Annex 12

SEMINAR: DYNAMICS OF RECRUITMENT OF FISH -PERSPECTIVES OF SURVIVAL STRATEGY OF PELAGIC FISH-

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

13-18 July 2016
Sapporo, Hokkaido Japan

Highlights of Japanese studies on population dynamics and early-life survival in small pelagic fishes in the Kuroshio/Oyashio ecosystem: Implications for management

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Japanese sardine (*Sardinops melanostictus*), anchovy (*Engraulis japonicus*) and chub mackerel (*Scomber japonicus*) in the Kuroshio/Oyashio ecosystem (KOE) are commercially important small pelagic fishes. Species replacements, associated with ocean/climate regime shifts, are well known through catch trajectories of these species. Overview of regime shifts in the Pacific Decadal Oscillation (PDO) and the North Pacific Gyre Oscillation (NPGO) and their mechanistic effects on KOE were presented. Recent studies on relationships between RPS or recruitment and sea surface temperatures and prey abundance based on pre-recruitment surveys in the Kuroshio/Oyashio Transition Zone in spring supported “growth-selective survival” hypothesis and “stage-duration” hypothesis in early-life stages for chub mackerel, and “optimum temperature” hypothesis for early-growth rates of sardine and anchovy that explains sardine/anchovy cycles. Variability in Kuroshio Extension path (and possibly velocity) affected transport of juvenile sardine and their subsequent recruitment. “Predator-specific growth-selective survival” hypothesis for anchovy larvae were also touched. Prey compositions of larvae and juveniles of sardine and anchovy were similar to each other and differed from those of chub mackerel, suggesting potential competitions for prey between sardine and anchovy larvae. Finally, implications of effects of fishing on RPS of chub mackerel, and a mismatch between investments to fishing fleets and declined sardine productivity

associated with the 1988 regime shift were discussed.

Discussion:
First of all, the presenter mentioned balance between field survey and desk work with limited staff. And then, as the response, stability and unstability of oceanographic conditions, such as some kinetic energy, mixing and up- and down-rolling, were explained to likely affect to biological productivity. Effects of regime shift, possibility of predicting abundance and relationships among multi-species were discussed and the growth rate of fishes were explained how to calculate. It was clarified that climate change and shift of Kuroshio were discussed to be related from each other based on the oceanographic physical model. The possibility to forecast survival and abundance of a cohort were also discussed based on the nice correlation evaluated from the statistical model.

Survival processes of Pacific bluefin tuna in their early life history: Approached by field surveys and rearing experiments

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Survival process of fishes in their early life stages plays an important role for recruitment success. In this presentation, I review 3 researches concerning the survival processes in early life stages of Pacific bluefin tuna by collaborating field surveys with laboratory rearing experiment. (1) In order to estimate the survival process of larval Pacific bluefin tuna in relation to their growth, otolith microstructure analysis was carried out. Estimated growth histories were compared between the larvae and juveniles, which were considered to be the survivors of the larval cohorts. The larvae with higher growth and developmental rates had a higher probability of survival to juvenile, indicating that the survival of larval Pacific bluefin tuna depends largely on their growth during the very early stage of their life history. (2) In order to assess the nutritional status of field-caught larval tuna, starvation experiments of hatchery-reared larvae were conducted and changes in the RNA/DNA ratio of fed and starved larvae were analyzed. The nutritional status of 3 cohorts of field-caught larvae was examined based on the value of the RNA/DNA ratio of the 1 day starved larvae from the starvation experiment. 4.35-25.77% of the cohorts were regarded as the “starving condition”, which was negatively correlated to the ambient

prey densities. These findings suggest that the nutritional condition of larval tuna was influenced by the ambient prey density. (3) The importance of piscivory for growth of tuna larvae was examined using laboratory-reared fish. The tuna larvae after onset of piscivory showed significantly faster growth than the tuna in zooplanktivorous stage. Stable isotope and otolith analysis revealed that small growth variations of tuna larvae in zooplanktivorous stage could induce further large growth variations in consequent piscivorous stages. The results of laboratory experiment suggest that piscivory in Pacific bluefin tuna larvae must be a potential key factor for their growth selective survival processes in the field.

Discussion:

It was clarified that the point of no return of larvae of Pacific bluefin tuna was estimated about 3 days after starvation. The presenter mentioned that temperature condition in the laboratory was covered the field environmental temperature range in the sampling area for RNA/DNA ratio analysis. The difficulty to detect the patch in the spawning area was noted and the physical condition is also one of the important factor to larvae survival. A question of cannibalism in the environmental condition was raised. As the response, the presenter mentioned that the cannibalism opportunity would not be happen in the environmental condition unlike in the hatchery-tank. It was noted that the DNA derived from diet of PBF has not been found from the stomach contents of the other larvae based on the DNA analysis. It was identified that the research of the abundance of larvae's prey would be a next step to improve understanding of survival process in the early life stage of PBF.

Discussions on Next Steps for Understanding Survival Strategy of Pelagic Fishes

In the seminar, two presentations were provided from the macro and micro points of views to identify the survival strategy in early life stage. It was noted that the specie which has longer life span tends to have stricter temporal-spatial condition for the reproduction. A presenter thought that PBF has longer life span, narrower spawning ground, and shorter spawning season, indicating that the impact of environment would affect their survival strongly. The northward-southward shift of spawning ground in the Sea of Japan was suggested as an example of the environmental impact for the PBF reproduction. Another suggestion regarding the effect of stock level toward the recruitment variability was stated based on the jack mackerel example.

Only thing we know is that environmental condition is changing continuously. We

should take much effort for the comparative analysis among the different current systems to address the impact of environmental condition by the climate change. ISC chair noted that the ISC-PICES collaborative work will make progress our knowledge of climate impact for the fishing stock.