Inference on nature of Atlantic bluefin tuna off Brazil caught by Japanese longline fishery around the early 1960s

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Abstract

Available literatures and relevant data were reviewed and analyzed to make insight on nature of the bluefin captured by the Japanese longline fishery which appeared suddenly and virtually disappeared in about 10 years with a substantial catch around the early 1960s. Changes in time/area of the Japanese longline operations by 1 degree square and month indicated migration probably for spawning to the Gulf of Mexico and adjacent waters and further north to New England waters of the USA followed by return migration to Brazil-Central tropical Atlantic in autumn and then, further southward movement to Argentine waters. Among several hypotheses that were proposed to explain this event, temporal distribution hypothesis (similar to the concept of metapopulation) seems to be most viable one. Comparative study with Pacific bluefin fisheries shows that the similar events seem to have occurred also in the Pacific. For further investigations with this hypothesis data mining of the old Japanese longline fishery around this time period should be made, especially for size data. If this hypothesis is proven valid, there could be a significant implication both to science and to management of bluefin tuna.

Introduction

There has been a strong interest to the peculiarity of the Atlantic bluefin tuna fishery conducted by the Japanese longline boats around the 1960s. The fishery started its operation in the Atlantic around Venezuela-Brazilian waters from the latter half of 1956 targeting yellowfin and albacore in the tropical waters for export to can industry and encountered bluefin that was not target tunas at that time. Within a few years the catch of bluefin increased rapidly reaching a peak in 1964 about 13000 mt but virtually disappeared from the longline catch by 1970. After this event, there reported almost no bluefin tuna catch from the South Atlantic. Due to very limited information other than catch (in number of fish) and effort (in number of hooks) statistics of this fishery coupled with patchy information about bluefin fisheries by other countries at that period, only a few papers dealt with this event in emphasis on stock structure and migration of the

Atlantic bluefin tuna, e.g.,Wise and Davis (1973), Shiohama et al. (1965), Mather et al, (1995), Takeuchi et al (1999). This paper, through reviewing what is know, reanalyzed the Japanese longline catch and effort statistics with other fragmental information on this fishery and infers major migratory pattern of bluefin tuna at that period and proposes working hypothesis on the nature of bluefin tuna captured by this fishery.

Materials and methods

Catch and effort statistic of the Japanese longline fishery were used for the period from 1956 to 1970 which roughly cover the occurrence of Atlantic bluefin tuna in the tropical waters off Brazil-Central Atlantic. Time and area resolution of the catch and effort statistics is moths and 1 degree squares. There remains some concern about species discrimination between bluefin and southern bluefin because no entry code for southern bluefin tuna was given until 1966, However, preliminary check by scientists was made for species discrimination in compiling the catch and effort statistics by moth/1degree. In addition, there would not be serious problem for species identification in the tropical, subtropical and warmer temperate waters of the Atlantic, i.e., north of 30 S because of rare distribution of southern bluefin tuna. Shift of apparent abundance expressed by hook rates, catch in number of bluefin tuna per 1000 hooks, was used for inference of migration.

Results

Over all distribution of catch and effort during this epoch period is shown in Fig. 1. Major distribution of bluefin catch and that of fishing effort differs significantly, indicating yellowfin and albacore were targeted and bluefin was not the target species at this period. Catch of the bluefin extends a substantially larger area than so called "Off Brazil bluefin" covering almost entire tropical waters extending from South American coasts to African coasts with higher abundance centering on the Brazilian-Central Atlantic (west of about 30W). Low catch in the Gulf of Mexico seems to be an artifact caused by the fact that the Japanese longline boats scarcely operated in the Gulf during bluefin spawning months of April-May-June. Monthly change of fishing ground in terms of hook rates was shown in Fig. 2 illustrated by example of 1964 when the fishery was in peak. It should be noted that the changing pattern of catch rates are somewhat different each specific year from the 1964 example but the 1964 example most clearly shows continuous migratory pattern. Major change in 1964 is described briefly as follows:

*March-April : Concentrating in the waters off Brazil- Central Equatorial Atlantic from south Brazil-Argentinean waters

*May-June: Toward Gulf of Mexico and adjacent waters for spawning along the Caribbean waters (some may move toward the Canary-Moroccan waters (1962) although not clearly indicated)

*July-August: Further migration to US New England waters

*September-October: Returning from the North Atlantic to Brazil-Central Equatorial Atlantic, no clear indication of return migratory route but assumed to either taking reverse routes with spawning migration to the north or taking more offshore Central Atlantic rout.

