Contrasted micronekton ecosystems identified in tropical Pacific with active acoustics and environmental parameters, *Barbin et al.*

-- Supplementary materials --

INTRODUCTION FIGURES

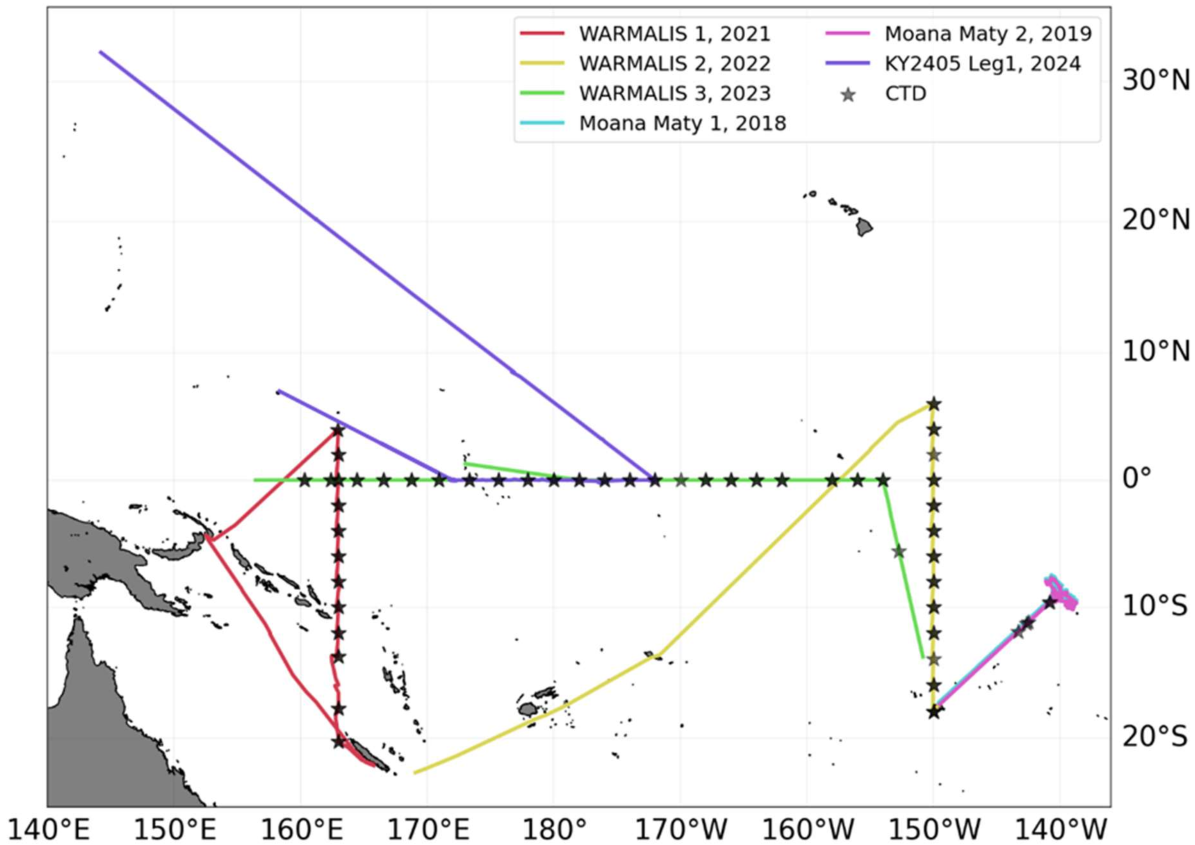


Figure S1. Tracks of the surveys used in this study: MOANA MATY 1 & 2: Rodier (2018, 2019), WARMALIS 1, 2 & 3: Menkes and Allain (2021, 2023), Allain and Menkes, (2022) and the first leg of KY2405, the 5th survey of 2024 onboard the Japanese research vessel (R/V) Kaiyo-maru (FRA), involving scientists from Japan (FRI) and New Caledonia (SPC/IRD). Black stars indicate CTD locations.
KY2405-Leg1 data have been shifted 4° north of latitude in the classification (poster Fig.4 and 6) to avoid mixing equatorial data from two different ENSO events in the same cells (see Fig.S2 for ENSO index). This choice was made because the boundary between the warm and upwelling zones shifts with ENSO. During W3,

the warm pool is detected between 160°E and 180°, whereas in this same area during KY2405, we were in the upwelling region (see poster Fig.4).

