PROGRAM

Nov. 10 AM (Monday Morning)

09:00 - 09:30 **Registration**

09:30 - 10:30 **Opening Session**

Chair: Doo-Jin HWANG (Chonnam National University)

1. Introduction of Guests and Leaders
   Doo-Jin HWANG, General Director of AFAS2008
2. Welcome Address
   Hyeong-Il SHIN, Chairman of Steering Committee of AFAS2008
3. Chairman's Address
   Kohji IIDA, Chairman of Asian Fisheries Acoustic Society

Sesseion Ⅰ

Chair : Kohji IIDA (Hokkaido University)

Special Lectures

10:00-10:40 An Ecosystem-based Fisheries Assessment Approach for Korean Fisheries
Jae-Bong LEE, National Fisheries Research and Development Institute, Korea

10:40-11:20 Development in studies and applications of the target strength of Fish
Masahiko FURUSAWA, Tokyo University of Marine Science and Technology, Japan

Reports from board members

11:20-11:35 Activities on Fisheries Acoustics in South East Asia
Raja Bidin Raja Hassan, SEAFDEC, Malaysia

11:35-11:50 Activities on Fisheries Acoustics in Taiwan
Ming Anne LEE, National Taiwan Ocean University, Taiwan

11:50-12:05 Report of ICES International Symposium 2008 -SEAFACTS-
Kohji IIDA, Hokkaido University, Japan

12:05-13:30 **Lunch**

Nov. 10 PM (Monday Afternoon)

13:30-14:30 **General Meeting of Asian Fisheries Acoustics Society, FY2008**

Session Ⅱ
Acoustic Technologies for Fisheries

Chair: Yasushi NISHIMORI (Chair of SGAT)

14:30-14:45 Review on acoustic technologies for fisheries
Yasushi NISHIMORI, Furuno Electric Company, Japan

14:45-15:00 Development of broadnand split-beam method using dolphin-like sonar signal
Tomohito IMAIZUMI*, Masahiko FURUSAWA, Kazuo AMAKASU,
Tomonari AKAMATSU, Yasushi NISHIMORI, Shinji OGAWA
National Research Institute of Fisheries Engineering Fisheries Research Agency, Japan

15:00-15:15 Introdution of simple quantitative echo sounder, SQ-2020
Yoshihiro NISHIYAMA*, Katsuhiro KOMIYAMA, Furuno Electric Company, Japan

15:15-15:30 Development of the CH-300 Dual Frequency search light sonar
Takeharu YAMAGUCHI, Furuno Electric Company, Japan

15:30-15:45 Addressing different objectives in fisheries research in a diversity of environments using a combination of complementary underwater acoustic technologies
Lars Nonboe ANDERSEN* and Kjell EGER, Simrad, Kongsberg Maritime AS, Norway

15:45-16:00 Development status of quantitative scanning sonar system
Yasushi NISHIMORI, Furuno Electric Company, Japan

16:00-16:15 Session Discussion

16:15-16:30 Coffee Break

Session Ⅲ
Acoustic Theory and Target Strength of Marine Animals

Chair : Tohru MUKAI (Chair of SGTS)

16:30-16:45 Review on theoretical studies and target strength
Tohru MUKAI, Hokkaido University, Japan

16:45-17:00 Preliminary reports on the hydroacoustic ex situ target strength measurements of Moon Jellyfish(Aurelia aurita)
Chang-Won LEE*, Don-Hyug KANG, Hyung-Been LEE, Jeng-Goo MYOUNG
Marine Living Resources Research Department, Korea Ocean Research & Development Institute, Korea

17:00-17:15 In-situ Target Strength measurement of ray-finned fish
Raja Bidin Raja Hassan Jafri DIN*, Sunardi, DPPSPM SEAFEC-MFRDMD, Malaysia

17:15-17:30 Target strength measurements of Japanese Jack Mackerel
Koki ABE*, Tsuyoshi SHIMURA, Kouich SAWADA, Rie SHIOTA, Ken ISHII, Tohru MUKAI
National Research Institute of Fisheries Engineering, Fisheries Research Agency, Japan

17:30-17:45 Change of moon jelly's target strength by pulsation and posture
Tohru MUKAI*, Miyuki HIROSE, Kouichi SAWADA, Hokkaido University, Japan

17:45-18:00 Session Discussion

18:00 **Welcome Reception**

Nov. 11 AM (Tuesday Morning)

Session Ⅳ
Methodologies and Evaluation of Acoustic Survey

Chair : Kazushi MIYASHITA (Chair of SGES)

09:00-09:15 Review on methodologies and evaluation of practical acoustic fisheries survey
Kazushi MIYASHITA, Hokkaido University, Japan

09:15-09:30 A study on dynamic characteristic of zooplankton by acoustic survey in the internal tide active region of the northern south china sea
Shang-Hang TSAI, Hsueh-jung LU, Ming-Anne LEE*, Kuo-Tien LEE
National Taiwan Ocean University, Taiwan

09:30-09:45 Catch estimation using acoustic data obtained from research vessel's routine surveys in the coastal zone of northern Taiwan
Shang-Hang TSAI*, Hsueh-Jung LU, Cheng-Hsin LIAO, Kuo-Tien LEE
National Taiwan Ocean University, Taiwan

09:45-10:00 Acoustical survey of bighead and silver bighead in Qinghe reservoir of China
Yong TANG*, Guosheng ZHANG, Kohji IIDA
College of Ocean Engineering, Dalian Fisheries University, China

10:00-10:15 Acoustic survey in the coastal waters off northern and western Kyushu in Japan from 1997 to 2008
Seiji OHSHIMO, Kenji ASANO*
Seikai National Fisheries Research Institute, Fisheries Research Agency, Japan

