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Contents

Keynote Speakers

KS-1

Recent Advances in Instantaneous Wide-Area Sensing of Fish Population Density and Behaviour with Ocean Acoustic Waveguide Remote Sensing

Nicholas Makris [1*], Olav Rune Godų [2], Josef Michael Jech [3], Gavin J. Macaulay [2], Purnima Ratilal [4], Ankita D. Jain [1], D. H. Yi [1], Shourav Pednekar [1], and Byunggu Cho [1]

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Keywords: Ocean Acoustic Waveguide Remote Sensing (OAWRS) , multi-spectral, high resolution acoustic

Cod, capelin and herring populations were surveyed over wide areas in their Nordic Seas spawning grounds with Ocean Acoustic Waveguide Remote Sensing (OAWRS) in February through March of 2014. Spatial charts of instantaneous population density were obtained for entire cod shoals spanning tens of kilometers in the Lofoten region (Fish Fish 2019), as well as similarly sized capelin shoals in the Barents Sea and herring shoals in the Alesund region. By multi-spectral OAWRS imaging, the relative density of species in mixed shoals were instantaneously distinguished and charted remotely over wide-areas in the Barents Sea revealing meso-scale predator-prey interactions. Similar multispectral imaging enabled herring shoal depth to be instantaneously estimated over wide areas during spawning migrations to Georges Bank (Remote Sensing 2018). With cod shoal parameter information obtained from OAWRS in 2014, historic Lofoten cod data was re-analyzed revealing that in the mid-20th century, the total Lofoten cod population apparently came precariously close to the mean size of a single shoal during previous and current periods of much higher total population (Fish Fish. 2019). This is consistent with previous qualitative observations that cod stock collapses elsewhere in the North Atlantic coincided with the disappearance of large spawning shoals. Lofoten cod shoal size was found to follow a log-normal distribution, consistent with theoretical expectations.

KS-2

Utilization of Underwater Acoustic Technology for Hydro-Oceanographic Surveys

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Keywords: underwater acoustics, hydro-oceanographic survey

Underwater acoustics play an important role in the development of the earth sciences including hydrography and oceanography. The Hydro-Oceanographic Center of Indonesian Navy (Pushidrosal) as a national hydrographic institution has utilized underwater acoustic technology since the first time using an echosounder as the equipment to record the depth of the seabed. In addition to using both single beam and multibeam echo sounders to obtain bathymetric data, Pushidrosal also employs other equipment that uses underwater acoustic principles such as side scan sonar for imaging the seafloor and sub-bottom profiler to determine the layering and thickness of seabed sediments. The side scan sonar data which is relatively identical to the backscatter multibeam echosounder data can produce an analysis for the types, characteristics and distribution of seabed sediments namely sand and gravel. The results of the analysis of the characteristics and distribution of this sediment are compiled with data on the characteristics of the water column specifically ocean currents, which can be used for the analysis of the seabed for the anchorage area, analysis of the dredging area plan as well as for military purposes such as the sitting area of a submarine when carrying out subsurface operations. Backscatter data is also compiled with layering and sediment thickness data to search for unexploded ordnance (UXO) such as marine mines in a marine minesweeping operation or hazardous metals. The implementation of this underwater acoustic technology is used to obtain accurate hydro-oceanographic data, and not only to promote the safety of navigation, which data is always updated, but it can also be used to support military purposes and the advancement of the maritime sector in Indonesia.

Sponsor Session

SS-1

Scientific Echosounder and ADCP System for Modern Sensor Platforms with Worldwide Examples

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Keywords: echosounder, EK80, applications, ADCP, USV

Kongsberg Maritime (SIMRAD) have been releasing the scientific echo sounders for many years. The scientific echo sounder has been installed and used on ships, mainly dedicated research vessels. However, in more recent times the need to utilize alternative platforms to collect scientific data with more temporal and spatial resolution has emerged. Supplementing research vessel echosounder data with data from smaller, more silent platforms also allow scientists to address uncertainties from echosounder blind zones and fish avoidance from ship. To meet the need for scientific data from new platforms a range of variations of the same acoustic instruments had to be developed. In recent years, EK80 scientific echosounders has gone from using only narrow band (CW) to also allowing for wideband (FM) data to be collected to increase range resolution and improve species identification. This allows for same electronics to be used with a range of transducers. The EK80 can integrate the function of ADCP with EC150-3C. After releasing the research vessel version (WBT) dedicated versions for unmanned surface and submerged platforms (WBT Mini), cabled platforms (WBT Tube) as well as platforms without power and data available (WBAT) was developed and introduced to the market. For the deep water CTD system, we develop the 6000m depth rate system of WBAT. In this report, in addition to the examples installed and used in the latest sensor platform, various measurement examples such as moored WBAT and systems that can be installed in fishing trawl are shown. The report will also highlight the latest development of a complete EK80 USV solution that includes echosounder frequencies from 18 to 333 kHz, 150 kHz ADCP with transducers mounted in a gondola for improved performance, as well as a digital cloud solution for onboard fish classification.

SS-2

Products Introduction of The Split-Beam Echo Sounder FURUNO FCV-38 and The Multi-Beam Sonar WASSP

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Keywords: echo sounder, split-beam, multi-beam, SONAR-netCDF4

FURUNO FCV-38 is a low frequency and high power quantitative echo sounder system, with standard beam width of about 7 degrees, the beam stabilization function and the calibration function. Built-in motion sensor and signal processing provide correct target strength in rough sea conditions. A calibrated system by sphere echoes provide correct target strength, the recorded raw data format is selectable the FURUNO original file format or the SONAR-netCDF file format. This system was also designed as a multi-beam echo sounder, maximum 5 different directions echoes are useful to get underwater information. WASSP Multibeam is a wide, 120 degrees swath, multi-beam sonar system specifically designed for fisheries with applications spanning across commercial fishing, hydro-acoustics and research as well as aquaculture, as an assessment tool. The design is predicated on high sensitivity, a broad range of operating frequencies and wide dynamic range. This allows effective evaluation of both water column targets, providing calibrated fish and other species target strength, and seafloor assessment for real-time bathymetry and backscatter. Data collection allows for real time monitoring and visualisation as well as post processing of processed or raw data, using either native tools or 3rd party applications.

SS-3

Feasibility Study for Detection of Shrimp Feed Pellets on Pond Bottom Substrate Using a Scientific Sonar System

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Keywords: Shrimp farming, Aquaculture feeding monitor. Shrimp feed pellets

Optimization of the application of shrimp feed amounts, timing and location within an operational grow-out site is critical to maximizing profit. Feeding the maximum amount the population will consume, without overfeeding, is an ongoing challenge to shrimp farming operators. Underfeeding slows the time it takes the population to achieve optimal harvest weight, increasing production costs. Overfeeding wastes costly feed and can cause detrimental effects to the production environment. Commercial shrimp farmers are investigating the use of new shrimp feed monitoring technologies to help optimize feed use by assessing the accumulation of wasted feed left on the bottom, uneaten, after a feeding event. Any technology used for this application must be accurate, easy to use and provide automated results. BioSonics is supporting this technology investigation by testing the use of their scientific sonar technology and automated processing software, to see if this technology can be used for shrimp feed pellet bottom accumulation assessment. BioSonics obtained shrimp feed pellets and set up and conducted several feed pellet detection experiments in a lab setting at their facility in Seattle, simulating conditions that may exist at operational shrimp grow-out sites to test the feasibility of this approach. Individual feed pellets and groups of pellets were successfully detected and quantitively assessed by BioSonics sonar technology when placed in isolated open water conditions. When feed pellets at various densities were placed directly on a simulated bottom surface, detectability was very difficult, as the small physical size of the pellets and the weak acoustic reflectivity compared to the simulated bottom caused the sonar signature of the pellets to be “masked”.

SS-4

Introduction of Echoview (Solutions, Applications and Workflow Echoview)

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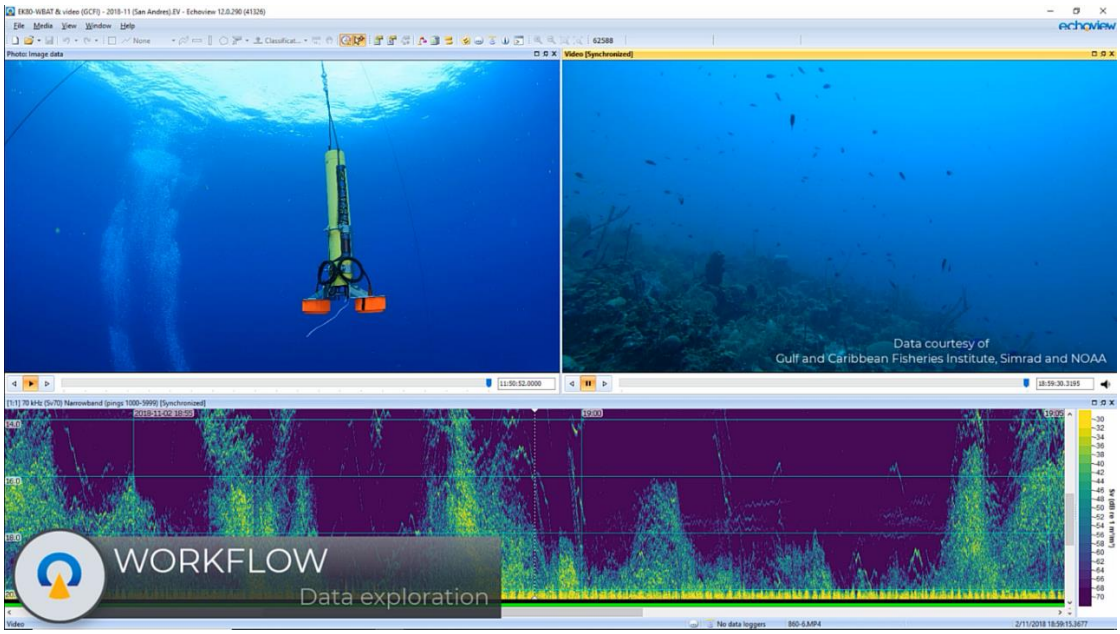

Session Ⅰ.