References:

Allain, V., and Menkes, C. 2022. WARMALIS 2 cruise, Alis R/V. Sismer. https://campagnes.flotteoceanographique.fr/campagnes/18001260/.

Menkes, C., and Allain, V. 2021. WARMALIS 1 cruise, Alis R/V. Sismer. https://campagnes.flotteoceanographique.fr/campagnes/18000710/.

Menkes, C., and Allain, V. 2023. WARMALIS 3 cruise,Antea R/V. Sismer. https://campagnes.flotteoceanographique.fr/campagnes/18001831/.

Rodier, M. 2018. MOANA-MATY 2018 cruise,Alis R/V. Sismer. https://campagnes.flotteoceanographique.fr/campagnes/18000580/.

Rodier, M. 2019. MOANA-MATY 2019 cruise,Alis R/V. Sismer. https://campagnes.flotteoceanographique.fr/campagnes/18000887/.

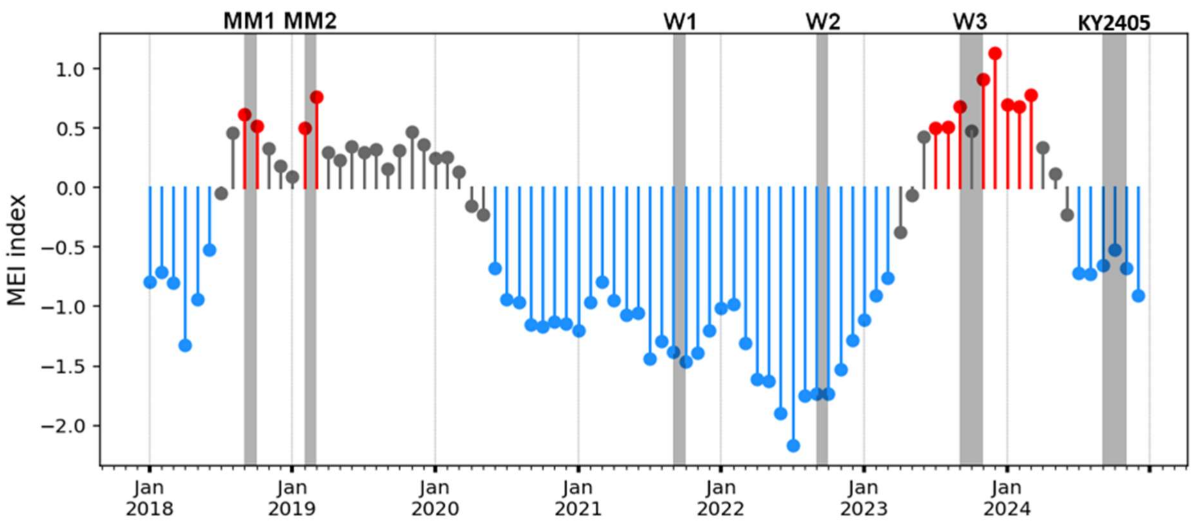


Figure S2. Multivariate ENSO index (MEI index) between 2018 and 2024. Each survey period is indicated with shaded vertical area. A positive red index indicates an El Niño event, while negative blue index indicates La Niña. In particular, W3 and KY2405 both took place along the equator during 2 different ENSO event. MEI index downloaded from NOAA.

