CHAPTER IV

BLACK SEA COUNTRY PROFILE FOR TURKEY

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INTRODUCTION

The primary objectives of this article are to provide a review of the state of Turkish research on the Oceanography of the Black Sea and to provide a brief survey of the existing Institutional capabilities.

The focus here is on the large scale research efforts and major capabilities. In order to be just to the work not mentioned in this review, a selected bibliography for Turkish and cooperative research is provided. In particular, the references made within the text can be found in this bibliography.

MAJOR INSTITUTIONS OF RESEARCH AND EDUCATION

Presently, there are four major institutions in Turkey that carry out large scale oceanographic research in the seas surrounding the Country. Three of these institutions are Graduate Schools of Marine Sciences so they are also involved in education and training.

The Institute of Marine Sciences of the Middle East Technical University (IMS-METU) is located in Erdemli on the Mediterranean coast of Turkey (Fig. 1). Established in 1975, the main strength of the Institute is in the fields of Physical and Chemical Oceanography, Marine Geochemistry and Fisheries Biology. Capabilities exist also for Marine Geological and Geophysical research.

The recent major research activities of IMS-METU include circulation dynamics and biogeochemistry of the Levantine Basin, the Sea of Marmara and the Black Sea, quasigeostropic and primitive equation models for these seas, dynamics and the environmental health of the Turkish Straits, transport of pollutants from the atmosphere, and fish stocks of the Black Sea. The Institute owns a 500 gross ton research vessel, the R/V Bilim, with a length of 41m, width 9.5m and draft of 3.8m. Two smaller vessels of 16m length are utilized for coastal ocean research, including fisheries.

The Institute of Marine Science and Technology of the The Nine of September Dokuz Eylül University (IMST-NS) is located in Izmir (Fig. 1). It was established in 1975. The main strength of this institution is in the field of Marine Geology, Geophysics and Biology, although marine chemical and ship hydrodynamics research capabilities also exist.

The present major research activities of IMST-NS include particle fluxes in and the geochemistry of the Black Sea, marine pollution in the Aegean, and fisheries stock assessment studies in the Mediterranean. The Institute's research vessel fleet consists of a 300 gross ton,

36m long and 8m wide research vessel, R/V K.PIRI REIS with a draft of 2.8m, and two smaller boats.

The Institute of Marine Sciences and Geography of Istanbul University is also involved in geographical sciences. The Marine Sciences section of the Institute is relatively small. The main scientific interests of the Institute lie with the marine biological, geomorphological and marine chemical studies. The fish stocks of the Sea of Marmara and the oceanography of the Turkish Straits (jointly with METU) are among the recent research activities. The Institute's research vessel Arar (173 gross tons, 31m in length, 6.5m in width) is utilized in various surveys.

The fourth major institution involved in marine research is the nonacademic Department of Navigation, Hydrography and Oceanography (DNHO) of the Turkish Navy. This is the oldest oceanographic institution in Turkey and has contributed significantly to the development of ocean science in the country's academic institutions. The Department's recent activities include specific hydrographic work related to bathymetric charts and functioning of ports, monitoring of the Straits, and seismic studies. DNHO's 600 gross tons R/V Cubuklu, with the same dimensions as R/V Bilim of METU, is utilized in hydrographic surveys together with several smaller vessels.

Needless to say, there exist in Turkey other institutions which carry out Marine Science related work, although they are not involved in oceanographic investigations on the scale as the four institutions mentioned above. The most notable Marine Technology related work is accomplished in Istanbul Technical University in relation to ship hydrodynamics and design. Some small scientific groups at Istanbul Technical University, Bogazici University (Istanbul), Ege University (Izmir), the Nine Of September Dokuz Eylül University and the Middle East Technical University are engaged in selected marine environmental issues. In addition, there also exist relatively small and developing centers, called the Schools of Aquatic Resources, of the various Universities in the Mediterranean, the Aegean and the Black Sea.

A historical note is warranted in passing. In Turkey, the first institute of oceanography in the modern sense was established in 1951 by the Istanbul University and was named the Institute of Hydrobiology. Extremely important scientific research was accomplished by this Institute whose publications related to the Black Sea are given in the attached selected bibliography. The institute was closed in 1983.

MAJOR CRUISES

Little purpose will be served here by listing all the Black Sea cruises carried out by the various Turkish research groups. We will instead discuss the major cruises, which imply basin or sub-basin scale surveys, and provide a succinct summary of the important results obtained in these efforts.

Pektas Expedition

The inaugural Turkish basin scale Black Sea cruise was accomplished during June 26-August 8, 1957. The region covered was essentially to the south of 45° North latitude (Fig. 2).

