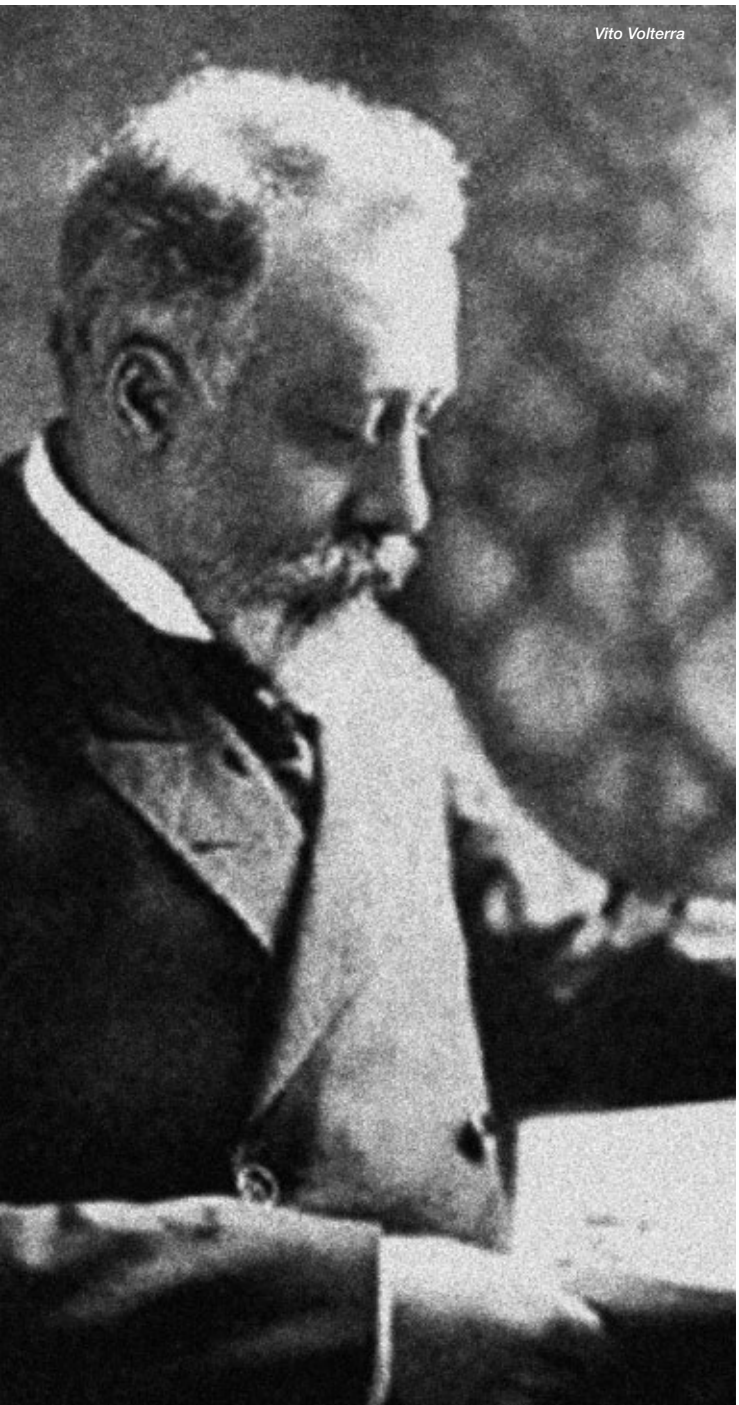
Fifth section

Research in fisheries and aquaculture



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Chapter 15

Research in responsible fisheries

15.1 Research in sustainable fisheries

Cataudella S.

In the early 20th century, the need for scientific research sustaining management options on how to regulate fisheries emerged. Today, the need for an independent research in fisheries is at the base of European policies but is also essential to operate correct management options, to measure *ex post* the impacts of the decisions taken.

Responsible fisheries requires independent and quality research projects, with data collected with correct sampling protocols, shared methodologies for data analysis, suitable models to improve the foreseeable capacity and to speed up and make more profitable the achievements of research results.

The independence of research is a first aim which has only been partially achieved; much work still has to be done, in particular to guarantee the access to research to all those who are interested in it, though limiting pressures by lobbies by both those who would like to close fisheries down, and those who would like to fish with no rules.

Italy contributed to research in fisheries with continuity, as reported in the various chapters of this book. Government laws enabled the MiPAAF; today MiPAAF, to carry out three-years plans with funding resources, in order to favor coordination among research groups at a national level.

Coordination was necessary as in Italy research in fisheries has never been concentrated in one single research institute. The General Directorate for Fisheries and Aquaculture therefore grouped together coordinated teams who learned to work together, and with the new generations created a national system made of Universities, CNR, ICRAM (ISPRA at present), research cooperatives for fisheries, trade unions and ship owners.

The Italian system for research in capture fisheries and aquaculture was born by the coordination of the research teams involved on the first surveys of demersal resources and the first research projects in aquaculture. It educated scientists to work in coordinated teams.

In this framework, weaknesses are also present, but it is evident that a diffused network is present in Italy in all GSAs and that the access to knowledge, to research and to its results is guaranteed to all the experts in it.

Among the new products of Italian research in fisheries the following examples can be cited: the GIS system for Italian fisheries and the ItaFishNet network.

Italian Fisheries GIS

Among the tools used to develop the new policy of Italian fisheries and to make it more coherent with the CFP, the MiPAAF realized in 2009 the Italian Fisheries GIS, with the support of the public and private institutes specialized in the collection of fisheries data.

In its role of territorial information system Fisheries GIS represents the tool for the collection, registration, analysis, visualization and draw back of information deriving from georeferenced data on the different fisheries components (fleet, fishing effort, productions, living resources) including the cartography and the characteristics of the marine environment (figure 15.1).

All the data acquired by the system have a certified origin (national public administration, experimental fishing surveys with methodologies shared at community level, reference cartography of the Istituto Idrografico della Marina and Istat, collection of data according to EU regulations) and were inserted in a geodatabase that established the functional relationships between the different groups of data and enabled the production of new information through statistical methodologies and data analysis (figure 15.2).

By including georeferenced data on the environmental characteristics of Italian Seas (bathymetry and depth, spatial distribution of sediments and bethonic biocoenosis, surface temperature and water productivity, etc.) and the reference cartography for protected areas (Marine Protected Areas, Zone of Biological Protection, Sites of Community Importance (SCI), Fisheries GIS also permits to consider the ecosystemic framework.

The system represents a tool with great flexibility of analysis and integration of data at different spatial and time scales, in order to be able to support the needs that the public administration will have to face in the future and the information that has to be regularly collected according to EU obligations.

Fisheries GIS will also be on line, and some of the information will be made available through a graphic interface, that will lead the user in the exploration of fisheries information within the national spatial scale (figure 15.3).

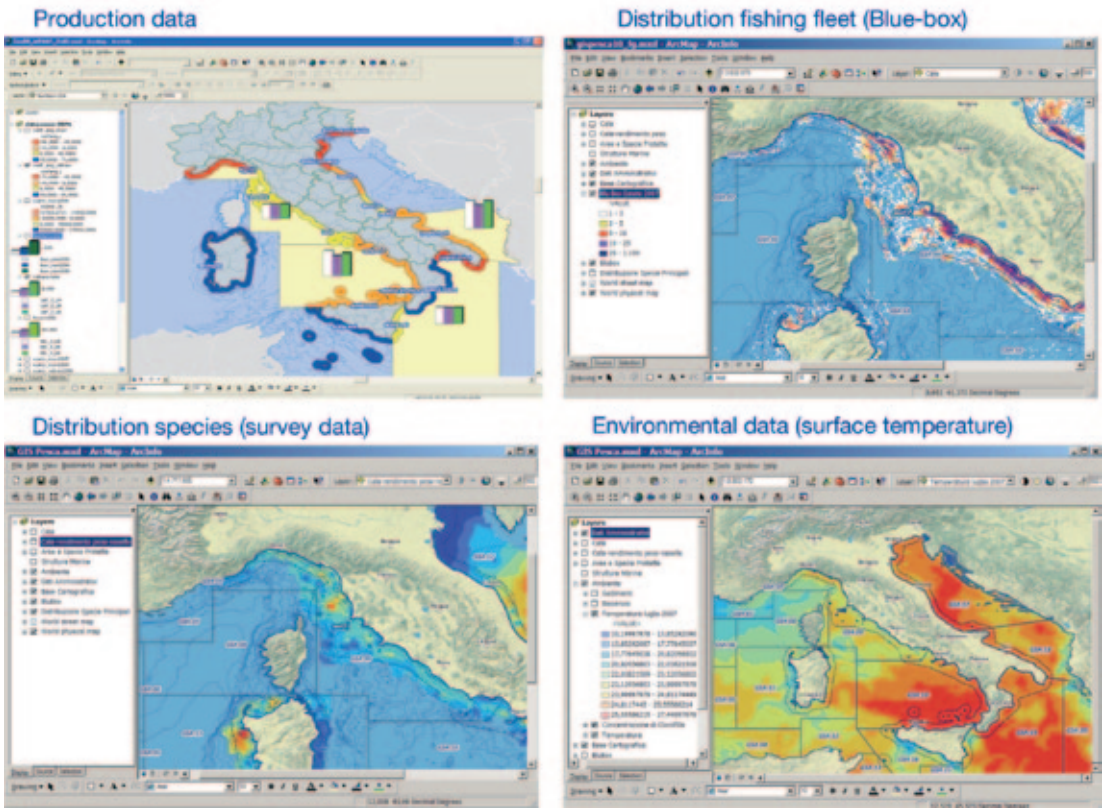

Figure 15.1 - Examples of spatial elaboration of Fisheries GIS data.

