

# Scientific & Management Plan



HELLENIC CENTRE FOR MARINE RESEARCH

**Institute of Marine Biological Resources  
and Inland Waters (IMBRIW)**

November 2013

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## A. The Institute

### A.1. Background

HCMR resulted from the merging of IMBC and NCMR in 2003. The new Centre included 5 Institutes. Two of them, IMBR and IIW were merged in 2012 forming the IMBRIW (Fig. 1). During 2005-2012, Dr Diapoulis was the director of IIW and Dr Papaconstantinou was the director of IMBR. After the merging of the two Institutes, Dr Economou was acting director of the (new) IMBRIW. Professor Stergiou was elected in April 2013 but officially assumed his duties on the 4<sup>th</sup> of November 2013. The present organizational structure of IMBRIW is shown in figure 2.

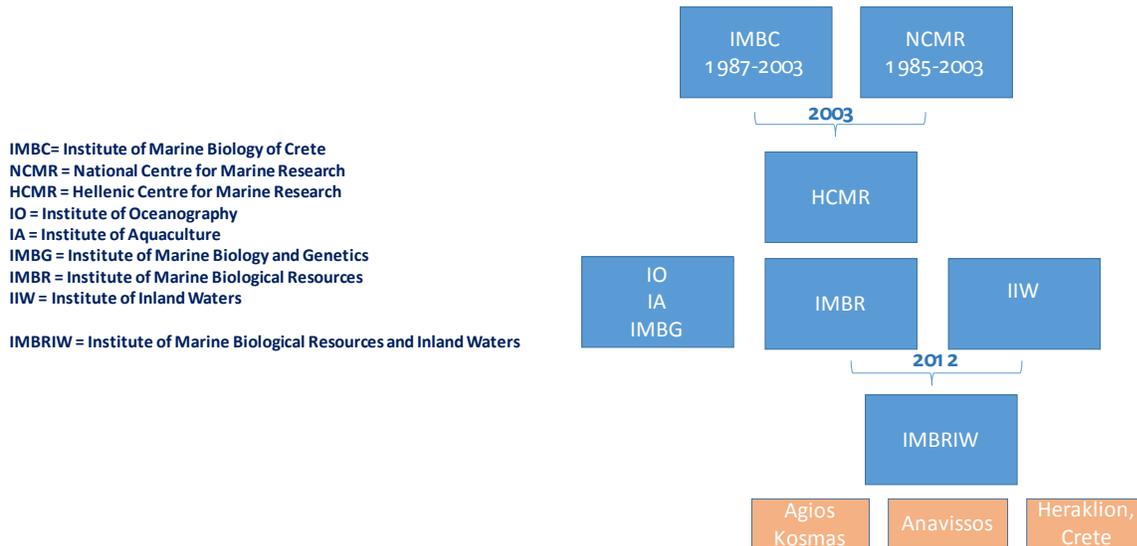


Fig. 1. The history of the IMBRIW. Orange indicates the regional units.

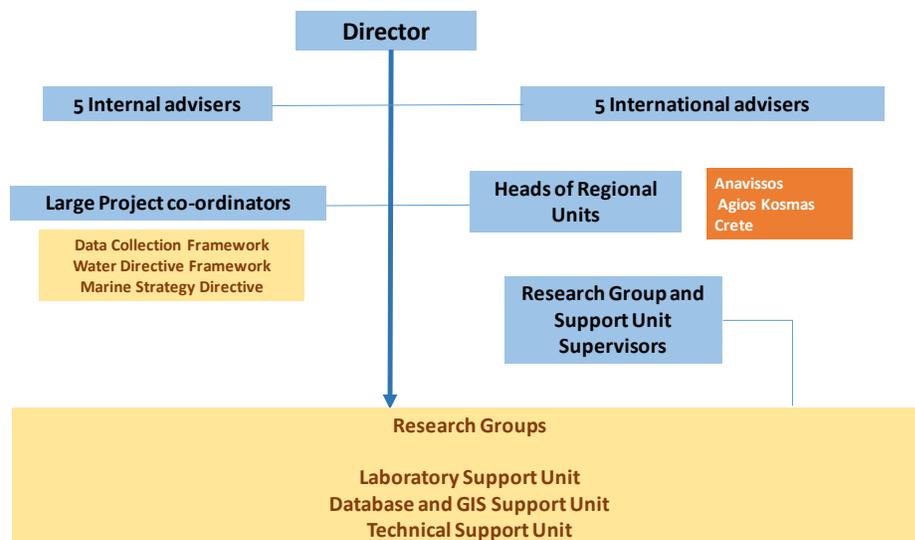


Fig. 2. Organizational structure of IMBRIW. Orange indicates regional units.

### A.2. Mission and goals

IMBRIW is the leading institution in Greece, with a key role in the Mediterranean region, and an important presence in Europe on aspects related to fisheries and inland water research.

The mission of IMBRIW is (a) to support the conservation and management of aquatic biological resources, habitats and ecosystems in order that the latter will continue providing their services for future generations; (b) to provide advice and services to national, Mediterranean, EU and other International bodies on environmental conservation and management; and (c) to sensitize the public at large on issues related to the conservation of aquatic biological resources, habitats and ecosystems.

The mission of IMBRIW is accomplished through (a) carrying out multidisciplinary and integrated field, laboratory and experimental, basic and applied research; (b) monitoring and scientific assessments and predictions of the status of fish and shellfish stocks in Greek waters; (c) ecological quality assessments and monitoring of inland waters; (d) giving advice for the sustainable exploitation of fisheries resources in Greek and Mediterranean waters; (e) undertaking specific pilot studies, developing new tools and designing management plans on specific issues for national, Mediterranean and EU institutional bodies and (f) disseminating information and knowledge on major achievements through publications and a variety of organized events. To this end, IMBRIW closely co-operates with the other two Institutes of HCMR.

IMBRIW's geographical scope of activities extends to most European countries, the Middle East and northern Africa.

The main goals of IMBRIW are the production of knowledge related to structural and functional aspects of inland aquatic ecosystems, and the high trophic level components (including fisheries), of marine ecosystems, and the application of this knowledge for integrated river basin and coastal zone management, ecosystem approach to fisheries, and biodiversity conservation. A key element is the development and application of state-of-the-art tools for ecological monitoring, weather forecasting, hydrometeorological, water quality and ecological modeling.

### **Outline of IMBRIW research (see also Fig. 3)**

- Biology, ecology and life-history of aquatic organisms and fisheries resources (i.e. demersal organisms, small and medium pelagics, large pelagics, marine cetaceans and reptiles, freshwater organisms: age, growth, reproduction, population dynamics, mortality, feeding, spatiotemporal distribution, abundance, behavior, migrations, acoustics, tagging)
- Early life history (taxonomic identification, age, growth, feeding, mortality, dispersal, abundance-daily egg production, diversity)
- Biodiversity conservation and environmental restoration (taxonomy, distribution, abundance, biology and ecology of freshwater organisms, genetic structure of fish,

- conservation of endemic freshwater fish, habitat restoration, marine and freshwater alien species and their interaction with native ones)
- Ecological quality assessments and monitoring (monitoring and assessment of ecological status of surface waters according to the Water Framework Directive provisions development of river typology schemes, establishment of reference conditions, selection of metrics for assessing ecological degradation, definition of the metric scale to assess deviation from reference conditions)
  - Integrated river basin management (integrated water resources management at the catchment scale employing ecological quality assessments, numerical modeling to simulate processes driving hydrology and water quality and to produce management scenarios, study of 'hot moments', i.e. droughts and floods, and their effects on aquatic communities, predictability of water cycle, through studying land-surface and coastal water processes and optimal integration of models with observational data)
  - Fisheries ecology and Ecosystem Approach to Fisheries Management (fisheries-aquaculture-environment interactions, adult/juvenile spatio-temporal bathymetric distribution, geographic distribution, conservation of non-fisheries resources, integrated coastal zone management including design and management of artificial reefs and marine protected areas, ecological modeling and simulations of fisheries exploitation scenarios in an ecosystem context, monitoring through the Marine Strategy Framework Directive)
  - Fisheries dynamics and capture (monitoring through the EU Data Collection Framework, fleet dynamics, landings, stock assessments, new fisheries resources, small-scale and trawl gear selectivity, discards, VMS monitoring, socio-economics, development of management plans)
  - Modeling and assessment (various age-based and global production models, time series models, habitat suitability models, Individual Based Models - IBM, Ecopath-w-Ecosim, numerical weather prediction models, hydro-meteorological models, statistical evaluation of weather forecasts)
  - Database and GIS Support Unit.

IMBRIW provides services to the following agencies:

- (a) General Secretariat of Research and Technology
- (b) Ministry of Agricultural Development and Food
- (c) Ministry of Ministry of Environment, Energy and Climate Change
- (d) Ministry of Tourism
- (d) European Commission
- (e) International Management Bodies and Committees (EFARO, EC STECF, CIAC, GFCM, FAO-EASTMED, ICCAT, NAFO, ICES, UNEP MAP RAC/SPA, EEAJRC etc)
- (f) Municipalities, prefectures and regions
- (g) Management Agencies of Protected Areas and national parks in Greece
- (h) Mariculture Business Innovation Center, Croatia
- (i) NGOs and

(k) Fishers' and farmers' associations.

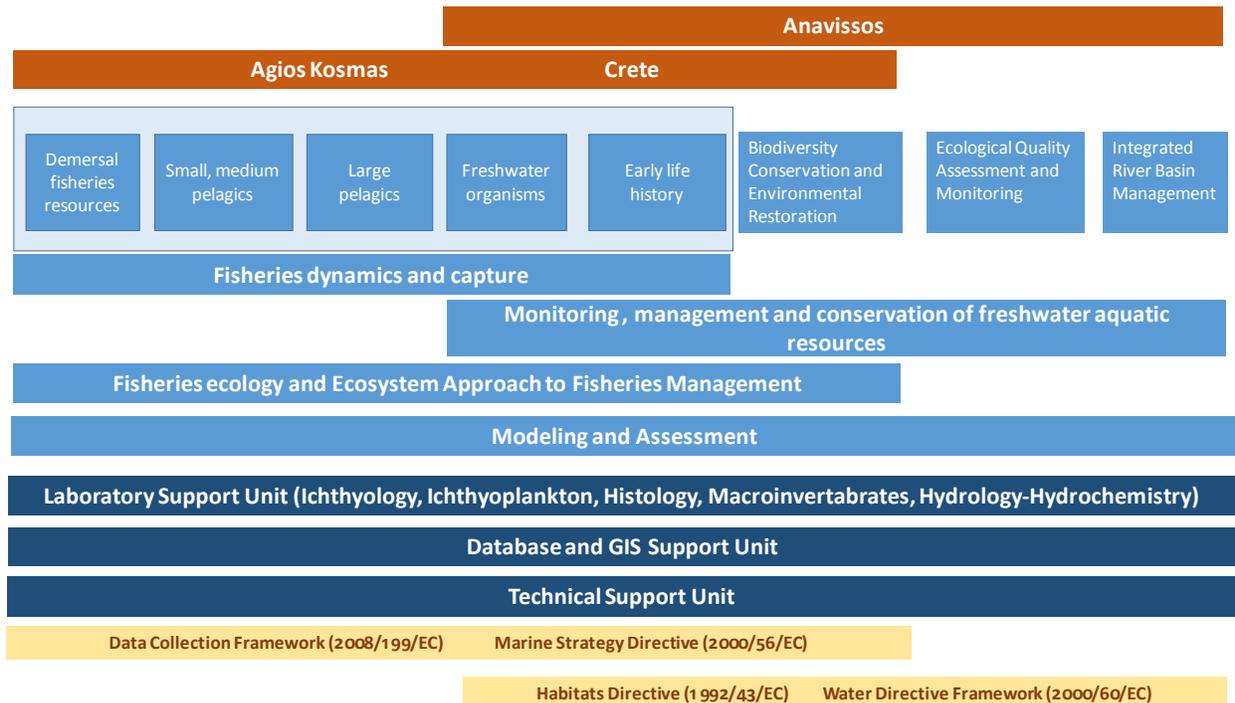


Fig. 3. IMBRIW research structural scheme. Research groups (blue), large Framework programs (yellow) and support units (dark blue). Orange indicates regional units.

### A.3. Strategy and policy

During the current period of evaluation, both former Institutes, today constituting IMBRIW, directed their efforts to:

- increase their international role by strengthening their membership in International Organizations, research networks (e.g. ERANET, EUROCEAN) and Working Groups
- enhance their academic reputation by increasing the number of publications in high-profile journals and the number of MSc and PhD students trained in IMBRIW
- fully exploit the multi-disciplinarity of research staff
- increase their policy-relevant advisory role (e.g. Management Plans) and dissemination activities at the National and European level and, thus,
- ultimately attract almost exclusively EU funds (since national funds are limited and unpredictable) and address high-order research questions (see Fig. 13 in section F).

All the above aims were successfully realized during 2005-2012 (see the corresponding sections).

With respect to the former Institute of Marine Biological Resources during the current evaluation period (2005-2012) specific strategic research objectives were directed to the issues listed below and resulted in many publications in mainstream journals.

### *Biodiversity and conservation*

- A special effort has been given to study alien species aspects (i.e. dynamics, trends in introduction and pathways/vectors of introduction, invasive species, raising public awareness) in European Seas. One member of the Institute is the co-ordinator and Manager of the Hellenic Network on Aquatic Invasive Species (ELNAIS; <http://services.ath.hcmr.gr>). At Mediterranean level, the Institute is responsible for the development of the Mediterranean Marine Invasive Alien Species (MAMIAS) database ([www.mamias.org](http://www.mamias.org), supported by UNEP MAP RAC/SPA). More than 35 articles (including 3 reviews) have been published on alien species at European, Mediterranean and National level in collaboration with 122 experts.
- Biodiversity analyses of demersal fisheries' exploited communities in the framework of the various projects and activities.

### *Modeling and assessment*

- Several stock assessments have been done for developing Management Plans as well as in the framework of GFCM and STECF.
- Harmonization of the pan-Mediterranean acoustic survey. The Institute has coordinated the pan-Mediterranean survey-at-sea for small pelagic species (MEDIAS) for 2008-2010 and has taken a leading role in the standardization of Mediterranean acoustic surveys through the AcousMed project (2010-2012).
- Development of harmonized methodologies for coherent and relevant environmental status assessments. Efforts related to environmental status assessments within the framework of various projects (e.g. FP7 PERSEUS and DEVOTES; SEAS-ERA project MERMAID), aiming to the definition of Good Environmental Status as described in the Marine Strategy Framework Directive. One of the challenges is that due to the trans-boundary nature of many marine ecosystems close collaboration and networking is necessary between scientists of both EU and non-EU countries to set common targets and thresholds and harmonize methodological approaches to achieve coherency in assessments across the EU regional Seas.
- The Institute expanded its research on ecological modeling, specifically "Ecopath with Ecosim" and "OSMOSE" methodologies, which integrate information from fisheries, low trophic (phytoplankton and zooplankton) and high trophic level (fish, large invertebrates, marine mammals and seabirds) components of the ecosystem.
- IBMs have recently developed in which biogeochemical models are linked with anchovy bioenergetics to explore population dynamics.

### *Fisheries dynamics and capture*

- Monitoring, through the EU Data Collection Framework, of population age and length structures, fleet dynamics, fishing effort, landings and socio-economic data.
- Deep-water resources, deep-water fisheries, deep-water habitats. IMBRIW initiated this activity since 1996 through various research projects (DEEP FISH, INTERREG II, RESHIO, CoralFISH, DEEPFISHMAN, MEDITS, PAGEBOG, DEEPSHRIMPS) carried out mainly in the Ionian Sea focusing on deep-water fisheries resources: exploration and assessment of

the deep-water resources, abundance and distribution of the shrimps *Aristeus antennatus* and *Aristeomorpha foliacea*, study of the biology and feeding strategies of deep-water fish and shrimps, bio-economic evaluation of water resources, assessment of the status of the stocks, presence and distribution of deep-water corals and study of their habitat and the relationship with deep-water fish assemblages.

