附錄二　會議資料

AFAS Overview

International meetings on Fisheries Acoustics in Asia were held four times over the last decade. The first meeting was held in Pusan, Korea in 1997, entitled "International Workshop on Acoustic Surveys of North Pacific Fisheries Resources", and the second meeting was held in Hokkaido, Japan in 2000, entitled "International Symposium on Advanced Techniques of Sampling Gear and Acoustical Surveys for Estimation of Fish Abundance and Behavior", both in conjunction with the PICES (The North Pacific Marine Science Organization) annual meetings.

The third meeting was held in Dalian, China in 2007. In this meeting, we independently established the Asian Fisheries Acoustics Society (AFAS) based on past activities in order to promote further progress of science and technologies on Fisheries Acoustics in Asian countries.

The fourth meeting was held in Incheon, Korea as the second annual meeting of AFAS (AFAS2008), which was four major topics, total of six countries, more than 40 scholars, and published 26 papers. At the annual meeting also decided that the 5th meeting (including the third annual meeting) will be held in Taipei, Taiwan in 2009. It will be hosted by National Taiwan Ocean University, Environmental Biotechnology and Department of Fisheries Science, and the chairman Dr. Ming-An Lee as the organizer, contact person are Dr. Don-Chung Liu (the Chief Secretary of Fisheries Research Institute of COA Taiwan) and Dr. Cheng-Hsin Liao (the Director of Environmental Biotechnology and Department of Fisheries Science of NTOU).

The coming fifth meeting will be held in November 2009. Since there are many particular problems in Asian fisheries, the AFAS aims to apply the acoustical technologies for Asian fisheries.

Organizing Committees

Dr. Ming-An Lee
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Department of Environmental Biology and Fisheries Science
College of Ocean Science and Resource
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Dr. Don-Chung Liu
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Professor
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Steering Committees

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Professor
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Dr. Dezhang Chu
Supervisory Physical Scientist (Acoustics Team Leader)
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Department of Environmental Biology and Fisheries Science
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Dr. Long-Jing Wu
Director
Coastal and Offshore Resorce and Research Center
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Keynote Speakers

Kohji Iida

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Faculty of Fisheries Sciences, Hokkaido University
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Research Interests:

- Development of hydro-acoustic instrument for fisheries science.
- Biomass estimation of marine organisms using acoustical methods.
- Application of underwater acoustics for fisheries.

Education:

- B.S.(Fisheries) HokkaidoUniversity, 1976
- M.S.(Fisheries) HokkaidoUniversity, 1979
- Ph.D.(Fisheries) HokkaidoUniversity, 1987

Dezhang Chu

Supervisory Physical Scientist (Acoustics Team Lead)
NOAA/NMFS Northwest Fisheries Science Center, Seattle, WA, USA
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Background:

Dr. Dezhang Chu joined FRAM's Acoustics Team in October, 2007. He has a B.S. in Electrical Engineering from the University of Geosciences in Wuhan, China, and a Ph.D. in Geophysics from the University of Wisconsin. Prior to joining the FRAM Division, Dr. Chu worked at Woods Hole Oceanographic Institution (WHOI).

Current Research:

Dr. Chu's research interests cover a variety of topics in fisheries acoustics. His current research focuses on applying advanced sampling technologies to fisheries surveys,

developing more advanced data processing techniques, and developing more sophisticated and robust scattering models.

D. Benjamin Reeder

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Education:

PhD -Massachusetts Institute of Technology/Woods Hole Oceanographic Institution, 2002
Oceanographic Engineering
BS -Clemson University, Clemson, SC, 1988
Physics (magna cum laude)

Research Interests:

- Ocean acoustics, theory and experiment

Memberships:

- Acoustical Society of America
- American Geophysical Union

Masahiko Furusawa

Tokyo University of Marine Science and Technology, Professor Emeritus
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Phone: 09090194965
Email: frsw@fine.ocn.ne.jp

Education:

PhD (Engineering), Tokyo Institute of Technology, 1989

BS (Engineering), Tokyo Institute of Technology, 1967

Research Interests:

- Design and development of underwater acoustic methods and instruments for fisheries and plankton acoustics.
- Modeling and measurements of acoustic scattering from fish and other organisms.

Memberships:

- Asian Fisheries Acoustics Society,AFAS
- Acoustic Society of Japan
- Marine Acoustic Society of Japan
- The Japanese Society of Fisheries Science
- IEEE Ocean Engineering Society

The International Conference on Fisheries Acoustics and Contribution for Sustainable Fisheries in Asia, 2009

November 9

Time	Program	page
09:00-10:00	Registration	
10:00-10:30	Opening remark： Dr. Kuo-Tien LEE, President of National Taiwan Ocean University.	I
	Opening remark： Dr. Wei-Cheng Su, Director of Fisheries Research Institute, COA.	III
	Welcome Address： Dr. Ming-An LEE, Dean of college of Ocean Science and Resource, National Taiwan Ocean University.	V
	Chairman's Address： Kohji IIDA, Faculty of Fisheries Sciences, Hokkaido University	VII
10:30-11:00	Group Photo	
11:00-12:00	Session I：Present State and Characteristics of Asian Fisheries Chairs：Kohji IIDA (Faculty of Fisheries Sciences, Hokkaido University, Japan) Ming-An LEE (Dean of college of Ocean Science and Resource, National Taiwan Ocean University)	
	Keynote： ● **Technology evolutions and advances in fisheries acoustics** (Dr. Dezhang Chu, NOAA/NMFS Northwest Fisheries Science Center, USA)	1
	Keynote： ● **Visualization and Quantification of Fisheries Resources Using Underwater Acoustics** (Dr. Kohji IIDA, Faculty of Fisheries Sciences, Hokkaido University, Japan)	2
12:00-13:00	Lunch	
13:00-14:00	AFAS General Meeting	

14:00-17:25	Session II：Advanced Technologies in Fisheries Acoustics Chairs：Yoshihiro. Nishiyama (Furuno Electric Co., Ltd., Japan) Y. Tang (Ocean Engineering College, Dalian Fisheries University, China)	
	Keynote： ● **Marine animal acoustics research: Physics-based modeling and measurement** (D. Benjamin Reeder, U.S. Office of Naval Research , USA)	3
	Reports： ● **The actual status of scientific fisheries acoustic in the United States** (Kjell Eger, Kongsberg Maritime As,Subsea Simrad Div., Norway)	4
	● **Analysis of ME70 data in Echoview-current capability and future directions** (Myounghee Kang, Myriax Software Pty Ltd, Hobart, Australia)	5
	● **Eonfusion-in support of an ecosystem approach to fisheries management** (Ian Higginbottom, Myriax Software Pty Ltd, Hobart, Australia)	7
	Discussion / Report (15:15-15:30)	
	● **Review of the newly developed dolphin mimetic sonar to classify fish species (report from SGAT)** (Yasushi Nishimori, Furuno Electric Co., Ltd., Japan)	
	Tea Break (15:30-14:40)	
	● **Development of tool for scanning sonar data recording/analyzing** (Yoshihiro Nishiyama, Furuno Electric Co., Ltd., Japan)	9
	● **Overview of the newly developed dolphin mimetic sonar to classify fish species** (Tomonari Akamatsu, Fisheries Research Agency, Japan)	10
	● **Broadband frequency characteristics of echoes from Japanese sardine (*Sardinops melanostictus*) compared with three other fish species (red seabream; *Pagrus major*, Japanese jack mackerel; *Trachurus japonicus*, chub mackerel; *Scomber japonicus*)** (Tomohito Imaizumi, Fisheries Research Agency, Japan)	11
	● **Developments of a novel broadband split-beam echo sounder** (Yong Wang, Technology Development & Researching Laboratory, Furuno Electric Co., Ltd, Japan)	13

	● **Classification of fish species using the temporal structures with the dolphin mimetic sonar** (Ikuo Matsuo, Department of Information Science, Tohoku Gakuin University, Japan)	14
	● **Features extraction for discrimination of fish species by tracking with the broadband split-beam system** (Masanori Ito, Department of Information Science, Tohoku Gakuin University, Japan)	15
	Discussion (17:10-17:25)	
18:00-	Welcome Party (B1 Dining Room)	

The International Conference on Fisheries Acoustics and Contribution for Sustainable Fisheries in Asia, 2009

November 10

Time	Program	page
09:00-11:55	Session III：Theoretical Research and Target Strength of Marine Animals Chairs：Tohru Mukai (Hokkaido University, Japan) Koki Abe (National Research Institute of Fisheries Engineering, Fisheries Research Agency, Japan)	
	Keynote： ● **Echo integration near the seabed** (Masahiko Furusawa, Tokyo University of Marine Science and Technology, Japan)	16
	Reports： ● **Standardization of body and swimbladder shape of Japanese anchovy for target strength estimation** (Koki Abe, National Research Institute of Fisheries Engineering, Fisheries Research Agency, Japan)	17
	● **Daytime in situ target strength of Japanese anchovy** (Kazuo Amakasu, Tokyo University of Marine Science and Technology, Japan)	19
	● **Effect of depth-dependet target strength on biomass estimation of Japanese anchovy** (Hiroto Murase, the institute of cetacean research, Japan)	21
	Discussion / Report (10:15-10:30)	
	● **Review on theoretical studies and target strength (report from SGTS)** (Tohru Mukai, Hokkaido University, Japan)	
	Tea Break (10:30-10:40)	
	● ***In situ* and *ex situ* target strength measurement of myctophid fish, Diaphus theta** (Kouichi Sawada, National Research Institute of Fisheries Engineering , Fisheries Research Agency, Japan)	22
	● **The influence of swimming angle on target strength of large jellyfish *Nemopilema nomurai*** (Miyuki Hirose, Faculty of Marine Technology, Chonnam National University, Korea)	25

	● **Variation of target strength according to pulsation of large jellyfish, Nemopilema nomurai** (Doo-Jin Hwang, Faculty of Marine Technology, Chonnam National University, Korea)	26
	● **Study on target strength of tuna species aggregated by fish aggregating device** (Hsueh-Jung Lu, Professor, National Taiwan Ocean University)	27
	● **Target strength estimation of Japanese jack mackerel Trachurus japonicus at two frequencies** (Rie Shiota, Graduate School of Fisheries Sciences, Hokkaido University, Japan)	28
	Discussion (11:55-12:10)	
12:10-13:00	Lunch	
13:00-15:00	Session IV：Methodologies and Evaluation of Acoustic Survey Chairs：K. Miyashita (Tokyo University of Marine Science and Technology, Japan) R. Hassan (OPPSPM SEAFDEC-MFRDMD)	
	Reports： ● **Present status of the quantitative echosounder application at local fisheries research institutes in Japan** (Tadanori Fujino, Japan Sea Fisheries Research Institute, Japan)	29
	● **Pelagic fish stock assessment in the east cost of Peninsular Malaysia** (R. Hassan, Senior Researcher, SEAFDEC-MFRDMD, Chendering Fisheries Garden, Malaysia)	30
	● **Acoustic resource assessment of silver carp and bighead carp in Qinghe Reservoir of Liaoning** (Yong Tang, Ocean Engineering College, Dalian Fisheries University, China)	31
	● **Spatial estimation of euphausiid abundance of Pacific coast of Hokkaido, Japan in early summer of 2008** (Naoki Tojo, Akkeshi Marine Station, Aquatic Research Station, Japan)	32
	● **Distribution of walleye pollock Theragra chalcogramma juvenile before and after the period of transition for feeding in Funka bay, Hokkaido in 2006 and 2007** (Youhei Kawauchi, Graduate school of Environmental Science, Hokkaido University, Japan)	34
	● **Summer diel variation in mean volume backscattering strength of sound scattering layer across the shelf waters of southern East China Sea** (Ming-An Lee, Department of Environmental Biology and Fisheries Science, NTOU)	36

