THE INTERNATIONAL CONFERENCE ON UNDERWATER ACOUSTICS FOR SUSTAINABLE FISHERIES IN ASIA

The Seventh Annual Meeting of Asian Fisheries Acoustics Society

AFAS2013

5 – 6 November 2013, Tokyo Japan

Book of Abstracts

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Venue: Tokyo University of Marine Science and Technology

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MESSAGE FROM CHAIRMAN FOR AFAS2013

Professor Kohji Iida
Chairman of AFAS
Hokkaido University, Japan

On behalf of the Asian Fisheries Acoustics Society, I would like to give a brief address. Our society has been established in 2007 in Dalian, China, and I am very pleased to have the seventh annual meeting AFAS2013 in Tokyo, Japan for the first time. Since its foundation, we have experienced six annual meetings of AFAS held in Dalian, Incheon, Taipei, Penang, Qingdao, Busan in Asian countries.

Fortunately the number of attendee to this meeting has been increased year by year, and the technologies on underwater acoustics have been developed. The purpose of the establishment of AFAS is to promote further progress of science and technologies on fisheries acoustics in Asia by cooperation across borders of countries.

Recently there are some welcome news for us, for example, an association of fisheries acoustics in China is actively moving, new outstanding products have been developed by companies, and students who want to study underwater acoustics is increasing. Furthermore when the Great East Japan earthquake happened and the huge Tsunami hit the pacific coast of Japan in March 11, 2011, many acoustic technologies and equipments including echo sounder, side looking sonar, and underwater telemetry were used to contribute for recovery of afflicted area.

Since there are many particular subjects in Asian fisheries such like small quantities but many species, benthic fishery, freshwater fishery, and aquaculture fishery, the AFAS aims to challenge to solve these problems using acoustical technologies.

It is a great pleasure for us to have the 7th AFAS meeting in Tokyo, Japan with so many people coming together here. I believe the network on fisheries acoustics in Asia will be spreading more and more. I hope that all participants will feel free to discuss and to exchange opinions, so as to make this meeting success.

Finally I would like to express my sincere gratitude to Prof. Yoshinori Miyamoto of Tokyo University of Marine Science and Technology for hosting this conference and Prof. Nobukyuki Endo, a President of Marine Acoustic Society of Japan for joint hosting of this conference. Also I appreciate to all members of the Steering Committee of AFAS2013, and all staffs of the Local Organizing Committee for preparing this conference.

SUMMARY OF AFAS2012

The sixth annual meeting of Asian Fisheries Acoustics Society, AFAS2012 entitled “The International Conference on Underwater Acoustics for Sustainable Fisheries in Asia” was held at Vistas Hotel, Pukyong National University, Busan, Korea from 26th to 27th of November, 2012 hosted by Pukyong National University. About 80 researchers from 27 countries/regions including Korea, Japan, China, Taiwan, Malaysia, and other countries attended the conference. The conference included Opening/Closing Sessions, Special session, 4 Technical sessions, Board meeting, General meeting, and Welcome/Farewell parties for two days.

Board meeting

The board meeting was held in the late evening on the day before the conference, at the lobby of Vistas Hotel. Eleven board members including K. Iida, Raja. H, D. Hwang, Y. Miyamoto, K. Miyashita, Y. Nishimori, Y. Tang, K. Abe, A. Hamano, K. Sawada, H. Lu and Prof. H.O. Shin, the chairman of LOC were attended the meeting. The board meeting was proceeded by the chairman of AFAS in accordance with the agenda. 1) Following to chairman’s greeting, activities in the special field were reported by the chair of Science Group. D. Hwang reported about organizing of AFAS2012, and local activities were reported by Laja. H, Y. Tang, H. Lu. 2) To reserve the post of vice chairman of AFAS and to revise the AFAS Statutes were discussed. 3) To create the awards for young researchers and students to encourage their further progress were approved. The awards included “Young Fisheries Acoustician Award” for under 40 and “Student Best Presentation Award“ for students. 4) The venue and the date of next annual meeting, AFAS2013 by joint hosting with Marine Acoustics Society of Japan to be held in Tokyo, Japan, in November of 2013 was recommended.

Opening Session

Opening session was held in the morning of the day one at the conference room in Vistas Hotel. Prof. Hyeon-Ok Shin, chairman of LOC of AFAS2012, Prof. Young-Soo Jang, dean of Pukyong National University, Dr. Woo Jeung Choi, the head of National Research and Development Institute, Prof. Hyeong Il Shin, chairman emeritus of AFAS2012, and Prof. Kohji Iida, the chairman of AFAS addressed to participants in AFAS2012 as opening remarks. After the ceremony, group photo with all participants was taken in conference room.

Special Session

In the morning of the day one, we had a special session named “Sustainable Fisheries in Asia”, and two keynote lectures were delivered. Prof. Sukgeun Jung of Jeju National University delivered under the title of “Comparison of anchovy abundances estimated by trawl, egg production methods and acoustic survey”, and Dr. Tomonari Akamatsu delivered Under “Applications of broadband acoustics in fisheries”. After special session, the chairman gave

them commemorative gifts with appreciation.

General Meeting

The 6th AFAS General Meeting was held in the afternoon of the day one in the conference room chaired by Prof. A. Hamano, advisor of AFAS. Following the chairman's greeting, 1) general report, working group activities and regional activities were reported by the board members. 2) Reservation of the post for vice chairman of AFAS and revision of AFAS Statutes were approved. 3) The venue and the date of next annual meeting, AFAS2013 by joint hosting with Marine Acoustics Society of Japan to be held in Tokyo, Japan, in November of 2013 were approved.

Technical Session

In the afternoon of the day one and all day of the day two, four technical sessions were held at the conference room. Each session were proceeded by the chair of WG. Four titles for WGAT, 3 titles for WGTS, 11 titles for WGES, and 9 titles for WGAA, with a total of 33 oral presentations were reported. Six posters were presented in the conference room. Also some exhibitions of acoustic products by donor companies were held outside the conference room.

Closing Session

Closing ceremony was held in the evening of the day two. Chairman Iida summarized that, 1) Several presentation concerning broadband techniques will contribute to species identification, and 2) Simple and low cost technology will also contribute to promote fisheries acoustics in Asia. These studies were welcomed to support of the purpose of AFAS. Lastly the winners of AFAS award were announced. "Young Fisheries Acoustician Award" was given to K. Amakasu for his presentation of "Verification of broadband echo processing to determine volume backscattering strength spectra" and "Student Best Presentation Award" were given to H. La for his presentation of "Ex situ target strength measurements of ice krill (Euphausia crystallorophias), Antarctic Ocean" and to H. Shao for her presentation of "Spatial estimation of the kelp forest (Laminaria spp.) distributions in coastal waters of Aomori, Japan, using acoustic method". The chairman presented the award certificates and trophies to the winners.

Parties

A welcome dinner hosted by Luky Susan Ltd., the sponsor of AFAS2012 was held at the banquet room in Vistas hotel on the first day evening and a farewell party hosted by AFAS was held at the banquet room on the second day evening in attendance of KOICA's interns from 20 countries.

Acknowledgements

AFAS appreciate the twelve sponsors who supported the conference and to Pukyong National University for hosting. Thanks are also due to the Local Organizing Committee for their preparing meeting and arranging attendance of KOICA's interns.

Asian Fisheries Acoustics Society

AFAS Statutes

1. Name

The name of this society is Asian Fisheries Acoustics Society.

2. Objective

The Asian Fisheries Acoustics Society promotes the progress and the popularization of science and technologies on Fisheries Acoustics in Asia.

3. Activities

The Asian Fisheries Acoustics Society has the following programs.

(1) It organizes the science meeting to discuss on Fisheries Acoustics.

(2) It researches the specific theme on Fisheries Acoustics in Asia.

(3) It contributes the education and training about Fisheries Acoustics in Asia.

(4) It supports the cooperative works for acoustic surveys and experiments in Asia.

(5) It emits the profitable information about Fisheries Acoustics for members.

4. Membership

(1) Any researchers who are interested in Fisheries Acoustics in Asia, or who support the AFAS activities can become regular members of AFAS.

(2) A person who wants to join the membership should propose the application to AFAS secretariat with personal information (i.e., name, affiliation, address, TEL/FAX, Email)

5. Directors

(1) Chairman(1 person), Vice-chairman(2 persons), board members(15 persons), Scientific advisers(2 person), and secretary(1 person) are placed in this society.

(2) Chairman and Vice-chairman are elected by the regular member's vote in the general meeting based on the recommendation by the board of directors.

(3) Board members are elected by the current board of directors.

(4) Scientific Advisers and Secretary are invited by the board.

(5) Director's term of office is two years. However, it is possible to be reappointed.