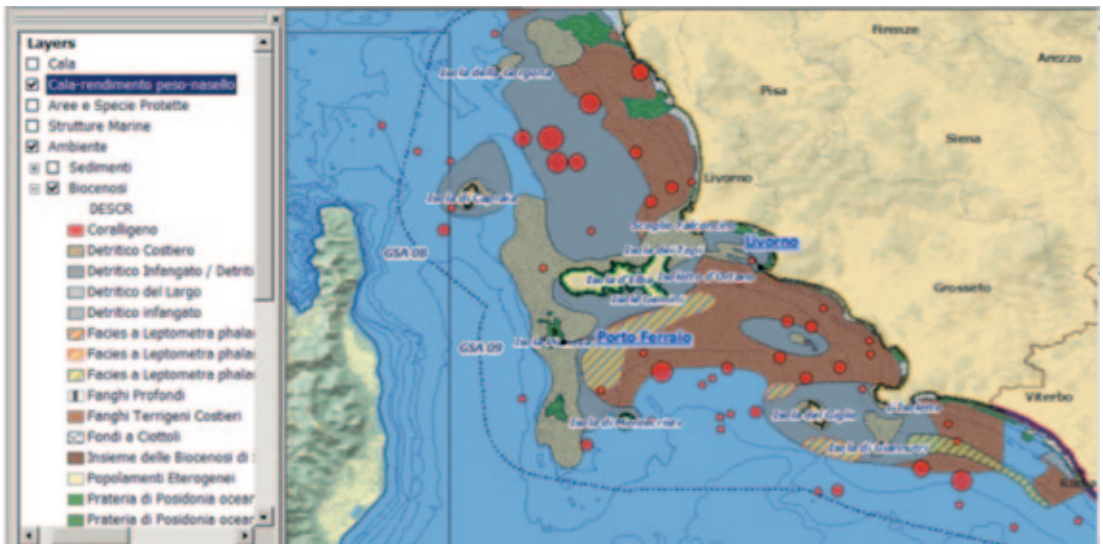

Figure 15.2 - Examples of integration of spatial information: relationship between European hake abundance in Tuscany (data from Medits 2005 survey) and distribution of bethonic biocoenosis.

Figure 15.3 - Graphic interface of the GIS Fisheries web application, with an example of search of production data.

ItaFishNet: setting up a network for Italian research in fisheries

ItaFishNet (2008) was created as a new tool to link and coordinate the main Italian fisheries scientists, contributing to a continuous and quick diffusion of information and opinions, and to generate a national network for research.

The network therefore operates as a national "virtual" institute for fisheries to serve fisheries policies. At present the network includes about 80 members, who were indicated as focal points for the network by the research team involved in fisheries sciences. It is important to underline that members include several age groups and different backgrounds, ranging from young research scientists to experts in various topics.

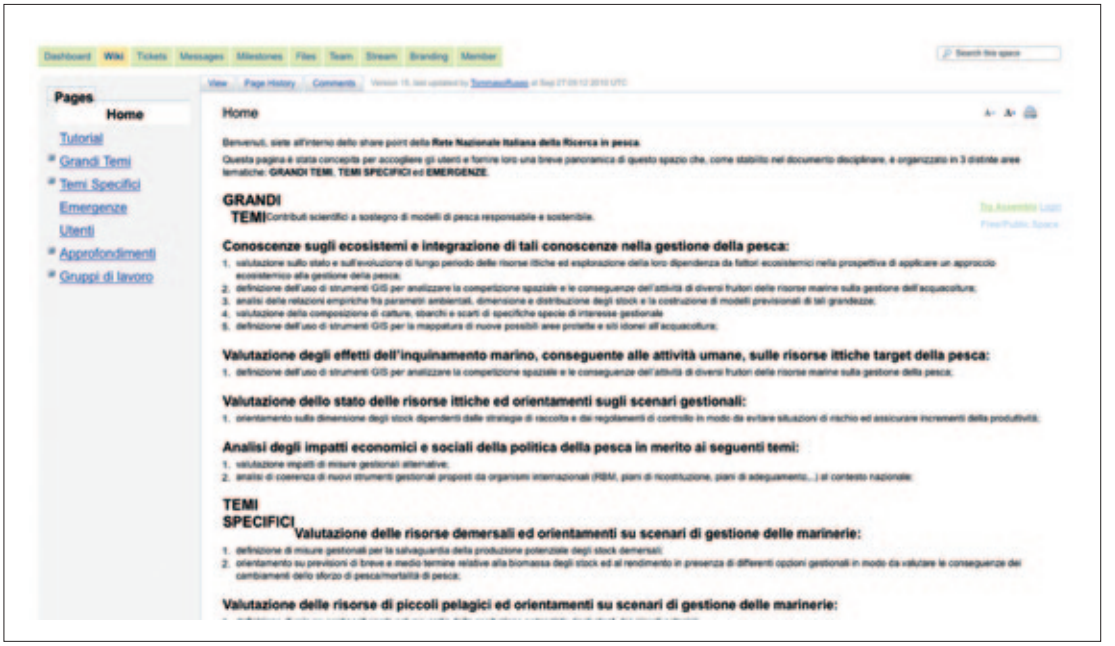

Figure 15.4 - ItaFishNet home page.

The topics treated in the network are articulated as follows:

- General topics (conservation and management of cartilaginous fish, implementation of dir. (CE) 56/2008)
- Specific topics (fisheries temporary withdrawal; new EU regulation, optimization of management plans)
- In depth analysis for various emergent topics
- Contributions of specific working groups (at present the groups related to ecosystemic indicators, to the construction of the fisheries yearbook, to bioeconomic modeling)

All these topics can be downloaded from the ItaFishNet home page (figure 15.4).

Each single user has free access to discussions, and using the tools available on the web, has the opportunity to load, manage and search for different types of documents (*pdf* files, images, word documents). Although the network cannot be compared to a real data bank for tools available and for efficiency, it still represents a useful space to build an archive of the resources useful for the network.

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15.2 The evolution of applied research in fisheries in Italy

Bombace G.

Fisheries and cooperation within this system

The fisheries sector can be defined as the system of viewpoints, actions, and phenomena that happen in the fishery area and in resources management activities, in which three main elements are involved, namely: research, public fisheries management bodies and operators, i.e. fishermen and their representatives. After a long history begun in the 1950s, the world of fisheries realised that fishery resources can be correctly managed only by collaboration and cooperation between these three entities. An example of this cooperation can be found in the preparation of important national laws.

Research in fisheries and aquaculture in the first half of the 20th century

In the first half of the century, the few people who carried out research and investigations in fisheries were focused, above all, on the classification and biology of the most important fish species. Technical measures relating to fisheries management were mainly based on the limitations on fishing gears, catch periods, reproduction areas and the minimum sizes to be observed for the most common species. Regulations sought to defend both spawning stock and juvenile fishes.

At that time research facilities were not present in all Italian coastal areas, and basic research activity was affected by the lack of personnel, research equipments and financial availability. Nevertheless, some early fisheries and aquaculture investigations can be mentioned: the work of Brian (1931) on the "scampi-beds" biology in Liguria, and that of Levi-Morenos (1903, 1920) on aquaculture and lagoons fisheries in Veneto. His work, published in the *Memorie del Regio Comitato Talassografico Italiano* (Notes of the Royal Italian Marine Studies Committee), was at the cutting edge as regards to resources management. In other research institutions, the work carried out was mainly centred on the life cycles of marine species.