	Discussion (14:30-14:45)	
	Tea Break (14:45-15:00)	
15:00-17:00	Session V：Broad Aspects of Underwater Acoustics for Fisheries Chairs：Y. Miyamoto (Tokyo University of Marine Science and Technology, Japan) D. Hwang (Chonnam National University, Korea)	
	Reports： ● **Movement, behavior of yellowfin tuna (Thunnus albacares) associated with a subsurface fish aggregating device (FAD) off south-western Taiwan from acoustic tagging data** (Jinn-Shing Weng, Coastal and Offshore Resource Research Center, Fisheries Research Institute Council of Agriculture)	38
	● **The relationship between Photo-environment and Diel vertical migration of mesopelagic animals** (Tomohiko Matsuura, Course of Applied Marine Environmental Studies, Tokyo University of Marine Science and Technology, Japan)	40
	● **Attempt of biotelemetry by fishing boat intended for demersal fish** (Aki Miyagi, Tokyo University of Marine Science and Technology, Japan)	42
	● **Relationship between directivity of backscattering strength and orientation distribution of fish school using omni-directional multi beam sonar** (Ryuzo Takahashi, Graduate School of Fisheries Sciences, Hokkaido University, Japan)	43
	● **Using ultrasonic technique to characterize underwater organisms in reverberant cavity** (Yen-Wen Chang, Department of Engineering Science and Ocean Engineering, National Taiwan University)	44
	● **Spatial estimation of kelp forests (*Laminaria* spp.) before and after harvesting in coastal water of the Shiretoko Peninsula, Hokkaido Japan** (Kenji Minami, Graduate School of Environmental Science, Hokkaido University, Japan)	46
	● **Estimate of seagrass canopy height using an echosounder of two frequencies** (Yao-Ting Tseng, Institute of Oceanography, National Taiwan University)	48
	Discussion (16:45-17:00)	
17:00-17:30	Closing ceremony	
18:00-	Dinner (2F Yueshiang Restaurant)	

National Taiwan Ocean University

AFAS members and the AFAS scientific organizing committee

Dear Sir/Madam,

On behalf of the National Taiwan Ocean University, I fully support the faculty of the College of Ocean Science and Resource coordinating with the researchers and scientists in National Taiwan University and the Fishery Research Institute of the Agricultural Council to hosting the AFAS 2009 Conference in Taiwan.

National Taiwan Ocean University is a comprehensive university specialized in the marine affairs and ocean sciences, particularly in marine environmental informatics, fisheries oceanography with satellite remote sensing, and geographic information system (GIS). This university currently have about 8,500 students in six colleges comprised of 15 departments, and 12 graduate institutions offering 26 Master's degrees and 17 PhD programs.

The fabulous beauty of Keelung city and the innate hospitality of our people will make it a memorable and pleasant stay for all your delegates. For the sake of bringing more international exposure to local students and encourage further internationally collaborative research projects, I deeply appreciated that the Asia Fisheries Acoustics Society (AFAS) scientific organizing committee offered this great opportunity to Taiwan. It is our honor to serve as host for the AFAS 2009 Conference.

Yours sincerely,

Kuo-Tien Lee

Kuo-Tien Lee, President
National Taiwan Ocean University

Opening Remarks at the AFAS 2009 International Conference on Fisheries Acoustics and Contribution for Sustainable Fisheries in Asia

by Wei-Cheng Su, Ph. D.
Director General
Fisheries Research Institute, COA
Monday, November 9, 2009

Dr. Kohji Iida, President of the Asian Fisheries Acoustics Society, Dr. Kuo-tien Lee, President of National Taiwan Ocean University, distinguished guests, ladies and gentlemen:

It is my honor and pleasure at this opening session to extend a warm welcome on behalf of the Fisheries Research Institute to all of you, especially those from abroad attending this conference.

Acoustics appear to be an appropriate tool to observe and characterize fish density and biomass. Acoustic hardware and associated post-processing systems are now commonly used in fish abundance estimation, behavior studies and observations of physical attributes of the seafloor. Many field surveys typically utilize several acoustic tools.

In this year's conference, there are five different aspect of themes, including present state and characteristics of Asian fisheries, advanced technologies in fisheries acoustics, theoretical research and target strength of marine animals, methodologies and evaluation of acoustic survey, and broad aspects of underwater acoustics for fisheries, these studies could facilitate our understanding of ecosystem processes and improve monitoring efforts. This will improve our ability to clearly and accurately

document the structure and function of the ecosystem, and support sustainable fisheries. I am sure this conference will contribute to both acoustic techniques and the sustainable fisheries management under the ecosystem approach.

It gives me special pleasure to see over so many experts, scholars and officials from different countries are attending this conference. As fisheries acoustic studies are quite important in the countries represented, I am sure that you would have to gain the update knowledge for exchanging expertise and information of all participants in this conference .

Finally, I would like to wish this conference great success and our guests from abroad a pleasant and useful visit here. Thank you.

Welcoming address

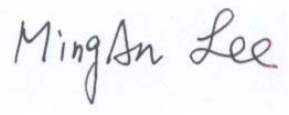
On behalf of the Organization Committee I would like to extend my warmest welcome to all speakers and participants of the AFAS 2009 hosted by the College of Ocean Science and Resources, National Taiwan Ocean University. In this conference we have more than 60 scientists from Taiwan, USA, Norway and other Asian countries. Your enthusiastic participation is a significant signal that this meeting shall serve us as a good platform for a co-operative work in theoretical and practical fields of fishery acoustics research.

The main theme of this conference, "Innovation in Fisheries Acoustic Technologies for Asian Sustainable Bioresources Development", clearly expresses the aim of our meeting. Scientists of applied research and theoretical development that are closely connected with fisheries acoustics should take full advantage of the current significant advancement in the following fields, namely, "Methodologies and evaluation of acoustic survey" and "Broad aspects of underwater acoustics for fisheries" etc. These works are highlighted in the title of the present conference.

Development of acoustic theories and application of acoustic study to fisheries are two of our principal missions in the National Taiwan Ocean University. I was, therefore, very delighted to accept the invitation at our last meeting in Korea to host the AFAS 2009 conference and the 3rd meeting of AFAS. Now I welcome your participation in this conference, and wish you to take this unique and exciting opportunity to share the latest information regarding all aspect of fisheries acoustics and related technologies, and I hope that through discussion to advance and expand the perspective of application of acoustic science in fisheries. Finally, I hope that all participants in this conference will have a wonderful time during your stay in Taiwan, and bring home with pleasant memories of our activities.

General Chairman

The 3rd meeting of Asian Fisheries Acoustics Society



Dean, college of ocean science and resources, NTOU

Greeting for AFS2009

Kohji Iida, Chairman of AFAS

Dear respected Prof. Kuo-Tian Lee, distinguished guest, and members of AFAS!

On behalf of the Asian Fisheries Acoustics Society, I would like to give a brief address. As you know, our society has just been established 2007 in Dalian, China, and I am very pleased to have the third annual meeting AFAS2009 today in Taipei, Taiwan.

Although we are only three years old, we already have had past four international symposia on Fisheries Acoustics in Asia. Fortunately the number of researchers in Asia has been increased year by year, and the technologies on underwater acoustics have been highly developing in Asian countries. However, the exchanges of information and cooperative works among the Asian countries look like very few so far.

The purpose of the establishment of Asian Fisheries Acoustics Society (AFAS) is to promote further progress of science and technologies on Fisheries Acoustics in Asia by cooperation across boarders of countries.

Since there are many particular problems in Asian fisheries such like small quantities with many species, benthic animals, freshwater fishery, and aquaculture, the AFAS aims to apply the acoustical technologies for those problems.

It is a great pleasure for us to have many people from foreign countries coming together here today. Especially to our delight, we have welcome many friends from USA, Norway and from Australia for this meeting. I believe the network on Fisheries Acoustics in Asia is now spreading little by little. 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. Kuo-Tian Lee, the president of The National Taiwan Ocean University for hosting this conference. And Prof. Ming-An Lee from NTOU, the General Director of AFAS2009 and other staffs from NTOU for preparation of this meeting.

Thank you.

Technology evolutions and advances in fisheries acoustics

Dezhang Chu

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Abstract

The oceans provide a virtually boundless habitat for ten's of thousands of marine species ranging from microbes, to phytoplankton, to zooplankton, and all the way up to marine mammals - the highest level in the marine food chain. The dynamic distribution of the biomass and/or abundance of these organisms provides the spatial and temporal signatures of the ocean ecosystem and is of crucial importance to human existence. In reality, the oceans, however, are grossly under-sampled. To understand the temporal and spatial variations in the distribution of these marine species, we need to sample as much ocean volume and extract as much information as possible. Conventional pump and net samplers can provide discrete information on biomass, size distribution, patchiness, and time evolution of marine animals, but these sampling methods are time consuming and inefficient. To sample the oceans more efficiently, acoustic technology has evolved significantly from the simple analog, single-channel, and single-frequency systems to the much more sophisticated digital, multi-channel, and/or multi-frequency systems. With advances in acoustic techniques, the efficiency and accuracy of oceanographic-biological surveys have been substantially improved. In this presentation, a review of several major advances in sonar techniques over the past few decades is given, and its applications to and impact on fisheries surveys are emphasized.

Keywords: Acoustics, fisheries, technology

Visualization and Quantification of Fisheries Resources Using Underwater Acoustics

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Abstract

Quantification and visualization of fisheries resources under the water are important methods to study fish stocks and their behaviors. Generally some underwater acoustic techniques are used for like this survey in the ocean. There are mainly three kinds of technologies used for observation of marine animals, namely, an echo sounder, a scanning sonar, and an underwater acoustic camera.

An echo sounder which uses downward single acoustic beam provides the cross sectional images called echogram along the ship track. Even if the echogram displays two-dimensional image, combined echograms obtained along transects which are well organized will provide us the three dimensional distribution of fisheries resources.

Meanwhile a scanning sonar which has multiple beams can scan its acoustic beams quickly to any direction thus provides us the two or three dimensional distribution of fish resources almost instantaneously. Moreover by quantifying the sonar echo signals, we can estimate the three dimensional distribution of fish abundances.

Lastly, a high resolution underwater acoustic camera which uses high frequencies (mega hertz), very short pulse (nanosecond), and a large number of acoustic beams enables to measure the size, shape and movement of the living marine animals in the water. Live animals, such as fish, squid, jellyfish and krill, were observed and a three-dimensional image of internal structure of animals was reconstructed by the image processing techniques in order to measure size and volume of internal organs.