Acoustic Technology (SGAT)

New or advanced technologies on fisheries acoustics.

AT-1

Designing and Implementing Active Sonar Monitoring System for Detecting Floating Objects Detection in the Water Column

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Keywords: transducer, piezoelectric, driver acoustic, beamforming

Acoustic transducers are indispensable for acoustic energy sources in underwater sensing activities. Measuring Source Level of transducer is one important parameter in the sonar equation. The transducer design will determine the beamforming beam pattern. The right transducer design will affect the coverage area and sensing accuracy. In this research, we design a piezoelectric transducer using Matlab software and apply the results by assembling several piezo elements from PZT4 material into an array according to the calculation results. The manufacture of an acoustic driver with a simple but reliable working principle is also carried out to provide transmitting commands. The resulting beamforming pattern will be compared with the Matlab design. The receiver module will then receive the acoustic signal emitted and the results can be recorded for further analysis activities.

AT-2

Echo Data Transmission Around an Artificial Reef Installed in Gijang Coastal Area by The LTE Mobile Communication

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Keywords: echo, data transmission, artificial reef, LTE, mobile communication

In this study, the authors developed a prototype echo data transmission system consists of a telesounder based on the LTE mobile communication and a data server for monitoring the appearance of school of fish around artificial reefs instal1ed in Gijang coastal area, Korea and its data saving. The telesounder consists of a conventional fishfinder (50 and 200 kHz), a digital timer for turning OFF and ON the power both of the fishfinder and the LTE router, a DC to DC converter (12 V to 5 V) and a LTE router including a data controller and dual antennas (gain: 10 dBi; omni-directional). The data server computer consists of two data server (A and B) worked on the Unix operating system. One of the server-A is conducted mainly that accumulates the echo data (size: 1 kB) received from the telesounder and sends an echo data file (size: 74 kB approximately) to another server. The other server-B is carried out some works that saves the echo data file received from the server-A and supplies the echo data files to approved users. The LTE communication network is connected automatically by the data controller whenever turned on the power, the echo data from the fishfinder through RS-232C are transmitted divided 1 kB capacities to a base station of a mobile communication company. The echo data received on the base station is delivered through the internet optics cable to the data server-A installed in a laboratory of Pukyong National University. At results, the echo data transmission around the artificial reefs through the prototype telesounder and the data server was successful.

AT-3

Experimental Study on The Measurement of Calibration Sphere Echoes by Broadband Scientific Echosounders

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Keywords: fast fourier transformation, window size, pulse compression processing, spectra

Broadband echosounders using linear frequency modulated (LFM) transmit signals reduced the limitation on single target detection due to high-range resolution realized by pulse compression processing applied to the received echoes. Frequency spectra of target strength (TS) can be also obtained from the pulse compressed single target echoes and contribute for species identification. However, fast Fourie transformation (FFT) for the single echoes is necessary and the echo processing is more complex than that of conventional narrowband echosounders. FFT window size (WS) is one of the key parameters both in calibration and TS measurement. If the WS is not appropriately set for the single echoes of standard spheres or target animals, the errors in the system gain or measured TS spectra are occurred. Therefore, the authors firstly focused on the echoes of standard spheres and investigated appropriate FFT WS both in a tank and the sea to perform the sphere calibration accurately. The used broadband echosounder was EK80 (Simrad–Kongsberg, Norway) mainly composed of a wideband transceiver mini and two split-beam broadband transducers ES120-7CD and ES70-7CD. Fast ramping LFM pulses with a duration of 2.048 ms were used and the frequency range was 90–170 kHz and 55–90 kHz, respectively. Three spheres with diameters of 22, 25, and 38.1 mm (provided by Simrad), which were made of tungsten carbide with 6% cobalt binder (WC), were used as standard targets. We calculated the mean absolute error (MAE) between the measured and predicted TS spectra in different WS from 0.05 m to 3 m in 0.05-m increment steps to find the appropriate WS. The center of FFT window was set on the peak of the sphere echoes waveform. The results showed that when WS was too small for the echo waveform (e.g., WS = 0.1 m), the MAE of WC22, WC25, and WC38.1 at transducer ES120-7CD were 0.14 dB, 0.48 dB, and 0.58 dB, respectively. Such errors would affect the system gain. The MAE decreased gradually with the increase in WS. The changes of MAE in the tank experiment and the sea experiment were similar. When the WS were 0.4 m and 0.6 m for ES70-7CD and ES120-7CD respectively, the MAE was negligible and started to become stable. Therefore, such WS would be appropriate for the calibration of our system using the above WC spheres. This work was supported by a JSPS KAKENHI Grant Number 20K21329.

AT-4

Evaluation of The Resources of Penaeus Vannamei in Aquaculture Water Based on DIDSON

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Keywords: DIDSON, resource assessment, underwater sound detection, analysis model

In order to accurately monitor and evaluate the resources of Litopenaeus vannamei (abbreviation: prawn) in the aquaculture water, a method of monitoring and evaluating the prawn resources by imaging sonar is proposed. A resource assessment of a shrimp pond was carried out using dual-frequency identification sonar (DIDSON). Prawn targets in DIDSON image were tracked and counted by ECHOVIEW acoustic data post-processing software, the accuracy of target tracking and counting was verified by combined with manual visual counting. The results showed that the proportion of the large prawn (Length > 0.1m) was 78.20%; the surface density of the prawn is about 7 ind/m2 ; The total number of the prawn in shrimp pond is about 74815 ind, and the statistical error of the model is about 8.45% compared with the artificial visual counting of acoustic image; According to the power function relationship of body length and body weight of the prawn, the body weight of the prawn is about 1405.52kg, the evaluation error is about 6.30% Compared with the empirical value. In this paper, the image data of DIDSON is used to monitor and evaluate the prawn resources for the first time. The research shows that DIDSON is suitable for shrimp related research and broadens the application field of DIDSON. At the same time, it provides a new method of accurate investigation for shrimp breeding management.

AT-5

A Long-Range Target Detection and Classification System for Environmental Monitoring at Marine Hydrokinetic (MHK) Sites

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Keywords: marine renewable energy, marine mammal tracking

BioSonics and team members have developed a practical, unobtrusive, robust and cost-effective long range (200 – 300 meters) active acoustic monitoring system to automatically assess marine life behavior at potential or operational MHK sites. The system includes a Perimeter Detector, that automatically detects and geolocates targets at ranges of 200-300 meters. The system includes a Directed Classifier that automatically aims at detected targets to track the target's position in three dimensions. This tracking capability allows automated measurement of the target's behavior (i.e., speed, direction and tortuosity), a strong indicator of target classification. Acoustic signatures from tracked targets are analyzed to provide additional target classification information. Low band width, real-time reports are automatically generated and transmitted to project operators, including target location, depth, behavior and classification. The project team has improved upon the existing baseline technology which is currently in operation in automated underwater threat detection applications at US Navy sites. Targeted improvements have included performance optimization for MHK project monitoring and overall cost reductions. Active acoustic technology is the most effective way to assess marine life behavior at range, but existing technology has shown limitations in usefulness in the MHK monitoring applications as there may be potential behavioral changes of detected animals (specifically marine mammals) due to their ability to "hear" the monitoring system. The project team has implemented new shaped pulse and Chirp capabilities to suppress off-frequency sound energy within the hearing range of marine mammals while increasing the overall detection range. MHK developers, regulators and the public need to understand how candidate MHK devices affect the behavior of fish, marine mammals and other marine organisms for project permitting. The long-range target detection and classification system developed by the project team helps answer these key questions with scientific accuracy and at a low cost. This technology will move the MHK industry forward.

Session II.

Theory and Target Strength (SGTS)

Theoretical studies or practical issues on fisheries acoustics including target strength.

TS-1

The First Report Target Strength Seahorse (Hippocampus comes) Versus Brood Pouch Volume

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Keywords: target strength, acoustic, brood pouch, seahorse

Male seahorses have brood pouches, useful as a fertilization medium. This pouch is also a tool for sex identification of seahorses. The presence of the pouch is thought to have an effect on the acoustic reflectance. This study aims to analyze the value of Target strength (TS) of seahorses versus brood pouch volume (Vbp). The acquisition of the TS value was carried out using a scientific echosouder Simrad EK-15 with a frequency of 200 kHz on a grounding platform called a kelong in the Bintan seawater. The seahorse (Hippocampus comes) samples used were from the waters of Bintan, collected from fishermen as by-catch. Data analysis was performed with Sonar5 post processing software. The results showed that the distribution of TS values for pregnant male seahorses ranged between -67.75 (S.D ± 1.26) dB and -61.67 (S.D ± 2.08) dB. Brood pouch volume has an effect on the response of the TS value, the linear regression results show the equation TS versus Vbp, TS = 1,968 log10(Vbp) - 65.27 (dB) with a coefficient of determination (R2) 9.1%. Pregnant male seahorses tend to have lower TS values. Brood pouch is thought to be able to reduce TS value.

TS-2

Target strength of *Puelurus phase* : Scalloped spiny lobster (*Panulirus homarus*) and Ornate spiny lobster (*Panulirus ornatus*)

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Keywords: hidroacoustics, targeth strength, *puerulus*, lobster pasir (*Panulirus homarus*), lobster mutiara (*Panulirus ornatus*), SDWBA model

The main challenge in stock assessment with acoustic survey, how to improve the accuracy of the results. The factors of bias is high diversity of species,body shape and size. Therefore it is important to have a database of acoustics backscattering strength (Targeth Strength, TS) on a particular type and size object, as a reference used in grouping and estimating length of species. TS measurements were performed on each individual of each species object and various sizes. Data numerically analysis through the best-fit technique to establish the relationship between length, object orientation, and target strength. Two species of live *puerulus* that have been successfully measured are scalloped spiny lobster (*Panulirus homarus*) and ornate spiny lobster (*Panulirus ornatus*). The formulation obtained for species scalloped spiny lobster (*Panulirus homarus*) is TS_{200kHz} = -143.3+40.39$\log_{10}$(L) (95% CI:-116.3 to -118.2, 17 to 21; R^2=0.91) and ornate spiny lobster (*Panulirus ornatus*) is TS_{200kHz} = -139.01+33.54$\log_{10}$(L) (95% CI:-120.8 to -122.2,18 to 23; R^2=0.93). The results of SDWBA model with a straight body shape have different backscatter values. In acoustic frequency range, the model results show different values at same size object. The formulation and model may be used to eliminate bias in the fisheries resource stock assessment by acoustic method and may be used as a reference or as a database of TS values of the types of fisheries resource in FMA-NRI.