- Fishing Capacity Assessment. With fisheries resources being overexploited during the last decades, the matching of fleet capacity to resource conservation levels is urgently required. Work has been carried out and a number of papers have been published in the mainstream literature dealing with capacity utilization and assessment for the first time for the eastern Mediterranean and Greek fisheries purse seine fishery.
- Discards is a practice closely related to fishers' behavior. Research to identify drivers connected to fishers' incentives was developed in the framework of the MariFish BADMINTON project, which contributes to the revised CFP goals related to reduction/banning discards in EU waters.
- Selectivity and technology of fishing gears. The improvement of gear selectivity minimizes the capture of juveniles, increases the size of first capture and the yield per recruit of target species and reduces discards and thereby the environmental impact. The Institute initiated this activity in the early 1990's through various research projects (NEMED, IMAS-FISH, PAGEBOG, NECESSITY, SELMED, SELDAT). The studies investigated the selectivity of different mesh sizes of trawl codend, gill nets and traps. The staff has been also involved for the specifications of the most used fishing gears within service provision towards DG MARE (ARCHIMEDES, MyGears, DRIFTMED).

#### *Fisheries ecology and ecosystem approach to fisheries management*

- Essential fish habitat suitability modeling, at the Mediterranean scale, for several small pelagic and demersal species (e.g. anchovy, sardine, hake, round sardinella, *Illex* spp., ctenophore *Mnemiopsis leidyi*) with a series of publication in mainstream journals.
- Marine litter on seafloor and ingested by marine organisms. Marine litter is a global growing problem of increased concern for the European seas. Marine debris includes all kinds of solid material, which ends in the marine environment (i.e. plastics, metals, glass, ropes, textiles, wood, fishing gears and other material). The study of marine debris has been included in the Marine Strategy Framework Directive (2008/56/EC). IMBRIW initiated this activity in the 2010s, investigating marine litter on the seafloor and in the guts of fish based on data of the research projects (INTERREG II, RESHIO, MEDITS, CoralFISH, COCONET).
- Density dependence and the structure of the planktonic food web affect food consumption and prey selection by small pelagic fish. This research aims to investigate and model the key link of marine food webs, i.e. the plankton-forage fish interaction.
- The effect of the unreported source of aquaculture escapees (i.e. dispersal and survival of eggs of cultured fish in commercial sea cages) in surrounding coastal ecosystems.
- Investigation of the importance of trophic conditions on stock reproductive potential of small pelagics in the Mediterranean in the context of the daily egg production.

- Evaluation of the impact of trawling on the seabed and how can this impact be reduced using less damaging gears or alternative techniques.
- The interaction between fisheries-aquaculture. This research aimed to investigate the effect of aquaculture on fish and communities and fisheries landings.
- Evaluation of the extent and distribution of Marine Protected Areas and Fishery Restricted Areas in the Mediterranean.
- Marine Spatial Planning as a tool to minimize conflicts between human uses (e.g. fisheries, other human activities, ecosystem conservation priorities). The application of systematic conservation planning in Greek waters as a case study during the FP7 MESMA project was a first approach that produced interesting results, and can be further developed to provide feedback to stakeholders on priority areas that should be protected minimizing socio-economic costs.
- Socio-economic studies of the fisheries sector, application of mental modeling techniques, economic valuations, elaboration of integrated coastal zone management tools (e.g. PEGASO, DEDUCE and InDAM/GFCM indicators) for sustainable development.

With respect to the former Institute of Inland Waters during the current evaluation period (2005-2012) specific strategic research objectives were:

#### *Biodiversity conservation and environmental restoration*

- Exploration of the geographical distribution of inland water fish species (both native and introduced) and description of species assemblages in the hydrographic basins of Greece.
- Identification of new freshwater species or cryptic species, using morphological and genetic techniques, for the taxonomic validations of vulnerable or endangered taxa.
- Genetic variation studies of different populations of endangered fish species to define separate “evolutionarily significant units” within each species to be conserved separately.
- Studies on the ecology and biology of fish species, assessments of habitat requirements and determination of habitat conditions of some vulnerable species and populations,
- Protection of endangered species and formulation of management plans for species and habitats through conservation and restoration projects.
- Investigation of anthropogenic impacts on habitats and the biota (e.g. construction of dams, water abstraction, sand/gravel abstraction, pollution) and determination of appropriate restoration actions.
- Elucidation of the competitive interactions between invasive and native freshwater species.

#### *Ecological quality assessment*

- Continuation and upgrading the research on ecological status and monitoring methodologies for streams and rivers, as required for the WFD implementation . Research on using existing, adapted or developed ecological status assessment

methodologies, particularly regarding chemical-physicochemical (nutrients) and biological quality elements (macroinvertebrates, fish).

- Standardization of sampling procedures and field protocols. Development of river typologies and the designation of reference conditions for a number of river basins using the spatially based approach.
- Expansion of research on ecological status and monitoring including new indicator attributes (riparian habitats, macrophyte vegetation and diatoms), new methods of ecosystem health diagnosis (screening-level assessment procedures) and new water body types (temporary rivers and ponds, urban streams, lakes and lagoons).
- Implementation, in 2009, of a preliminary National Monitoring project (Actions for the implementation of the Water Framework Directive).
- Implementation, in 2012, of the National Monitoring Program for rivers (“Monitoring of the ecological status of rivers, transitional and coastal waters pursuant to Article 8 of the WFD”) at 149 operational and 300 surveillance stations throughout the mainland and island Greece.

### *Integrated River Basin Management*

#### Basic research

- Research on the factors and processes driving the origin, forms, levels and dynamics of nutrients in minimally disturbed areas.
- Start applying water quality monitoring in Lakes and Estuaries by utilizing remote sensing techniques to develop predictive algorithms.
- Implementation of ecotoxicological approaches in order to assess the impact of complex sources of pollution on aquatic ecosystems by applying the Microtox system, acute toxicity bioassays and biochemical biomarkers for stream macroinvertebrates affected by agro-industrial wastewaters.
- In regard to temporary water bodies (rivers, streams and ponds), innovative research was developed, focusing towards the understanding of processes driving changes in hydrology, aquatic quality and biota.

#### Development/application of tools

- Identification of pressures, assessment of the state and impacts (application of the DPSIR principle) and management scenarios within Integrated Water Resources Management Plans and River Basin Management Plans.
- Development of a rapid prediction tool of aquatic quality and a nutrient classification system.
- Application of groundwater vulnerability and pollution risk assessment methodologies according to the COP method developed under the COST Action 620 project.
- Application of the Revised Universal Soil Loss Equation (RUSLE) , a model developed by the USDA Soil Conservation Service (now the USDA Natural Resources Conservation Service), which, combined with remote sensing and GIS tools, estimates the annual soil erosion potential per unit land area on a river basin scale.

- Application of a grid-based GIS modeling method for the estimation of flood hazardous areas.

#### *Development/application of numerical modeling*

##### Hydro-meteorology

- Development of techniques for assimilating surface observations to produce high operationally high-resolution atmospheric analysis fields.
- Improving convective precipitation forecasting through assimilation of regional lightning measurements in a numerical weather prediction model.
- Investigating the predictability of seasonal weather forecasting on regional scale
- Generation of high-quality atmospheric analysis dataset that can be used as the forcing to drive wave, ocean hydrodynamic and hydrological models and the baseline data for environmental impact assessment studies.
- Effect of forcing the land surface scheme of an atmospheric numerical weather prediction model with remotely sensed precipitation datasets, instead of the model-generated rainfall fields.
- Ongoing research on improving operational numerical weather forecasts.
- Ongoing research on the development of a fully coupled atmosphere–ocean wave system.

##### River basins

- Numerical modeling to simulate the relevant processes controlling hydrology and water quality at a catchment scale for environmental and river basin management (MIKE by DHI), including climate and land use change scenarios; water budget models; dynamic groundwater models for exploring the pathways of aquatic pollutants; modeling software for simulating the entire hydrologic cycle at a catchment scale and for simulating hydrochemistry in surface waters.

#### **A.4. Adequacy of the resources**

After the merger of the two former Institutes, the new IMBRIW now has the critical mass of scientists, the expertise required and the material infrastructure to tackle its mission and goals, also taking into account the need for enhancing integration with other research disciplines (e.g. physical-biological coupling, inland-inshore-offshore interactions). Through infrastructure funding by the General Secretariat for Research and Technology during 2005-2009, existing laboratory and field equipment have been partially upgraded and modernized (see 'Facilities' below). However, the effort of upgrading infrastructure should be continued to keep pace with the rapid technological changes in the relevant research fields.

#### **A.5. Funding policies**

During the current evaluation period, IMBRIW directed its efforts to secure funds mainly (>85%) through European research projects (FP6, FP7, LIFE, INTERREG, MARIFISH), European structural funds (NSRF–ESPA, [www.espa.gr](http://www.espa.gr), OPF-EPAL, [www.alieia.gr](http://www.alieia.gr)) and projects for the implementation of European policies (Data Collection Framework - DCF, Water Framework

Directive - WFD), with a high success rate, and to a much lesser degree through national funding *per se*.

Overall, IMBRIW has been involved in 103 projects, bringing a total of 20,465,856 Euros, which are 1.36 times the amount directed to the IMBRIW through the Greek government regular public budget (=15,093,992, Euros). The annual funding through all types of projects (Fig. 4) fluctuated between 1.18 and 4.20 million Euros. The annual regular public budget (Fig. 5) fluctuated between 1.47 and 2.12 million Euros. In general, during 2005-2012, IMBRIW received on average about 22% of the HCMR regular public budget.

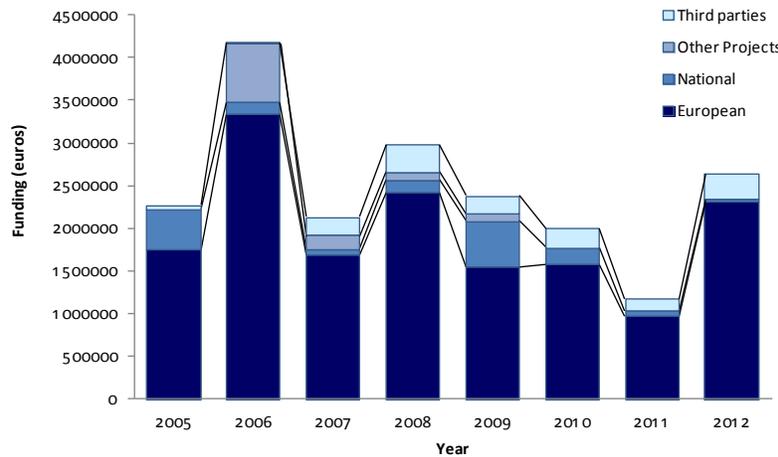


Fig. 4. IMBRIW funding through projects, 2005-2012. ‘European’ implies funding in the framework of European projects, including the investment or ‘matching funds’ awarded to IMBRIW from the corresponding Ministry for having a specific EU project funded, as well as projects for the implementation of European policies (Data Collection Framework, Water Framework Directive). ‘National’ implies mainly income from the NSRF and OPF projects funded from the Greek Government through the European structural funds. ‘Other projects’ implies income from other National funds (e.g. municipalities). Finally, ‘third parties’ implies funding from all remaining non-European sources.

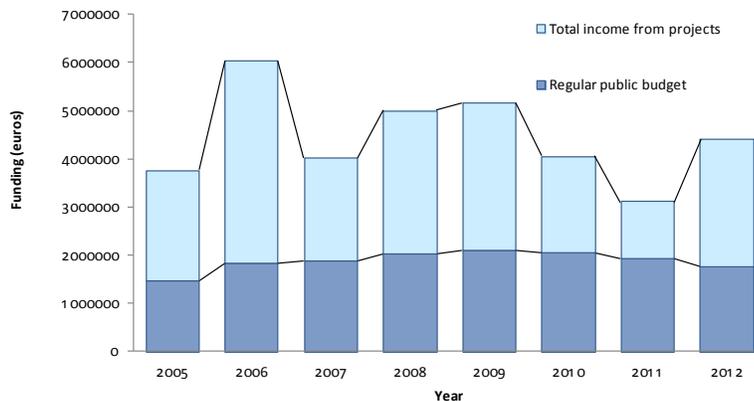


Fig. 5. IMBRIW total income from projects and regular public budget, 2005-2012.

## **A.6. Facilities**

IMBRIW extends in three main buildings each at a different location: Anavissos, Agios Kosmas and Heraklion (Crete). The total surface of the buildings is 1340 m<sup>2</sup>. IMBRIW has a variety of computing, laboratory and field equipment (see excel sheet 3.facil) that are adequate to fulfill its mission. More specifically, it includes five main equipped laboratories (Ichthyology, Ichthyoplankton, Histology, Macroinvertebrates, Hydrology-Hydrochemistry).

IMBRIW is the main user of the Research Vessel (R/V) 'PHILIA' for collecting data in the field (equipped with fishing gears, fish plankton-nets, CUFES egg sampler, hydro acoustic system, ROXANN bottom profiler). R/V 'PHILIA' is also hired by third parties to conduct fisheries research since it is the only vessel in Greece equipped with instruments (sampling and sensing) for such activities. It has already been used for fisheries research hired by other organizations and state authorities (e.g. the state of Libya).

In addition, IMBRIW also uses ROVs for benthic fisheries community studies. One project (KRIPIS) has already been accepted in 2012/2013 for upgrading the Institute's field equipment (including those onboard) whereas a project proposal has been submitted (in 2013) for the reconstruction and modernization of the R/V 'PHILIA'.

IMBRIW has constructed and harmonized a central database system (Fig. 6) including all data that have been collected within the framework of all projects undertaken (i.e. environmental, CTD and satellite data, raw data on abundance indices, length-frequencies, age distribution, reproduction, larval species composition, adult species composition, fleet effort and landings by metier, fleet activity, VMS data, MEDITS, and all other data collected within the Data Collection Framework and Water Framework Directive, including all the annual data published by the Hellenic Statistical Authority). In addition, unique databases with meteorological data, as well as with biological (fish, macroinvertebrates, diatoms, aquatic macrophytes and riparian vegetation) habitat, physicochemical, chemical and hydrological data from all river basins, are in the process of integration into the central database. Although raw data (i.e. data per sampling event) are only available to national administration and EU, aggregated data are available to the public upon request.

The facilities of the Institute are regularly used by research partners from various EU and international projects, a fact mediating the exchange of know-how. In addition, the facilities of IMBRIW are also used for the training of university students (i.e. undergraduate, MSc, PhD studies).

## **A.7. Academic reputation**

During 2005-2012, the academic output of the IMBRIW included 629 peer-reviewed papers, 102 book chapters and books and 1024 other publications and overall received 7573 hetero-citations and 3550 self-citations.