L. Sanzo, who directed the Istituto Sperimentale Talassografico in Messina, worked on the embryological development of several bathyal species in the Messina Strait. His work is unique and was published in Memorie del Regio Comitato Talassografico Italiano. This work was continued by his successor, A. Spartà, who published his works (1935 and 1939) on the development of Percidae (today Serranidae) in the above Memoirs. As far as the Northern Adriatic Sea was concerned, the pioneer was Vatova who carried out its research activity on benthic biological classification, namely "Compendio della Flora e Fauna del Mare Adriatico presso Rovigno (Vatova,1928) and "La fauna bentonica dell'Alto e Medio Adriatico (1949) published respectively in Notes of the Royal Italian Marine Studies Committee and in Nova Thalassia (New Marine Studies. Finally, highly prestigious monographs were published, such as the ones by Parona (1919) entitled "Il tonno e la sua pesca" and by Bullo on coastal lagoons fisheries. The Marine Studies Institutes, which were the hinge groups of Italian research at those time, were all highly specialised in some way. The Central Laboratory of Hydrobiology, located in Rome, was the only Institute whose scientific applied investigations in fisheries was included in its institutional responsibilities.

There were also small research centres on marine biology and fisheries at the university of Trieste and Padua. In the latter, U. D'Ancona, who worked with the mathematician V. Volterra, formulated the first equations on the predator/prey ratio and then carried out in Chioggia research activities on the development of the eggs and larvae of fish and other marine species. The marine and fisheries laboratory in Fano, Bologna University, carried out both basic and applied research on fisheries in the Middle Adriatic area. Finally, the activity of the "A. Dohrn" Zoological Station in Naples, aimed at investigating the fauna and flora of the Bay of Naples, should be mentioned. This institute hosts marine biologists from various countries for study and research stages.
At the end of the 1950s, the Experimental Centre for the Fisheries and Marine Products Industry was founded in Sicily. One of its objectives was to identify new trawling fishery grounds for Sicilian fleet which had developed enormously.

The evolution of the fisheries system from the post-war period to the 1960s

The 1950s and 60s were characterised by large-scale development in production methods, by a consequent increase in landings and by a growing demand for fish products. In the early 1960s, the complexity of the fisheries system started to emerge and the first problems began to come to light (e.g. small-scale fishing with set gears versus bottom trawling). Problems also raised between fisheries and other sectors. In the meantime legislation and research were experienced the natural complexity (physical, geo-morphological, and biological as well as environmental) of the Italian surrounding marine habitats, that strongly differ from biological, morphological and halieutic point of view. Due to this complexity the Italian basins are considered as the most important marine regions in the Mediterranean Sea for their peculiarities and biodiversity levels. About 700 fish species live in Mediterranean Sea, of which at least 150 have commercial interest. The high number of species exploited especially by the demersal fishery characterizes the Italian fisheries as remarkably multi-specific. In Italy there were something like 800 small, medium and large landing points, as reported by IRPEM (Istituto Ricerche Pesca Marittima) 1980s PESTAT (Fisheries Statistics Survey investigation).
In the early 1960s, fisheries were already problematic as they involved several aspects and different jurisdictional competences (state property, fisheries administration, transport, defence administration, welfare aspects, etc.). It was clear for the Central Fisheries Administration that the sector could only develop properly and take its proper international position (FAO/GFCM) if the three groups (Research, Administration and Operators) were able to discuss and bring solutions to fisheries problems at an institutional level. These considerations produced the first regulatory law for fisheries, namely law 963/1965, which was entitled "Marine fisheries regulations". Since the beginning this law showed some weakness at a technological and scientific level, such as the technical rules for net mesh sizes measurement.
In the early 1970s the technical competencies of the just established Fisheries Technology Laboratory of Ancona had strongly contributed to improve fisheries legislation and to solve the previous weakness. The Presidential Decree 22/9/1978 and the Ministerial Decree 21/5/1981, (Merchant Navy Ministry) introduced the necessary technical modifications thereby ensuring that the regulations could be implemented. With these new measures Italian legislation recognized the recommendation 1/1976 of the FAO/GFCM. This Recommendation encouraged Mediterranean countries to adopt the same

40 mm mesh opening in the cod-end of bottom trawl nets, as well as the measurement tools approved at an international level, together with other related aspects.

Fishery research from the late 1960s to the early 1980s: establishing new institutes of the National Research Council (CNR)

In the late 1960s, fisheries and aquaculture research in Italy were both in an unsustainable position. Italian Government and fishermen organisations urgently requested the support of fisheries research in order to afford the raising problems with the management of fisheries resources. In 1968 the Consiglio Nazionale delle Ricerche (CNR) set up the following research institutions: the Institute of Marine Biology in Venice, which incorporated the local Institute of Marine Studies, the Institute of Marine Geology in Bologna, the Fisheries Technology Laboratory in Ancona, which was renamed as Fishing Research Institute (IRPEM) in the following years and which is nowadays the Fisheries Section of the Institute of Marine Sciences (ISMAR), and finally the Institute for Biological Exploitation of Lagoons in Lesina. In 1969, the Institute for Large Mass Dynamics was founded in Venice. All these research facilities investigated different aspects of Oceanography and Marine Sciences, although within the CNR, only Ancona carried out multidisciplinary research and investigations on fisheries and only Lesina carried out aquaculture research. The reality was that fisheries research in Italy was unable to meet all the needs of the different field areas nor was it able to fulfil the demands of the Central Administration or international institutions for statistical data on stock assessment and the state of resources. There were structural gaps, a lack of expertizes and specialized personnel and there were no schools of fisheries science or halieutic studies.

It was necessary to create at least one research structure for fisheries in Sicily and another in the Mid-Tyrrhenian Sea which could carry out research in both fisheries and aquaculture. Finally, it was necessary to propose unified research projects which would allow all the research institutions present in the country (CNR, Universities and others) to concentrate their activity on common objectives, in response to the demand from central government and administration, producers (fishermen Cooperatives) and international organisations.

From 1980 to the present day: the fragile maturity of fisheries research in Italy

As from 1985, fisheries expanded enormously and the catches/effort curves on demersal stock began to decline together with landings, whereas fishing effort remained constant or declined slowly. In the meantime, fortunately, the contribution of fish biomass from aquaculture raised. In that period its contribution to national production was about 30% (it is around 40% at present). As it concerns fish resources, the stocks of small pelagic species showed extensive biomass and catch fluctuations. In the following decades it was possible to observe an evident decline of these stocks (Cingolani *et al.*, 2004). However in the 1980s the fish demand and the excess of fishing effort was readdressed to the exploitation of these resources.

In this new scenario a further development of fisheries legislation was required. The minimum size of marine organisms that could be caught and the minimum mesh sizes of the nets were not enough to manage or reduce the overall fishing effort and to protect living resources. Moreover

the lack of research institutions in most of the Italian coasts strongly influenced the management of fisheries resources. There was a need for a new law aimed at managing and organizing in an efficient way Italian fisheries. Moreover there was a need for stock assessment studies covering all Italian basins and for management measures which enabled to control the fishing effort. In the late 1970s, two important cultural factors had emerged. Fisheries issues were tackled and discussed in the framework of the Italian Marine Biology Society, where many research scientists shared their experience and scientific results on relevant topics relating to capture fisheries, aquaculture and coastal areas protection (artificial reefs or habitat, protected marine zones, etc.).
The other factor was the institution of the CNR Oceanography and marine bottoms Project which was divided into various subprojects. One of these was the Living Resources Subproject which was able to ensure that CNR, university and private operator units were focused on both applied and basic topics. The CNR Oceanography and marine bottoms project, which operated from 1976 to 1981, allowed research scientists, from various backgrounds, to work together. Technical and scientific language is now common to fisheries administrators, operators and their representatives, as well as to the research scientists, who first spread it. In the same period, a decree dated 29/05/1982 by the President of the CNR, established the Institute for Fish and Fisheries Technology in Mazzara del Vallo (Sicily). In 1998 its name was changed to the Institute for Research on Marine Resources and the Environment (Istituto Ricerche Risorse Marine ed Ambiente, IRMA) and after the latest CNR reorganisation (2002), together with other Southern Institutes, it became part of the Institute for the Coastal and Marine Environment (ICME) which is based in Naples. As a result of the same reform, the CNR Marine Fisheries Research Institute (IRPEM) of Ancona became the Fisheries Section of the Institute for Marine Sciences, which has his central Direction in Venice.