TS-3

Analysis of Target Strength of Blue Swimming Crab (*Portunus pelagicus*) Based on Sex Differences

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Keywords: sex ratio, single beam, swimming orientation angle, tethered method

The sex ratio is one of the parameters in controlling and managing crab stocks in nature. So far, sex ratio data has been obtained from measurements of fisherman catches. One alternative in estimating the sex ratio is using the acoustic method. The purpose of this study was first to analyze the acoustic target strength (TS) of the crab based on the different sexes of the crab at different swimming orientation angles and the second to analyze the comparison of the average target strength of male and female crabs. The method used is the tethered method through ex-situ. The instrument used is a single beam echosounder Simrad EK15 at a frequency of 200 kHz. The results obtained from this study are TS mean value of female crabs is -47.22 dB lower than the average TS of male crabs is -46.30 dB. The mean value of TS also tends to decrease with the increasing angle of the swimming crab's orientation towards the transducer. The results of the comparative test of the mean TS value showed no statistically significant difference between male and female crabs ($p>0.05$) however, the mean value of the total length of male and female crabs showed a significant difference ($p<0.05$).

TS-4

Broadband Target Strength Measurements of Three Bladderless Fishes

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Keywords: target strength, bladderless fish, broadband quantitative echosounder

The backscatter from the fish is the amalgamation of bladder, backbone, flesh, and head. However, over 90% of the backscatter from a bladder fish is from the bladder. There are many commercially important fish species without the bladder in the world. As the acoustic properties of bladderless fish are not known well, abundance estimates in acoustic methods cannot be in progress accurately. This study measured the target strength (TS) of three bladderless fishes, pointhead flounder, arabesque greenling, and Japanese sand lance to examine bladderless fish's acoustic properties. TS measurements were taken in a seawater tank (width, 10m; length,5 m; depth, 6m) using EK80 (Simrad) over a frequency range of 45 -90 kHz and FCV-2100 (Furuno) over a frequency range of 80 -120 kHz by tether method. Pitch angle characteristics were measured from a head-down orientation (-30°) to a head-up orientation (30°), and TS from EK80 was processed using Echoview 10 software (Echoview), TS from FCV-2100 was processed using the FCV-2100 replay software (Furuno). Higher TS and directivity were observed at higher frequencies for pointhead flounder and arabesque greenling. However, it shows contrary properties for Japanese sand lance. The TS of a fish is approximately proportional to the square of the body length L, expressed in decibels, TS = 20logL + TScm. We tried to calculate their TScm and found that the TS of arabesque greenling cannot approximate the square of the body length. For pointhead flounder, the maximum TScm is -76.2 dB, and the average TScm is -85.4 dB ($4 < L/\lambda < 11$). For Japanese sand lance, the maximum TScm is -70.5 dB, and the average TScm is -76.6 dB ($5 < L/\lambda < 13$). Pointhead flounder showed a higher TS than arabesque greenling and Japanese sand lance under the same L/λ. This is considered to be affected by the cross-sectional area of fish.

TS-5

Target Strength Distribution in The North Waters of Alue Naga Using Simrad Ek-15 Echosounder

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Keywords: target strength, hidroakustik, Simrad EK-15, Perairan Utara Alue Naga

Hydroacoustics is one of the leading methods in the field of underwater exploration. The use of the hydroacoustic method in this study was to obtain the distribution of Target strength (TS) values in the waters of Alue Naga, Banda Aceh City. Field data collection was carried out using the Simrad EK-15 instrument which was attached on the port-side of a traditional fishing boat. Data analysis was performed using post-processing software Sonar 5-Pro. Acoustic data is limited to a depth of 1 to 60 meters which is divided into six layers, so that each layer has a thickness of 10 meters. The results showed that the value of target strength along the research trajectory was obtained ranging from -35 dB to -55 dB with a target mean value of all depths was -53.31 dB. The value of the target strength tends to increase along with the deeper layers. The largest average target strength is found in the 5th layer (41 to 50 meters). In situ catch results obtained when sailing in these waters include rambai fish (Carangoides caeruleopinnatus), selar fish (Selaroides leptolepis), cangah fish (Aphareus furca), moontail grouper (Variola albimarginata) and big eye fish (Priancanthidae sp.).

Session III.

Echo Survey (SGES)

Research methodology or the evaluation of acoustic fisheries survey.

ES-1

Fish Identification by Acoustic Characteristics Analysis of Multi-Frequency

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Keywords: echosounder, multi-frequency, East China Sea

East China Sea is adjacent to the waters south of Jeju Island in Korea. And Kuroshio current, Tsushima current, Yellow Sea Warm Current, and Chinese coastal water circulate, making it a spawning ground, habitation, and migration path for various fish species. This study conducted a basic study on fish identification in the East China Sea for fishery resource using acoustic scattering characteristics of multi-frequency. Acoustic data were collected from July 14-16th, 2020 using scientific echo sounder (EK80, Simrad, Norway) installed on the Saedongbaek (T/V). The beam type of the scientific echo sounder is split beam, and acoustic data of multi-frequency as collected by setting in the frequency modulation (FM) mode, used frequencies were 38, 70, 120, 200, and 333 kHz. The collected data were analyzed by underwater sound processing software (echoview v 8.0, echoview software Pty Ltd, Australia). The analysis method tracked fish after performing a single target detection wideband variable through TS and angular position for pulse wideband ping collected in acoustic data. According to the results of study, the average TS of whole echo signals collected on July 14 (St. 17-18) was 20Log(L)-51.0(dB), and the average TS of echo signals estimated as fish was 20Log(L)-51.3(dB). In addition, the average TS of whole echo signals collected on July 16 (St. 9-10) was 20Log (L)-50.1(dB), and the average TS of the echo signals estimated as fish was 20Log (L)-46.0(dB).

ES-2

Diel Vertical Migration of Mesopelagic Fishes in The Central and Southern Waters, South China Sea

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Keywords: mesopelagic fishes; diel vertical migration; acoustic; community structure; South China Sea

In this study, the vertical distribution and diel vertical migration of mesopelagic fishes were continuously observed and sampled using Simrad EK60 scientific echosounder (38 kHz split–beam transducers) and mid-water trawl. The field surveys were carried in Nansha Island (S1 station) and Zhongsha Island (S2 station) in June 2017 and Nansha Island (F1 station) and Zhongsha Island (F2 station) in December 2017, respectively. The diel migration process, vertical distribution, acoustic migration proportion, community structure, and migration pattern of mesopelagic fishes were analyzed. The results showed that mesopelagic fishes started to migrate upward before sunset and the large-scale upward migration process ended within 30-120 minutes after dark, and began to migrate downward before dawn and the large-scale downward migration process ended within 10-50 minutes after sunrise. At the S1, S2, F1 and F2 stations, mesopelagic fishes are mainly distributed in the 360-700 m, 350-520 m, 350-680 m and 300-700 m depth range in the daytime, respevtively; the acoustic migration proportions of mesopelagic fishes are respectively 44.5%, 29.8%, 25.7%, and 58.0% at the above stations. For the same trawling layer, the catch rate, species richness, diversity and species evenness of mesopelagic fishes at night were higher than that in the daytime. In the epipelagic zone (<100 m), despite the acoustic density and catch rate of mesopelagic fishes were high, its diversity and species richness were not high. Lantern fish was the dominant biological group of migratory nektons, and from the epipelagic zone to 600 m depth the number and mass percentage of lantern fish decreases with increasing depth at night. Cephalopoda was an important component of migratory nekton. We identified 212 fish species, 26 cephalopod species, and 2 shark species at 4 stations. 43 fish and cephalopod species were clearly determined to have strong diel vertical migratory habit, including 23 lantern fish species, 8 cephalopod species, and 12 other fishes species. 6 fish species such as *Diaphus lucidus*, *Melamphaes microps*, *Argyropelecus affinis*

were determined to have weak diel vertical migratory habit. 13 fish species such as *Sternoptyx obscura*, *Argyropelecus sladeni*, *Sternoptyx diaphana* were determined to have no diel vertical migratory habit. The migratory habit of the other 178 species (including fish, cephalopod and shark) could not be determined. The research results indicated that the acoustic migration proportions of mesopelagic fishes present seasonal and regional differences, and the compositions of its community structure present the dependance of light-night cycle and depth. In order to enhance the level of researching deep sea ecosystem, the study suggests comprehensively strengthening research on mesopelagic fishes in the South China Sea from the following aspects: community structure and diversity and its space-time dependence, diel migration patterns and mechanisms, new methods and technologies for assessing resource, and the development of a new automatic open-closed stratified sampling trawl system.

