DETERMINATION OF POTENTIAL ARTIFICIAL REEF AREAS BY MARINE GEOPHYSICS RESEARCH IN İZMIR BAY

İZMIR KÖRFEZINDE DENIZ JEOFIZIĞI ARAŞTIRMALARI ILE POTANSIYEL YAPAY RESIF ALANLARININ BELIRLENMESI

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Geliş Tarihi / Received: 25.11.2021
Kabul Tarihi / Accepted: 21.12.2021
Araştırma Makalesi/Research Article
DOI: 10.38065/euroasiaorg.913

ABSTRACT

Artificial reefs are man-made underwater structures built to stimulate marine life and improve fisheries in areas with low biodiversity. However, with the use of artificial reefs by the Japanese after the second world war, their use has emerged to prevent erosion, tourism, contribute to the re-increase of natural coral reefs and even treat some diseases. In the last 30 years, artificial reef applications have been carried out in suitable areas in Turkey in order to increase the tourism potential, to restore the degraded ecosystems and to prevent uncontrolled fisheries. In İzmir, the work on creating artificial reefs, which was first started by the Ege University Faculty of Fisheries (EGE-SÜF) in 1989, with the sinking of 10 trolleybuses into the Gulf, continued in the following years with the cooperation of Ege University, local municipalities and fishermen's cooperatives. In 2017, with the geological and geophysical studies carried out with the Dokuz Eylül-3 research ship in three pilot sea areas (Maltepe, Urla and Gülbahçe Bay) in İzmir Bay, suitable artificial reef areas that will not cause the slightest negative ecological impact in the future were tried to be determined. As a result, areas where artificial reefs can be placed have been determined and the importance of reefs has been pointed out in order to increase the living and non-living activity of İzmir Bay together with sea tourism.

Keywords: İzmir Bay, Artificial Reefs, Ecosystem, Marine Geology and Geophysics

ÖZET

Yapay resifler en genel tabirle, biyolojik çeşitliliğin az olduğu bölgelerdeki deniz yaşamını hareketlendirmek ve balıkçılığı iyileştirmek amacıyla inşa edilmiş insan yapımı su altı yapılarıdır. Ancak yapay resiflerin ikinci dünya savaşının ardından Japonlar tarafından kullanılmaya başlamasıyla birlikte erozyon önleme, turizm, doğal mercan resiflerinin yeniden arttırılmasına katkıda bulunmak ve hatta bazı hastalıkları tedavi etmek için dahi kullanım amaçları ortaya çıkmıştır. Türkiye'de son 30 yıldır, başta turizm potansiyelini arttırmak, bozulan ekosistemlerin yeniden canlandırılmasını sağlamak ve kontrolsüz balıkçılığın önüne geçmek amacıyla uygun görülen alanlarda yapay resif uygulamaları yapılmaktadır. İzmirde, ilk olarak 1989 yılında Ege Üniversitesi Su ürünleri Fakültesi'nin (EGE-SÜF) tarafından Körfeze 10 adet troleybüsün batırılmasıyla başlanan yapay resif oluşturma çalışmalarına sonraki yıllarda yine Ege Üniversitesi, yerel belediyeler ve balıkçı kooperatiflerinin iş birliği ile devam edilmiştir. 2017 yılında İzmir Körfezinde üç pilot deniz alanında (Maltepe, Urla ve Gülbahçe Körfezi) Dokuz Eylül-3 araştırma gemisiyle yapılan jeolojik ve jeofizik çalışmalar ile gelecekde en ufak negatif ekolojik etkiye sebep vermeyecek uygun yapay resif alanları belirlenmeye çalışılmıştır. Sonuçta, yapay resiflerin konulabileceği alanlar tespit edilmiş ve deniz turizmi ile birlikte İzmir Körfezi'nin canlı ve cansız aktivitesinin arttırılması için resiflerin önemine işaret edinilmiştir.