6. Management

(1) This society is managed under voluntary donation by members and supporters.

(2) This society does not collect membership fee from members.

(3) The business year of this society is assumed from January 1 to December 31 every year.

7. Conference

(1) Conferences consist of the general meeting, directors meeting, and the meetings of Science committee (SC), Science group (SG), and Working group (WG).

(2) The general meeting is held once in a year in Asian country.

(3) The member can make research presentation and discussion at the annual meeting.

8. Publication

This society publishes the report book after the annual meeting as soon as possible.

9. Secretariat

The secretariat has its office in the chairman's affiliation.

Enacted in November 26, 2012

PROGRAM

Tuesday 5 November

08:00-09:30

Registration

09:30-10:00

Opening session

Opening address
Yoshinori Miyamoto
Chairman of AFAS2013 Steering Committee

Welcome address
Kohji Iida
Chairman of Asian Fisheries Acoustic Society

Welcome address
Nobuyuki Endoh
Chairman of Marine Acoustics Society of Japan

Group photo

10:05-11:45

Invited lecture

Chair: *Kohji Iida*

10:05 **International significance and trends of acoustic research** p.14
David A. Demer

10:55 **Fisheries application of autonomous underwater vehicle** p.15
Hayato Kondo

11:45-13:15

Lunch at a cafeteria in the University Hall

13:15-14:40

Session I: Fisheries and ecosystem monitoring I (by SGES)

Chair: *Kazushi Miyashita* (Chair of SGES), *Yong Tang*

14:30 Free discussion (10 min.)

14:40-14:55

Break

14:55-16:20

Session II: Fisheries and ecosystem monitoring I (continued)

Chair: *Tohru Mukai, Myounghee Kang*

16:10 Free discussion (10 min.)

16:20-16:35

Break

16:35-18:00

Session III: Echo-sounding systems and technology (by SGAT)

Chair: *Yasushi Nishimori* (Chair of SGAT), *Yoshimi Takao*

17:05 **Development of a new chirp echo sounder** p.28
○*Satoshi Misonoo, Yuriko Ohnishi, Yoshihiro Nishiyama, Shinji Ogawa*

17:20 **The measurement of fish close to the bottom by the broadband split-beam echo sounder** p.29
○*Tomohito Imaizumi*[Y], *Kaoru Fujita, Shintaro Yamasaki, Koki Abe, Koichi Sawada, Masanori Ito, Ikuo Matsuo, Wang Youg, Yasushi Nishimori, Tomonari Akamatsu*

17:35 **Calibration of a high-frequency broadband echosounder using a 38.1-mm-diameter tungsten carbide sphere** p.30
○*Aito Takeishi*[S], *Kazuo Amakasu*, and *Yoshinori Miyamoto*

17:50 Free discussion (10 min.)

18:30-20:00
Welcome reception at the conference venue

Wednesday 6 November

08:00-09:00
Registration

09:00-09:50
Invited lecture
Chair: *Kohji Iida*

09:00 **Listening to the Deep-Ocean: A global underwater noise monitoring initiative** p.31
○*Michel André, Mike van der Schaar, Ludwig Houégnigan, Joan Castell*, and *Antonio M. Sánchez*

09:55-11:05

Session IV: Passive acoustics and biotelemetry (by SGAA)

Chair: *Yoshinori Miyamoto* (Chair of SGAA), *Tomohito Imaizumi*

10:55 Free discussion (10 min.)

11:05-11:20

Break

11:20-12:30

Session V: Target strength of fish and zooplankton (by SGTS)

Chair: *Kouichi Sawada* (Chair of SGTS), *Doo-Jin Hwang*

11:50 **Target strength of copepods (*Neocalanus cristatus*) with oil sacs at 120 kHz** p.38

○*Yoshiaki Fukuda*[Y], *Kouichi Sawada, and Tohru Mukai*

12:05 **The effect of material properties on euphausid (*Thysanoessa* spp.) target strength estimated using an acoustic scattering model** p.39

○*Takuya Mizukami*[S], *Kosuke Yamazaki, Tohru Mukai,* Yoshiaki Fukuda, *Kouichi Sawada, Kazuhiko Itaya, and Kohji Iida*

12:20 Free discussion (10 min.)

12:30-13:45

Lunch at the cafeteria in the University Hall

13:45-14:45

General meeting of AFAS

14:45-15:45

Poster session

Chair: *Kazuo Amakasu*

Acoustic detection of Hrmful Algal Bloom's (red tide) in summer season 2013, south sea of the Korea p.40

○*Donhyug Kang, Hyungbeen Lee, and Yoon-ho Lee*

Geographical distribution of acoustic impedance in the head of harbour porpoise *phocoena phocoena* p.41

○*Mika Kuroda*[S], *Motoki Sasaki, Kazutaka Yamada, Nobuhiro Miki, and Takashi Matsuishi*

Seasonal variation of scattering strength in the estuary of Tan-Sui river, Taiwan p.42

Szu-Chia Kao and ○*Ming-An Lee*

15:45-17:10

Session VI: Fisheries and ecosystem monitoring II (by SGES)

Chair: *Raja Bidin Raja Hassan, Jun Han*

15:45 **Identification of zooplankton using three frequency difference methods around Funka bay, Hokkaido Japan** p.43

○*Eunho Kim*[S], *Tohru Mukai, and Kohji Iida*

16:00 **Estimating the fishing efficiency of framed midwater trawl net and ring net using an acoustic method** p.44

○*Zhen Lu*[S], *Kohji Iida, and Tohru Mukai*

16:15 **Semi-automated detection of giant jellyfish *Nemopilema nomurai* by echo trace analyses on high resolution echograms** p.45

○*Tomohiko Matsuura*[Y], Kazuhiro Sadayasu, *Ryuichi Matsukura, and Yoshimi Takao*

16:30 **Application of an acoustic camera and echo sounder for understanding fish lengths and orientations** p.46

○*Myounghee Kang, Hui Zhang, and Qiwei Wei*

16:45 **Echoview - a software partnership for continuous development** p.47

○*Ian Higginbottom*

17:00 Free discussion (10 min.)

17:15-17:45

Closing session

18:30-20:30

Banquet at Dai-ichi Hotel Tokyo Seafort (28F, Top of the bay)

International significance and trends of acoustic research

David A. Demer

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Keywords: multi-species surveys, sensor, sensor platforms, environmental forcing, Pacific Decadal Oscillation, data integration, ecosystem approach, transboundary stock

Fish stocks are naturally governed by their environments, prey, and predators, which generally transcend national boundaries and policies. The sustainable harvest of transboundary marine fish stocks therefore requires cooperative management with an ecosystem approach. To do this, fisheries scientists must gather and assimilate large quantities of interdisciplinary data. Presented here are the models, tools, and results of one investigation of basin-scale forcing of local ecosystem dynamics, and how data for multiple species and their environment have been integrated to predict trends in stock recruitment, migration, and size. In this research conducted by the Advanced Survey Technologies Group at NOAAs Southwest Fisheries Science Center, a dual-phase model was developed which links the environment in the North Pacific, indicated by the Pacific Decadal Oscillation index (PDO), to the recruitment of the northern stock of Pacific sardine (*Sardinops sagax*) in the California Current. The model identifies summer feeding seasons conducive to good adult condition factor followed by spring spawning seasons supportive of good larval retention and growth. A probabilistic generalized additive model was also developed using a 12-year dataset including the presence and absence of sardine eggs and concomitant remotely sensed oceanographic variables. Based on significant relationships identified between eggs and sea surface temperature, chlorophyll-a concentration, and the gradient of sea-surface height, the model accurately predicts the habitat and seasonal migration pattern of sardine, irrespective of spawning condition. These model predictions have been used to optimize sampling in multi-species, acoustic-trawl method (ATM) surveys conducted off the west coasts of the United States (US) and Canada, and to better interpret the survey results. In addition to providing information about the abundance, migratory behavior, and size and age distributions of sardine, the ATM surveys concurrently yielded information on the biomasses and spatial distributions of multiple other coastal pelagic fish species within the survey areas. Collectively, these results show that the PDO has recently transitioned to a cold period, consequently the reproductive condition and productivity of sardine has been poor, the population has been reduced to a small number of cohorts that are unlikely to produce an appreciable new cohort, the population is declining, its migration is contracting, and other forage fish species may be thriving. Affected are fisheries in Mexico, the US, and Canada. Through this example, it is shown that acoustic measurements traditionally made from fisheries survey vessels are increasingly being augmented with data from a variety of sensor platforms including satellites, manned and unmanned aircraft, small boats, autonomous underwater vehicles, gliders, remotely operated vehicles, buoys, floats, landers, and marine animals. The traditional suite of ship-based acoustic sensors is being expanded from ADCPs and multi-frequency echosounders to include broad bandwidth multibeam echosounders, broad bandwidth imaging sonars, and long-range searchlight sonars. The validation of acoustic targets with nets and trawls is being augmented with optical target validation using cast or towed cameras, optical nets, and self-contained acoustic-optical samplers.

