South Pacific Regional Fisheries Management Organisation

SPRFMO Scientific Working Group , Port Vila, Vanuatu, 19-23 September, 2011

Acoustic data from fishing vessels: What can be obtained that research vessels cannot offer?

(Results from a SNP/IRD workshop on the Peruvian fishery, March, 2011)

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European Commission
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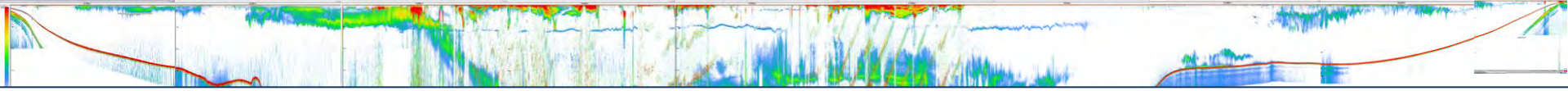
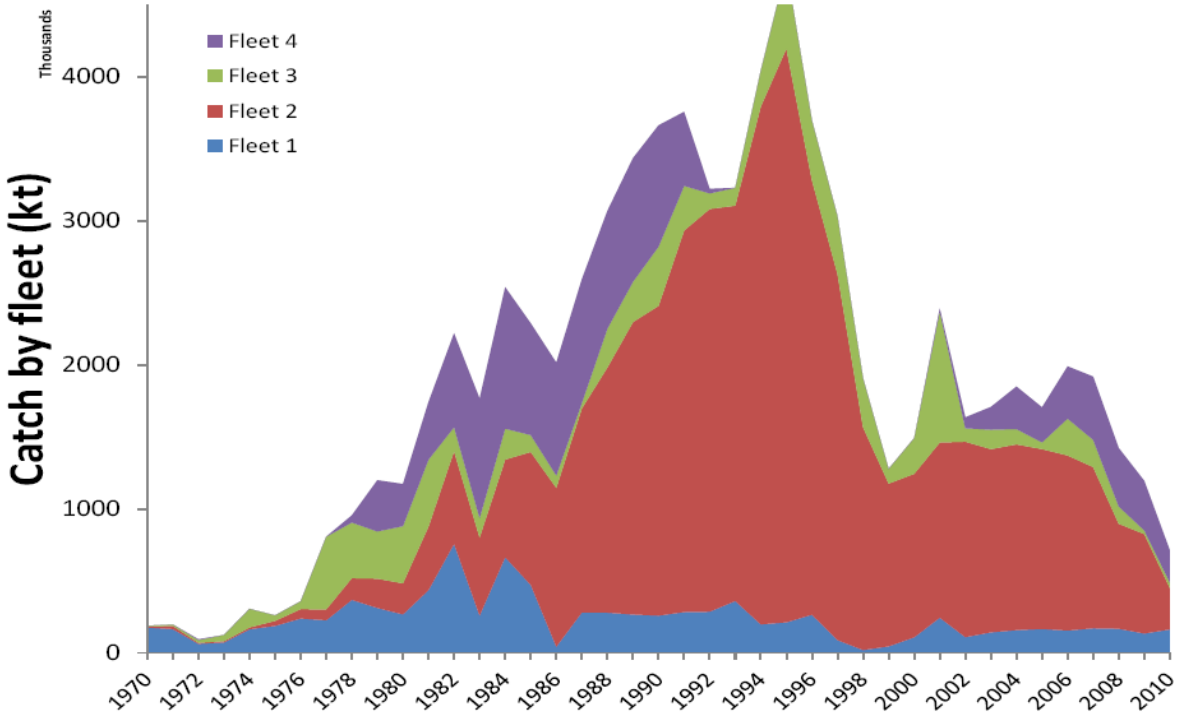
SOCIEDAD NACIONAL DE PESQUERIA



Trachurus murphyi: a population exploited by industrial fisheries



Catches Chilean jack mackerel (CJM), 1970-2010 (data SPRFMO).

Most of the fishing vessels used by the fleets are equipped with modern acoustic devices

Acoustic information available from fishing/research vessels

- Time-spatial **location of fishery resources** and abundance (biomass) estimates
- Time-spatial **distribution of preys** (krill, zooplancton, mesopelagtic fish, all micronekton)
- Description of **habitat** through continuous measurement of ecosystem indexes.
- Multifrequency **species identification** on vessels equipped with 2 frequencies.
- Extraction of **structures and abundances** for each group or species
- **Fish samples and oceanographic data** in stations

ICES COOPERATIVE RESEARCH REPORT

RAPPORT DES RECHERCHES COLLECTIVES

NO. 287

AUGUST 2007

COLLECTION OF ACOUSTIC DATA FROM FISHING VESSELS

WILLIAM A. KARP, EDITOR

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ICES International Council for the Exploration of the Sea
CIEM

Karp (Ed.), ICES CRR, 2007

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Commercial fishing vessels, automatic acoustic logging systems and 3D data visualization

Gary Melvin, Yanchao Li, Larry Mayer, and Allan Clay

Melvin, G. D., Li, Y., Mayer, L., and Clay, A. 2002. Commercial fishing vessels, automatic acoustic, logging systems and 3D data visualization. – ICES Journal of Marine Science, 59: 179–189.

Over the past five years we have investigated and used commercial fishing vessels and their associated acoustic hardware as platforms for acoustic surveying and data collection. During this period we developed an automated acoustic logging system that will simultaneously record data from the ship's existing sounder, sonar, and navigation systems. The system was designed to be self contained and easy to activate. Once calibrated, the vessel's vertical echo sounder can be used for quantitative fish biomass estimates in a manner similar to a scientific echo sounder. Sonar data are collected in the form of digital images with a navigation file header. Post processing, editing, and visualization tools were developed to scale the sonar images according to range setting and tilt angle. Thereafter, both the sounder and sonar data are combined into a 3D visualization package for presentation, observation, and school area estimates. Industry based acoustic surveys of herring spawning grounds have been used to estimate spawning stock biomass and for near real-time decision regarding harvest levels in NAFO Statistical Division 4WX since 1997. Currently, there are eight systems deployed on commercial purse seiners within the region. For the past four years data from structured surveys and fishing excursions have played a key role in the assessment of herring spawning stock biomass. While the application of the technology has been driven by a stock assessment mandate, its potential use is more far reaching. The spatial nature the data assure that detailed and quantitative studies of fish behaviour, vessel avoidance, fish distribution, and target area can be undertaken from commercial fishing vessels with the addition of minimal equipment. However, quantification of sonar images is restricted to uncalibrated echosounder or no digital amplitude data are available from the commercial fishing units.

Keywords: Atlantic herring, fishing vessels, hydroacoustics, surveying, stock assessment, visualization.