10:15-10:30 Coffee Break

10:30-10:45 Acoustic observations of jellyfish in the east china sea in early summer 2007 and 2008
Doo-Jin HWANG*, Eun-Ho KIM, Eun-A YOON, Tohru MUKAI, Miyuki HIROSE, Sun-Beom JEONG, Yang-Ho YOON, Ho-Young SOH, Yong-Ju KIM, Hyeong-Ho SHIN, Il-Su CHOI, Hyeong-Il SHIN, Chonnam National University, Korea

10:45-11:00 Acoustic observations in the east china sea in early summer 2008
Eun-Ho KIM*, Doo-Jin HWANG, Eun-A YOON, Tohru MUKAI, Miyuki HIROSE, Sun-Beom JEONG, Ho-Young SOH, Chonnam National University, Korea

11:00-11:15 Biomass estimation of pelagicfish and mesopelagicfish by using the echo sounder
Eun-A YOON*, Doo-Jin HWANG, Eun-Ho KIM, Il-Su CHOI, Heong-Il SHIN
Chonnam National University, Korea

11:15-11:30 Spatial interaction of recruited walleye Pollock juveniles(Theragra chalcogramma) with prey, predator, and marine environment variables in Pacific coast of Hokkaido, Japan
Naoki TOJO*, Hiroto MURASE, Ryuichi MATSKURA, Hiroki YASUMA, Shiroh YONEZAKI, Hikaru WATANABE, Shigeyuki KAWAHARA, Kazushi MIYASHITA, Hokkaido University, Japan

11:30-11:45 Isada Krill(Euphausia pacifica) distribution in frontal environments in the North Pacific Ocean
Naoki TOJO*, Hiroto MURASE, Ryuichi MATSUKURA, Hiroki YASUMA, Shiroh YONEZAKI, Hikaru WATANABE, Shigeyuki KAWAHARA, Kazushi MIYASHITA, Hokkaido University, Japan

11:45-12:00 Session Discussion

12:00-13:30 **Lunch**

Nov. 12 PM (Tuesday Afternoon)

Session Ⅴ
Broad Aspects of Underwater Acoustics for Fisheries

Chair : Yoshinori MIYAMOTO (Chair of SGAA)

13:30-13:45 Review on broad aspects of underwater acoustics for fishery and fishery surveys
Yoshinori MIYAMOTO*, Keiichi UCHIDA, Toshiharu KAKIHARA, Kazuo AMAKASU Tokyo University, Japan

13:45-14:00 Density estimates of Nemopilena nomurai Jellyfish in Yellow Sea during 2006-2008
Kyoung-Hoon LEE*, Soo-Jeong JANG, Jeong-Hwa CHOI, Won-Deuk YOON, Yeong-Min CHOI, Heui-Chun AN, NFRDI, Korea

14:00-14:15 Measurements of acoustic volume backscattering from harmful algae using underwater ultrasonic sensor
Eun-Hye KIM*, Hyung-Been LEE, Jung-Yal NA, Jee-Woong CHOI, Don-Hyug KANG, Yang-Ho YOON, Hanyang University, Korea

14:15-14:30 Net swimming speed of Nemopilema nomurai Jellyfish using acoustics and visualization analysis
Kyoung-Hoon LEE*, Jae-Hyun BAE, In-Ok KIM, Won-Deuk YOON, Jong-Keun SHIN
NFRDI, Korea

14:30-14:45 Coffee Break

14:45-15:00 Species identification of fish schools on the east china sea using acoustic descriptors
Aymen CHAREF*, Ichiro AOKI, Seiji OHSHIMO, University of Tokyo, Japan

15:00-15:15 Method for aerial measurement and underwater measurement of the auditory brainstem response of fish
Tomonori HIRAISHI*, Tomohiro SUGA, Tomonari AKAMATSU, Ryo KAWABE
Hokkaido University, Japan

15:15-15:45 Session Discussion

15:45-16:00 Coffee Break

16:00-16:30 **General Discussion**

16:30-17:00 **Closing Session**

18:00 **Beer Reception**

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An Ecosystem-based Fisheries Assessment Approach for Korean Fisheries

Jae-Bong LEE

National Fisheries Research and Development Institute, 408-1, Shirang-ri, Gijang, Busan 619-905, Korea

Concern is growing over how ecosystems are being affected by fishing. A comprehensive ecosystem-based approach is required to holistically assess and manage fisheries resources and their associated habitats by considering ecological interactions of target species with predators, competitors, and prey species, interactions between fishes and their habitats, and the effects of fishing on these processes. A pragmatic ecosystem-based approach was developed for the assessment of fisheries resources in Korean waters involving three management objectives: sustainability, biodiversity, and habitat quality. A two-tier analytical method was employed. Tier 1 was designed for situations where sufficient information is available to allow for a quantitative evaluation of the status of the system, while Tier 2 was designed for situations where available information necessitated a semi-quantitative or qualitative assessment. A total of 20 Tier 1 indicators and 24 Tier 2 indicators were developed for assessment of ecosystem status. Both target and limit reference points were chosen for each indicator to assess the status of species, fisheries and ecosystems. Nested risk indices, such as objectives risk index (ORI), species risk index (SRI), fishery risk index (FRI), and ecosystem risk index (ERI), were developed to assess the ecosystem status at the management unit level. A risk assessment diagram was developed and found to be useful in quickly displaying results. A management status index (MSI) was also developed to evaluate the level of management improvement in species, fisheries, or ecosystems among different time periods or different areas. The method was demonstrated by applying it to the Tongyeong marine ranch and the Korean large purse seine fishery. It was found that this approach can be used to compare the status of species, fisheries and ecosystems spatially and temporally using an ecosystem perspective.

