Journal of Coastal Development
Volume 10, Number 3, June 2007 : 181 - 187

ISSN : 1410-5217
Accredited : 23a / Dikti / Kep / 2004

Original Paper

VERTICAL TEMPERATURE, THE FATE OF UP WELLING AND SPATIAL DISTRIBUTION OF FISH BIOMASS OF NORTH PAPUA WATERS

*Agus Hartoko**)

Deptartement of Fisheries, Faculty of Fisheries and Marine Science,
Diponegoro University, Semarang. 50275, Central Java. Indonesia

Received : April 2, 2007 ; Accepted : May, 25, 2007

ABSTRACT

The increasing need to introduce and highlight the analysis of deep water temperature (both horizontal and vertical) profile for up welling process and its relationship to fish biomass spatial distribution was inevitable. Especially to avoid the misleading interpretation of using only surface water temperature data for deep water fish biomass analysis.

The paper analyze and revealed the fate / occurrence of up welling zone in adjacent of Halmahera islands through the analysis of both multi-layer horizontal and vertical temperature data. Further analysis on the temperature and fish biomass data revealed the close relationship of horizontal temperature pattern especially at depth of 80m with spatial distribution of total fish biomass (acoustic numeric data : in dB unit) and fish biomass (ton/mile square) with fish total-length above 30cm.

Keywords : temperature profile, fish biomass, up welling, papua

***Correspondence** : Phone +62-24-7460038;fax. +62-24-7460039; e-mail : agushartoko@yahoo.com

INTRODUCTION

The increasing need to introduce and highlight the analysis of deep water temperature (both horizontal and vertical) profile for up welling process and its relationship to fish biomass spatial distribution was inevitable. Especially to avoid the misleading interpretation of using only surface water temperature data for deep water fish biomass analysis. The most relevant data was offered by the study of Kuroda et.al (1995) for the occurrence of North Guinea Coastal Under Current (NGCUC), but its effect to the development process of up welling especially at adjacent of Halmahera islands was not known yet.

Some authors earlier such as Dahuri,et.al, (2000) estimated the occurrence of up welling zone at adjacent of Halmahera waters, of the north of Papua. While this paper, will analyze and prove the fate / occurrence of up welling zone had been revealed through the analysis of both horizontal and vertical temperature data. It is gratifying to hope that this discovery will in turn stimulated a great deal of further research and analysis based on the similar phenomena, especially in the tropical Indonesian waters. Important evidence for the high-salinity water from the Eastern part of Indonesian archipelago (Papua and

Journal of Coastal Development
Volume 10, Number 3, June 2007 : 181 - 187

ISSN : 1410-5217
Accredited : 23a / Dikti / Kep / 2004

Halmahera), at the depth of about 150m with the thermocline (Klaus Wyrtki, 2005).
Another important point to be postulated and analyzed in the paper is that analysis of correlation for the horizontal temperature data to fish biomass data should consider the layer of whether small pelagic such as *Rastrelliger*.spp, *Sardinella*.sp etc for the surface water or large pelagic schools such as tuna (*Thunnus*.sp), etc with relevant horizontal temperature layer at depth of 80m, 100m (thermocline detph), 150m etc.

MATERIALS AND METHODS

Research data was a part of Fish Stock Assessment Expedition by RV. Baruna Jaya IV (BPPT) Length Over All : 60.4m; 1200GT, June – August 1997 off the North of Papua. Both horizontal (surface water) and vertical temperature data was measured using CTD with 0.01 degree Celsius accuracy. Fish biomass in term of acoustic data was measured using Scientific Split Beam Echo-integrator SIMRAD EK-500; working frequency :120kHz; 1000 watt . GPS coordinate recorded every 6 minute interval. Design of survey track was 'U' parallel grid track ranged from 120 - 240 mile off the North of Papua 60 interval between the main-leg, with total length of 3375 mile survey track (Johannesson and Mitson (1982) and MacLennan and Simonds (1992) in Nugroho et.al (1996; **Fig.1**). Both field CTD data and acoustic data were processed using 'Kriging' method using Er-Mapper software (licensed user). Analysis of horizontal temperature data approached with a multy-layer analysis method developed earlier (Hartoko,A et al. 2005).