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Introduction

Prior to 1995 the Scotia-Fundy Atlantic herring stock (NAFO Statistical Division 4WX) was assessed and managed as a single stock complex with a global "total allowable catch" (TAC). It was however recognized that within the TAC, individual major and minor spawning components could be adversely affected by concentrating fishing effort on a single spawning area, especially during periods of low abundance (Figure 1). Past occurrences, such as the collapse of the Trinity Ledge spawning component, the decline in 1992 and 1993 of catches on German Bank and the rapid decrease in catches from the Little Hope area, have clearly demonstrated the potential negative effects of such activity (Stephenson *et al.*, 1996). In 1994 the herring industry expressed concern about absence of fish from traditional fishing grounds, poor fat content, and the level of effort being exerted by the roe fishery on individual spawning components. The 1995 stock assessment affirmed their concern and indicated a significant decline in stock abundance (Stephenson *et al.*, 1995). The quota was

1054-3139/02/020179+11 $35.00/0

Melvin et al, ICES JMS, 2002

1231

Using acoustic data from fishing vessels to estimate walleye pollock (*Theragra chalcogramma*) abundance in the eastern Bering Sea

Taina Honkalehto, Patrick H. Ressler, Richard H. Towler, and Christopher D. Wilson

Introduction

Walleye pollock (*Theragra chalcogramma*) is an abundant, semidemersal pelagic fish that inhabits the continental shelf waters of the North Pacific Ocean from Washington State, USA, north and west to Japan. In the US Exclusive Eco-

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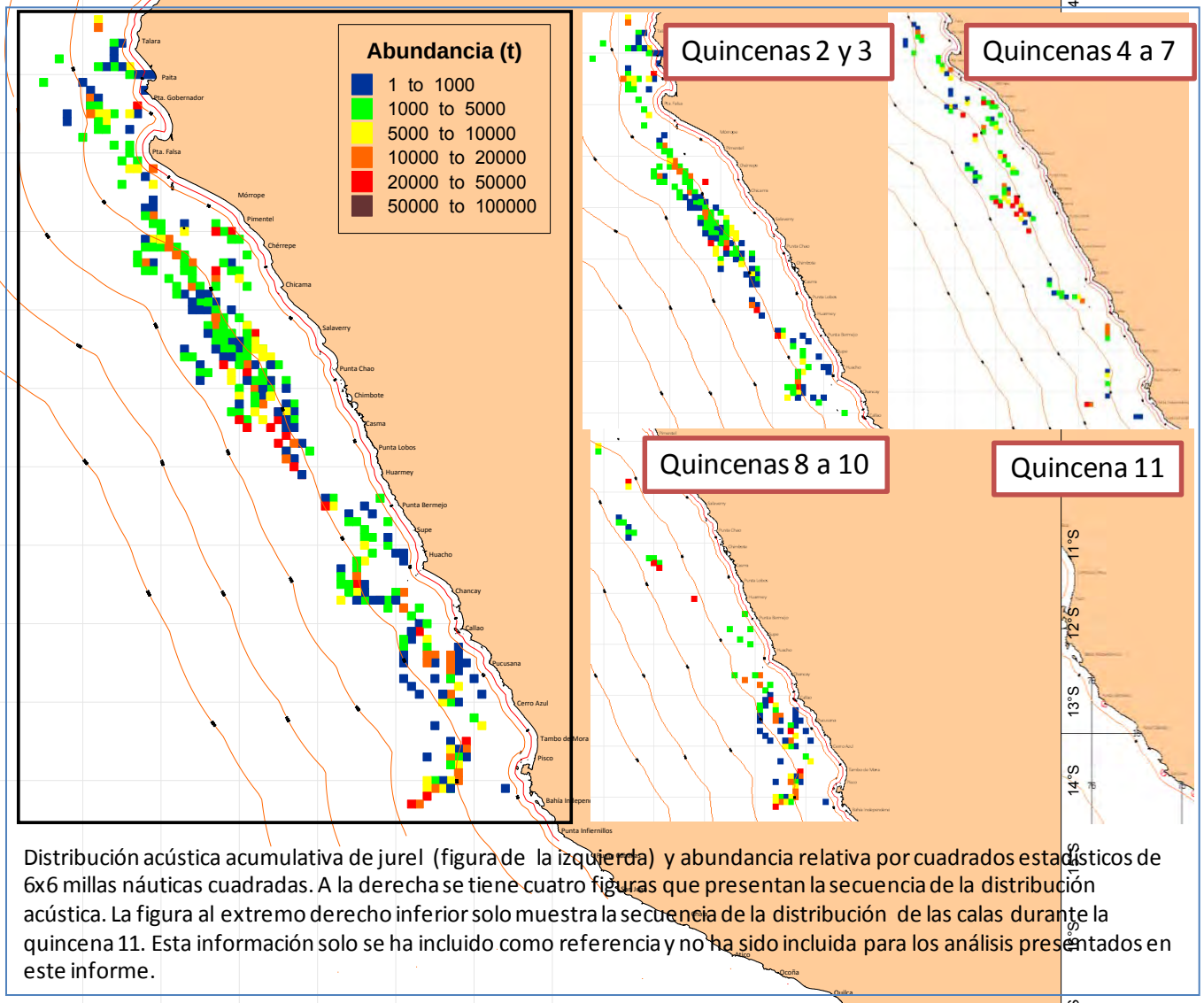
Honkalehto et al, CJFAS, 2011

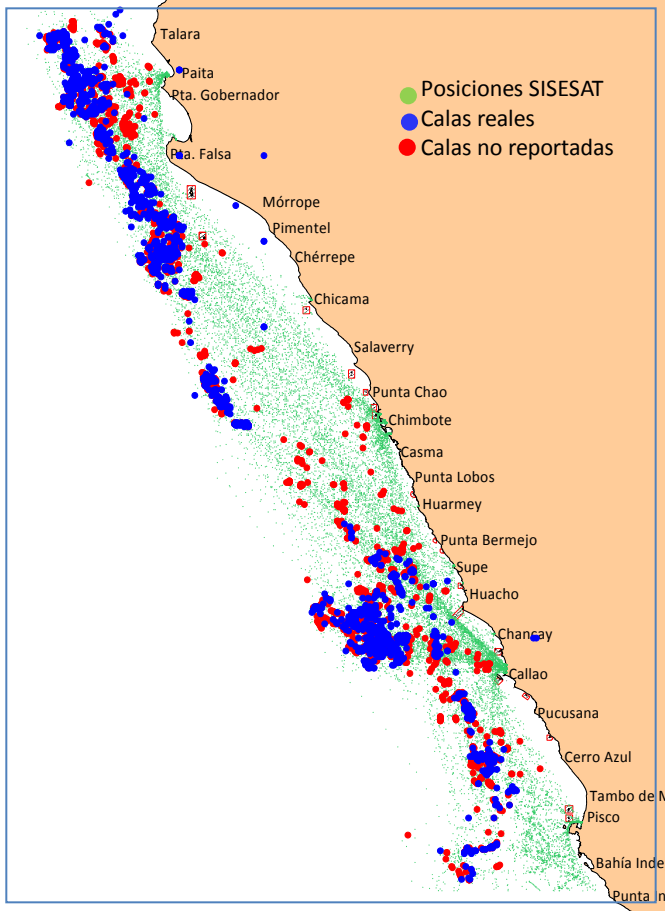
There is already an important scientific background in the use of acoustic data from fishing vessels (e.g. above)

Abundance estimates using acoustic data from fishing vessels January–May 2011



Distribución acústica acumulativa de jurel (figura de la izquierda) y abundancia relativa por cuadrados estadísticos de 6x6 millas náuticas cuadradas. A la derecha se tiene cuatro figuras que presentan la secuencia de la distribución acústica. La figura al extremo derecho inferior solo muestra la secuencia de la distribución de las calas durante la quincena 11. Esta información solo se ha incluido como referencia y no ha sido incluida para los análisis presentados en este informe.