Law 41/1982 and fisheries and aquaculture research up to the present day

This law was the result of the fruitful collaboration between the Fisheries Directorate of the Merchant Navy Ministry (which was responsible for fisheries) and representatives of the world of research and stakeholders.
This highly innovative law was entitled “Plan to rationalise and develop marine fisheries”. First of all, every three-year the national fisheries and aquaculture plan became compulsory, and this was used as a planning tool. The plan is drawn up by the “National Committee for the Conservation and Management of Marine Living Resources”, and representatives of all members of fisheries are represented within this organism.
The Central Institute for Scientific and Technological Research applied to Marine Fisheries (ICRAP) was founded by the law 41/82; this Institute allowed to face the weakness of data and information relating to the Mid-Tyrrhenian Sea due to the lack of research institutions in this area. Nevertheless, several new developments in the political and governmental scene diverted the CISTR activity away from its institutional function. Indeed, its responsibilities in fisheries and aquaculture research became of secondary importance. Together with law 41/1982, the law 979/1982 (“Measures for Safeguarding the Sea”) was issued; ICRAP was appointed as the Institution responsible for the implementation of this law, which is very wide ranging and extends to all Italian seas. At a later stage, the institute’s name was changed by the law 220/1992 in the Central Institute for Marine Research (ICRAM) and its main responsibilities

were extended to protecting the marine environment, monitoring the quality of marine waters, studying dystrophic or catastrophic events etc.

Fisheries research in the first decade of 2000

The investigations concerning the stock assessment and their exploitation ware permitted initially by law 41/1982 and later by law 57/2001, decree law 226/2001, law 38/2003 and by decree law 154/2004. Since the 2000 a new legislative period began in which several previous laws were repealed, but also Community measures had to be taken into account, in particular the European Council Regulation (EC) 1967/2006 which for the first time indicated specific measures for managing Mediterranean living resources.

Since the beginning of the new century the reference Ministry for fisheries and aquaculture matters was no longer the Merchant Navy Ministry, but the Ministry of Agriculture, Food and Forestry Policies (MiPAAF). The EC recognised the FAO/GFCM and is now a member of this commission. In the last ten-fifteen years this situation has ensured a secure financial support for research and investigations on stock evaluation and resources management. The MEDITs project was thus created and it is supervised by the GFCM, with financing being provided by the EU and by the Mediterranean EU member states. The project aims at assessing the state of resources with the goal of providing technical and scientific objectives for ensuring that over-exploited resources, which have reached their exploitation limits, are allowed to recover.

Council Regulation (EC) 1967/2006 does not exclude the possibility of exceptions, that could be introduced in the framework of Management Plans based on scientific evidence.

Conclusions

After a long and difficult history several important factors have given more impetus and have improved the state of fisheries and aquaculture research:

- the laws on fisheries and in particular Law 41/1982 and EC legislation, as regards project financing, and creation of research institutes (ICRAP);
- the CNR as regards the creation of research organisms financial support to innovative research projects, technical training for the administrative and executive staff of the relating Ministry. Furthermore, the Marine Studies Institutes were transferred to the CNR thereby ensuring to them a strong improvement.
- universities, which introduced Fisheries Biology and Aquaculture in their studies programmes. The universities also set up the National Interuniversity Consortium for Marine Sciences (CONISMA) - (Ministry of Education, Universities and Research (MIUR) - Ministerial Decree dated 15/03/1996) to coordinate and provide administrative support to the university consortium members.30 universities involved in the different research programmes at a national and international level;
- the Italian Marine Biology Society (SIBM) which set up Committees and Working Groups in fisheries, aquaculture and the coastal area, and organised (and still continues to do so) seminars on specific topics.

Nowadays, research aims at achieving new goals in terms of the knowledge to be gained and the investigations to be carried out on the complex relationships among the environment, living resources and fisheries. It would seem, for example, that the decline in stocks is not to be entirely attributed to the ongoing excessive fishing effort. Indeed, climatic changes could play an important role and this complex relationship still has to be completely investigated.

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15.3 Research in capture fisheries

Conte P., Bertelletti M.

The Code of Conduct for Responsible Fisheries (FAO, 1995) dedicates an entire section (Article 13) and twenty paragraphs to research in capture fisheries. Among the most significant requirements, Paragraph 1 deals with the centrality of the role of research activities, specifically appealing to States to recognise that "Responsible fisheries requires the availability of a sound scientific basis to assist fisheries managers and other interested parties in making decisions". It also stipulates that "States should ensure appropriate research is conducted into all aspects of fisheries including biology, ecology, technology, environmental science, economics, social science, aquaculture and nutritional science" and that by creating an appropriate institutional structure, reliable and accurate data should be gathered which are required for evaluating the status of the ecosystem and of fisheries resources.

Well before the adoption of the FAO's Code of Conduct for Responsible Fisheries, in Italy Law No 41/1982 (later repealed with the introduction of Legislative Decree 154/2004) expressly envisaged, as a priority action, the development of scientific and technological research applied to marine fisheries and aquaculture as being useful for achieving the objectives of the law. It also envisaged, for the first time in our system, that the fishery effort should be regulated on the basis of the consistency of the marine living resources, as confirmed by research projects. It was supposed to provide the elements for verifying the abundance and level of exploitability of living resources in Italian seas and provide the necessary data for maintaining the most convenient balance between resources exploitation and their availability.

The interventions were organised into three-year fisheries and aquaculture plans. In Article 7, Law No 41/1982 included the studies regarding the assessment of living resources and their rational management.

The three-year fisheries plans, right from the time when Law 41/1982 was first applied, envisaged a regular research programme. The 1984-1986 national plan contained the results already obtained in the implementation of the so called "National Plan Preliminary Scheme" published in

the Official Gazette on 12 April 1983. It emphasised that the start-up of numerous projects within the framework of a coordinated programme of research in fisheries was an "historic event" that had seen the involvement of 50 research institutions and approximately 500 research scientists.
After having described the important findings, the second three-year fisheries and aquaculture plan (that came into effect with the Ministerial Decree dated 4 August 1988) envisaged the continuation of living resource assessment programmes as well as those on fishing technology, on the hygiene and nutritional quality of fisheries products and fisheries and aquaculture economy. Today these issues are still macro areas of intervention for research activities.
The third national fisheries and aquaculture plan (1991) revealed that some 700 research scientists had taken part in funded projects throughout the previous three-year period, recording a substantial expansion of research institutions. This was side by side with the very few institutes that previously had already been active and which, in turn, were capable of developing their capacity for research and intervention still further.
The fourth three-year plan (1994) affirmed that the "the findings and level of analysis achieved and the range of strategic opportunities offered to the Administration were evidence of the degree of maturity achieved by Italian research in fisheries."
Subsequently, in the fifth three-year plan (1997), a further increase in the number of research scientists was confirmed, which corresponded to a growth in the number of research institutions involved and an improvement in the quality of the findings. The greater contributions by Italian research scientists to international publications was considered evidence of this, even if margins of improvement in the coordination were highlighted, with a constructive debate on the methods for evaluating the resources for establishing common approaches. This was in order to render Italy's position increasingly more established and competitive, in view of the Common Fisheries Policy and Italy's role in the Mediterranean region.
The sixth plan (2000) increased further the value of previous findings, highlighting that "with a widespread commitment across the country, in national bodies and private research facilities" it became possible to create "coordinated systems for assessing living marine resources of economic interest, without overlooking research activities in marine ecosystems".
In short, research in fisheries received continued support during the implementation of the different three-year plans (table 15.1). The maximum number of projects recorded during the period of the fourth plan is to be interpreted by taking into account the increased attention paid to the issues of fisheries ecology, such as the research activities on the impact on marine ecosystems of different fisheries activities, the underscoring of sensitive areas and the effect of environmental instability on fisheries. It is worth highlighting the reduction in average funding per project in the sixth three-year plan, something that can be understood by taking into account that the GRUND project, which was initially funded within the framework of the three-year plans, from 2002 became part of the national programme of collecting fisheries data as per Regulation (EC) 1543/2000.
The sector which benefited from the greatest funding was the evaluation of living resources, divided into species types (demersal fish, large and small pelagic fish and bivalve molluscs). 1985 saw the launch of the GRUND project, an evaluation of demersal stocks through experimental fishing surveys (direct methods) and the use of motor trawlers and other commercial equipment, with a progressive intercalibration of the apparatus used. At the same time, along with the project known as MEDITS, funded by the European Community since 1995, an alternative campaign was launched in coordination with the Euro-Mediterranean countries, using standardised apparatus for all of the operational units.