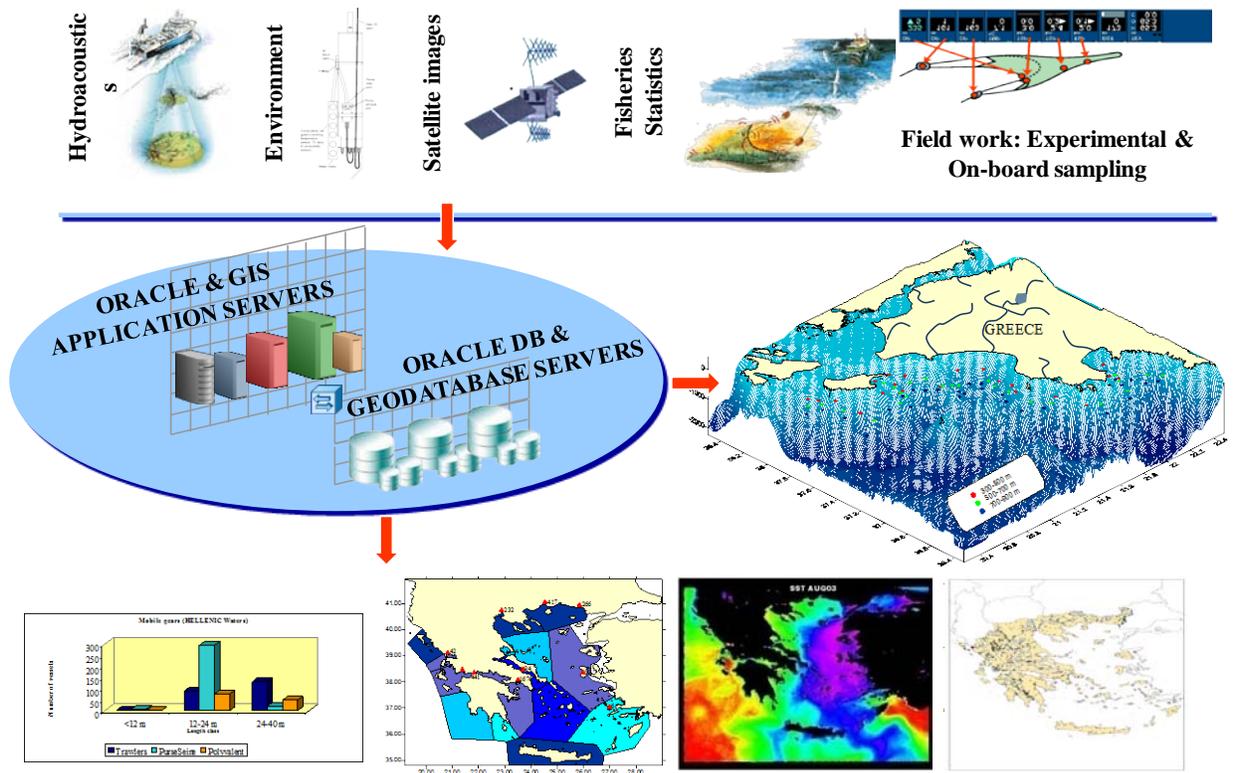


Fig. 6. Schematic presentation of the IMBRIW database.

It is worth pointing out that HCMR publishes one of the two Greek journals that are included in the ISI database, the *Mediterranean Marine Science* (with an impact factor of 1.6). The editor-in-chief of this journal is a member of IMBRIW. Another member of IMBRIW is also editor-in-chief of the *Journal of Animals and their Management*. In addition, several members of IMBRIW serve in the Editorial Boards of the following scientific journals: *Marine Ecology Progress Series*, *Scientia Marina*, *Hydrobiologia*, *Mediterranean Marine Science*, *Acta Ichthyologica et Piscatoria*, *Turkish Journal of Fisheries and Aquatic Sciences*, *Electronic Journal of Ichthyology*, *International Journal of Fisheries and Aquaculture*, *Journal of Aquaculture in the Tropics*, *Scientific World Journal*, *American Journal of Experimental Agriculture*, *Fisheries Research* (guest editor) and *The Open Fish Journal*.

The ICCAT Mediterranean swordfish Group, the Pan-Mediterranean Acoustic Survey (MEDIAS), Working Group on age reading of red mullet and striped mullet (WKACM) and GFCM Working Group on small pelagic were all coordinated by IMBRIW staff.

The research staff of IMBRIW participates in MSc and PhD post-graduate courses in Greek and foreign Universities. They also offer training services to students from several Greek Universities, such as University of Crete, University of Athens, University of Thessaly, University of Thessaloniki and University of Aegean and various Technological Schools. Overall, the number of PhD students supervised by IMBRIW staff almost doubled from 2005 to 2012.

## **A.8. Societal relevance**

The activities of IMBRIW:

- enhance ecosystem services (i.e. by increasing the economic, cultural and aesthetic value of the aquatic and riparian environment, advancing its potential for ecotourism development, increasing the welfare of fisheries communities and protecting public health). This is accomplished through information dissemination, consultancy services and the elaboration of management plans for the sustainable use and conservation of natural resources to the benefit of the society at large;
- contribute to sound environmental and fisheries policy making, at the regional, national and European levels, through their participation in various council bodies (e.g. Greek fisheries council, Greek Water Council, ICCAT, GFCM, FAO-EASTMED, ERC, Drin Core Group);
- enhance public awareness in environmental conservation issues since the intense public informative campaigns (especially targeting primary and secondary school students) sensitize people to environmental conservation issues and accredits the long-term preservation of valuable resources;
- are characterized by a strong interaction with stakeholders (fisher associations, consumer associations, other associations and public authorities) providing them general and technical advice as well as training on issues related to the conservation of aquatic resources and ecosystems. In several cases, stakeholders (fishers' associations, Developmental Companies, Municipalities, other authorities) participate, through the co-operation with IMBRIW, in EU projects;
- provide training of fisheries related courses in Universities and high education establishments as visiting professors
- create new jobs, i.e. scientific and technical personnel employed either at the Institute or at the implementation sites of the IMBRIW projects, and lead to direct monetary flow at the projects' implementation sites (subcontracting local companies for various final construction plans, constructions, fieldwork, e.g. in Life projects) and
- include the training of undergraduate and postgraduate students, thus increasing their potential to get a specialized job.

## **A.9. Weaknesses and threats**

The high average age of researchers, nationally imposed freeze in recruiting permanent research staff, severe salary cuts, brain-drain especially of the young and comers, decline of national funding, unpredictability of the administrative and institutional environment and sterile bureaucracy, all in a synergetic fashion impose significant constraints and counteract IMBRIW's efforts.

## **B. Quality of IMBRIW**

### **B.1. Contribution to the field**

During the current evaluation period, IMBRIW had original contribution to addressing high-order scientific questions (see Fig. 13 in section F), including alien-species dynamics, status

assessment and conservation of endemic freshwater fish, identification of essential habitats–habitat mapping, effect of fishing on marine ecosystems, optimum exploitation of marine stocks, aquaculture-fisheries-environment interactions, assessment of ecological status in surface waters, structural and functional ecosystem aspects, temporary aquatic ecosystems, integrated river basin management.

Indicative of the above is the fact that during the last 8 years, the IMBRIW staff has been actively involved in MARI CURIE, ERANET and, nearly all, FP6, FP7 relevant European projects (e.g. FISBOAT, BECAUSE, EFIMAS, NECESSITY, PRONE, CAFÉ, AFRAME, SARDONE, MESMA, MEECE, **BADMINTON**, REPRODUCE, CORALFISH, DEEPSEAFISHMAN, SUSY, ODEMM, MADE, JACKFISH, AQCES, PERSEUS, PEGASO, ARCH, MYFISH, CREAM, SOCIOEC, TEMPQSIM, MIRAGE, FAME, STAR, HYDRATE, **ACOUSTIC RAINFALL**, **PREWEC**, **MEDISEH**, **ACOUSMED**, ECODOM, JOINT ASSIMILATION, PREVENTESCAPE, **EnviEFH**)<sup>1</sup> resulting in many original scientific publications (see also section ‘Scientific publications’).

Major scientific contributions of IMBRIW that go beyond the application of existing technologies include:

- the acquisition of a unique data-modeling expertise for advancing predictability and impacts assessment for river basin management ,
- modeling efforts and remote sensing in various lagoon and inland water bodies to assess their vulnerability to climate change and human activities,
- interpretation of biogeochemical processes during draughts and initial floods ,
- effects of droughts on freshwater aquatic communities,
- ecotoxicological assessment of agro-industrial wastewaters’ effects on aquatic communities,
- development of indicators on Alien species
- development of ecosystem models,
- essential fish habitat modeling with advanced remote sensing and statistical modeling,
- Geographical Information Systems tools for fisheries applications,
- remotely operated instruments to assess trawling impacts,
- development of non-destructive methods (visual surveys with SCUBA or ROVs) to assess marine populations,
- coupling of fish bioenergetic models to operational lower trophic level and oceanographic models to predict population variability,
- bioeconomic models in fisheries,
- numerical weather forecasting.

Routine collection and maintenance of data is important for providing advice at national and European level, yet, the existence of such databases is a requisite in environmental and fisheries research projects that are highly dependent on analyzing/modeling these data, thus

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<sup>1</sup> with bold are marked the projects coordinated by IMBRIW members.

allowing us to address high-order questions. There is no other organization in Greece that can take the task of such data collection within EU Data collection frameworks.

## **B.2. Coherence of the Institute**

IMBRIW is characterized by team working in multidisciplinary fields of research, covering both earth and biological sciences. Its holistic ecological background and perspective is the greatest of its assets, covering a broad scope with respect to the scientific areas handled, i.e., conservation and management of fisheries resources, inland waters, coastal zone and marine ecosystems, which require a diverse expertise. This multidisciplinary framework is also evident from the involvement of scientists from various fields in joint projects, their joint publications, etc.

Furthermore, during the one year that has lapsed since the merger of the two former Institutes, IMBRIW has already succeeded in getting funding through the KRIPIS project, which targets to study and evaluate the effect of river inputs to the coastal zone (hydro-meteorological modeling of runoff and water flow, assessment of water chemical quality, pollution and their effects on marine ecosystems and its components such as ichthyoplankton, plankton, fisheries).

The RTD activities of the Institute are supported by the common Modeling and Assessment Unit, the Laboratory Unit (Ichthyology, Ichthyoplankton, Histology, Macroinvertebrates, Hydrology-Hydrochemistry) and the Database and GIS Unit.

Moreover, projects related to four large EU Directives (Habitats Directive, Data Collection Framework, Water Framework Directive and Marine Strategy Directive) strongly improve the collaboration between the members of the Institute, due to their highly multidisciplinary nature, with two of these projects also involving co-operation with the Institute of Oceanography (IO). In addition, the incorporation of the Department of Meteorology of IO to IMBRIW further strengthened the collaboration between IMBRIW and IO and allows for IMBRIW to expand its research on the effect of climate change on aquatic ecosystems.

## **B.3. Research staff**

### **B.3.1. Director of the Institute**

The new Director of IMBRIW, Prof. Konstantinos I. Stergiou, has a BSc in Biology, School of Biology, Aristotle University of Thessaloniki (1976-1981), a MSc in Oceanography, Institute of Oceanography, McGill University (1981-1984) and a PhD in the Department of Zoology, School of Biology, Aristotle University of Thessaloniki (1986-1991). He has attended special training courses in Portugal (NATO ASI on Operational Fisheries) and USA (Summer school on Ecological Time Series, Cornell University). Since 1985, he has held a position as a research associate in the National Centre for Marine Research (NCMR, now HCMR, Greece) whereas during 1995-2001 served as an Assistant Professor, since 2001 as an associate professor and since 2006 as a professor at the School of Biology, Aristotle University of Thessaloniki. He teaches both undergraduate and graduate courses on Ichthyology, Fisheries Biology, Fisheries Resources and Management and Time-Series Analysis. He supervise(d)s 18 MSc and 6 PhD theses and co-supervise(d)s 6 PhD theses. He was the Director of the laboratory of Ichthyology for 2007-2013.

He has research interests on fish life-history and population dynamics, fisheries ecology, modeling and forecasting, and ecosystem management, and bibliometrics. He has participated in 26 national and international projects of NCMR and Aristotle University, and has coordinated 8 European Union (EU) projects. He was a member of the EU STCFM committee (1997-2002) and the Coordinator of the Fishery Science Task of CIESM (International Commission for the Scientific Exploration of the Mediterranean Sea). During 2001-2004 he was the Head of the CIESM Subcommittee on Living Resources and during 2004-2007 was the co-Chair of the CIESM Committee on Living Resources and Marine Ecosystems. He acted as the National Coordinator of FishBase for Greece (since 1998) and since 2004 is the representative of Aristotle University (School of Biology, Department of Zoology) in the FishBase Consortium.

He has participated in the Steering Committee of 8 national or international Symposium/Congresses and organized-coordinated three CIESM Workshops. He serves in the Editorial Board of the journals *Fisheries Research*, *Ethics in Science and Environmental Politics*, *Journal of Biological Research* and *Mediterranean Marine Science*. He is also a contributing editor of the journal *Marine Ecology Progress Series* and Associate Editor for the FishBase Section (responsible for 'Short Communications in Ichthyology') in the journal *Acta Ichthyologica et Piscatoria* and Academic Editor of *Plos-One*.

He has contributed 128 papers in peer-reviewed journals, 18 book chapters, as well as more than 220 other publications (i.e. conference proceedings, special publication, newspaper and magazines) and co-authored 37 technical reports. For more information see Google Scholar profile (<http://scholar.google.gr/citations?user=k8hb4pIAAAAJ&hl=en&oi=ao>).

### B.3.2. Other research staff

All IMBRIW researchers (their number during 2005-2012 is shown in figure 7) have, apart from their individual 'Excel 4b sheets', Google Scholar pages in which their publications, the journals in which these publications appear, their total citations and h indices are shown.

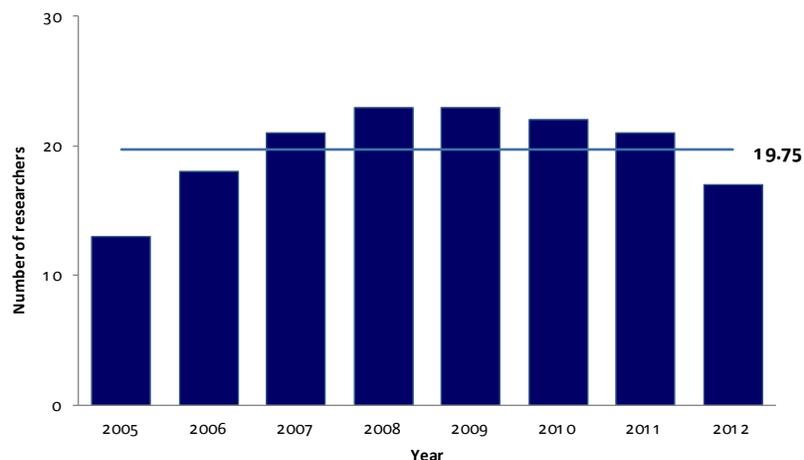


Fig. 7. Number of IMBRIW researchers, 2005-2012

### B.4. Scientific publications (scientific impact)

During the current evaluation period, the staff of IMBRIW published in 152 journals, some of which are among the best and most prestigious for the field with impact factors > 2<sup>2</sup>. The average and median 2012 impact factor of the journals in which the staff of IMBRIW published during 2005-2012 was higher than the average and median impact factor of the two categories 'Fisheries' and 'Marine and freshwater research' of the ISI system, combined (Table 1). The same is also true of the two fields separately (results not shown).

Table 1. Statistical properties of the Impact factor (IF) of the journals in which IMBRIW published its research in 2005-2012 compared with those referring to all journals of the ISI categories 'Fisheries' and 'Marine and Freshwater Biology' combined. In brackets the weighted average, by number of articles, of the IMBRIW publications.

|                    | All journals of the two ISI categories | Journals in which IMBRIW published its research |
|--------------------|--|---|
| Number of journals | 130                                    | 152   |
| Average IF         | 1.62                                   | <b>1.99 (1.91)</b>                              |
| Minimum IF         | 0.14                                   | <b>0.26</b>                                     |
| Maximum IF         | 14.37                                  | <b>7.22</b>                                     |
| Median IF          | 1.31                                   | 1.70  |

During this period, IMBRIW received a total of 11123 citations of which 3350 were self-citations and 7573 hetero-citations. The annual number of hetero-citations increased from 439 in 2005 to 1448 in 2012 (Fig. 8).

We point out here that all citations were estimated using Google Scholar<sup>3</sup> checking for each unique publication separately.