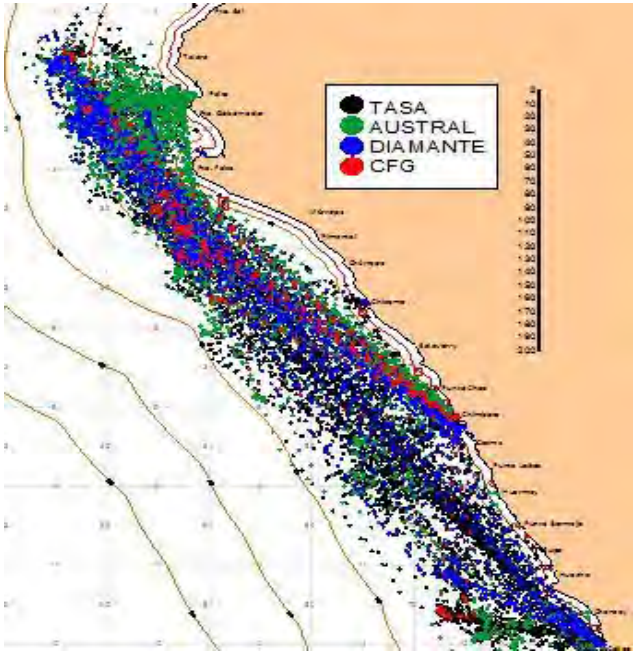
Spatial sampling by fishing vessels (January-May 2011)



Distribución de calas reportadas (puntos azules) y posiblemente descartadas durante la temporada de pesca (16 de enero a 20 de mayo). Ha habido presencia de otras especies sobre las cuales no existe permiso de pesca (agujilla, bonito, melva y barrilete principalmente) y capturas de caballa con alta incidencia de anchoveta.

Distribution of reported (blue) and probably unreported (red) sets (16th January – 20th May, 2011). Other points display the CISESAT positions recorded with no set

A workshop on fishers' data, Peru, March 2011: acoustic data on jack mackerel from 4 fishing companies
(Data: January-March 2011)



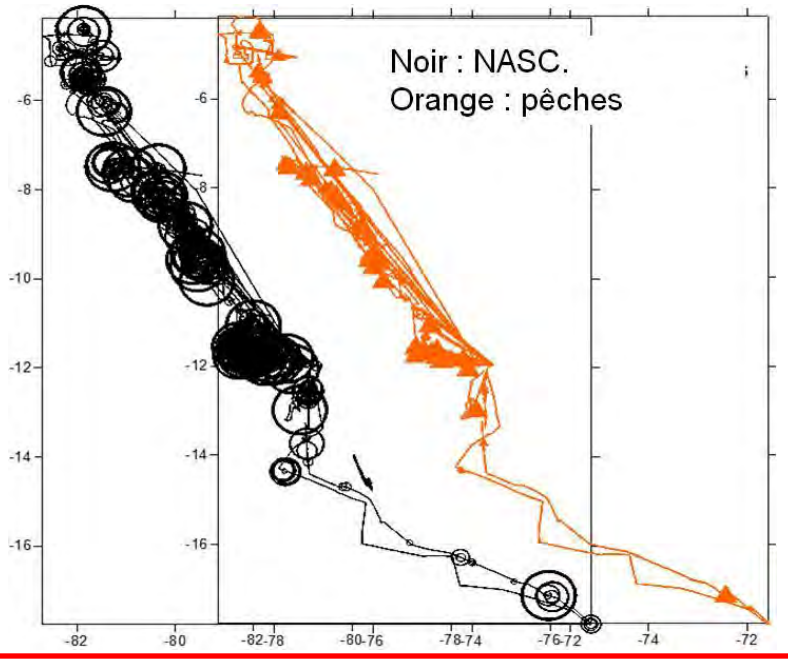
Map of the 150 000 EDSUs sampled by the 4 main fishing companies, January-March, 2011

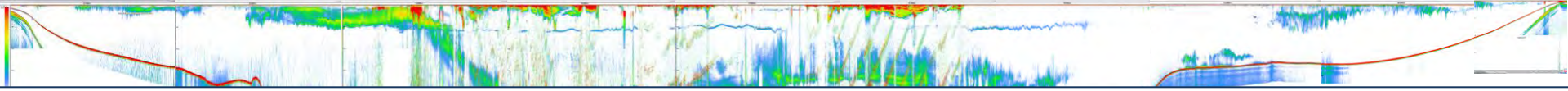
Routes of the 25 fishing trips used for the research (15000 EDSUs).

Black: distribution of the CJM schools observed during the trips. Circles are proportional to the NASCs

Orange: fishing operations

January-March, 2011

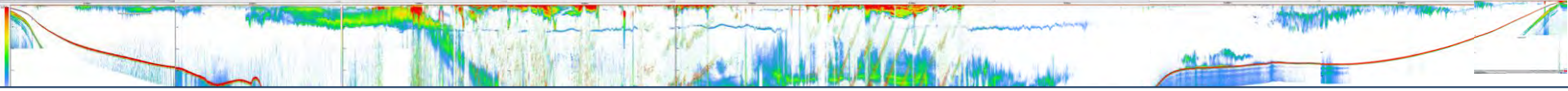




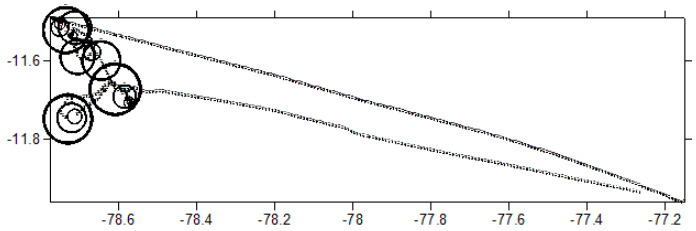
Main data collected continuously and integrated each 3 minutes (approx. each ½ mile)

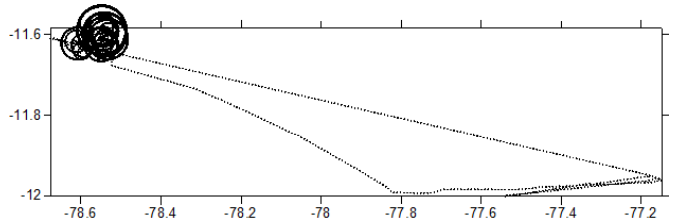
VESSEL	ACOUSTICS	POSITION	DATE	DENSITY
Process_ID	Sv_mean	Layer_depth_min	Date_S	Frequency
BARCO	NASC	Layer_depth_max	Time_S	Anchovy
CODIGO	Sv_max	Ping_S	Date_E	Jack mackerel
Sem anch	Sv_min	Ping_E	Time_E	Mackerel
pesca	Sv_noise	Ping_M	Date_M	Mixed JM + M
Interval	NASC_noise	Dist_S	Time_M	various
Layer	Height_mean	Dist_E		bonito
Dist_Recta	Depth_mean	Dist_M		agujas
F_C_Dist	Samples	VL_start		squid
	Alpha	VL_end		Munida
	Gain_constant	VL_mid		euphaus.
	Noise_Sv_1m	Lat_S		Vinciguer.
	Minimum_Sv_threshold_applied	Lon_S		Myctophid
	Minimum_integration_threshold	Lat_E		
	Maximum_Sv_threshold_applied	Lon_E		
	Maximum_integration_threshold	Lat_M		
	Exclude_above_line_applied	Lon_M		
	Exclude_above_line_depth_mean			
	Exclude_below_line_applied			
	Bottom_offset			
	Standard_deviation			
	Skewness			
	Kurtosis			
	ABC			
	ABC_noise			
	Area_Backscatter_Strength			
	Thickness_mean			
	Range_mean			
	Exclude_below_line_range_mean			
	Exclude_above_line_range_mean			
	Beam_volume_sum			
	No_data_samples			