Salinity, temperature, dissolved oxygen, alkalinity, nutrients, plankton and egg-larvae density were the primary parameters measured.

The results indicate that egg and larvae distribution throughout the basin exhibits significant patchiness (Einarsson and Gurturk, 1960). The largest numbers are observed west of the Bosphorus within the permanent anticyclone in the southwest, in the northwest shelf and southeast of Crimean peninsula. Spawning apparently commences earlier in the eastern Black Sea.

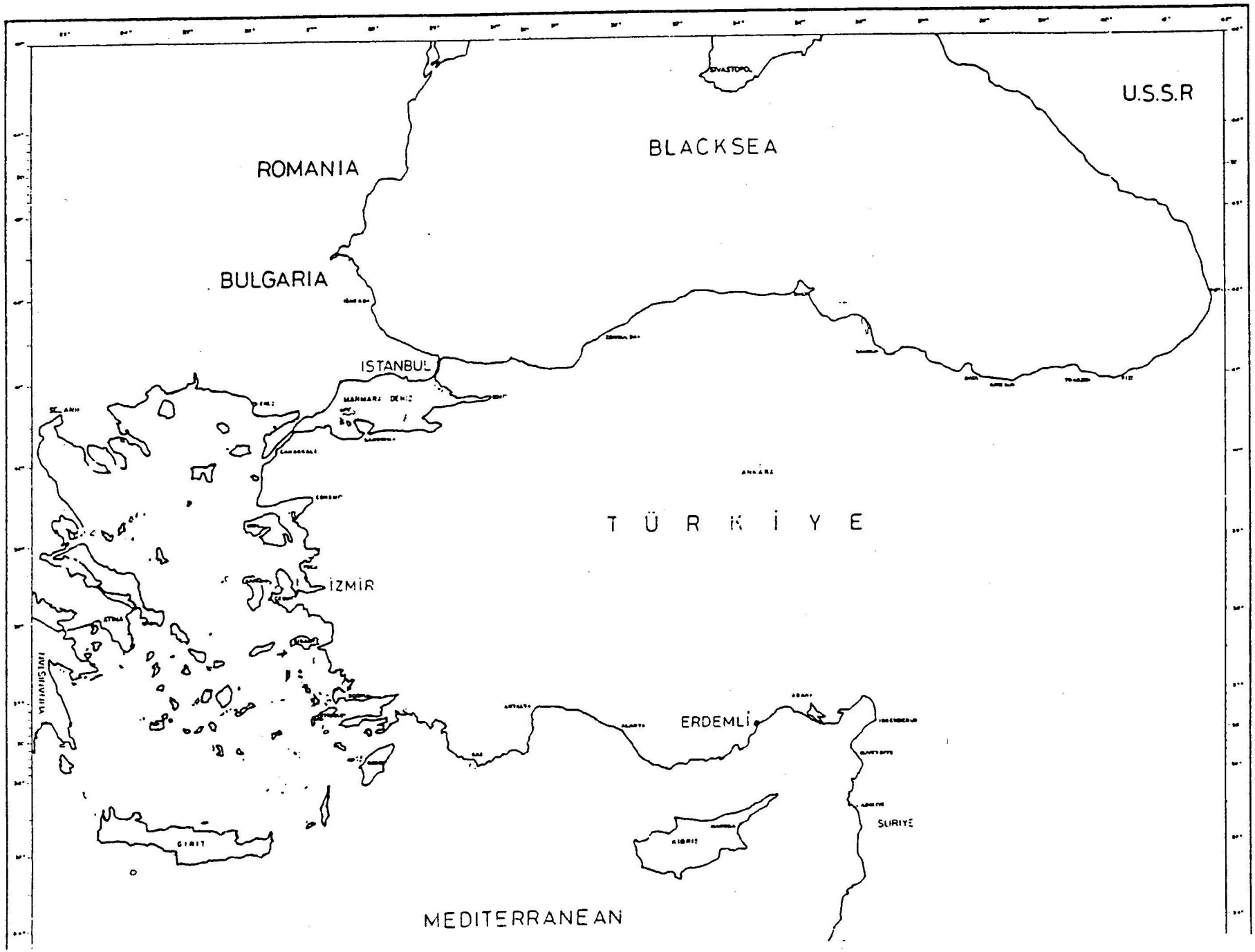

Figure 1. Location map.