Anahtar Kelimeler: İzmir Körfezi, Yapay Resifler, Ekosistem, Deniz Jeolojisi ve Jeofiziği

INTRODUCTION

The main purpose of artificial reefs is to increase the success of commercial fishing. (Grove and Son 1985, Mottet 1985, Stone 1985, Seaman and Sprague 1991). Japan and America have been the countries that have used artificial reef applications the most for centuries (Ino 1974, Bohnsack and

Sutherland 1985). Artificial reefs, first used in 1960 to study coral reef fish assemblages (Randall 1963), have since been used in a wide range of studies, from reef fish ecology to more recently the treatment of disease (Bohnsack and Sutherland 1985). The primary purposes of artificial reefs are; stability (to compensate for habitat loss as a result of coastal filling), topographical relief, and the provision of shelter and shelter (Clark 2002). Thus, habitats for fish and other biota are created and hard substrates (concrete, etc.) are formed for the settlement of coral communities (Schuhmacher 1973, Fitzhardinge and Bailey-Brock 1989, Hudson et al. 1990, Clark and Edwards 1994, Thongtham and Chansaang 1999, Kaufman 2006).). As for secondary purposes; to create new areas for sport fishing and diving tourism, to prevent wave-induced coastal erosion, to prevent illegal trawling and to help protect seagrass meadows.

Although artificial reef studies in Turkey were considered to have started in 1983, the first serious information was obtained as a result of the studies carried out in Izmir Bay in 1989. The first recorded and monitored artificial reef project was realized by EGE-SÜF as a doctoral thesis project in 1991 by placing a total of 30 blocks (Figure 1), consisting of three sets of 4+1, at 9 m and 18 m depths on the shores of Hekim Island in İzmir Bay (Lök and Gül 2005) and continued with similar projects until 2016 (Table 1). Today, artificial reef studies are carried out within the framework of the "Artificial Reef Applications Project Planning Guide" of the Ministry of Agriculture and Forestry.

Figure 1. Cubic concrete artificial reefs placed around Hekim Island in 1991

Table 1. Artificial reef projects with certain coordinates made in İzmir

Location	Coordinates	Design/Material	Total	Depth (m)	Year
Hekim Island	38°27.07' N 26°46.42' E 38°27.08' N 26°46.23' E	Cubic Concrete	30	9-18	1991
Dalyanköy	38°21.20' N 26°19.85' E	Plus and Cubic Concrete	100	21	1995
Ürkmez	38°03.72' N 26°55.00' E 38°04.49' N 26°57.65' E	Pentagon Dome Concrete	160	14-21	1998
Gümüldür	38°04.18' N 26°58.34' E 38°03.29' N 27°00.13' E	Cubic Concrete	30	12-15	1999
Urla	38°22.37' N 26°45.46' E 38°22.56' N 26°45.46' E 38°24.20' N 26°47.17' E 38°24.19' N 26°47.29' E	Type-Specific Concrete	80	14-20	2005
Gümüldür	38°03.11' N 26°59.01' E 38°01.48' N 26°58.02' E	Steel, Polypollen	4	50-100	2008
Karaburun	38°38'55.60 N 26°31'36.22 E 38°38'57.57 N 26°31'36.22 E	Steamboat	2	28-35	2016

MATERIAL AND METHODS

The choice of places where artificial reefs can be placed is very important. Reefs to be built close to the shore will be adversely affected by human-induced terrestrial impacts and maritime traffic. The reefs to be built too far from the shore will increase the fuel costs of the fishermen. For these reasons, artificial habitats for fishing should be chosen neither too close nor too far from the shore. However, distance to shore should not be considered if the reef is intended to increase habitat or protect certain areas. In order to minimize interactions between the surrounding natural reefs and artificial reefs, the distance between the reefs should be kept at least 600–1000 m (Lök, 1995). The working area must be large enough for the application to fully function. However, this size should not change the hydrological conditions in the application area and uncontaminated areas should be chosen where the sea water is not turbid (Cirik and Neşer, 1999).