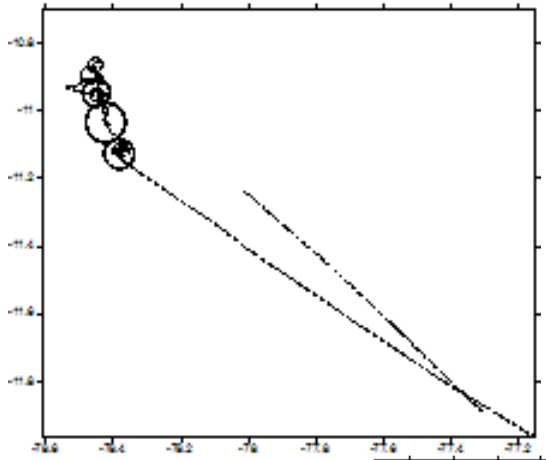
In yellow: data used in the workshop for analysing the apport of fishers' acoustics

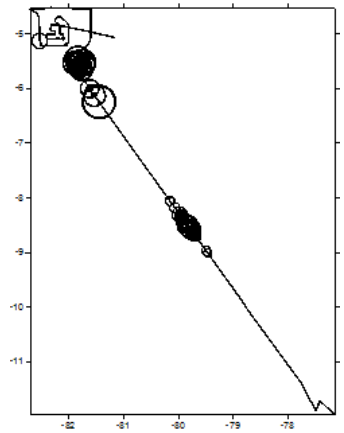


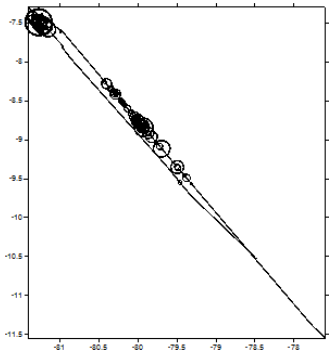
Some examples of routes.
Densities (NASC) in jack mackerel are given by ½ nautical mile and represented by proportional circles

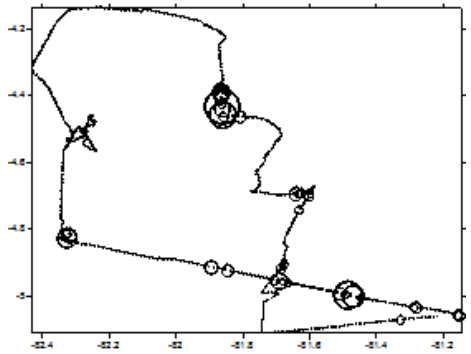


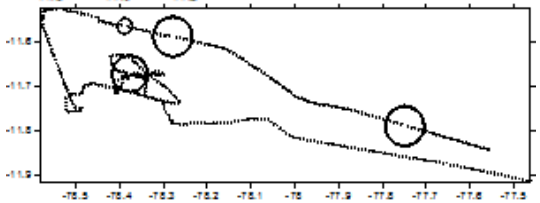


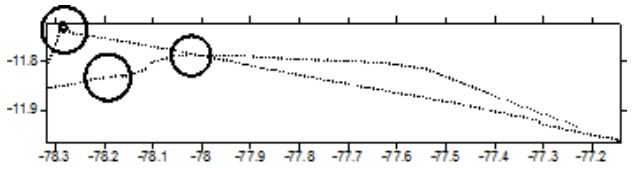










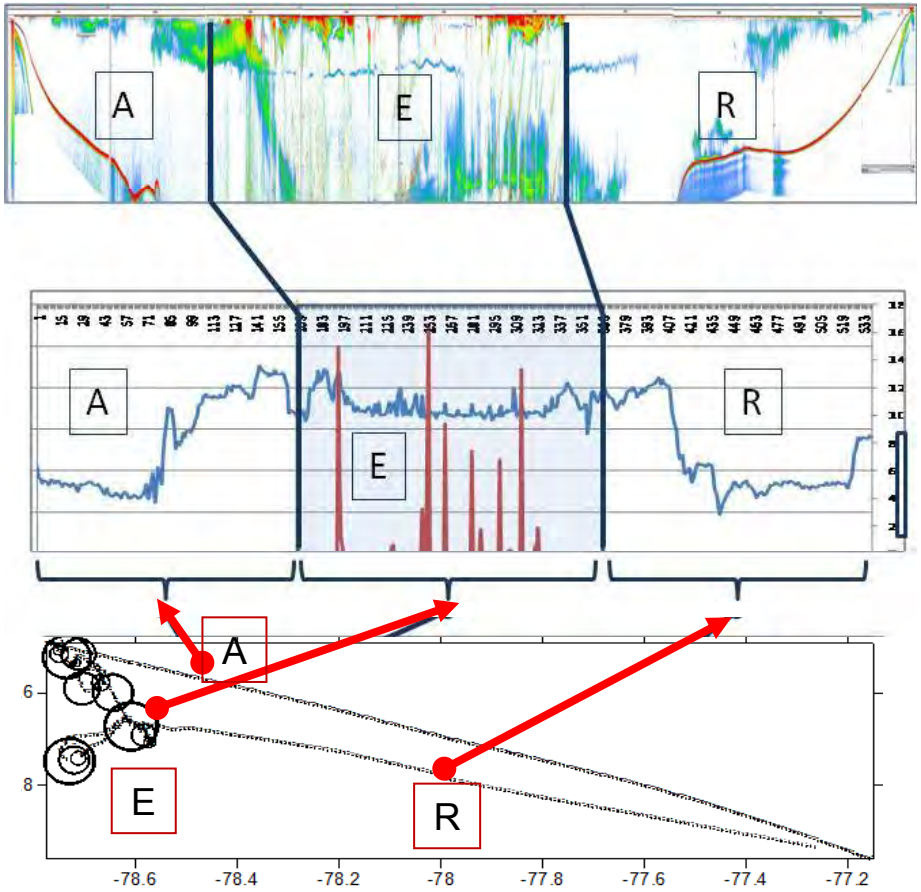


Analysis of the trips.