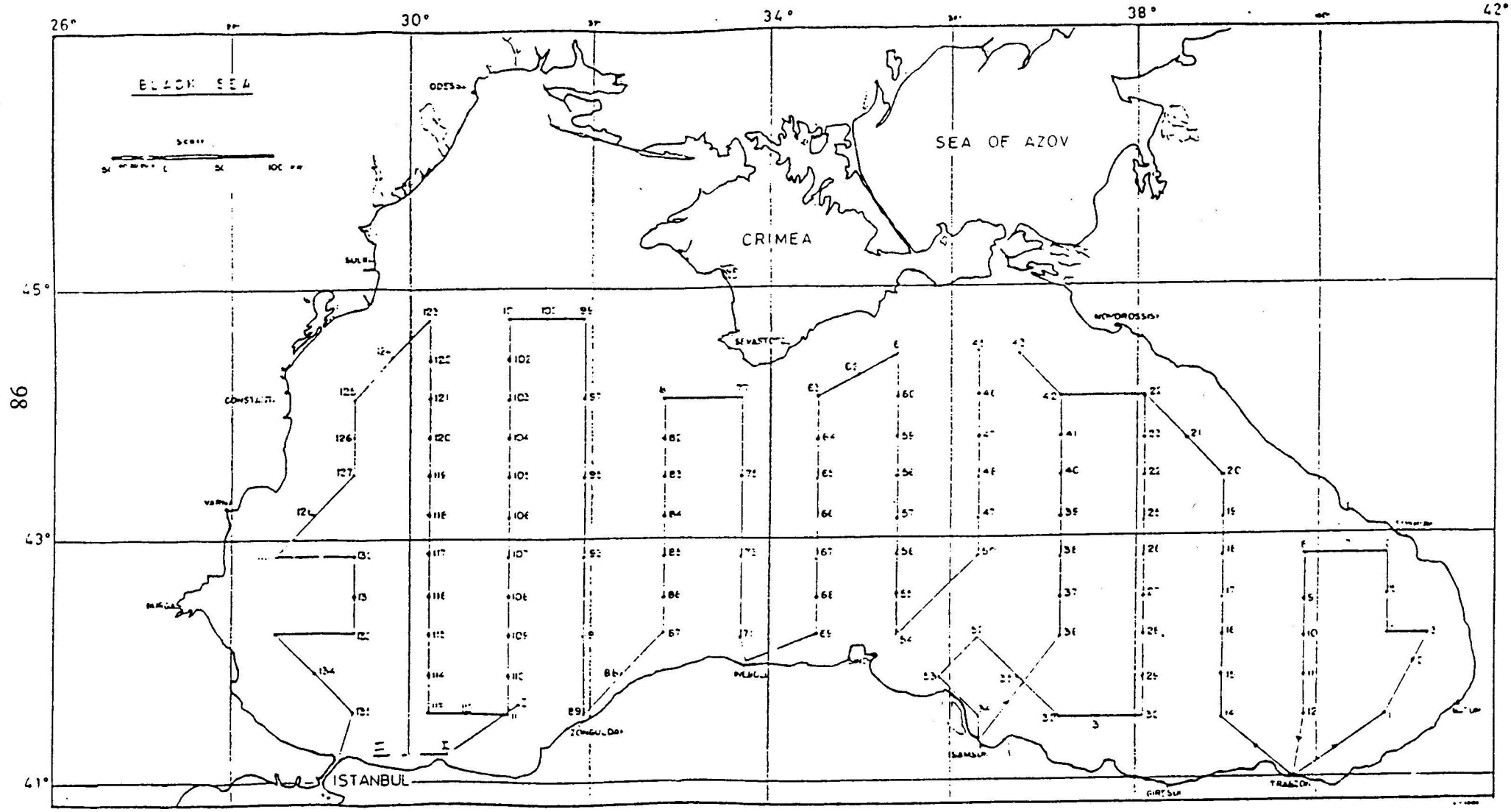

Figure 2. Pektas Expedition cruise track.

Department of Navigation, Hydrography and Oceanography Cruises

Fourteen major cruises were accomplished by DNHO between 1963 and 1980. The survey area lies to the south of 44° N (Fig. 3). The cruise dates are:

APRIL, JULY, OCTOBER, 1963	2 JUNE, DECEMBER 1968
APRIL, JULY, 1964	2 NOVEMBER 1972
JANUARY, APRIL, 1965	2 SEPTEMBER 1978
MARCH, MAY, 1966	2 AUGUST 1980

The parameters measured included salinity, temperature, light penetration, dissolved oxygen, hydrogen sulfide, nitrate, phosphate and plankton.

