DEVELOPMENT OF ACOUSTIC METHODOLOGY FOR ZOOPLANKTON BIOMASS ASSESSMENT

LMR/PEL/09/08

2010 – 2013 (extension 2014)
Budget = 45 000 US$

Janet Coetzee (South Africa)
Graça D’Almeida (Namibia)
Filomena Vaz Velho (Angola)

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BACKGROUND

- Hydro-acoustic surveys are used routinely to collect information on fish biomass and distribution.
- These surveys are often carried out at more than one frequency.
- Given that different organisms reflect sound differently at different frequencies – can we extract information on zooplankton from these surveys?
1. Analysis of zooplankton samples for ground-truthing of acoustic data. A student/technician will be contracted to analyse zooplankton multi net samples collected in South Africa between 2004 and 2008.

2. Derivation of discriminatory algorithms and comparison with the net samples.

3. Training of local scientists in acoustic data processing and derivation of classification algorithms.

4. Application of classification algorithms to long term acoustic data collected within the region and derivation of zooplankton biomass and size class time series estimates.....this objective was outside the scope of this project and seen as a longer term project that should be undertaken independently within the research centres of the region.
OBJECTIVE 1

Analysis of zooplankton samples for ground-truthing of acoustic data. A student/technician will be contracted to analyse zooplankton multi net samples collected in South Africa between 2004 and 2008.

- Technician appointed in March 2011 to analyse multi-net samples. Analyses was completed April 2012.
- 94 multi-net samples were analysed
- Wide range of organisms dominated samples: incl. small copepods, large copepods and euphausiids, siphonophores, chaetognaths, salps etc.
Here the same station data is presented in terms of number per size class – this classification (rather than biomass per species) more realistically captures the degree of classification ultimately expected.
OBJECTIVE 2
Derivation of discriminatory algorithms and comparison with the net samples.

- Appointment of post doc student Ainhoa Lezama-Ochoa (IRD funding) in 2013
- Tasked with development of algorithms and comparison with net samples
- Development of noise removal procedures (TVG, electrical spikes, vessel noise, ringing)
- Africana 200 kHz data too noisy for use
- Focused on 18, 38 and 120 kHz data
- Limited identification to macrozooplankton (>2mm)
- Classification into fish, macrozooplankton and others (includes Jellyfish)
Theoretical basis for discrimination

![Graph showing frequency bands and different species.

- Fish
- Euphausiids
- Copepods

Frequency bands: 12 kHz, 18 kHz, 38 kHz, 50 kHz, 70 kHz, 120 kHz, 200 kHz, 364 kHz.

Sv dB scale ranges from -120 dB to -40 dB.]
Noise removal techniques

Spike removal

TVG noise removal

Intermittent noise removal
200kHz cannot be sufficiently cleaned without removing too much signal
Theoretical basis for discrimination

- Fish
- Jellyfish
- Euphausiids
- Copepods
Echopen V1.6. South Africa: Organizational chart

**STEP A**
- EK5 files
- RAW files
- HAC files (To apply noise filter)
- Movies 3D &

**Reformatting**
- (Manual bottom line correction)
- (Read bottom line from echoview)

**Reformatted data**

**STEP C**
- Resampling
  - (Noise removing)
  - (Manual bad regions)
  - (Use bad regions from echoview)

**Cleaned and resampled data**

**STEP D**
- Histo 1D
- Histo 2D
- Class by difference
- « Colour » echogram
- Algorithm

**Classified data**

**Data file**

A new tool developed Echopen

Legend:
- Process (option)
Classification by all frequencies differences

GROUP 1 = 32% of valid samples
GROUP 2 = 26% of valid samples
GROUP 3 = 9% of valid samples
GROUP 4 = 33% of valid samples
From observations and exploratory analysis the threshold was established at 
-128 dB
the data is separated as:

- 120 kHz
- 38 kHz

- Higher than -128 dB
- Lower than -128 dB

120 kHz +38 kHz
120 kHz + 38 kHz
120 kHz

Fish (38 KhZ)

Macrozoopk (120 KhZ)

euphausiids, copepods, salps and siphonophores (without gas inclusion)

‘Others’ (120 KhZ)

gas-bearing small organisms (fish larvae, siphonophores), some gelatinous organisms

38 kHz
OBJECTIVE 3
Training of local scientists in acoustic data processing and derivation of classification algorithms.