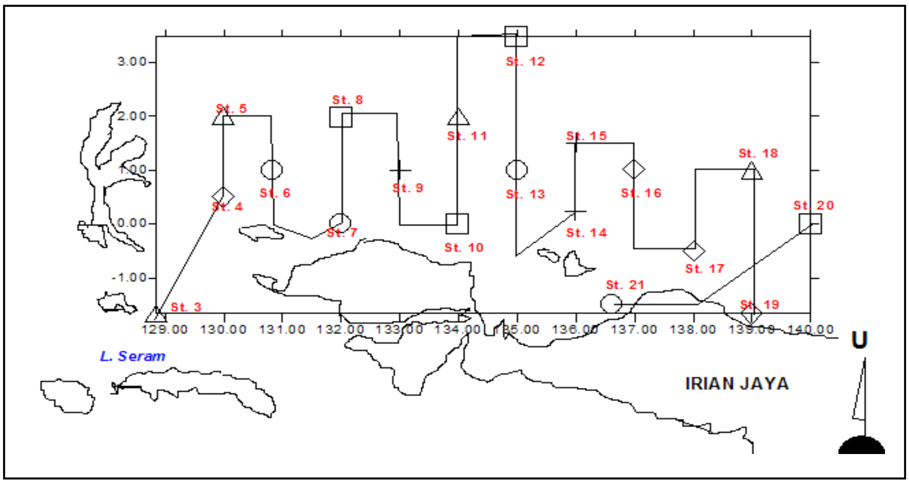

Fig 1 : Survey track during RV BARUNA Jaya fish stock assessment study.

RESULTS AND DISCUSSION

Horizontal and vertical temperature profile was analyzed. Based on the plot of horizontal surface water temperature **(Fig.3),** in general indicates that the Westward flow of Pacific warm water mass toward Halmahera islands, breaking up into directions, that is to the toward equator and flows into Indonesia waters via the corridor between Halmahera and Papua islands. The horizontal surface temperature of North

ISSN : 1410-5217
Accredited : 23a / Dikti / Kep / 2004

Original Paper

Papua pattern which indicates a West-North temperature flow of water mass, also known as North Guinea Coastal Under Current (NGCUC) studied by Wyrtki (1961) and Kuroda et.al (1995). Uniquely, there is a warm water mass (29.865 – 30.479ºC, **(Fig 3)** was trapped at the coast of Cenderawasih Bay, whether this is due to El Nino was not clear. The main issue had been revealed and to be inclined in this paper, is that horizontal temperature pattern at surface water is always different with horizontal temperature pattern at any other layer of depth, in this case with samples of North Papua are at 80, 100,120 and 150m,etc.

The occurrence of up-welling process, was performed through the analysis of vertical temperature profile which shows the vertical flow of water mass with temperature of 27 ºC from depth of 80 – 100m at station 5 off North Papua to the surface layer at station 3 around Halmahera island forming a cold water eddies **(Fig.2 and 3)**. The effect of the vertical flows of water mass in this area was also brings up the nutrient concentration from the deeper water to the surface water and cause a water mass nitrification and plankton bloom at station 3 (Hartoko, 2000).

Other implication of the current, temperature – depth interactions, both water current and depth contribute significantly to the vertical temperature profile. North Molucas and Halmahera, with the average current velocity is about 2.5 cm sec-1 respectively (Robertson and Field, 2005).

