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How to assess the effects of protection on fish? The Port-Cros National Park and the first underwater visual censuses in the Mediterranean Sea

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Abstract. The first underwater visual censuses (UVC) in the Mediterranean Sea were performed in the Port-Cros national Park in 1973, following a method developed specifically to assess the effect of protection on fish assemblages. This method was published in the first volume of the Scientific Reports of the Port-Cros national Park in 1975. Since then, the use of UVC techniques has become widespread for coastal fish community studies in the Mediterranean Sea.

Keywords: Marine protected areas (MPA), Coastal fish communities, Fish monitoring methodology, Underwater visual census.

Résumé. Comment estimer les effets de la protection sur les poissons ? Le Parc national de Port-Cros et les premiers comptages visuels sous-marins en Méditerranée. Les premiers comptages visuels sous-marins en Méditerranée ont été réalisés dans le Parc national de Port-Cros en 1973, suivant une méthode développée spécifiquement pour étudier les effets de la protection sur les peuplements de poissons. Cette méthode a été publiée dans le premier volume des Travaux scientifiques du Parc national de Port-Cros en 1975. Depuis, l'utilisation des techniques de comptages visuels pour l'étude des communautés de poissons côtiers s'est généralisée en Méditerranée.

Mots-clés : Aires marines protégées (AMP), Communautés de poissons côtiers, Méthodologie du monitoring des poissons, Comptages visuels en plongée.

Introduction

"Once upon a time", in the early1970s', two scientists were asked by the Port-Cros National Park (PCNP) for a method of evaluation of fish assemblages in the marine protected area (MPA) of the Park, the first MPA in the Mediterranean Sea, declared in December 1963. But how to proceed when catching fish is forbidden and when you know that data on

both fish local diversity and abundance are biased by traditional fishing devices? SCUBA diving was commonly used by fish ecologists working on tropical coral reefs and recognized as the best, and often the only one possible, method of studying fish ecology and behaviour. Combining our experience of Mediterranean and coral reef fish ecology with those of the few coral reef ichthyologists available in the literature at that time (Brock, 1954; Bardach, 1959), we proposed an easy and accurate method of underwater visual census (UVC) of coastal fish assemblages. Fish species were recorded on plastic sheets by swimming at a constant speed along 50 m long x 5 m wide transects parallel to the coast. The abundance and size of the individuals were noted using pre-established discrete classes, 5 classes of abundance (1, 2-3, 5-10, 10-50, >50 individuals) and 4 size classes (small, medium, large, very large individuals), allowing for estimating both fish density and population size structure. We recommended also noting the reaction of fish towards the diver to estimate human-induced perturbations on fish behaviour, in particular the impact of spearfishing. This first and seminal paper for the Mediterranean Sea, and more generally the non-tropical seas, was published in the first volume of the Scientific Reports of the Port-Cros national Park (Harmelin-Vivien and Harmelin, 1975).

First applications and development of the method

1970's - The first fish surveys in Port-Cros and other Mediterranean islands

This UVC method was first applied during the "Crevette 73" campaign performed in PCNP waters in September 1973. Organized by the CNEXO[1] and FFESSM[2], the "Crevette 73" campaign gathered scientists, sport divers (including two spearfishing champions) and PCNP rangers - all good divers and trained in Mediterranean fish species identification. The first qualitative and quantitative inventory of fish communities in PCNP waters, while partial, was established during this campaign. At that time, only 7 dusky groupers were recorded, all around the islet of La Gabinière in the south of Port-Cros. A second survey ("Cometes 74") using the same UVC method was conducted in May 1974 around three islands submitted to different levels of protection: Port-Cros, Levant and Porquerolles. Then, in September 1975, a third survey ("Cometes 75") was conducted at Scandola, Corsica, by the same team just before the establishment of the Natural Reserve of Scandola in December 1975, included in the Regional

[1] CNEXO : Centre National pour l'Exploitation des Océans, now IFREMER (Institut Français de Recherche pour l'Exploitation des Mers).
[2] FFESSM : Fédération Française d'Etudes et de Sports Sous-Marins.

Natural Park of Corsica and now UNESCO World Heritage site. These first visual censuses now serve as a 'reference' level of fish population abundance in these sites to assess the effectiveness of protection across time.

1980's – A first workshop on UVC and the start of systematic surveys in PCNP

In June 1984, the Centre d'Océanologie de Marseille organized a first workshop on underwater visual censuses of fish assemblages, gathering French and Belgium scientists to discuss on UVC techniques, their efficiency and reliability. Theoretical discussions took place at Sausset-les-Pins in the Parc Régional marin de la Côte Bleue, including the presentation of different methods adapted to fish species, environments or ecological questions, with a discussion of the problems related to these methods and linked to SCUBA diving, fish behaviour, habitat structure and diver experience among others. Then, practical exercises and experimentations were performed in the waters of PCNP to test the reliability of some techniques or improve the efficiency of some others depending on the ecological problem addressed. The results of these discussions and experimentations represented the first published synthesis of UVC techniques for the Mediterranea Sea (Harmelin-Vivien *et al.,* 1985). In the early 1980s', UVC were also used to first assess the effect of protection on fish assemblages in the Banyuls-Cerbère marine reserve, declared in 1974 (Bell, 1983).