Table 15.1- Number of projects and funding per three-year plan associated with living resources and fisheries technology. Plan I and II also include the issues of experimental surveys and the protection of living resources and restocking actions (Source: MiPAAF research data bank, General Directorate for Marine Fisheries and Aquaculture).

Three-year plan	No of projects on living resources	Total funding (€)	Average funding (€) (per project)
I (1984-86)	51	4,055,736.11	79,524.24
II (1988-90)	54	5,441,906.35	100,776.04
III (1991-93)	51	6,181,472.59	121,205.34
IV (1994-96)	91	11,817,566.78	129,863.37
V (1997-99)	48	8,732,671.56	181,930.66
VI (2000-02)	67	6,485,402.83	96,797.06

A group of operational units was also established for the large pelagic fish-types (mainly bluefin tuna and swordfish) to study stock dynamics, reproductive biology, population growth and genetics as well as for the monitoring of catches.

Operations for small pelagic fish took place on a multidisciplinary level in as much as some of the operational units undertook studies on the ecological aspects that influence the species recruitment, whilst others conducted an evaluation of the principle stock parameters, sparking a debate over the different research methods: direct methods, acoustic methods and the analysis of data relating to catches and landings.

In conclusion it is possible to state that from 1985 it became possible, over time, to put together and consolidate different research teams, divided into geographical areas and topics of research, and to adopt and fine tune scientific methodologies and improve coordination between them.

The progress achieved at this stage in the quality of the work undertaken and the degree of coordination between the operational units involved represented an added value for Italy, prior to the strengthening of the role of the FAO/GFCM.

When a real scientific structure was being established within the GFCM, Italy started to contribute to the scientific advice at a Mediterranean level with a vast scientific community already in place, allowing it to constitute the foundations for a broader involvement in the work within the SAC, its sub-committees and working groups. As far reports are concerned, Italy's contribution was among the most consistent and productive in terms of assessments and scientific opinion.

Furthermore, thanks to the experience acquired during the implementation of the three-year fisheries and aquaculture plans, the launch of FAO Mediterranean cooperation projects on research in fisheries and marine resources funded by Italy (the AdriaMed project for the Adriatic Sea and the MedSudMed project for the Strait of Sicily) witnessed Italian experts taking on a coordinating and active role for a true exchange of knowledge among research scientists from the Mediterranean countries. Amidst some of the more important results to be recorded there is the by now consolidated activity with research scientists from other Mediterranean countries and the joint evaluation of shared stocks, in the framework of common methodological approaches.

Since 2002 the European Commission has furthermore made a system for gathering fisheries data compulsory for Member States, in compliance with Regulation (EC) 1543/2000 that establishes a community framework for the gathering and management of the necessary data for the implementation of the CFP. According to this regulation, the responsibility for gathering data rests with the Member States, whilst it includes the involvement of the EU for the costs of creating

the related national programme. To proceed with the scientific assessments that are required for the CFP, it is essential to gather complete data that concern the biology of fish stocks, fleets and their activities, as well as economic and social issues.
It is clear that the coming into force of the aforementioned Regulation (EC) 1543/2000, later replaced by Regulation (EC) 199/2008, which standardised the type and methods of investigation in fisheries at a European level, profoundly changed national interventions in the field of research, reorienting its objectives.
At the same time Regulation (EC) 2371/2002 included the drawing up of recovery and management plans, for the first time in fisheries management.
The management plans were formulated on the basis of the precautionary approach to fisheries management and take into account the reference limit values recommended by the relevant scientific groups. They guarantee the sustainable exploitation of stocks and ensure that the impact of fisheries on marine ecosystems is maintained at sustainable levels.
Along with the same Regulation came the establishment of the Scientific, Technical and Economic Committee for Fisheries (CSTEP), which is consulted at regular intervals on issues relating to the conservation and management of living aquatic resources, including biological, economic, environmental, social and technical aspects. In presenting the proposals relating to fisheries management within the framework of this regulation, the Commission took the views of CSTEP into account.
The consolidation of the presence of a research network for these topics in Italy has been fundamental for the production of expert scientific opinions.
Nationally, Legislative Decree 154/2004, concerning the "Modernisation of fisheries and aquaculture" (in accordance with Article 1, Paragraph 2 of law 38/2003, which repealed law 41/1982), introduced the criteria of sustainability, as a basis for the integration between the measures for preserving aquatic resources and the environment and the safeguarding of business activities. It also envisaged that those interventions that fall under national jurisdictions (guidance and policies) should be listed in the national fisheries and aquaculture programme.
Among the objectives of the fisheries programmes, the regulation also envisages the "development of applied scientific research in fisheries and aquaculture" aimed at "sustaining the pursuit of objectives envisaged by the national programme". Particular reference was made to: the pursuit of the "durability of fish resources for present and future generations and safeguarding of biodiversities"; the "sustainable development of fisheries and aquaculture and related activities"; the "safeguarding of the consumer in terms of traceability of fish products and the enhancement of the quality of national production and the transparency of information".
On these bases the "first three-year fisheries and aquaculture programme for 2007-2009" considered it "urgent to integrate the know-how and areas of expertise of the various research centres spread throughout the regional territories and to bring about a central coordination", bearing in mind the strategic importance of creating "an organised network for the management of data on the state of living resources". This would permit the "optimal use of the expertise available on a national level", as well as being less costly than setting up centralised bodies that can weigh down operations to the disadvantage of the organising of centres of research at a local level and the "improvement of an organisational model that is already well established in the regions in the management phase of the three-year plans".
Therefore, the official organisation of a research network, which was established at an experimental level in 2009, constitute a basic instrument to increase Italian capabilities to face

new challenges in fisheries. What is needed is a sound cognitive base for the new CFP both for evaluating sustainable stock exploitation and for the full application of the ecosystem approach at a Mediterranean level.

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- Regulation (EC) 199/2008 of the Council of 25 February 2008 concerning the establishment of a Community framework for the collection, management and use of data in the fisheries sector and support for scientific advice regarding the Common Fisheries Policy.
- Regulation (EC) 967/2008 of the Council of 29 September, amending Regulation (EC) No 834/2007.

Box 15.1

Phytoplankton primary productivity and fisheries management

Scardi M., Conti L.

Introduction

Ecologically sound analyses of fisheries dynamics cannot be carried out independently of the assessment of primary productivity, i.e. independently of an estimate of the energy flow that supports the ecosystem from which fish biomass is extracted. Therefore, data about phytoplankton primary productivity, which accounts for more than 95% of the overall primary productivity of marine ecosystems, are the basis for trophic web analyses that link microalgae – through their consumers - to commercially exploited fish species. An accurate description of all the components of these trophic webs obviously requires complex *ad hoc* studies, but even a rough approximation may support an energy-based approach to fisheries management.

Trophic level of fish species

Our present knowledge of marine trophic webs enables to define, at least approximately, the role most nektonic consumers play. A recent study by Stergiou & Karpouzi (2002) reported

the variation interval of the trophic level (TL) of all the Mediterranean fish species, grouped into functional groups defined according to their habitat (15.5).

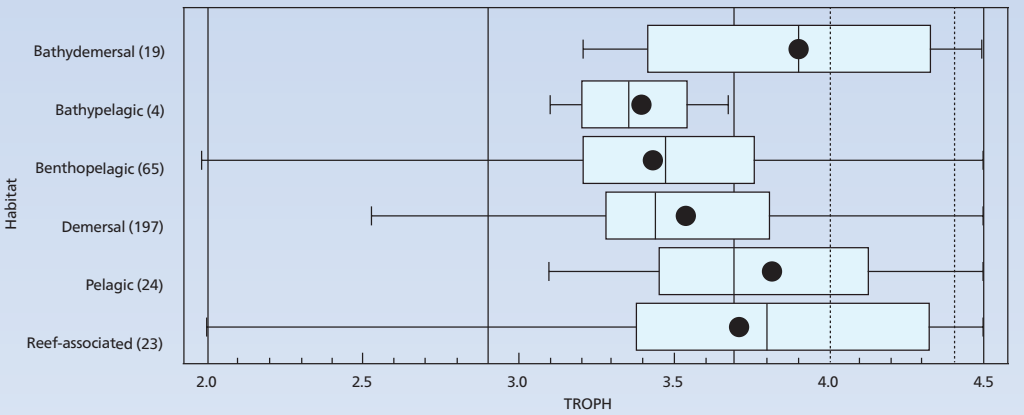

Figure 15.5 - Assessed fractional trophic levels of Mediterranean fish species grouped by habitat. The central box shows the second and third quartiles of the distribution, while the black circle shows the average TL (Source: Stergiou & Karpouzi, 2002).