Within the scope of the research, marine geology and geophysics studies were carried out in the Urla (URL) and Maltepe (MLT) sea areas of İzmir Bay and in Gülbahçe Bay (GLB) in order to determine the areas where suitable artificial reefs can be created (Figure 2).

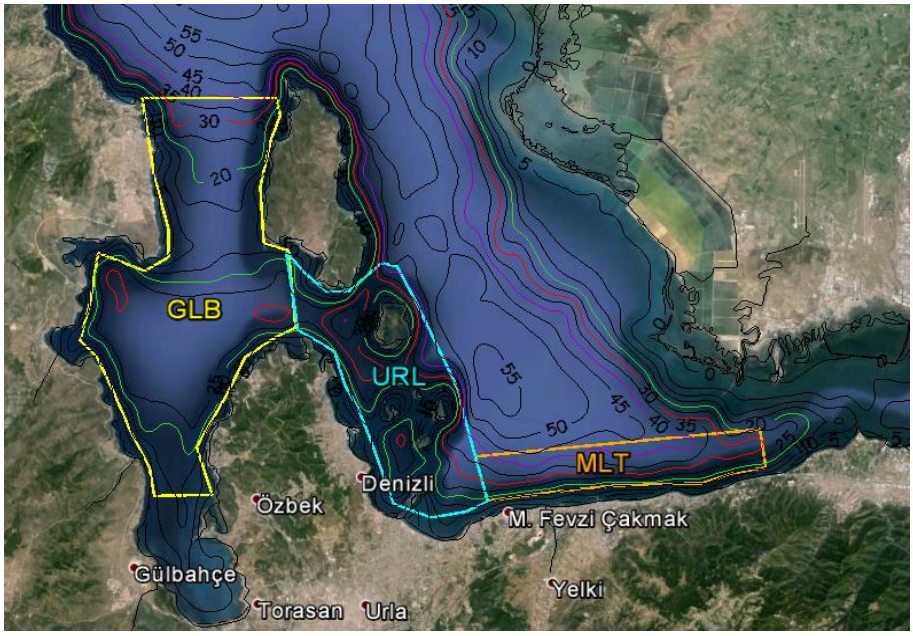

Figure 2. Study area

Within the scope of the study, dual frequency echosounder was used for water depth measurements. However, to determine the geology under the seafloor, records were taken with Shallow Seismic and Side Scan Sonar systems that show detailed seafloor structures. CTD measurements were made to determine the physical parameters of the water and Grab was used in the grain size data. The concurrent data collected were evaluated and interpreted.

RESULTS

During the study, measurements were made with existing systems in an area of 193 km^2 and at 17 stations. As a result of these studies, the bathymetry map of the study area was revealed in detail (Figure 3a and 3b).