*November-February: Move further south to south Brazil-Argentinean waters

The schematic migratory routes with months is shown in Figure 3

Discussion

The inferred migratory rout of the Atlantic bluefin tuna seems closely related to spawning and subsequent feeding migration mostly north-south direction along the north and south American continent. Tagging experiments made for giant bluefin tuna around the Bahamian waters during the roughly same period when the Japanese longline had been capturing the giant bluefin (between 160 cm and 260 cm with mean 220 cm according to Takeuchi et al. (1999) confirm basic interred routs as Mather et al. (1975) mentioned. Since the tagging experiments also show a clear connection of the giants between Bahamian waters and Norwegian waters, the fish captured by the Japanese longline fishery in the tropical waters, at least part of it, overlapped in the length composition of bluefin caught by the Norwegian purse seine fishery belong to the same population.

It is difficult to make inference with the giants distributed in the Mediterranean and Ibero-Moroccan waters as there were almost no Japanese longline operations covering those areas at that period. However, those areas are close to the marginal distribution of the extensive large core area with high density of bluefin. In addition, it has been known by tagging released from Norwegian waters that those giant are connected with the Ibero-Moroccan giants. Therefore, it is logical to assume that two different components from west and east Atlantic/Mediterranean stocks mixed in the purse seine caught giants during the same period with the Japanese longline operations.

Turning attention to the Pacific bluefin tuna and looking for if similar events with the Brazilian giant bluefin case, there are at least two cases (Nakamura 1965). They are shown in Fig. 3. Incidentally, both events occurred more or less in the similar periods. Although the two cases occurred in separated areas around the Japan, they showed a sudden appearance and disappearance with lasting fisheries about 10-15 years accompanied with a continuous increase of average size of the catch somewhat similar with the Norwegian purse seine case. It appears that these events in the Pacific occurred due more to natural factors than fishery stress since the fisheries at the period were not industrialized and opportunistic.

There are several possible explanations how this event occurred. Takeuchi et al. (1999) pointed out an array of possibilities:

1) Artifact, shift of fishing ground toward the higher CPUE area in the early period of fishery, 2)Seeped-out stock to the peripheral waters of major distribution area when the stock size is very large, 3)Transition of strong year class, 4) Local depression caused by the spike fishery, 5) Isolated independent stock, 6) Unknown environmental anomaly causative of this event. However, none of them were plausible for the authors. If analogy works, it is likely we see an increasing trend of average size or the transition of strong year class in bluefin tuna caught by the Japanese longline fishery in the Brazil-Central tropical Atlantic as seen elsewhere in the Atlantic and Pacific. Takeuchi et al (1999) dismissed "transition of strong year class" as no such trend was detected from the size data. However, size data relevant to the fishery is so small, less than 1 % of the total catch that it is not possible to ascertain whether or not such increasing trend of average size actually occurred. In other words, further data mining with the old Japanese longline data relevant to this fishery, if successful, will give answer. It is noted that size range of bluefin tuna caught in the Brazil-Central tropical Atlantic partly overlap with the size range of the purse seine caught bluefin in Norwegian waters as mentioned previously.