ES-3

Fishery Independent (Acoustic) Survey of The Blue Mackerel Spawning Ground in Yilan Bay, Taiwan

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Keywords: scientific echo sounder, blue mackerel, target strength

Mackerel fishery is currently the coastal fishery with highest production in Taiwan. However, overfishing issue regarding the main catches, including blue mackerel, chub mackerel, and horse mackerel, has been highly concerned by the general public as well as their stock status and relevant management policies. I-Lan Bay in the northeastern waters of Taiwan is one of the main spawning grounds for blue mackerel, and the spawning period is January to May each year. The standing crop of blue mackerel migrated in spawning season in I-Lan Bay can serve as a leading index of reproduction success rate prior to spawning season. We used portable scientific echosunder SIMRAD EY60 system equipped with 200 kHz transmitter together with pole and line fishing to conduct line transect surveys in I-Lan Bay in the beginning of 2021 spawning season. We expected to grasp the relevant information of the blue mackerel migrated in the spawning ground during the spawning period. The species sampled by the pole and line sampling were blue mackerel and pufferfish. The two species were caught in different depths by which we can grasped blue mackerels' echoes. The TS-TL conversion formula for blue mackerel were then been established (R^2 is 0.93). We found that most of the blue mackerel migrated in I-Lan Bay reached matured size and the larger blue mackerel mainly gathered around the Guishan Island. In the near future, we will adopt multi-frequency echosounder survey and cooperate with commercial fishing vessels to collect more information of blue mackerel spawners. We expect that the result of fishery independent survey using acoustic can contribute relevant policies formulation.

ES-4

The Spatio-Temporal Distribution of Fish Density in Arafura Sea

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Keywords: hidroacoustic, density, spatial distribution, pelagic fish, demersal fish

The aim of the research was to study the pattern of spasio-temporal fish distribution base on the survey conducted in November 2006 and October 2016 in Arafura Sea. RV Bawal Putih and RV Baruna Jaya IV was used for the survey, and Simrad EK60 split beam Echosounder with frequency 120 kHz and 38 kHz was used for acquisition of acoustic data. The data analysed descriptively to explain the spasial and temporal distribution of fish density. The results presented in histogram and map of fish distribution. Temporal distribution of pelagic fish was indicated that they move to the surface at night time, while in the day time they move down to deeper strata. For demersal fish, most of them are close to the bottom in the day time rather than night time. Spasial distribution was indicated that pelagic and demersal fish not have normal distribution in survey area, but each of schooling was detected at selected location.

Invited Speaker

Title:
Continental Shelf-scale Passive Ocean Acoustic Waveguide Remote Sensing of Marine Ecosystems, Dynamics and Directional Soundscapes: Whales, Fish, Ships and other Sound Producers

Authors:
Purnima Ratilal, Sai Geetha Seri, Hamed Mohebbi Kalkhoran, Matthew Schinault, Max Radermacher, Heriberto Garcia, Chenyang Zhu and Nicholas C. Makris

Abstract:
Passive ocean acoustic waveguide remote sensing (POAWRS) employs a large aperture coherent hydrophone array system to provide instantaneous wide area remote sensing and monitoring of sound producers in marine ecosystems, including detection, localization and classification. Coherent array processing techiques such as beamforming can (1) enhance the signal-to-noise ratio of received signals by filtering noise outside of the signal beam, (2) provide estimates of signal bearing, and hence (3) enhance signal detection ranges by one to two orders of magnitude over that of a single hydrophone. A bearing-time trajectory sequence of detected signals from a sound producer can be employed for localization estimation. Here we discuss POAWRS monitoring of marine ecosystem and dynamics in three distinct environments, the Gulf of Maine (2006) and the Great South Channel (2021) off the US Northeast coast, and the Norwegian and Barents Seas (2014). The sound producers include marine mammal vocalizations from a large variety of baleen and toothed whale species, fish grunts and other fish produced signals; ship generated tonal machinery and broadband sounds; seismic airgun and other natural and man-made sound sources. When POAWRS observations are combined with other sensing modalities, such as OAWRS, ultrasonic echosounding, visual and underwater photography, important behavioral dynamics including predator-prey interactions at a variety of temporal-spatial scales can be elucidated. POAWRS applications including real-time environmental assessment for seismic surveys and other geophysical prospecting activities, monitoring marine ecosystems around wind farms, and marine directional soundscaping, in addition to maritime surveillance and defence.

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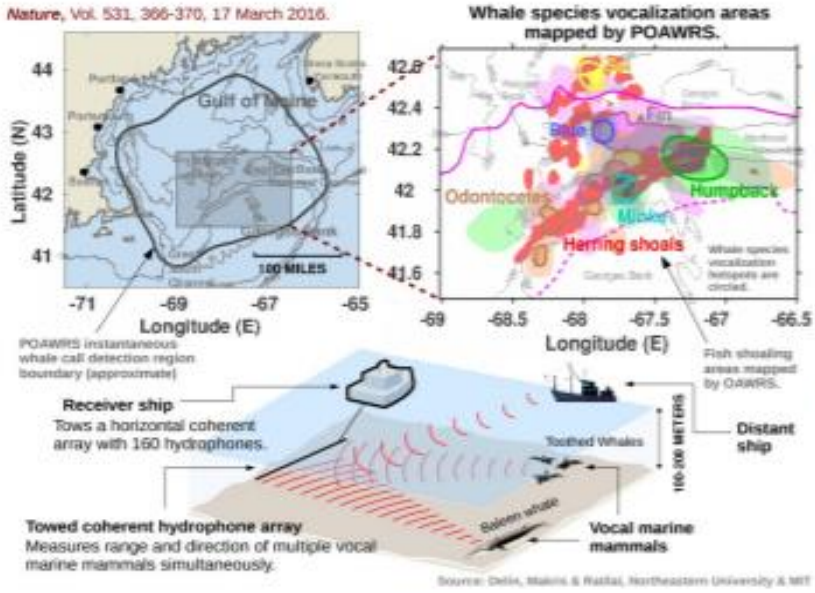

Figure 1: Example of POAWRS system deployed in the Gulf of Maine environment in the US Northeast coast in an experiment in 2006. Objects detected, localized and classified with POAWRS include marine mammals vocalizations, fish grunts, and ship radiated sound.

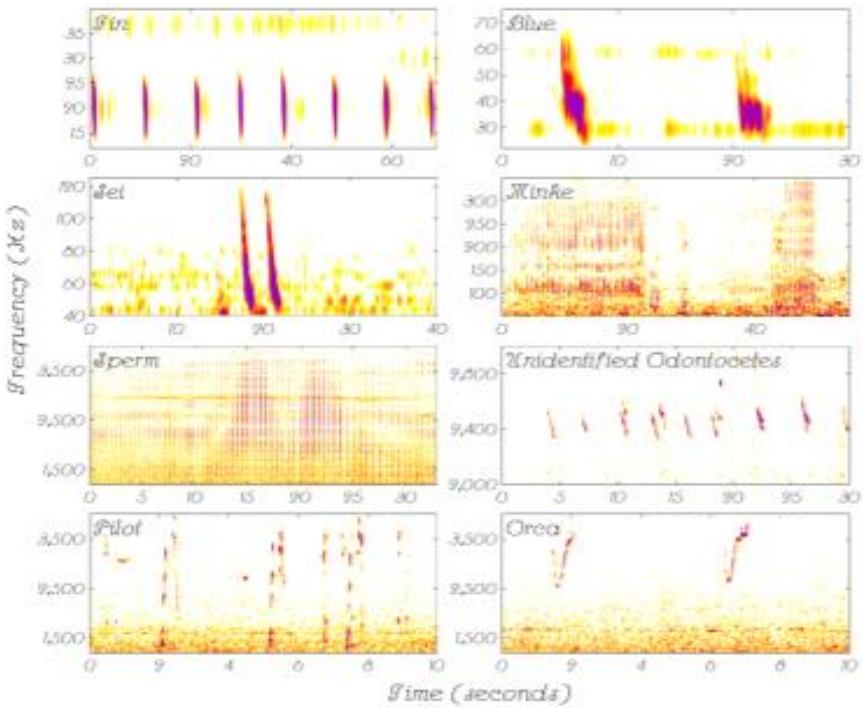

Figure 2: Beamformed spectrograms of typical repetitive vocalizations from diverse marine mammal species observed using the POAWRS receiver array in the Gulf of Maine from 19 September to 6 October 2006.

Session IV.

Acoustic Application (SGAA)

Broader aspects of underwater acoustics for fishery and fishery surveys.

AA-1

Fish Stock Assessment in North Alue Naga Waters Using Single Echo Detector

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Keywords: acoustics, density value, area density, density volume

Acoustic methods can be used for various scientific purposes and support underwater survey activities, especially in the marine and fisheries sector. This study was aimed at estimating fish stocks using the hydroacoustic method. Field data acquisition was carried out in North Alue Naga waters in April 2021. Acoustic data collection was carried out using the Scientific Echosounder Simrad EK-15 device which is attached to the port-side of a traditional fishing boat. Based on the results of the integration using the density area and density volume, it can be seen that the density distribution tends to increase within increasing of water depth. The highest fish density value is found at a depth of 41-50 m with a value of 136.90 fish/ha or 1.78 fish/1000 m^3.

AA-2

Swimming Behavior Comparison of Olive Flounder (*Paralichthys Olivaceus*) Against The Periphyton Attachment to Underwater Structure of The Wind Power Plants

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Keywords: acoustic telemetry, olive flounder, movement range, stay duration, behavior

In this study, it was analyzed the behavioral response of the olive flounder (Paralichthys olivaceus) before (below 1 year after construction) and after (above 1 year after construction) the periphyton attachment to underwater structure of the wind power plants. In this study, four olive flounders were released near the wind power generation and traced using the acoustic tracking with 20 VR2W receivers array. On 15 August 2019, before the periphyton attachment, the olive flounder CF1-1 and CF1-2 respectively stayed about 20 minutes and 47 minutes within the 400 initial point, and then about 3 days and 13 days within the site of the offshore wind power plant. On 31 October 2020, after the periphyton attachment, the olive flounder CF2-1 and CF2-2 respectively stayed about 1.8 hours and 1.8 hours within the 400 initial point, and then about 3 days and 6 days within the site of the offshore wind power plant. In this study, it was shown that the periphyton occurrence on the underwater structure of the power plant affected on the stay duration of olive flounder. However, it did not affect on the stay duration of another fish (black rockfish). Therefore, the follow-up study is necessary to find the differences of the fish species.