The major results of these cruises involve the demonstration of a strong spatial, seasonal and interannual variability in all the parameters measured. The temporal variability extends down to 500m. The existence of the permanent anticyclone in the southwest corner of the basin as well as the interactive sub-basin structures were identified (Yuce, 1985a,b, 1987 and Ozsoy et al., in preparation).

Knorr Cruises

A joint expedition encompassing a sequence of five cruises was conducted during April 16-July 29, 1988 by R/V Knorr of the Woods Hole Oceanographic Institution. The expedition was organized by U.S. and Turkish scientists. The region covered was within the Turkish Exclusive Economic Zone (EEZ). A detailed description of this undertaking together with the major results to date was presented by Prof. James Murray, co-chairman of the steering committee of the Knorr Expedition (companion volume). The sequence of Knorr cruises was concerned with the following:

NO.1 : Sedimentary evolution of the Black Sea; Particle fluxes and sediment cores,

N0.2 : Microbiology of carbon, nitrogen and sulfur cycles,

NO.3 : Cycling of trace elements and nutrients across anoxic interface,

NO.4 : Ventilation, geochemistry and depositional history,

NO.5 : Nitrogen and carbon cycle distributions and microbiology,

Black Sea Naional Program (BLSNP)

This is a subprogram of the National Program in Oceanography that covers the Mediterranean, the Sea of Marmara and the Black Sea. It has been operational since 1987. The program is supported by the State Planning Office (SPO) and The Turkish Scientific and Technical Research Council (TUBITAK).

Both IMS-METU and IMST-NS carry out research under the Black Sea National Program. IMS-METU research has been coupled to the work carried by this Institute in the Bosphorus-Sea of Marmara- Dardanelles under the sponsorship of the Municipality of Istanbul and TUBITAK.

Measured parameters include salinity, temperature, hydrogen sulfide, nutrients, Chlorophyll-a, petroleum hydrocarbons, mercury, dissolved organic carbon, and to a lesser extent plankton, and benthic organisms.