Finally, it seems that this kind of sudden change in distribution was observed only with the large fish. This implies spawning could be involved in the event. Like size data information, maturity information on the bluefin taken by the Japanese longline fishery during the period in question is almost none except for fragment comment such as "spent" in experimental cruise report made in that period in the Atlantic by Japan. Richards (1969) reported the occurrence of bluefin larvae from the Gulf of

Guinea during the same period of Brazil-Central tropical bluefin catch by the Japanese longliners. However, he noted that given relatively scarce occurrence of the bluefin larvae, this area would have minor importance, if any, as for spawning. Speculation can be made that a fraction of the Atlantic bluefin tuna spawned in the Brazil-Central tropical waters during the period but could neither sustain the spawning activities nor establish habitat there and South Atlantic. Northern bluefin often shows a conspicuous change in distribution not observed for other tunas. This trait could be interpreted as one of adaptive responses to the environments for diversification of more survival chances of the species as a whole. Related subject on the trait of bluefin stock structures is described in more sorted way by Fromentin and Powers (2005).

Conclusion

Although size data is lacking, it is likely giant bluefin the Japanese longline fishery exploited in relatively short period around 1960 in the tropical Atlantic has had the similar traits with other bluefin segments like the Norwegian purse seiners and some of the Pacific bluefin segments. At this stage, we are supportive of a working hypothesis that the stock exploited by the Japanese longline around 1960 was one of metapolulations that had merged with other metapolulations or become extinct.

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Captions for Figures:

Fig. 1. Over all area extent of Atlantic bluefin catch (upper panel:in number of fish) and fishing effort (lower panel: in number of hook) by Japanese longline fishery, cumulative 1959-1970

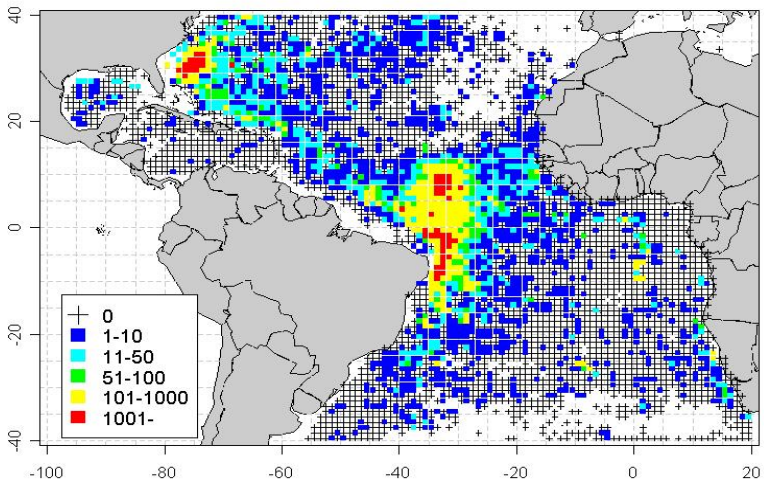
Fig. 2. Example of seasonal change of fishing ground expressed catch rate (No. fish per 1,000 hooks) by month and 1 degree squares in 1964 (April and May 1962 are shown for comparison)

Fig. 3. Schematic migratory routes inferred from change in CPUE shown in Figure 2.

Solid and dotted lines indicate observed movements in this paper and inferred movements, respectively. Numbers indicate months.

Fig. 4. Two examples of sudden appearance and disappearance of Pacific bluefin tuna around Japanese waters (After Nakamura, 1965)

Fig. 1.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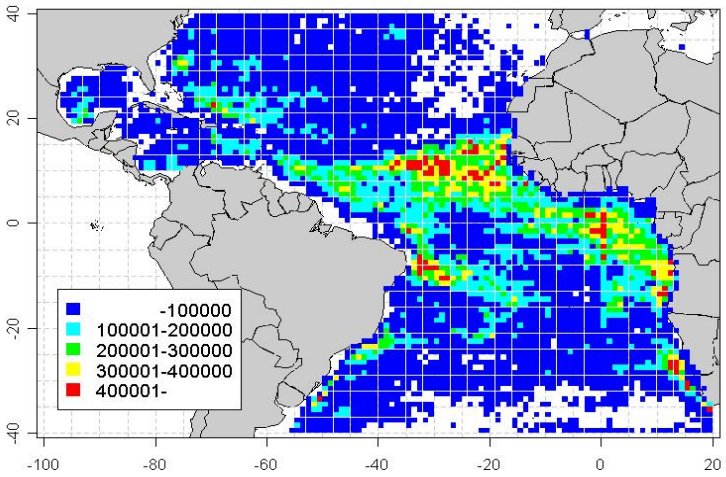
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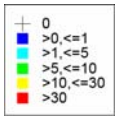
Fig.2.