The possibilities and limitations of these underwater acoustic techniques for fishery applications were discussed.

Keywords: visualization, quantification, echo sounder, scanning sonar, acoustic camera

Marine animal acoustics research: Physics-based modeling and measurement

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Abstract

The U.S. Office of Naval Research has sponsored research in the area of marine animal acoustics for many years. The research program has included development of theoretical physics-based acoustic scattering models of single fish and zooplankton, high-resolution laboratory measurements of scattering by individual animals, and at-sea field experiments. The program has been focused on both the backscattered and forward-scattered signals. Acoustic surveys, which rely on the backscattered signal, provide non-invasive, non-destructive, rapid, high-resolution, large area survey capability compared to traditional net tows. Horizontally-oriented acoustic surveys also provide the opportunity to investigate the forward-scattered signal and its impact on long-range acoustic propagation characteristics in the shallow water environment.

Both cases require an understanding of the scattering characteristics of each type of organism in the acoustic path as a function of acoustic frequency and orientation relative to the acoustic source and receiver. A review of the research program is presented.

The actual status of scientific fisheries acoustic in the United States

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Abstract

In the United States, the National Oceanic and Atmospheric Administration (NOAA), National Marine Fisheries Service (NMFS), has modernized their fisheries survey fleet with the addition of four new Fisheries Survey Vessels (FSV). Each FSV-40 vessel is constructed as an acoustically "quiet ship" with the capability of 40 days endurance. In accordance with the NOAA/NMFS mission, to promote sustainable fisheries, NOAA/NMFS has installed the new Scientific Multibeam Echo Sounder System (SMES) on all four vessels, the traditional scientific echo sounders with four or more frequencies, and both wireless and wired trawl monitoring systems. These acoustic systems have all been accepted are included on all four FSV-40 vessels. The names of these vessels are "Oscar Dyson", "Henry Bigelow", "Pisces" and "Bell Shimada" with each vessel located at a regional office within the United States. The SMES is developed by Simrad AS in cooperation with IFREMER, France 2005. The scientific multibeam sonar system (SMSS) is specified within the requirements, in addition to the above acoustic equipment for the next FSV-40 vessel (vessel # 5). FSV-5 is scheduled is be awarded in 2010 with estimated delivery in 2012. The SMSS is developed by Simrad, AS with IMR, Norway. Some results of the SMESS are shown in this report.

In addition, the different platform for fisheries acoustic from the fisheries survey vessel is shown. The mooring system of scientific echo sounder with 38kHz frequency was set on the seabed for monitoring in Monterey Bay Canyon at more than 800m depth. The system is developed and operated by the University of Washington. For the deep mooring, the deep water transducer is supplied and the transceiver is assembled into the glass float of pressure-proof. The mooring system is connected to the Monterey Accelerated Research System(MARS). The echogram is monitored in the place of experiment in Moss Landing in California at the real time. Some results of the system are shown in this report.

Analysis of ME70 data in Echoview – current capability and future directions

Myounghee Kang* and Ian Higginbottom

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Abstract

The Echoview team has a vision of collaborating with the world fisheries acoustics community to elegantly process the vast data sets produced by the new Simrad ME70. Echoview's functionality for multibeam data processing has been updated to provide key functionality for the ME70 for detection and characterization of 3D schools and for multiple frequency analyses. Currently Echoview creates an S_v "sector plot" (conventional multibeam echogram) for each ME70 ping and flexible multibeam operators in an intuitive graphical user interface. The software also provides views of the vertical and horizontal cross sections of schools, and extensive export functionality for further analyses outside of Echoview. The individual-beam data can be processed as for any EK60 split beam so that single-target and fish-track detection and analysis techniques are available. Data from the ME70 can also be easily compared with that from an EK60 for the experimental verification of ME70 performance.

In this study we will present data from the Eastern Bering Sea showing schools of Rockfish and Walleye Pollock in order to demonstrate Echoview's current capabilities. We are grateful to Sarah Stienessen and Chris Wilson for permission to use these data.

The ME70 is a new and incredibly flexible instrument, and we can expect that requirements will develop and evolve as experimental work continues. The Echoview team will seek to develop a flexible and extensible data model in close collaboration with ME70 users. In the first instance, we are working with US researchers to investigate the addition of high-resolution interferometric bathymetric algorithms and support for a range of standard and novel ME70 beam configurations. We welcome ideas and requests for functions so that we can continue to develop our software to match the capacity of this new instrument.

Keywords: Echoview, ME70, 3D school, EK60, cross section, multibeam

Analysis of ME70 data in Echoview – current capability and future directions

Myounghee Kang* and Ian Higginbottom

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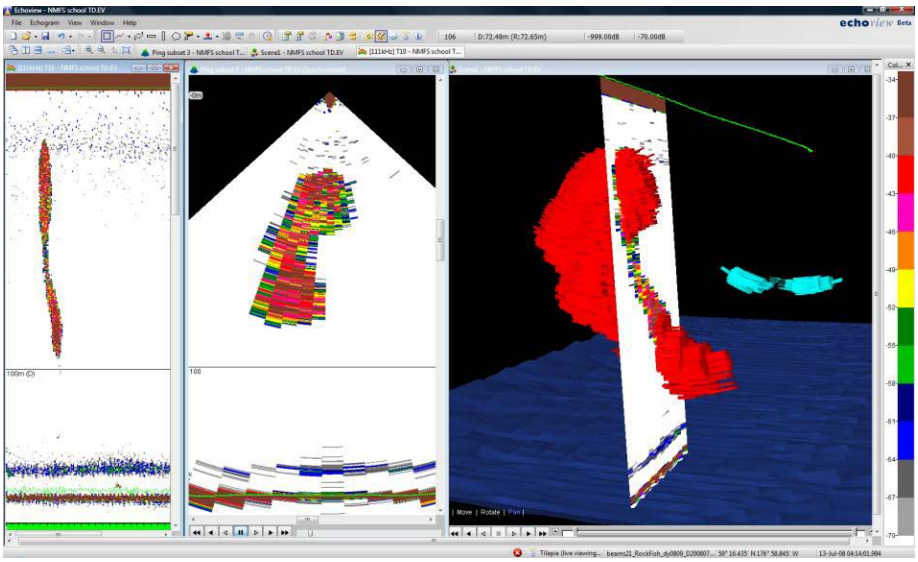

An example of 2D echogram, multibeam echogram and Scene using ME70 data in Echoview

Title: Eonfusion - in support of an ecosystem approach to fisheries management

Authors: T., Pauly, I., Higginbottom*
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Abstract
Fisheries managers are increasingly demanding an ecosystem approach to fisheries management. Fisheries data must now be understood in the context of its environment and new tools are required to integrate, analyse and visualise the required information-rich spatio-temporal data. Further, the understanding of the behavior of marine mammals and other predator species requires visualization in the context of the 4D distribution of prey species – typically observed using fisheries acoustics.

Eonfusion is a closely-coupled data integration, visualisation and analysis tool, designed for researchers and managers engaged in ecosystem approaches to fisheries management and in behavioral studies. Eonfusion provides fusion of complex environmental data sets into a revolutionary 4D graphical space. Users can intuitively explore and analyse multi-dimensional data without limitations imposed by scale or source, and create spectacular visualisation and communication outcomes. Eonfusion's genesis can be traced to requirements of multi-disciplinary Antarctic marine research conducted within the framework of the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) which included significant fisheries acoustic surveys. A significant challenge facing such researchers is the bridging of domains between disciplines and technologies.

Typically the temporal, visual and analytical components are not well handled within a single software application or by combination of existing tools, and the final products are often difficult to share with collaborating researchers and managers. Eonfusion directly addresses these issues, as the software significantly enhances the ease with which scientists can integrate diverse data types (raster, vector and media) and share methods across disciplines. Eonfusion enhances the communication of results and analysis methods through high dimensional visualisation and sharable interactive graphical dataflow methods. In this paper we show how Eonfusion enhances the integration, analysis and understanding of diverse data with examples including: sea lion behavior in relation to acoustically derived fish distributions; acoustically tracked lobsters in relation to seabed habitats; and the ground truthing of acoustically derived seabed habitats.

Key words: data integration, visualization, analysis, four-dimensional, fisheries, oceanography, environmental, software, data fusion, communication

Development of tool for scanning sonar data recording/analyzing

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Abstract

We have developed a data recording/analyzing tool for fisheries scanning sonar. This tool is supplied as a kit to be added on current scanning sonar system.

The kit is mainly consists of additional PCB to be installed on scanning sonar system for data output and application software to be installed commercial PC. Application software provides data recording/analyzing capability. Selectable two way data recording modes are available such as 'Master mode' for recoding data suitable for researcher studying fish school and 'Slave mode' for recording data when a skipper is fishing. Fish-school detect function detects/tracks targets automatically and calculates school parameters can be used for evaluating the schools. 2D Map display shows past echo signals from scanning sonar on geographical axis and enables to catch overall fish school distribution at wide area. Combination of field calibration and measured gain index of all individual beams makes data accurate.

Keywords: fisheries scanning sonar, data recording, calibration

Overview of the newly developed dolphin mimetic sonar to classify fish species

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Abstract

Classification and identification of underwater targets is essential not only for fisheries surveys but also for underwater security measures. We developed a "dolphin sonar simulator" using impulse ultrasonic click sounds of a bottlenose dolphin and artificially synthesized chirp sounds. The dolphin sonar simulator has a high-power broadband transducer adapted for 70–130 kHz (–3 dB width) with a source level up to 223 dB re 1 uPa rms (at 100 kHz). The short-pulse echo sounder produced very high spatial resolution, allowing identification of individual fish in a dense school of Japanese anchovy in Tokyo Bay, whereas the conventional quantitative echo sounder provided relatively rough images of the school of fish. The dolphin sonar simulator has four channel receivers to make it a split-beam system; the split-beam function was able to visually replicate three-dimensional movement of each fish in the school within a 5-cm resolution on a horizontal plane at a depth of 10 m. Moreover, the temporal structure of the echo waveform matched well with X-ray images of captive fish along the incident sound beam axis, suggesting that the dolphin sonar simulator was able to provide a one-dimensional "acoustic fluoroscopic image" of the fish. We compared echoes of broadband sonar signals from three fish species (red seabream, *Pagrus major*; Japanese jack mackerel, *Trachurus japonicus*; chub mackerel, *Scomber japonicus*) in a large acoustic experimental tank (10 × 15 × 10 m). These species were successfully classified based on the acoustically observed internal structures consists of echoes from the swim bladder, the head and the backbone. These findings may also explain why dolphins and porpoises have such excellent target classification ability. [Supported by the Research and Development Program for New Bio-industry Initiatives]

Keywords: broadband sonar, echolocation, biosonar, porpoise

Broadband frequency characteristics of echoes from Japanese sardine (*Sardinops melanostictus*) compared with three other fish species (red seabream; *Pagrus major*, Japanese jack mackerel; *Trachurus japonicus*, chub mackerel; *Scomber japonicus*)

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Abstract

There are many acoustic surveys using echo sounders for stock management. The Japanese sardine (*Sardinops melanostictus*) is one of the species that must be monitored as required by the Total Available Catch (TAC) program in Japan. In acoustic surveys the target strength (TS) is and important parameter when estimating stock size. However, there are few target strength studies of Japanese sardine. In addition, acoustic surveys have several problems. It is difficult to identify fish species using only acoustic information. Our purpose in this study is to increase information for the identification of fish species and to measure the accuracy of TS values of the Japanese sardine. Thus we measured broadband frequency characteristics (TS spectra) of echoes from fish in a large acoustic experimental tank (10×15×10 m).

