A 30-YEAR STUDY OF SEAGRASS BED FISH FAUNA SUBMITTED TO DIFFERENT WASTEWATER TREATMENTS (MARSEILLE, NW MEDITTEREAN)

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Abstract
The fish fauna of a *Posidonia oceanica* seagrass bed influenced by the Marseille sewage outfall was studied in summer and winter between 1980 and 2012, i.e. before and after improvements to the treatment of wastewater. A decrease in species richness, abundance and biomass was observed in summer, but not in winter. A modification of the trophic structure of the fish community also occurred in summer, with a decrease of zooplanktivores and labrids, and an increase in the relative importance of macrocarnivores.

Keywords: Teleostei, Posidonia, Sewage pollution, North-Western Mediterranean

Introduction
Posidonia oceanica seagrass beds provide shelter and food for a diverse fish community [1]. Like other Mediterranean coastal ecosystems [2], these seagrass habitats are subjected to human impacts, such as fisheries and sewage outfalls. The wastewaters of Marseille, the second largest city in France, remained untreated till 1987. They then received physico-chemical treatment that removed 70% of the particulate organic matter (OM). Since 2008, an additional biological treatment has been performed, retaining >90% of the dissolved and particulate OM. This raises the question 'Has the fish fauna associated with *P. oceanica* beds exposed to the sewage discharge been modified following these different treatment phases?'

Material and Methods
Fishes were collected with a small skid trawl in a *P. oceanica* bed located at Plateau des Chèvres (PC) near Marseille, a site frequently exposed to the wastewater of the Cortiou sewage outfall. Standardized trawls were conducted by day and night in summer and winter in 1980 prior to any wastewater treatment [3], in 2000 three years after the primary treatment phase [4], and in 2012 four years after the establishment of the secondary treatment plant.

Results and Discussion
The total number of fish species collected at PC has decreased slightly between 1980 (38 spp) and 2000 (32 spp), and was much lower in 2012 (25 spp). Labridae, Sparidae, Serranidae and Scorpaenidae remained the dominant families, but the diversity of Gobiidae, Syngnathidae, Mullidae and flatfishes was reduced. A significant decrease in fish abundance (70%) was observed in summer between 1980 and 2012 (ANOVA, $p<0.001$), while no difference in abundance was recorded in winter ($p>0.05$) (Fig. 1). The high seasonal variation in fish abundance observed in 1980, diminished over time and was nonexistent by 2012. Similar patterns were observed for fish biomass.

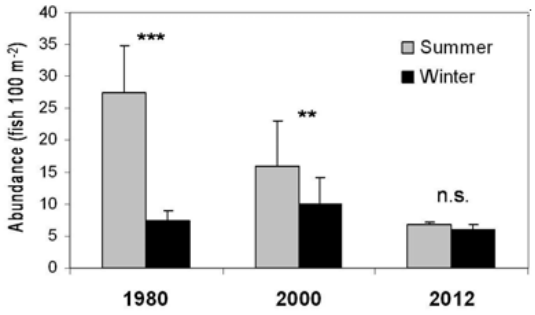

Fig. 1. Mean fish abundance in summer and winter at Plateau des Chèvres during years corresponding to different wastewater treatments.

The trophic structure of the fish community was modified only in summer. Mesocarnivores-1 (labrids) [5], which dominated in 1980 (46%), represented only 26% of the biomass in 2012. The relative importance of zooplanktivores also largely decreased from 1980 (25%) to 2012 (11%), whereas the biomass of macrocarnivores increased significantly (from 19% to 52%). While the decline in mesocarnivores-1 affected all the species, the decline in zooplanktivores was largely linked to the disappearance of the omnivorous *Boops boops*, which prefers waters rich in OM. The increase in macrocarnivore biomass was mainly due to *Scorpaena porcus*, and to *Diplodus sargus* and *D. vulgaris* for mesocarnivores-2. However, no modification of the trophic structure was observed in winter, where mesocarnivores-1 always dominated the community (55-60%), followed by macrocarnivores (22-27%) and zooplanktivores (9-15%).

Although the species richness of the *P. oceanica* fish fauna has declined since 1980, the improvement of wastewater treatments resulted in a decrease in fish abundance and biomass only in summer. The decrease in OM inputs resulted in the decline of species with a low trophic level and an increase in higher trophic level species. Thus, reductions in OM have resulted in a fish community that is now more similar to the typical *P. oceanica* seagrass fish communities of the region.

References
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