<sup>2</sup> Hydrobiologia, Aquaculture, Ecological Modelling, Journal of Environmental Monitoring, Fisheries Oceanography, Marine Policy, Journal of Experimental Marine Biology and Ecology, ICES Journal of Marine Science, Estuarine Coastal and Shelf Science, Atmospheric Research, International Journal of Climatology, Monthly Weather Review, Journal of Hydrometeorology, Marine Environmental Research, Journal of Environmental Quality, Advances in Water Resources, Biological Journal of the Linnean Society, Journal of Plankton Research, Marine Biology, Biological Invasions, Marine Pollution Bulletin, Marine Ecology Progress Series, Journal of Marine Systems, Environmental Toxicology, Marine Geology, Journal of Hydrology, Environmental Science & Policy, Animal Behaviour, Journal of Geophysical Research- Atmospheres , Limnology and Oceanography, Environmental Modelling and Software, Hydrology and Earth System Science, PLoS ONE, Freshwater Biology, Geophysical Research Letters, Climate Dynamics, Water Research , Environmental Science & Technology, Fish and Fisheries, Bulletin of the American Meteorological Society, Oceanography & Marine Biology: An Annual Review, Global Ecology and Biogeography

<sup>3</sup> For justification on use of Google Scholar see Pauly & Stergiou (2005) Ethics Sci Environm Polit 2005:33-35; Stergiou & Tsikliras (2006) Ethics Sci Environm Polit 2006: 15-17; Harzing & Van Der Wal (2008) Ethics Sci Environm Polit 8: 61-73; Harzing (2011) Publish or Perish book. Tarma Software Research.

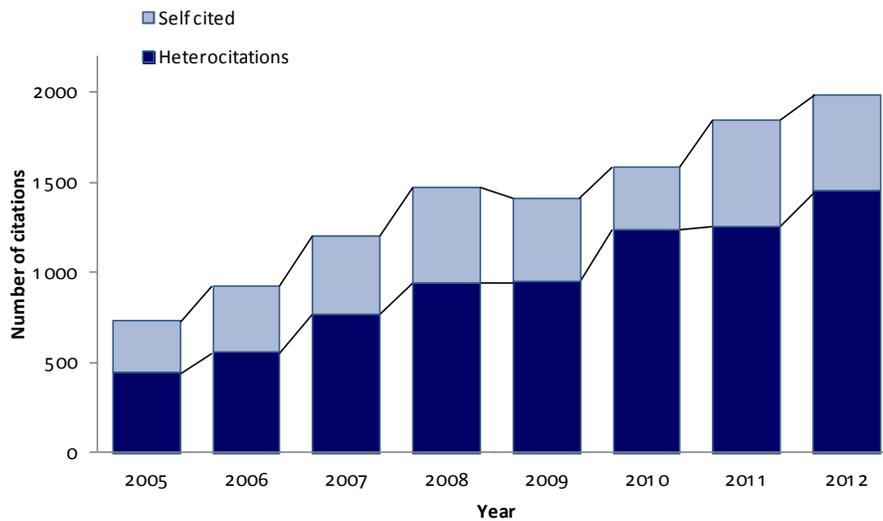


Fig. 8. Number of citations, IBMRIW, 2005-2012.

## C. Productivity aspects of IMBRIW

### C.1. Number of PhD theses

During the current evaluation period, the number of PhD students supervised annually by IMBRIW members has increased from 10 in 2005 to 17 in 2012. It should be noted, however, that till 2008, the Greek legal framework did not allow researchers in Institutes to formally supervise MSc and PhD students in Greek universities. Thus, the role of researchers was to participate in the three-member advisory committee and support students rather than officially supervise them.

### C.2. Number of scientific publications

During the current evaluation period, the staff of IMBRIW has produced a total of 1755 items of which 629 (36%) are in peer-reviewed journals (including full articles in international conferences) (Fig. 9).

The number of publications in peer-reviewed journals during 2005-2012 fluctuated between 62 and 92, with a mean annual rate of 79 papers (Fig. 10). The total number of all remaining type of publications was 1126, and a mean annual rate of 141 items per year (Fig. 11). It is worthy to point out that IMBRIW has also published a multi-authored book entitled *State of the Hellenic Fisheries*.

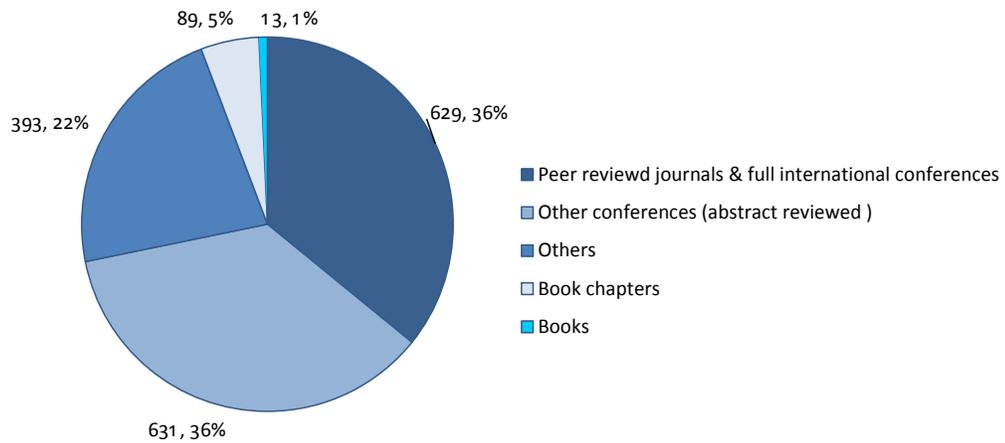


Fig. 9. Number of publications and % per publication category, IMBRIW, 2005-2012

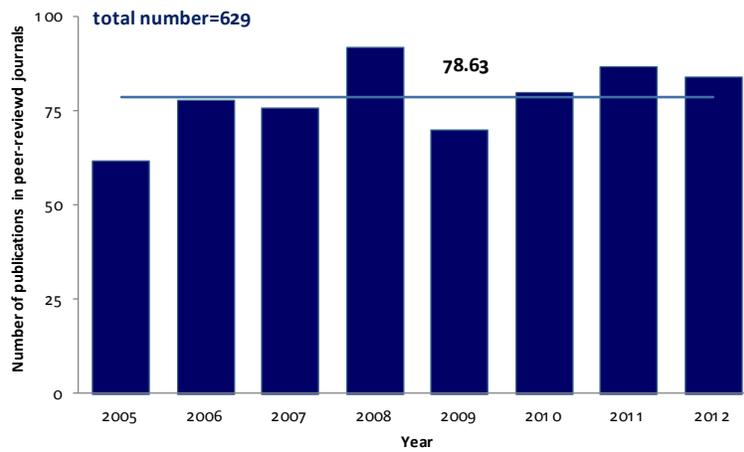


Fig. 10. Number of publications in peer-reviewed journals, IMBRIW, 2005-2012.

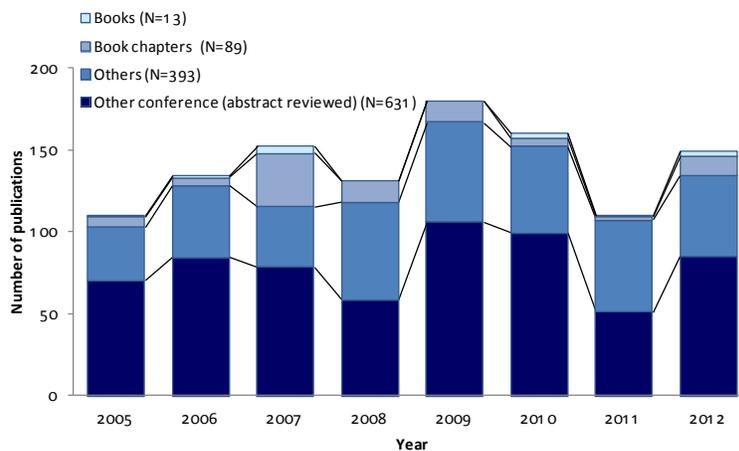


Fig. 11. Number of all other publications, IMBRIW, 2005-2012.

The number of peer-reviewed articles in journals per researcher declined from 4.77 in 2005 to 3.04 in 2009 and increased again to 4.94 in 2012, with an annual mean of 4.06 articles/researcher/year (Fig. 12, upper part). The number of all other published items per researcher also declined from 8.46 in 2005 to 5.24 in 2011 and increased again to 8.76 in 2012, with an annual mean of 7.25 items/researcher/year (Fig. 12, lower part).

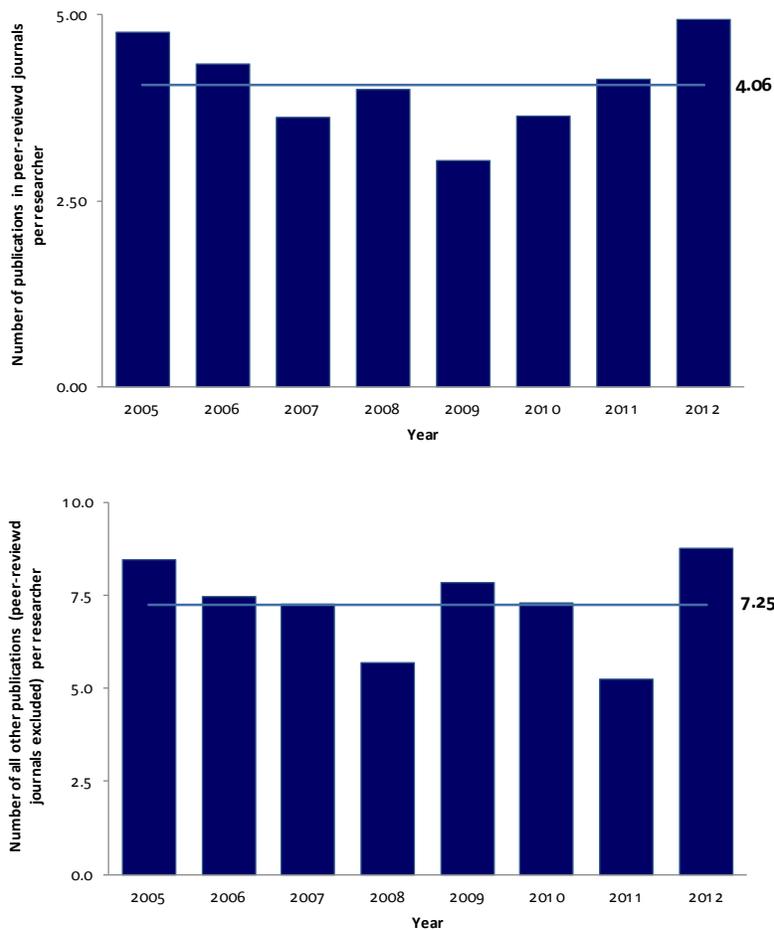


Fig. 12. Number of publications per researcher, IMBRIW, 2005-2012.

### C.3. Other results

During the evaluation period, IMBRIW, within the framework of its collaboration through advising the Greek authorities, has produced several Management Plans, among them one for purse-seines and another one for trawls in implementation of 2006/1967/EC, which have been adopted by STECF and have already been incorporated into the Greek Legislation. In addition, members of the IMBRIW have been awarded 10 prizes (e.g. three best LIFE projects, ECOCITY award). The Institute is the official data base administrator for marine cetaceans and turtles standings in Greece. In 2005, following the previous evaluation from the General Secretariat of Research and Technology, the Institute was appointed as the Centre for Excellence for Fisheries and Coastal Zone Management. A member of the Institute has been also actively involved in

the preparation of the new Regulation (9.9.2013) on the prevention and management of the introduction and spread of invasive alien species (<http://ec.europa.eu/environment/nature/invasivealien/docs/proposal/en.pdf>).

## **D. Relevance of IMBRIW research**

### **D.1. Advancement of knowledge**

IMBRIW has advanced knowledge on marine and inland water ecosystems in the Mediterranean, European and international level by addressing high-order scientific questions: (a) alien- species dynamics, (b) status assessment and conservation of endemic freshwater fish, (c) identification of essential habitats – habitat mapping, (d) optimum exploitation of marine stocks, (e) assessment of ecological status in surface waters, (f) ecosystem structure and function, (g) aquaculture-fisheries-environment interactions, (h) effect of fishing on marine ecosystems, (i) impact of extreme events (droughts and floods) on river ecosystems, (j) temporary aquatic ecosystems, (k) hydro-meteorological processes (l) integrated river basin management and (m) establishment of integrated coastal zone management policies and tools in Greece.

### **D.2. Dissemination of knowledge**

The information, main findings and knowledge produced by IMBRIW research projects and other activities is disseminated to the scientific community, stakeholders (i.e. fishers, farmers and their associations, industry, managers, Ministries, Regions, Municipalities and other authorities, NGOs) and public at large, through: (a) publication of scientific papers in peer reviewed journals, publications in books and national and international conferences, symposia, meetings and workshop proceedings and publication of technical reports; (b) popularized articles in magazines, periodicals and newspapers; (c) the Institute's webpage; (d) dedicated project webpages; (e) the organization of special events (i.e. popular talks, meetings, workshops) organized by the Institute as well as by participating in meetings organized by third parties including Environmental Education Centres; (f) leaflets, CD-ROMs and documentary video productions; (g) teaching courses in Universities and other high education establishments (h) through the activities of the HCMR Educational Unit, which organizes regular environmental education events and training for primary, secondary and tertiary students and teachers, and (i) Special environmental interpretation exhibits in protected areas (e.g. Trichonis Lake).

### **D.3. Implementation of knowledge**

Avenues for the implementation of the knowledge produced by IMBRIW are (a) the elaboration of management plans, including restoration and development of protected areas, (b) consultation and advising on policy and its implementation to various Ministries, governmental organizations, and EU Policy applications (e.g. Common Fisheries Policy, Water Framework Directive) in which knowledge accumulated through time and research can contribute to official regulations and measures and (c) development of education, training and public awareness

initiatives to influence wider understanding and participatory processes in aquatic resource management.

**E. RESPONSE TO THE 2005 EVALUATION**

Given that the 2005 evaluation referred to the two institutes that today make up IMBRIW, the response to the 2005 evaluation comments is provided separately, in Appendix I for the Former Institute of Marine Biological Resources and in Appendix II for Former Institute of Inland Waters.

## F. FUTURE STRATEGY 2013-2018

IMBRIW's past, present and future research directions and main questions addressed are summarized in figure 13.

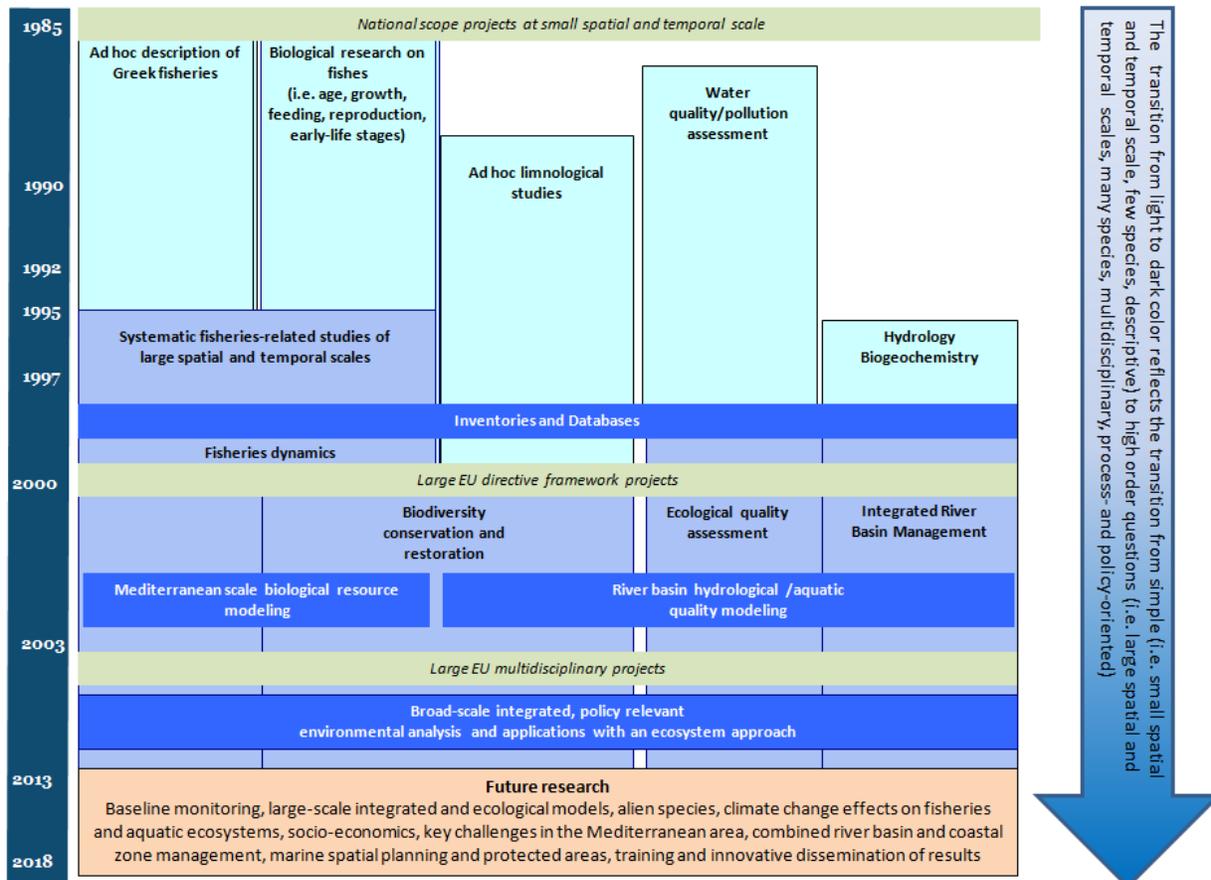


Fig. 13. IMBRIW's past, present and future research directions and main questions addressed.

