Treatment of acoustic data obtained from echosounder buoys for tuna biomass estimates

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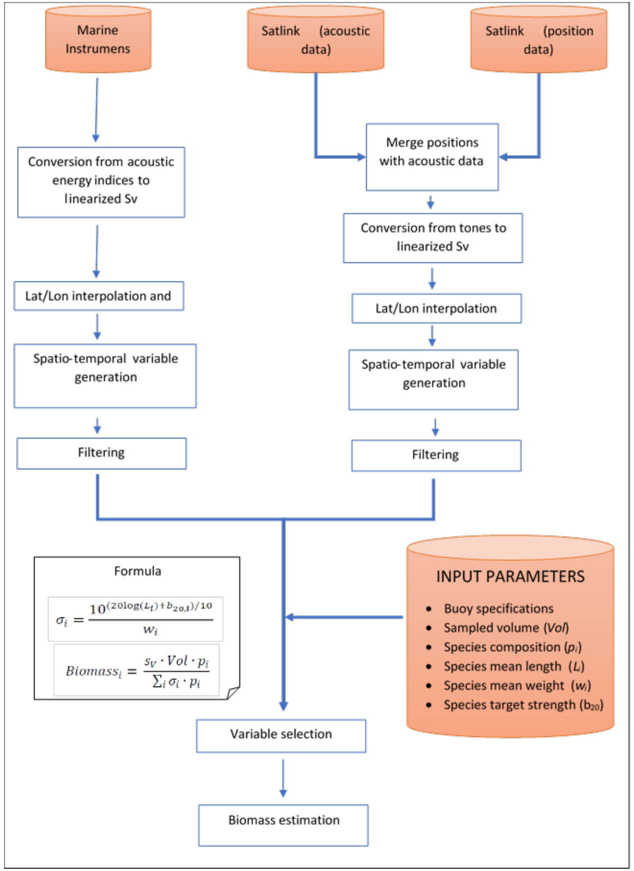
Objective

Harmonization of inter-buoy/brand acoustic data processing for consistency

Specific Objectives:

- To establish the methodology for setting all data sources at the same acoustic units and equivalent sampling volume.
- Integration of common target strengths (TS), species composition and fish lengths information to convert the acoustic signal on species-specific biomass estimation

Acoustic data processing flow chart

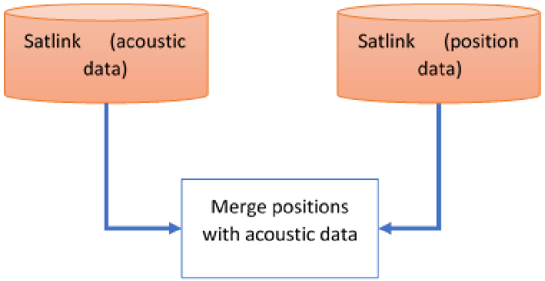


Acoustic data processing : from brand-specific abundances to harmonized acoustic data

Raw data:

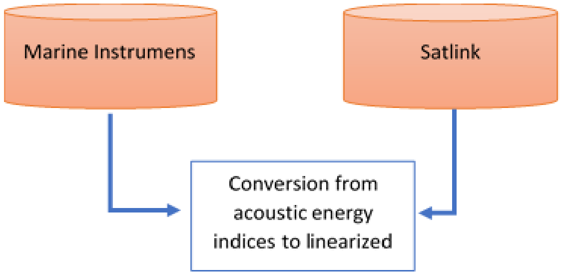
- 1st Step:

  Join position data and acoustic data from Satlink based on buoy ID and date.

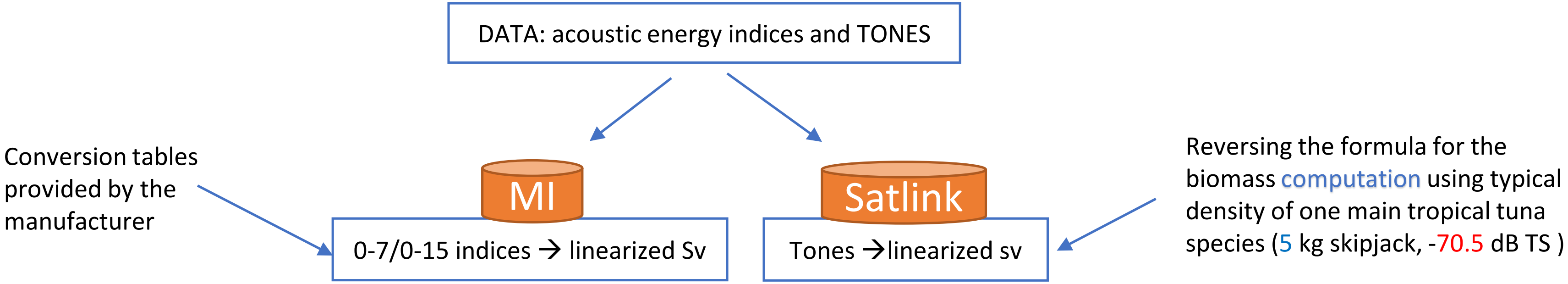


- 2nd Step

  Geolocated raw data → Linearized Sv values



Acoustic data processing : from brand-specific abundances to harmonized acoustic data