The vertical line in each bar shows the median TL of each functional group, whereas the black circle shows the average TL. Most of these values are in the 3.3-3.9 range, while the average TL is about 3.4 for demersal and benthopelagic species and 3.6 for pelagic ones. These values are in agreement with those reported by Pauly *et al*. (1998), who pointed out that the overall average value is 3.4.
According to Ware (2000), who took into account the findings of several authors in different ecosystems, the ecological efficiency of some relevant energy pathways can be summarized as follows:

$$\text{phytoplankton} \rightarrow \text{primary consumers} = 13.9\%$$

$$\text{primary consumers} \rightarrow \text{nekton}_{=3} = 9.7\%$$

$$\text{phytoplankton} \rightarrow \text{nekton}_{TL3} = 13.9\% \times 9.7\% = 1.3\%$$

$$\text{phytoplankton} \rightarrow \text{nekton}_{TL4} = 13.9\% \times 9.7\% \times \sim 10.0\% >> 0.13\%$$

$$\text{phytoplankton} \rightarrow \text{nekton}_{TL3.4} = 0.3\text{-}0.6\%$$

Basically, the nektonic production at the average TL of the fisheries yield (TL_C=3.4) accounts for a very small (<1%) fraction of the phytoplankton primary productivity.

Energy transfer to fish and sustainability

Assuming that fisheries yield is balanced by the production of exploited species, the fraction of primary productivity that is actually conveyed to these species can be easily assessed. Tudela *et al.* (2005) cited several studies aimed at this goal, but only two out of 65 dealt with Mediterranean ecosystems, although the authors were certainly familiar with this region. The first one was about the Catalunian Sea from 1994 to 2000, in a situation of heavy fishing pressure: TLC was 3.1 and the percentage of primary productivity that was needed to support fisheries yield (PPR%) was 43.9% (Coll *et al.,* 2004). The second

study was aimed at the Bay of Revellata (Corsica), where TLC=3.8 and %PPR=11.9 were found (Pinnegar, 2000). The lack of studies focused on Mediterranean ecosystems is a clear symptom of the limited amount of ecological information available in this region, which shows clear signs of overfishing (Farrugio *et al.*, 1993; Aldebert & Recasens, 1996; Sardà, 1998; Papaconstantinou & Farrugio, 2000; Palomera *et al.*, 2007; Coll *et al.*, 2009).

The results obtained by Tudela *et al.* (2005) are summarized in figure 15.6. The two Mediterranean ecosystems are highlighted in red (Catalunian Sea) and green (Bay of Calvi), while three dashed curves show the boundary between overfishing (in the upper left corner) and sustainability at 50% (upmost), 70% and 90% probability level. Assuming the 50% probability curve as a reference, the dashed red line shows that 12.9% is the %PPR that corresponds to TLC=3.4, i.e. to the average trophic level targeted by fisheries. In other words, the probability that a 12.9% %PPR would be sustainable would be 50% if the average trophic level were actually 3.4. Given the same TLC, %PPR should not be larger than 3,27% in order to attain a 90% probability of sustainability. In general, the smaller the fraction of primary productivity that supports fisheries yield, the larger the probability that ecosystem exploitation is sustainable.

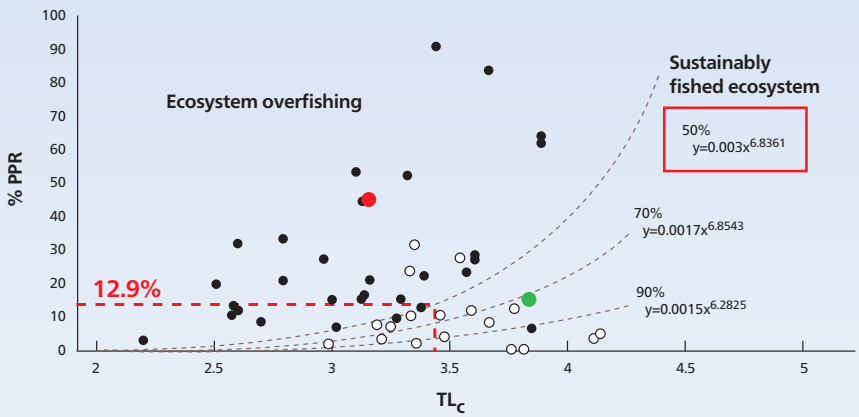

Figure 15.6 - Fraction of the primary productivity transferred to fisheries yield (%PPR) is plotted against the mean trophic level of catches (TL_C). The red dashed line shows the %PPR obtained for TL_C= 3.4 and a 50% probability of sustainability. Symbols correspond to 65 marine ecosystems, two of which are in the Mediterranean Sea: the Bay of Calvi (green) and the Catalunian Sea (red) (modified from Tudela *et al.*, 2005).

Assessing maximum sustainable catches of Italians GSAs

The relationship between TL_C and %PPR, in conjunction with the estimated primary productivity (which can be easily modeled from satellite data), allows computing the Ecosystem-based Maximum Sustainable Catches (EMSC) at any probability level.

If the selected probability level is 50%, then $EMSC_{50}$ can be computed, and their estimates for the four GSAs around Italy are as follows:

- $EMSC_{50}$ GSA 9 = 0,61 t km^{-2} $year^{-1}$
- $EMSC_{50}$ GSA 10 = 0,52 t km^{-2} $year^{-1}$
- $EMSC_{50}$ GSA 17 = 0,85 t km^{-2} $year^{-1}$
- $EMSC_{50}$ GSA 18 = 0,58 t km^{-2} $year^{-1}$

As for GSA 9, the estimated phytoplankton primary productivity is 13.6 g C m^{-2} $year^{-1}$ and 0.3-0.6% (0.45% as the average value) of it can be transferred to the TL 3.4, i.e. 0.061 g C m^{-2} $year^{-1}$. Converting C units to fish fresh weight and upscaling from m^2 to km^2, the assessed $EMSC_{50}$ is 0.61 t km^{-2} $year^{-1}$. Estimates for other GSAs range from 0.52 t km^{-2} $year^{-1}$ (GSA 10) to 0.85 t km^{-2} year for GSA 17.
An effective representation of the ecological efficiency of fisheries, based on the trophic features of targeted ecosystems, was proposed by Nixon *et al*. (1986) and then adapted by Nixon (1992) to a very diverse set of ecosystems (figure 15.7). The conversion from primary productivity units (g C m^{-2} $year^{-1}$) to fisheries yield units (kg ha^{-1} $year^{-1}$, wet weight) was approximated under the assumption that 1 g C m^{-2} $year^{-1}$ of fish production corresponds to 100 kg ha^{-1} $year^{-1}$ of wet weight. Any given level of ecological efficiency can be represented in this plot by a diagonal line and the one in figure 15.7 marks the 1% level.
It is interesting to notice that all cases but one (an estuarine ecosystem) lay below that line, as the overall energy transfer efficiency from primary productivity to fisheries yield is lower than 1%.

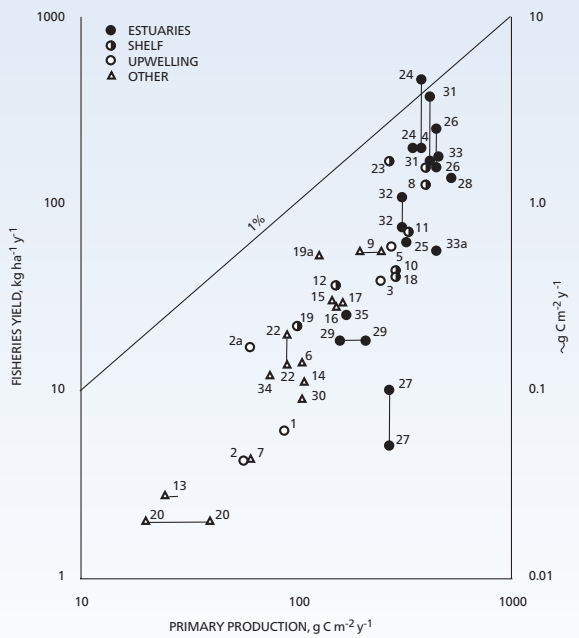

Figure 15.7 - Relationship between primary productivity and fisheries yield in dfferent marine ecosystems: upwelling (white circles), platform (black/white circles), estuarine (black circles) and others (white triangles) (Source: Nixon, 1992).