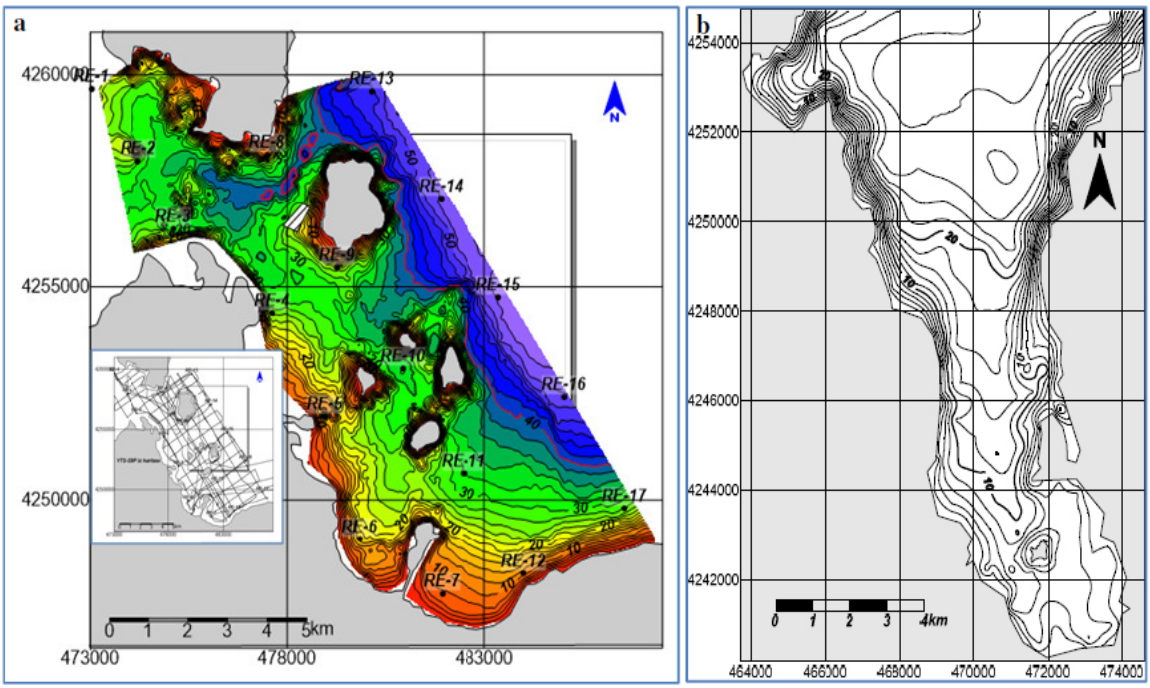

Figure 3. a) Bathymetry map of Urla (URL) and Maltepe (MLT) marine areas, b) Bathymetry map of Gülbahçe Bay (GLB)

During the CTD measurements, the material on the base was photographed at 11 stations (due to turbidity) with the GoPro camera attached to the device, although not at all stations (Figure 4). *Posidonia oceanica* was encountered in 3 stations, and sometimes hard and sometimes soft sand and mud contents were encountered in other stations.