During the next period, IMBRIW will exploit existing know-how and expertise to enhance its international role, academic reputation, policy-relevant advisory role and dissemination activities at the National, European and International level. This will contribute to focusing on successfully addressing high-order research questions, notably the effect of climate change on fisheries and aquatic ecosystems, ecosystem approach to fisheries management, key challenges in the Mediterranean area such as water scarcity, water conflicts and water-borne diseases within the wider theme of climate change and integrated management approach, restoration and rehabilitation of degraded aquatic and semi-aquatic ecosystems, integration of river basin and coastal zone management. Special emphasis will be given to a fuller integration of socio-economics and environmental engineering in management and restoration, as well as to the integration of fisheries in marine spatial planning and coastal zone management.

IMBRIW is in the process of establishing an effective collaboration network among key role players in Mediterranean and Black Sea fisheries research and management with respect to the

Ecosystem Approach to Fisheries. We are seeking to identify the gaps (in terms of data, knowledge, training, coordination), which hamper at present the full application of the Ecosystem Approach in the management of Mediterranean and Black Sea fisheries. We will further develop a strong training and capacity-building component in order to harmonize data collection and methodologies used in fisheries assessment and management in the Mediterranean and Black Sea, both in EU member states and third countries.

Moreover, IMBRIW is in the process of organizing a formal network of research institutions active in Mediterranean basin research, management and conservation, including stakeholders, NGOs and policy and decision makers. Among the aims of the network are: gap analysis of research, management and conservation needs, enhance knowledge transfer among different players active in integrated river basin management, definition of emerging environmental policy issues and their promotion at EU policy levels. A number of 20 institutions mainly from the European Mediterranean countries participate currently in the informal network. This number is expected to increase and extended to non-European Mediterranean countries with the approval of a COST proposal will be applied.

IMBRIW will continue putting effort to the four major European Directives (WFD, MSD, DCF, HD) because through this IMBRIW will gain access to EU and international projects, scientific networks and funding sources.

The future funding strategy of IMBRIW will be also oriented towards exploiting the new EU smart specialization opportunities, at the regional level, towards sustainable development, advancement of more effective resource use, as well as more environmentally friendly and competitive economy. In the framework of IMBRIW's adapted strategy to the new regionalization of the European funding policy, IMBRIW has already submitted proposals and is cooperating with certain regional authorities. IMBRIW is in the process of strengthening collaboration with UN regarding integrated river basin management in third countries and intends to allocate funds from this organization in the near future. Finally, IMBRIW will also explore funding opportunities from private charity funds.

IMBRIW will actively pursuit the recruitment of young post-doc scientists as well as to radically increase the number of PhD students conducting their research in the facilities of the Institute. To that end, IMBRIW also plans to develop two MSc level programs in co-operation with Greek universities as well as the establishment of a series of summer schools.

IMBRIW will put effort in hiring an environmental economist (or develop this discipline through PhD theses undertaken in collaboration with Universities) so that to fully develop multidisciplinary approaches involving biologists, economists, oceanographers and meteorologists.

Special attention will be given to increase coherence and synergies between the members of the two former institutes for the full integration of their activities. For this purpose, joint research activities will be encouraged and funding for such initiatives will be actively pursued;

an example of this is the proposal (“Development of a system for the integrated management of river basins and adjacent coastal area”) that has been approved by the General Secretariat of Research and Technology. This project includes two research strategies:

- Integration of Integrated River Basin Model (IRBM) with coastal zone management. This goal will be implemented through research collaboration between the scientists of IMBRIW.
- Further integration of ecological status assessments and biodiversity conservation, as well as of hydro-meteorological models and tools coupling with hydrological and aquatic quality watershed models.

Further upgrade and modernization of research infrastructure, focusing on IMBRIW’s new synergies, to keep pace with the rapid technological progress in scientific research and the methodological requirements of research projects. Special attention will be given to the reconstruction and modernization of R/V PHILIA for which proposals have already been submitted in 2013. In addition, IMBRIW’s laboratory facilities will be expanded within 2014 by about 100 m<sup>2</sup> using project funds.

IMBRIW plans also to promote its services through the Institute's website, attracting contracts to provide specialized consultation to various stakeholders including fishers’ associations, regional and local governments, management bodies, NGOs, private clients, etc.

**Specific goals related to the research directions of IMBRIW are presented below.**

IMBRIW will continue its research on various issues addressed during 2005-2012 in addition to the state-of-the-art scientific issues described below.

*Modeling and assessment*

- Application and testing of novel data-limited stock assessment and management methods in the Mediterranean Sea. The Mediterranean Sea is a classical example of a ‘data-limited’ stocks region. We will examine and test a number of novel data-poor stock assessment methods (e.g. Bayesian, Catch-MSY, depletion-corrected average catch analysis DCAC) with regard to their general applicability in the Mediterranean fisheries management system.
- Development of an integrated bio-economic modeling tool to advance and support multi-objective approaches for fisheries management. We will develop a modeling tool to evaluate the biological and economic effects of different harvesting strategies directed at extracting the long-term maximum sustainable production while avoiding the risk of recruitment overfishing and modification in the ecological structure and functions of the exploited fish community.
- Maximizing yield of fisheries while balancing ecosystem, economic and social concerns. There is a commitment to direct management of fish stocks towards achieving MSY by 2015. Research is underway to provide definitions of MSY variants which maximize other measures of “yield” than biomass and which account for the fact that single species rarely exist in isolation. The aim is to integrate the MSY concept with the overarching

principals of the CFP: the precautionary and the ecosystem approach. To this end we will use modifications of existing ecosystem and fisheries models to perform maximization of stakeholder approved yield measures while ensuring acceptable impact levels on ecosystem, economic and social aspects.

- The Institute will expand the application of IBMs to more species' full life cycle, not only to explore population dynamics and environmental and fisheries effects but evaluate management scenarios, define recruitment areas and investigate the link of biogeochemical processes with higher trophic level production. For this application, IMBRW will cooperate with the IO of HCMR.
- Further expanding Ecopath-w-Ecosim models, incorporating an end-to-end approach, and develop spatial and temporal simulations to evaluate the effects of fisheries on ecosystems, the effect of discard ban and selectivity improvement in order to explore different management scenarios in the Mediterranean.

#### *Fisheries dynamics and capture*

- Two pieces of information that are missing in order to evaluate the total biomass removed from the Greek (and Mediterranean) waters, and thus to model marine ecosystems, are the catches of sport fishery, subsistence fisheries as well as discards and the illegal, unregulated and unreported catches. These components, which are not included into the National database of the Hellenic Statistical Authority, can be as high as 100% of reported landings. Thus, research will be directed in estimating these missing fisheries components. This will eventually lead to the complete reconstruction of Greek marine fisheries landings for 1900-today. An attempt will be made to eventually incorporate these reconstructed landings into the official Hellenic Statistical Authority database.
- Fishing effort monitoring will be upgraded using the Vessel Monitoring System that has been recently introduced to Greece to evaluate the true effort and its spatial distribution on a daily basis, to study fisher's behavior and the relationship between effort and demersal and pelagic abundance and distribution.
- Fishing Capacity Assessment. IMBRIW will direct research efforts towards evaluating fishing capacity utilization and economic efficiency of trawl fisheries in Greece. The aim is to obtain quantitative measures of excess and overcapacity that could provide critical information in balancing the productive capacity of the stock with the harvesting capacity of the fleet.
- Fishers' behavior and fleet dynamics. Work will be directed at (a) supporting the objectives of the reformed CFP on regionalized fleet-based management through aiming management measures to fleet segments that contribute the most to stock depletion and (b) evaluating fishers' attitudes for new management measures proposed under CFP reform process and how fishers make trade-offs between alternative policy attributes.

#### *Fisheries ecology and ecosystem approach to fisheries management*

- Evaluate the effects of climate variability on the distribution, abundance and life-history of pelagic and demersal species.
- The expertise of IMBRIW on acoustics, which have so far been applied to small pelagic fish only, will be expanded for simultaneous biomass long-term monitoring of small pelagics and zooplankton. This will provide continuous, high resolution, 3D data in contrast to other methods that collect dispersed point data. Such a modern approach, which will involve also the IO, will contribute to clarifying the food web function and structure, thus, serving as a sampling platform for an ecosystem approach to fisheries management. It will also provide additional indices for studying the marine reserve effects.
- Evaluation of the importance of seabed habitat and functionality in sustaining demersal fish populations in the oligotrophic Eastern Mediterranean.
- Evaluate the economic, social and ecosystem effects of the new discard ban especially for oligotrophic ecosystems such as the Mediterranean ones. According to the reform of the Common Fisheries Policy, discarding will be gradually banned in EU waters. In this context, IMBRIW's goal is to contribute to the assessment of impacts of the discards ban on the ecosystem and on fisheries resources. Furthermore, the feasibility and effectiveness of the implementation of the new regulations should be explored by taking into account fishers' conceptions and strategies, socioeconomic aspects and the viability of the fisheries sector as well as by proposing ways to avoid unwanted catches through technical specifications (selectivity improvement) and avoidance of fishing grounds (spatiotemporal closures and adaptations to fishing strategies) that generate high unwanted catches.
- Socio economic effects of management measures of the future EU Common Fisheries Policy. We will bring together fisheries scientists with industry partners and other key stakeholders to work in an integrated manner on solutions for future fisheries management, which can be implemented at a regional level. Our goal is to evaluate the impacts of the management measures that emerge from this process, particularly in terms of their economic and social impacts.
- Investigation of the appropriate governance structures contributing to effective fishery management. This will be achieved through research to determine the appropriate governance structures required for different fishery types, considering particularly scale issues and stakeholders. Address enforcement and compliance issues, tackling monitoring, control, and surveillance through the application of innovative technologies, and by increasing awareness of fishers' on ecosystem sustainability.
- The establishment and management of marine protected areas within a marine spatial planning framework.
- Historical reconstruction of the Mediterranean marine ecosystems, with special emphasis on fish and the charismatic mega fauna (i.e. marine turtles, marine mammals, sea birds), using information from different sources.

*Biodiversity conservation and environmental restoration*

- Modeling the distribution of alien species in the Mediterranean Sea and the interactions with local species and climate change. Biodiversity indicators of exploitable fisheries communities.
- Continuation of studies for the identification of new species, the exploration of freshwater species and habitats not investigated in the past, as well as studies on the genetic composition of species, their biology and ecology.
- Further exploration of alien-native species' interactions, e.g. assessing the impact of invasive freshwater fish species on condition and reproduction of native species.
- Continuation of assessment of dam construction in Greek rivers on fish and their habitats, estimation of minimum ecological flow for conserving local fish populations and formulation of potential rehabilitation actions for the restoration of natural substrata and fish assemblages.
- Integration of socio-economics in projects concerning the management, restoration and rehabilitation of degraded aquatic and semi-aquatic ecosystems.
- Implementation of conservation projects that will entail a strong collaboration between the IMBRIW scientists, international research groups working in the field of conservation, stakeholders and users of the resources.
- Further development of the appropriate infrastructure and managerial tools for the efficient conduct of conservation and restoration activities in various scales (local, regional, national).
- Increasing dissemination of the results of IMBRIW research in local, national and international level.

#### *Ecological quality assessment*

- Continuation of the National Monitoring Program.
- Development or modification and validation of existing ecological quality metrics and indices for state-wide application using the results of the National Monitoring Program. This initiative will enable the creation of nationally-approved bioassessment tools based on macroinvertebrates, fish and diatoms. Special emphasis will be given to less studied river types such as non-wadeable rivers, temporary and island rivers and streams, small wetlands, lakes, ponds and lagoons. Three PhD dissertations will focus on development of stream macroinvertebrate metrics including perennial streams, non-wadeable rivers, and island streams. The latter PhD thesis will address island biogeographical and conservation aspects.
- Through collaboration with German and Austrian research teams a fish-based bioassessment index employing a predictive modeling approach will be developed.
- Assessment of ecological-flows in rivers in the framework of a recently approved project (ECO-FLOW). A PhD will target the development of methods for the assessment of ecological flows in rivers using fish as indicators.

#### *Integrated River Basin Management*

Specific goals for future research strategy include:

- Research on improving operational numerical weather forecasts.
- Research on the development of a fully coupled atmosphere –ocean wave system.
- Regarding water quality monitoring in Lakes and Estuaries by combining remote sensing techniques, operational monitoring algorithms will be attempted by combining satellite and in-situ data while the prediction accuracy will be increased and more widely applicable models will be produced, (at a regional or even country level).
- Short-term flood forecasting through the application of distributed hydrologic modeling to advance the predictability of flash floods and develop more accurate warning systems by coupling numerical weather prediction models with fully dynamic hydrologic models (MIKE by DHI).

*Integrated coastal zone management*

- Develop tools for the sustainable development of Greek coastal area focusing on spatial planning, conflict resolution, establishment of marine protected areas and artificial reefs combined with business plans for further economic exploitation
- Develop activities related to telemetry monitoring applications including the development of robotic systems and related patents
- Elaboration of management plans for marine protected areas in support of the National Agencies of Protected Areas
- Provide services in third countries and especially Middle East and Africa (sub-saharan)
- Several collaborations related to integrated coastal zone management, (this is already established through the PEGASO project business plan)

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## **APPENDIX I**

### **Response to 2005 evaluation comments Former Institute of Marine Biological Resources**

***Leadership. In comparison to other Institute directors there seemed to be a lack of international leadership in the field of Fisheries management. The focus seemed to be on following EU directives rather than informing the policy makers at national, EU and international fora.***

During the last eight years, the Institute has strengthened its international role within and outside the Mediterranean basin in the field of fisheries and fisheries ecology and management. The Mediterranean Sea is a special area from many aspects. It is a closed basin, of general oligotrophic nature and high spatial heterogeneity. Fisheries management is solely based on technical measures with the exception of blue fin tuna. It is characterized by very old mixed fisheries, shared stocks, short time series of monitoring surveys and stock are known to be 'data poor'. All these aspects impair the need to adjust fisheries management accordingly. Members of the Institute during the last eight years have grabbed the opportunity and challenge to work towards covering gaps in knowledge on local stocks, adjusting applied methodology and techniques to local needs and peculiarities. This was largely achieved by taking either a leading role or being active members in several Consortia (MAREA), Working Groups (e.g. major Working groups of the General Fisheries Council for the Mediterranean – GFCM, STECF stock assessment working groups), international projects (e.g. BADMINTON, PREVENTESCAPE, EnviEFH, MEDISEH, AcousMed, MEDPEL, Archimed, StockMed, Bemtool, Mygears) and internationally coordinated surveys (i.e. MEDITS, MEDIAS) in the Mediterranean with the main aim of advancing fisheries research, improving fish stock assessments, standardizing monitoring surveys, and adjusting surveys and sampling to the needs of the ecosystem approach to fisheries. Thus, the Institute had the opportunity to disseminate findings and suggestions on management advice in a more effective way directly to policy makers at national and EU levels.