• Course held in Cape Town 11-15th August
• Attended by 20 scientists/technicians from the region, including 2 Angolans, 10 South Africans, 7 Namibians and 1 Mozambican
• Presented by Ainhoa Lezama-Ochoa (IRD) with assistance from Louis du Buisson (IRD/UCT Phd student) and Janet Coetzee
• Aimed at scientists/technicians/students working on acoustic projects/surveys in the BCC region, who already have prior knowledge of acoustic applications and have advance knowledge of the acoustic principles and tools commonly used for analysing acoustic data, particularly Echoview
• The aim was to introduce the basic principles, tools and logical processes through which characteristic acoustic responses of different organisms can be extracted from acoustic data and optimized for use in subsequent identification
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44 page manual with detailed specifications of algorithms and method for application in Myriax Echoview©

Distribution to all course attendees and to other research centres
Estimating the acoustic target strength of round herring *Etrumeus whiteheadi* through the application of multi-frequency techniques.

Dagmar Merkle¹, Janet C Coetzee¹ and Ainhoa Lezama-Ochoa¹,²,³

¹ Branch Fisheries Management, Department of Agriculture, Forestry and Fisheries, Private Bag X2, Rogge Bay 8012, Cape Town, South Africa
² Institut de Recherche pour le Développement (IRD), UMR212 EME, Avenue Jean Monnet, BP 171, 34203 Sète Cedex, France
³ Department of Biological Sciences and Marine Research Institute, University of Cape Town, Private Bag X3, Rondebosch 7701, South Africa

**METHODS**

The sound scattered by different organism types is frequency-dependent. This information is used to separate echoes from swim-bladdered fish and other organisms.

Further improvement in single target screening is achieved by limiting the collection of target strength data to parts of the echogram where the density is very low (~ < 0.2 ind.m⁻³).

When more than one transducer is installed, the pulse duration of the second transducer can be reduced to decrease the pulse volume. This enables matching of single targets at both frequencies and the removal of multiple targets.

Noise reduction techniques are implemented to remove spurious echoes and background noise. This reduces the probability of including unwanted echoes in the target strength data — particularly at higher frequencies.

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(a) 30kHz 5s original echogram
(b) 30kHz single targets splitbeam method 2 on original data
(c) 30kHz 5s Fish only where noise has been removed
(d) 30kHz 5s Fish only where Sₙ < -41 dB (if sardine Tₕ assumed then 90% probability that density is <0.2 ind.m⁻³)
(e) 30kHz single targets splitbeam method 2 masked by fish only where Sₙ <0.2 ind.m⁻³
(f) Tₕ intersection between 30 and 200 kHz
Quantification of the bias associated with inclusion of sound scattered by zooplankton in acoustic abundance estimates of sardine and anchovy using the bi-frequency method

Ishmail Letsheleha¹, Ainhoa Lezama-Ochoa²,³,⁴, Janet C. Coetzee⁴, Fannie Shabangu⁴ and Conrad Sparks¹

¹Cape Peninsula University of Technology, PO Box 652, Cape Town 8000, South Africa
²Institut de Recherche pour le Développement (IRD), UMR212 EME, Avenue Jean Monnet, BP 171, 34203 Sète Cedex, France
³Department of Biological Sciences and Marine Research Institute, University of Cape Town, Private Bag X3, Rondebosch 7701, South Africa
⁴Department of Agriculture, Forestry and Fisheries, Private Bag X2, Rogge Bay 8012, Cape Town, South Africa

e-mail: ishmail.ldaaff.gov.za; www.ldaaff.gov.za

Figure 2: Echogram displaying fish and plankton at 38 and 120 kHz before bi-frequency application (top row) and after (bottom row).

Figure 10: % change in biomass obtained by using the bi-frequency derived densities instead of the -65dB threshold for each species by stratum in the November survey.
WAY FORWARD

• Many studies focus on the relationship between fish and the environment, particularly temperature.

• However, to understand the effect of the physics (and possible changes therein) on fish distribution patterns, it is important to first understand the intermediate relationships with zooplankton.

• Most zooplankton sampling is done through net sampling and since macrozooplankton easily avoid nets, accurate information of this component is scarce.

• Now possible to investigate interactions between fish-macrozooplankton-physics at fine spatial resolution for all SA surveys since ~2000 and for Angolan surveys since mid 1990s.

• Namibia will start to collect data at 38kHz and 120kHz soon (R.V.Mirabilis)