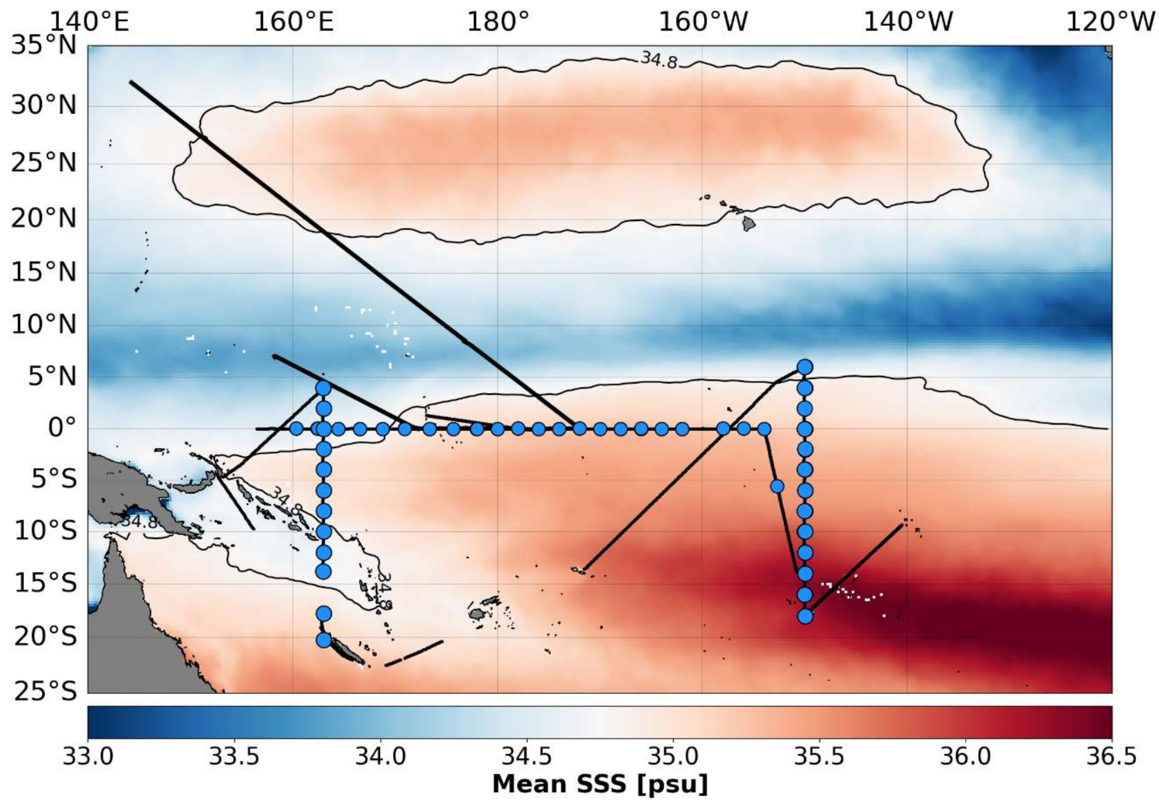


Figure S3. Sea Surface Salinity (SSS) averaged over the 5 surveys (sept/oct 2021 to 2024), from Copernicus Marine Product (Global Ocean Physics Analysis and Forecast; (European Union-Copernicus Marine Service, 2016). Use of monthly average.

Reference:

European Union-Copernicus Marine Service. 2016. Global Ocean 1/12° Physics Analysis and Forecast updated Daily. Mercator Ocean International. https://resources.marine.copernicus.eu/product-detail/GLOBAL_ANALYSISFORECAST_PHY_001_024/INFORMATION.

Table S1. Acoustic acquisition parameters of EK60 and EK80 hull-mounted echosounders. [a] EK60 for W1, W2, MM1 and MM2 surveys and EK80 for W3 and KY2405. [b] 3 seconds for all survey at the exception of 7 seconds for KY2405.

Signal type	**Continuous Wave (CW)**	**CW**	**CW**
Echosounder	EK60 / EK80 [a]	EK60 / EK80 [a]	EK60 / EK80 [a]
Beam pattern	Split-beam	Split-beam	Split-beam
Transmitted frequency (kHz)	38	70	120
Pulse duration (µs)	1024	1024	1024
Transmit power (W)	2000	600	200
3 dB beam width	7°	7°	7°
Calibration sphere	Tungsten Carbide (6% Cobalt) (WC-Co)	Tungsten Carbide (6% Cobalt) (WC-Co)	Tungsten Carbide (6% Cobalt) (WC-Co)
Sphere size (Φ in mm)	38.1	38.1	38.1
Ping interval (in s)	3 / 7 [b]	3 / 7 [b]	3 / 7 [b]