Keywords: Ecosystem-based approach, Fisheries assessment, Risk assessment diagram, Korean fisheries

Development in studies and applications of the target strength of fish

Masahiko FURUSAWA

Tokyo University of Marine Science and Technology

The target strength (TS) of fish is a pivotal factor in fisheries acoustics. It is the scaling factor to transform the backscattering strength of fish schools to distribution density, is used to estimate the body size of fish, and offers important information to estimate fish species. In this presentation, how to interpret or apply the TS, our important works on the TS, and perspective of relative technologies are described. Japanese researcher Hashimoto conducted a pioneering experimental work on the fish TS. Referring to his method and Nakken and Olsen's method, the author's group conducted comprehensive measurements of the TS for the important fish species around Japan. Theoretical modeling of TS is effective to estimate the characteristics and complement laborious experiments. A prolate-spheroid modal-series (PSMS) model is especially useful to understand the general trend of the fish TS because of its simplicity and versatility. An application of the model for sonar surveys is exemplified. Advances in single echo discrimination and single echo trace analysis combined with target tracking technique are important for in situ TS measurements.

Keywords=Target strength of fish, Prolate-spheroid model, Single echo discrimination, Echo trace analysis

Development of broadband split-beam method using dolphin-like sonar signal

Tomohito IMAIZUMI[1*], Masahiko FURUSAWA[2], Kazuo AMAKASU[1], Tomonari AKAMATSU[1], Yasushi NISHIMORI[3], Shinji OGAWA[1]

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Dolphins are considered to use the spectral information of fish echo to classify their prey. Therefore, a broadband split beam system which can measure the target strength (TS) spectrum of fish was developed to simulate the sonar of dolphin. The system uses separate transmit and receive transducers to realize the spectrum ration method which calibrates system responses by making the ratio of reflected and incident signals. The TS spectrum was measured using a bottlenose dolphin-like sonar signal. First, the positions and TS spectra of a tungsten carbide sphere (TC) were measured at a water tank and at sea to confirm the capability of the method and system. The directivity coefficients were determined by a theoretical directivity function by the position angles obtained by cross-correlating two signals from two pairs of half-circular arrays. The measured form functions of the TC sphere were in good agreement with the theoretical values in the -6dB bands of the incident wave. Using the method and system, TS spectra of a tethered and wild fish were continuously measured at sea and shown as "TS spectrogram." The TS spectra of fish will be important information especially for species identification.

Introduction of simple quantitative echo sounder, SQ-2020

Yoshihiro NISHIYAMA*, Katsuhiro KOMIYAMA

Furuno Electric Co., Ltd., Nishinomiya, JAPAN

Scientific echo sounder is popularly used for acoustic survey today and the system based on the split-beam technology is mainly used. Split-beam system provides high accuracy data, but it is mostly large and expensive for total system. Also the survey target will be limited due to its non-portability.

While on the actual acoustic survey situation, it is considered that very high accuracy data is not always required depending on the purpose, or sometimes researcher may wants to install the system on the small boat.

The SQ-2020 is developed as a small and simple quantitative echo sounder. The system is consists of only four components that; network sounder DFF3, commercial windows based PC, GPS positioning system and transducers, then it makes possible hand-carrying the system on boat.

The ping data is saved as a SV value in binary format with position and time date data. Data conversion function into CSV format is available.

Keywords: Acoustic survey, Quantitative echo sounder, Scientific echo sounder

Development of the CH-300 Dual Frequency Search Light Sonar

Takeharu YAMAGUCHI

FURUNO ELECTRIC CO., LTD., Nishinomiya, Japan

World's first dual frequency search light sonar CH-300 has been developed for small fishing vessels. This sonar uses low frequency signal for wide range detection, whereas the high frequency is used for accurately tracking the targets. Since the transmission of the search light sonar is angled, suppressing the side-lobe level is an important design factor to reduce the artifacts on the image. CH-300 adapted a sophisticated array structure and shading design to achieve the required performance. It is proven in the sea trial conducted in Kagoshima that CH-300 is capable of discriminating juvenile sardines from other type of fish species with 85/215kHz dual frequency transducer.

Keywords: Dual frequency, Sonar

Addressing different objectives in fisheries research in a diversity of environments using a combination of complementary underwater acoustic technologies

Lars Nonboe ANDERSEN* and Kjell EGER

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In the field of fisheries research, scientists require a huge variety of information to describe an aquatic ecosystem. Some of this information can be obtained using underwater acoustics. As examples acoustics is often used to provide information about size of fish stocks, biological species compositions, size distributions, behavior in space and time, and links to other environmental information such as habitats. This information is mandatory in a wide diversity of environments such as small lakes, rivers, and large oceans and for many different types of biological organisms such as large marine mammals, fish of different sizes, and small plankton organisms. The targets can be distributed spatially in a variety of ways such as large widely distributed aggregations, in small compact schools, or as sparsely distributed individuals. Some of the information also needs to be monitored over a long continuous time to understand the changes and mechanisms taking place throughout a year and maybe even over several years. The acoustic methods are often accompanied with sampling techniques using various types sampling gear such as trawl, purse seine, or gillnets. In this case acoustics is also often used to provide information about the sampling gear during operation, such as the position, depth, and performance of the sampling gear. Over the years different types of acoustic technology have evolved such as quantitative multi-frequency split-beam echo sounders, omni directional sonars, multibeam echo sounders, multibeam matrix sonars, miscellaneous trawl monitoring systems, remote buoys, and autonomous underwater vehicles (AUV's). Also the acoustic technologies have been applied in many different creative ways providing the scientists with new information addressing the many different objectives in fisheries research. In this paper a combination of complementary acoustic technologies are presented along with different application examples which address a variety of fisheries research objectives in a diversity of environments with different challenges.