Legend: Catch in No. of BFT/1000 hooks



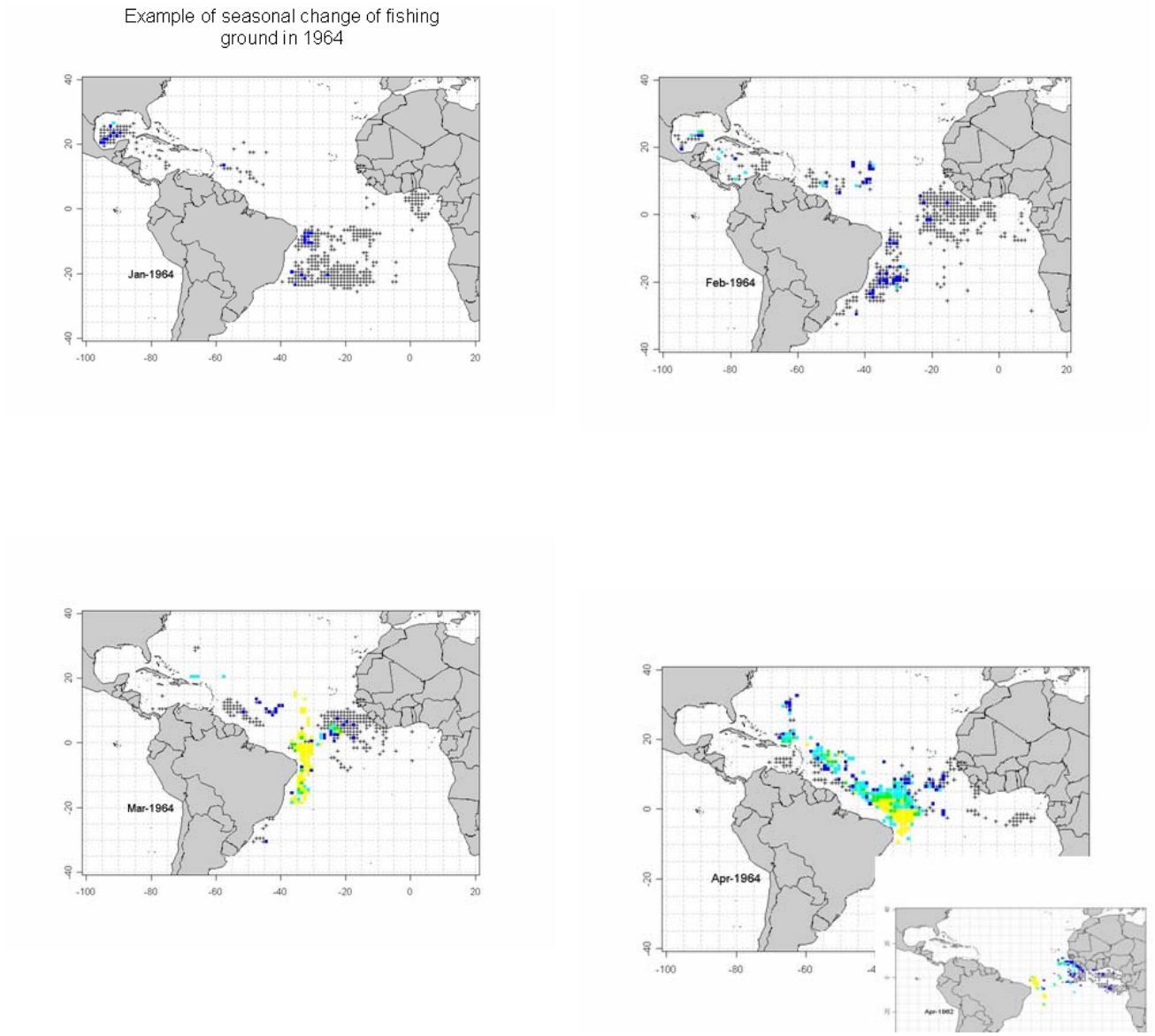
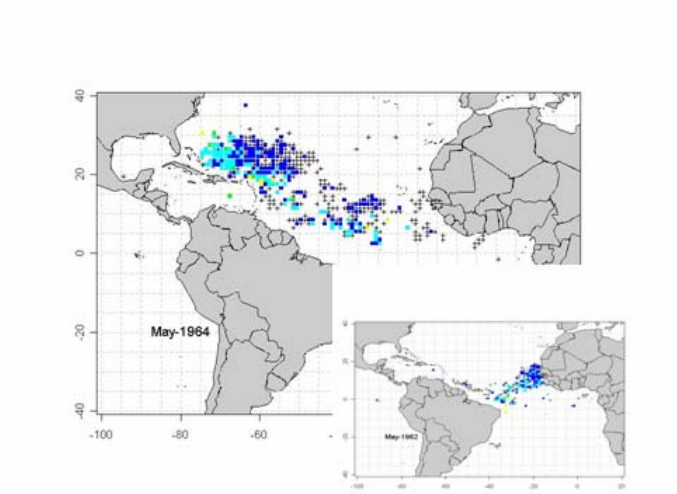