The target strength spectra of Japanese sardine were measured by using broadband sonar signal. The measurement system uses separate transmit and receive transducers to obtain incident sound and fish echoes with which we use to calculate the spectrum and the ration between the reflected and incident signals. First, the experimental live fish were anesthetized by using the formalin and the anesthesia (FA-100). Secondly swimbladder shapes and body shapes were measured by using soft x-ray photography. Lastly the variations in target spectra with respect to the tilt angle of fish (TS spectra pattern) were measured. And for comparison, the theoretical TS spectra patterns were calculated by using the soft x-ray results as input to the Kirchhoff-ray mode model (KRM).

We found that there were the same trends when comparing the theoretical TS spectral patterns and measured results. We also compared TS spectra pattern of fish among the four species (red seabream; *Pagrus major*, Japanese jack mackerel; *Trachurus japonicus*, chub mackerel; *Scomber japonicus* and Japanese sardine *Sardinops melanostictus*). In same species there are few TS spectral differences. But, there were TS spectral differences among the four species that we could confirm. Consecutive TS spectra and TS

spectral patterns of fish will give important information for species identification. [Supported by the Research and Development Program for New Bio-industry Initiatives]

Key words: Broadband, Target strength spectra, Japanese sardine *Sardinops melanostictus*

Developments of a novel broadband split-beam echo sounder

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Abstract

Recently, fishermen wish to know fish size and fish species within a fish school before catching it. Acoustic remote monitoring of fish size, amount of fish and fish speed within the school will be useful for the sustainable fisheries. For this purpose, a novel broadband split-beam echo sounder has been developed. The broadband transceiver can transmit the signal from 70 kHz to 130 kHz @ –3dB with the source level at 223 dB re 1uPa@1m and receive echoes using four channels. Signal processing is performed in real-time software, which enables convenient control of signal types (conventional CW, FM and dolphin sound) and pulse length. In this paper, we will show some echograms recorded in the TATEYAMA Bay.

Keywords: broadband, split-beam, echo sounder

Classification of fish species using the temporal structures with the dolphin mimetic sonar

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Abstract

Identification and classification of fish species are essential for acoustic surveys of fisheries. The echo from the fish contains components from multiple reflections, including those from the swim bladder, head and other organs, and can be used for the discrimination of fish species and the estimation of fish abundance. Therefore, it is necessary to clarify the relationship between these inner organs and temporal structures of the fish echo and clarify the characteristic of the temporal structure, which is useful for classification of fish species. By using the dolphin-like or chirp sound, the echoes were measured from anaesthetized fishes of three species (red seabream, *Pagrus major*; Japanese jack mackerel, *Trachurus japonicus*; Chub mackerel, *Scomber japonicus*) in a large acoustic experimental tank (10 × 15 × 10 m). The temporal structures and echo duration were extracted from the fish echo using the cross-correlation function and the lowpass filter. It was shown that this extracted temporal structure matched well with X-ray images of the fish along the incident sound beam axis. The temporal structure and echo duration were changed dependent on the fish species and orientation. It was examined that fish species could be classified by the temporal structure under the assumption that fish orientation was known. [Supported by the Research and Development Program for New Bio-industry Initiatives]

Keywords: Broadband signal, sonar, classification, fish species, temporal structure

Features extraction for discrimination of fish species by tracking with the broadband split-beam system

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Abstract

Selective fisheries are strongly desired for the sustainable management of fish resources. Remote identification of the size and the species of fish is important for the selective fisheries. The developed broadband split-beam system can localize the echoes and track them using estimated positions. We tried to find the features from tracked fishes for discriminating fishes. The backscattering echoes of fishes were measured from the anchored vessel in Tokyo Bay. At the same time, the fish species of echoes were identified by fishing or monitoring using a camera. Echoes from Japanese anchovy (*Engraulis japonica*), Japanese jack mackerel (*Trachurus japonicus*) and Chub mackerel (*Scomber japnicus*) were measured and analyzed. The cross correlation between measured signals and the incident signal was calculated. Then Hilbert transform was applied to obtain envelope of the signal. Local maxima exceed predefined threshold were regarded as targets. In order to localize the target, echo delay time was used to estimate the range and time difference which can be measured by the split-beam transducer to obtain the direction. Cross correlation function was used for calculation of the time difference and polynomial fitting of the function resulted in better position estimation. Tracking was completed, connecting neighbor echoes in the consecutive pings. Tracking process made it possible to monitor movements of individual fishes in a school and to understand the behavior under the sea. Through the tracking process the postures of the fishes were estimated. Measurements from different positions relative to the vessel and the estimated posture angles gave us information in multiple aspects. Envelope patterns of the echoes from various incident angles were related to anatomical structures which depend on fish species. Duration of the echo or swimming speed might be useful. Considering these features from echoes, the best way to discriminate is discussed. [Supported by the Research and Development Program for New Bio-industry Initiatives]

Keywords: Broadband signal, split-beam echo-sounder, tracking

Echo integration near the seabed

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Abstract

Fisheries resources surveys near the seabed are very important, because many fish such as seabream inhabit near the seabed and many animals such as squid make schools near the seabed in the nighttime although they may distribute mid-water in the daytime. Acoustic surveys near the seabed have been recognized to be difficult, because dead zones (DZs) are inevitably generated just above the seabed. If, however, we remove misunderstandings about the DZ such as mixing of the DZ and miss sampling, the DZ exists only for the bottom offset set to avoid inclusion of bottom echoes in an integration layer, at least for a flat seabed. Further, we can expect up-to-date technology to reduce the offset considerably; it includes intelligent bottom detection techniques and automatic compensation techniques for transducer motion. Therefore, the DZ near the seabed is not such fatal as has been considered, and there are many chances to make acoustic surveys possible. In this paper, we start from reviewing the echo integration theory and processing, clarify the discrimination between the DZ and the miss sampling, and establish a clear idea on the DZ near the seabed. Next, we exemplify the echo integration process for actual echo data obtained near the seabed Finally, we discuss on the techniques to decrease and compensate for the DZ effects.

Keywords: echo integration, dead zone, seabed

Standardization of body and swimbladder shape of Japanese anchovy for target strength estimation

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Abstract

Japanese anchovy (*Engraulis japonicus*) is one of important commercial fish for Japanese fisheries. And it is important as a key species in the marine ecosystem, because of its production is very high and many large pelagic fishes (e.g. Tuna, Skipjack) and marine mammals are feeder of anchovy. Acoustic surveys using quantitative echo-sounder are conducted to estimate the abundance of Japanese anchovy around the coast of Japan. Though the target strength (TS) is necessary to convert the acoustic energy to the abundance, TS of Japanese anchovy is unstable on the ground of that they are physostome. In particular, it is reported that their TSs show depth dependences. This study investigates the standard shape of swimbladder of Japanese anchovy in the situation of at surface to make reference for discussing depth dependence of their TS.

Body length (BL) of samples was ranged from 4.69 cm to 9.91 cm (n=59). Swimbladder shapes were photographed by x-ray radiograph system (SOFTEX Protest 100) and body shapes were photographed by digital still camera. Both photographs were digitized by software (Golden Software Didger 3) using graphics pen tablet (WACOM Intuos 3). Parameters for shape analyzing were body length (BL), body height (BDH), body width (BDW), swimbladder length (SBL), swimbladder height (SBH), swimbladder width (SBW), swimbladder starting point (SBS), respectively. These parameters were regressed using least squares and the obtained regression formula showed the relation between BL and shape parameters. The results were shown in below.

$$BDH = 0.155\ BL - 0.056 \quad (R=0.95)$$
$$BDW = 0.094\ BL - 0.010 \quad (R=0.87)$$

$$SBL = 0.364\ BL - 0.035 \quad (R=0.94)$$
$$SBH = 0.053\ BL - 0.083 \quad (R=0.80)$$
$$SBW = 0.046\ BL - 0.048 \quad (R=0.82)$$

The correlation coefficients were high value, therefore standard shape of body and swimbladder were able to be estimated from BL by the regression formula. The "standard shape anchovy TS" was predicted using Kirchhoff-ray mode model (KRM) and the result is $\langle TS_{STD} \rangle = 20 \log BL - 63.9$ [dB] (R=0.97).

Keywords: Japanese anchovy, target strength, swimbladder, shape standardization

Daytime *in situ* target strength of Japanese anchovy

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Abstract

Japanese anchovy is a key species in the coastal waters of the western Pacific Ocean and are also important commercial pelagic species. Therefore, acoustic surveys to estimate their abundance have been conducted with scientific echosounders in Japan. The target strength (TS) of Japanese anchovy was recently found to be dependent on the depth (Zhao *et al*., 2008). Amakasu *et al*. (submitted) measured the backscattering pattern at a depth of 2 m in a tank and revealed the relationship between fish length and TS averaged over the mean orientation angle 0° with a standard deviation of 10° assuming that it is the daytime swimming orientation. Moreover, the depth-dependent TS on fish length was obtained by including a depth effect in the TS-L relationship. Although the acoustic surveys in Japan were conducted during the daytime, the *in situ* TS previously published were measured in the nighttime. Therefore, the *in situ* TS measurements were performed in the daytime and then we compared the *in situ* TS with the depth-dependent TS shown by Amakasu *et al*. and Zhao *et al*.

Acoustic data were collected with a scientific echosounder KFC-3000 (Sonic corp.) on 23 and 24 June 2006 in Tateyama Bay. A 38 kHz hull-mounted split-beam transducer was used and the pulse duration was 0.6 ms. The system calibration was performed with a 38.1 mm diameter tungsten carbide sphere. Biological sampling with simple fishing tackles was made to confirm species and fish length. The *in situ* TS were extracted from the acoustic data using TS and SV analysis software (Sonic corp.). The cutoff angle was 2° or 3° and the upper region of the fish school was selected and analyzed.

Japanese anchovy were sampled from one of fish school which the *in situ* TS were extracted, and the mean length was 12.1 ± 0.6 cm (n = 33). Although species and fish length of all fish schools were not confirmed successfully, we inferred qualitatively that they were Japanese anchovy of the same length from past experience and shape or depth of fish school.

The normalized mean TS obtained from the *in situ* TS distributions extracted from three less dense fish schools were −67.2 dB (n = 127), −68.3 dB (n = 116), and −68.1 dB (n = 68), respectively. And the mean depth were 8.5 ± 1.7 m, 8.7 ± 2.2 m, and 10.6 ± 1.6 m, respectively. These were 2–3 dB smaller than that of Amakasu *et al*., but were closer to that of Zhao *et al*. and the difference was −0.1 to 0.8 dB. It is possible that the swimming orientation was close to that of fish in a dispersed school in the nighttime. The normalized mean TS obtained from five more dense fish schools were −66.1 dB (n = 40) and the mean depth was 11.8 ± 3.2 m. Although the number of the *in situ* TS extracted was small, it was in good agreement with that of Amakasu *et al*. and the difference was −0.5 dB.