Fisheries application of autonomous underwater vehicle

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Keywords: autonomous underwater vehicle, fish monitoring, acoustic camera

Autonomous Underwater Vehicles (AUVs) have become useful platform to survey seabed, sub-seabed and seawater by using sonars, cameras and other special sensors. Compare to the traditional system such as Remotely Operated Vehicles (ROVs) and towed systems, they have advantage that they can move free from ship and can move stably because they have no tethered cable or wire which is connected to a ship and disturb vehicle's stability by ship motion. Because of this advantage AUVs can provide high quality sonar data of seabed, and they are used by subsea mineral resources survey companies and navies.

In 2007, an interdisciplinary research project was started in Tokyo University of Marine Science and Technology. Within the project a big goal was planned that AUVs will take a roll of taking care fish in offshore without a net, which is like a sheep dog to take care sheep in a ranch. For this research project a Biointeractive AUV has been developed. Biointeractive means that the vehicle has an ability to monitor schools of fish interactively by giving stimulus to fish to observe fish behavior caused by the stimulation. The vehicle has a demand feeding system, a variable color lighting system, and an underwater speaker for giving stimulus, and has HD video camera and acoustic camera for monitoring. The Biointeractive AUV can stay in the environment where fish is living and swim together to monitor their life style from the same viewpoint of them.

The first Biointeractive AUV "BA-1" has launched in early 2009. The length of the vehicle is 3m and the weight in air is about 400kg. It has both hovering and cruising capability to operate in a test tank, an aquaculture pen and at the real sea. The design of BA-1, preliminary tests of equipped demand feeding system and a variable color lighting system, and interaction test with fish in an aquaculture pen will be addressed.

Diel acoustic characteristics and zooplankton composition of the sound scattering layer in I-Lan Bay, northeastern Taiwan

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Keywords: Sound scattering layer, zooplankton composition, northeastern Taiwan, I-Lan Bay.

I-Lan Bay was one of the important fishing grounds in the Northeastern waters of Taiwan. The shelf waters of the East China Sea meet the Kuroshio Current in this area, and any changes in the physical, chemical, and biological environment could have a profound impact on marine phenomena important to biology, ecology, and dynamic carbon transformation. The boundary between the Kuroshio water and nutrient-rich shelf water might also play an important role in primary production in this area, enhancing zooplankton production.

A 36-h acoustic observation of I-Lan Bay was conducted on board “Ocean Research II” from June 2 to 4, 2013.The acoustic volume backscattering strength (SV) was measured using a scientific echo sounder (EK500, 38kHz) to observe the acoustic characteristics of the sound scattering layer before and after the vertical movement of scatter in the deep scattering layers (DSLs). Two DSLs were found in daytime at depths of 80~130 and 130~230 m, with mean SVs of about -82 dB and -78 dB, respectively. Clear diel vertical movement was also detected for the deeper DSL, which started to ascend at dusk with a speed of 2.08 cm/s, and stayed at 10~80 m at nighttime. The deeper DSL started to descend at dawn with a speed of 1.25 cm/s and then stayed at depths of 130~230 m during daytime. The depth of the shallower DSL changed with temperature. The zooplankton composition is also discussed.

Spatial relationship between gray whale and zooplankton in the Bering and Chukchi Seas in early summer of 2013 using a quantitative echosounder

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Keywords: quantitative echosounder, gray whale, zooplankton, Arctic Sea, early summer

Gray whales (*Eschrichtius robustus*) annually migrate to higher latitude to forage. They are well known as a benthic feeder; however, some recent reports noted that whales feed at surface, and their distribution is related to Euphausiids in the Arctic Sea. The Euphausiids distribution survey in the Arcic was, however, conducted only in fall, a part of the feeding period of gray whales. To understand the relationships between gray whales and zooplanktons in early summer, the quantitative echosounder (Simrad ER-60, 38 and 120 kHz) survey was conducted alongside of the cetacean sighting survey from T/S Oshoro-maru in the Bering and Chukchi Seas in July 2013. The range of the Sv differences with 8-30dB was assigned to zooplankton category. The echo forms were used to identify Euphausiids or not. The zooplankton density was calculated as the Nautical Area Scattering Coefficient (m^2/nmi^2). In this survey, many of gray whales fed on benthos because of mud plumes at surface. They were higly aggregated (101 animals, 120-km range) in the northern Chirikov Basin. On the other hand, the strongest echoes (32006 m^2/nmi^2) were observed in the southern St. Lawrence Island, yet these echoes were not likely from Euphausiids. It was reported that Euphausiids drifted from the Bering Sea had formed highly dense aggregations in the Chukchi Sea in later summer. Our study, therefore, suggests that gray whales feed on general benthos in early summer, and may shift their prey to Euphausiids in later summer.

Year-round observation of sound scatters in the southern Chukchi Sea of the Arctic Ocean with a moored echosounder

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Keywords: Arctic Ocean, Chukchi Sea, moored echosounder, year-round observation

The recent drastic decrease in Arctic sea ice may cause various changes in the Arctic climate and ecosystems. Therefore, a mooring observation with an echosounder has been conducted to investigate the interaction between marine organisms and their physical environment in the southern Chukchi Sea of the Arctic Ocean. We used an echosounder, Acoustic Zooplankton Fish Profiler (AZFP, ASL Environmental Sciences) operating at four frequencies (125, 200, 455, and 769 kHz). It is a battery-operated echosounder and echo data can be internally recorded. A year-round observation was successfully conducted with two AZFPs. The first AZFP was deployed on 16th July 2012 at a biological hotspot in the southern Chukchi Sea and was recovered on 2nd October 2012. The second AZFP was deployed on 3rd October and was recovered on 20th July 2013. Both AZFPs were moored upward 6 m above the seabed at about 50-m depth. The echo data were converted to mean volume backscattering strength (MVBS) and the MVBS were visualized as echograms. Seasonal changes of the MVBS and diel vertical migrations were clearly observed and were relevant to nighttime or daytime hours, wind directions, and water temperature. Also there were echoes from not only biological sound scatters but also supposedly physical structures.

Long-term monitoring of fish aggregation flux around artificial reef using side-aspect acoustic system

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Keywords: artificial reef, fish flux, side-aspect acoustic system

Various artificial reefs are being used worldwide for creating fish ground in coastal region. Monitoring and assessment of established artificial habitats to know their effectiveness are a prime interest. Traditionally, net cage and visual census have been applied for evaluating the effectiveness. Recently, acoustic method was proposed to monitor biomass or fish flux for long term period.

In the study, fish flux at artificial reef was evaluated for a long time through a stationary hydroacoustic system (Acoustic Zooplankton Fish Profiler, AZFP, Canada), especially side-aspect view. The study was conducted at a artificial reef which was constructed in 2001 and built-up in 27 m depth. The shape and material was pyramid type (wide 7 m * long 7 m * height 7 m) and steal. Acoustic transducer was established at 25 m distance away from the reef and the acoustic beam was focused on the center of the reef's broadside. The system continuously collected acoustic data for 25 days (28 August - 22 September 2013). Acoustic frequency, beam width, and pulse length were 120 kHz, 8 degree and 0.2 ms, respectively. Environmental data such as water temperature, current, and tide were continuously measured for comparing acoustic data.

From long term monitoring, acoustic data show that fish aggregation had a typical pattern of the daily period. During the whole period the lowest levels were generally recorded in the night time (out flux), whilst the highest levels were commonly observed in the day time (in flux). And in the environmental parameter, the flux of the fish aggregation might be correlated with tidal period. [This study was supported by the grant No. PG47730].

Acoustic evaluation of the efficacies of different types of artificial reefs deployed in water off Haiko, Pingtung County, Taiwan

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Keywords: acoustic evaluation, artificial reef, canonical variables

Haiko artificial reef (AR) region is a particular place where there was deployed with a warship reef, twelve steel reefs and a group of concreted-electric-reefs in Taiwan. To compare the efficacies of renewing fishery resources and relationships with environmental factors after the reefs were installed at the AR region with different types of reefs, two acoustic surveys were conducted by using Simrad EY-60, EY-15 portable scientific echo sounders, CTD and acoustic Doppler current profiler on June 25th~26th and July 17th~18th, 2013, in water off Haiko, Pingtung County, Taiwan. Observations on in situ target strength (TS) and back scattering volume (Sv) versus environmental factors were recorded accordingly. Results thus obtained indicated (1) two daily movement patterns of fish schools around the reefs can be identified; (2) distribution of in situ TS, which were identified as fish school near artificial reefs, were significantly ($p<0.01$) affected by its locality and materials of reef; (3) values of in situ Sv near artificial reefs were also significantly ($p<0.01$) affected by temperature, salinity, and appearing period of fish; (4) correlations between dependent and canonical variables were 0.902 and 0.789, respectively.