PCNP was also the place where systematic surveys of vulnerable emblematic fish species like the dusky grouper, *Epinephelus marginatus* (Lowe, 1834) and the brown meagre, *Sciaena umbra* Linnaeus, 1758 (Fig. 1), were first conducted using appropriate UVC techniques (Harmelin, 1984). The assessment of the dusky grouper started in 1983 around the islet of La Gabinière through the impulse of PCNP rangers with the help of local diving clubs (Robert *et al.,* 1987). Ten years later, in 1993, the population of dusky grouper was censused in the whole PCNP waters, all around the islands of Port-Cros and Bagaud, by the GEM[3] team and, since then, continues to be studied every 3 years (Harmelin *et al.,* 2010). In the period from 1973 to 2011, the population of the dusky grouper in Port-Cros MPA has grown from 7 individuals to more than 700 and is still continuing to increase, testifying of the long term effect of protection! The systematic survey of the brown meagre started in 1990 (Harmelin and Marinopoulos, 1993). Due to the efficient protection existing in the PCNP, the population of this vulnerable species was multiplied by 6 in 15 years (Harmelin and Ruitton, 2007; Harmelin, 2013). These two examples demonstrated clearly

[3] GEM : Groupe d'Etude du Mérou

that MPAs are efficient tools for the replenishment of fish populations, but also that it is a long term process since fish populations are still increasing in PCNP, even after 50 years of protection. Mediterranean environments have been so depopulated by fishing for such a long period that they are far from recovering their carrying capacity.

Figure 1. Census of the brown meagre in a Mediterranean marine protected area (Scandola, Corsica). Photo © J.G. Harmelin.

1990's and later - From the first EU program to the common use of UVC in the Mediterranean Sea

In the 1990s', the use of UVC for studying Mediterranean littoral fishes and assessing the role of MPAs as a tool for the replenishment of fish communities and the management of fishing resources, was widely accepted and used by the scientific community. Several programs, in which UVC techniques were applied, were funded by the European Union and performed in Spain, France and Italy. The program SetMort (1993-1996, Coordinator Enrique Macpherson) was a study of the settlement and mortality of *Diplodus* species in protected and unprotected areas (Macpherson *et al.,* 1997; Vigliola *et al.,* 1998), while the program BIOMEX (2003-2006, Coordinator Serge Planes) focussed on the assessment of biomass exportation from marine protected areas and its impacts on fisheries in six MPAs of the western Mediterranean Sea (Harmelin-Vivien

et al., 2008). An international workshop on fish visual census techniques and their use in assessing and monitoring fish assemblages and their environment was held at Ustica in June 1997, gathering scientists working on Mediterranean and coral reef environments (Vacchi *et al.,* 1999). Since then, UVC were largely used not only to study the effect of MPAs on fish assemblages, but also to improve our knowledge on coastal fish communities all around the Mediterranean Sea (e.g. Harmelin, 1987; García-Rubies and Zabala, 1990; Francour, 1994; Harmelin *et al.,* 1995; Letourneur *et al.,* 2003; Bariche *et al.,* 2004; García-Charton *et al.,* 2004; Guidetti *et al.,* 2005; Seytre and Francour, 2008, among many others).

UVC techniques represent the most efficient methodology to collect data on fish assemblages with the minimal impact on the environment, meeting conservation aims in marine reserves and allowing long term surveys with a minimum of technology and data processing. Video-recording, which is developing particularly on coral reefs (Pelletier *et al.,* 2011) and kelp forests (Francour *et al.,* 1999), may provide complementary and useful information in the study of fish behaviour and temporal variation of the community structure. However, this technique implies a substantial involvement in data processing (Stobart *et al.,* 2007).

Port-Cros national Park has been then at the origin of the development and deployment of visual census techniques for assessing and monitoring fish assemblages in the Mediterranean Sea. PCNP is not only the oldest Mediterranean MPA, but also the place where the longest underwater surveys of dusky grouper (30 years) and brown meagre (22 years) continue to be performed, and still brings new insight in MPA management through its scientific activities.

“And fourty years later, the two scientists had many scientific descendants”... This paper is dedicated to all the scientific colleagues and MPA rangers who trusted in UVCs and contributed to develop fish ecology and MPA management in the Mediterranean Sea. They are too many to be individually cited, but they will recognize them!

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