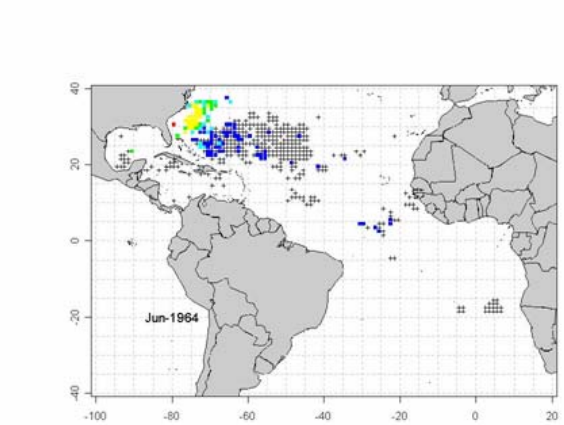
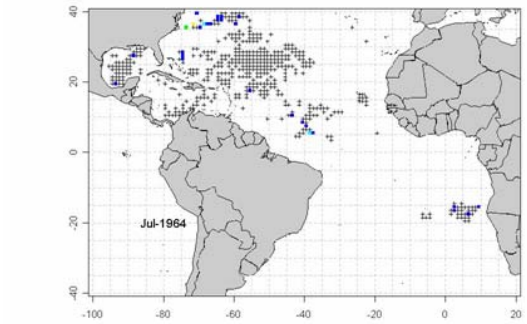