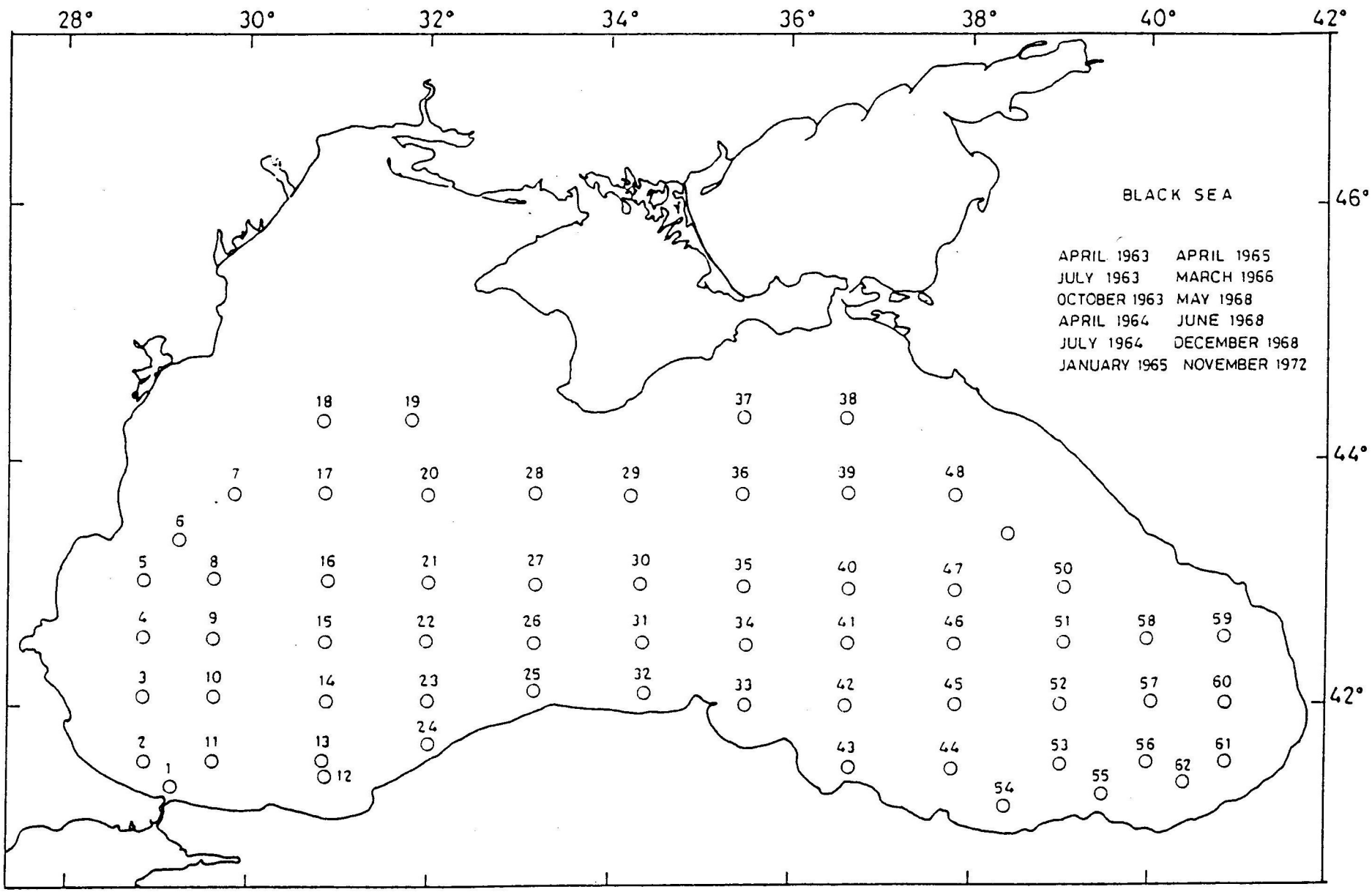

Figure 3. Station network for the Department of Navigation, Hydrography, and Oceanography cruises.

To date sixteen cruises within the Turkish Exclusive Economic Zone have been accomplished under this program. Ten of these can be classified in coverage as major cruises.

Two of these cruises were carried out jointly with the Marine Hydrophyics Institute and the Institute of Biology of the Southern Seas of the Ukrainian Academy of Sciences, covering nearly the entire Basin (Figs. 4 and 5). Another cruise, HydroBlack '91 (this volume) was accomplished with the participation of all the Black Sea riparian states and the Woods Hole Oceanographic Institution (WHOI; Fig. 6).

The major results emerging from the work carried out under BLSNP are summarized below.

Observations indicate that the Mediterranean inflow into the Black Sea is essentially continuous, blockage occurring over a 2-3 day period under very strong northerly winds and increasing surface influx into the Bosphorus (Latif et al., 1991). The path of the inflow is governed strongly by topography near the Black Sea. Intense dilution takes place until the shelf edge. The Mediterranean water then behaves as a time dependent "Plume", sinking to different depths and forming horizontal layers, double diffusive intrusions playing a significant role (Ozsoy et al., 1989; Oguz and Rozman, 1991; Murray et al., 1991; Ozsoy et al., 1991).

Along the Turkish coast the rim current meanders intensely between the shelf seas and the deep water. The presence of squirts, filaments and coherent structures, such as dipole eddies, extending from the coastal and shelf seas to the shelf edge and beyond imply, together with the meanders, strong cross-shelf exchanges with the deep water masses. Quasi permanent meso-scale anticyclones are found to be imbedded in the rim current. Propagating meso-scale anticylonic eddies and dipole eddies with sub-basin scales are also observed in the deeper parts of the basin. Meso-scale and sub-basin scale anticyclonic structures appear to entrap significant amounts of the Cold Intermediate Water (Oguz et al., 1989; Oguz et al., 1990; Ünlüata and LaViolette, 1990; Oguz et al., 1991).

A comparison with the past data indicates a net depletion of reactive silicate and inorganic nitrogen in the surface waters during the 1960 - 1991 period, implying a net decrease in the annual production of algae relative to pre-1980 period (Oguz et al., 1990; Tugrul et al., 1992). There is strong evidence that silicate is becoming a limiting nutrient, which would have a drastic effect on the anchovy population since the main food of the anchovy is copepods.

Drastic decreases in the ammonia concentrations, varying from 2 to 5 μM in the oxic layer of the Black Sea during the 1960's to 0.1-0.5 μM levels in recent years, are observed (Tugrul et al., 1992). Significant reduction in Si:N:P ratios in comparison to their past values are also observed.

Maximum nitrate concentrations in the oxic upper layer are found to have increased 2-3 times from 1970 to 1991 (Codispoti et al., 1991; Oguz et al., 1990; Tugrul et al., 1992).

Tugrul et al. (1992) have observed a significant and consistent correlation between the large phosphate anomaly and the first appearance of sulphidic waters (H_2S >3μM), independent of geographical location.