AA-3

Waveform Detection from Biosonar (*Tursiops Aduncus*)

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Keywords: waveform, dolphin, source level, frequency

Biosonar is an important thing in monitoring the condition of marine mammals, namely dolphins, biosonar is a combination of science where biology and SONAR detect sounds in animals. This is an urgency to conduct research to identify waveforms and sound patterns produced from these objects. This study performs signal processing using Raven Pro software and performs data processing on Source Level results from dolphin objects (Tursiops aduncus). The results of processing the sound data of the Tursiops aduncus dolphin have 5 sound patterns with a time range of 0-50 ms, 150-200 ms, 400-450 ms, 500-550 ms, and the last 600-650ms. The highest Source Level value is at 200 ms with the highest Source Level (SL) value generated, which is 24.50 dB with a frequency of 15200 Hz, and the maximum sound detection is at a frequency of 21000 Hz.

AA-4

Eelgrass Habitat Identification Using Multispectral Multibeam Echosounder at Richardson Bay, California

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Keywords: Bathymetry, Backscatter, Eelgrass, Multispectral, Multibeam Echosounder.

Eelgrass, *Zostera Marina*, is a group of seagrasses which can grow in shallow waters with a depth of 1-10 meters. This biota is a shelter for various types of fishes, contributes to the carbon sequestration process, as well as an intention to protect the coastline. This angiosperm class plant is spread in various places, one of which is in Richardson Bay, California, United States. In this research, the identification of eelgrass habitat was performed using multi-frequency multibeam echosounder. The water column and the backscatter data from multibeam echosounder were utilized to determine the area of the eelgrass field and the type of surficial sediment at the research site. The multi-frequency multibeam echosounder transmits several acoustic wave frequencies at the same data acquisition. This results multispectral water column and backscatter data which can improve the analysis of the eelgrass habitat as it provides spectral variations in data processing. The multi-frequency multibeam echosounder utilized in the study is R2Sonic-2022 which has an acoustic frequency variation of 170kHz, 225kHz, and 450kHz at a swath angle of 120° and 350kHz, 450kHz, and 700kHz at 70° of swath angle. Qimera, FMMidwater, FMGT, and Fledermaus from QPS are utilized in data processing to collect the bathymetry, multispectral water column and backscatter data. The results show the distribution of eelgrass field with a 1 to 2 meters depth within area of 1010.04 m² at the research area. The sediment analysis of multispectral backscatter data shows the distribution of surficial sediment types in the research area are categorized into three classes: sand, silt, and clay. Silt is the dominant sediment type in the study area with an area of 4041.38 m². The identification results can indicate the waters health condition at the research site and the biodiversity of marine lives ecosystem considering other factors such as the lights, water clarity, and temperature.

AA-5

Applications SIMRAD EK-15 Echosounder for Estimating The Temporal Distribution of Pelagic Fish Target Strength in Pancur Waters, Indonesia

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Keywords: target strength distribution, pelagic fish, echosounder, Pancur waters

Information about the distribution and abundance of fish in the waters is very important, especially to support the livelihoods of the people in Pancur who are generally traditional fishermen. Acoustic method is used to determine the estimated value of target strength as a scaling factor for estimating fish stocks. This study aims to analyze the distribution of target strength values and estimation of fish abundance using a scientific echosounder SIMRAD EK-15 with a frequency of 200 kHz. Data collection was carried out using a boat, moving parallel to the shoreline with a tracking length of 48.2 miles. Data analysis was performed using Sonar4 software. Data collection on the catch of fishermen is also carried out for one month at the fish landing site. The results showed that the distribution of the target strength values ranged from -68 dB to -38 dB, with a total of 84,276 fish targets on the tracking path. The distribution of the largest TS value at -68 dB to -65 dB with an estimated 39,577 fish. The lowest TS distribution was at -41 dB to -38 dB with an estimated number of 141 fish. The TS value -68 dB to -56 dB is thought to be the dominance of the anchovy group (Stolephorus spp) with a size of 1.57 - 6.24 cm. In this study, it was also found that the vertical distribution of TS values tends to decrease based on depth.

AA-6

Evaluation of Fish School Resources Based on Echo Statistics

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Keywords: evaluation of fish stocks, marine pastures, fishery acoustics, echo statistical method, fish school sound scattering model, Furong Island

In order to obtain the temporal and spatial distribution and changes of fish resources in marine pastures, and realize the acoustic monitoring and evaluation of fish resource proliferation in marine pastures, this paper studies the acoustic evaluation technology of fish resources based on the echo statistics method. First, the fish school echo signal is constructed based on the Kirchhoff-ray model for simulation; the simulation results show that the echo statistics method is suitable for acoustic monitoring of fish stocks in marine ranches. In November 2020 and March 2021, the self-developed fish finder was used to survey the national marine ranch demonstration area in the western waters of Furong Island in Shandong Province by navigating. The two voyages use the same route, which passes through artificial reef areas and natural seas. The data of the two voyages were post-processed using the echo statistics method, and the density changes and activities of the fish schools in different times and regions in the surveyed sea were obtained. The analysis results show that the echo statistics method is suitable for the monitoring and evaluation of fishery resources in the marine pasture area.

AA-7

Insights on The Distribution and Drift Trajectories of Fish Larvae in Cendrawasih Bay Papua Indonesia

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Keywords: Cendrawasih Bay, CROCO model, ichthyops, larvae transport, fisheries acoustics, small pelagic fishes

As part of the coral triangle area, the semi-enclosed Cendrawasih Bay (CB) Papua Indonesia is considered to be the center of global marine biodiversity in the shallow waters of the tropics, providing high marine biodiversity, such as coral fish species, coral reefs, and small pelagic fishes. This study aims to investigate the distribution of model fish larvae transport trajectories from a simulation of the Coastal and Regional Ocean Community Model (CROCO) between 2012-2014 and validated by hydroacoustic dataset from the fisheries acoustics survey onboard the R.V. Bawal Putih III. The fish larvae transport model was released in 6 different nursery grounds within the bay with 10,000 larval particles in October 2013. The results showed that after 25 days from releasing time, distribution of larvae particles was found predominantly in the western and eastern part of the bay, and around the Yapen and Biak islands in the northern part. Larval transport distribution in the bay were influenced significantly by the cyclonic eddy currents as well as the large-scale currents of Pacific in northern bay that recirculates the larvae particles into the bay. About 77 % of fish larvae particles (or 7,700) were found in the bay. The model fish larvae trajectories are in good agreement with fisheries acoustics survey in November 2019, where high abundance of small pelagic fishes were found in the eastern, western and in the central bay.

AA-8

Estimation of Fish Stock Using Integrated Acoustic Biomass and Catch Composition in The Inland Waters of Giam Siak Kecil, Bengkalis Indonesia

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Keywords: biomass, echo counting, inland waters, SIMRAD EK15

The Inland waters in Giam Siak Kecil (GSK) Bioreserve Bengkalis-Indonesia consist of watersheds and swap swamps, whose fish resources have been exploited for a long time. However, there is no management action yet. This study aimed to estimate the stock of fish resources in The Inland waters of GSK. The study was conducted from May to November 2017, with 6 trips of acoustic surveys using SIMRAD EK15-200 kHz and records of catch composition from 5 landing bases along watersheds. Echograms were analyzed with the echo counting method. There were 12 species recorded and dominated by baung (Hemibagrus umumrus) 37% and selais (Kryptopterus sp) 33.5% individually. Other economic species are tapah (Wallago leerii) 1% and toman (Channa micropeltes) 3%, with an average weight of 0.5 kg and 1 kg, respectively. Estimation of all fish potency was 2870 tons/year which the highest was toman, selais, baung, and tapah were about 1167 tons/year (41%), 575 tons/year (20%), 435 tons/years (15%), 297 tons/years (10%) respectively. In general, the fish stock in swap swamps was higher than in watersheds. The highest biomass was found at 4 swap swamps, i.e. Bagan Belado Besar 652 tons/years (toman 48%, selais 22%, baung 18%, tapah 11%), Serai 588 tons/years (toman 49%, selais 21%, baung 19%, tapah 11%), Tasik Baru 530 tons/years (42% toman, selais 29%, baung 15%, tapah 14%), and Tasik Pangkalan Siam 504 tons/years (48% toman, selais 22%, baung 18%, tread 11%). The potency of fish resources was a basis for defining allowable catch for fisheries management, according to stock status in this inland fisheries to advise the optimum fishing effort.

AA-9

Fish Aggregation Patterns Under the Effect of Light on Stationary Lift net Using Acoustic Methods in Banyuasin Waters-Indonesia

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Keywords: stationary lift net, lamplight, fish aggregation pattern, Banyuasin waters

One of the success factors for catching fish on a Stationary Lift Net is the setting time and duration from setting to hauling. The purpose of this study was to determine the effective time for setting and hauling based on the acoustic method and to analyze the pattern of fish aggregation on the effect of light based on the duration of the hauling time. This research was carried out in November 2019 using the Scientific Echosounder SIMRAD EK15 single beam instrument with a frequency of 200 kHz. Data processing using SONAR 5 software, Arc GIS 10.1. The results showed that the best time for the setting was in the midnight - early morning period. The strongest correlation (r = 0.9058) at 00:00 – 05:00 WIB and the strongest correlation (r = 0.8378) at 17:00 – 00:00 WIB. The pattern of fish aggregation under the influence of light, namely at a duration of 1-16 minutes the fish began to gather, at 17-32 minutes more and more gathered with the highest density of 4.460 gr/m^3 and began to spread at a duration of 33-64 minutes. The longer the lighting, the density of fish that gather around the light decreases. Anchovies and squid dominate the catch. The average fish length ranges from 5.48 cm to 7.91 cm with a TS value of -62.65 dB to -65.41dB.