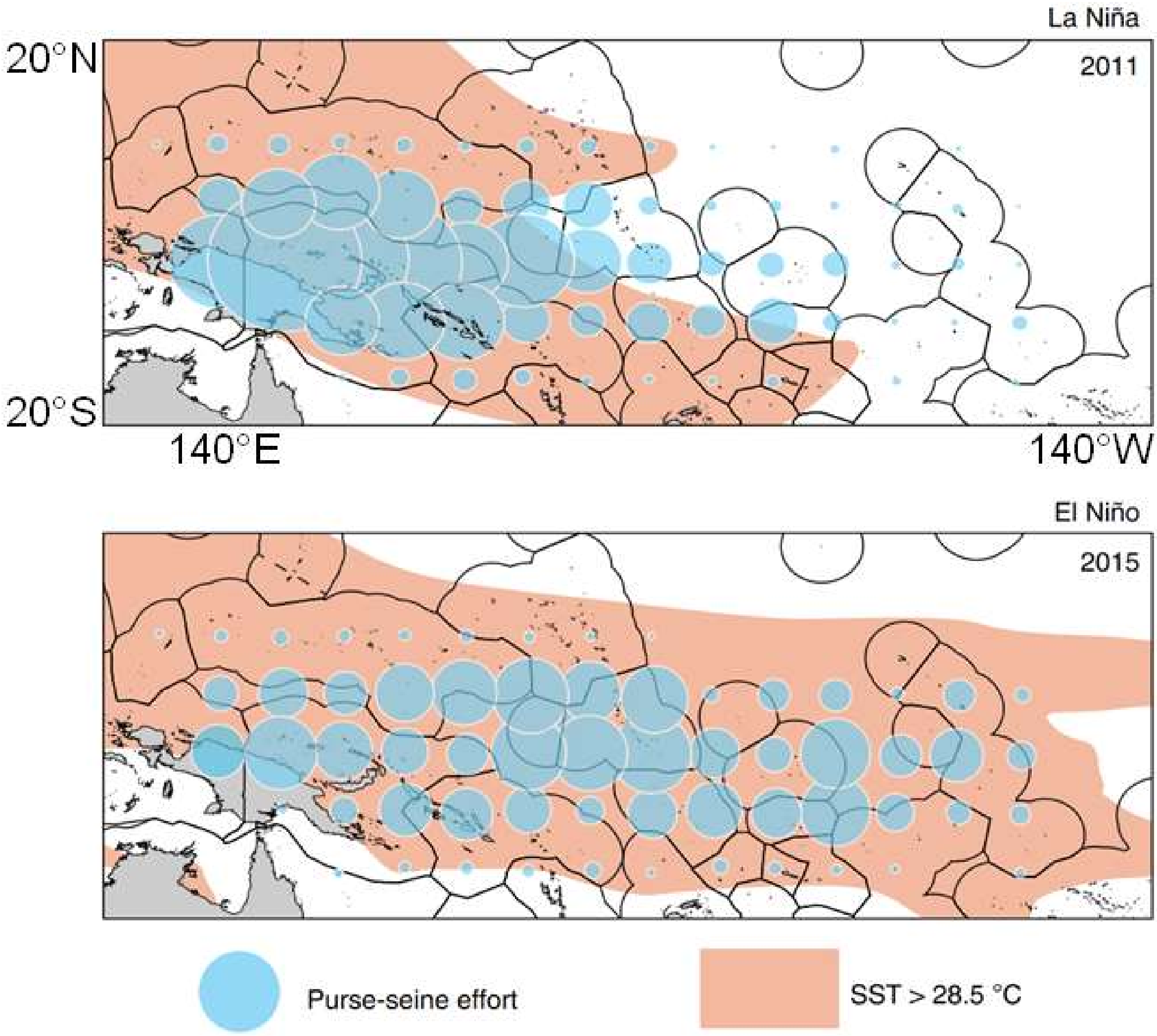


Figure S4. Purse-seine effort for Skipjack for two years (2011: La Niña, 2015: El Niño) on EEZ areas. Adapted from Bell et al.*, (2021).*

Reference:

Bell, J. D., Senina, I., Adams, T., Aumont, O., Calmettes, B., Clark, S., Dessert, M., *et al*. 2021. Pathways to sustaining tuna-dependent Pacific Island economies during climate change. Nature Sustainability, 4: 900–910.