Outside the Mediterranean, the Institute has been an active member in a number of International Organizations, Consortia and Working Groups like the EFARO (Organization of the directors of fisheries and aquaculture research centers of European member states), the EC STECF (Scientific Technical and Economic Committee for Fisheries) and its SubGroups, the Cephalopod International Advisory Committee (CIAC), the ICES Working Group on Fisheries Acoustics and Technology, Fish Aging and Cephalopod Biology and Life Strategy, the International Commission for the Conservation of Atlantic Tunas (ICCAT) and the Northwest Atlantic Fisheries Organization (NAFO). This also assured that the Institute followed the current advances on fisheries science. There has also been an active participation in large research networks and ERANETs, such as MARIFISH and COFASP, the EU COST Action "FRESH" and the EUROCEAN. Furthermore, the Institute has been coordinating the pan-Mediterranean survey-at-sea for small pelagic species (MEDIAS) for the period 2008-2010 and has taken a leading role in the standardization of acoustic surveys in the Mediterranean through the AcousMed project (2010-2012).

A member of the Institute has been actively involved in the preparation of the new Regulation (9.9.2013) on the prevention and management of the introduction and spread of invasive alien species <http://ec.europa.eu/environment/nature/invasivealien/docs/proposal/en.pdf>.

The main income of the Institute derives either from major EU projects, or small international projects (i.e. contract services to DG MARE), in which the staff is actively involved producing new knowledge and developments in the field of fish stock assessment and management and fisheries oceanography, with case studies from the Mediterranean Sea. Since 2007, the Institute has also been playing the main role in providing advice to the Greek Ministry for the adoption and implementation of Management Plans for the Greek Fisheries in line with the New EU Regulation for Mediterranean Fisheries.

***Strategy and policy. Apart from groups mentioned above long-term strategy would appear to be lacking.***

The long term strategy of the Institute has been revised. During the current period of evaluation, the Institute directed its efforts to:

- increase its international role by strengthening its membership in International Organizations, research networks and Working Groups
- enhance its academic reputation by increasing the number of publications in high-profile journals and the number of MSc and PhD students trained in IMBRIW
- fully exploit the multi-disciplinarity of research staff
- increase its policy-relevant advisory role (e.g. Management Plans) and dissemination activities at the National and European level and, thus,
- ultimately attract almost exclusively EU funds (since national funds were limited and unpredictable) and address high-order research questions (see Fig. 13 in section F).

Along these lines, multidisciplinary approaches are required, i.e., the involvement of biologists, economists, oceanographers and modelers in fisheries research. Recruitment of young scientists, PhD students and increasing collaboration with other institutes of HCMR (i.e. the Institute of Oceanography) has been a priority with successful results.

***Adequacy of the resources and Funding policies. The various groups all requested major equipment upgrades in order to undertake planned studies. There is an obvious problem with recurrent capital expenditure within the centre. However, the group should be encouraged to develop alternative sources of funding for large equipment purposes.***

Recent infrastructure funding issued by General Secretariat for Research and Technology have helped in upgrading and modernizing existing laboratory equipment in the histology and ichthyology labs. In the period 2005-2009 there have been 2 additional infrastructure-dedicated projects and 2 RTD funded by the General Secretariat for Research and Technology and the Ministry of Rural Development and Food. All these projects funded the procurement of new laboratory and field equipment (sampling equipment, histology lab) as well as equipment

for the upgrade of the Research Vessel PHILIA (Underwater Fish Egg Sampler and hydro acoustics). The effort of upgrading infrastructure should be continued because of fast technological changes and the need of harmonization with other European Research Institutes.

During the period after the 2005 evaluation, the Institute directed its effort to secure funds mainly (>85%) through European research projects (FP6, FP7, LIFE, INTERREG, MARIFISH), European structural funds (NSRF –ESPA, [www.espa.gr](http://www.espa.gr), OPF - EPAL, [www.alieia.gr](http://www.alieia.gr)), contract services to DG-MARE and projects for the implementation of European policies (Data Collection Framework), with a high success rate, and to a much lesser degree through national funding per se.

***Academic reputation. Widely known for their research in the eastern Mediterranean***

As shown in the comment regarding Leadership (above) the Institute is now widely known also throughout the Mediterranean and plays an important role in Europe. This is evident by the increasing trend in number of citations received, participation in different international consortia and Committees, leadership in several international working groups (e.g. the ICCAT Mediterranean swordfish Group, the Pan-Mediterranean Acoustic Survey (MEDIAS), the Working Group on age reading of red mullet and striped mullet (WKACM), GFCM Working Group on small pelagics were all coordinated by the Institute's staff), increased partnership or coordination of European Research projects, and membership in Editorial Boards of international scientific Journals. It is worth pointing out that HCMR publishes the Mediterranean Marine Science (with an impact factor of 1.6). The editor-in –chief of this journal is a member of IMBR. Another member of IMBR is also editor-in-chief of the Journal of Animals and their Management. The staff of the Institute has increased its participation in PhD and MSc post-graduate training courses in foreign Universities, and its participation in committees which organized new PhD and MSc courses of foreign Universities (University of Dubrovnik Croatia), teaching university courses in Greek and foreign Universities and finally, participation in teaching courses through invited lectures. Finally, staff offers training services to national Universities such as the University of Athens, the University of Thessaly and the University of Aegean.

***Strengths and weaknesses. The strength is there expertise and prominence in marine research in the Eastern Mediterranean with few other Institutes able to compete in this area. A weakness is that boat time and equipment costs are high and if these are not properly supported then the institute will have difficulty in maintaining its mission.***

An increased effort was made so that the Institute to be prominent and competitive in Mediterranean, European and regional level and this is evident from the achievements described above. During 2005-2012 (3rd Greek Structural Program co-funded with the EU), 4 major projects were carried out by the Institute funded by the General Secretariat for Research and Technology and the Ministry of Rural Development and Food. These projects provided funding for the procurement of laboratory and field equipment and scientific instruments as well as equipment for the upgrade of the Research Vessel PHILIA. Regarding the boat time and

similar expenses, it must be noted that all such costs are fully covered by the research projects (eligible expenses), hence they do not hinder the mission maintenance of the Institute.

***Originality of the approach and ideas. The Institute is responsible for several statutory duties on behalf of the Greek government. This reduces their ability to undertake original research. Their work is rather applied and entails the application to the existing technology to the Greek environment and society.***

During the last 8 years, the staff of the Institute has been actively involved in most major European projects (e.g., FISBOAT, BECAUSE, EFIMAS, NECESSITY, PRONE, CAFÉ, AFRAME, SARDONE, MESMA, MEECE, BADMINTON, REPRODUCE, CORALFISH, DEEPSEAFISHMAN, SUSY, ODEMM, MADE, JACKFISH) aiming to advance methodologies, technologies and knowledge in order to improve fish stock assessment and fisheries management in the Mediterranean and Europe. Six additional European projects BADMINTON, PREVENTESCAPE, EnviEFH, SMALLPELAGIC, MEDISEH, ACOUSMED were co-ordinated by the Institute's staff. Through these projects the staff is able to participate in the development of modern and state-of-the-art scientific methods and techniques which are adapted and applied to the Greek fisheries sector particularities either directly or through scientific advice to the stakeholders of the sector, the administration and the EU.

Major developments go beyond the application of existing technologies and include the development of bioeconomic models in fisheries, the coupling of fish bioenergetic models to operational lower trophic level and oceanographic models to predict population variability, the development of ecosystem models, essential fish habitat modeling with advanced remote sensing and statistical modeling, Geographical Information Systems tools for fisheries applications, remotely operated instruments to assess trawling impacts, the development of non-destructive methods (visual surveys with SCUBA or ROVs) to assess marine populations, etc. An increasing number of publications have appeared in the Scientific Journals with results from these projects. Some of these publications are mainly methodological proposing new approaches in fisheries biology and management. It should be noted that, whereas, the Institute plays a key role in collecting, managing and analyzing data from the fisheries sector and perform research surveys at sea to estimate the abundance of fish stocks in Greek waters, its focus is mainly on original research rather than application of existing methodologies to provide services to Greek and EC authorities. Routine collection and maintenance of data is important for providing advice at national and European level, however, the existence of such a database is a pre-requirement in fisheries research projects that are highly dependent on analyzing/modeling these data.

***Significance of the contribution to the field. Some of the research staff make a strong international contribution to the environmental impact of fishery activity on the marine environment.***

The Institute has kept its position in the centre of the latest developments in European research through its active participation in almost all European Framework, as well as relevant European

projects to the field - Projects (e.g., FISBOAT, BECAUSE, EFIMAS, NECESSITY, PRONE, CAFÉ, AFRAME, SARDONE, MESMA, MEECE, BADMINTON, REPRODUCE, CORALFISH, DEEPSEAFISHMAN, SUSY, ODEMM, MADE, JACKFISH, PREVENTESCAPE, MEDISEH, ACOUSMED, EnviEFH) looking at fisheries impacts, evaluating closed areas and MPAs, developing modeling tools and ecosystem based marine management options, bioeconomics and ecosystem and habitat modeling. The Institute has also participated in the ERANET MariFish. Within the MariFish project, the Institute cooperates with the fisheries research funding agencies of EU for the management of the common Mediterranean ecosystem, the exchange of expertise and information, the harmonization of research funding practices among national funders and data sharing in high priority subjects.

***Coherence of the institute. In general the teams work together well but that this could always be improved.***

An effort has been made to increase collaboration among researchers. This has resulted in increased co-authorship and increased production of scientific papers.

***Prominence of the Institute head. As a senior scientist that has a good European reputation in marine biology and fisheries***

The Director of the Institute remained the same during 2005-2012.

***Prominence of the other research groups. Apart from the areas already identified the reputation of the remaining staff is mainly regional***

As noted above, the international reputation of most research teams in the Institute has been constantly improving. Proof for this is the IMBR staff participation in almost all EU FP6 and FP7 projects, in addition to numerous national projects. Recruitment of new researchers during 2005-2012 is expected to enhance scientific output and subsequent prominence of the groups. At the same time the Institute is required to show equal interest on the national front as it is the main Greek data and scientific advice provider for the Greek government and the fisheries sector stakeholders for all fisheries aspects.

***Quality of the scientific publication (scientific impact).The majority of the papers are applied and only appropriate to regional journals. Although the number of peer review papers has increased every attempt should be made to publish in higher impact journals.***

We would like to note here that we do not agree with this interpretation of the previous evaluation. It must be kept in mind that the impact factor for journals on Fisheries is relatively low, compared to other scientific disciplines. Nevertheless, our mean impact factor for the period evaluated has more than doubled (1.99 now, compared to 0.93 in the period 2000-2004) and is higher than the average impact factor (for 2012) of the journals in the ISI category 'fisheries' (=1.4). Furthermore, the number of publications in peer reviewed Journals has also increased in 2005-2012. Many of these papers are methodological, proposing novel methods

and approaches in fisheries biology, monitoring and management of marine resources and address high-order questions. The number of citations also considerably increased.

***Quality of other results. This marking reflects the institute's ability to help the Greek government meet their statutory requirements under the CFP. There are also significant outputs from the socio-economic studies.***

Since 2007, the Institute has a key role in performing scientific analysis to support advice for regional Management Plans in line with the New EU Regulation for Mediterranean fisheries. Thus, the Institute has produced two Management Plans, one for purse-seines and another one for trawls, that have been adopted by STECF and have already been incorporated into the Greek Legislation. Many recent projects require active involvement and interaction of the Institute staff with fishers and other stakeholders in the coastal zone.

***Number of Ph.D theses. The research undertaken by this Institute should present many more opportunities for PhD studies.***

In the period 2005-2012, the Institute has been supporting 9 PhD students (compared to 2 in the previous evaluation). An effort has been made to attract PhD and MSc students from Universities, particularly from the University of Crete with which the Institute is collaborating in a regular basis in the framework of its Postgraduate studies program. In addition, the Institute has made a formal agreement with the University of Dubrovnik (Croatia) to offer teaching services at both the under-graduate and post-graduate (MSc and PhD) levels. Actually a member of the Institute was a member of the Committee which elaborated the post-graduate course for PhD on coastal area management and fisheries of the Dubrovnik University in 2007. It should be noted, however, that till 2008, the Greek legal framework did not allow researchers in Institutes to formally supervise MSc and PhD students in Greek universities. Thus, the role of researchers was to support students rather than officially supervise them.

***Number of scientific publications. The number of peer reviewed publications has increased in recent years. This trend should be encouraged.***

The number of peer reviewed publications has largely increased (more than doubled) in the period 2005-2012.

***Number of professional publications. An evident improving trend in peer review publications has seen a similar drop in professional publications although the numbers now appears to have stabilized.***

This comment does not apply since “Number of professional publications” in both 2005 (and 2012) was empty (i.e. does not apply to our case).

***Distribution of published output within the Institute. The publication effort is skewed with some individuals markedly more productive than others.***

Efforts have been made to encourage publication by all researchers in the Institute and indeed the publication effort is less skewed during 2005-2012. The recruitment of young researchers has enhanced these efforts.

***The advancement of knowledge. This group has advanced our knowledge of marine ecosystems in the eastern Mediterranean.***

As described above, the Mediterranean and international dimension of the Institute has been highly strengthened since 2005.

***The dissemination of knowledge. They have generated a large amount of profession information to the Greek fisheries sector. New developments in Socio-economic studies look very promising.***

Effort has increased along these directions.

***The implementation of knowledge. The national statistics network should result in greater impact as they will be better able to inform national policy makers.***

The National Program for Fisheries Data Collection for the implementation of the Data Collection Framework 2008/199/EC was co-funded by EU and the Ministry of Rural Development and Food and has been the only basis of the Greek fisheries policy in the recent years. The importance of this system is being increasingly recognized by the National and European authorities.

***Its past scientific performance. In a highly applied area the Institute has made useful advances using standard methodologies.***

Major advances have been made in developing rather than only applying methodologies as described above. Active participation in most key research projects in Europe during 2005-2012 and in many international research Actions and working Groups has significantly contributed to these advancements. Many methodological papers have been published during 2005-2012.

***Its future plans and ideas. The future planned projects appear to be scientifically sound but may be limited by financial constraints.***

During 2005-2012 the Institute directed its effort to secure funds mainly (>85%) through European research projects (FP6, FP7, LIFE, INTERREG, MARIFISH), European structural funds (NSRF –ESPA, [www.espa.gr](http://www.espa.gr), OPF - EPAL, [www.alieia.gr](http://www.alieia.gr)) and projects for the implementation of European policies (Data Collection Framework), with a high success rate, and to a much lesser degree through national funding per se.

***The staff age and mobility. The established staff have a problem with succession because of current prohibition on staff replacement. This may become critical for the Institution in the medium term but is out of the Institute's control.***

During the last 8 years, 7 new researchers were recruited whereas the post-docs and PhD students increased. However, the brain-drain problem, because of the crisis, is a big threat.

***Facilities. Infrastructure in Crete is of a high European standard, those in Athens are poor and redevelopment will cause considerable disruption to staff and will be uneconomic. We understand that the Philia is outdated and is the main vessel used by this Institute. The Panel felt that the planned expenditure to redevelop obviously very limited facilities in Athens on a move to Crete and upgrading there working tools.***

This was NOT adopted since funds for upgrade and renovation of buildings are not considered eligible by the Ministry even within the infrastructure-dedicated projects. However, it must be pointed out that the infrastructure for laboratory and field work as well as of the Research Vessel PHILIA has been updated recently. In particular during the period 2005-2009, four (4) projects were funded by the General Secretariat for Research and Technology and the Ministry of Rural Development and Food. Such infrastructure include among others the histology laboratory, fisheries research and sampling field equipment, the coastal zone management laboratory and field equipment, upgrades of the Research Vessel PHILIA. In addition, two proposals regarding the enlargement and modernization of the R/V PHILIA have been submitted. Moreover, the fisheries data center complete renovation with 1 GBit LAN, servers and laptop/desktop computers and software (GIS, web applications etc.).