Keywords: target strength, Japanese anchovy, depth-dependence

Effect of depth-dependent target strength on biomass estimation of Japanese anchovy

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Abstract

Several studies confirmed that target strength (TS) of Japanse anchovy was changed in relation with depth. However, the effect of the depth-dependent TS on biomass estimation has not been examined. In this study, biomass of anchovy was estimated using following four TS models to examine the effect: (1) TS=20logTL-71.9 (Foote, 1987), (2) TS=20logTL-72.5 (Zhu and Iversen, 1990), (3) TS=20logTL-(20/3)log(1+z/10)-67.6 (Zhao et al., 2008) and (4) TS=20logTL-(20/3)log(1+z/10)-64.7 (Amakasu et al., unpublished data) where TL and z represent total length (cm) and depth (m), respectively. Formulas (1) and (2) have been used in conventional fisheries resources surveys. Formulas (3) and (4) take account of depth-dependent TS. Formulas (1) to (3) are based on the in-situ measurements while formula (4) is based on the measurement in the experimental tank. In formula (4), orientation angle is assumed 0°. Acoustic data were recorded by a quantitative echosounder as a part of the Japanese Whale Research Program under Special Permit in the western North Pacific-Phase II (JARPN II). The operating frequency of the echosounder was 38 kHz. Length and wet weight of anchovy were obtained by trawl hauls conducted by Tohoku National Fisheries Research Institute. TSs at each 1 m depth bin from 10 m to 150 m water depth and at mean distribution depth of anchovy (23 m) were calculated by using formulas (3) and (4). Biomasses estimated by these two TSs were not different. TS at mean distribution depth can be used to estimate biomass if formulas (3) and (4) are used. Biomass estimated by formula (3) was 82 % and 73 % of formulas (1) and (2), respectively. Biomass estimated by formula (4) was 51 % of formula (3). The results indicated that the effect of the orientation angle on the biomass estimation could be very large even if the effect of the depth-dependent TS was taken account. Orientation angles under conditions of fisheries resources surveys should be investigated in future study to obtain realistic TS. Application of formula (3) is recommended for the time being.

Keywords: abundance, *Engraulis japonicus*, pelagic fish

In situ and *ex situ* target strength measurement of myctophid fish, *Diaphus theta*

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Abstract

In situ target strength (abbreviated as TS) measurement of myctophids fish, *Diaphus theta*, was conducted off the east coast of Hokkaido in Aug. 24, 2008. Newly designed acoustic-optical measurement system (J-QUESTχ) was used for measuring target strength. J-QUESTχ comprises a 70 kHz split-beam echosounder, a stereo-video camera system, and a motion sensor installed in a pressure housing. Blue and red LED illuminations and a CTD sensor were attached to the housing. The split-beam echosounder, stereo-video camera, motion sensor, CTD sensor, and the illumination were controlled and monitored aboard a ship through a 530 m optical-power cable. J-QUESTχ was deployed from R/V Wakataka-maru at the depth of 150 m which was just over the aggregation of *Diaphus theta*. Target strength data was collected for thirty minutes. After the TS measurement, frame trawl with mouth opening of 5 m^2 was conducted to confirm the species composition and length distributions. Average TS of –55.8 dB (n=4829) was obtained. The trawl result showed that 99 % of the sampled fish was *Diaphus theta* of 55.6 ± 4.5 mm in length. Empirical model of TS vs. Log(L) was derived for *Diaphus theta* from measured average TS and length. *Ex situ* TS pattern measurement was conducted in a seawater tank at a frequency of 120 kHz and the prolate spheroid scattering model calculation was conducted based on the swimbladder shape. After the good agreement between the measurements and the model calculation was confirmed, predicted TS pattern at 70 kHz was used to calculate the theoretical model of TS vs. Log(L) by assuming several tilt angle distributions. Empirical model obtained from *in situ* measurement was compared with

the theoretical model and good agreements were found between them.

Keywords: target strength, *Diaphus theta*, J-QUESTχ

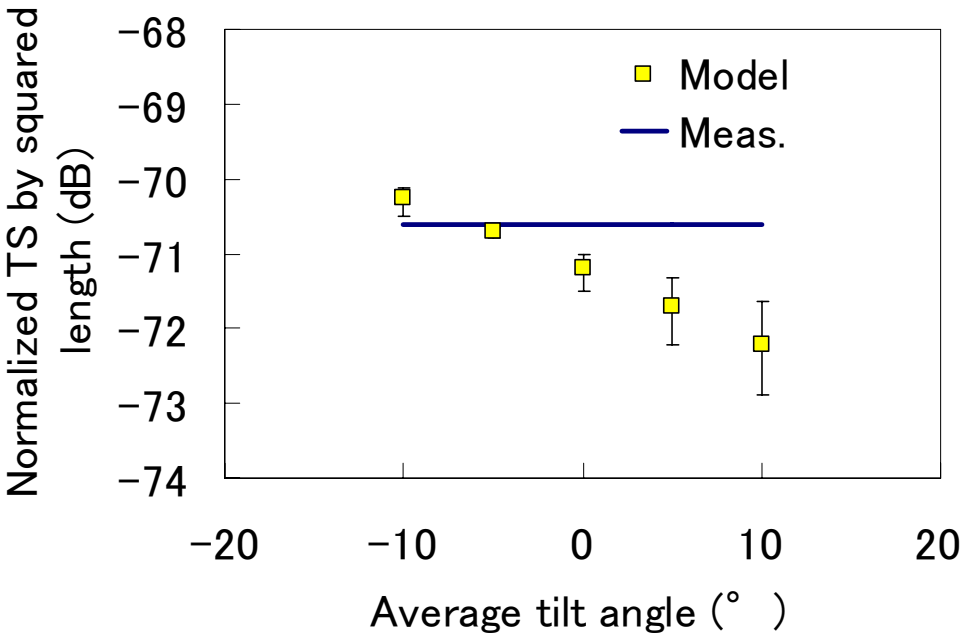

Fig. 1 Normalized TS vs average tilt angle.

The influence of swimming angle on target strength of large jellyfish *Nemopilema nomurai*

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Abstract

With the increasing number of reports about damage (e.g. clogged nets and decreased fish catches) caused by jellyfish, concern over the increased abundance of jellyfish has been growing worldwide. For example, *Nemopilema nomurai*, which reaches up to 2 m in diameter and 200 kg in weight, has occurred in large numbers and has caused damage exceeded one billion yen to fisheries in Japan and Korea in recent years. When jellyfish enter nets, fewer fish are caught and the nets are sometimes damaged. Since they cause so much damage, estimates of the abundances and distributions of various jellyfish species are needed to forecast when and where their blooms will occur in coastal areas.

Acoustic techniques are commonly used to study the distributions and abundances of fish and zooplankton because these techniques can survey large areas relatively quickly. Recently, acoustic methods have been applied for monitoring jellyfish. Consequently, investigations have examined the acoustic-scattering characteristics of jellyfish which are needed to interpret surveys using echosounders. Several studies have examined the acoustic-scattering characteristics of *N. nomurai*, but it is not yet clear the influence of changes in swimming angle on target strength. These information have important implications to precise abundance estimation of jellyfish using acoustic method. In this study, target strength of live jellyfish were measured in the sea-water tank on August 2009 to clarify the relationship between target strength and swimming angle. The results for three kinds of swimming angle, namely head-aspect (0°), side-aspect (90°), and intermediate-aspect (45°), will be shown and discussed.

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Keywords: Target Strength, Jellyfish, Swimming Angle

Variation of target strength according to pulsation of large jellyfish, *Nemopilema nomurai*

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Abstract

The study was conducted to investigate the effect of target strength in accordance with pulsation of *Nemopilema nomurai* jellyfish. The jellyfish used for this experiment were collected from costal waters in southern Korea by a scuba diver. Living jellyfish tethered to monofilament line in a tank (5m×5m×5m) filled with seawater and behavior of jellyfish was monitored by side camera. The target strength of jellyfish was measured at 38 kHz by split beam system (EK500, SIMRAD) and data of 100 pings was analyzed using Echoview (SonarData). The bell diameter of jellyfish was 32.0 cm and target strength was ranging from -73.7 to -65.7 dB. Also, the pulsation cycle of jellyfish was observed from 1.5 to 2.0 sec and the cycle of target strength appeared from 1.0 to 2.5 sec. The relationship between target strength and bell diameter depending on pulsation of jellyfish will be discussed. [This work was partially supported by JSPS-KOSEF Core University Program on Fisheries Science (FiSCUP) and JSPS-KOSEF joint research program under the Japan-Korea Basic Scientific Cooperation Program.]

Keywords: Jellyfish, Pulsation, Target strength

Study on target strength of tuna species aggregated by fish aggregating device

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Abstract

Bycatch of small yellowfin and bigeye tunas when using fish aggregation device (FAD) during tuna purse seine operation become a controversial issue in recent decades. Acoustical evaluation before net setting is a possible option to avoid such bycatch and the characteristic of target strength (TS) among those aggregated fish is important for the evaluation. In this study, TS of 31 fish sampled from moored FAD were measured and analyzed, including small yellowfin tuna, skipjack tuna, bullet tuna and rainbow runner with body lengths of 28~55 cm. We found that dorsal and lateral TS of yellowfin are higher than those of skipjack when body length larger than 35 cm, because swimbladder in yellowfin tuna starts to grow since 35 cm fork length. Fishing action should be forbidden if TS are under -38 dB since both yellowfin and skipjack tunas are at young stage (juvenile). Fishing should be carefully evaluated if TS are at the ranges of -34~38 dB, because small yellowfin tunas and matured skipjack tuna co-existed by using 50 kHz echo sounder. The following information found in the study would be helpful to distinguish small yellowfin tunas. The variance of △TS in all directions for yellowfin tunas caused by swimming orientation, the difference TS between 200 KHz and 50 KHz, are larger than those for skipjack tunas. The mean △TS from dorsal aspect of yellowfin and skipjack tuna reached 1.53 dB is the most differentiable among others. Moreover, the samples of small yellowfin tuna obtained in this study are at very young stage (juvenile). The size of swimbladders of yellowfin and bigeye tunas increase dramatically while growing, their TS and △TS during diving and rising behavior would be much more significantly than skipjack.

Key words: Fish Aggregating Devices, Tuna Purse Seine Fishery, Target Strength, Yellowfin tuna, Skipjack tuna

Target strength estimation of Japanese jack mackerel *Trachurus japonicus* at two frequencies

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Abstract

A demand has grown to develop ways of using echo sounders to estimate the quantity of Japanese jack mackerel *Trachurus japonicus*. However, few studies have reported about the target strength (TS) of this fish. The *ex situ* TS of Japanese jack mackerel at two frequencies were measured and the theoretical TS using Kirchhoff ray-mode (KRM) model were compared.