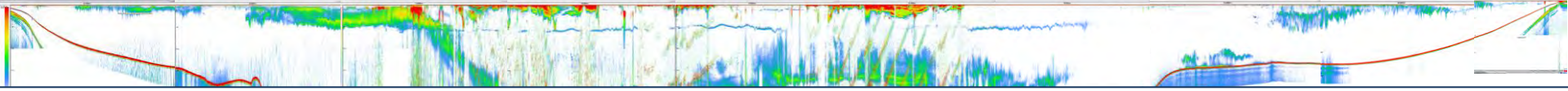
Echogram of the whole trip

Sv (blue) and NASC per school (red) during the trip. EDSU: 0.5 nautical mile

Drawing of the routes and CJM abundance

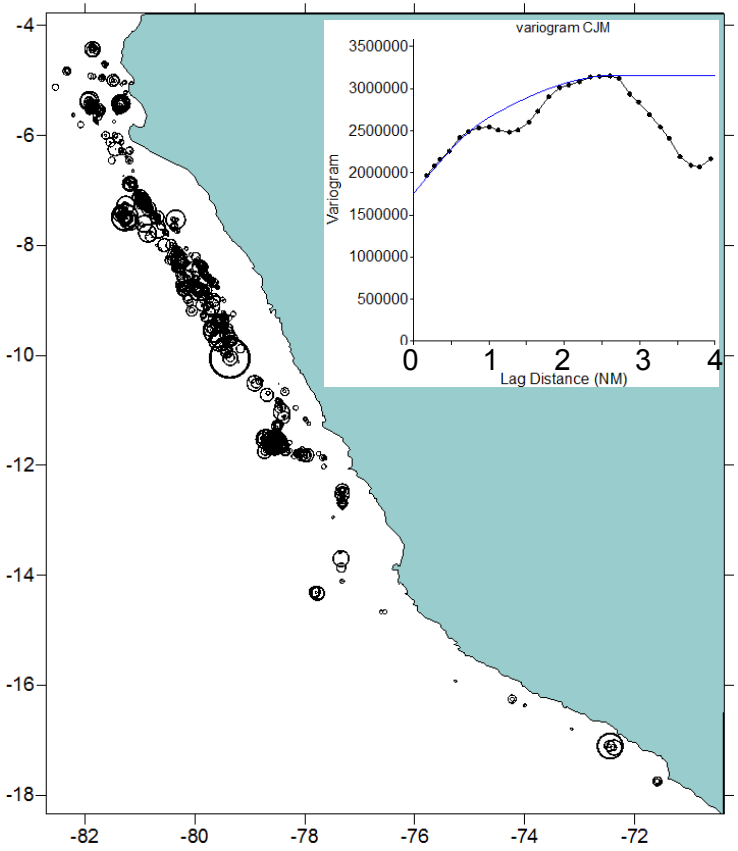


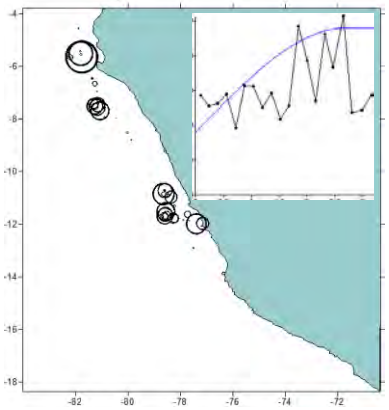
Separating the trip in 3 parts: route to fishing grounds (A), exploration/exploitation (E), return (R)



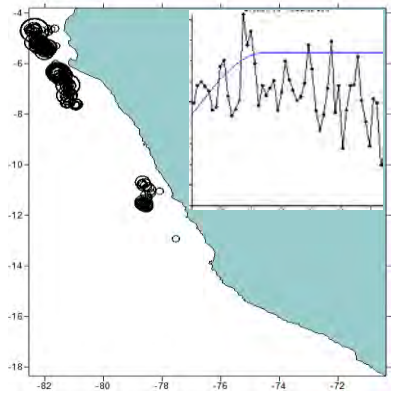
Spatial distribution of fish and ships

Variograms on fish density distribution: range = 2.7 Nm

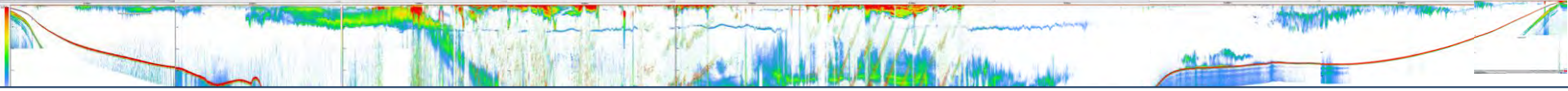




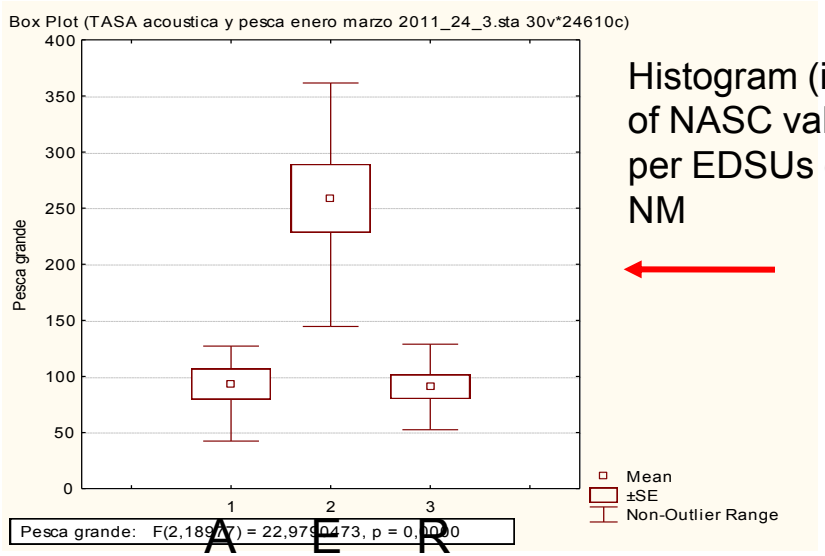
Variogram of catch distribution for the 25 trips: range = 2.7 NM



Variogram distribution for all catches, January-March: range = 1.8 NM

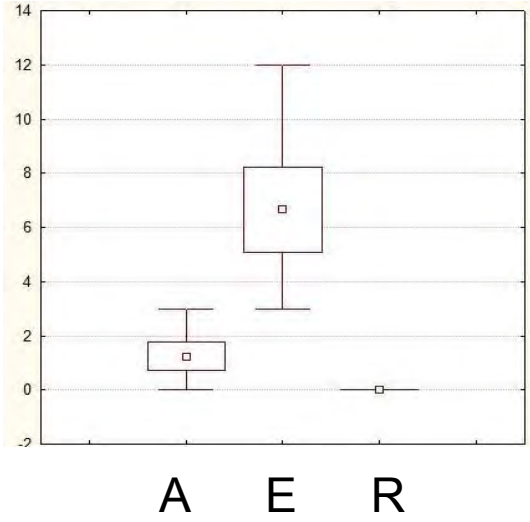


Abundances measured by fishing vessels:

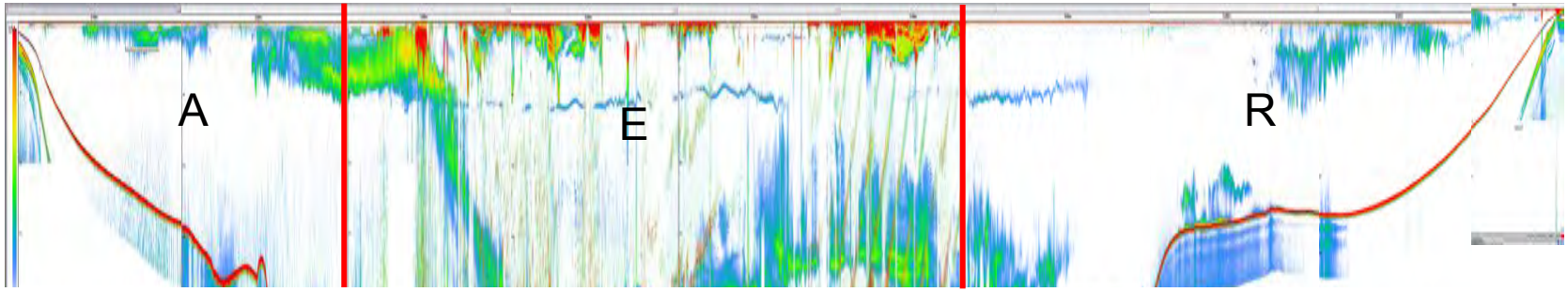


Histogram (in dB) of NASC values per EDSUs of 0.5 NM

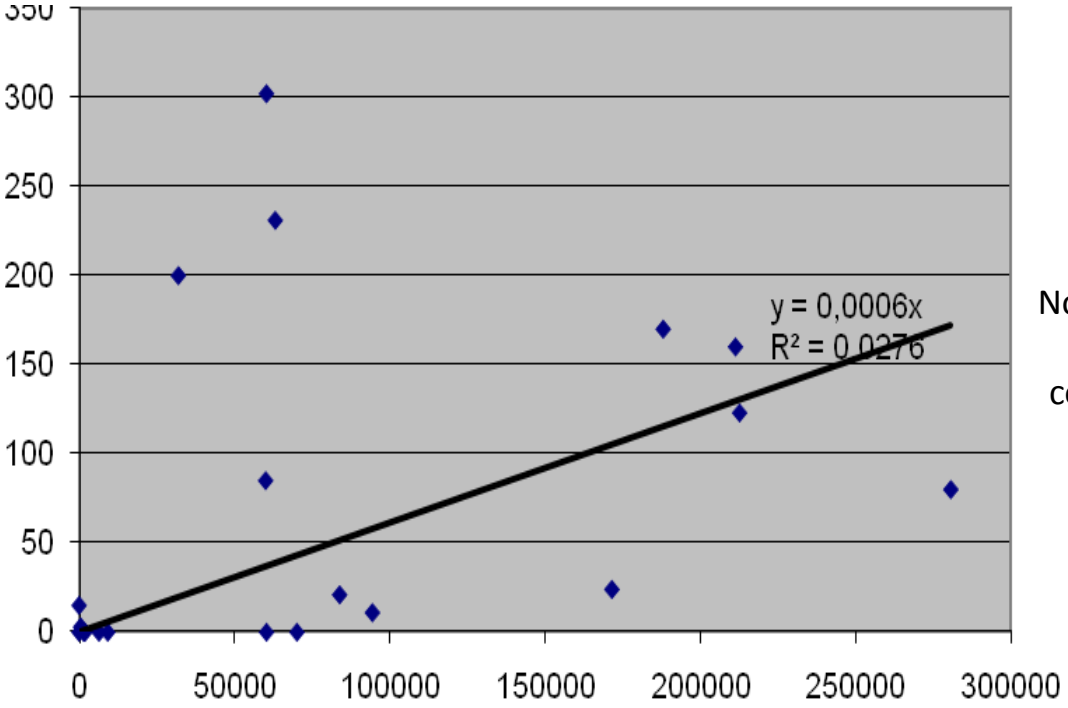
Mean catch per set (tons)



A: travel to fishing grounds; E:exploration/exploitation; R: return



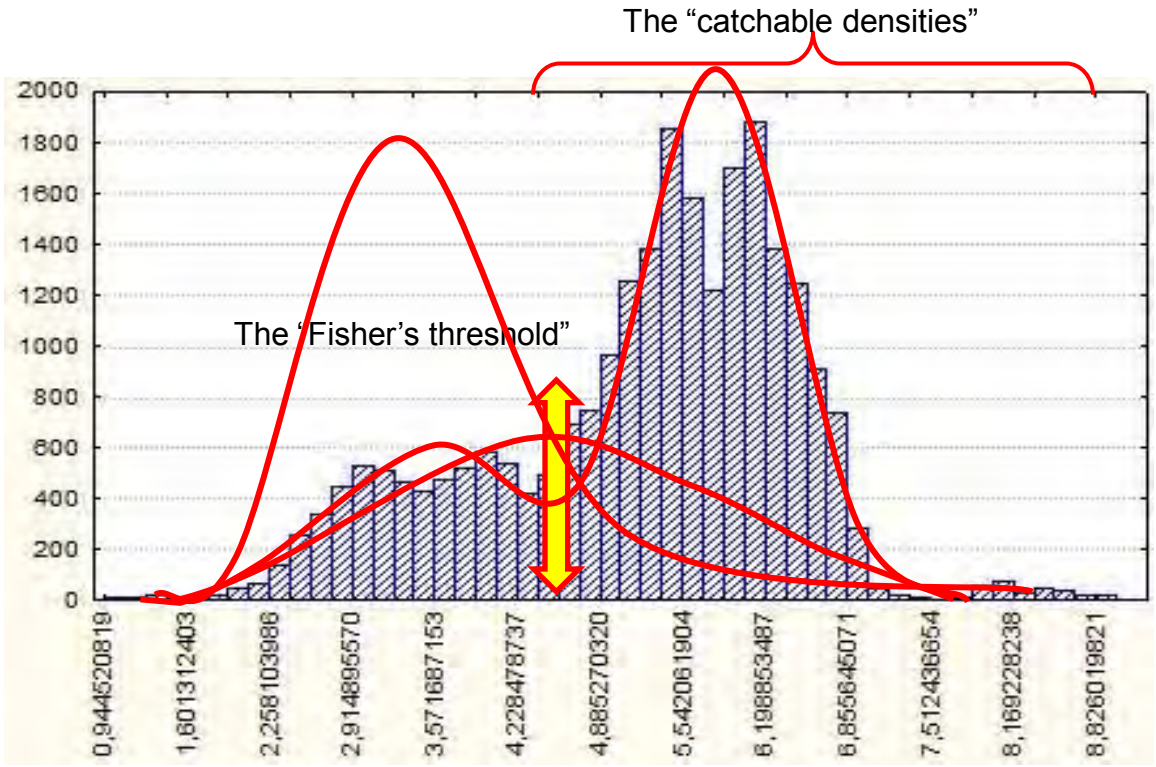
CPUE of CJM: catch vs. abundance



No correlation, but too few data for any consistent conclusion

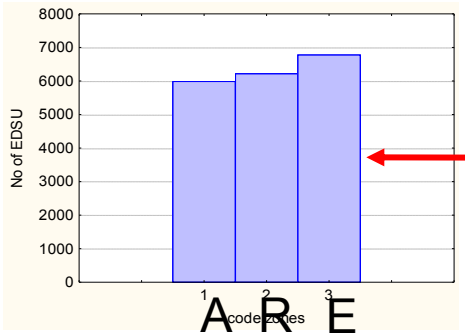
Relationships between total catch (tons) and total abundance (NASC) per trip in the exploration zone (25 trips)

How representative of the stock is a sampling from fishing vessels?

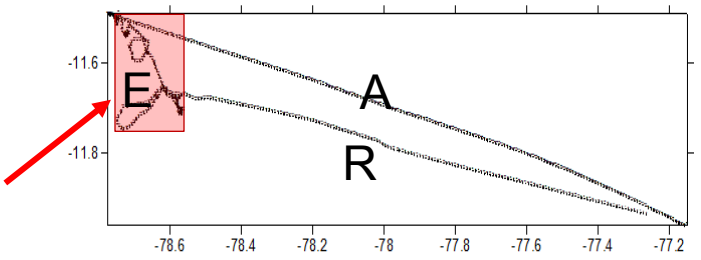


Histogram of NASCs for the 25 trips

What is the good histogram? What effect on the CPUE?