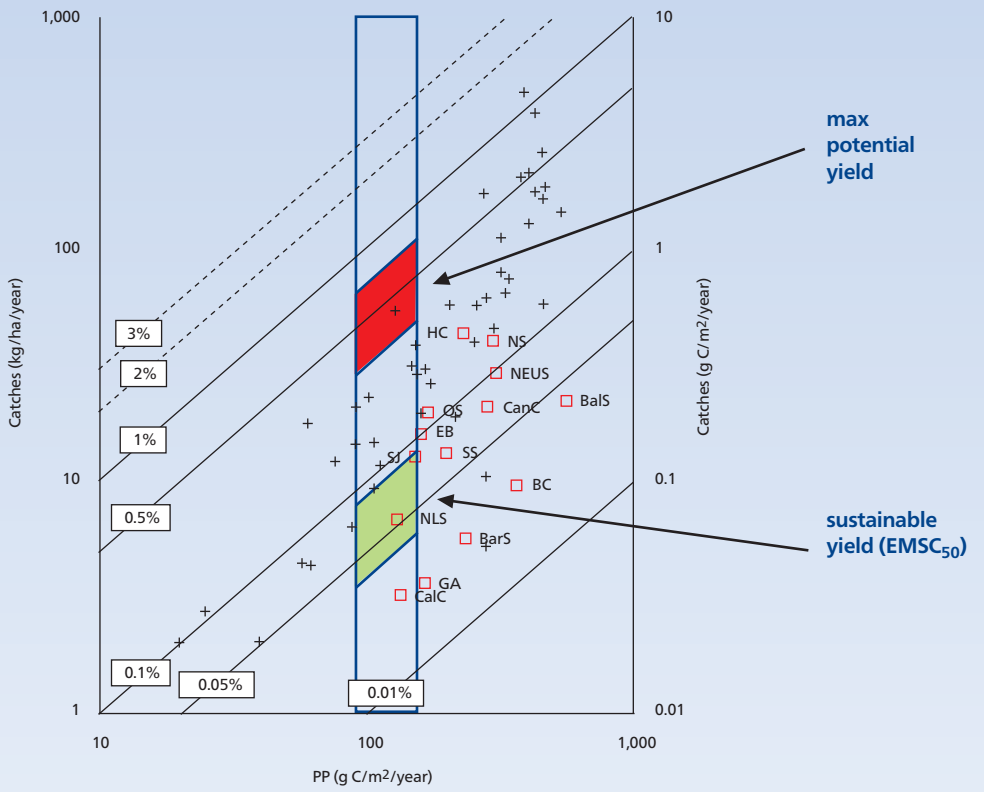

Figure 15.8 - Relationship between primary productivity and fisheries yield in GSAs 9, 10, 17 and 18. The red area shows the region defined assuming the maximum level of ecological efficiency, whereas the green area corresponds to EMSC50, i.e. to Ecosystem-based Maximum Sustainable Catches at 50% probability level.

This approach may take profit of several time series that are now available online (e.g. the *Sea Around Us Project)*, including a wide range of remotely sensed ocean data.

Assessing phytoplankton primary productivity at basin scale requires appropriate mathematical models and their careful selection is of paramount importance. In order to avoid overestimating sustainable yield, conservative primary production models should be favored according to a precautionary approach.

While estimating phytoplankton primary productivity is the basis for the analysis of fisheries sustainability, a thorough ecosystem approach is needed in order to preserve marine resources and the overall environmental quality of our seas, as clearly stated, for instance, in the EU Marine Strategy Framework Directive (2008/56/CE).

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15.4 Cooperative research

Buonfiglio G.

The "phenomenon" of cooperative research in fisheries, which began in Italy in the second half of the 1970s, developed above all in the 1980s due to several concomitant factors (Community grants, lack of know-how in firms that had started up in aquaculture, demand for feasibility and project studies as well as for technical assistance with production cycles, and availability of research funds in three-year plans by MiPAAF).

Young biologists were then just beginning to take their first steps in marine aquaculture facilities, and in the best cases they had previous experience in the older and simpler freshwater fish farms where trouts and carps were grown. They dived into a sector in which the demand for permanent and seasonal expert services was continuously growing. The demand for sea bass and bream fry, the first experiences in shrimp farming in coastal lagoons, intensive eel production, experimental trials in induced spawning and larval rearing, initial farming of innovative species, all seemed to lead to further developments. This was due to good market conditions and to incentives, initially for investment (above all for setting up land-based facilities), but which in just a few years were

also extended to include applied research programmes as a result of the funding made available by law 41/82.
In the same years marine aquaculture soon spread to the entire Mediterranean area, although in each country it brought various types of production and technologies according to local conditions. There was support even from bilateral and multilateral cooperation (FAO in particular via the MEDRAP (Mediterranean Regional Aquaculture Project)). Further work opportunities for Italian biologists were created by the hatcheries built in Greece, Turkey and Tunisia, and the interest for managing coastal lagoon areas all over the southern Mediterranean coast (where the eel trapping weirs built by Italians in the previous decades had already enhanced production in these particular environments showing their potential). Italian biologists were able to offer a wide range of services, due to their experience in lagoons, fisheries and with wild fish juveniles, and more recently in hatcheries and modern fish farm facilities.
There were also interesting opportunities for biologists to sail on ocean fishing vessels to carry out experimental fishing surveys financed by the EU as preparation for fishing agreements between the community fleet and third countries (Falkland Islands, Ivory Coast, Mauritania, etc).
All these activities pushed an increasing number of graduates and near graduates in life and veterinary sciences to dedicate themselves to fisheries. Faced, too, with an increasing demand for skills and services, they organised themselves in what was then (but which still is) the simplest and cheapest form of company, namely: the cooperative.
As with most cooperatives, even the ones formed by biologists joined one of the Italian Cooperative Federations: Lega Coop (National League of Cooperatives and Mutual Associations), Confcooperative (Federation of Italian Cooperatives) and AGCI (General Association of Italian Cooperatives) and further opportunities arose as a result of these relationships with fisheries associations.
The connection with national associations was, and still is, an advantage for research cooperatives in carrying out their surveys and monitoring activities, in that they can easily feed into their partner Association's network of offices and associates located throughout Italy in the main national fishery areas.
The role of cooperative research development in providing employment in Italy has been significant and allowed many young biologists to find a job in relatively short time (above all compared to the years of irregular work in other areas). This has not, however, forced them to cut their links with the original university environment that provided the training or research "imprinting" for the various groups in the different expertise areas.
The story of research cooperatives is unusual and has had several effects. Together they constitute a considerable heritage of experience and skills throughout Italy in the field of investigations, studies and monitoring activities that are indispensible for managing and regulating fisheries. Research cooperatives are the natural "bridge" between fishermen and fish farmers, the scientific community and central and local institutions. This is a role and impact that the associations wanted to enhance and develop, when they promoted the unifying consortium Unimar at the onset of the Financial Instrument for Fisheries Guidance (FIFG) planning. This brought together into a single body the Consorzio Mediterraneo, CIRSPE (Italian Centre for Fisheries Research and Studies) and ICR (Cooperative Research Institute), members respectively of Lega Pesca, Federcoopesca and AGCI Agrital (Association of the Agri-Food and Fisheries sector of AGCI). To be more specific, Unimar nowadays employs, via the 3 national association consortia, 639 research scientists and experts who are members of 40 cooperatives distributed over 13

Regions. It publishes several journals and publications, and provides technical assistance to the Directorate-General of Fisheries of the MiPAAF. It also collaborates with the International Commission for the Conservation of Atlantic Tunas (ICCAT) and the European fisheries control agency (EFCA) in Vigo, Spain, and works on research programmes for the Three-Year Fisheries Plans and the former Community Regulation (EC) 199/08 (collection of fisheries data).
Nowadays, the Unimar Research Consortium, including the research cooperative network from which it was formed (via the national CIRSPE, ICR and Mediterraneo consortia), is a qualified facility that provides a wide range of services including studies and research. It is available as an instrument for the Government and administrative regions, and its close links with production facilities ensure that its activities easily progress throughout Italy.
Although Unimar is close to the world of associations, it is not an instrument for supporting trade union-type campaigns. As expressly intended by the very associations that moved to set it up, Unimar aspires to be an institution capable of providing both valid scientific data and independent opinions, and this is an essential condition if cooperative research is to be advantageous in bringing Italian fisheries forward along the path towards full sustainability.

Box 15.2

The national cooperative research network

Pelusi P.