In 2008 and 2009, the TSs of Japanese jack mackerel ranged from 5.0 to 22.3 cm in fork length (FL) were measured with an echo sounder at two frequencies: 38 and 120 kHz. The samples were suspended in the water tank to measure the TS from the dorsal aspect at every pitch angle from –50° to +50°. The TS characteristics of each sample at two frequencies were obtained. Before measuring the TS, the swimbladder and fish body were photographed by soft X-rays and an optical camera. From these images, the swimbladder and fish body shapes were traced and changed into coordinate data. Then the relations between swimbladder and fish body lengths and FL were obtained. The theoretical TS was computed for each sample with a KRM model using the morphological data derived from X-rays images and fish body data derived from photographs. These were compared with the measured TS.

The peaks and lobes in the TS pattern increased with increasing frequency and size of the sample. The relationship between the maximum TS and FL was estimated TS = 25.1 log(FL) – 69.8 dB at 38 kHz and TS = 26.8 log(FL) – 70.7 dB at 120 kHz. Most of samples, the theoretical maximum TS showed higher value than the measured TS.

Finally, the swimming angles of Japanese jack mackerel were measured to calculate the averaged TS. An average swimming tilt angle of –4.2 ± 14.5° (average ± standard deviation) was obtained. Using this swimming angle distribution, the averaged TS was calculated at two frequencies. The following regression equations were acquired: TS = 16.8 log(FL) – 64.0 dB at 38 kHz and TS = 19.2 log(FL) – 69.0 dB at 120 kHz.

Keywords: jack mackerel, target strength, 38kHz, 120kHz, KRM model, ex situ, X-ray, swimbladder

Present status of the quantitative echosounder application at local fisheries research institutes in Japan

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Abstract

In Japan, large numbers of quantitative echosounder (QES) are held by the local fisheries research institutes. To describe the present status of the QES application, a questionnaire was conducted to each local fisheries research institutes (in total 48) in Japan in 2008. The questionnaire was consisted of 13 questions: whether or not the institute holds QES, for what purpose and how frequently the QES is used, analysis level of the acoustic data, requests to the scientist and manufacturer, etc. Among the 41 institutes that replied to the questionnaire, 31 were holding a QES. Approximately half of these institutes (16) were practically using the QES for acoustic survey. Purpose of the acoustic survey was mainly to provide information of the abundance and distribution of the stocks to the local fisherman, or to estimate the standing stock of the target species. Those institutes which were not using the QES answered, malfunction and difficulties of operation, lack of human resources, and lack of money for maintenance were the reasons. To fisheries acoustic scientist, demands for analysis support, informing useful references and study focused on commercially important species was proposed. To makers, request of a QES lease and offer of a secondhand QES was proposed. For the future development of acoustic monitoring of aquatic resources in Japan, fisheries acoustic scientist would need to enhance supports to the local institution and develop the species identification method to increase the number of species which could be monitored by a QES.

Keywords: quantitative echosounder, local fisheries research institution, questionnaire

Pelagic Fish Stock Assessment In The East Cost of Peninsular Malaysia

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Abstract

An acoustic survey in the waters of Kelantan, Terengganu, Pahang and East Johor was carried out from 13th April to 27th June 2007 to evaluate the pelagic fish resources in the East Coast waters off Peninsular Malaysia. The survey was conducted by using research vessel KK SENANGIN II that equipped with a scientific echo sounder FURUNO FQ80 system. The total area surveyed was 117,892 km^2 comprising coastal and offshore waters. Raw data of back scattering strength from 103 transects were recorded by FQ80 Data Analyzer. Data were analyzed using the built-in FQ80 Data Analyzer and EXCEL softwares. Quantitative assessment to estimate for pelagic fish biomass was carried out by using the average density of pelagic fish at each transect. While calculation for pelagic fish density was based on the dominant pelagic species for each transect. The average density of pelagic fish in the east coast was estimated at 3.58 tonnes/km^2. The total pelagic fish biomass was estimated at 422,053 metric tones which is about 42.3 % less of the biomass recorded in 1998.

Acoustic Resource Assessment of Silver Carp and Bighead Carp in Qinghe Reservoir of Liaoning

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Abstract

Silver crap (Hypophthalmichthys molitrix) and bighead carp (Aristichthys nobilis) are the important species in freshwater breeding in the north of China, and its resource assessment influence on making production plan and the release number of juvenile fish. The acoustic survey was conducted to estimate the silver carp and bighead carp in Qinghe reservoir located on Liaoning Province by using a single-beam echo sounder (ETR30-SV, 38kHz, 200kHz, FURURNO) and a split-beam scientific echo sounder (EY60, 70kHz, SIMRAD) in April and July 2009, respectively, to study a applying method for fresh water survey. The survey lines were set at zigzag and parallel in April and July survey, respectively, and a 38.1mm diameter tungsten carbide sphere was used to calibrate the echo sounder in both surveys. On post-processing, the software (Echoview，Myriax) was used to detect single fish and count them at every survey track to analyze the characteristics of fish distribution for various seasons at day and night. As a results, the silver crap and bighead carp aggregate in spring and shows different distribution at day and night. It shows homogeneous distribution between 2m and 10m depth layer at night in summer, but almost aggregate in 8m depth at day. So, the acoustic assessment survey in Qinghe reservoir for silver crap and bighead carp is more convenient at night in summer with zigzag survey tracks. The abundance of sliver and bighead carp was estimated by using the echo-counting methods and the echo-integration methods, near 6-7 million ind. in total survey area.

Keywords: freshwater fisheries, resource assessment, acoustic survey, silver crap, bighead carp

Spatial estimation of euphausiid abundance of Pacific coast of Hokkaido, Japan in early summer of 2008

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Abstract

Coastal shelf environment along the pacific coast of Hokkaido Island, Japan is one of the most important fishing grounds for various commercial fishes. including walleye pollock (*Theragra charcogramma*) in the North Pacific. The catches as well as ecosystem diversity in this region is dependent on the abundant zooplanktons based on a productive western boundary current, Oyashio. In this study, we focused on euphausiids and estimated the abundance of it over the coastal shelf of the Pacific coast of Hokkaido Japan in early summer 2008. Euphausiid abundances over areas has been estimated using acoustic surveys in various waters, but its spatial dynamics, influences actual availability as prey, is not able to be analyzed with only the acoustic mythology. So, spatial analyses were conducted using geographic information system (GIS) platform to quantitatively understand the actual dynamics of euphausiids distribution over study area. Marine environmental determinants of the found euphausiid distribution and its ecological significance as available prey were discussed based on the integrated analyses on the GIS platform. Acoustic data were obtained in both day (6:00-18:00) and night (18:00-6:00) using on-board EK 60 (SIMRAD)

with multiple frequencies (200, 120, and 38 kHz) in a survey conducted by Hokkaido National Fisheries Research Institute (HNF), entrusted by Fisheries Agency of Japan in June 2008. Main transect was designed orthogonal to isobaths, and optional transect to validate the adequacy of interval distances among main transect to capture spatial autocorrelations in euphausiid distribution Direct sampling using BONGO net was also conducted to the found backscattering echoes in nighttime. > 50 CTDs and XCTDs were cast on the main transect to obtain temperature and salinity to specify the water type at detected echoes. Echoes of euphausiids were specified based on the difference between volume backscattering strength (ΔSV), calculated with seasonal theoretical target strength of a dominant euphausiids, *Euphausia pacifica*. Semivariogram was analyzed to quantify spatial autocorrelations, and best-fit kriging models were used to qualitatively interpolate the euphausiid distribution over study area. The actual model performances were evaluated with cross-validation errors. Continuity of the distribution trend on optional transects were >15,000 m, indicating adequacy of interval distances among main transects, originally sat to assess walleye pollock recruitment. Estimated euphausiid abundance reached > 10 gWWm-2, suggesting generally abundant prey for large fishes over study area though developed GIS map also suggested spatial variability in its availability. There was nearly one-order difference in estimated abundances between day and night, and dense aggregations (hot spot) showed shoreward extensions. Distribution of euphausiids corresponded to Oyashio water (< 7˚C, > 33PSU). Oyashio intrusion enhances distribution pattern and abundance of euphausiids in study area. Spatial variation caused by the offshore-inshore oceanography determines the location of hot spots and availability of prey for commercially important fishes in the area. Found day-night difference of estimated abundance was caused by spatial variability in diel movement of euphausiids. Acoustic dead zone and behavioral change in euphausiids may strongly influence abundance estimation in night over coastal shelf environment.

Keywords: euphausiid, ΔSV, spatial estimation

Distribution of walleye pollock *Theragra chalcogramma* juvenile before and after the period of transition for feeding in Funka bay, Hokkaido in 2006 and 2007

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Abstract

For The Japanese Pacific walleye pollock (*Theragra chalcogramma*) stock, Funka bay (FB) is one of the important areas for growth and survival as the nursery ground (Shimizu and Isoda, 1997; Nakatani et al., 2003). General studies in early-life survival of this stock have been conducted so far, but specific quantitative and ecological investigation focused juvenile in FB is still limited.

Physical environments (e.g. water temperature) indirectly impact survival of walleye pollock via metabolism and growth (Kooka et al., 2007). Especially in FB, threshold size (30mm) of juvenile walleye pollock to large-size prey has been suggested, so specific growth phase, period of transition for feeding (Nakatani and Maeda, 1987, 2003; Hirakawa, 1983), dependant survival may exist in variable prey availability. We hypothesized that physical environments influence distribution and its temporal variability of juvenile in the period of transition and aimed to test the developed hypothesis using acoustic measurement and integrated analyses with Geographic Information System (GIS).

As the first step of our project, the distribution of juvenile walleye Pollock in different growth phases were quantified and compared, and its habitat were specified in this study.

The acoustic data were collected at two frequency (38 and 120kHz) by on-board EK60 (SIMRAD) at R/V Kinsei Maru, belonging to Hokkaido Hakodate Fisheries Experiment Station in FB from May to June in 2006 and 2007. We identified echo in the acoustic data as that of juvenile walleye pollock by net sample (FMT net and intermediate trawl net). Dual

frequency method was used based on the difference of backscattering strength (⊿MVBS) at each frequency (e.g. Kang et al., 2002). Backscattering strength per a individual (Target Strength, TS) of juvenile in each frequency were calculated using bladder-resonance model (Furusawa, 1988, 1990). Based TSs ⊿MVBS of juvenile walleye pollock was specified, and echo of juvenile was over or under threshold size (30mm) at the period of transition. Detected echoes under transects were converted to abundance of juvenile walleye pollock, and vertically and horizontally visualized using GIS. The difference of distribution patterns and spatial autocorrelations were examined between > 30mm and < 30mm. Obtained results were ecologically discussed with directly collected species composition in net samples and physical environment measured in same as conducted acoustic surveys.

