EnviEFH (022466)
Environmental Approach to Essential Fish Habitat Designation

Publishable final activity report

In the last decade, the degradation of aquatic habitats essential for sustainable fish production has become a growing concern everywhere in the world. The importance of such essential fish habitats (EFH) – which can be defined as the waters and substrata necessary for fish to spawn, breed, feed, or grow to maturity – has since then been widely recognised. EFH mapping and designation can support the spatial component of fisheries management, a component that has often been overlooked in previously enforced fishery policies. With the introduction of the ecosystem-based approach to fisheries management in the Common Fisheries Policy (Council Regulation (EC) No 2371/2002), however, the clear identification and protection of essential fish habitats and their inclusion in new fishery policies is now required.

The EnviEFH Project (Environmental Approach to Essential Fish Habitat Designation) is based on the latest advances in EFH mapping and identification, which are characterized by a broad approach to EFH designation including all the physical, chemical and biological properties of marine areas and the associated sediment and biological assemblages that sustain fish populations throughout the various stages of their life cycle. Under the ecosystem approach to fisheries management, species life history information is introduced in an integrated EFH mapping effort including the mapping of ocean production processes, species spawning, nursery and feeding aggregations, over-exploited areas and alternative fishing grounds under the specialized development of a comprehensive EFH Designation Tool.

The overall objective of the EnviEFH project is to facilitate the spatial component of fisheries management, which primarily includes the proper designation of Essential Fish Habitats and their protection through new fisheries policies. Fishery management goals cannot be achieved if the managed species do not have sufficient suitable habitat available. The identification and spatiotemporal mapping of EFH represents the main scientific task of the spatial component of fisheries management. The main objective of the EnviEFH project is to facilitate the spatial component of fisheries management by applying an environmental approach to the mapping and designation of essential fish habitats in the Mediterranean Sea. The specific objectives are as follows:

1. To collate and use existing environmental and biological data in order to develop the basis for an Essential Fish Habitat Designation Tool that will facilitate the spatial component of fisheries management;

2. To identify and map the spatiotemporal distribution of ocean production processes that affect species distribution and create favouring habitats throughout the various stages of species life cycles;

3. To introduce species life history information to the description of environment-species interactions in order to identify spawning, nursery and feeding aggregation regions as well as over-exploited areas and alternative fishing grounds;

4. To validate and disseminate project research results to fisheries managers and scientists as well as to coastal fishing communities through the Internet, hardcopy habitat maps and stakeholder workshops.

During the first year of the project, an extensive inventory of available environmental and fisheries datasets was made and acquired data were organized in a commonly geo-referenced GIS database (i.e. a Geographic Information Systems database, linking data to locations). Specifically, environmental data, including time series of satellite imagery for the whole Mediterranean basin (e.g. sea surface temperature, chlorophyll-a, photosynthetically active radiation, altimetry, salinity and bathymetry) as well as fisheries surveyed data, including data on small pelagic (e.g. sardine, anchovy), large pelagic (e.g. swordfish, small tuna), demersal species (hake, shrimp) and certain egg-feeding parasites (e.g. *Mnemiopsis*) were uniformly processed under GIS. The oceanographic part of the GIS database was used to derive time series maps of certain oceanic processes that affect species distribution and create favouring habitats throughout the various stages of species life cycles (e.g. thermal fronts, marine productivity hotspots, upwelling). The biological part of the GIS database was then combined with the environmental data: each fishery surveyed point from acoustic, plankton, and trawl surveys was linked to each of the assembled environmental parameters. These joined fisheries-environmental datasets provided the basis for the development models that allowed for the deduction of minimum and maximum environmental ranges preferred by the surveyed species. After deducting these ranges, they were applied in satellite images, which enabled the modellers to map those areas that included the deducted environmental ranges of all environmental parameters, thus giving an overview of the Essential Fish Habitats for the studied species in the Mediterranean.