The study on behavior of fish on an artificial reef using hydroacoustic

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Keywords: marine ranching areas, artificial reef, hydroacoustic, behavior.

Marine ranching areas (MRAs) were designed to preserve habitat, provide spawning ground, and improve productivity of fisheries resources around artificial reefs. To effectively use artificial reefs, the abundance, spatio-temporal distribution, and behavior of fish on the artificial reefs need to be continuously assessed.

The aim of this study was to use hydroacoustic in order to better understand fish behavior, such as - migration patterns of fishes in an artificial reef.

To assess fish behavior patterns, an acoustic survey was conducted from a drifting ship (36°41.46’N, 129°29.05’E) on an artificial reef (13.2 m × 13.2 m × 8.2 m) in the Uljin MRA in November 2012. Acoustic data were collected using frequency 200 kHz (dual-beam, BioSonics) during over 5 h period (15:54 - 21:00) and were analyzed using Echoview (3.0, Myriax).

The results of this study will be used as baseline data for the estimation of fisheries resources of artificial reefs by hydroacoustic.

Remote monitoring of conditioned juvenile chum salmon (*Oncorhynchus keta*) in a cage using bottom-mounted echosounder and stereo-video camera system

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Keywords: echosounder, conditioning by sound, juvenile salmon.

Juvenile chum salmon in a sea cage were remotely monitored using a bottom-mounted echosounder and a stereo-video camera from 15 to 21, April in Yamada bay, Iwate prefecture. The number of juveniles inserted into the experimental sea cage was estimated as 50000 in number. The juveniles had been conditioned in a hatchery station by making sound combined with automatic feeding. Conditioning has been continued on the sea just before the release day (17, April, 2013). A 70 kHz transducer (KFC3000, Sonic Corp.) was mounted on the bottom under the cage with upward looking before the juveniles were transported. Underwater stereo-video camera (horizontal field angle 45.4 degrees, base line 30 cm) was set to look upward to cover a feeding part of the cage. Monitoring system on a raft over the cage was consisted of a power generator, echosounder, stereo-camera, control PCs, and LAN. It was linked with the PCs on shore through wireless LAN. Measured average SV was converted to fish density using ventral average target strength of, -51.4 dB, for the juveniles with 50.3 (□2.9) mm in an average standard length. Though the juveniles were expected to be attracted by the conditioning sound after the release also, estimated densities decreased within a day after the release. It was found to be effective to use both the echosounder and video camera linked with shore for monitoring fish in a net cage.

New 3G network based remote display fish finder system

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Keywords: fish finder; telemetry; 3G network; remote display; image processing

An echo sounder telemetry system was developed in early 1960s, which send echo image of fish and sea bottom from sea to a distant place at land. That system could be helped fishermen to comprehend the fish entrapped time and the amount of fish, thus lead to increase the fishing efficiency. Echo sounder telemetry system was employed into set net fisheries in Japan successfully since 1970s. However, the system was using VHF (very high frequency) radio to transfer echograms, which limit their communication distance. Moreover, since the revision of Japan radio wave law, licenses are required for fishermen to use VHF radio. Therefore, this system is rarely used for marking fishing now. In recent years, benefit from the rapid development of wireless communication technology and hardware improvement, remote sensing and monitoring from anywhere at any time via mobile phone network become possible. However, the cost of mass data transmission is still not affordable for fishermen, and continuous mass data transmission may cause the data network be cut off. In this study, we propose a new method to display echo image of fish shoal and sea bottom remotely via 3G (3rd Generation) Network. The following system was conceived to demonstrate the possibility, and description of which is as followed.

The system includes a fish finder terminal and a web server. The fish finder terminal is comprised of a portable fish finder, an A/D converter, a compact PC, and a 3G USB data card. And, these units are built into a buoy with a battery. The web server receives data from buoy terminal and shows them to users who access to. First, the fish finder transmits ultrasound pulses into water and receives the reflected echoes. The reflected signals will then be converted to digital signals by the A/D converter and then inputted into the compact PC by a USB interface. Then, the software in the PC will process the data to detect the sea bottom, and extract fish schools from the echoes by digital image processing. The extract fish schools are constructed in the form of polygons and average echoes strength inside the polygons, which significantly compress the data size. After that, the extract data will be sent to the server via 3G network. The web server then reconstructs the echogram from the extracted data and shows them to the users. The functions and capabilities of the new system have been demonstrated by a sea trail experiment.

Spatial and temporal distribution of hairtail (*Trichiurus lepturus*) in Bungo Channel, Japan

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Keyword: *Trichiurus lepturus*, area backscattering coefficient, standing crop.

To ensure sustainable utilization of hair-tail fishery resources in the coastal and offshore waters off Japan, thirteen acoustic surveys were conducted in 2007 and 2012, respectively, using the Sonic KCE300 echo-integrator with a 38 kHz split-beam transducer. Longline fishing operations were used to exam the target species. TS to length relationship TS=20 log la -68.3 was used to estimate theoretical TS. The preanal length to length relationship $BW=1.11 \times 10^{-5} \times la^{3.04}$ was used to estimate the standing stock. The results are following

1. Preanal length of hair-tail fish was measured from 21.5 to 38 cm (mean was 27.34 ±13.36 cm) in July, while the preanal length was ranged from 15 to 45.5 cm(man was 25.12 ±15.40 cm) in October. Preanal length of hair-tail fish measured in July was larger than that in October.
2. Results showed that the area backscattering coefficient (Sa) of fish schools mainly distributed in the shallow areas in summer (from May to July). As the season changed, fish schools migrated to deeper areas in autumn (from October to November). At last, fish schools located in deeper areas of Bungo Channel in winter.
3. The reason why the standing crop estimated in summer was lower than any other seasons, is that it could be influenced by the migration of fish to shallower waters for spawning in the Bungo Channel. On the other hand, the highest evaluation of standing crop for hair-tail in autumn, indicate that they migrated back to the study area. As a result, some of fish schools moved to offshore waters to avoid the cold water mass; thus, the estimated standing crop obtained from the study area decreased in winter.

Stock abundance of *Rastrelliger kanagurta* and its correlation with sea surface temperature off Sarawak waters

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Keywords: Acoustic survey, Sea Surface Temperature, Chlorophyll and Pelagic Biomass

A survey to determine abundance of pelagic stock off Sarawak waters were conducted by using KK SENANGIN II from 26th of June to 1st July 2013. This vessel was equipped with a scientific echo sounder FURUNO FQ80 system to collect raw SV data from each survey transect in order to determine density of small pelagic comprising *Rastrelliger kanagurta* species. Physical oceanographic parameters mainly on sea surface temperature and density of chlorophyll were sampled using Hydrolab CX-5. Data were obtained from each sampling station which designed 30 nm apart from one station to another. Sampling only carried out during day time starting from 7:00 am to 7:00 pm daily. Observation for occurance of free schooling fish especially neritic tuna was monitored using normal binocular handled by one technical staff. Preliminary results indicate that occurence and abundance of *Rastrelliger kanagurta* has positive correlation with the sea surface temperature pattern and distribution of Chlorophyll concentration. This species was found more favourable living outside of thermal fronts where temperature gradient was higher than 0.5oC. The total biomass of *R. kanagurta* was estimated about 68,700 mt and the potential yield of 33,320 mt. Further studies were required to confirm these results.

Proposal for a fisheries quantitative echosounder

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Keywords: fisheries echosounder, quantitative echosounder, design, signal-to-noise ratio, fisheries resources survey

Fishermen have used fisheries echosounders (FES) to detect fish schools, while researchers have used quantitative echosounders (QES) to survey fisheries resources. The two types of echosounder are the same in principle, that is, the pulse-echo technique, but are different in purposes, that is, detection and quantification. Fisheries resources are materials for fisheries industry and therefore fishermen should know the present state of their resources and utilize them while sustaining them. The QES has advanced much and now it will not be so difficult to deliver its technique for fishermen's use. In this paper, a quantitative echosounder for fishermen's use (Fisheries Quantitative Echosounder, FQES) is proposed and designed, and its application to resources survey cooperatively performed by researchers is considered.