Keyword : Walleye Pollock, Acoustic measurement, Transition for feeding, GIS

Summer diel variation in mean volume backscattering strength of sound scattering layer across the shelf waters of southern East China Sea

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Abstract

Two acoustic studies were carried out on board of the "Ocean Research II" across the shelf waters of southern East China Sea from August 3 to 5 of 2007 and July 21 to 22, 2009. The three 24-hr observation stations were respectively located in the shelf water (121°56.795'E, 25°29.224'N), slope water (122°26.608'E, 25°19.95'N), and Kuroshio water (123°09.027'E, 25°05.019'N). Hydrographical conditions were significantly different among these waters. Acoustic volume scattering strengths (SVs) of EK500-38 kHz were simultaneously collected, and Echoview software was used to compare the diel variations of sound scattering layer in these three stations (Figure 1). In Kuroshio water, SVs of surface scattering layer (SSL) was about -76.6 dB, 8.3 dB lower than that in nighttime. Two deep scattering layers (DSLs) in daytime at depth of 400-500 m and 600-700 m were about -71.2 dB and -78.2 dB, respectively. Two clear diel vertical movements (DVMs) were also detected from these two DSLs. The echogram showed that parts of these two DSLs started to ascend at 16:00-17:00 with a speed of 2.92 to 3 m/min and stayed at 10 to 120 m at nighttime, while parts of these DSLs remained in the deep layer during daytime. These two DSLs started to descend at 4:30 with a speed of 1.9 to 2.85 m/min and then stayed at depth of 400-500 m and 600-700 m, respectively during daytime. In slope waters, SVs of surface scattering layer (SSL) in daytime was about -74.2 dB, 5.5 dB lower than that in nighttime. However, the sound scattering layers were complex. One major DSL at depth of 300~450 m, was found with DVM behavior. It started to ascend around 18:00 with a speed of about 5 m/min and stayed at 10 to 150 m at nighttime, while it started to descend at 5:00 with a speed of about 4.4 m/min and stayed around the resident depth during daytime. Due to the limitation of 24-hr observation other vertical movements of sound scattering layers were difficult to examine in the present study. In the shelf region, the diel variation of sound scattering layer was distinct, but not DVM. The maximum SV of SSL around 30-80 m was observed after dawn, and mean SVs of SSL in nighttime was about -62.7 dB, 4.4 dB higher than that during daytime. The daily mean SV of surface scattering layer was about -64.9 dB, 6.4 dB and 7.5 dB, respectively, higher than those in the slope and Kuroshio water. Our result suggested that the diel variation of sound scattering layer was apparent. The DVM phenomena appear in our studied area except for shelf water. And acoustic biomass was significantly more abundant in shelf waters than in the slope and Kuroshio water.

Keywords: diel vertical movement, deep scattering layer, sound scattering layer, volume scattering strength, southern East China Sea

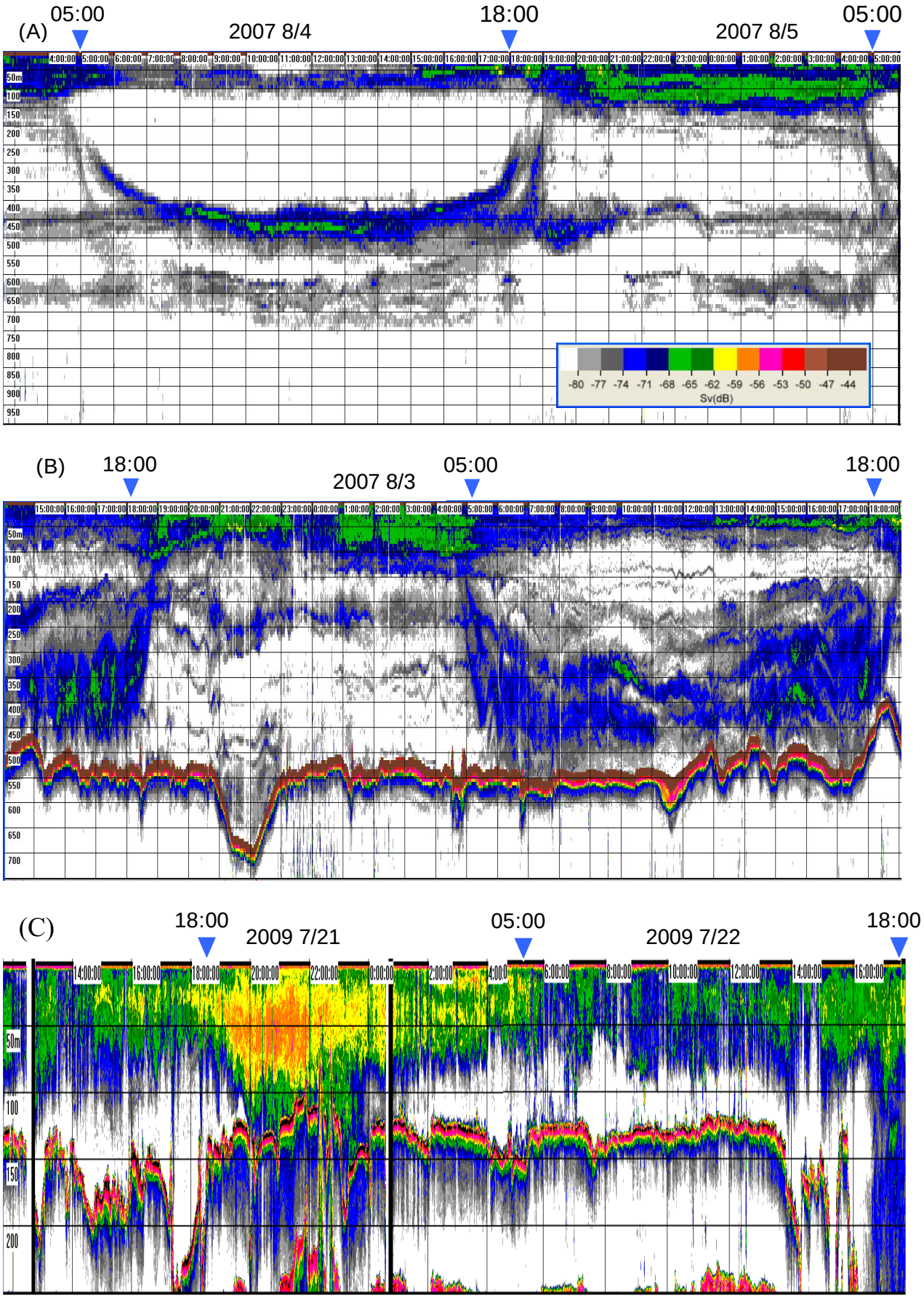

Figure 1 The diel variation in mean volume backscattering strength of sound scattering layer in the shelf (A), slope (B) and Kuroshio (C) waters of southern East China Sea. The color bar indicated the scale of volume scattering strengths.

Movement, behavior of yellowfin tuna (*Thunnus albacares*) associated with a subsurface fish aggregating device (FAD) off south-western Taiwan from acoustic tagging data

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Abstract

Thirty-four yellowfin tuna (35-80cm in fork length) were caught and released with implanted ultrasonic telemetry tags around a subsurface FAD in the coastal waters of Shiao-Liu-Chiu Island. Our objective was to document the behavior and distribution of yellowfin tuna associated with a subsurface FAD. The results showed that the maximum inhabitation around the subsurface FAD was 30 days. Furthermore, the small yellowfin tuna spent the majority of their time in the depth between 60 and 80 meters in daytime and the maximum diving depth was 250 meters, deeper than the larger ones in average. In nighttime, the small fish mainly gathered in the shallower waters of less than 20 meters, and the larger fish swam in the layer of 20 to 60 meter depth. Average night-time depth was correlated with lunar illumination. The horizontal movement of the small fish was about 600 meters distance from the subsurface FAD, and the larger fish was about 1000 meters.

Key word: Yellowfin tuna, Ultrasonic telemetry tag, Fish Aggregating Device

The relationship between Photo-environment and Diel vertical migration of mesopelagic animals

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Abstract

Light seems to be a major factor for regulating the depth of the Deep Scattering Layer (DSL), and particular species often seem to follow particular isolumes during the migration. Species identification using the relationship between photo-environment and diel vertical migration was considered from this phenomenon. On the other hand, Diel vertical migration by mesopelagic animals is important due to the vertical transport of organic materials between surface and mesopelagic layers. Therefore standing stock estimates of mesopelagic animals have been required. Though species identification is essential for an acoustic survey using a quantitative echosounder, the acoustic method has limitations to identify species at present. Accordingly species identification using the acoustic method and the relationship between photo-environment and diel vertical migration is suggested.

In Aug 2008, off Hokkaido, vertical migration of DSL was observed by an echosounder (KFC3000, SONIC CORPORATION) mounted on a vessel and the downwelling irradiance at 6 wavelengths on the deck was recorded by Profiling Reflectance Radiometer (PRR600/610, Biospherical Instruments Inc.) during the migration. Irradiance at depth was estimated based on the Lambert-Beer law with measured attenuation coefficient. The DSL was sampled using the Matsuda–Oozeki–Hu Trawl (MOHT; Oozeki *et al*., 2004). The upper and the lower outlines of DSL on the echogram during migration were traced. The traced outlines matched the estimated underwater irradiance profile at 490nm (blue light) well. *Diaphus theta* and Euphausiacea were dominant taxa from the total catch of mesopelagic animals in this area. About 90% of catches were these taxa. *D.theta* was caught at 190-200 m and Euphausiacea was caught above these depths during the day. The upper and the lower irradiance

corresponding to the upper and the lower edges of *D.theta* school were about 7×10^{-7} and 3×10^{-4} [μ W/cm^2/nm], respectively. Those for Euphausiacea were about 3×10^{-4} and 6×10^{-3} [μ W/cm^2/nm], respectively. Distributions of *D.theta* and Euphausiacea were different by underwater irradiance.

Keywords: diel vertical migration, irradiance, mesopelagic animals

Attempt of biotelemetry by fishing boat intended for demersal fish

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Abstract

In Tokyo Bay, small boat bottom trawling intended for demersal fishes (e.g. flatfish, conger-eel) and the conger-eel tube fishery are popular fishing methods. Hypoxic water occurs in this area during summer, influencing the ranges of these fishes. However, the distribution of the hypoxic waters moves greatly because of tides and wind. How fish react to such environmental changes is still unknown.

In aquatic biological research, the ultrasonic telemetry system is used to track organisms. This system attaches an ultrasonic transmitter (pinger) to the organism, and it is tracked by receiving a signal by the ultrasonic receiver. In cases of wide-ranged behavioral surveys, there are two common methods; the follow-up type (the ship equipped with a receiver pursues the signal from the pinger), and the stationary type (the signal from the pinger is received by the receivers set in the sea at regular intervals). It is difficult to install the receiver for the long term in areas of high ship traffic, such as Tokyo Bay.

In this study we examined a fishing boat equipped with ultrasonic receivers which carried out the operation daily and searched for the target species. We set the follow-up type receivers (VEMCO VR-100) to a fishing boat and the receiving ranges were measured. The frequency range used in this experiment was from 51 kHz to 81 kHz, which was used by ultrasonic biotelemetry.

Though it was greatly dependent on the signal strength of the pinger, it was confirmed that to receive from between 300m and 800m was possible.

Keywords: ultrasonic telemetry, demersal fish, follow-up type receiver

Relationship between directivity of backscattering strength and orientation distribution of fish school using omni-directional multi beam sonar

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Abstract

The quantitative omni-directional multi beam sonar FSV-30R has a function of measuring the backscattering strength and the volume of target fish school. The principle of estimating fish school abundance is to divide the backscattering strength of the fish school by the target strength of a single fish (Ts). Normally the backscattering strength of fish school is described by the product of the directivity function of Ts and the orientation distribution function of the fish in the school. However, even if the target strength function was given, it is difficult to know the orientation distribution function of fish in the school. In this study, the directivity function of backscattering strength of fish school was estimated by analyzing the fish school echo from various aspects.