Fig. 2. …continued.







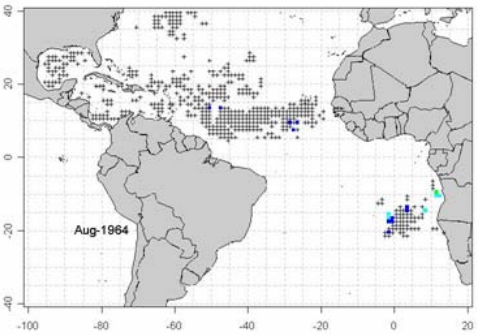


Fig. 2….continued.

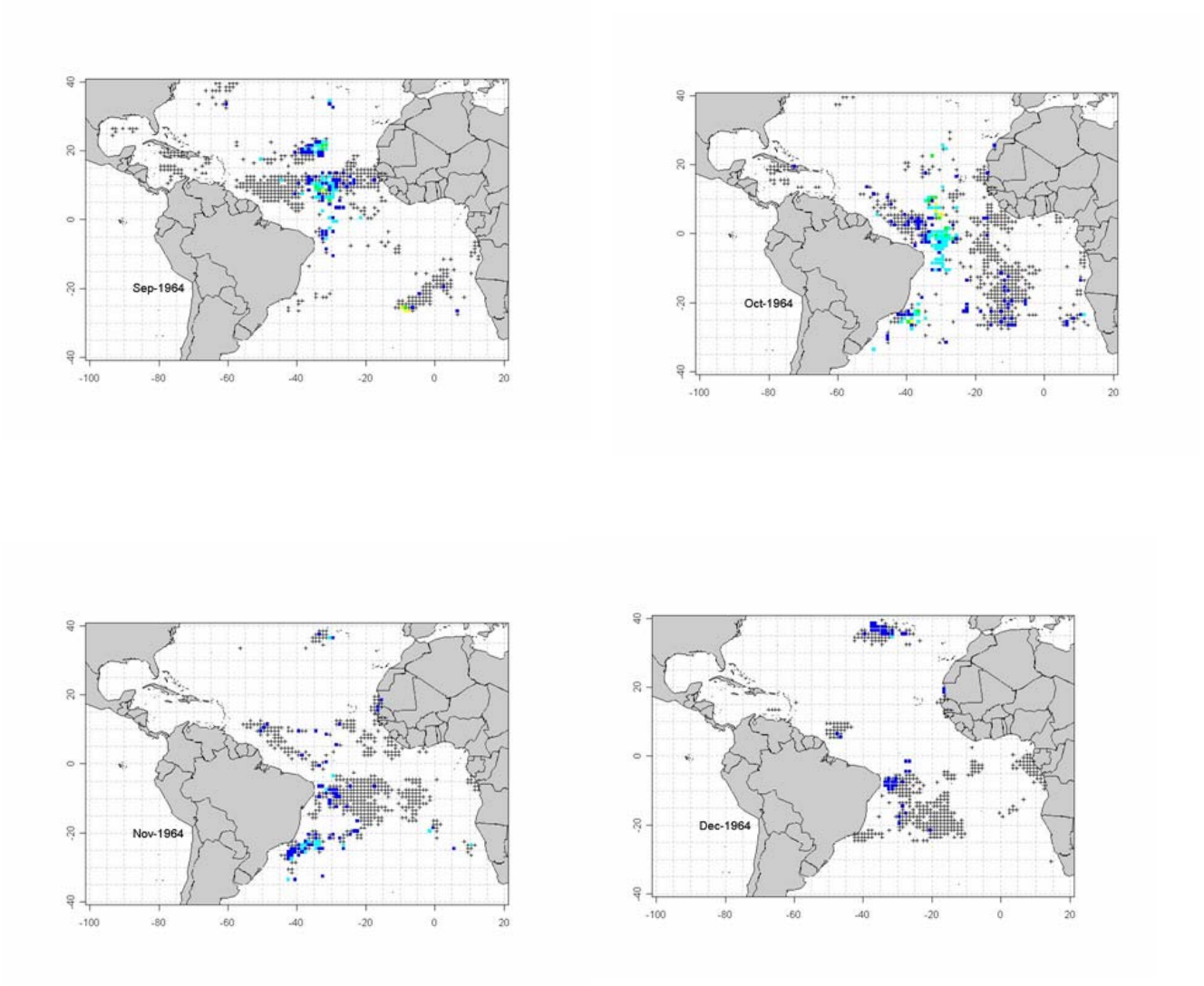


Fig.3.