1. MICRONEKTON ECOSYSTEMS CLASSIFIED WITH ACOUSTICS

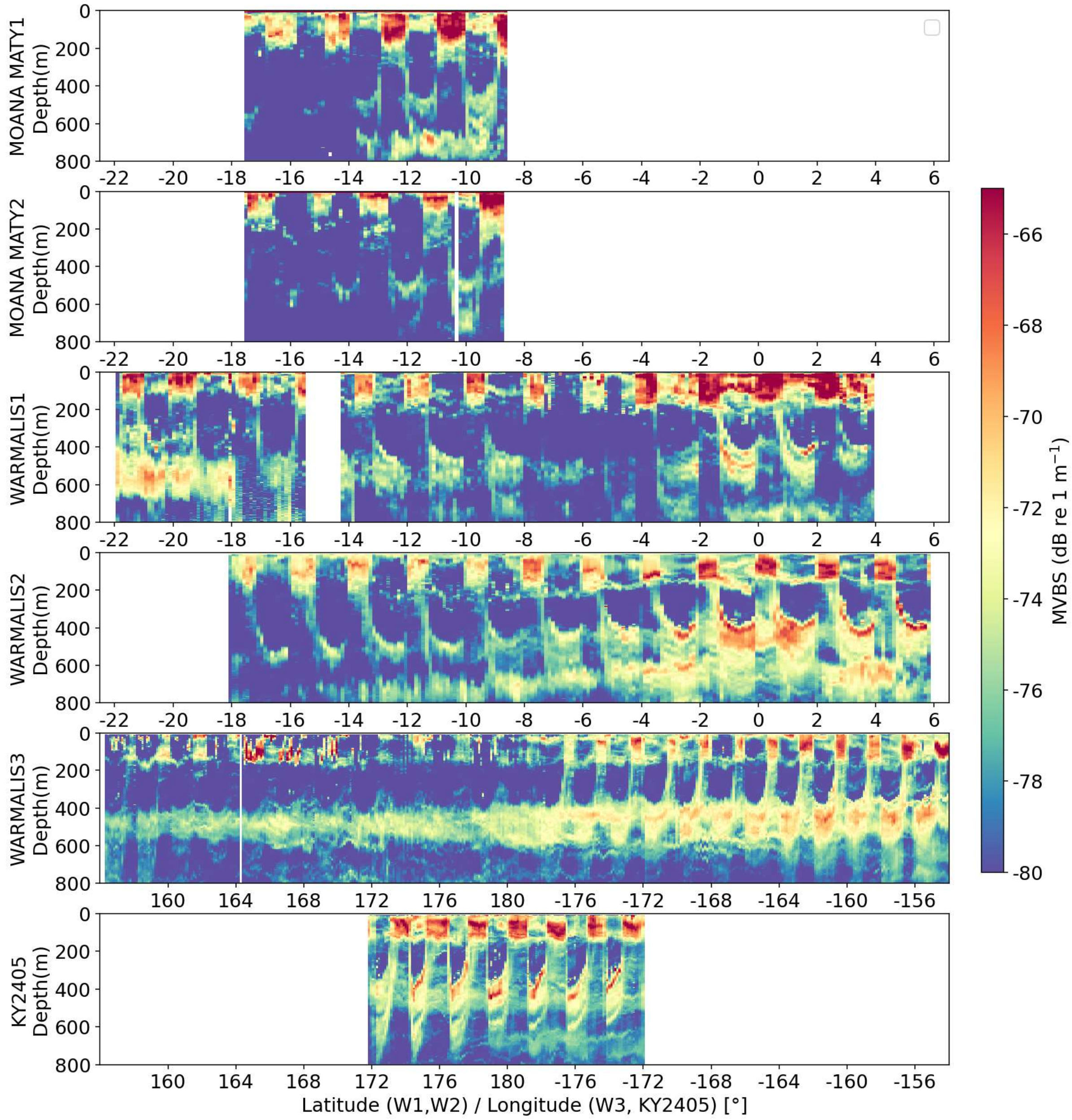


Figure S5. Acoustic density per volume unit (Mean Volume Backscattering Strength: MVBS) echograms at 38 kHz for each survey during transects as a function of depth (in m) and Latitude (in °) for MM1, MM2, W1, W2 and Longitude (in °) for W3 and KY2405. The resolution is 3 m vertically and 5 nmi horizontally. Blank spaces indicate areas where no data were acquired during the transects of these surveys.