Decibels → linearized sv ; Sv (decibels)=10 log(sv(linearized))

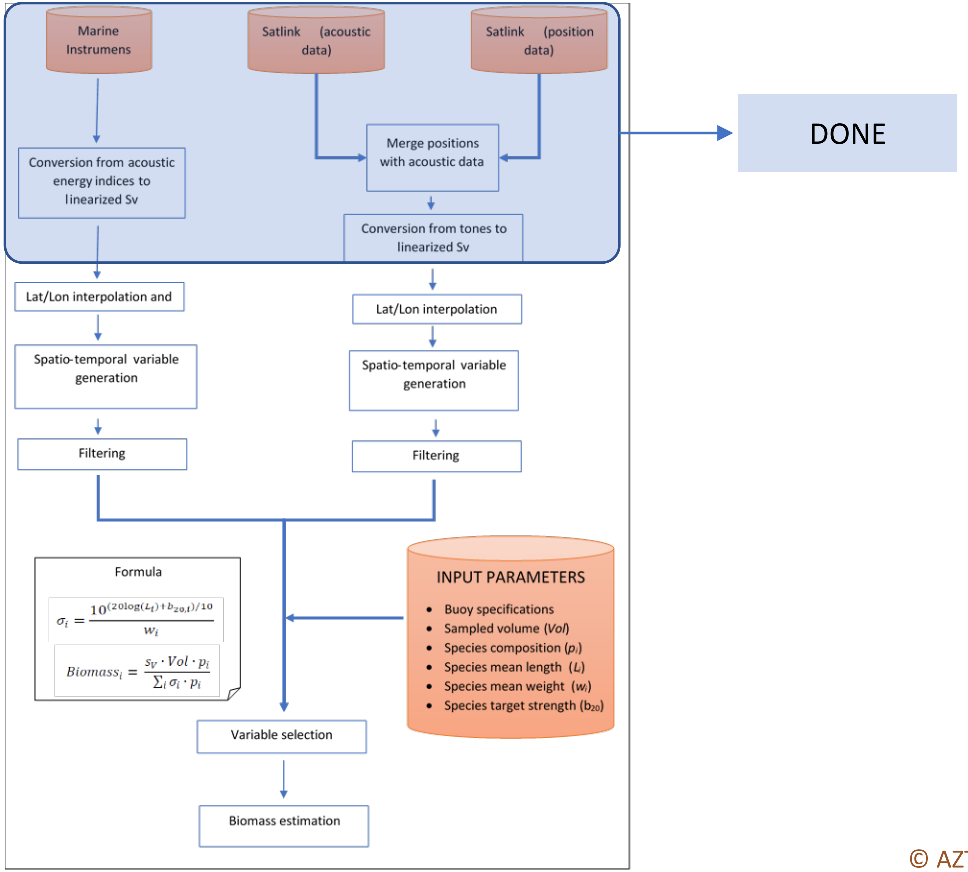
$$\sigma_i = \frac{10^{(20\log(L_i)+b_{20,i})/10}}{w_i} \quad ; \quad sv = \frac{Biomass_i.\sum_i \sigma_i \cdot p_i}{Vol \cdot p_i};$$

where:

- L_i <-((5/(7.480e-6))^(1/3.2526)) is obtained from weight-length conversion tables.
- b20sat<- -70.5 -(20 log10(length)) is the TS - length relation.

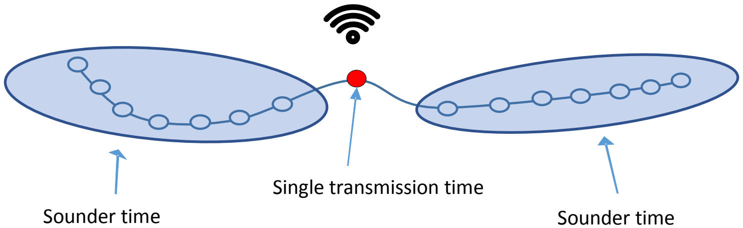
Harmonized acoustic data: sv (Volume backscattering acoustic energy)

Acoustic data processing flow chart



Acoustic data processing : from brand-specific abundances to harmonized acoustic data