Keywords: underwater acoustic technology, echo sounder, sonar, multibeam, trawl, AUV

Development status of quantitative scanning sonar system

Yasushi NISHIMORI

FURUNO ELECTRIC CO,., LTD.. Nishinomiya, Japan

We have been researching and developing the quantitative scanning sonar co-operating with Hokkaido Univ. using low frequency scanning sonar FSV30 for fishery since 2003. In this project, the three dimensional echo data recording function enabling quantitative analysis, an algorithm to estimate fish school abundance by three dimensional echo integration, and the other simplified algorithm to perform the school abundance estimation by using two-dimensional data for the practical use were developed. We implemented these functions to the PC software application and have conducted several field evaluations. The system has continuously progressed according to the researcher's requirements. The two dimensional echo mapping function was developed to know the distribution of fish schools in wide area. And the application for the middle frequency sonar FSV84 has been added and tested at the real fishing field. I will focus to introduce these recent progress of our quantitative scanning sonar development .

Preliminary reports on the hydroacoustic *ex situ* target strength measurements of Moon Jellyfish (*Aurelia aurita*)

Chang-Won LEE[1*], Don-Hyug KANG[1], Hyung-Been Lee[2] and Jung-Goo MYOUNG[1]

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Jellyfish abundance such as *Aurelia aurita* and *Nemopilema nomurai* appears to have seriously increased in recent years in coastal area of Korea, Japan and China. The jellyfish are important consumers of various zooplankton and ichthyoplankton, and may affects fish populations and ecosystem. Thus, knowledge of jellyfish distribution and abundance is of fisheries economic as well as ecological importance. In this study, acoustic target strength (*TS*) and volume backscattering strength (*Sv*) measurements for hydroacoustic survey of moon jellyfish are presented for tethered individual and multiple *Aurelia aurita* in Korean water. Tethered jellyfish were ensonified at 38, 120, and 200 kHz split beam echo-sounders within large cage (6 m × 6m × 6m). Simultaneously, an underwater video camera was used to continuously monitor behaviour and tilt angle during the acoustic measurements. After TS measurements, density contrast (*g*) using dual-density method and sound speed contrast (*h*) using time-of-flight method were measured, respectively. As preliminary results, the acoustic *TS* of the individual moon jellyfish were various distributed depending on umbrella size; ranging from –67 to –57 dB at 38 kHz, -75 to –57 dB at 120 kHz and –73 to – 57 dB at 200 kHz. The level of *Sv* was increased as increasing individuals. Experimental results of the acoustic *TS* and *Sv* of moon jellyfish distributed intermediate scattering level, which is lower than those of fish and higher than those of zooplankton and ichthyoplankton. Measured results of *g* (4 individuals) and *h* (10 individuals) of the moon jellyfish were ranging from 0.9527 ~ 0.9986 and 0.9981 ~ 1.0014, respectively. The preliminary results of *ex situ* measurements provided various information about the TS of moon jellyfish; this information can be applied to improve acoustic surveys and also improve the accuracy of moon jellyfish biomass estimates.

In-situ Target Strength Measurement of Ray-Finned Fish

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This paper discusses the Target Strength (TS) measurement for *Atule mate* (Yellowtail scad) and *Decapterus maruadsi* (Japanese scad), two of ray-finned fish (Class Actinopterygii) which are commercially pelagic fish in Malaysia. The In-situ fish TS measurement has been conducted by using Furuno FQ-80 Scientific Echo Sounder. The low and high frequency transducers were placed at the bottom of the vessel KK Senangin II with draft of 2.8 m. The fish cage was placed 3.0 m below of the transducer before the fish target strength measurement were carried out. TS values have been detected using 120 kHz frequency transducer. The source level of echo sounder is fixed at 221.9 dB. Single Yellowtail scad of 19.5 cm and 17 cm of Japanese scad have been measured using the same protocol. Weights of these young fish are 35 g and 50 g respectively. Single fish TS values at every ping were recorded by observing the top view of TS diagram. Single fish targeted then can be extracted as fish detected at particular depth, position (x-y-z) from transducer, and its TS. Total of 89 to 280 pings of single fish detection for these fishes had been analyzed. Japanese scad is stronger of TS value than Yellowtail scad. The average of TS for Yellowtail scad and Japanese scad are -53.08 dB and -51.14 dB respectively with standard deviations are 2.51 and 2.53. Backscattering cross section then calculated, where 4.9×10^{-6} dB for Yellowtail scad and 7.7×10^{-6} dB for Japanese scad.

Keywords: Target Strength, backscattering cross section, Yellowtail scad, Japanese scad

Target Strength Measurements of Japanese Jack Mackerel

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Japanese jack mackerel (*Trachurus japonicus*) are widely distributes in the Japanese coastal waters. They are among the important commercial pelagic fishes and are designated as one of the species controlled by the total allowable catch (TAC). They are fished mainly using a purse seine in the western Sea of Japan. The acoustic surveys the juvenile Japanese jack mackerel have been carried out using quantitative echo sounder, because of the necessity to grasp quantity before being done fishing, for managing the resources. In this work, the backscattering of juvenile Japanese jack mackerel was measured by the tethered method in a large tank filled with fresh water. Target strength (TS) was measured as a function of dorsal aspect incident angle in 1°steps of the fish rotation from -50 degree (head down) to +50 degree (head up) for 19 specimens. The fork length (FL) ranged from 4.8 cm to 13.1 cm and the average was 6.4 cm (1.9 cm in S.D.). The swimbladder photographs from dorsal and lateral aspects were taken using a soft X-ray device before and after the TS measurement. Outlines of the swimbladder were digitized based on the X-ray photographs taken before the TS measurement and used for the theoretical calculations based on the Kirchhoff-Ray Mode (KRM) model. The relation between FL and measured average TS was $\langle TS \rangle = 20\log FL - 66.5$ (n=19, 38kHz), and measured TS patterns as a function of tilt angle agreed well with the predicted ones by the KRM.