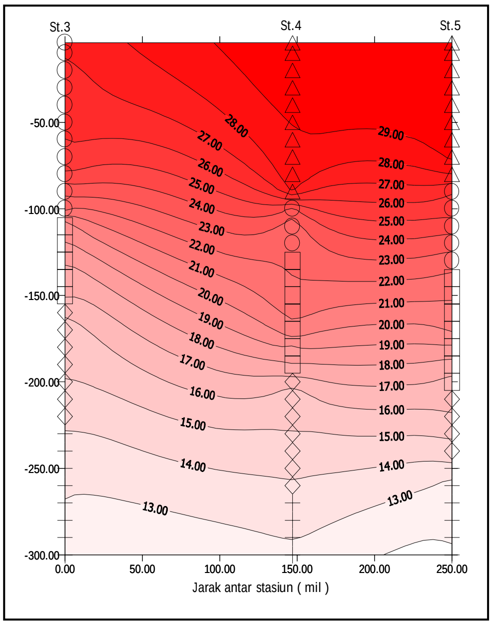

Fig 2 : Vertical temperature profile at station 5, 4 and 3

Plot of horizontal temperature layer at depth of 80m clearly shows the occurrence of two cold water eddies, with temperature of 26 – 27.6 C at station 5 and 3 next to Halmahera island **(Fig 4).** Further analysis by using two layer of horizontal temperature plot, showed that at surface water and 80m-depth with cold water eddy at depth of 80m and surface water, over a bathymetric layer **(Fig 5)** give more clear indication to the process of up-welling with flows of cold water mass from depth of 80m at station 5 to the surface water at station 3 **(Fig.2, 3, 4 and 5).**

