	0.002
0.6–0.7	27	0.012
0.5–0.6	128	0.057
0.4–0.5	28	0.012
0.3–0.4	124	0.055
0.2–0.3	169	0.075
0.1–0.2	177	0.079
0.0–0.1	1422	0.632

c. Albacore

reduction ratio	operation number	the ratio of operation
0.9–1.0	36	0.025
0.8–0.9	0	0.000
0.7–0.8	0	0.000
0.6–0.7	3	0.002
0.5–0.6	35	0.024
0.4–0.5	4	0.003
0.3–0.4	31	0.021
0.2–0.3	42	0.029
0.1–0.2	110	0.076
0.0–0.1	1182	0.819

Table 3 continue

d. Blue Marlin

reduction ratio	operation number	the ratio of operation
0.9–1.0	372	0.231
0.8–0.9	2	0.001
0.7–0.8	15	0.009
0.6–0.7	64	0.040
0.5–0.6	198	0.123
0.4–0.5	32	0.020
0.3–0.4	99	0.061
0.2–0.3	85	0.053
0.1–0.2	27	0.017
0.0–0.1	717	0.445

e. Bigeye Tuna

reduction ratio	operation number	the ratio of operation
0.9–1.0	2	0.001
0.8–0.9	0	0.000
0.7–0.8	0	0.000
0.6–0.7	0	0.000
0.5–0.6	2	0.001
0.4–0.5	3	0.001
0.3–0.4	14	0.004
0.2–0.3	43	0.011
0.1–0.2	317	0.084
0.0–0.1	3405	0.899

f. Swordfish

reduction ratio	operation number	the ratio of operation
0.9–1.0	146	0.137
0.8–0.9	0	0.000
0.7–0.8	3	0.003
0.6–0.7	3	0.003
0.5–0.6	58	0.055
0.4–0.5	1	0.001
0.3–0.4	18	0.017
0.2–0.3	5	0.005
0.1–0.2	3	0.003
0.0–0.1	827	0.777

Table 4 The histogram of operation number depend on reduction ratio by removing 1-2nd hooks. a: Striped Marlin, b: Yellowfin Tuna, c: Albacore, d: Blue Marlin, e: Bigeye Tuna, f: Swordfish

a. Striped Marlin

reduction ratio	operation number	the ratio of operation
0.9–1.0	1137	0.464
0.8–0.9	136	0.056
0.7–0.8	138	0.056
0.6–0.7	227	0.093
0.5–0.6	302	0.123
0.4–0.5	43	0.018
0.3–0.4	87	0.036
0.2–0.3	48	0.020
0.1–0.2	6	0.002
0.0–0.1	326	0.133

b. Yellowfin Tuna

reduction ratio	operation number	the ratio of operation
0.9–1.0	398	0.177
0.8–0.9	12	0.005
0.7–0.8	25	0.011
0.6–0.7	114	0.051
0.5–0.6	267	0.119
0.4–0.5	93	0.041
0.3–0.4	230	0.102
0.2–0.3	244	0.108
0.1–0.2	124	0.055
0.0–0.1	743	0.330

c. Albacore

reduction ratio	operation number	the ratio of operation
0.9–1.0	110	0.076
0.8–0.9	0	0.000
0.7–0.8	4	0.003
0.6–0.7	26	0.018
0.5–0.6	95	0.066
0.4–0.5	27	0.019
0.3–0.4	88	0.061
0.2–0.3	139	0.096
0.1–0.2	182	0.126
0.0–0.1	772	0.535

d. Blue Marlin

reduction ratio	operation number	the ratio of operation
0.9–1.0	651	0.404
0.8–0.9	26	0.016
0.7–0.8	46	0.029
0.6–0.7	108	0.067
0.5–0.6	226	0.140
0.4–0.5	27	0.017
0.3–0.4	74	0.046
0.2–0.3	45	0.028
0.1–0.2	6	0.004
0.0–0.1	402	0.250

e. Bigeye Tuna

reduction ratio	operation number	the ratio of operation
0.9–1.0	10	0.003
0.8–0.9	0	0.000
0.7–0.8	1	0.000
0.6–0.7	13	0.003
0.5–0.6	25	0.007
0.4–0.5	28	0.007
0.3–0.4	118	0.031
0.2–0.3	432	0.114
0.1–0.2	1198	0.316
0.0–0.1	1961	0.518

f. Swordfish

reduction ratio	operation number	the ratio of operation
0.9–1.0	256	0.241
0.8–0.9	0	0.000
0.7–0.8	3	0.003
0.6–0.7	8	0.008
0.5–0.6	78	0.073
0.4–0.5	3	0.003
0.3–0.4	26	0.024
0.2–0.3	12	0.011
0.1–0.2	6	0.006
0.0–0.1	672	0.632