Keywords: Target Strength, Jack Mackerel, Swimbladder, Soft X-ray, KRM

Change of moon jelly's target strength by pulsation and change of posture

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When observing a jellyfish drifting in the sea, it can be seen that the bell size or the posture is changing by its pulsation. How and how much the target strength is changed by these changes was investigated. The experiments were conducted in the seawater tank of the National Research Institute of Fisheries Engineering (NRIFE) in March 2008. The moon jellyfish used for this experiment were bred in an aquarium in Niigata prefecture. Individual living jellyfish was tethered using thin fishing line and its bell was faced sideways. Frequency used for measurement was 120 kHz. Incidence angle was changed by rotating a transducer concentrically around the jellyfish at 5 degree intervals. Target strength was measured about 500 data at each angle between ±30 degrees. The appearance of jellyfish's pulsation during the target strength measurement was monitored by a video camera set next to a transducer. In this trial experiment, two jellyfish (bell diameter in the air: 8.6 cm and 10.4 cm) were used. In an advance report, it was found that about 10dB change caused by the heartbeat and about 15dB change caused by the posture. Advanced experiments will be performed from 19th November to clarify these effects.[Work supported by JSPS and KOSEF Core University Program on Fisheries Science (FiSCUP) and International Collaboration Research on Giant Jellyfish.]

Keywords: target strength, jellyfish, pulsation, posture

A study on dynamic characteristic of zooplankton by acoustic survey in the internal tide active region of the northern South China Sea

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There are many internal wave activities in the northern South China Sea (SCS). In the past, studies on acoustic feature of internal wave in the northern SCS mostly focused on environmental noise and energy loses by using passive acoustic systems, yet the biological mechanism observed by active acoustic system after the occurrence of internal wave has not been discussed. In this study, on board of research vessel "Ocean Research I" in April, 2007, we used echosounder system EK500 (38 and 120 kHz) and MTD plankton net to observe sound-scattering characteristic of zooplankton in internal waves activity region. The result showed that calanoids, ostracods and protozoans, comprising 74.44-90.83% of the total zooplankton, were dominant taxa in this region. Both ΔMVBS values and the taxa compositions at one and three hours after the occurrence of internal waves differed notably, and the depth distribution of small-size zooplankton (ΔMVBS>10dB) ascended slightly. These results suggest that internal wave activities disturbed the vertical distribution of zooplankton, and resulted in the variation in ΔMVBS. In conclusion ΔMVBS is an effective index to show vertical distribution of zooplankton in internal wave active region. The open sea acoustic survey data collected by our SCS study, therefore, can be used to identify internal wave activity and effect of the internal wave activity on spatial distribution of zooplankton.

Keywords: South China Sea, Internal Wave, Zooplankton, Echosounder

Catch Estimation Using Acoustic Data Obtained from Research Vessel's Routine Surveys in the Coastal Zone of Northern Taiwan

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Acoustic survey is a useful and rapid method to estimate biomass in vast waters. In the last five year, we compiled 37 acoustic survey data collected on board of the Ocean Researcher II, using Simrad EK500 scientific echosounder to establish a method to monitor total biomass variation in the northern coastal waters of Taiwan. All acoustic data of 38 kHz with different transects in each survey were aggregated using 2 nm x 2 nm grids and were transferred to average values of grids. Average volume backscattering strengths ($\overline{SV}$) were calculated using echo-integration to estimate relative density of marine organism. The $\overline{SV}$ values of the entire surveyed area from April to September were 1.5-12.6dB higher than those from October to March, and 5.7dB higher than the 5-year average. These differences suggested that there were strong seasonal variability of biomass in the surveyed area. The $\overline{SV}$ values of the entire surveyed area were positively correlated with the total catches of coastal fisheries ($r^2 = 0.7831$, $p < 0.01$). Therefore, the post-processed acoustic data collected by the research vessel can be used as fishery independent indices when there is shortage of fisheries catch data.

Keywords: Acoustic Survey, Coastal Zone of Northern Taiwan, Fishery Independent Index, Scientific Echosounder

Acoustical Survey of Bighead and Silver Bighead in Qinghe Reservoir of China

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In China, the resource of river and lake is abundance. The development of freshwater fisheries is always regarded as an important industry. The production of freshwater fish has increased over 25 million tons in the year of 2006, which is near a half of fisheries amount. Among the freshwater fisheries, producing in large scale lake and reservoir is very important for region entironment and sustainable utilization, with the method of artificial breed almost. However, lacking the correlating investigation of fish abundance and environment, it is difficult to control the parameters of resource aggregate, amount of artificial breed and production. So, it influence to sweeping development of freshwater fisheries.

Fisheries resource acoustical assessment has applied for several decades in advanced fisheries countries. Since the scientific echo sounder is expensive for developing nations like China, this method can not be popularized in freshwater resource assessment. So, this research tried to modify a commercial fish finder (GP-7000F, 50kHz, Furuno) to obtain the fish echo data. Through an AD converter (16bit, Contec), the output signal of echo with the GPS data was recorded in a note PC as raw digital data format (nor TVG). This data also can be replay on screen as an echogram or to calculate the SV or TS of fish.

The field experiment was conducted in the Qinghe reservoir located at Tieling of Liaoning Province in the northeast of China. The Qinghe reservoir was constructed by damming the Qinghe River in 1958, the length of dam is 1600m, the water area is near 50 km^2 and maximum depth is near 40m. The bighead and silver bighead is main species to breed, and the production is near 350 tons one year, also the other species fish was tried to be bred in recent years. The survey was conducted around with the sunset and sunrise time after calibrated the system response with a standard sphere (φ 38.1mm, WC). As a result, the single echo from the bighead and silver bighead can be confirmed at 20m depth layer. Considering the TS surveys of bighead is difficult with it's big size near 1m length, the echo counting method should be primary at first step, then the echo integration method or different frequency characteristics of fish also should be referred to distinguish the fish species and body length.