AA-10

Acoustic Detection and Extraction of Artificial Reefs

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Keywords: artificial reef aggregation mode; side scan sonar image; multibeam sonar; target detection

Artificial reefs are an important link in the construction of marine pastures, and the use of sonar to detect and extract large-scale artificial reefs on the seabed is the current main method. This paper divides the artificial reef aggregation modes into three modes: discrete type, aggregation type and combined type. The artificial reefs under the three different modes are automatically identified and extracted, and the corresponding methods are given. In the discrete mode, the deep learning network technology FasterR-CNN and SSD are used to automatically detect and extract large-scale artificial reefs from the side scan sonar images, so as to obtain the location information and distribution status of the reefs. In the aggregation mode, multi-beams are used to obtain seabed topography data, and then the seabed reef area DEM is constructed and subtracted to extract artificial reefs to obtain data such as the volume and air volume of the reefs. In the combined mode, the side-scan sonar and multi-beam combined detection are used. The side-scan sonar is used to obtain the large-area seabed landform and the position of the artificial reef is determined. Then, the artificial reef is measured by the high-precision multi-beam to obtain the Three-dimensional topographic map. The experimental results show that the three methods can be well adapted to the detection and extraction of artificial reefs, and can provide necessary scientific data support for the quality assessment of artificial reefs.

AA-11

Fish Larvae and Density of Pelagic Fishes Distribution in the Java-Flores-Makassar Seas

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Keywords: triangle seas, fish larvae sampling, fisheries acoustics survey, abundance, small and large pelagic fishes, target strength

Sampling of fish larvae and fisheries acoustics survey have been carried out in the triangle seas of Java-Makassar-Flores (JMF) onboard the R.V. Geomarine 3 and R.V. Baruna Jaya 8 in August 2015, as part of a multi-disciplinary field experiment to investigate marine sediment, seawater properties, biogeochemistry, fish larvae, and pelagic fish resources. Bonggo net was used to sample fish larvae equipped with a flowmeter. Mesh size of bonggo is 500 µm, its diameter and length is 60 cm and 300 cm, respectively. Towing was carried out horizontally at a depth of 10-25 m, for 15 minutes during the day and 10 minutes at night. Acquisition of 200 kHz acoustic data to detect the distribution of pelagic fish resources is carried out from surface to a depth of 200 m. The results of this study showed that high fish larvae abundance (>9,000 ind./1000 m^3) was found near the shore waters of both northern Java (Cirebon and Tuban) and southern Kalimantan (Pangkalanbun and Matasiri), and in the center of upwelling region around (8.5°S,118.9°E). The highest abundance of fish larvae (18,664 ind./1000 m^3) was in the coastal water of Tuban East-Java, and the second was in the center of upwelling region (14,548 ind./1000 m^3). Mean fish larvae abundance in the triangle seas: eastern Java Sea is 5.797 ind./1000 m^3, southern Makassar Strait is 8.984 ind./1000 m^3, and western Flores Sea is 3.064 ind./1000 m^3. Distribution of fish larvae family in Java Sea is dominated by Leiognathidae, then Charangidae and Scombridae in eastern area (Makassar). For pelagic fish of scad fish (D. macarellus) distributed in lengths of 5-32 cm or Target Strength (TS) ranged from -60 to -44 dB. The size of large pelagic of skipjack tuna which is distributed at TS ranged from -44 to -34 dB or at length 28-70 cm. Meanwhile, for yellowfin tuna (Thunnus albacares) which are distributed in the TS size of -34 to -24 dB or in the length size of 70-170 cm. Density of small pelagic fish tends to decrease with increasing depth. Density of large pelagic fish is relatively

much lower than the density of small pelagic fish. Acoustic survey results shows that up to a depth of 200 meters, the estimated value of total biomass in August-September for small pelagic fish is 209,091 tons with an average of stock density about 0.46 ton/km^2. The total biomass for large pelagic fish is estimated of 838,684.66 tons with a stock density of around 1.86 tons/km^2.

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AA-12

Estimation of Stock Abundance of Fish Resource Using Hydroacoustic Method in Banyuasin Waters, Banyuasin Regency, South Sumatra Province

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Keywords: abundance of fish, hydroacoustic, drift gill nets

The Banyuasin Coast is a mangrove forest ecosystem with great potential. Mangrove forest areas are closely related to fish resources, so information on potential fish resources is important to study in order to maintain the sustainability of fish resources. This study aims to estimate the stock abundance of fish resources using the hydroacoustic method. Acquisition of acoustic data using the Scientific Echosounder SIMRAD EK-15 single beam frequency 200 kHz and sampling of fish using drift gill nets. The results of the average measurement of oceanographic parameters compared to sea water quality standards indicate that Banyuasin waters are in the natural category. Fish biodiversity obtained diversity index results in the categories of low to moderate, moderate to high in uniformity, and low to high in dominance. Fish sampling in Banyuasin waters in October 2020 consisted of 10 families and 13 species, the most dominant fish found was Hexanmatichthys sagor (Sagor Catfish). The target strength value of Sagor Catfish ranged from (-38.25) – (-33.52) dB with a fish length of 29 – 50 cm. The average value of fish density in Banyuasin waters is 39 ind/1000 m3 and the average value of fish volume density is 0.0233 kg/m^3.

AA-13

Acoustic Surveys to Estimate Fish Biomass in Indonesia Marine Waters

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Keywords: biomass, Indonesia FMA, transducer, small pelagic, large pelagic, demersal

Fisheries independent data from acoustic surveys could be an alternative for estimating biomass and comparing stocks based on landing data. On the Fisheries Management Area (FMAs) level, acoustic surveys were started in 2015 in 11 WPPs. While FMAs surveyed in 2016-2020 were 6, 3, 3, 2, 2, respectively. Acoustic surveys were conducted one time for one FMA per year. SIMRAD EK60, EK80, and ME70 installed in each Research vessel were used for data acquisition. We estimated aggregate fish biomass for small pelagic, large pelagic, and demersal. In deep seas, i.e. FMAs 714, 715, 716, and 717, the bottom fish could not be recorded due to the limited power transmitted on the transducer. We determined current status of fish biomass which estimated from last survey for each FMA. Therefore, biomass estimation (million tons) of small pelagic fish in FMA 571, 572, 573, 711,712, 713, 714,715, 716, 717, and 718 were about 0.13, 0.61, 0.73, 0.70, 0.57, 0.17, 0.19, 0.78, 0.29, 0.36, and 1.07 respectively. Large pelagic fish were about 0.22, 1.54, 1.02, 0.59, 0.19, 0.47, 0.70, 0.16, 0.60, 0.82, 1.45, respectively. Demersal fish were about 0.25, 0.38, 0.02, 0.10, 0.88, 0.16, N/A, N/A, N/A, N/A, 1.21, respectively. Biomass of three fish groups has been used for most FMAs to estimate the current potency stocks in the Indonesia FMAs.

Session V.

Ecosystem Monitoring (SGEM)

Underwater acoustic study on ecosystem monitoring.

EM-1

Quantification of Seabed Acoustic Backscatter Strength Using Scientific Single Beam Echosounder

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Keywords: acoustic backscatter strength, Lancang Island waters, quantification, seabed substrate

Hydroacoustic technology was able to quantify the seabed substrate and can be estimated accurately and near real time on the acoustic characteristics of each substrate. The purpose of research is to quantify the acoustic backscattering of the seabed substrate in an effort to devolop marine information technology. Data acquisition using the Simrad EK-15 Single Beam Echosounder acoustic instrument at a frequency of 200 kHz. Data processing and analysis includes acoustic backscatter strength, sediment type, acoustics bottom backscattering computation of seabed substrate and spatial analysis of seabed acoustic backscattering in the Lancang Island waters. The results of this study indicate that the acoustic backscatter value of the seabed substrate based on the SS value and particle size at each sampling station is the type of substrate sand were -21.08 to -24.55 dB, fine sand were -25.67 to -26.67 dB, and very fine sand ranging from -27.42 to -28.03 dB. Based on the range of acoustic backscatter values obtained from the sampling station, the classification of the type of seabed substrate along the survey line is very coarse sand, coarse sand, medium sand, fine sand, very fine sand, coarse silt, medium silt, fine silt, coarse clay and fine clay in the range of values were -47.85 to -17.07 dB. Most of the sand substrates were found at the study site with a composition greater than silt and clay.

EM-2

Acoustic Backscatter from Tilted Multibeam Echosounder Sonar System to Detect Fringing Reef Habitats

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Keywords: multibeam echosounder, fringing reef, marine park, backscatter

Fringing reefs habitats are important because it provides home and food to other marine species and protect coastal from extreme wave and storms. Systematic approach of identifying, detection, and characterization of these habitats are vital for conservation action and plan. Remote acoustic technique using Multibeam Echosounder Sonar System (MBES) is one of the emerging tools in detecting and mapping seafloor features with full coverage at high spatial resolution. However, the occurrence of fringing reef habitats at shallow water areas provides difficulties for surface vessel MBES to be fully utilized. This study aims to evaluate the performance of acoustic backscatter from MBES to detect and map fringing reef habitats with a tilted transducer head. This method was tested at Tioman Marine Park in Pahang, Malaysia where both depth and intensity data were recorded. Correction and reduction of acoustic backscatter were done using an in-house Matlab script developed by the authors. Two types of backscatter intensity information were extracted and produced: angular backscatter intensity, and normalized backscatter data (i.e., backscatter mosaic). Both data were analysed to evaluate how acoustic backscatter can be used to discriminate and differentiate between sediment and reef features. The findings from this study are useful to design a method to remotely map fringing reef using MBES without having to carry out a substantial conventional ground sampling.