The surveys were conducted during winter in 2007 at the Pacific coast of North-east Japan and at Barents Sea in Norway. The sonar data were obtained by purse seine fishing boats Soho-maru (99GT) and Zeta24 (2218GT) that equipped FSV-30R.

Some fish school echoes were extracted and measured their position, the volume, and the backscattering strength (Sv), then estimated the directivity function of the backscattering strength of fish school.

Results showed that there were obviously significant directivity in fish school echoes. Four fish schools which showed strong directivity were moving faster than 1.5m/s and the major axis of the directivity of the backscattering strength showed perpendicular to the moving direction. Two fish schools which moved slowly showed a weak directivity or a multi-pole directivity. These results explain that fish in the fast moving fish school are oriented uniformly; meanwhile fish in the slow moving fish school are oriented randomly. It suggests us how to know the distribution function of orientation of fish in the school by analyzing fish school behavior.

Keywords: multi beam sonar, orientation distribution, directivity of Sv

Using ultrasonic technique to characterize underwater organisms in reverberant cavity

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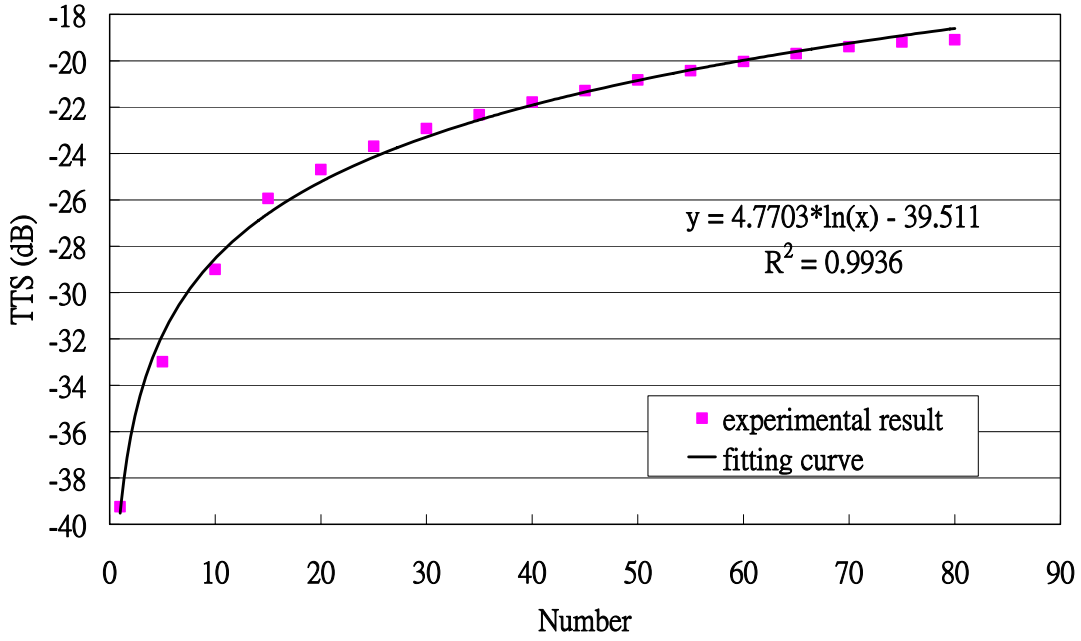
Abstract

Characterization of underwater organisms by ultrasonic techniques has been under development. It is a harmless technique to monitor underwater organisms. In a previous study, ultrasonic measurement was used to monitor non-invasively the number of fishes and even growth rates in the future that under highly reflecting boundaries. These measurements were performed remotely, without human interaction with the fish. Recently, it has been demonstrated that the acoustical total scattering cross section of fish swimming in a basin can be measured from multiple reverberation time series. These measurements have been used successfully to estimate the number of fish in a tank in laboratory conditions.

Different kind of species (such as Shubunkin Goldfish, Neon Tetra fish and Golden Zebra fish) was used as the organism measured to identify the characteristic signals magnitude in the study. Further, the calculation of the different number of fish corresponded total target strength was made. Finally, the measurement of corresponded total target strength to the three species of fish was made.

Keywords: ultrasonic、total target strength、organism characteristic


-18
-20
-22
-24
-26
-28
-30
-32
-34
-36
-38
-40
TTS (dB)
0
10
20
30
40
50
60
70
80
90
Number
y = 4.7703*ln(x) - 39.511
R2 = 0.9936
experimental result
fitting curve

Spatial estimation of kelp forests (*Laminaria* spp.) before and after harvesting in coastal water of the Shiretoko Peninsula, Hokkaido Japan

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Abstract

Along the Shiretoko Peninsula, one of the World Natural Heritage site, sustainable management of the kelp forests called public attentions because of their ecological and economic importance. Determining coverage of kelp forests and harvests provide essential information for the management. The objectives of this study were to spatially estimate the area and thickness of the kelp forests in coastal waters of the Shiretoko Peninsula. Between before and after harvesting, the area and distribution of the forests were compared. The field survey was conducted in the coastal waters of eastern side of the Shiretoko Peninsula (23.74 km^2) in the ends of July and August 2008, immediately before and after harvesting. Data on the presence or absence and thickness of the kelp forests were collected via acoustic observation. The acoustic component consisted of a BL550 echosounder (Sonic Co.) with a 200 kHz, 6˚ single-beam transducer that generated continuous pulses (pings) every second. The vertical resolution of the pulse was 6 cm. The survey transect was designed orthogonally or parallel to the shoreline at constant intervals in water less than 30 m in depth. The cruising speed of research vessel was 4-6 knots on the transect unless evading set nets or cultivation areas. Acoustic data were interpolated by geostatistical method using ArcGIS ver. 9.2 (ESRI). The measurements and estimations were validated by ocular observation

with Micro ROV (Video Ray). The kelp forests before harvesting continuously distributed, over 5.64 km^2 especially obvious near the Shiretoko Cape (44˚ 01.14' N, 145˚ 12.19' E). Estimated thickness ranged between 33 and 91 cm (RMSE 23 cm), and the 90% of all kelp forests falling in the below 78 cm range. After harvesting, kelp forests sparsely distributed over 2.73 km^2. In the southern part of study area, influence of harvests was observed as declines of forest area. Estimated thickness ranged between 35 and 105 cm (RMSE 20 cm), but most fall in the below 66 cm. Relatively thick (>55 cm) parts were majority of most likely harvested part of the kelp forests in study area. These results suggested that the harvesting on kelp along Shiretoko Peninsula in 2008 was selective for product sizes and distributed area. Quantitative assessment on both distribution and harvest of kelp forests were successfully made. Contentious surveys and applications of analytical method as this study provide time-series information to reveal the ecological and anthropogenic mechanism determining the kelp forests along Shiretoko Peninsula.

Keywords: Acoustic observation, Geostatistical method, Kelp forests, Shiretoko Peninsula

Estimate of seagrass canopy height using an echosounder of two frequencies

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Abstract

In this study, a determination scheme of seagrass canopy height using an echosounder of two frequencies is provided. It mainly involves investigations of acoustic backscatter from *Posidonia* seagrass meadows for the purpose of potential acoustic methods that can quantitatively give seagrass canopy height for the use in effective estimates of seagrass biomass on coastal seafloors. The investigation of the proposed method is illustrated by a data set collected from coastal seafloors within depths of not more than 20 m in Western Australia in 2005. The experiment was carried out by the use of a single beam echosounder of two frequencies deployed with a normal incidence configuration. Based on the detected waveform analyses of the two operational frequencies, it was found that the lower frequency was a steady indicator of the water-bottom interface while the higher frequency was sensitive to the existence of seagrass canopies. By measuring the detected range differences between reference points on the backscattered waveforms at the two frequencies within a small bounded area, the estimated seagrass canopy height gave reasonable results when comparing to the groundtruthed recordings. By employing the acoustically detected range difference of the study targets at the two frequencies, the proposed scheme has the potential of giving sound estimate results for the seafloor vegetation biomass by taking advantage of sonar systems with two frequencies.

Keywords: Seagrass, canopy height, echosounder, two frequencies, backscatter

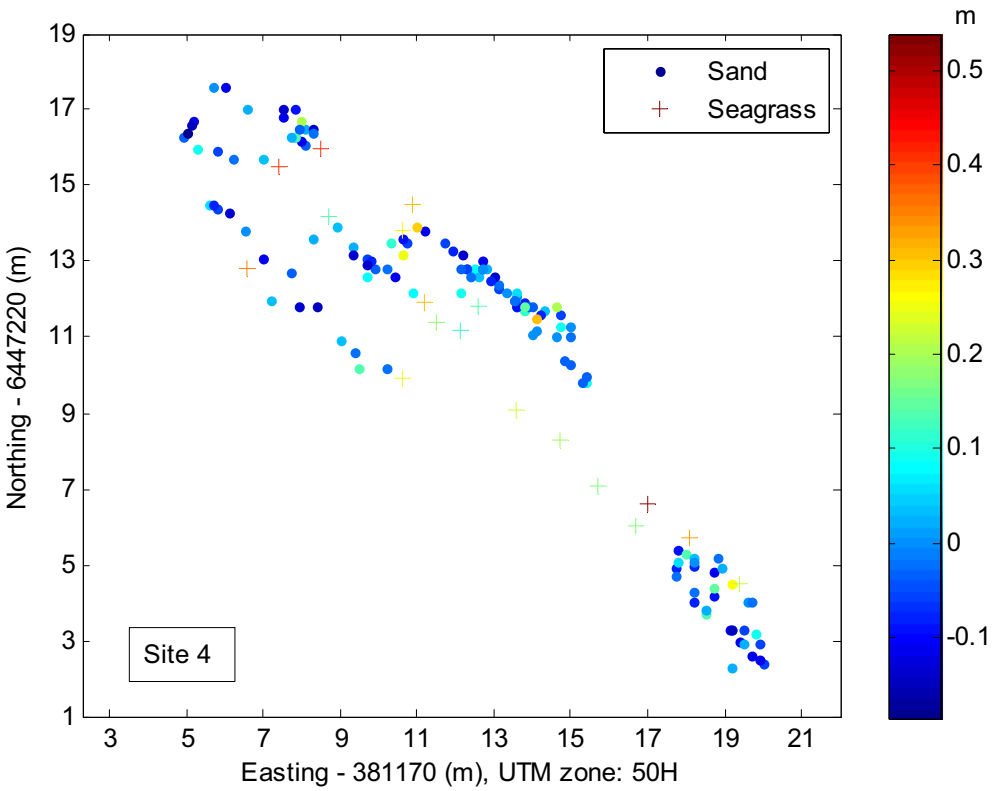

Figure 1 Distributions of the sand and seagrass samples identified by a selected acoustic parameter (EPW) with the seagrass canopy height derived from a selected parameter (RD) shown in color for data collected from Western Australia in 2005.

附錄三、國內外專家與學者及廠商互動交流之情形