Initial analysis produced interesting results, revealing the spatiotemporal distribution of EFH of various species and life stages. Points of interest included the EFH mapping between Western and Eastern Mediterranean for small pelagic species where, although different areas from the oceanographic perspective, EFH environmental descriptors were very similar in both areas. In addition, the EFH mapping of *Mnemiopsis*, an anchovy egg-feeding parasite, for the whole Mediterranean basin was based on surveyed data from the north-eastern Mediterranean but it revealed the main anchovy spawning areas in western Mediterranean as well. Finally, verification of anchovy habitat environmental descriptors based on north-eastern Mediterranean surveys for 2003-2005 were applied during the 2006 survey and the forecasted EFH map was very similar with the surveyed data, a case that applies to various species groups.

During the second year of the project, EFH mapping was finalised using fishermen input and other statistical techniques, while the EnviEFH Consortium produced a Special Issue on Essential Fish Habitats in the Mediterranean through the international journal of aquatic sciences *Hydrobiologia*. This issue includes a publication series of 21

contributions dealing with EFH mapping of various species such as anchovy, sardine, hake, shrimp, squid, and swordfish as well as explaining the teleconnection patterns of largescale phenomena (e.g. North Atlantic Oscillation) to corresponding local environmental variation in the Mediterranean. In addition, a 20-minute educational video was finalized and disseminated through CretAquarium, the Hellenic Center for Marine Research aquarium facility.

By using new concepts in fisheries management (the spatiotemporal mapping of EFH as part of the ecosystem-based approach) and new scientific developments (Remote Sensing, Spatial Analysis and GIS technologies), EnviEFH provides the means that enhance the efficacy of technical measures: the ability of the Essential Fish Habitat Designation Tool to identify spawning, nursery and feeding aggregation regions as well as over-exploited areas and alternative fishing grounds will contribute to healthy marine ecosystems by allowing the growth of an economically viable and competitive fisheries industry. EnviEFH products are useful for the application of the Council Regulation (EC) No 1967/2006 "concerning management measures for the sustainable exploitation of fishery resources in the Mediterranean Sea", which was adopted on December 21, 2006, and requires Members States to draw up a list of protected areas in which fishing activities are restricted for biological reasons.

The activities of the EnviEFH project (Table 1) were organised through two plenary meetings and several working-group workshops among the EnviEFH Consortium, which included the following research centres, universities, non-governmental organisations and enterprises (Table 2).

Table 1: Summary of EnviEFH deliverables.

DELIVERABLE	DESCRIPTION
D1-D14 (Dedicated Internet Node)	established using HyperText Macro Language (HTML) and Javascript programming. The node includes all EnviEFH components and is under continuing update and enrichment even after the termination of the project on February 29, 2008.
D2 (Project Presentation Leaflet)	includes major information about the EnviEFH project on a 3-page cumulative information document.
D3 (Inventory of Relevant Data Sources)	includes a table of assembled and organized information on species, their life stages and environmental parameters that are available to the EnviEFH project.
D4 (Final Plan for Using and Disseminating Knowledge)	includes the activities of the project towards dissemination of research outputs to stakeholders and the general public.
D5-D10 (GIS Oceanographic and Fisheries Database for the Mediterranean Sea)	include all datasets available to the project in a GIS database. The database was developed on ESRI's ArcGIS software and includes commonly geo-referenced fisheries and oceanographic datasets and derived products.
D6-D11 (Time series Maps of Upwelling, Thermal Fronts and Marine Productivity Hotspots)	includes a series of major ocean processes digital maps that influence the distribution of marine species.

	Maps were derived through combined analysis of several satellite imagery products.
D7-D12 (Time series of Essential Fish Habitat Maps)	derived through statistical and GIS techniques applied on fisheries and environmental datasets.
D8-D13 (EFH Designation Tool)	includes a combined set of 4 tools developed in ESRI ArcGIS (offline) ESRI ArcView (offline), ESRI ArcServer (online) and ESRI MapObjects (offline) technologies. These tools are combined under one integrated tool and target a variety of users, and it is freely distributed through the EnviEFH website.

Table 2: The EnviEFH Consortium.

PARTICIPANTS	SCIENTIFIC TEAMS	SUBCONTRACTORS
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