EM-3

Sound Scattering Layers within And Beyond The Seychelles-Chagos Thermocline Ridge (SCTR) in The Southwest Indian Ocean

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Keywords: scattering layer; frequency response; Seychelles-Chagos Thermocline Ridge

In global oceans, ubiquitous and persistent sound scattering layers are frequently detected by echosounders. The southwest Indian Ocean has a unique feature, a region of significant upwelling known as the Seychelles-Chagos Thermocline Ridge (SCTR), which affects sea surface temperature, ocean-atmosphere coupling, biogeochemistry, and fisheries. Yet, few studies on sound scattering layers within and beyond the SCTR have been conducted. An acoustic survey was conducted from April 20, 2019, to May 15, 2019, at 3–27°S latitude and 60 and 67°E longitude, using a Simrad EK 80 sounder aboard the RV Isabu. In this study, the region north of 12°S latitude in the survey area is defined as SCTR, and south of 12 °S latitude is non-SCTR. Acoustic scatterers were categorized based on ranges of ΔMVBS (the difference in mean volume backscattering strength at 18 and 38 kHz). The categorized acoustic scatterers based on time and their metric characteristics were described using the depth layers, such as the epipelagic (0–200 m), upper mesopelagic (200–600 m), and lower mesopelagic (600–1,000 m) layers, in the SCTR and non-SCTR regions. The results showed that diurnal vertical migration was clearly observed at approximately 400–600 m. The acoustic scattering intensity in SCTR was much higher (2.6 times) than that of non-SCTR. The center of mass (CM) of the categorized acoustic scatterers was deeper, and the spreading degree of the backscattering around its CM was more diffused in SCTR than non-SCTR. The largest spread occurred in the upper mesopelagic layer in both regions. There were significant differences in most categorized

acoustic scatterers between day and night times in the two regions. The profile of acoustic scatterers was significantly low in the epipelagic layer during dawn and day times in both regions. The acoustic scattering values gradually increased approaching dusk, with the highest value (223.6 m2/nm2 in 60 m of the SCTR, 48. 3 m2/nm2 in 70 m of non-SCTR) during the nighttime. Acoustic scattering values centered around 400–500 m in the SCTR showed relatively high scattering values (approximately 50 m2/nm2) regardless of time, but they were very low in non-SCTR. Lower temperature, lower salinity, and lower dissolved oxygen water were observed in SCTR than in the non-SCTR within all depth layers except for the salinity in the lower mesopelagic layer. Echograms and interpolated marine environmental properties were also visualized. The acoustic scattering values and environmental properties exhibited strong or weak correlations. Lastly, there was no significant correlation between acoustic scatterer (crustacean/small non-swim bladder fish-small) and total dry zooplankton weight. Additionally, the top ten dominant species of zooplankton from the net samplings were tabulated.

EM-4

Bottom Condition Survey Using Fishfinder for Fishery

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Keywords: fish finder, echo sounder, sea bottom survey, data collection

Conditions on the sea bottom are important information for understanding the habitat of shellfish and demersal fish living near the sea bottom. Researchers have established accurate methods for measuring bottom conditions by surveying with multi-beam quantitative echo sounder and side-scan sonar. However, both methods require a survey vessel equipped with expensive measuring instruments and a lot of time for the survey. In this report, we will use a inexpensive single-beam echo sounder such as those used on fishing vessels. And, we will describe a method for conducting extensive and easy bottom conditions surveys. We conducted our survey in Hakata Bay, Fukuoka Prefecture, Japan. The survey period is from August 2020 to August 2021. The depth of the bay is about 5 to 25 meters and the main bottom condition are silt, mud and fine sand. We used a single-beam fishfinder (FURUNO FCV-1900: 88 kHz) to collect the echo data. The data from the fish finder was stored in a PC provided on board, and SS (Surface Backscattering Strength) and roughness of the sea bottom were calculated in post-processing. We collected sea bottom sediments from several points and compared them with echo data. And we compared the data obtained during the survey and the data obtained during other purposes such as regular cruises. In this survey, we did not calibrate the fish finder to show the possibility of surveying under the same conditions as general fishing vessels and research vessels without quantitative echo sounder. This is because it is difficult to calibrate them frequently on those vessels.

EM-5

Measurement and Analysis of Acoustic Backscatter for Bottom Classification of Tidung Island Waters

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Keywords: Tidung Island, sea bottom, backscattering strength

Seabed has an important role for organisms, namely as a habitat, a place for foraging for food, and a place for spawning. These sediment can affect the composition of organisms in the water. The purpose of this study is to calculate the value of acoustic backscatter for the classification of the sea bottom and to see the effect of sediment grain size on the backscatter value obtained from a single beam acoustic instrument. Data collection was carried out from 10 to 12 June 2021 in the waters of Tidung Island of Seribu Islands, using the SIMRAD EK-15 single beam, single frequency 200 kHz instrument. Sediment sampling was carried out at 13 stations. The results showed that the waters of Tidung Island were dominated by muddy substrate which was classified based on the Surface Backscattering Strength (SS) value. The larger grain size of the bottom sediment followed by the larger SS value.

EM-6

Guidance on Measurement and Evaluation Methods for Underwater Sound

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Keywords: underwater noise, offshore windfarm, standard, pile driving, ambient noise

In recent years, there has been a concern about the influence of underwater sound emitted from offshore wind power generation, resource exploration, and shipping, on marine life. However, the measurement method of the sound in the ocean and the evaluation method have not been developed in Japan. The importance of compiling the information about these methods is gaining attention, especially for the environmental assessment in the ocean. The Marine Acoustical Society of Japan organized the "Study Group on the Evaluation Methodology of Marine Noise" in order to provide a guidance* on the measurement method of marine noise in shallow water and the evaluation method of its influence. This guidance is a summary of the results of the study group. The practical measurement and the evaluation method of the underwater sound proposed in this committee are not required to be acoustically accurate. Currently, many environmental assessments are being carried out for the offshore windfarm projects. On the other hand, it is necessary to obtain sufficient information and to show the condition of the measurement to compare with each other in order to evaluate the influence because different methods are adopted for the measurement of the underwater sound depending on the purpose by far. The guidance is based on the audible distance due to physical masking effects by comparing the arriving sound from the source with the ambient noise level. This means that the present guidance does not focus on the effect of noise exposure on individual species since the audible distance of the present guidance does not depend on the auditory threshold. The measurement and evaluation methods of underwater sound proposed in this study group will be revised according to future technical progress and expansion of the target sound sources.

* https://www.masj.jp/wp-content/uploads/20210322_guidance.pdf

EM-7

Acoustic Measurement of The Cyanobacterium Microcystis Aeruginosa Using a Quantitative Echo Sounder in Lake Sakura

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Keywords: acoustic measurement, cyanobacterium microcystis, dam reservoir, echo sounder

Water blooms, overgrowths of cyanobacteria, contribute to deterioration of the water quality of dam-formed lakes. Therefore, it is necessary to establish a method for monitoring blooms both spatially and temporally. In this study, we used an acoustic method to investigate the relationship between acoustic reflection intensity and number of cells. The study was carried out at Miharu dam reservoir (Lake Sakura), Tamura-gun, Fukushima, Japan, in August 2019 and 2020. Using a 120 kHz quantitative echo sounder, volume backscattering strength (SV) was measured to 10 m from the surface, where blue-green algae move vertically. Samples were then counted. As a result, the SV at these depths ranged from -81 to -55 dB. The cyanobacteria count ranged from 11,000 to 232,362,600 cells/L, and the most abundant species was Microcystis aeruginosa. There was a significant correlation between SV and number of cyanobacteria cells ($p < 0.01$). Because gases from the air contributed to the acoustic reflection intensity, it is believed that the gas vesicles in M. aeruginosa also contributed to the acoustic reflectance and thus the significant correlation between SV and the number of cyanobacteria cells. In the future, it is expected that the acoustic measurement method will be valuable for evaluating cyanobacteria spatially and temporally in Miharu dam reservoir.

EM-8

Monitoring of Jellyfish at The Water Intake of Nuclear Power Plant by Using Acoustic Methods

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Keywords: jellyfish, acoustic monitoring, resource assessment, detection of early warning

In recent years, large-scale jellyfish outbreaks have occurred in the Bohai Sea in summer, causing a large impact on the cold source water intake of Fuzhou Bay Hongyanhe Nuclear Power Plant and threatening normal operation. In This study, For the early warning of jellyfish invasion, an acoustic monitoring system for cold source organisms was designed and developed using echosounders to monitor the echo of cold source organisms inlet in real time. The monitoring period was from June to September 2019; the monitoring location was set to the first caisson on the south side, and used an echosounder (EY60,70 kHz, Simrad) for shore-based monitoring. The transducer was fixed and installed in the underwater horizontal direction. The transceiver (GPT) was installed in the power distribution cabinet set on the caisson and connected GPT with the computer in the shore-end control room through the erected cables. Thus daily average SV and TS are obtained from in situ measurement, then the daily average flux is calculated in combination with the current velocity and the included angle between current and cross-section of water intake. According to the monitoring results The maximum and minimum daily average values of SV and TS were -62.7 dB, -80.0 dB and -37.2 dB, -81.0 dB, respectively. The maximum and minimum daily average values of flux were 5.36 ind./(s·m^2) and 1.2x10-5 ind./(s·m^2). Combined with the daily cleaning amount of the monitoring point back-end intercepting network and meteorological data, the comparative analysis is carried out. The results showed that the trends in average flux and amount of cleaned net are correlated weekly and can provide a scientific basis for acoustic monitoring system and early warning of an invasion of jellyfish. And it is possible to determine the index level of the acoustic warning for cold source biological flowing into the water intake according to the correlation between average flux and amount of cleaned net.

Session VI.

Others Topics

Including Ocean Instrumentation, Acoustical Oceanography, Marine Robotics, etc.

OT-1

Ocean Temperature Stratification Inverted from Low-Frequency Acoustic Reflection in The Northern Maluku Sea

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Keywords: marine seismic, seismic inversion, seismic oceanography, stratification

Seismic oceanography (SO) is a new tool that use seismic reflection to study water column structure with unprecedented resolution. This study aims to determine temperature stratification along a seismic-line in the northern Maluku Sea. Seismic reflection data from 72 channel which acquired on 7 Mei 2016 was used to invert temperature using the Intermediate Parameter Method (IMP). The inverted temperature was compared with available hydrological CTD data. Water column stratification was classified using 0.05^{o}C/m gradient for upper and lower thermocline boundaries. Inversion of sound speed and temperature shows good accuracy in comparison with archive data. The Mean Absolute Error (MAE) ranged from 0.69 to 2.6 m/s and 0.68 to 0.91 °C for sound speed and temperature respectively. The inverted temperature showed that the mean and the standard deviation was 30.38 °C and 0.08 °C in the mixed layer, 19.78 °C and 0.397 °C in the thermocline layer, 7.64 °C and 0.25 °C in below thermocline until the depth of 1000 m. The lower boundaries of the mixed layer depth (MLD) reach 40 m, while the lower boundaries of thermocline layer are at a depth of 240-374 m and has a thickness ranging from 226-410 m. The depth of mixed layer in the eastern section is shallower than that in the middle and western section, but the lower boundary of thermocline layer on the eastern section is much deeper than that observed in the western section. This temperature stratification difference demonstrates that the northern Maluku Sea plays an important role on ocean dynamics such as the region of generating and propagating internal waves, as well as recirculation of Indonesian Throughflow into western equatorial Pacific.