Keywords: freshwater, echo sounder, bighead, resource assessment, echo counting

Acoustic surveys in the coastal waters off northern and western Kyushu in Japan from 1997 to 2008

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We estimated the biomass index of small pelagic fishes, such as anchovy, round herring, sardine, jack mackerel, mackerels, scads, lantern fish and pearlside, using acoustic surveys in summer in the coastal waters off northern and western Kyushu in Japan, and these sea areas provide nursery grounds for 0-age small pelagic fishes. The acoustic echo sounder used was a Simrad EK505, and the frequency was 38 kHz. Fish species were identified from the results of midwater trawling. The height and width of net mouth were 20 m and 20 m, respectively. The acoustic surveys were only conducted in the daytime, because we could judge the four school types using acoustic echogram in the daytime. The four groups of echogram were as follows; 1) clupeid fishes, 2) jacks, mackerels and scads, 3) lantern fish and 4) pearlside (Ohshimo, 2004: Fisheries Science, 70, 389-400). The biomass indices of small pelagic fishes were calculated by the percentage of catch weight of midwater trawling after dividing the echogram into four groups. The annual fluctuation of biomass index of round herring, jack mackerel and mackerels were similar to the results of 0-age stock size based on VPA (virtual population analysis). The biomass index of sardine rapidly increased since 2007, and the results would be reflected as increasing the stock size of sardine in these waters. Lantern fish and pearlside were thought to play important roles in the marine ecosystem, because the biomasses of those fishes are very large and are planktivorous. This study would be the first report of estimating the long-term annual fluctuations of lantern fish and pearlside in these waters.

Key words: acoustic survey, biomass index, small pelagic fishes

Acoustic Observations of Jellyfish in the East China Sea in Early Summer 2007 and 2008

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Jellyfish abundance is increasing in numerous marine ecosystems worldwide, perhaps as a consequence of "regime shifts" associated with climatic change, increasing fishing pressure, or both. Jellyfish are important consumers of zooplankton and ichthyoplankton, and may detrimentally affect fish populations. Nomura's jellyfish, Nemopilema nomurai is very abundant in the Yellow Sea and the Sea of Korea/Japan and could affect coastal trawl and set net fishing.

Nomura's jellyfish is very large, the bell diameter is over 1m and weight is over 200kg at the adult stage in the ocean. Recently, it had a negative effect on fish biomass. Acoustic technologies are commonly used to estimate biomass and describe distributions of fisheries resources in coastal areas and the open ocean.

Acoustic surveys were conducted by the EK-500 scientific echo sounder it hull mounted transducer on DongBeak training ship during the early summer from 2003 to 2008 in the East China Sea. In additionally, jellyfish species and horizontal distributions in the sound scattering layer on the echogram were sampled using a bottom trawl and frame mid-water trawl at survey area.

In this study, we would like to report jellyfish distributions only the 2007 and 2008, because it were very different of appearance in the area the two year. The jellyfish were distributed very widely from around west of the Jejudo to southern part of the China Sea in 2007, that Sv were -65.2~-75.7dB(38kHz) and -69.9~-75.6dB(120kHz) on the echogram and 200kg to 2500kg caught at 10 trawl stations. On the other hand, the jellyfish were distributed very small area at south-western part of the East China Sea near the Zangtz-river in 2008, that Sv were -63.1~-73.7dB(38kHz) and -66.4~-73.9dB(120kHz) on the echogram and only one or two jellyfish caught four trawl stations.

Acoustic Observations in the East China Sea in Early Summer 2008

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The east china sea is a sea area which has abundance resources, where not only Korea but also China, Japan and neighboring countries are competing for fishery resources. And it was a important fishing ground.

Survey has been made continue about sound scattering layer(SSL). But, study hasn't been performance about an inhabitant of juvenile in SSL. So, the object of this study is to understand species of juvenile in SSL.

Acoustic and Framed mid trawl(FMT) survey were conducted to understand the characteristics of the sound scattering layer(SSL) in the northwestern part of the East China Sea. The survey was carried out during June 27~30, 2008 at 15 sampling stations.

Fish samples were performed by FMT from 5 stations. The station 1, 3, and 12 were caught squid. The mean target strength were analyzed from -48.33dB to -57.61dB at 38kHz, from -49.16dB to -59.16dB at 120kHz. The metallic was caught in the station 4. The mean target strength indicated -54.48dB at 38kHz, -55.66dB at 120kHz. Five species weren't indentified from five stations.

Keywords: Framed mid trawl, Sound scattering layer, Target strength

Biomass estimation of pelagicfish and mesopelagicfish by using the echo sounder

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The distribution and biomass of pelagicfish and mesoplegicfish in the Bo-ryeong were studied by the echo sounder from September 2006 to June 2007, every four season. The survey was performed by using 200kHz dual beam system, transmitter-receiver and indicator afterward recorded data was handled by using echo view software.

Based on the survey line, divided the survey waters with 6 sections was 227.68km^2. The volume backscattering strength(SV) of each season indicated -60.0~-65.0dB in September(autumn), -63.0~-65.0dB in November(winter), -65.0~-67.0dB in March(spring) and -55.0~-66.0dB in June(summer). In addition, the mean target strength(TS) of many fishes distributed in the survey waters in September, November, March and June was -57.0dB, -69.2dB, -69.1dB and -64.8dB, respectively. The fishes were caught 99% for Anchovy in September, 36~44% for Akiami paste shrimp in November, 35~50% for Akiami paste shrimp in March and 53~64% for Southern rough shrimp, 13~14% for Beka squid in June.

The biomass was estimated using identification of object fish, acoustics data of SV, SA, and TS, length and weight by sampling. As a result, the biomass was assumed by Anchovy of 11,164tons in September 2006, Akiami paste shrimp of 423tons in November 2006, Akiami paste shrimp of 2,063tons in March 2007 and Southern rough shrimp of 13,937tons, Beka squid of 153tons in June 2007.