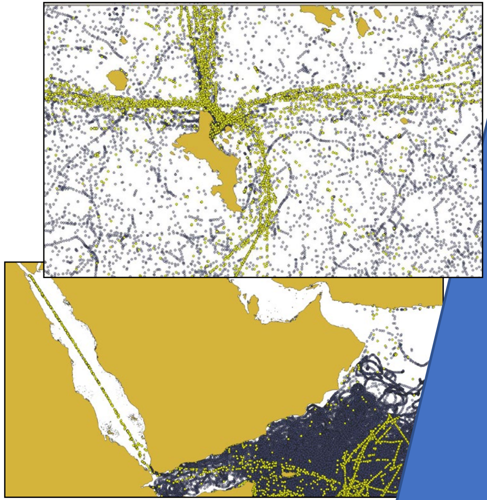
Interpolation



Lat/Lon interpolation

(Location only at data transmission via GPS. Sounder location interpolated based on the sounder time)

Filtering



FILTERING

- Isolated Position
- Duplicated data (all fields are the same)
- Data on land
- **Ubiquity. S**ame date/time different positions
- Not classified by the at sea/on board algorithm
- Buoys on board
- Buoys at sea.

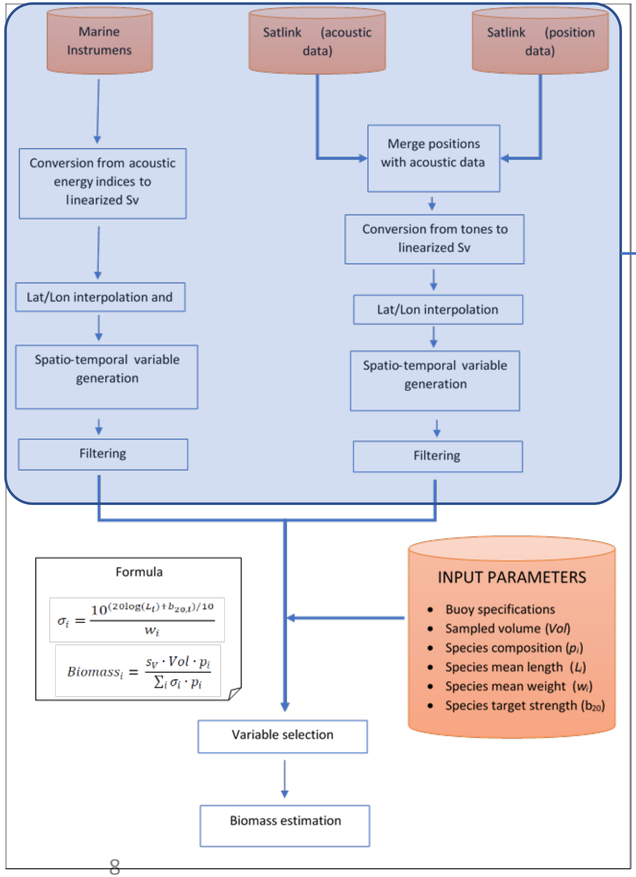
Spatio-temporal variable generation

(Distance,speed,aceleration,bearing, days to first and last deployed)

Filtering

(Duplicated,isolated,land,ubiquity, onboard filters)

Acoustic data processing : selecting approppriate input parameters



DONE

INPUT PARAMETERS

- **Buoy specifications**
- **Sampled volume (*Vol*)**
- **Species composition (p_i)**
- **Species mean length (L_i)**
- **Species mean weight (w_i)**
- **Species target strength (b_{20})**

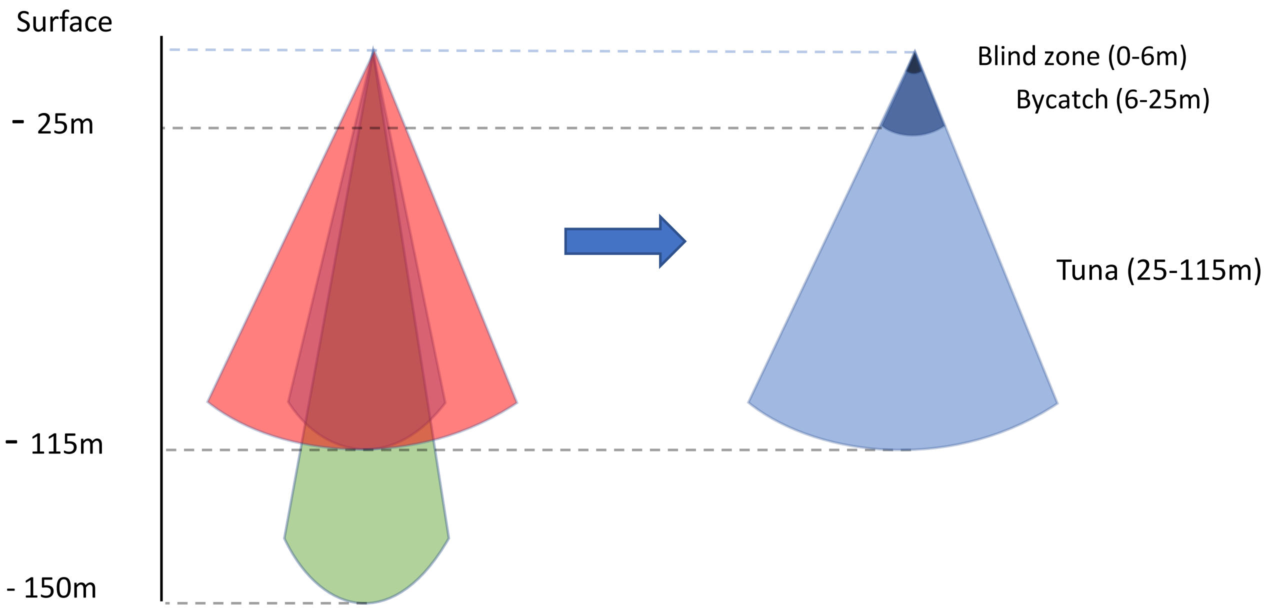
$$\sigma_i = \frac{10^{(20\log(L_i)+b_{20,i})/10}}{w_i}$$