Journal of Coastal Development
Volume 10, Number 3, June 2007 : 181 - 187

ISSN : 1410-5217
Accredited : 23a / Dikti / Kep / 2004

Original Paper

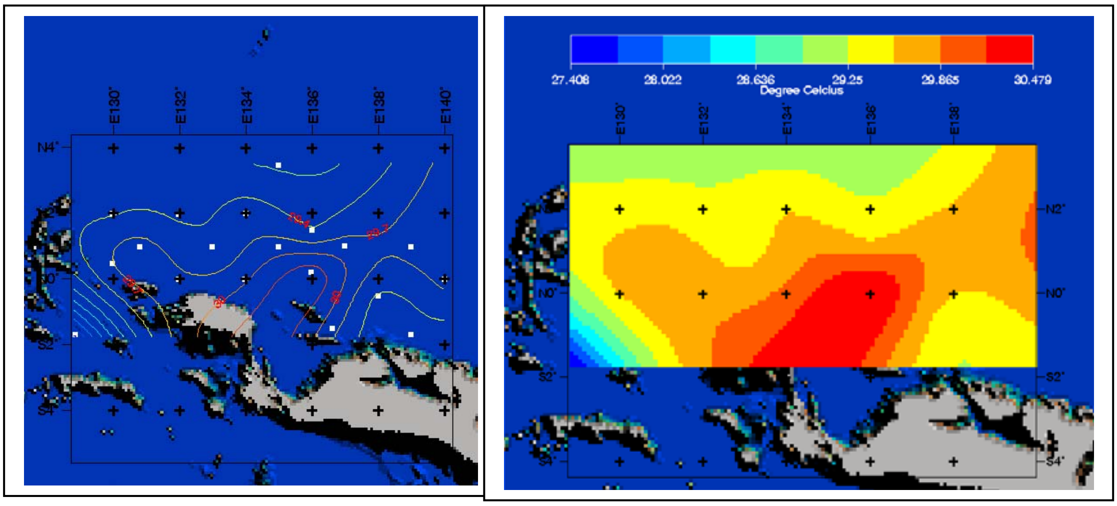

Fig 3. Horizontal temperature profile at surface water

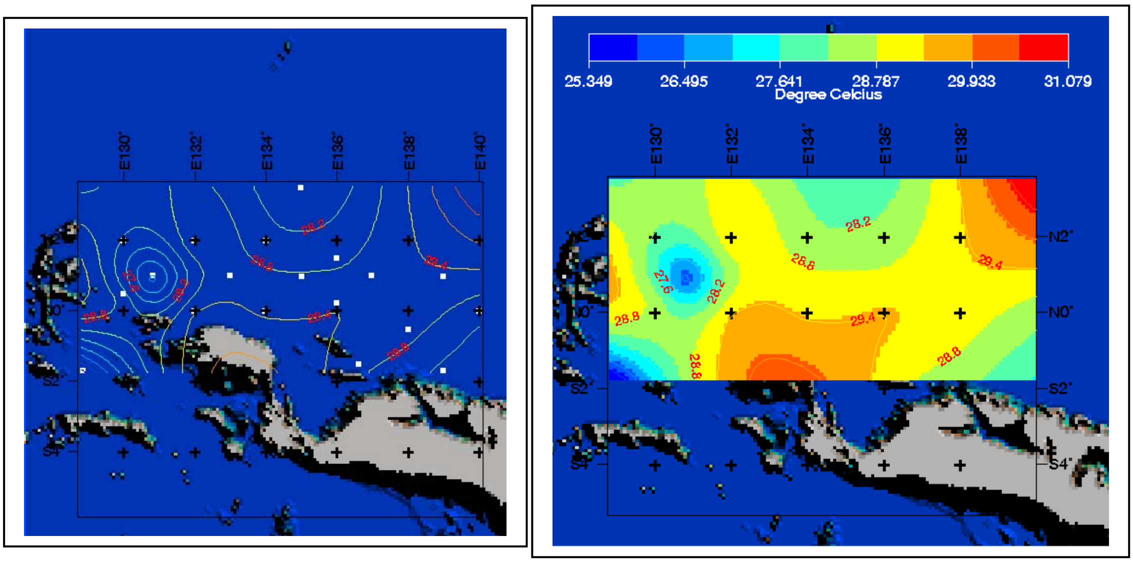

Fig 4. Horizontal temperature profile at depth of 80m

Inflow of water mass from the Pacific into the Eastern Archipelago during the northwest monsoon and an outflow to the Indian Ocean during the southeast monsoon. The pattern also made it clear that the seasonal up-welling and sinking in the Banda Sea was intimately related to these changing flows flow high salinity water from the Pacific into the Eastern Archipelago at a depth of about 150m within the thermocline (April – September). Within the Indonesian seas, incoming stratified Pacific Ocean waters are radically altered by vertical mixing such that the changing flows flow high salinity water from the Pacific into the Eastern Archipelago at a depth of about 150m within the thermocline (April – September). Within the Indonesian seas, incoming stratified Pacific Ocean waters are radically

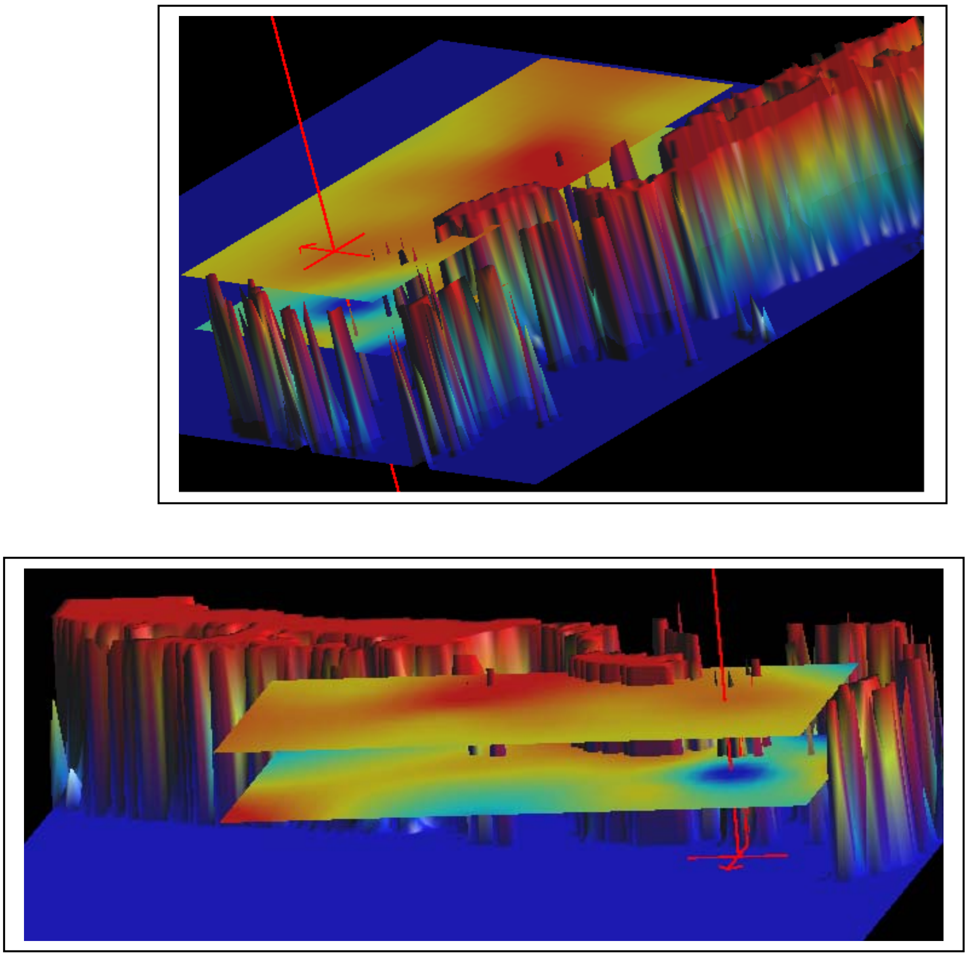

Fig 5 : Plot of surface and 80m-depth horizontal temperature data off North Papua (pointer arrow always pointing to the North)