*We would like here to point out that a low score on infrastructure per se instead for a score on the ratio (scientific output)/(existing infrastructure) results to a low grade in the evaluation and, thus, lower funding by the Greek Government.*

**APPENDIX II**

**Response to 2005 evaluation comments  
Former Institute of Inland Waters**

***Institute to consider how to continue to encourage the mobility of young scientists to establish in the Institute with the assistance of appropriate funding mechanisms.***

During the current evaluation period, an experienced Researcher in the field of Hydrometeorology (Professor in the Civil and Environmental Engineering Department of the University of Connecticut, USA) was invited to collaborate with the scientific staff of the IIW, aiming to advance research targeting the predictability of water cycle, through an improved understanding of land surface and coastal water processes and the optimal integration of models with observational data. To facilitate this, an application made for a Marie Curie Excellence Grant aiming at establishing a Marie Curie Excellence Team in the area of water cycle and climate research has been approved. During the first three years of that Project (2007-2009), seven Scientists have been hired. This Project was the fertile ground to win another three Marie Curie Grants, including two International Reintegration Grants, through which two experienced Scientists from USA have joined the research team. Also, several EU research projects (e.g., PreWEC, MEXT-CT-2006-038331, HYDRATE, GOGE-2006-0370024, MIRAGE, FP7-ENV-2007-1, LIFE ENVI-FRIENDLY, LIFE05 ENV/GR/000245, LIFE-CRETE, LIFE04 NAT/GR/000105), national monitoring projects (a. “Actions for the implementation of the Water Framework Directive – Analysis of basin characteristics, establishment of monitoring networks and assessment methodologies – classification of the ecological status of inland, transitional and coastal waters” on a national scale and b. “Monitoring of the ecological status of rivers, transitional and coastal waters pursuant to Article 8 of the WFD”) and other smaller projects supplied or continue to supply the appropriate funds for the staff members that do not hold permanent positions (e.g. the national monitoring projects supplied funds for seven IIW members in the period 2008-2009 and 18 in 2012).

***Target strategic priorities for the application of the research talents of the Institute e.g. reflecting the specific needs for Greece to implement effectively the WFD and agreements made at WSSD, Johannesburg.***

The 2005 business plan defined hydrometeorology as a new strategic objective for further expanding the research directions of the Institute. The emphasis was placed on advancing predictive understanding of water dynamics and water quality as tools for conservation and management of water resources reflecting needs derived from the country’s obligation to implement the EU environmental policies and international treaties.

The research orientations and accomplishments over this eight-year period were along three areas: (a) ecological quality assessment, (b) biodiversity conservation and environmental restoration, (c) integrated river basin management including hydrometeorology. List of achievements and progress made over the past years in the above areas is presented below.

#### **Ecological quality assessments**

- Continuation and upgrading the research on ecological status and monitoring methodologies for streams and rivers, as required for the implementation of the WFD.

This research aims at the development and standardisation of sampling protocols, the determination of data treatment techniques and analytical procedures, the establishment of supporting databases and the elaboration of ecological quality classification systems based on fish, macroinvertebrates and abiotic parameters. The research includes assessment of the impacts of artificial desiccation, due to excessive water abstraction, on the ecological status of intermittent water bodies. Relevant projects: LIFE ENVI-FRIENDLY, ILARION, SKOPOS PAPADIAS, MONTENEGRO, MIRAGE, UPLAND RIVERS, ANAPODARIS RIVER BASIN (Crete), INTERCALIBRATION EXERCISE, LIFE-CRETE, NATIONAL MONITORING PROGRAMS, CYPRUS RIVERS.

- Expansion of research on ecological status and monitoring to include new water body types (small wetlands, temporary rivers, ponds and lagoons), new indicator attributes (riparian macrophyte vegetation) and new methods of ecosystem health diagnosis (screening-level assessment procedures). Projects that contributed to the development of these research activities are: SCHINIAS-MARATHONAS, RIPIDURABLE, MIRAGE, NATIONAL MONITORING, PLASIRAS, CYPRUS WETLANDS, ANAPODARIS RIVER BASIN (Crete), LIFE ENVI-FRIENDLY, LIFE-CRETE, KOUMOUNDOUROU.
- The IIW is a pioneer research organisation regarding the study of intermittent rivers in Greece. A key issue that has or is still being addressed in the framework of TEMPQSIM, LIFE-CRETE, LIFE ENVI-FRIENDLY and MIRAGE projects is the assessment of underlying hydrological and biogeochemical processes that drive aquatic quality and aquatic fauna assemblages in intermittent water bodies. Desiccation and initial autumn floods comprise particular “hot moments” regarding hydrology and aquatic quality that substantially affect biocommunities. The term “artificially dry” has been introduced for river reaches that desiccate under human induced water stress conditions (Skoulikidis et al., 2011).
- Ecotoxicological assessment of lagoon sediments was carried out by using the Microtox® system. In addition, the toxicity and the biochemical effects of olive mill wastewater and citrus processing wastewaters on stream ecosystems were evaluated using acute toxicity bioassays (*Gammarus pulex* and *Hydropsyche peristerica*) and biochemical biomarkers (AChE and GST) (Karaouzas et al. 2010; 2011a,b).
- Research on the origin, levels and dynamics of nutrients in a minimally disturbed river basin, using hydrological pathways, speciation and in-stream spatio-temporal variations (including initial flood pulses), along with soil/sediment characteristics (Skoulikidis & Amaxidis, 2009) was carried out within TEMPQSIM project.
- Inclusion of urban streams and urban biotopes in ecological assessment studies (PIKRODAFNI STREAM, ATTIKI-WETLANDS).
- Within the frame of two national monitoring projects for WFD implementation, monitoring operations initiated in 2009 with a first round of sampling conducted over 36 river basins and 122 stations and continued in 2012 on an updated network of 449 stations (300 surveillance and 149 operational).

## **Biodiversity conservation and environmental restoration**

- Fish species distributional surveys and conservation status assessments in protected areas as demanded by the reporting process of the “Habitats Directive”. Relevant projects: SCHINIAS-MARATHONAS, RIPIDURABLE, V. LETOURNEUXI, UPLAND RIVERS, GADOURAS, ATTIKI-WETLANDS.
- Small wetland identification and delineation, wetland habitat and species description, and environmental quality assessment for conservation planning implementation. Inclusion of urban streams and urban wetlands subject to conservation. This research field includes environmental monitoring and supports the commitment of national laws and international treaties (P.D. 67/81, RAMSAR, Bern Convention, IUCN, Habitats Directive 92/43/EC) for information gathering relevant to conservation management and restoration. Relevant projects: RIPIDURABLE, PIKRODAFNI STREAM, ATTIKI-WETLANDS, LIFE-CRETE, CYPRUS WETLANDS.
- Assessment of the status of riparian forests, restoration proposals and restoration activities (including the creation of a poplar riparian forest in collaboration with the Technical University of Crete). These activities were undertaken in the frame of the projects RIPIDURABLE and LIFE ENVI-FRIENDLY.
- Research was undertaken in the Evrotas basin to study the impacts of hydrological regime alterations and morphological modifications in river beds and riparian areas on biological communities, focusing particularly to the assessment of threats on endemic fishes. Management scenarios and measures to restore perennial flow and preserve species and their habitats were elaborated and conservation actions were proposed that included the creation of aquatic refugia in ecologically sensitive zones.
- Field and laboratory studies on the taxonomy, distribution, abundance, biology and ecology of endangered freshwater species, with the principal objective to determine species habitat requirements and environmental tolerance limits, to analyse the nature of threats, and to assess the species conservation status. This information is essential for defining species and habitats of conservation priority or proposing appropriate management actions, in accordance with obligations derived from the “Habitats Directive” and national regulations to implement area- or site-specific conservation. One of the themes in which considerable research effort was devoted was the study of the conservation biology of *Valencia letourneuxi*, a critically endangered fish species, for which a complete mapping of its geographical range and a thorough study of its ecology, biology and genetics were accomplished (Kalogianni et al., 2010a, b). Furthermore, extensive laboratory studies on identification of new species were carried out using fish morphometry techniques (e.g. Kottelat et al. 2007). Relevant projects: ILARION, SKOPOS PAPADIAS, V. LETOURNEUXI, LIFE ENVI-FRIENDLY, MIRAGE, MONTENEGRO, LADON, UPLAND RIVERS, GADOURAS.
- Research on the habitat preferences of macroinvertebrates is also currently undertaken. Relevant project: LADON, LIFE-CRETE, L. PLASTIRA.
- Investigation of the genetic structure of fish species, primarily for the scope of identification of “evolutionarily significant units” requiring special protection. This research supports the needs of conservation management demanded by various directives and agreements (e.g. Habitats Directive, IUCN) and was accomplished through

collaboration with Greek and foreign specialists in the field of genetics. Relevant studies include the genetic structure of native trout populations (Apostolidis et al., 2011) of the critically endangered *Valencia letourneuxi* (Vogiatzi et al., 2009) and of the freshwater gobies of Greece, aiming at the formulation of appropriate measures for the preservation of genetic diversity. Most relevant projects: SKOPOS PAPADIAS, V. LETOURNEUXI, ILARION.

- Investigation of anthropogenic impacts on habitats and the biota (e.g. construction of dams, water abstraction, sand/gravel abstraction, pollution, etc.) and determination of appropriate restoration actions. This research contributes to the formulation of management tools and solutions aiming to the maintenance of ecosystem integrity and the alleviation of adverse impact of human activities on species and their habitats, in line with the demands of the WFD, the Habitats Directive and national regulations. Relevant projects: SKOPOS-PAPADIAS, V. LETOURNEUXI, ILARION, LADON, ATTIKI-WETLANDS, SCHINIAS-MARATHONAS, RIPIDURABLE, LIFE ENVI-FRIENDLY, MIRAGE, NATIONAL MONITORING.

#### **Integrated river basin management**

- Through the extensive work undertaken in the Evrotas River in the frame of the LIFE ENVI-FRIENDLY project, the Evrotas River Basin was nominated as Pilot River Basin for Agriculture. This basin was included in the European network of Pilot River basins (PRB) for studying the linkages between agriculture and water resources management and testing agricultural-related issues of WFD implementation.
- The IIW, jointly with the Technical University of Crete provided a Preliminary Management Plan for the Evrotas River Basin which aims at developing a toolkit of environmental friendly agricultural technologies and includes as specific objectives the minimisation of pollution sources and the rationalisation of the use of irrigation water.
- During the LIFE ENVI-FRIENDLY project, several technologies for the minimization of point and non-point pollution sources were demonstrated and tested.
- Ecological quality assessment in Plastira and Koumoundourou Lakes. Detailed and complete studies were undertaken to identify the linkages between anthropogenic pressures, pollution risk and water quality and ecosystem health. Several state-of-the-art methodologies and tools have been utilized including remote sensing and GIS applications for mapping vegetation and land use changes at river basin level, quantification of relevant ecosystem changes and soil erosion risk modelling. The combination of all these methodologies led to the better understanding of the long term impacts of human activities on the specific ecosystems, contributed to the proposal of restoration actions and facilitated the development of tools for the integrated management of natural and artificial lake ecosystems.
- Biodiversity conservation science integration within river basin management frameworks, particularly in drought-impacted regions. This was implemented within the WFD implementation process both for Greece and the Republic of Cyprus. Relevant projects: LIFE ENVI-FRIENDLY, MIRAGE, CYPRUS WETLANDS.

- A series of modelling efforts has been made in various Greek water bodies aiming to assess their vulnerability to climate change and human activities. MIKE SHE modelling platform has been extensively used in river and lake catchments in order to test water management scenarios and quantify the associated impacts on the ecosystem health. Water balance studies comparing the hydrologic and environmental regime of river catchments before and after human interventions have been also used to increase public awareness and facilitate the implementation of IWRM principles. The distribution and fate of pollutants at a catchment scale have been also modelled, aiming in understanding the underlying processes and the natural attenuation capabilities of the different ecosystems. Flood risk modelling has been also attempted to contribute to the improvement of civil protection system and the ecological maintenance of the riparian areas. Under this scope, the flood risk of urban streams, under extreme precipitation events, were modelled.
- A series of efforts to understand the various ecosystem processes in Deltaic areas (ECODOM project) and to quantify the relationships between pressures from human activities, water quality levels and ecosystem health has been attempted. For this purpose, hydrological and water quality models have been used at a catchment scale and extensive *in situ* and laboratory measurements in a series of parameters have been made to understand the underlying processes and quantify the aforementioned relationships.
- Climate change impact assessments on the hydrological and water quality status of lake ecosystems (Trichonis and Kourna Lakes) have been implemented to identify the associated risks and promote relevant mitigation measures (LIFE-TRICHONIS, LIFE-CRETE project).
- We have initiated an experimental effort on researching the connection of coastal pollution with the hydrological processes at watershed scale. Specifically, the measurements focused on two main research topics: (a) to determine how changes in the water cycle affect exchanges of nutrients, pollutants and carbon in wetlands and coastal waters and (b) to examine the effects of terrestrial inputs on coastal water quality, biogeochemistry, optics, underwater light fields and ocean colour. We focused our experiments on three watershed systems that vary widely in environmental characteristics and carbon sources: Evros wetlands (Ramsar site) in NE Greece, Sperchios River in central Greece, and Amvrakikos wetlands (Ramsar site and Special Protection Area under EC Directive 79/409) in NW Greece.
- Estimation of Ecologically Acceptable Flow Regimes by taking into account hydraulic, hydrologic and ecosystem data has been attempted for the first time in Greek river systems. In this effort a hydro-ecological modeling approach is used to simulate a relationship between the stream flow and the fish species habitats, in order to assess the degree of habitat degradation in impaired rivers. During the last 4 decades, altered water flow regimes due to human activities (eg. dam construction, irrigation abstractions, etc) and climate change, generate serious impacts on the aquatic biological community, and also affect key socio-economic functions (e.g. irrigation, hydroelectric generation etc.).The estimation of scientifically sound ecological flows values is a

necessity but until now it was done in a more or less empirical manner according to the provisions of the Ministerial Decision 12160/155 2B/3-9-99) which has led to detrimental impacts. The new eco-hydraulic approach that is implemented by IMBRIW through the ECOFLOW project will offer valuable tools to the water managers and engineers for the estimation of efficient ecological flows.

- We have conducted research on improving the current operational weather forecasts. Specifically, we have worked on the modifications and the better tuning of the physical parameterization packages (for resolving the atmospheric processes with scales smaller than the model grid structure) of the numerical weather prediction model of the POSEIDON system (Papadopoulos, A. and P. Katsafados, 2009).. Additionally, we have implemented and tested a new state-of-the art numerical weather prediction model with improved physical parameterization schemes, e.g., for resolving convective processes, surface energy balance.
- In collaboration with the Harokopio University of Athens, we have implemented a mesoscale 3D meteorological data assimilation package, the Local Analysis Prediction System (LAPS), to produce operationally high resolution analysis fields.
- In collaboration with the Institute of Oceanography and the Harokopio University of Athens we are working on the development of a fully coupled regional atmosphere-ocean wave model for Mediterranean Sea. The dynamic coupling accounts for the feedback of the sea surface roughness on the wind-wave spectrum and the modification of the surface momentum and heat fluxes.
- We have developed an assimilation technique to directly use regional cloud-to-ground (CG) lightning data in mesoscale meteorological simulations of flood and flash flood inducing storms. The technique relies on real-time data from a long-range lightning detection network to indicate areas of deep, moist convection within the model domain. Model-generated humidity profiles are then nudged relative to the observed lightning intensity to compute heating rate profiles more compatible with the local convective environment. The performance of the technique has been assessed using as reference distributed rainfall estimates from a network of radar observations as well as surface data from conventional weather observing stations across Europe. Results from this work have been published in Monthly Weather Review (Papadopoulos et al., 2005) and in Atmospheric Research (Papadopoulos et al., 2009).
- In collaboration with the Harokopio University of Athens, we investigated the capabilities of a state-of-the-art AGCM for the estimation of the atmospheric conditions on seasonal time scale. Seasonal simulations have been carried out using the NCAR Community Atmosphere Model (CAM 3) coupled with the Common Land Model (CLM). Results from this work are currently under review in the Natural Hazards and Earth System Sciences Discuss (Katsafados et al., 2013). The meteorology research team will continue with their efforts to investigate means of improving seasonal forecasts, and will most probably focus on the development of regional scale rainfall forecasting.
- We have designed and applied a sophisticated downscaling procedure to reproduce high resolution historical records of the atmospheric conditions across the Mediterranean. This was accomplished by the dynamical downscaling of the European

Center for Medium-Range Forecasts ERA-40 reanalyses with the aid of the atmospheric model of the POSEIDON weather forecasting system. This effort has been published in the *Mediterranean Marine Science* (Papadopoulos et al., 2011).