The design principle is simplicity and robustness. Traditionally used two frequencies, 38 kHz and 120 kHz, are selected because of the superiority of 38 kHz and the reasonable separation of the two frequencies. Using "universal diagram for echosounder performance", developed by the present author, which indicates the signal-to-noise ratio as a function of frequency for important parameters, the maximum detectable range and necessary power are estimated for two frequencies; the maximum range for a fish with target strength (TS) value -40 dB is about 300 m and appropriate electrical power is around 2 kW. Volume backscattering strength (SV) measurement and TS measurement by a quasi-dual-beam method are two fundamental methods. By using stored SV values, fish abundance estimation through the echo integration method is possible.

The accurate calibration of the system is performed sometimes by an engineer or researcher, but, by using flat standard sea bottom echoes, system check can be performed by a fisherman. Three types of surveys are supposed: Type I: researcher's survey using research vessel and QES, Type II: fishermen's survey using FQES and their fishing boat in good conditions such as slowing speed, and Type III: fishermen's survey in fishing operation. By systematically combining these survey data, more precise and dense evaluation of fish resources will be possible.

Development of the simple system for measurement of fish distribution in shallow water usig GPS fish-finder

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Keywords: GPS fish-finder, quantity of the fish shoal, volume-backscattering

Investigation of biomass by acoustic method in a shallow sea area does not advanced very much. The reasons are that the quantitative echo sounder is expensive. There is very little acquisition system that can be used in a simple way. The commercial GPS fish-finder are equipped on many small fishing boats. We thought that it might be able to use that GPS fish-finder instead of quantitative sonar. We tried to develop a system that can measure an approximate quantity and distribution of the fish shoal in a simple way using a GPS fish-finder. Generally, positional information and depth of the water information can be taken out in NMEA form from the commercial GPS fish-finder, but the sound signal cannot be taken out. Therefore we experimentally developed the device that take in an analog sound signal from a GPS fish-finder. This device that have AD converter can save the raw sound data of the GPS fish-finder by using recording software. Moreover, gain of the receiver amplifier was designed as 60 dB (low) and 80 dB (high). Because it was aimed to make the quantification in a simple way, frequency was used 50 kHz that less influence of a swimming posture and the beam shaking. Next we checked about the validity of this system at the Tateyama bay on October 24, 2012. After checking the validity of this system, we investigated at the Tateyama bay on April 25, 2013, and we could calculate the volume backscattering strength (SV) and area backscattering strength (SA). So, we have succeeded in developing a system that can measure a rough quantity and distribution of the fish shoal in a simple way by using the GPS fish-finder.

Development of a new chirp echo sounder

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Keywords: fish, size, chirp, broadband

The fish size indication function has applied general type echo sounder so far, fishermen have requested to improve performance. In this background a new echo sounder was developed.

This echo sounder is using broadband chirp technologies to be able to get higher resolution images than the traditional echo sounders. Therefore the fish size information is improved by using chirp technologies.

In this presentation, we will introduce the feature of the echo sounder using some field images.

The measurement of fish close to the bottom by the broadband split-beam echo sounder

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Keywords: Broadband, bottom trawl

It has been difficult to estimate the stock of fish close to the sea bed by conventional quantitative echo sounder. Because duration of a transmitted pulse is long enough to be mixed between the echoes from the fish and the bottom. Recentry, a broadband echo sounder was proved to have high spatial resolution using pulse compression technology. We identified individual echo trace and measured target strength of each benthic fish by using a broadband split-beam echo sounder (FSS-SBx, Furuno Electric Co. Ltd.,) during bottom trawling net. Acoustic data were measured by using the broadband split-beam echo sounder which can transmit liner FM chirp signal (70 kHz to 130 kHz). The distance resolution was approximately 8 cm. The survey was conducted at June 2012 off Choshi Japan by using Taka-maru (NRIFE, 67t). The depth sensors (ATD-HR, JFE Advantech co., Ltd.) was fixed at the upper and lower entrance of the trawl net. The difference of the measured depth and the bottom depth corresponds to the net height during trawling time by time.

The ratio of catch numbers, Japanese jack mackerel (*Trachurus japonicus*) accounted for approximately 60%, 30% were heterosomata (ex. flatfish), and 10% were other species (ex. octopus) in one seining net experiment. Although some echoes from pelagic school could be obtained, most of single echoes were measured close to the bottom. All fish echoed within the net height from the bottom were used for the further analysis. The average net height was 1.5m. A target strength was measured at the maximum echo intensity of an echo trace. The average target strength during the survey was -48.4 dB The body length estimated by the acoustic and direct catches by the trawl net was correlated well . The broadband split-beam ystem was proved to be a tool to observe benthic fish.

Calibration of a high-frequency broadband echosounder using a 38.1-mm-diameter tungsten carbide sphere

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Keywords: broadband echosounder, calibration, echo from front interface, standard sphere

A high-frequency broadband echosounder operating at the frequency band 200–700 kHz was constructed. Although calibration of broadband echosounders can be performed by several ways, the standard-sphere technique using a tungsten carbide sphere is often applied to the calibration. For a good calibration, a sphere of appropriate size, which the frequency dependence of its target strength (TS) is weak at the frequency band of echosounder, should be chosen. For our system, a sphere of diameter 4 mm is reasonable. However, it is not easy to suspend such a small sphere on the beam axis and is not suitable for a field calibration. Therefore, we used a 38.1-mm-diameter tungsten carbide sphere which is usually used for the calibration of narrowband scientific echosounders. Although there are many resonances in the frequency dependence of the TS of the 38.1-mm sphere, to avoid the resonances, we employed the method presented by Dragonette et al. [J. Acoust. Soc. Am., 69, 1186-1189 (1981)] and Stanton and Chu [J. Acoust. Soc. Am., 124, 128-136 (2008)], which exploits the echo from the front interface of a sphere. The calibration measurement was conducted in a fresh water tank. The transmitted signal was a linear frequency modulated signal with a frequency sweep of 250–700kHz. The received echo waveform was pulse compressed to improve the range resolution. The echo from the front interface and other echoes were clearly separated and the system response could be obtained. In order to examine the accuracy of the calibration result, the TS spectrum of a 20.6-mm-diameter tungsten carbide sphere was measured. As a result, the measured and predicted TS spectra of the sphere of diameter 20.6 mm were in good agreement.

Listening to the Deep-Ocean: A global underwater noise monitoring initiative

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Keywords: underwater noise, marine observatories, marine life

The growing scientific and societal concern about the effects of underwater sound on marine ecosystems has been recently recognized through the introduction of several international initiatives aiming at measuring the environmental impact of ocean noise on large spatial and temporal scales. From a regulatory perspective, the European Marine Strategy Framework Directive includes noise as one of eleven descriptors to determine Good Environmental Status of the oceans. The Directive specifically requires Member States to provide a measure of annually averaged noise. LIDO (Listening to the Deep-Ocean Environment) has developed a software package that measures sound levels and monitors acoustic sources in real-time; this software is now operating to provide industry with an environmentally responsible approach. The system is currently operating worldwide from several wired and radio-linked platforms, including the JAMSTEC underwater observatories. Recently, through a zero-cost contract with the CTBTO (Preparatory Commission for the Comprehensive nuclear-Test Ban Treaty Organization), years of data from hydroacoustic stations were analysed to look for background noise trends and to detect cetacean presence. Here, we present the analysis of four CTBTO platforms, each covering 42 months of data, focussing especially on the estimation of background noise levels and the measurement of noise contributions from anthropogenic sources. Continuous monitoring of background noise will indeed help to understand whether long-term exposures to noise, in areas with intense shipping or seismic campaigns, for instance, might alter animal natural behaviour and may be used in the future to assess the effects of ocean noise on marine life.

Passive acoustic monitoring of multiple cetacean species in the Istanbul strait

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Keywords: echolocation, harbor porpoise, common dolphin, bottlenose dolphin.

The Istanbul Strait (*Bosphorus*) is a part of the Turkish Straits System, connecting the Aegean Sea and the Black Sea. There are three cetacean species in the Strait, namely the harbor porpoise (*Phocoena phocoena*), the common dolphin (*Delphinus delphis*), and the bottlenose dolphin (*Tursiops truncatus*). To monitor the presence of the cetaceans, a fixed stereo passive acoustic monitoring system (A-tag) was deployed in the middle of the Strait from July 2009 to September 2010. In total 26,814 click trains were detected. Presence, direction and inter-click intervals of phonating cetaceans were measured. Nocturnal presence was prominent in March and April. In this season, the cetaceans were concentrated in one specific direction from the fixed monitoring system. Short range sonar was commonly detected. In contrast, they were found in all directions for the rest of the year and ICIs could reach up to 150 ms. We tried to use two-band spectrum intensity ratio at 130 kHz and 70 kHz to identify Phocoenidae out of Delphinidae. Acoustic identification was verified by visual identification of species to assess accuracy of acoustic detection probability. Even different ration of species mixture between 26% and 80%, >80% correct detection and <20% false alarm for both species were confirmed. Dominant species in spring was suggested to be harbor porpoises in the present study site. Our findings suggest that odontocetes especially harbor porpoises were feeding or socializing in spring and mostly travelling in the other seasons. It is well known that pelagic fih such as sprat and bluefish start their migration from the Aegean Sea to the Black Sea in spring.

