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# In situ multi-indicators or the management of pelagic fish resources in shallow water lagoons

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**Monitoring three shallow water Mediterranean lagoon** at several levels of eutrofication. Fishing operations were carried out during autumn 1999. Commercial catches were monitored the same year using monthly surveys on the three lagoons. In autumn, the fish flow and the current amplitude inside the lagoon channel have been recorded using the split beam echosounder. Daily cycles were considered in September, October and November which are known as a period of occurrence of migration and transfer across the channel between the sea and the lagoon. Additional multi-beam high-resolution sonar data were recorded simultaneously with echo sounder on two lagoons in September and November.

**Mediterranean shallow water lagoon**

**Variation of temperature and salinity, environmental data...**

**Lagoon channel « grau » and mobile acoustic laboratory**

**High resolution sonar (455 kHz) Data**

Infobases acquisition menu, Zoom on a small fish

**Split beam echo sounder Data**

**Fishing Data (commercial and scientific)**

**Hydrodynamics status of the channel**

**General Linear Model applied to current flow data analysed by Fourier series**

The results show that the data fit well with the model. The highest variations of the currents speed are recorded in Prevost lagoon, the lowest were recorded in Ingril lagoon

**Global eutrofication state**

Lagoon 1999	Or	Prevost	Ingril	Colour code	Level
Global state	Black	Black	Black	Black	Bad
Water column	Black	Black	Black	Black	Mediocre
Phytoplankton	Black	Black	Black	Black	Mediocre
Macrophyte	Black	Black	Black	Black	Mediocre
Biological potentiality	Black	Black	Black	Black	Good
Phosphor sediment	Black	Black	Black	Black	Excellent

**Fish species diversity and CPUE**

September 1999	CPUE	Dicentrarchus labrax	Mugilidae	Sparus aurata	Atherina boyeri	Anguilla anguilla
Or	575.32	0.00	3.66	3.71	7.34	200.45
Prevost	219.53	9.30	16.68	10.71	0.57	128.68
Ingril	325.57	118.00	3.99	0.41	2.40	158.74

  

Sept. 1999	Ingril	Or	Prevost
Nb. Species	15	16	13
Delta Plus	87,86	90,42	92,95
Lambda Plus	215,65	262,33	46,43

Five levels are fixed for the quality of the : water column, phytoplankton, macrophyte, biological potentiality and sediment

The Web based Lagoon Monitoring Network (RSL) allows inter-comparisons between 22 lagoons of the Languedoc-Roussillon Region (Ifremer-DEL)

**Fish fluxes across the channel**

**Fish behaviour**

**Fish (TS) and school (Dimensions) size**

The diversity are similar for Or and Prevost lagoon, higher in Ingril. The CPUE level that the more abundant species by lagoon.

Monthly commercial fishing data allow to follow the evolution of caught. It permit also to discriminate species caught by modality of size (large/small)

The split-beam echosounder allows to detect individual fish and an « echo counting » of the number of fish which cross the channel in both directions (up and downstream).

The upper set of graphics shows fish movements according to the time of the day. A continuous monitoring using echo counting allows to evaluate the biomass transfer between the lagoon and the sea but also their swimming speed for large target, small target generated wrong absolute speed measurements.

The histograms show the schools' fluxes. Upstream and downstream fluxes are much higher than net fluxes (upstream minus downstream fluxes), which suggest the « multi-pass hypothesis ». Therefore, the net fluxes seem to be an indicator of the real biomass transfer between the lagoon and the sea. Sonar record allows also kinematics studies, here we show two kind of swimming behaviour: very straight or more sinuous).

Both indicators and movement of fishes according to the time of the day can be assessed separately with reference to the schools and to the individual fish.

Data on 93 881 individual fish were recorded during 9 diel cycles across three lagoon channels. Acoustics data allow to assess indicators of fish behaviour, i.e. :

- flux direction: upstream and downstream
- spatial location in the channel lagoon
- period of observation (temporal variation in lagoon water temperature and salinity)
- diel behaviour: night, day, transition period, etc.

Split beam echo sounder allows to measure the Target Strength of an echo of individual fish. The multi-beam sonar gives the size of the fish school recorded :

- (i) the Target strength (dB) of the individual fish which can be related to fish length
- (ii) the school dimensions across (Cw) and along (Lw) the acoustic beams, and their shape (Lw/Cw)

**Discussion-Conclusion**

Data from acoustics surveys and fishing operations are an aid to - the analysis of anthropogenic effects on - the management of the pelagic fish population of shallow water lagoons. For such purpose several indicators of the state of the fish resources are performed. The method is versatile as regards its uses. The impact of eutrofication on fish resources can be measured at the level of a shallow water lagoon using specific indicators. In situ behaviour of individual fish and schools can be approached using comparative approaches. Improvement of the accuracy of biomass estimates using echo-echolocation or fishing methods required improving knowledge on fish behaviour as well as on lagoon ecosystem functioning. In such complex system often declared as protected area and important nurseries of numerous fishes, the variety of available indicator allows now the fisheries scientist to propose adapted sensitive responses to local authorities for « decision making ».