Keywords : Biomass, Echo sounder, Volume backscattering strength, Target strength

Spatial interaction of recruited walleye pollock juveniles (*Theragra chalcogramma*) with prey, predator, and marine environment variables in Pacific coast of Hokkaido, Japan

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Walleye pollock (*Theragra chalcogramma*) is an important fishing target species off the coast of the North Pacific Rim. There are many milestone studies in pollock biology, but ecological approach involving interactions with species and environmental dynamics is expected in recent ecosystem-base fisheries management context. In this study, we aimed to understand the ecological interactions around juvenile walleye pollock using the GIS techniques. The selected study area were costal shelf (< 150 m depth) off Hokkaido Island (42-43 N, 143-145 E) where aggregations of recruited Juvenile pollock have been observed in historical surveys. Fish samples were collected using a dual purpose trawl net at 26 to 28 stations, and temperature and salinity were measured with STD at the each trawling station. The prey species were identified and sampled from the stomach contents. Fish densities at the specific locations were obtained using hydroacoustics echosounder (EK60, 38kHz, 120kHz) in fall surveys from 2003 to 2006. The noises in hydroacoustic data were filtered, and then juvenile pollock and its preys were identified using ΔMVBS method with the sample body lengths. Temperature, salinity, and derived bioenergetics variables were geostatistically interpolated with maximum likelihood method from the STD stations. The CPUE of Bottom predatory fishes, such as Kamchatka flounder (*Atheresthes evermanni*), were converted to indices of main predatory pressure, and interpolated with the best-fit kriging. Visual and statistical comparison between juveniles and the prey, predator, and marine environmental variables were made. Significant non-linear relationship (GAM, $P<0.05$) between juvenile distributions and larger preys, warmer environment with

colder bottom temperature, and gross growth efficiency indicate survival strategies of juvenile pollock. Potential predator avoidance response became obvious in fine scale analyses. Found dynamics of interactions probably depend on the influence of one of the boundary currents in the North Pacific Ocean, Oyashio.

Keywords: *Theragra chalcogramma*, predator-prey interaction, bioenergetics, ΔMVBS, Oyashio

Isada Krill (*Euphausia pacifica*) distribution in frontal environments in the North Pacific Ocean

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Isada Krill, *Euphausia pacifica*, is a key component as a main prey species in the North Pacific marine ecosystem. Ecological keystone species, such as large fishes, sea birds, and cetaceans, relay on its availability in their life histories. The spatial and temporal dynamics of the krill affects to its availability for these predators and determines the balances in the North Pacific marine ecosystem. We aimed to understand the spatio-temporal dynamics of Isada Krill in relation to the oceanic fronts in the offshore area of North Pacific Ocean. From 2002 to 2005 and in 2007, survey transects were designed off southern Kurile Islands near the Subarctic Front (SAF). The surveys involved quantitative echosounder, MOCNESS trawls, and CTD castings. We obtained density of krill from the hydroacoustic data using ΔMVBS method and extracted the distribution environment at krill patch locations from geostatistically interpolated temperature and salinity from CTD data and satellite imageries. The patch structure and mesoscale distribution trend were quantified using the selected semivariogram model. Sea surface height (SSH) and approximated geostrophic flows from satellite altimetry showed strong influences of oceanic transport on the mesoscale distribution trend. Near-front physical oceanography enhanced accumulation of krill distributions. The spatio-temporal distribution pattern of *E.pacifica,* available as prey is behavioral- and transport-dependent. Our

findings are meaningful for current and future ecosystem-based resource utilization management context in the North Pacific.

Keywords: *Euphausia pacifica*, geostrophic flow, prey species, sea surface height, subarctc front

Research Broad Aspects of Underwater Acoustics for Fishery and Fishery Surveys

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There is mostly application of an ultrasonic acoustic. As an example that participates in fishery directly, it divides roughly and reports to the following four.

1) Biotelemetry (Bio-Logging)

As an active type, the present condition and the trend of the method of using pinger, and the method of using Echo sounder are introduced. Moreover it refers for echolocation that receives the chirp of a fish as a passive type.

2) Acoustic camera

Until now, an acoustic camera is used for the purpose of inquiry. In recent years, the behavior monitoring of a fish is tried. Moreover, form measurement of swim-bladder of a fish with a meaning important for sound investigation is also performed.

3) Attraction or acoustic extirpation

The feed with sound etc. was tried. Moreover, sound intimidation can also be begun as a measure against of the marine deforestation: Isoyake.

Keywords : biotelemetry, pinger, echolocation, acoustic camera, acoustic attraction, acoustic extirpation

Density Estimates of *Nemopilema nomurai* Jellyfish in Yellow Sea during 2006-2008

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A *Nemopilema nomurai* Jellyfish, which is presumed to be developing in the East China Sea, is recently migrated in Yellow Sea during a few years. National Fisheries Research & Development Institute (NFRDI) has researched on its biomass estimation by bottom trawl fishing gear and sighting survey during 5 years. These methods are effective to investigate density estimates of *nomurai* jellyfish and its distributed community in near bottom or surface, they have a difficulty in investigating the vertical distribution of jellyfishes. However, in this case, an echo sounding detection method can be utilized extensively and effectively to solve such problem. This research was conducted by echo counting method with scientific echosounder system (EK-500, Simrad co., Norway) in order to estimate *nomurai* jellyfish's density migrated in Korea-China Provisional waters for summer season during 3 years (2006-2008), and then, the jellyfish's echo signals were extracted from other sound backscattering scatterers on the basis of single echo shape and every ping's fluctuation for individuals. The density estimated results by echo counting would be compared with those values from trawl sampling and sighting survey. In 2008 in comparison with 2006 and 2007, density estimation of jellyfish which migrated in the survey area was very low relatively.

Keywords: *Nemopilema nomurai* jellyfish, Yellow Sea, Trawl sampling, Sighting survey, Echo counting.