Comparison of composite phosphate profiles from the historical data relative to density (sigma-t) reveals that no change in the depth of anoxic interface has occurred since 1969 provided that the density of this narrow zone has not changed. Saydam et al. (1992) report that the locations of both nitrate maximum and large phosphate anomaly relative to sigma-t values of 15.4 and 16.2, respectively, have remained stationary since 1987, even though their depths vary significantly in space and time. With the aid of CTD (conductivity, temperature and depth) measurements, one can thus sample this transition zone properly to study its biogeochemical properties.

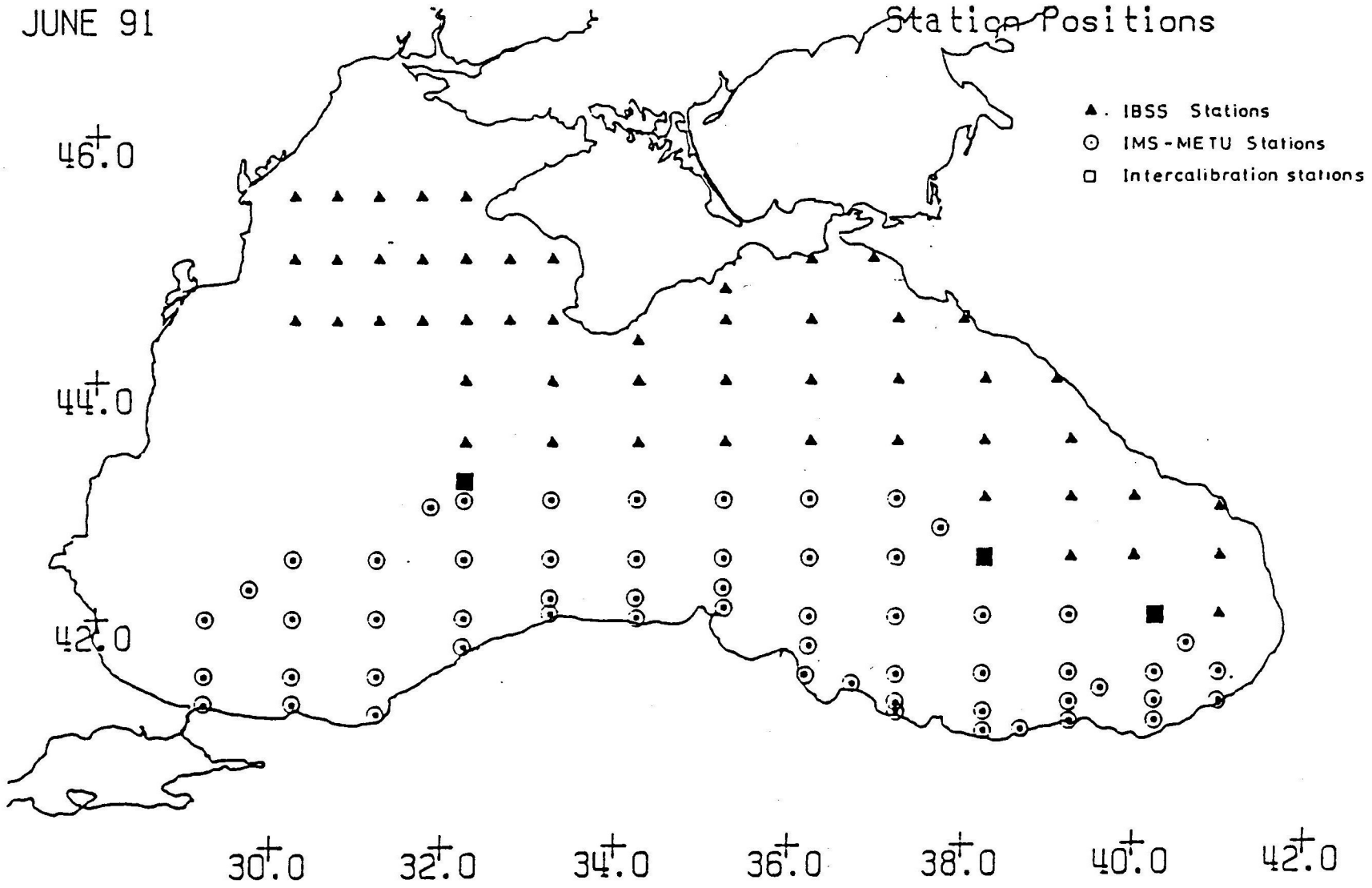

Figure 5. Station network for IBSS-UAS and IMS-METU June 1991 cruise.