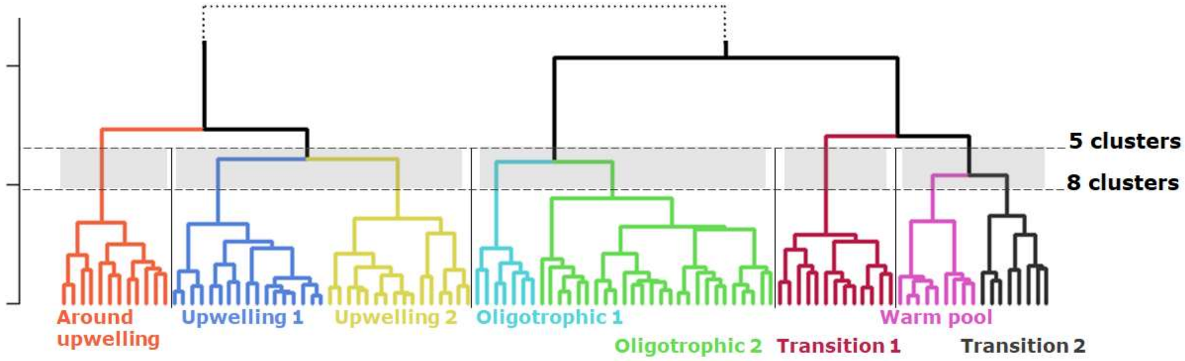


Figure S6. Classification tree of acoustic density profiles, with cuts at 5 and 8 clusters. We chose 8 clusters to highlight the warm pool in our study, but cutting at 5 clusters shows that some classes could be merged: the two oligotrophic and upwelling classes are derived from closely related branches. More surprisingly, the warm pool and transition 2 are in close branched despite being very different on Fig.5 (poster). This effect is probably linked to the concatenation of day and night profiles for clustering. In the warm pool, the epipelagic layer is strong during the day, whereas it is strong during the night in the transition 2 cluster. When concatenated, these day/night features create similar "total" profiles with low acoustic densities everywhere but in the epipelagic layer for one time period (day or night).

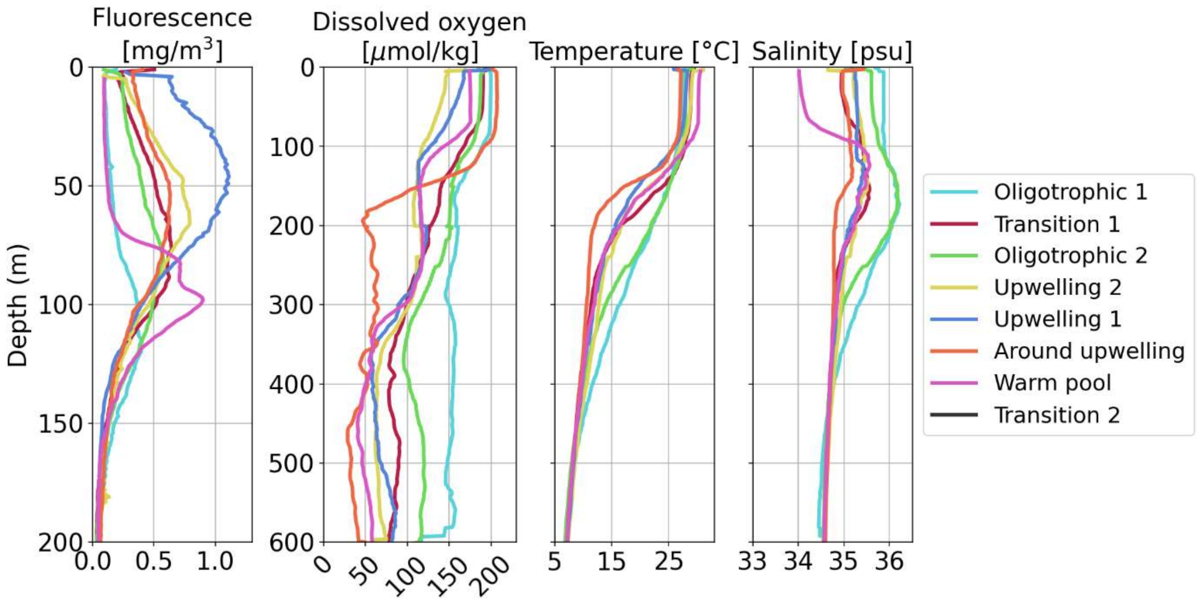


Figure S7. Mean fluorescence, dissolved oxygen, temperature and salinity CTD profiles in each cluster. Fluorescence is indicated only down to 200 m depth because it is <0.05 at depth>200m. All other variables are indicated on 600 m depth. No CTD data are located in the Transition 2 cluster.

