1. INTRODUCTION

The marine system is arguably more complex than any other ecosystem with highly interrelated processes between its physical, chemical and biological components. Its study and management requires information on all processes and an understanding of the structure and function of the systems. In addition, the increasing amount of national, supra-national and global legislation and agreements is producing the need to develop tools for the sustainable use of the marine environment, in particular management for conservation and biodiversity in order to protect habitat integrity. The paradox is that the scientific community is mostly working on very detailed and narrower aspects whereas; the managers require a holistic and ecosystem approach, not necessarily at a very high level of detail. This calls for multidisciplinary approaches to MPAs research and resource management.

The first MPA, (Fort Jefferson Marine Sanctuary, Florida US) was established in 1932. However, it was until 1962 with the First World Conference on National Parks Seattle, when countries were invited to create marine areas and parks. From there on, the number of marine protected areas has raised to around one and a half thousand, which have been established with different aims (Kelleher et al. 1995). In the Mediterranean the first MPA was the Port-Cros National Park (France) established in 1964. Most of the Mediterranean MPAs were created from the 80's onwards, principally in France, Spain and Italy (Cognetti 1990). In general, MPAs have been proposed throughout the world as an optimal way to protect marine ecosystems and associated fisheries (Lubchenco et al. 2003). Although Europe, with 800, has the highest number of MPAs, these are small and many only offer reduced levels of protection.

To be effective, MPAs have to be properly managed. This task includes defining objectives and goals from the outset, site selection, zoning, planning and implementing a surveillance and enforcement system, as well as monitoring actions (Kelleher 1999). In order to determine the validity of MPAs as fisheries management tools it is essential to evaluate the MPA performance by means of continuous monitoring.

Indicators are increasingly being developed and used as management tools to address environmental issues (OECD 1991, OECD 1994; EEA 1999 a y b). Environmental reports are widely produced using indicators to illustrate the conditions and trends of varied features such as fish stocks or the emissions of greenhouse gases (ANZECC 2000; Lehane et al., 2002). In addition, the UK and other countries use classification schemes to assess the water quality for rivers, estuaries and coasts (SEPA 1995).

Indicators are also used to assess the effectiveness of the actions and policies implemented, by measuring progress towards environmental targets (OECD 1994; DEFRA 2003). In this sense; indicators can contribute in the monitoring of the effectiveness of MPAs. Indicators are measures used to quantify or qualitatively describe phenomena that are not easily measured directly, but which society considers valuable to monitor over time (Boyd & Charles, 2006).

Waltz (2000) and Meadows (1998) listed the characteristics that indica tors should present: 1) to have an agreed scientifically sound meaning, 2) to be representative of an important environmental aspect for the society, 3) to provide valuable information with a readily understandable meaning, 4) to be meaningful to external audiences, 5) to help in focusing information necessary for answering important questions, and 6) to assist decision-making by being efficient and cost-effective in terms of use. Therefore, the selection of a set of indicators must ultimately provide information that can be understood by the managers and stakeholders, and provide them with a base for decision making. However before selecting and choosing indicators it is necessary to have the cause-effect relationships clear, and an established framework from which the indicators can be selected.

One of the techniques available in defining indicators is the driver-pressure-state-impact-response (DPSIR) framework. This methodology works well at simplifying the complexity of environmental management and makes communication among policy makers, scientists and the general public easier and hence it should improve cooperation. The DPSIR conceptual framework was suggested by Environment Canada and the OCDE.[1] Its structure is being used more and more to select indicators in the implementation of the European Water Framework Directive (e.g. Jeunesse et al. 2003; Mysiak et al. 2005; Borja et al. 2006) and in coastal zone studies (e.g. Cooley *et al.* 1996; Chesapeake Bay Program/USEPA 1999; EEA 1999; ME 2001; Casazza *et al.* 2002 a y b; Elliott 2002; Jorge *et al.* 2002; Silva and Rodrigues 2002;

1. http://www.ec.gc.ca/

Nunneri and Hoffman 2003; Picollo *et al*. 2003) as well as in fisheries management (Mangi *et al*. 2006).

The DPSIR scheme of indicators is a flexible model that can be adapted to the necessities of specific programmes to stress the different indicator types. This method is appropriate for the selection of indicators because it allows a better understanding between the results from an action developed and the effects produced in the different system components (e.g. the fisheries, the socio-economics), and hence is more suitable in the identification and analysis of indicators.

The purpose of this document is to identify, define and discuss basic indicators that can be used to assess the effectiveness of MPAs to conserve and restore fisheries and marine biodiversity. Specific goals include: a) to select the main factors affecting the fisheries other activities developed in the area and marine biodiversity, including their descriptors and their derived consequences; b) to define a conceptual model relating the selected components; c) to propose a set of parameters that can potentially be used as indicators at each level in the DPSIR framework.