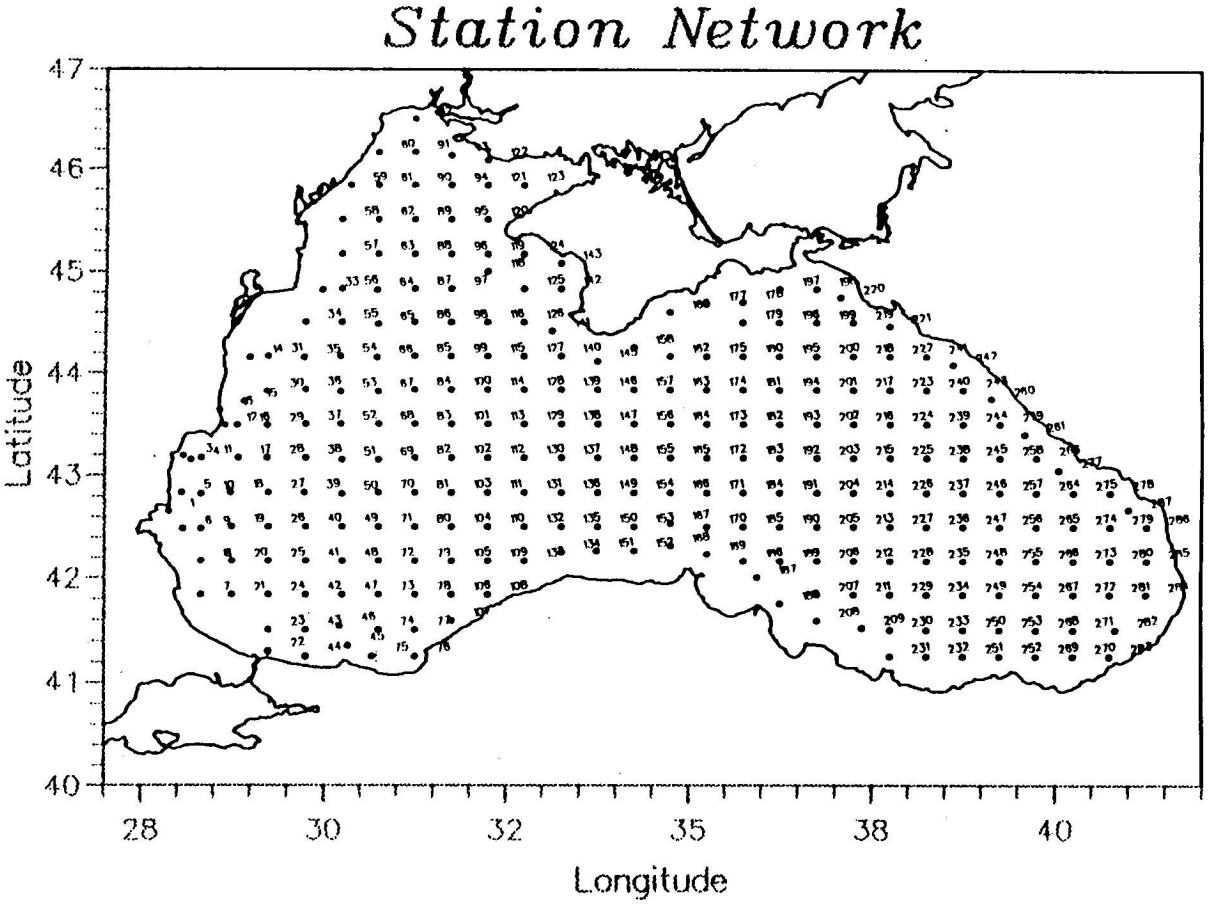

Figure 6. Hydro-Black 1991 cruise station network.

WHOI, Hamburg U. and IMST-NS Joint Cruises

This cooperative program, carried out jointly by IMST-NS, the Woods Hole Oceanographic Institution, and Hamburg University, commenced in 1982.

Measurements include long term sinking flux of particulate matter with sediment traps, water column measurements for some radionuclides and sediment coring. Various stations within the Turkish Exclusive Economic Zone have been occupied.

Major results that have emerged from this cooperative program can be summarized as follows:

The particle flux in the southwestern Black Sea has significant temporal variability with a range of 1-480 mg m^{-2} day^{-1}. Significant spatial variability is also found. Sinking velocity of the particles in winter is about 125 m/day with a standard deviation of 60m/day. High sediment fluxes are observed during two major periods extending from June to August and from October to January. These periods encompass the times of high productivity of dinoflagellates and cocco-lithophorids. Evidently the outputs from the surface processes are transmitted without a time lag to the deep layers. On the other hand consistently higher material fluxes measured in the deeper traps indicate sediment transport from the coastal and shelf seas (Izdar et al., 1987; Honjo et al., 1987; Benli, 1987; Hay et al., 1990).