$$Biomass_i = \frac{s_V \cdot Vol \cdot p_i}{\sum_i \sigma_i \cdot p_i}$$

Acoustic data processing : selecting approppriate input parameters

- **Buoy specifications and Sampled volume (*Vol*):**

A common range from 25 m to 115 m depth is established



Acoustic data processing : selecting approppriate input parameters

- **Species composition (p_i) and Species mean length (L_i) are estimated per spatio-temporal strata:**
    - 1 stratum: 1x1 degree grid, year, month.
    - 2 stratum : 1x1 º grid, trimester.
    - 3 stratum : Large regions, trimester.
- **Species target strength (b_{20}) from bibliography and ongoing studies.**

SUMMARY (Source: from ICCAT or IOTC resources)				
Range	6-25m (bycatch layer)	25-115m (tuna layer)		
Species	Bycatch	Skypjack	Bigeye	Yellowfin
TS (b20)	68.7	-70.5	-63.5	-68.7
Mean Fish Length (cm)	30	Mean by strata*	Mean by strata*	Mean by strata*
Species distribution (%)	100	% by strata*	% by strata*	% by strata*

Conclusions

- The data collected by fishers' echo-sounder buoys are not originally intended to be used for scientific purposes but for fishing. However, they offer large-scale interesting information that should be used for scientific purposes.

- The method presented here aims to convert information received from different sources in a common unit and improve the biomass estimates provided originally by manufacturers following the work of Lopez et al (2016) and Orue et al., (2019) by using new TS values and introducing the seasonal and spatial variability in species and size composition.

- This is a novel approach that has been applied to obtain indices of abundance of tropical tunas from echosounder buoys (Santiago et al., 2019).

Acknowledgments:

- Fishing companies belonging to ANABAC and OPAGAC.
- Marine Instruments, Satlink and Zunibal buoy suppliers.
- Basque Government
- European CECOFAD project (EASME/EMFF/201711.3.2.6/041512.776952 CECOFAD II - EASME/EMFF/2016/OO8 - SC NOO9)

- Boyra, G., Moreno, G., Orue, B., Sobradillo, B., & Sancristobal, I. In situ target strength of bigeye tuna (Thunnus obesus) at FADs.
- Boyra, G., Moreno, G., Sobradillo, B., Pe, I., Sancristobal, I., & Demer, D. A. (2018). Target strength of skipjack tuna (Katsuwanus pelamis) associated with Fish Aggregating Devices (FADs). ICES Journal of Marine Science, 75, 1790–1802. ttps://doi.org/10.1093/icesjms/fsy041.
- Lopez, J., Moreno, G., Boyra, G., Dagorn, L., 2016. A model based on data from echosounder buoys to estimate biomass of fish species associated with fish aggregating devices. Fish. Bull. 114.
- Orúe, B., Lopez, J., Moreno, G., Santiago, J., Boyra, G., Soto, M., & Murua, H. (2019). Using fishers' echo-sounder buoys to estimate biomass of fish species associated with drifting fish aggregating devices in the Indian Ocean.
- Orue, B., Lopez, J., Moreno, G., Santiago, J., Soto, M., & Murua, H. (2019). Aggregation process of drifting fish aggregating devices (DFADs) in the Western Indian Ocean: Who arrives first, tuna or non-tuna species? Plos One, 14(1), e0210435. https://doi.org/10.1371/journal.pone.0210435
- Santiago, J., J. Uranga, I. Quincoces, B. Orue, M. Grande, H. Murua, G. Merino, G. Boyra, 2019. A novel index of abundance of juvenile yellowfin tuna in the Atlantic ocean derived from echosounder buoys. ICCAT Collect. Vol. Sci. Pap., SCRS/2019/075.