2. LINK WITH ENVIRONMENTAL VARIABLES

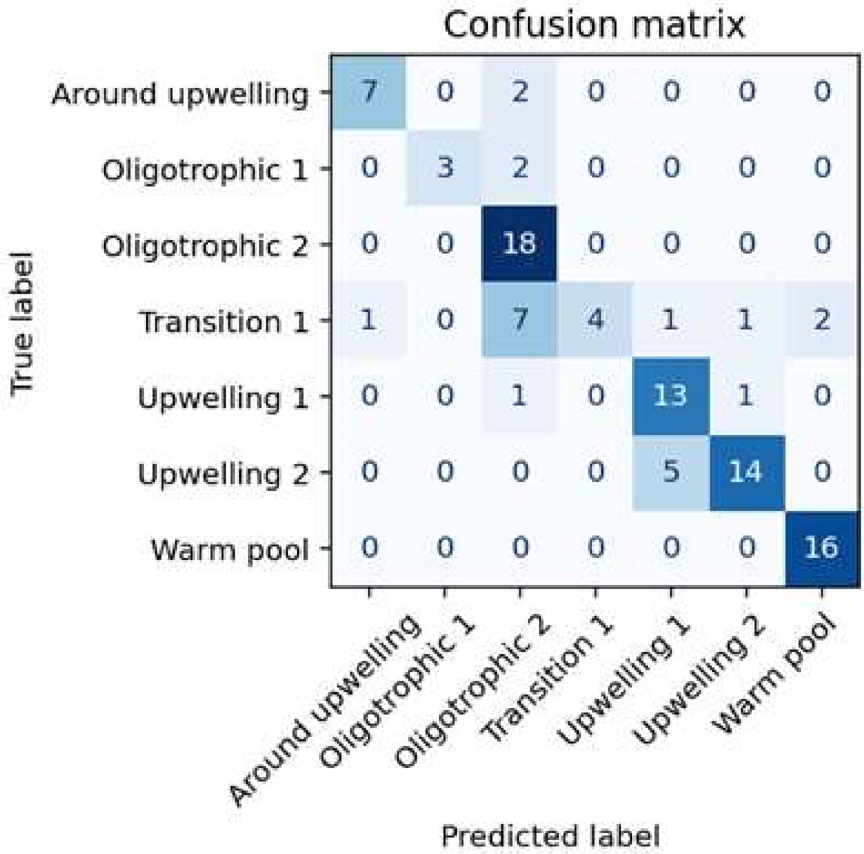
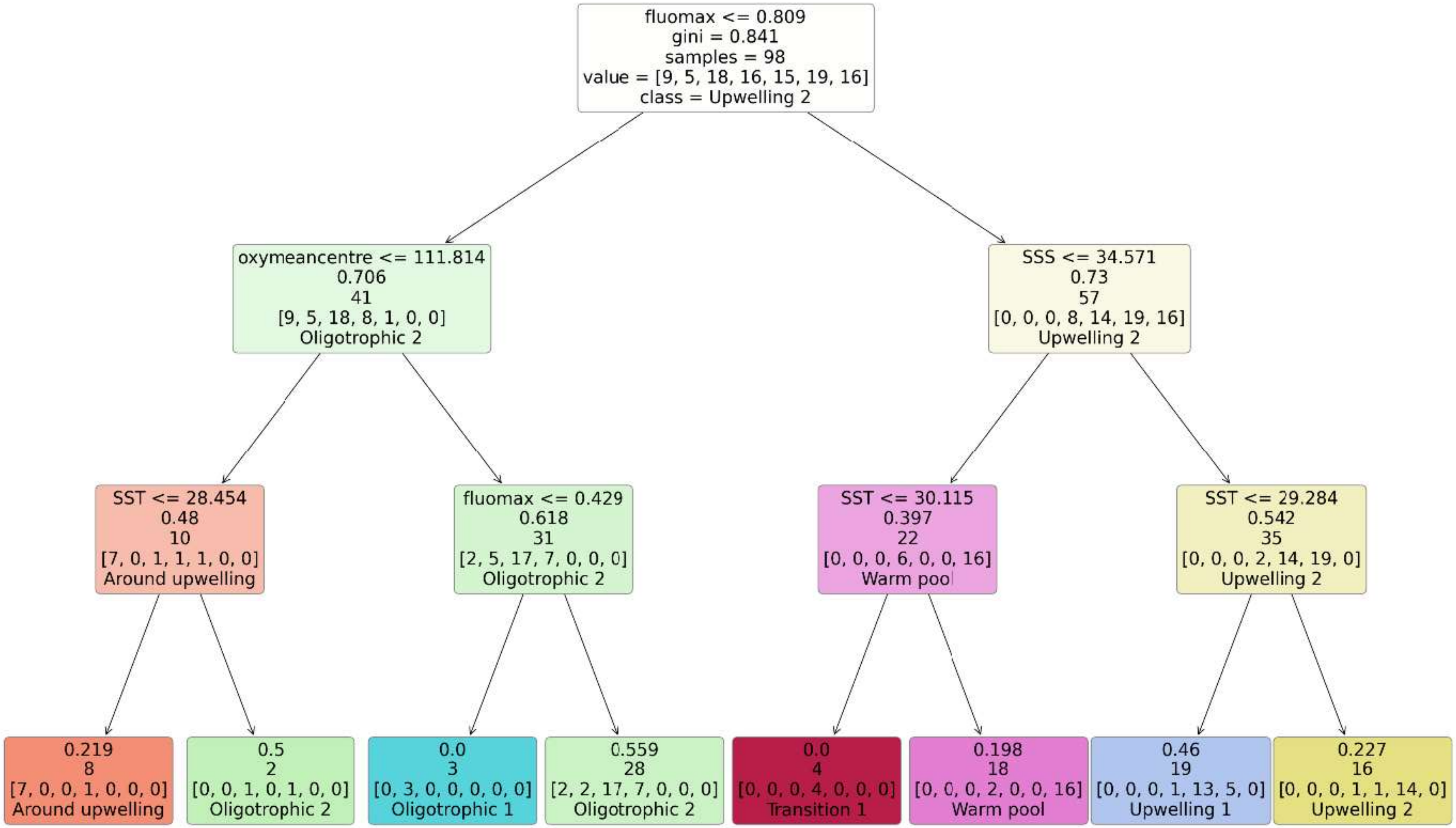