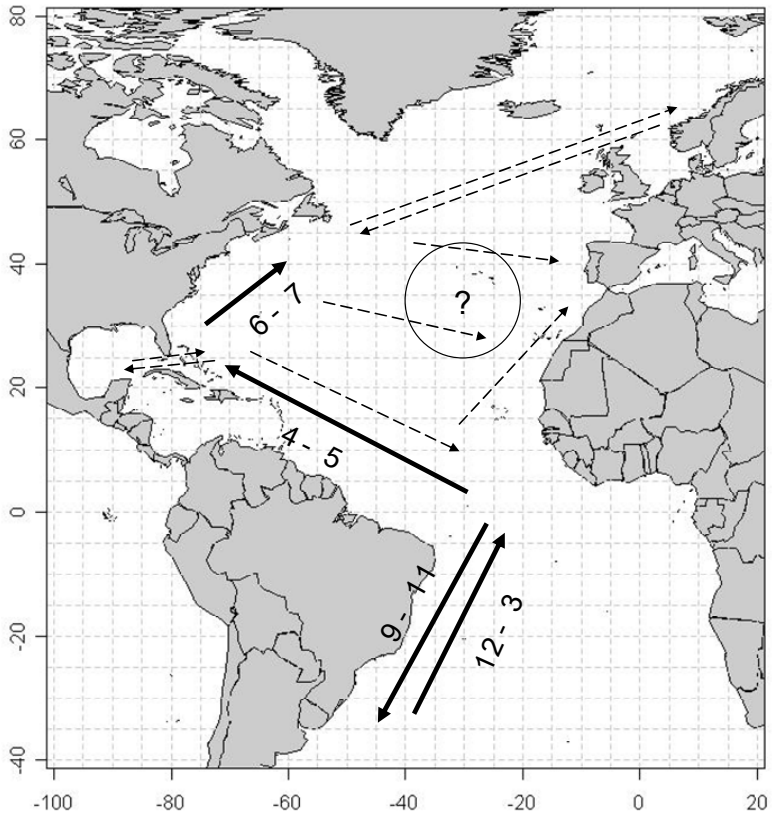
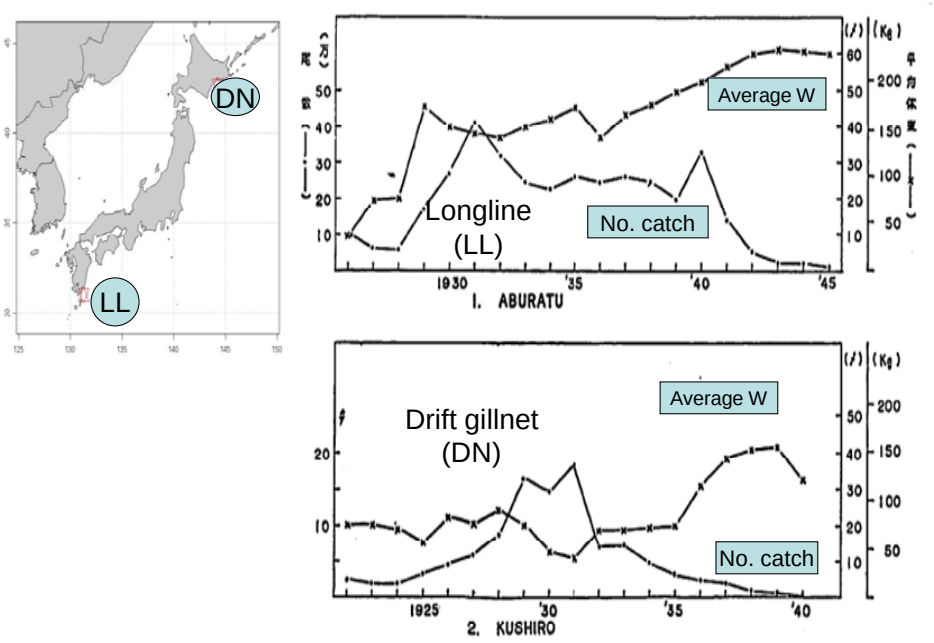


Fig. 4.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