altered by vertical mixing such that the distinctive salinity maxima originating from the North Pacific (salinity of 34.8 at 100m) and the South Pacific (salinity of 35.4 at 150m) eventually disappeared.

Ocean temperature throughout the Indonesian seas (and the Western Pacific Ocean) are cooler during El Nino years and warmer during La Nina years, at depth of 150m, they attain temperature about 1.5ºC cooler than usual during the El Nino of 1997 – 1998 when the thermocline shallow and temperature about 1.25 ºC warmer than usual during the La Nina of 1988 – 1989 when the thermocline deepens (Field and Robertson, 2005). Original total fish biomass data obtained in the form of numeric acoustic data (in dB unit) was then transformed into fish biomass data in ton per mile square and also into the length of the fish. The spatial distribution of total biomass (riu / dB unit; **Fig 6)** and plot of fish biomass (ton/mile square) with length bigger than 30 cm **(Fig 7)** which is assumed as bigger than *Rastrelliger*.spp and otherwise assumed as *Euthynus*.sp, Tuna, etc, give a similar pattern with the horizontal temperature pattern at depth of 80m and give high correlation coefficient (r = 0,75) between temperature at depth of 80m to total fish biomass (acoustic data , dB) and r = 0,72 for fish biomass with length bigger than 30cm (ton/mile square).