Figure S8. Confusion matrix of predicted cluster with decision tree applied to environmental CTD variables to define the performance of the decision tree algorithm.



fluomax <= 0.809
gini = 0.841
samples = 98
value = [9, 5, 18, 16, 15, 19, 16]
class = Upwelling 2
oxymeancentre <= 111.814
0.706
41
[9, 5, 18, 8, 1, 0, 0]
Oligotrophic 2
SSS <= 34.571
0.73
57
[0, 0, 0, 8, 14, 19, 16]
Upwelling 2
SST <= 28.454
0.48
10
[7, 0, 1, 1, 1, 0, 0]
Around upwelling
fluomax <= 0.429
0.618
31
[2, 5, 17, 7, 0, 0, 0]
Oligotrophic 2
SST <= 30.115
0.397
22
[0, 0, 0, 6, 0, 0, 16]
Warm pool
SST <= 29.284
0.542
35
[0, 0, 0, 2, 14, 19, 0]
Upwelling 2
0.219
8
[7, 0, 0, 1, 0, 0, 0]
Around upwelling
0.5
2
[0, 0, 1, 0, 1, 0, 0]
Oligotrophic 2
0.0
3
[0, 3, 0, 0, 0, 0, 0]
Oligotrophic 1
0.559
28
[2, 2, 17, 7, 0, 0, 0]
Oligotrophic 2
0.0
4
[0, 0, 0, 4, 0, 0, 0]
Transition 1
0.198
18
[0, 0, 0, 2, 0, 0, 16]
Warm pool
0.46
19
[0, 0, 0, 1, 13, 5, 0]
Upwelling 1
0.227
16
[0, 0, 0, 1, 1, 14, 0]
Upwelling 2

Figure S9. Decision tree to discriminate the seven clusters, using SST, SSS, Maximum of fluorescence and Mean dissolved oxygen in 100-500m. Only 7 clusters are predicted because no CTD are located in the last cluster ("Transition 2"). The Gini impurity index, the total number of sample and the main class represented are indicated for each step. Gini impurity index ranges between 0 and 1 and is a measure of how mixed or impure a dataset is. An Gini index of zero indicates a "pure" leaf or node composed of samples from a single class.

*The number of samples of each cluster at each step (nodes and leaf) is provided ("value" array). In the value array, the classes are ordered as follow: [**1:** Around upwelling, **2:** Oligotrophic 1, **3:** Oligotrophic 2, **4:** Transition 1, **5:** Upwelling 1, **6:** Upwelling 2, **7:** Warm pool].*