Underwater noise and behavior characteristics of pacific cod in Jinhae Bay, Korea

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Keywords: underwater noise, behavior, Pacific cod, acoustic telemetry, Jinhae Bay

In order to collect basic information of migration of pacific cod (*Gadus macrocephalus*), we investigate the behavior of pacific cod during winter in Jinhae Bay. Three wild fish (WC1 to WC3) were tagged with the acoustic tags by surgical internal method, and average total length and weight of tagged fish was 2.4 kg(±0.4) and 68.0 cm(±7.5), respectively. To detect tagged fish escaping from Jinhae Bay, six acoustic receivers (VR2) were moored at 5 m water depth layer below sea surface with an interval of 1 km along the mouth of the bay. The movement route of tagged fish was tracked using VR28 tracking system with four directional hydrophones. Three tagged fish, WC1 to WC3, were individually released within the bay on 12 to January and 14 February, 2011. WC1 and WC3 preferred to stay around the release points, and it did not escape from the bay during the experiment. However, WC2 moved toward the mouth of the bay and showed circular turning around with an interval of 15 to 20 minutes. The time required for making one circular turning around of the fish was 10 minutes, approximately. 1.1 hours later from releasing the fish completely passed the submerged underground tunnel constructed for passing cars. The fish after cross passing the submerged tunnel showed the movement behavior toward the mouth of the bay. During the experiment, maximum swimming speed was 2.9 TL/s and minimum was 0.5 TL/s. The underwater noise level in 5 m depth below sea surface measured around the submerged tunnel on 14 February 2013 was 123 to 124.0 dB (re 1μPa). The noise level was increased 3.7 to 5.4 dB (re 1μPa) than before construction of the tunnel.

Application equipment using correlation ASIC

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We had developed the correlation ASIC for underwater applications. The correlation ASIC can realize an advanced application for small sizing, low power dissipation and improved SN ratio. Biotelemetry device should be small, long life, easy treatment and new technology. Fusion Inc. have developed new equipment using the correlation ASIC FDC-1024 for underwater acoustic application shown in Fig.1. The Pinger receiver FMR-1000 can collect the Gold code pinger signal to SD card in three month. The Net mouth distance measurement SDKN-500 can measure the distance of net mouth and measured results are stored to SD card. The small size transponder FTP-250 responses to Gold code signal and transmits another Gold code signal to calling transducer. The Remote temperature device FRTD-600 transmits depth and temperature data using Gold code signal. The Interfish telemetry is very unique device. It can simultaneously transmit and receive multiple Gold code signals between multiple fish. It is also the device that has two functions of pinger and logger. The data of another fish behavior is stored to SD card of another fish device. Such a thing has been realized because there was existence of the correlation ASIC.

Latest products using custom correlator ASIC FDC-1024

- **Pinger receiver**
- **Net mouth distance measurement**
- **Small size transponder**
- **Remote temperature device**
- **Interfish telemetry device**
- **Tiny pinger (depth+temp.)**

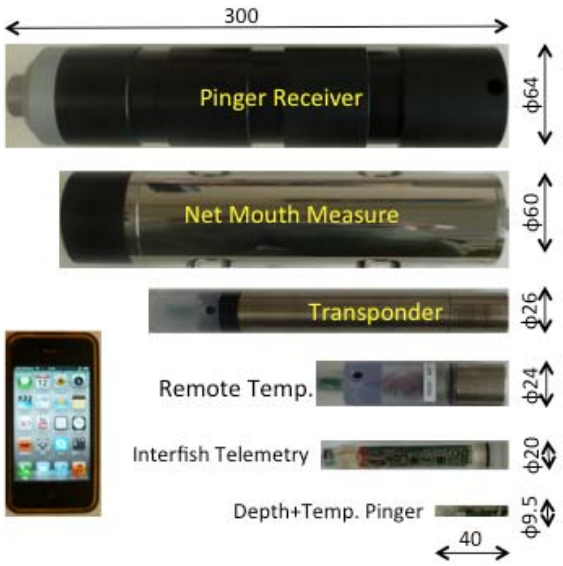

Fig.1 Hydroacoustic equipment using ASIC

Acoustic estimation of effective gathering range of squid jigging boat equipped with fishing lights

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Keywords: acoustic tag, fishing light, Japanese common squid, sonar, echosounder.

The effective range of fishing light for the Japanese common squid (*Todarodes pacificus*) jigging was investigated using acoustic methods in the Sea of Japan in late August 2011 and 2012. A research vessel (R.V. Kaiyo Maru No.5, 495 G.T.) collected acoustic signals of a sonar and a quantitative echosounder from squid around a jigging boat (R.V. Hakusan Maru, 167 G.T.) equipped with 78 metal halide lamps (total electric power 234 kW). Digital images of sonar echogram were composed to make maps which can be used to measure locations, sizes, and relative echo intensity of squid schools. Behavior of individual squid was observed by an acoustic coded tag with a depth-sensor (FPX, Fusion Inc.). A receiver with four hydrophones (FRX, Fusion Inc.) was equipped with on each vessel. The tag was attached on a backside of fin of squid onboard the research vessel. Total 81 tagged squids were released from the research vessel in seven nights and the distance between the vessels at release time ranged from 0.25 to 2.0 nautical miles (nmi). The signals from total 43 squids (53%) were received at the jigging boat after 1 - 3 hours from their release. Among them the signals from the two of four squids which were released at 2.0 nmi were received at the jigging boat. From these results, the effective gathering range of this jigging boat with 78 metal halide lamps was estimated to be at least 2.0 nmi.

Growth of swimbladder and acoustical behavior of walleye pollock (*Theragra chalcogramma*) larvae

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Keywords: swimbladder, walleye pollock, larvae, resonance

In this study, we observed swimbladder of walleye pollock larvae and investigated acoustic characteristics. Understanding the dynamics in early life history of walleye pollock is important for resource management. There is little knowledge about acoustic characteristics of walleye pollock larvae around Japan. Acoustic scattering properties are estimated theoretically from swimbladder shape. The larvae were hatched from spawning fish that had been kept in experimental tank of Hokkaido University. The eggs were collected through a filter and transferred to incubator. Swimbladder shape were observed using an optical microscope, and photographed with a digital camera. The outlines of swimbladder were traced from these digital photos to observe the shape. As a result of estimated target strength (TS) by the resonance model using swimbladder shape, resonance frequency f_0 was approximately 115 kHz, that parameters were swimbladder length by height b/a = 0.5, fish length l = 0.5 mm, a/l = 0.04, depth d = 10 m. The result shows that frequency responses of estimated TS were gentle.

Ex situ, in situ, and modeled target strength estimation of the large jellyfish *Nemopilema nomurai*

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Keywords: jellyfish, *Nemopilema nomurai*, bell diameter, target strength

As a target species, the jellyfish, which has a body composition of 95% water, has been difficult to detect acoustically because there is not much difference in signal impedance between seawater and jellyfish. However, the distribution and abundance of jellyfish has been estimated by Lynam (2006), Alvarez Colombo et al. (2009), and Graham et al. (2010) using acoustic measurement.

This study was a baseline study to estimate the distribution and abundance of *Nemopilema nomurai* in Korea, Japan and China. Our goal was to find the target strength (TS) - bell diameter (BD) relationship for *N. nomurai* by ex situ, in situ, and modeling methods.

For the *ex situ* experiment, we applied a frequency of 38 kHz (EK500, Simrad) to tethered *N. nomurai* in a seawater tank (5 m length × 5 m width × 5 m height) at the Aquaculture Center of Chonnam National University, Yeosu, Korea, in August 2009. An underwater video camera was used to monitor behavior and tilt angle of *N. nomurai* during acoustic measurements.

For the *in situ* experiment, TS was measured using two frequency, 38 and 120 kHz (EK500, Simrad), while on-board the training vessel “Dong Baek” of Chonnam National University between the northern part of the East China Sea (ECS) and the southern part of Jeju Island in June 2010. Sampling to identify the target species and size composition was carried out with a framed midwater trawl (2 m × 2 m opening, 0.3 mm mesh). The net was towed for about 10 min at a speed of 2 - 4 knots.