Since their establishment, research cooperatives have developed a remarkable spirit of collaboration, seeking to smooth the rough competitive edges in a sector that was almost the exclusive domain of public research. The creation of research cooperative consortia and the united consortium Unimar underlined this collaboration, enhancing it through the creation of a widespread national network actually present in all administrative regions (figure 15.9).
Each research consortium operates through its affiliates to contribute to the increase and dissemination of knowledge, to detailed examination of the main issues in fisheries, particularly those connected with biological, ecological, technological, economic and educational aspects, to the development and enhancement of fisheries and aquaculture, and to the protection of the Italian marine environment. In order to do this, it promotes, coordinates and creates study and research projects, integrating and making use of the various skills and synergies developed among the associated research scientists.
Each single consortium has a national operational headquarters, responsible for the identification, development and promotion of projects, coordination of the activities of the research scientists involved and the general organization of the consortium. The territorial centres, present in all Italian coastal regions, include a total of over 600 research scientists and technicians, with several years of experience in the various fisheries-related topics.
A particularly important part of the cooperative research activities in fisheries and aquaculture is the technical and scientific support provided to the production cooperatives working in the various fields of the fishing economy: capture fisheries, aquaculture, processing, marketing and financial activities. This support activity is integrated with study, research, monitoring, publishing, professional training and qualification for fisheries operators, in order to promote the responsible exploitation of marine living resources and enhancement of fish products quality.
Where possible, priority was given to the direct application of research findings to fishing

and aquaculture activities, to improve their production while ensuring the ecological sustainability and future continuity of these activities. This has included the provision of technical and scientific support to cooperatives faced with particular problems, requiring technical interventions to solve them or at least initiate or test a solution.

An important activity, which has always been part of the work of cooperative research, is publishing and providing information about the results of surveys and research: each research carried out is followed by a final phase in which the results are sent to the operators and administrations. This dissemination phase involves both the printing of scientific and informative publications as well as the organization of specific seminars, to which fisheries operators are invited, together with the relevant public administrations and research scientists from public and private research institutions. Information material on specific topics and legislation is also produced in almost all cases.

In general, efforts have been made in all cooperative research activities to strengthen the relationships with fishermen, to determine their needs and identify and propose solutions.

Figure 15.9 - Distribution of cooperative research facilities for capture fisheries and aquaculture (size of circles proportional to the number of cooperatives).

To achieve these objectives, funding opportunities have been sought, not only nationally but also at a regional and local community level, enabling directly applicable research to be conducted and helping to provide information to those public administrations involved in fisheries management policies. In recent times, with limited financial resources available for scientific research, the opportunity to carry out complimentary and synergistic activities relying on the national cooperative research network has become essential in order to achieve the objectives established in the various projects.
The presence of an integrated network among cooperative research centres in fisheries and aquaculture, as well as allowing an efficient exchange of information and providing further occasions for partnership between the various centres involved, each with its own specific experiences and skills, also provides rapid, widely available and accurate information on all topics of interest to the sector.
This integration among the centres and the amplification of their activities enables greater technical and scientific support to be provided to the policy makers, in their efforts to achieve the ecological and economic sustainability of fisheries that has been the objective of all recent policies for the development of this sector.

Box 15.3

Satellite Monitoring System for fishing vessels (VMS)

Russo T., Fiorentino F., Cataudella S.

Origins, development and technical aspects

The satellite control system for community fishing vessels was established by Regulation (EC) 686/1997, which made it an obligatory requirement for all boats exceeding 24 metres in overall length (OAL), in order to monitor activities during fishing trips. The requirement was then gradually extended to fishing vessels with an OAL > 18 metres (from 1 January 2004) and to those with an AOL > 15 metres from 1 January 2005. Around 60% of the vessels authorised for professional fisheries in Italian waters now have the vessel monitoring system (VMS) installed. From 1 January 2012 the requirement is further extended to cover fishing vessels with an OAL > 12 metres. Since 1 July 2006, boat owners have had to bear the full cost of the VMS, which was previously paid for by the state administration.
The VMS requires the installation of a satellite transmission device (known as a “blue box”) on board the vessel. The blue box is connected to the International Maritime Satellite Organization (Inmarsat) transmission network, which sends the signals to the National Fisheries Monitoring Centre (NFMC), established at the General Headquarters of the Italian Port Authority. On each fishing vessel, the blue box automatically transmits information regarding its position, course and speed, at intervals of around 2 hours. The blue box can also be used to manually send emergency and alarm messages. The land-based VMS management network also includes fishing area monitoring centres (CCAP, Centri di Controllo di Area dei Pescherecci), i.e. data processing units located in 14 Italian administrative regional centres (maritime directorates) that are connected to the NFMC central unit for management of the data flow. The monitoring centres are in Genoa, Livorno, Naples, Reggio, Calabria, Bari, Ancona, Ravenna, Venice, Trieste, Catania, Palermo, Cagliari and Pescara.

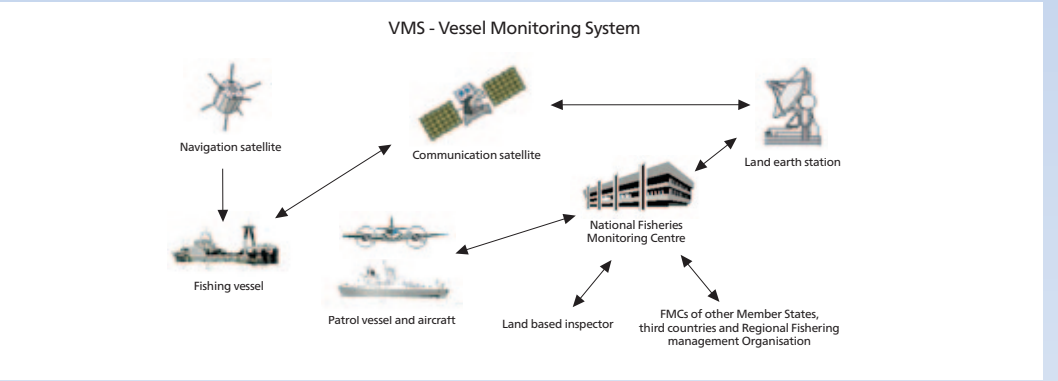

Figure 15.10 - VMS - Vessel Monitoring System
Source: http://ec.europa.eu/fisheries/cfp/control/technologies/index_en.htm

Scientific and practical implications

The data provided by the VMS is information of great importance for management and science, particularly due to its high degree of spatial precision and the fact that, being an automated system, it provides an independent source of information from the vessel logbooks. The EC CFP has therefore progressively required the use of this data for purposes of monitoring and control. These objectives have led to the development of three indicators of fishing pressure on marine ecosystems. In this case, the three indicators quantify: absolute spatial extension; the level of aggregation, i.e. the spatial heterogeneity of fisheries in relation to overall exploited areas; the extension of areas not affected by fishing, divided into bathymetric zones. All three indicators are calculated for the available historical series, in reference to a spatial grid divided into 3 km squares and using a high level of disaggregation in terms of space (per GSA), time (a monthly scale) and activity (per métier). The compilation of historical series for these indicators allows quantitative examinations to be made of the relationships between the extent/location of the fishing effort and the biological, economic and social repercussions of fishing.

From a scientific perspective, the VMS data provides a new and unique opportunity to investigate the dynamic aspects of the interaction between fishing and the environment on a spatial scale. These management and scientific applications, however, have both required a long period of methodological development to make the data useful and to relate it to other information gathered in relation to the CFP. Basically, approaches calibrated to the ecological and geographic situation of Italian seas have had to be developed in order to:

- overcome the limitation caused by the low transmission frequencies of the blue boxes. A special interpolation method was specifically designed for this purpose, capable of reconstructing the routes of fishing vessels for the duration of all trips and for all possible activities, with a high degree of reliability (Russo *et al.*, 2011a);
- cross-reference the data obtained with that from the equipment used and the catch data provided by the logbooks, in order to allocate each fishing trip to a specific segment of activity (Russo *et al.*, 2011b);
- distinguish the points corresponding to the actual sets (Russo *et al.*, 2011b) within each fishing trip;

- transform the raw data for the individual fishing points into more accurate data, for example, by using information regarding the characteristics of the fishing vessel (Russo *et al.*, 2011b).

Scientific research based on this data, both at present and in the future, in centred on its use to extend fisheries analysis and management models to the spatial dimension. Explicit models of fishing pressure and its spatial and temporal dynamics are being created. These models, calibrated using well-known realities of high strategic interest for Italian fisheries (for example GSA16), will be cross-referenced with those already available to describe the heterogeneity of the marine environment and the distribution of fishery resources. Analysis of how fishing pressure is distributed spatially (particularly for larger-sized vessels, with a much greater operating range) will allow the transition from management based on fleets, divided between maritime departments and therefore dependent on a "land-based" distribution, to a clearly much more effective management based on marine areas.

References

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