Measurements of acoustic volume backscattering from harmful algae using underwater ultrasonic sensor

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Harmful algae (or called red tide) seriously damages to coastal fisheries activities in Korea, especially aquaculture. Currently, high density red tide (blooming) is detected from optical counting of water sample or visual monitoring. Although the methods have the advantage of understanding species composition, it has a limit on detection of red tide at an early stage. In this study, we tried to detect red tide at an early stage using ultrasonic transducer. Acoustic volume backscattering strength (*Sv*) measurements were conducted on red tide (*Cochlodinium polykrikoides*) using an underwater ultrasonic sensors (3.5 and 5 MHz) in the field and laboratory. For comparing acoustic data, density of red tide was counted with microscope. With two ultrasonic transducers were attached to the side of a fishing boat, *in situ* acoustic measurements and water sampling were performed with GPS data in the survey areas, simultaneously. The field experiments were carried out in July and August 2008 near the coastal region in the South coast of Korea. From comparing acoustic data and directly counting data of red tide, the two methods have a relatively good agreement. These results have allowed us to apply the acoustic method to real-time early detection of harmful algal blooms.

Keywords: Harmful algae (red tide), acoustic detection, ultrasonic sensor, water sampling

Net Swimming Speed of *Nemopilema nomurai* Jellyfish using Acoustics and Visualization analysis

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A *Nemopilema nomurai* Jellyfish, which is presumed to be developing in the East China Sea, is recently one of major issues in the Northeast Asia region due to its fatal damage to fishery. Although biomass estimates have been conducted by trawl sampling and sighting survey methods, the biological research is also needed to clarify an environmental origin or diurnal migration patterns. While those methods are effective to investigate density estimates of *nomurai* jellyfish and its distributed community in near bottom or surface, they have a difficulty in investigating the vertical distribution of jellyfishes. However, in this case, an echo sounding detection method can be utilized extensively and effectively to solve such problem. This research was conducted with scientific echosounder system, optical and acoustical camera systems and CTD system during mooring at each station of the East China Sea, and offshore and inshore Korea, in order to measure the vertical distribution of *nomurai* Jellyfish over thermocline strongly formed. In addition, their patterns of moving behaviour and net swimming speed were analyzed using PTV (Particle Tracking Velocimetry) and acoustical tracking methods. Results from the optical camera and echo sounder system indicated that they were exited and moved at the water column under the thermocline. The mean net swimming speed was estimated as 0.6 times the bell size with the tendency to maintain a certain speed, and it was also verified in stabilized water tank. These results can estimate the net swimming speed of jellyfish, and it can be suggested as an index to a migration model forecasting their timing that develop on a massive scale in Northeast Asia entering the inshore and its origin in the future without considering current speed.

Keywords: *Nemopilema nomurai* jellyfish, net swimming speed, PTV analysis.

Species identification of fish schools on the East China Sea using acoustic descriptors

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The accuracy of stock size assessment for major commercial species relies on objectively identifying and allocating acoustic school-images to fish species.

Acoustic surveys were conducted annually during summer from 2002 to 2007. We collected acoustic data using one frequency scientific echosounder. We followed 27 parallel transects on the East China Sea off Japanese coasts.

Obtained echograms were scrutinized and we selected 800 echotraces. We extracted five school descriptors from each patch and they fell into 3 categories: (1) morphological: length, height and height mean; (2) energetic: backscattered volume (*Sv*); (3) positional: mean school altitude (Depth).

The discrimination of identified images resulted in defining three fish groups based on their features' characteristics. The stepwise discriminate analysis ranked depth, Sv and length as the most effective descriptors in discriminating fish schools. The overall correct classification was about 70%, emphasizing the usefulness of this classification method for the improvement of stock size assessment accuracy in the East China Sea.

Key words: identification, fish groups, acoustic descriptors, East China Sea.

Method for aerial measurement and underwater measurement of the auditory brainstem response of fish

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Various methodologies are used to measure audiograms of fishers. Simple method is to observe how the moving behavior responds to sound stimuli. But, it has been suggested that it is not easy to measure the sound level because it will change as the fish moves in a tank. So the behavioral conditioning method using cardiac suppression with electric shock has been used for a long time. However, this method is potentially stressful due to the invasive surgery needed to record cardiogram and give electric shocks.

The auditory brain response (ABR) method is an alternative method to measure fish auditory threshold. The ABR method allow quick and repeatable measurement of fish without invasive surgery. It has been reported that the ABR method is useful for measuring juvenile fish. The auditory threshold for juvenile Japanese sand lance *Ammodytes personatus* were measured based on ABR, This species is an important fish resource in Japan, and its population structure has been studied in detail. Especially the frequency of sound noise from vessels ranges form 100 Hz to 500 Hz . We investigated the auditory threshold to various low frequencies of sound from apprpximately 100 Hz to 500Hz/

Japanese sand lance responded to low frequency sounds between 128 Hz and 512 Hz with sound pressure level of 115-125 dB. These results indicate that Japanese sand lance can detect low frequency sound but are less sensitive than other fish species. These high thresholds are probably caused by the lack of swim bladder.

The ABR of fishes is commonly measured by bringing the heads of the fishes out of the water in a small tank. However, this method is inapplicable to experiment for large fishes that are economically important in large spaces such as the sea or in a large tank. We used a method of recording, the ABR for fishes in water, without exposing the fish heads to air, by using a waterproof, insulated electrode. The goldfish *Carassius auratus* was investigated and the ABR waveform and auditory threshold measured in water were compared with those measured on the surface.

Both ABR waveforms and auditory thresholds showed similar trends between the two methods. The underwater ABR method is useful to measure the auditory threshold of large fish in natural or on-site environments such as the sea, net enclosures and large aquaria in which precise positioning of the fish is not possible.

Key words: Auditory brainstem response, hearing, Japanese sand lance, goldfish.