Sound scattering by *N. nomurai* was estimated by the distorted wave-Born approximation (DWBA) model. The input parameters of *N. nomurai* were g=1.0040, h=1.0008, and the body shape description from Hirose et al. (2007) and Hirose et al. (2009).

Results of the TS – BD relationship for *N. nomurai* are presented and discussed.

Target strength of copepods (*Neocalanus cristatus*) with oil sacs at 120 kHz

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Keywords: Copepods, *Neocalanus cristatus*, Oil sacs, Target strength

Among the zooplankton, copepods are an integral component of oceanic ecosystems. Large grazing copepods *Neocalanus cristatus* are known to be preyed upon by some pelagic fishes, whales, and sea birds. Late copepodite stages of *N. cristatus* store copious quantities of liquid wax in an oil sac. In this study, we examined the difference in target strength (TS) by the oil sac presence. Side-aspect target strength of *N. cristatus* was measured as a function of the incident angle of the ensonified wave in a seawater tank (3.7×2.2×2.2m) in June 2 and 9, 2013 using an echo sounder (KFC3000, Sonic Ltd.) at 120 kHz. A specimen was tethered as its lateral aspect faced to the transducer, and the transducer was rotated around the specimen from -40° to 40° at intervals of 1 degree. These measurements were compared with the theoretical predictions by the Distorted-Wave Born Approximation-based deformed-cylinder model (DWBA model).

The target strength patterns of 12 individuals' *N. cristatus* (Prosome length: PL = 6.8 - 7.9 mm) were measured. And we made comparison with an estimate value by the DWBA model. The value of density contrast (g) and sound speed contrast (h) of *N. cristatus* for DWBA model calculation was g = 1.0022 and h = 1.0163, measured by a past, respectively. As a result, our data corresponded with DWBA model for TS of copepod without or with small oil sac but mismatches for copepod with large oil sac. The TS pattern of copepod without or with small oil sac and DWBA model estimation become the form of the convex on the main lobe, but copepod with large oil sac become the form of the concave on that. This is considered to be due to the difference of g value between body and oil sac, and we will study including examination of models to be used in the future.

The effect of material properties on euphausiid (*Thysanoessa* spp.) target strength estimated using an acoustic scattering model

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Keywords: *Thysanoessa* spp, DWBA, material properties, *ex situ* TS measurement

The target strength (TS) of euphausiids (*Thysanoessa* spp.) has been estimated using a distorted-wave Born approximation (DWBA) model with parameters which assumed that the euphausiid body has homogeneous properties. However, the properties of different body parts (cephalothorax and abdomen) are likely to differ, leading to inaccurate TS estimation. Therefore, it is crucial to examine these consequences by measuring the density contrast *g* of the cephalothorax and abdomen separately.

This study compared the TS measured using a 120-kHz echosounder with the theoretical TS calculated for the cephalothorax and abdomen of *g*. Euphausiids were sampled using an 80-cm ring net in the Okhotsk Sea and Funka Bay, Hokkaido, Japan. The *ex situ* side aspect TS of euphausiids was measured in a 3.7 × 2.2 × 2.2-m seawater tank. The *g* value of the cephalothorax and abdomen was 1.021 ± 0.009 (mean ± SD) and 1.035 ± 0.006, respectively, on November 2012, while the respective results on July 2013 were 1.027 ± 0.012 and 1.046 ± 0.003. The sound-speed contrast *h* was estimated to be 1.046 (water temperature 2.0℃) on July 2013.

The theoretical and measured TS indicated similar values around the main-lobe, while the theoretical value was slightly higher than the measured TS at the side-lobe. In conclusion, we confirmed the accuracy of using a DWBA for estimating the TS of euphausiids. In addition, the different *g* values of the cephalothorax and abdomen for estimating the dorsal aspect TS at 120 and 200 kHz were examined. The DWBA using the minimum *g* at the cepahlothorax and the maximum *g* at abdomen were similar to the value at main-lobe, but higher (maximum 10dB) than at the side-lobe using same *g* along the euphausiid body.

Acoustic detection of Harmful Algal Bloom's (red tide) in summer season 2013, south sea of the Korea

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Keywords: Acoustic detection system (HABs), Buoy type system, Harmful Algal Blooms

The toxic, Harmful Algal Blooms (HABs, called red tide) caused by the *Cochlodinium polykrikoides* has serious impact annually in coastal waters of Korea and its impact is a tendency to increase in the other ocean. As rapidly dispersive speed and massive damage of the aqua-cultured fishes, more rapidly detection is necessary. First of all, in order to mitigate or eliminate the species before making a vast damage, early detection is most important for fisherman. During the last 4 years, Korea Institute of Ocean Science & Technology has been developed real-time acoustic detection system, based on the acoustic scattering properties of *C. polykrikoides* and ~ MHz ultrasonic transducer. After consequently field and laboratory test of the prototype wireless system, from last year we tried to evaluate performance and usefulness of the full system in the field.

In summer season 2013, very strong red-tide occurred from July to August in the coastal area of the south sea in Korea. Because of the red-tide, aquacultured fishes species had a massive damages. From late June to September, we evaluated the system to detect red-tide for a long time. The acoustic data (volume backscattering strength) and surface temperature with 5 minute intervals were continuously recorded and transported to remotely control centre. From the evaluation, the developed acoustic system can early detect red-tide than traditional counting method, approximately 5 days. And the *Cochlodinium polykrikoides* species have a strong daily migration pattern; surface layer during daytime and bottom layer during nighttime. The system can be applied to real-time detect HAB in the coastal water and expanded to another field for detecting aquatic micro-organisms. [This study was supported by the grant No. PE98933]

Geographical distribution of acoustic impedance in the head of Harbour Porpoise *Phocoena phocoena*

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Keywords: Harbour porpoise, Sound emission, Acoustic impedance, Dissection

High complexity of the sound emission structure of Harbour porpoise makes the elucidation of the function very difficult. Sound emission process of the porpoise has been supposed from morphology of head soft tissue mainly by using macroscopic dissection or CT imaging. Though the goal of these studies is to reveal sound propagation system, few study have been conducted which are based on acoustic considerations, especially on the continuity of the acoustic impedance which is essential for effective sound propagation. Although the acoustic impedance is estimated from density and Young's modulus, little is known about these distributions. In this research, distribution of the acoustic impedance in the porpoise's head was investigated and the conventional hypothesis about the sound propagation system was verified. Distribution of sound impedance in melon increased continually from caudal to rostral and finally accorded with impedance of seawater. Additionally, acoustic impedance change was much more caused by the change of Young's modulus than density. Results show that conventional hypothesis which impedance matching happens in the porpoise's head could be supported. However, conventional studying method such as density-relying analysis should be reconsidered.

Seasonal variation of scattering strength in the estuary of Tan-Sui river, Taiwan

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Keywords: Volume scattering strength, seasonal variation, northwestern Taiwan, Tan-Sui river estuary.

Tan-Sui river with the average flow 180.07 m^3/s is one of the biggest rivers in northwestern Taiwan. It is not only offering the transportations, economics, and entertainment on our living, but also playing an important role on oceanic organism. Due to the inter-influence from tidal current, river-water and seasonal variation, biomass distribution in the Tan-Sui river estuary fluctuate dynamically. Acoustic survey allows surveyors to conduct their researches in a direct, swift, three-dimensional, and consecutive manner. In this study, we tried to find the seasonal variation of volume scattering strength (Sv) by the research vessel “Ocean Research II” mounted the echo sounder systems SIMRAD EK60 (38, 120 kHz) during 2012.

The results showed biomass distribution would change with seasons. And the Sv values also would change in different seasons, the Sv38 values were lowest about -81.1 ±1.9 dB in the spring; and highest about -56.7 ±3.0 dB in the summer. Those were -62.9 ± 1.3dB (Winter), -81.1±1.9dB (Spring), -56.7 ± 3.0dB (Summer) and -69.2 ± 5.4dB (Fall), respectively. The Sv120 values were lowest about -86.3 ±1.9 dB in the spring; and highest about -63.9 ± 3.0 dB in the summer. Those were -67.8 ± 1.2dB (Winter), -86.3± 1.9dB (Spring), -63.9 ± 3.0dB (Summer) and -64.6 ± 7.5dB (Fall), respectively. Usually, there was the higher Sv-value nearly the estuary of Tan-Sui river.

Identification of zooplankton using three frequency difference methods around Funka Bay, Hokkaido Japan

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Keywords: Funka Bay, acoustic survey, zooplankton, three frequency difference method

Around Funka Bay located in southwest of Hokkaido, Japan, copepods and krill are the dominant species of the zooplankton. They are important prey for walleye pollock and other marine animals in this area.

In this study, we examined the possibility of identification of krill and copepods using acoustic method which incorporates the three frequency difference method in order to identify the zooplankton species.