- We have investigated the effect of forcing the land surface scheme of an atmospheric numerical weather prediction model with remotely sensed precipitation datasets. The goal was to provide improved surface conditions for the atmospheric model in order to achieve accurate simulations of the mesoscale environment that can significantly affect timing, distribution and intensity of predicted convective precipitation. Results from this work have been published in *Advances in Water Resources* (Papadopoulos et al., 2008).
- We have worked with various datasets including satellite retrieved oceanic winds, ground meteorological observations (e.g. precipitation, cloudiness) as well as model outputs (Poseidon, NCEP). The main foci include the climatological studies in terms of the wind regime and the mechanisms that dominant planetary phenomena, such as the North Atlantic Oscillation, influence the Mediterranean basin. The study titled “9 years of QuickSCAT observations of extreme events over the Mediterranean and black Seas”, by Chronis et al., (2010) was accepted for publication in the *International Journal of Climatology*. The study titled “The NAO effect on the eastern Mediterranean” by Chronis et al., (2010) is currently under review in the *Journal of Climate*.

***Adopt a more practical approach to the development of tool kits enabling the effective integrated management of river basins.***

**The “Strategy for the development of the Institute and criteria of research actions / directions during the period 2006-2008” regarding Research team 1 (Ecological Quality Assessments) focused on the:**

Development of tools for the assessments of ecological status in surface freshwaters *based on fish, macroinvertebrates and abiotic parameters and expanding research to new indicator attributes (riparian macrophyte vegetation), new methods of ecosystem health diagnosis (screening-level rapid assessment procedures) and new water body types (lakes and reservoirs)*. In the following, the tools developed for Ecological quality assessment and monitoring in inland surface waters are categorised according to the different investigative categories:

**Tools for the development of typologies and the establishment of reference conditions of streams and rivers**

- Production of the first greek river typology based on biological and hydraulic criteria (Panagopoulos & Chatzinikolaou, 2012)
- Selection of the most appropriate abiotic factors for the typological classification of running waters in Greece, as promoted by the WFD (Skoulikidis et al., 2008).
- Determination of ichthyogeographic districts in Greece, for ecoregional boundaries revision and sub-ecoregional delineations (Zogaris et al. 2009).
- Development of fish-based typologies for upland, midland and lowland rivers at a regional scale and establishment of linkages with hydrological, physicochemical and geological features.

- Revision and improvements in the protocol for the establishment of reference conditions for rivers and streams, based on anthropogenic pressure analysis and GIS applications.
- Establishment of reference site selection criteria and development of fish-based reference conditions for some river types at a regional scale.
- Development of a methodology for the characterization and delineation of Water Bodies in the framework of MIRAGE project.
- Initial nutrient reference conditions for perennial rivers and streams have been developed (Skoulikidis et al., 2006). Updated nutrient reference conditions for perennial streams, based on the largest Greek database (~450 sites), have been developed within the Master Thesis of Sofia Laschou (in collaboration with the Chemistry Department of the University of Athens).

#### **Ecological status classification tools**

- Revision and improvements in the protocol for the pre-classification of ecological status for rivers and streams, based on anthropogenic pressure analysis and GIS applications.
- An initial nutrient classification system for perennial rivers and streams has been developed by Skoulikidis et al. (2006) and updated within the Master Thesis of Sofia Laschou (in collaboration with the Chemistry Department of the University of Athens). This tool is being used for the chemical-physicochemical status assessment (within the ecological status assessment) in the framework of the National Monitoring Programs for which the Institute is responsible.
- Development and application of a methodology to assess the chemical status of intermittent rivers (a) by combining pollution parameters in groups according to related pressures and (b) by considering sediment chemical quality elements, in addition to hydrochemical ones, in light of the temporal hydrological regime and anthropogenic impacts (Skoulikidis, 2008).
- Development and application of fish-based multi-parametric biological status assessment methods that are based on the spatial approach for (a) upland rivers of western Greece, (b) a representative midland river of central Greece, and (c) a representative lowland river of southern Greece. This tool also applies to temporary rivers.
- Development of a fish-based multi-parametric biological status assessment method for Greek running waters that is based on the modelling approach for the designation of reference conditions. This method (FATHeR: Fish-based Assessment Tool for Hellenic Rivers) has been tested and applied but not yet fully validated due to the lack of adequate field data.

#### **Ecological indicators research and tools**

- Study of the effects of olive oil mill and orange juice factory wastes on the biological status of rivers and streams, based on benthic invertebrate communities.

- Application of laboratory ecotoxicological studies for assessing the effects of olive oil mill and orange juice factory wastewaters on two bioindicators (*Gammarus pulex*, *Hydropsyche peristerica*).
- Wetland protected-area monitoring using birds as landscape-scale environmental indicators to assess restoration potential and restoration results.
- Development of a site-based visual rapid assessment method for rivers, streams and river corridors.
- Development of a riparian vegetation assessment protocol to classify stream typology and assess ecological integrity of river corridors in Greece.
- A water-plant vegetation assessment protocol to classify in-stream environments and assess ecological integrity in rivers and streams is under development.

#### **Tools to assess the ecological integrity of lakes**

- Application of diversity and richness metrics and expert judgement for the assessment of the biological status of an artificial lake (Lake Plastiras) based on benthic invertebrates (under development).
- Long term monitoring application for the identification of the main ecological threats of a heavily modified lakes (e.g. Koumoundourou Lake) and proposal of specific restoration actions.

**The “Strategy for the development of the Institute and criteria of research actions / directions during the period 2006-2008” regarding Research team 3 (Integrated River Basin Management) focused on hydro-meteorological and erosion/pollution aspects.**

**Here, tools that were developed and/or applied to facilitate Integrated River Basin Management including hydro-meteorological and erosion/pollution aspects are presented:**

#### **Remote sensing techniques**

- Development of a technique for stochastic generation of 3D (space and time) error ensembles for remote sensing data.
- Water quality monitoring in Lakes and Estuaries through measuring chlorophyll-a and suspended matter parameters from satellite data.

#### **Remote sensing & GIS**

- Development of a detailed methodology, including remote sensing and GIS for vegetation and land use mapping, quantification of relevant ecosystem changes and soil erosion risk modeling, to identify the linkages between pressures, pollution risk, water quality and ecosystem health on a lake watershed scale (Lake Plastiras basin).

#### **Numerical weather prediction**

- Implementation, testing and development of two numerical weather prediction models (WRF and ETA non-hydrostatic models).
- Development of a technique for assimilation of lightning data and associated methods developed for the ETA model.

- Implementation of the 3-D data assimilation package LAPS linked to ETA non-hydrostatic model for data assimilation.
- Hydrological modeling development and applications of various distributed hydrological models that include surface, subsurface and groundwater components, e.g. MIKE platform by DHI.
- Implementation of a land surface modeling system (the Community Land Model).

### **Hydrology**

- Development of a methodology based on the “Leitbild” approach to identify the driving force (natural or anthropogenic) of desiccation in temporary rivers. This methodology is based on the identification of hydrological pressures, analysis of historical hydrological and biological information and databases, current hydrograph analysis and application of river basin balance models according to current and past land and water uses, and was successfully applied in Evrotas River basin.

### **Soil erosion**

- Application of the Revised Universal Soil Loss Equation (RUSLE) combined with remote sensing and GIS for the estimation of the annual soil erosion potential per unit land area on a river basin scale (Lake Plastiras basin).

### **Flood hazard assessment**

- Application of a grid-based GIS modeling method for the estimation of flood hazards areas of Evros transboundary river basin.
- Flood risk modeling of an urban stream (Pikrodafni) based on the physically based distributed model MIKE by DHI.

### **Integrated River Basin Management**

- Biodiversity conservation science integration within river basin management frameworks, particularly in drought-impacted regions. This was implemented within the WFD implementation process both in Greece (Evrotas basin) and in the Republic of Cyprus (Water Development Department).
- Development of a methodology for the designation of water bodies on a river basin scale, based on site specific ecological status assessment, GIS applications and expert judgment (Evrotas River basin).
- Development of a preliminary Management Plan for the integrated management of Evrotas River basin (in collaboration with the Technical University of Crete).
- Development and application of groundwater vulnerability and risk assessment methodologies for assisting the decision support process in establishing protection zones and sustainable development practices.

***Enhance the linkage with other teams in Greece and elsewhere in Europe where the development of decision support systems is being undertaken at the river basin scale.***

Several coordinated efforts to involve the Institute in collaborating activities with other teams from Europe and in Greece were performed.

- Regarding the research and management of temporary rivers, the IIW collaborates since 2002 up to day with competent Greek and European research bodies, such as the Technical University of Crete, Greece; Centre for Ecology & Hydrology, CEH Wallingford, UK; Swiss Federal Institute for Environmental Science and Technology, Switzerland; Water Research Institute - National Research Council, Italy; University of Leeds, School of Geography, Leeds, UK; Leibniz Universität Hannover, Institute for Water Quality and Waste Management, Water Resources Management Division, Hannover, Germany; Joint Research Centre (IT), Institute for Environment and Sustainability, Rural, Water and Ecosystem Resources Unit, JEC, Ispra, Italy; HydroSciences Montpellier, IRD, Université Montpellier, France; Leibniz Institute of Freshwater Ecology and Inland Fisheries (IGB), Berlin, Germany.
- In 2005, collaboration was initiated between the IIW and the Zoological Society of London, UK, on the assessment of the status of the critically endangered fish species *Valencia letourneuxi* (Kalogianni et al., 2009).
- In 2005-2007, IIW researchers have collaborated with nine European partners from Portugal, Greece, France and Spain in the frame of the RIPIDURABLE project (project coordinated by the Municipality of Alpiarça, Portugal) in order to develop assessment tools for the Mediterranean stream riparian environments and to cooperate in riparian zone research and assessment applications.
- In the period 2006-2007, the IIW and the Department of Biology (University of Montenegro, Montenegro) undertook the joint project "Scientific Cooperation and Technology Transfer for the Development of a Fish-based Assessment Method of Surface Waters". As an EU member state, Greece has made advances in the development of ecological assessment systems, which are required for integrated watershed management, as dictated by the WFD. Scope of this project was to promote the transfer of technology to Montenegro on issues of ecological status assessments using fish as a tool for the assessment procedure.
- In 2008, Dr. Skoulikidis spent a month of his sabbatical at the Leibniz Institute of Freshwater Ecology and Inland Fisheries (IGB, Berlin, Germany) to exchange know how, enhance the collaboration between both Institutes (a Memorandum of Understanding has been signed from both parties) and discuss on the submission of common research proposals.
- In the period 2008-2009, the Institute was also part of a consortium of scientific organizations funded by the Hellenic Ministry of Environment, Physical Planning and Public Works to develop monitoring tools and establish monitoring networks for ecological status assessment in all important river basins of Greece. Through the initial national monitoring program, IIW collaborated with other research teams in Greece, namely the Greek Biotope/Wetland Centre (Thermi, Thessaloniki), the University of Thessaloniki (Department of Zoology, Thessaloniki), the University of Ioannina (Department of Botany & Plant Ecology, Ioannina) and the Fisheries Research Institute (National Agricultural Research Foundation, Kavala).

- In the period 2009-2012, IIW researchers have worked with the Water Development Department of the Ministry of Agriculture, Natural Resources and Environment (Dept of Hydrometry) of Cyprus on the assessment of biodiversity needs of water bodies within the implementation of river basin management. Two of the contracts concerned the use of fishes as biotic quality elements in Cyprus's river for the first time.
- In 2012, Dr. Skoulikidis together with the Director of IGB Prof. Klement Tockner initiated the idea for the establishment of a Network on the Mediterranean River Basin research, management and conservation. This idea is currently being implemented under the auspices of the Global Water Partnership - Mediterranean chaired by Prof. Michael Scoullou (Kapodistrian University of Athens, Dept. of Chemistry).
- Dr. Skoulikidis had a meeting with officials of the Ministry of Environment in Skopje, FYROM, to transfer "know how" towards the FYR Macedonian government regarding the application of the WFD in transboundary water bodies (such as the Axios/Vardar River) and discuss on a common research policy concerning their management. It is noted that the Axios River is one of the most polluted rivers in the Balkans.
- Dr. Dimitriou and Dr. Skoulikidis are members of Greek Focal Point (HCMR) in the Expert Working Group Monitoring and Information Exchange for the Drin Core Group.
- Dr. Skoulikidis is member of the CIS Working Group on Ecological Flows.
- The Institute has also developed strong collaboration and linkages with competent European research bodies in the field of biodiversity conservation and restoration. A LIFE project (LIFE-CRETE, 2004-2008) led to the exchange of experience and research tools between the IIW and research bodies, such as Tour du Valat, France and University of Göttingen, Germany for applying optimized management and conservation practices. The efficiency of this collaboration effort has been validated through team publications in International journals and is still going on through the submission of proposals for EU funding in the aforementioned scientific field.
- In 2012 Dr. Zogaris contributed to the IUCN's Freshwater Key Biodiversity Areas, meeting in Sarajevo for the Mediterranean Balkan Hotspot and participating in an assessment and expert screening process of important conservation areas in the Balkans. Through this and other initiatives ties have been established with neighbouring states, especially with ichthyologists and conservationists in Montenegro, Croatia, Bulgaria, Turkey and Cyprus. Dr. Zogaris was responsible for the ichthyological contribution in the Biodiversity Strategy of Cyprus.
- Finally, it is worth pointing out that Institute researchers are in the leading team of a major multi-national research activity in the Mediterranean (named HyMeX: The Hydrological Cycle in the Mediterranean Experiment), targeting the improvement of our understanding of the water cycle, with emphasis on extreme events, its monitoring, modeling and quantification of variability and impact on environment.

***Institute to consider how to collaborate more fully with the appropriate expertise from the Institute of Oceanography concerning modeling.***

The transfer of the Department of Meteorology from the Institute of Oceanography (IO) to the Institute of Inland Waters (IIW), in 2006, enhanced the collaboration between the two Institutes in the area of numerical modeling. The Meteorology research group of IIW remains responsible for the operational procedures of the weather forecasting system of the POSEIDON system. In the framework of various projects of the IO there is an excellent collaboration between groups of the two Institutes on the analysis and processing of meteorological parameters. On the basis of this collaboration, the IO provides access to its high-performance computer resources, buoy data and other databases to IIW scientists. The collaboration is currently expanding on integrative aspects of the water basin management that involves the effects of water and nutrient dynamics on the coastal ecosystems. Another field of fruitful collaboration between the IIW and the IO has been in the frame of the joint national monitoring projects (a) “Actions for the implementation of the Water Framework Directive – Analysis of basin characteristics, establishment of monitoring networks and assessment methodologies – classification of the ecological status of inland, transitional and coastal waters” and (b) “Monitoring of the ecological status of rivers, transitional and coastal waters pursuant to Article 8 of the WFD”, in which IMBRIW acts as co-ordinator. Furthermore, in the framework of the IO project SPICOSA, scientists of IIW studied human activities’ impacts on the hydrological and sedimentary regime at a catchment level, and this output has been used by researchers of the IO to identify impacts on the coastal zone and propose adaptive management practices. Moreover, further collaboration between the aforementioned Institutes has been also attempted in the field of water quality monitoring; extensive sampling, analyses and interpretation efforts occurred for more than four Greek catchments (through the IIW’s projects PreWEC and ECODOM), in order to identify the sources of organic pollution and prioritize the associated pressures and forcing factors.

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