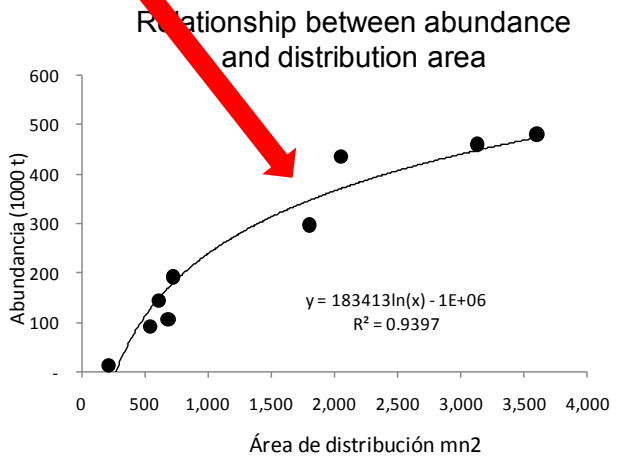
35 % of the sampling
on
8 % of the surface

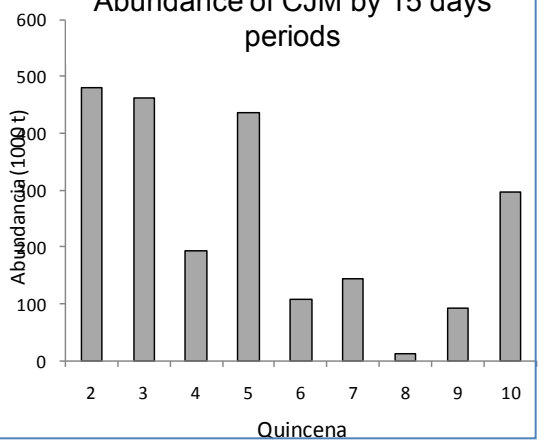


Other informations obtained through fishing vessels (I)

Quincena	Abundancia relativa (t)	Area de distribución (mn^2)	Densidad (t/mn^2)	Desviación Estandar (t)	CV (%)
2	481,016	3,600	134	7,974	60
3	460,908	3,132	147	12,402	43
4	192,464	720	267	12,674	76
5	435,408	2,052	212	10,032	76
6	106,640	684	156	10,002	56
7	143,992	612	235	9,920	85
8	12,168	216	57	3,363	61
9	92,070	540	170	8,131	75
10	299,160	1,800	165	8,140	73

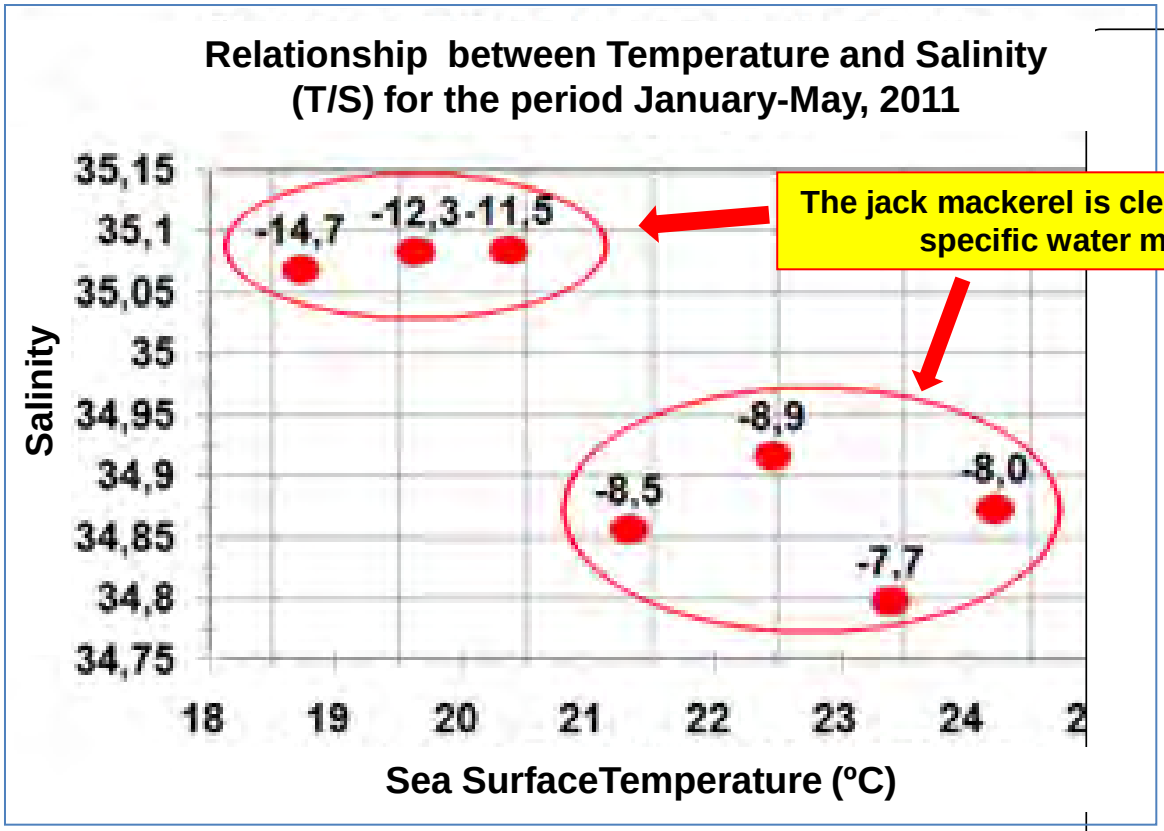
Note that the relationships is approximately asymptotic, which can be related to the shape of the histogram





Los estimados acústicos de abundancia por quincenas (tabla de arriba) han sido calculados por el método de Jolly & Hampton (biomasa por tallas e intervalos empleando un factor de conversión peso/sigma para cuadros estadísticos de 6 por 6 mn). Se emplea el término 'abundancia' en lugar de 'biomasa' por ser una expresión

Other informations obtained through fishing vessels (II)