OT-2

Trial of Seabed Classification Using Multifrequency Quantitative Echosounder

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Keywords: seabed, seabed classification, quantitative echosounder, frequency characteristics, surface backscattering strength

Seabed type is an important index for estimating benthic organism habitats. Quantitative echosounders have been used determine the quantity and behavior of biological resources. These data include not only biological but also seabed data. It would be advantageous to be able to identify the seabed type from these data. In this study, multifrequency backscattering data and surficial sediment samples were collected to evaluate whether bottom type could be classified by the multifrequency method. Acoustic measurements and surficial sediment sampling were carried out at nine sites in Hakodate Bay, Hokkaido, Japan, during the survey with T/S Ushio-maru, on July 24, 2020. The backscatter data from the seabed at each site were recorded using quantitative echosounders (Simrad EK60 systems) at 38, 120 and 200 kHz with the ship drifting. Surficial sediment sampling was performed with a Smith-McIntyre grab sediment sampler. The sediment samples were divided with sieves into four classes according to the grain size (gravel, coarse sand, fine sand, and mud) and classified based on their compositions. The recorded backscatter data were analyzed with Echoview 10 software. The mean and the standard deviation of surface backscattering strength SS, which indicates the amount of acoustic backscattering from the seabed per unit area, were calculated for each frequency. The results were used to evaluate the acoustic characteristics for each seabed type. The mean SS tended to increase with the grain size of the seabed type, and was higher at lower frequency for all seabed types. The standard deviation of SS was different between coarse sandy types and fine sandy types. The results suggested that it may be possible to discriminate between seabed types based on SS.

OT-3

Mapping of Seabed Surface and Sediment Types Using The Hydroacoustic Method in The Waters of Banyuasin, Banyuasin Regency, South Sumatera

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Keywords: Banyuasin Waters, seabed surface, hydroacoustics

The Banyuasin territorial waters have benefits in different sectors such as the transportation sector and the fisheries sector. In addition, in Banyuasin Regency, there is a conservation area of Berbak Sembilang National Park, which has an extensive mangrove ecosystem. This research aims to map the seabed surface and types of sediments in the Banyuasin territorial waters. This research was conducted from October 2020 to February 2021 in the Banyuasin territorial waters, Banyuasin Regency, South Sumatra. The method used in this research is a hydroacoustic method that utilizes sound waves to detect underwater objects using a Simrad EK-15 single-beam echosounder. The results showed that the lowest depth was located in the Tanjung Carat waters with 0,6 m. The highest is situated near the Banyuasin territorial sea border with a depth of 33 m. The depth of the Banyuasin territorial waters averages is 9 m. In this research, three types of sediments were obtained there are, clay, sandy clay, and clayey sand, and the dominant sediment type is clay sediment. Tidal measurements for mean sea-level values (MSL) is 1,3 m, and for chart datum, distance value (Z0) is 1,16 m.

OT-4

The Relationship Between the Surface Acoustic Scatter and The Sea Surface Environmental Factors

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Keywords: quantitative echosounder, surface acoustic scatter, SSS, SST

The conventional fishing ground forecasts are generally based on marine environmental data observed by artificial satellites and accumulated catch data. However, the commercial catches can't truly represent the biomass distribution of the target fish species, which will lead to affect the accuracy of the fish stock assessment and the ecological balance. Quantitative echosounders are increasingly being used to conduct high-precision of fishery resource assessments in recent years, because their advantages of high spatial resolution and large sampling volume. Therefore, the combination of acoustic data and environmental data will enable a better understanding of the fishing ground formation mechanism for pelagic fish, and improve the accuracy of fishing ground forecasts, but such studies are still relatively rare. In this study, we attempt to elucidate the relationship between the strength of surface acoustic scatter and the changes in the sea surface environment factors. Acoustic backscatter was measured using a quantitative echosounder KFC-3000 (Sonic) with two frequencies, 38 kHz and 120 kHz. The acoustic data were analyzed using MATLAB (MathWorks) and area backscattering strength (SA) was integrated in the depth of 10-50 m. The sea surface temperature (SST) and sea surface salinity (SSS) were obtained by an electronic particle counting and sizing system (EPCS). Our preliminary findings show the changes in SA were not always associated with the changes of sea surface environmental factors. In the front area of Oyashio current, the environmental factors have a great influence on the SA level. However, in coastal areas, the factor that has a greater impact on the SA level may be due to the bottom depth. Our oral report will present the preliminary results from the *R/V Wakataka Maru* cruise in July and August 2021.

OT-5

Acoustic Backscattering of Medium Voltage Underwater Power Cable Using Single Beam Echosounder

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Keywords: single beam, echo sounder, underwater cable

Electricity is one of the most important and comprehensive infrastructures that must be upgraded to various small islands or remote islands in Indonesia. Electricity is a very vital need to improve people's welfare. Lighting on small and remote islands currently only uses generators and very limited solar cells. Based on these conditions, although it is still relatively small, the government has built and distributed electricity based on the distribution of underwater power cables in several islands in Indonesia. Undersea cable commonly called marine cable is a cable that is installed on the seabed for a specific purpose. The existence of this cable is important to know so that the management of the cable is easier and faster used to determine the position of the cable, one of which is with hydroacoustic device. The purpose of this study is measure the backscatter value of underwater power cables. This research was conducted on June 12, 2021. This instrument used was SIMRAD EK-15 single beam single frequency 200 kHz. The recording of the cable is carried out for 5 minutes. The result obtained show that the cable surface backscattering (SS) value which was measured twice at a depth of 1.6 m and 1.4 m was (-14.18 dB) and (-15.78 dB). The standard deviation value of the backscatter value at a depth of 1.6 m was 0.45 while at a depth 1.4 m by 0.34. These differences indicate that there are other factors that affect the time of measurement which will then affect the value of SV and SS it self.

OT-6

Comparison of The Abundance and Distribution of Zooplankton in Two Different Study Areas Using The Scientific Echosounder Instrument in North Peninsula Coastal Banyuasin Waters, South Sumatra

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Keywords: Hydroacoustic, North Peninsula Coastal Banyuasin, spatial distribution, zooplankton abundance

Hydroacoustic is one of the methods that can be used in the detection of zooplankton. Zooplankton in the waters is an important indicator so that the presence of zooplankton needs to be known from its abundance and temporal spatial distribution. The study area in this research is the waters of the northern peninsula of Banyuasin of South Sumatra. The study area is divided into two, namely waters close to land and waters near or towards the sea with the aim of knowing the condition of zooplankton in the two study areas during the day and night using the hydroacoustic method. The study was conducted in October 2020 using the scientific echosounder SIMRAD EK-15 single beam instrument with an operational frequency of 200 kHz and the operation of a bongonet at each research station to determine the conventional zooplankton abundance value. We hope that this research can provide information about the condition of zooplankton in the study area because research on zooplankton in the study area has no relevant information. The abundance and spatial distribution of zooplankton during the day and night showed a significant difference, during the day zooplankton tended to be in the waters that led to the sea, while at night the abundance of zooplankton was more evenly distributed with zooplankton characteristics that dominated the fluid-like class in the waters of the northern peninsula of Banyuasin. This characteristic is evidenced by conventional observations and identification of zooplankton.

OT-7

Internal Wave Detection and Mapping Using SIMRAD EK80 Broadband Echosounder Instrument

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Keywords: backscatter, broadband, continuous wave, internal wave, microstructure, flood

Internal waves are events that occur in shallow sea and deep sea, where the appreance of internal waves can only occurs if the water column is stratified due to differences in water mass density. This study aims to determine when the internal waves are formed and to know the value of the internal waves backscatter. The data used is the measurement result of SIMRAD EK80 broadband echosounder instrument with frequency of 200 kHz continuous wave (CW) pulse type with supporting data for water level elevation, temperature, salinity, and density from CTD "yoyo" for 24 hours. The backscatter value was obtained by analysis using the Sonar5-Pro software. The time bar echogram shows the formation of nonlinear internal waves accompanied by the presence of temperature and salinity microstructures that occur when tidal waves carry water masses from different density through rough topography in Lombok Strait. The backscatter value of the segmentation results range from -60 dB to -75 dB.

OT-8

Relation Between Vertical Distribution of Pseudaspius Hakonensis and Environmental Factors in Stratified Dam Reservoir

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Keywords: acoustic telemetry, fish, stratification, hypoxic water, dam reservoir

Although the ecosystem structure of dam reservoirs has been extensively studied to understand water quality in Japan, the habitat and behavior of the fish living in them have been neglected. As such, this study aimed to clarify the relationship between the vertical distribution of Japanese dace (*Pseudaspius hakonensis*) and environmental factors in Miharu dam reservoir, Fukushima, Japan, in summer. To this end, an acoustic telemetry survey was conducted to track the dace. Simultaneously, a conductivity-temperature-depth analysis (hereafter CTD) was conducted to understand environmental factors, such as water temperature and dissolved oxygen. Those surveys were conducted for two periods between 19th August to 9th September (2019) and 18th August to 6th September (2020). The tracked individuals had a similar habitat, inhabiting a depth of approximately 17 m. Owing to the CTD, the surface temperature increased to 28 °C, and hypoxic water became widespread under the density cline. This study concluded that the habitat was restricted by water temperature and dissolved oxygen.