Acoustic surveys were conducted around Funka Bay June in 2012 using TS Ushio-maru which installed the quantitative echo sounder EK60. The acoustic data were collected by three frequencies including 38, 120 and 200kHz. Biological samples were collected by the ring net (diameter of 80 cm with mesh size of 334μm) with vertical towing. In order to identify copepod and krill, the echograms obtained by three frequencies were compared by Mean Volume Backscattering Strength (MVBS) according to the equation : $\triangle MVBS\ (dB) = MVBS_{\text{High frequency}} - MVBS_{\text{Low frequency}}$.

Copepod (mean PL 3.4mm) and krill (mean TL 14.5mm) size were compared with that obtained in net sampling. The result showed that the $\triangle MVBS_{120\text{-}38kHz}$, $\triangle MVBS_{200\text{-}120kHz}$ and $\triangle MVBS_{200\text{-}38kHz}$ of copepod were 17.4 ~ 19.9 dB, 5.0 ~ 8.8 dB and 22.4 ~ 28.7 dB, respectively. The differences in MVBS at three acoustic frequencies of krill were $9.5 < \triangle MVBS_{120\text{-}38kHz} < 15.5$, $-3.1 < \triangle MVBS_{200\text{-}120kHz} < 3.8$ dB and $6.5 < \triangle MVBS_{200\text{-}38kHz} < 19.3$ dB, respectively. According to the results of $\triangle MVBS$, biovolume of copepods has been underestimated in $\triangle MVBS_{120\text{-}38kHz}$ and $\triangle MVBS_{200\text{-}38kHz}$ than $\triangle MVBS_{200\text{-}120kHz}$. The biovolume of krill was overestimated with $\triangle MVBS_{200\text{-}120kHz}$ and $\triangle MVBS_{200\text{-}38kHz}$ than $\triangle MVBS_{120\text{-}38kHz}$.

Estimating the Sampling Efficiency of Framed Midwater Trawl Net and Ring Net Using an Acoustic Method

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Keywords: sampling efficiency, quantitative echosounder, acoustic method, plankton net

Estimating the sampling efficiency is necessary when deriving absolute abundance estimates from net survey data. Sampling efficiency can be estimated directly as the quotient of fish density from the sampling gear to density estimates from other methods, such as an acoustic method. The acoustic method has an advantage that enables to estimate biological density without damaging organisms. However, only a limited number of studies have been performed to estimate the sampling efficiency using the ratio of net densities and acoustic densities. In this study, we compared the plankton density estimated by an acoustic method and plankton nets, and calculated the sampling efficiency of the plankton nets for each species.

The surveys were conducted in the external part of Funka Bay in April, May and June 2011 and January 2012 using T/S USHIO (179t, 39.39 m). The net samples were collected using a Framed Midwater Trawl net (FMT, net mouth area 4 m^2, mesh size 1.5 mm) by horizontal towing at a speed of approximately 3 knots, and a Ring net (net mouth diameter 80 cm, mesh size 0.334 mm) by vertical towing at a speed of approximately 2 knots. The acoustic data were collected using a calibrated quantitative echosounder EK60 (Simrad, 120 kHz) and processed with Echoview 4 (Myriax).

Estimating the sampling efficiency was performed by a multivariate analysis. Here, we defined the volume backscattering coefficient (Sv) obtained from the quantitative echosounder as a response variable, and the product of the plankton density collected from net sampling and the backscattering cross-section (σ_{bs}), calculated using a Distorted-Wave Born Approximation (DWBA) model, as explanatory variables. Then, we performed a multiple regression analysis with SPSS, and estimated the sampling efficiency for each plankton group by calculating a partial regression coefficient.

The sampling efficiencies of the FMT net and the Ring net were estimated at a high confidence level for euphausiids and copepods. For the FMT net, the sampling efficiencies were estimated to 0.2, 0.5 and 0.4 for small euphausiids, large euphausiids and copepods respectively. For the Ring net, the sampling efficiencies were estimated to 0.7, 0.1 and 0.9 for small euphausiids, large euphausiids and copepods respectively.

Semi-automated detection of giant jellyfish *Nemopilema nomurai* by echo trace analyses on high resolution echograms

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Keywords: echosounder, echo-trace counting, giant jellyfish, school detection.

Investigation of the distribution of giant jellyfish (*Nemopilema nomurai*) in their visit period is significant to prevent serious damage to coastal fisheries of Japan. An echo-trace counting method was established to assess continuously the horizontal and vertical distribution of the jellyfish. The echo-trace counting on the echogram by eyes realizes high precision, but it is time-consuming. Therefore, in this study, the semi-automatic detection of giant jellyfish echoes was tried by school detection software (Echoview, Myriax Software). The giant jellyfish echoes were detected on the high resolution echograms obtained by a quantitative echosounder (EK60, SIMRAD) operated at 200 kHz around the Tsushima strait in July 2009. The vertical and horizontal echo lengths were used to discriminate a giant jellyfish. The range of the horizontal echo length of a single jellyfish was set wide as 2.3 to 12.0 m, because it varies according to depth. And, the range of the vertical echo length was set as 0.33 to 0.95 m considering the pulse length and the bell-diameter composition of jellyfish measured by nearest trawl net sampling. As the result of school detection, 60 echoes were detected on the 0.1 nautical miles range near the net sampling point. Among detected 60 echoes, the 19 echoes of them were judged not to be a giant jellyfish by eyes. In addition, two echoes were not detectable by the software because of the overlapped two jellyfish echoes. In this range, the detection rate (60/62) was 95.3 %, and the false detection rate (19/60) was 31.7 %. The false detection rate was high to be caused by using only two detection parameters. Therefore, it is necessary to extract characteristic parameters from the detected giant jellyfish echoes and to consider what parameter is available to detect them with accuracy.

Application of an acoustic camera and echo sounder for understanding fish lengths and orientations

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Keywords: echosounder, acoustic camera, freshwater, fish length, fish orientation

An acoustic camera, which is a type of imaging sonar, is a relatively new instrument compared to echo sounders. The acoustic camera produces high resolution data samples, even though the detection range is relatively short e.g., approximately 30 m at 1.8 MHz and 90 m at 1.1 MHz. This system has video-like data quality, so that it has been increasingly employed to elucidate the ecology and population of aquatic organisms, especially in fresh water environments. It is expected that more information could be obtained, the more the system is used. In this study, the acoustic camera (Dual-frequency Identification Sonar, DIDSON) and the echosounder (EY 60) were both used to collect acoustic data in Mituo of Yangtze River on April 19, 2011. The Mituo area was decided as the core zone of the National Nature Reserve for the Rare and Endemic Fishes in the Upper Reaches of the Yangtze River. It is a river channel with the largest turning angle (approximately 124 degrees), and is an extremely important area since many juveniles of endangered and endemic fish species were found around the area. Any information related to these species is highly necessary for more suitable river management and natural conservation. This demands a tool for obtaining that information. Therefore, the aim of the study is to devise a method for understanding fish length, density and their movement using acoustic data from two systems. The precise steps of this method are demonstrated using Echoview (Fisheries Acoustic Data Analysis Software). As a result, not only the number of fish detected but also fish length, their distribution depth, change in depth, speed and time are exported for further analysis. This application can be used to evaluate fish density and to understand their ecological characteristics in various environments.

Echoview – a software partnership for continuous development

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Keywords: Echoview, post processing, software, echo integration.

Echoview is a unique software package that is continuously enhanced to meet the evolving needs of the world's fisheries acoustics community. The enhancement process attempts to maximise the value provided to the acoustics community given size of the development team and taking into account a diversity of needs. The process of selecting enhancements considers the needs of different segments of users and the trends in technological and scientific changes in the practice of fisheries acoustics.

User needs considered include: speeding improvements to reduce processing time, improving user interface and data flows to reduce processing time, making acoustic data processing simpler and easier to understand, adding algorithms to allow more advanced analyses, supporting new acoustic instruments, supporting larger data sets and supporting new analysis techniques.

Echoview version 5 will be used to illustrate the enhancement process. Version 5.0 included a major re-write of core elements of Echoview to support "multiple threading" that set the software up for taking advantage of multi-core processes on current computers. The new architecture allows significant speed improvements for current processing needs and the ability to support much larger data sets, such as multiple frequency, broadband and multi beams into the future. Versions 5.1, 5.2 and 5.3 have built on the new architecture to deliver the speed improvements, improve existing algorithms (such as handling of "bad" or missing data), support for Windows 8 and new instrument support.

Recent enhancements will be illustrated and a roadmap of anticipated developments presented – a roadmap that will be modified based on user feedback and requests as we attempt to maximize utility of Echoview to the fisheries acoustics community.