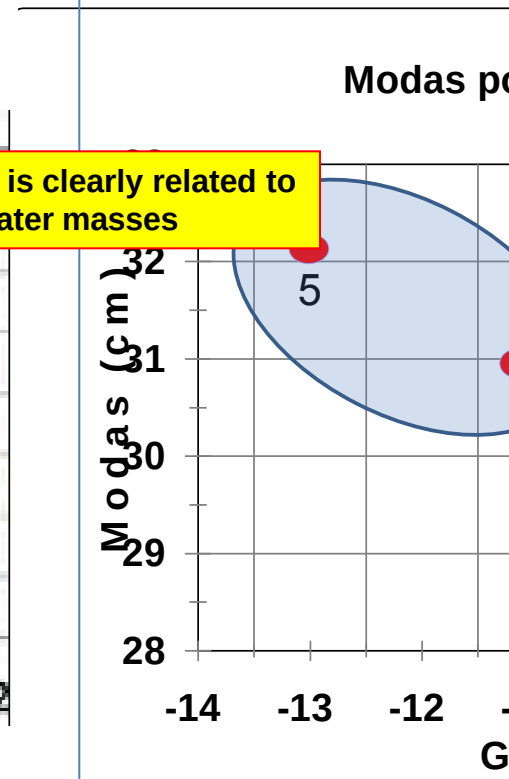
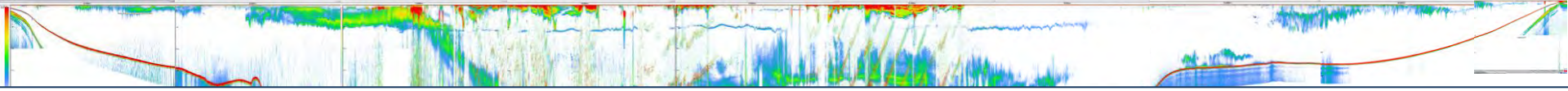
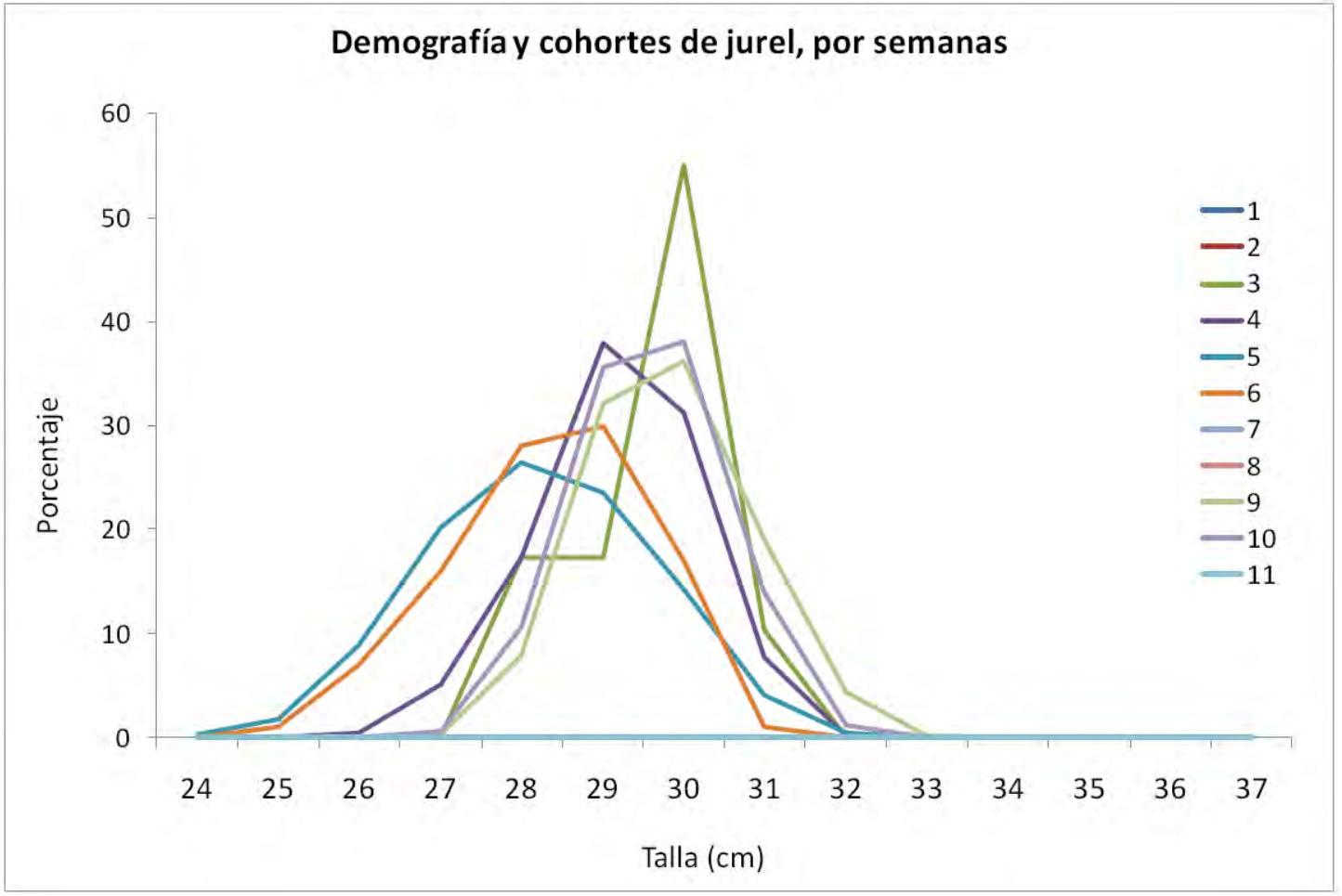


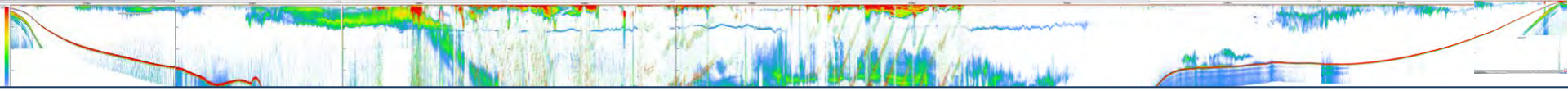
Figura de la izquierda: entre enero y mayo el esfuerzo de pesca ha sido realizado en dos zonas bien relación Temperatura-Salinidad (T/S). En la esquina superior izquierda se aprecia la relación entre la de ASS con temperaturas relativamente bajas y que corresponde a latitudes entre Chancay y Bahía mostrada en la esquina inferior derecha caracteriza una zona con presencia de mezcla entre ACF y A entre Chicama y Chimbote (7,7 a 8,9°S). En la figura de la derecha se aprecia que las dos zonas d

Según lo observado, los reclut dando de norte a sur coin especímenes



Other informations obtained through fishing vessels (III)

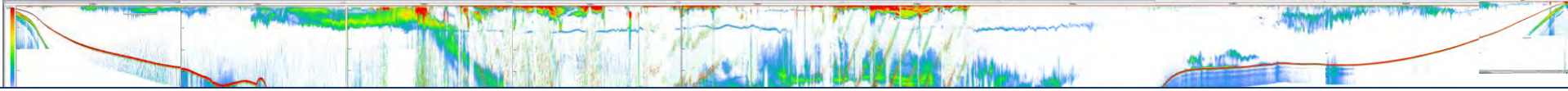




Conclusion (I)

- Cost: acoustic collection and processing requires:
  - digital echosounders (e.g. SIMRAD ES60)
  - processing software (e.g. Echoview)
  - 1 hour of technician for processing 1 day trip

- More than 150 000 data (EDSU) collected in one trimestre for the CJM fishery in Peru
- Data can cover all the fishing grounds
- Part of the fishery data present the same quality as scientific data
- Trajectories, fisher and fish behaviour are documented by the data
- Evaluation of fish and fisher distribution (help for scientific recommendations)
- Information on CPUE meaning
- Informations on relationships environment-distribution



Conclusion (II): future activities

- Spatial data from fishers are likely the best descriptors for the fish biomass (but not for relationships with the ecosystem)
- Data from research vessels are likely the best descriptors for the relationships with the ecosystem (but nor for the biomass)

- … then what research should we develop to take advantage of informations from fishing vessels?

- Organisation of a working group inside SPRFMO on fisheries acoustics for:
- Defining a common methodology for data collection, extraction, processing and analysis
- Collect and organize data from the JM international fisheries (ideal : 3 or 4 vessels from each one of the major fishing countries: Chile, Perú, EU, Russia)

- Introduction of fishers' data in models for JM assessment