The organic carbon content of the sinking particle varies between 3.5 and 45 percent in summer and autumn and between 2 and 3 percent in winter and spring. Organic carbon fluxes are in the range of 1-44 mg m^{-2} day^{-1} in summer-autumn and 0.4-5 mg m^{-2} day^{-1} in winter-spring periods (Izdar et al., 1987; Hay et al., 1990).

Low C/N ratios (8-12) observed for the near surface layers are interpreted as representing input of fresh organic material produced in the photic layer during periods of high phytoplankton biomass (Izdar et al., 1987).

Three kinds of mineral enrichment process are found to exist in the Black Sea: gels rich in iron and manganese at the anoxic interface, uranium enrichment at the abyssal plain and hydrothermal sulfide accumulation within the terrigenous sediments (Izdar and Ergun, 1987).

Geological and geophysical evidence indicates that the Black Sea has been subject to recent subsidence accompanied by active tectonism. 4He and 3He isotopes are found to be injected with flux of the latter isotope to the former's being on the order of 10^6.

Sediment trap results have revealed a rapid removal of a considerable fraction of Chernobyl radionuclides to the deep waters of the Black Sea by sinking particles with subsequent release back at the mid-waters (Buesseler et al., 1987; Buesseler et al., 1990).

Stock Assessment Studies

This is a research program supported jointly by NATO Science for Stability Program, SPO and TUBITAK. It is carried out jointly by IMS-METU and the Ministry of Agriculture.

The program started in 1988. The purpose of the project is to provide an assessment of stocks of selected species of fish within the Turkish EEZ, the primary task being the establishment of a data base for stock management through hydroacoustic and trawling surveys supplemented by environmental data and satellite imagery. Six stock assessment cruises has been completed to date.

An examination of the fish statistics during the 1967-1987 period reveals that when anchovy catches were 300,000 tons, the existing fishing fleet was economically optimum, but it was over-fishing.

Starting in 1989, a basin-wide major collapse of Black Sea fish stocks accompanied by significant changes in some compartments of the ecosystem occurred, reflecting over-fishing, long term climatic changes, anthropogenic effects or a combination of these. Drastic reductions in fish biomass of both pelagic and demersal species were observed (Anchovy catch was down from 300,000 tons to 100,000).

Increase in competitive and predatory species such as Jellyfish (*Aurellia aurita*) and a special species of Ctenophora of Atlantic origin called *Mnemiopsis leidyi* (with an estimated majestic biomass of 800 Million tones- USSR sources) are observed and their biomasses are monitored.

Existence of offshore potential fishing grounds, within the warm-core anticyclonic eddies and located 40-60 nm from the shore, was determined. Large copepods, small individuals of sprat, jelly fish and ctenophora are found in this location.

RECOMMENDATIONS

The inputs and pathways leading to the rapid degradation of the marine environment of the Black Sea, detrimental changes in its ecology for reasons that are not well known, the lack of understanding of the physical and biogeochemical processes that regulate the Basin's Oceanography are among the serious issues facing the Marine Science community today.

There is little doubt that the preservation, protection and the optimum utilization of the marine environment of the Black Sea will require an effective and integrated management approach that will often involve conflicting political, social and economic issues. While this may be the case, there should be no doubt about the fact that the optimum management of any environment requires a sound understanding of the physical, biogeochemical and the ecological characteristics of that environment, space-time variability of these characteristics and the underlying fundamental processes. Steps should be taken to fulfill this requirement so that a judicious blend of research and management is accomplished for the Black Sea.

The Black Sea is a unique environment in that it is semi-enclosed and nearly 90 percent of its volume is anoxic. The basin's oceanography is affected by river inputs, atmospheric forcing, thermohaline circulation, strait flows and topography. Because of its size and internal dynamics, there is a strong coupling between the various regions of the Black Sea over scales extending up to the scale of the Basin. A sound understanding of the marine environment therefore requires cooperative and integrated investigations starting with those on the scale of the Basin. As a result coordinated research efforts involving scientists from the coastal states and others who are interested in the Marine Science of the Black Sea are much needed.

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Marine Science Country Profiles
Profils nationaux en sciences de la mer
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3

Black Sea Research Country Profiles (Level II)

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3

Black Sea Research Country Profiles (Level I)

These profiles summarize basic information on Black Sea Research provided by marine scientists from Bulgaria, Romania, Russia, Turkey, Ukraine, and European and North American institutions which have studied this unique marine area at a Workshop in Varna, Bulgaria (30 October-4 November 1991)

Paris, 1993