Journal of Coastal Development
Volume 10, Number 3, June 2007 : 181 - 187

ISSN : 1410-5217
Accredited : 23a / Dikti / Kep / 2004

Original Paper

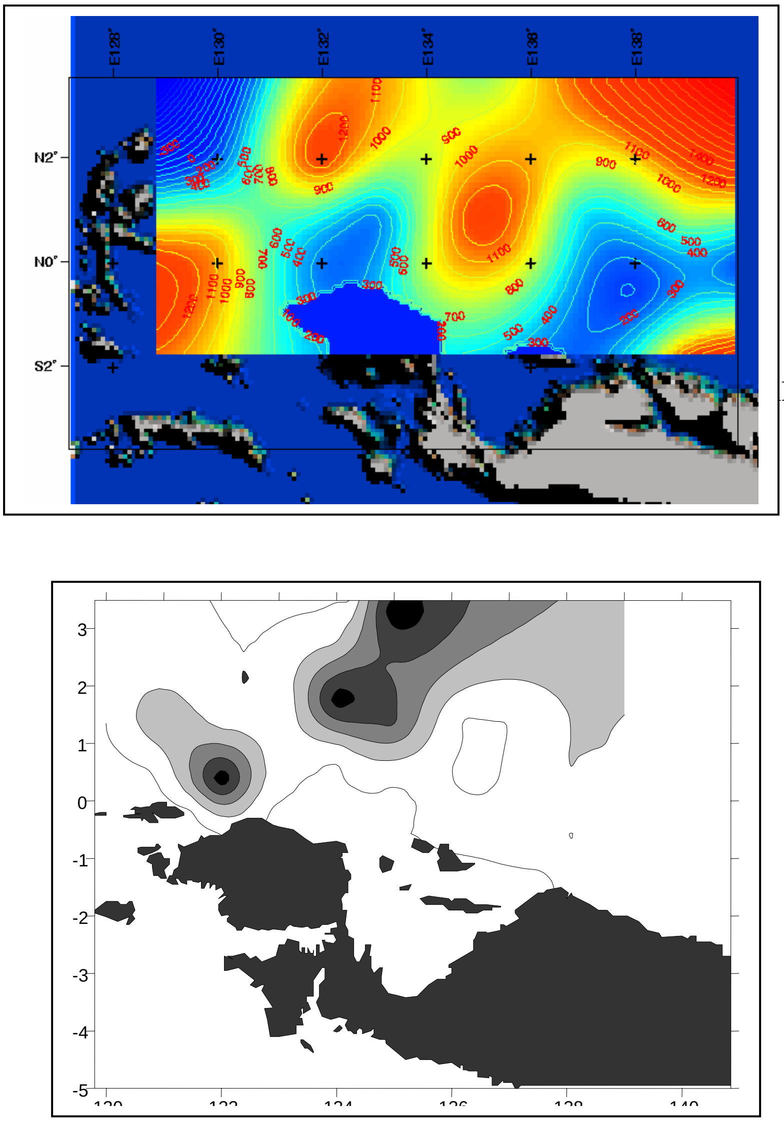

Fig 7: Plot of fish biomass (ton/mile square) with length of fish bigger than 30cm (Nugroho,D. 2000-personal communication)

Conclusion

To conclude, the analysis of both vertical and horizontal temperature data confirms the process of vertical water-mass flows from depth of 80m to the surface around Halmahera island. Further spatial and statistical analysis (regression) revealed a high correlation coefficient between horizontal temperature profile at depth of 80m to both total fish biomass (acoustic data) and fish biomass with length bigger than 30cm (ton/mile square).

ISSN : 1410-5217
Accredited : 23a / Dikti / Kep / 2004

Original Paper

ACKNOWLEDGEMENT

The author would like to thank to the management board of R/V.BARUNA JAYA IV, especially to Djoko Hartoyo, Leut Col (Navy) Handoko, Captain (Navy) Suhendro, and all crews and technicians for their immaculate cooperation and helps. Also special thanks to Mr Duto Nugroho and all friends from Marine Research Bureau - Ministry of Marine and Fisheries, Ancol Jakarta.

REFERENCES

Dahuri, Jacub Rais, 2000. Pengelolaan Terpadu Sumberdaya Wilayah Pesisir Indonesia. Pradnya Paramita

Hartoko,A ; NR Nganro; J.Rais; S.Mira; J.Kahar 2000a. *Aplikasi Teknologi Inderaja Untuk Pemetaan Karakter Ekosistem Ikan Pelagis Besar di Utara Irian Jaya/Papua*. Papaer on 2nd National Conference. Management of Coastal Marine Resources. Makasar.15-17 Mei 2000.

Hartoko,A ; NR Nganro; W.Nugroho; B.Hasyim 2000b. Dynamic Mapping on Specific Characters of Small Pelagic Fish Ecosystem Arround Kangean Islands.

Majalah Ilmu Kelautan.No.18. Tahun v. September 2000. ISSN 0853-7291.

Hartoko,A and M.Helmi 2005. Development of Multilayer Ecosystem Parameters Model . Journal of Coastal Development. Vol.7,No.3,June 2004. ISSN : 1410-5217

Kuroda Y; K.Ando; H Mitsudera; D Hartoyo;A.Alkatiri; Y Kashino, K. Yoneyama and K. Muneyama 1995. Oceanic Structure in the Western Tropical Pacific Observed During TOCS Cruises. Proc. International Workshop on the Throughflow Studies in and Around Indonesia Waters. BPPT Jakarta Indonesia.pp 105 – 121.

Nugroho.D; Petit,D; Cotel P and Luong N 1996. Pelagic Fish Schools in the Java Sea. Java Sea Pelagic Fishery Assessment Project. The Pelfish Communication Given to the Fourth Asian Fisheries Forum, 16-20 October 1995. Beijing, ORSTOM and EEC.

Wyrtki, K. 1961. Physical Oceanography of the Southeast Asian Waters. Scientific Result of Marine Investigations of the South China Sea and the Gulf of Thailand. 1959-1961. Naga Report.Vol.2. The University of California. Scripps Institution of Oceanography. La Jolla, California. pp. 62-195.

Wyrtki,K. 2005. Discovery the Indonesian Through flow. Oceanography, vol.18.no,4)

Robin Robertson and Amy Field, 2005. M2 Baroclinic Tides in the Indonesian Seas. Oceanography, vol.18.no,4.: 62 - 73

Amy Field and Robin Robertson, 2005. Indonesian Seas Finestructure Variability. Oceanography, vol.18.no,4