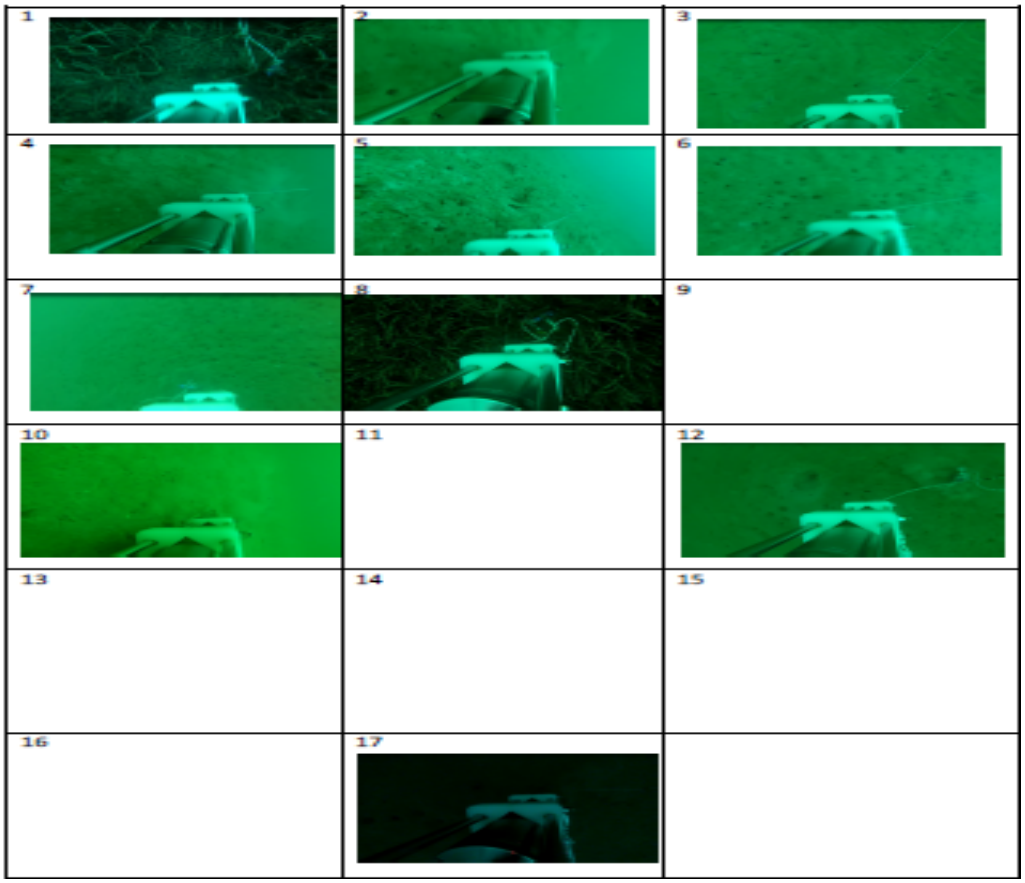

Figure 4. GoPro camera images recorded at 11 stations out of 17 stations in the study area

An example of the base structure information obtained from Side Scan Sonar recordings is shown in Figure 5a. At the same time, when the records of the shallow seismic system were examined, findings suitable for the characteristics of the study areas were obtained (Figure 5b).

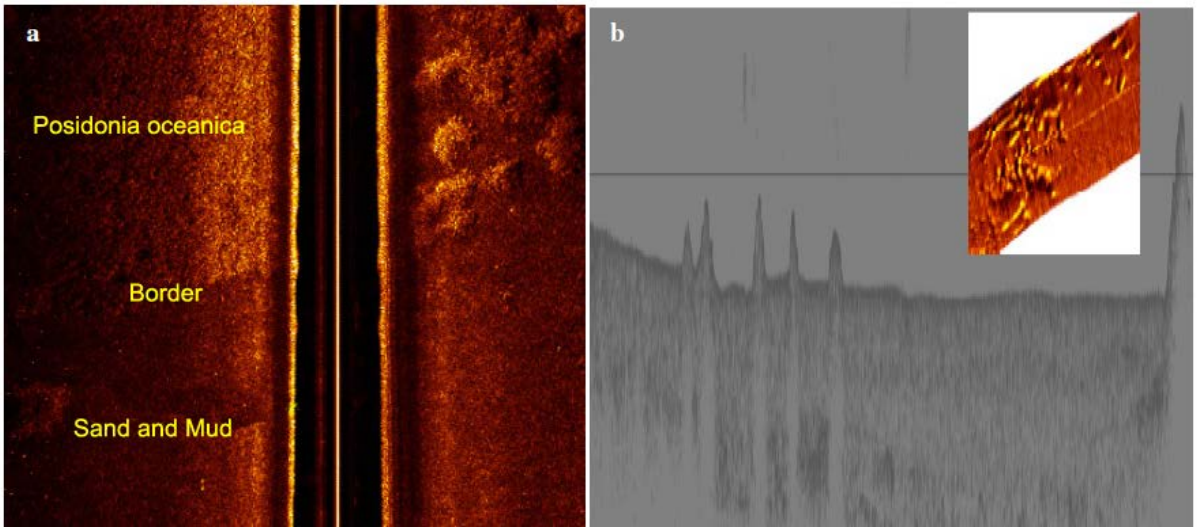

Figure 5. a) Side scan sonar (SSS) recording recorded on the west coast in the south of the study area, the Posidonia oceanica area, the characteristic boundary zone without borders and seagrass meadows, b) Dome-shaped, 0.5-5m high, located on the sea floor at 5-25m water depths and in places 200m in length elevations formed as a result of possible biological activity (SSS image of dome-shaped structures at upper right).

As a result of CTD measurements made at 17 stations, the temperature and salinity variation ranges at water depths between 20-40m are 11.4-12.2ºC and 38.8-39.1ppt, respectively (Figure 6). However, the sediment particle size data and the measured seci disc depth values are shown in Table 2.

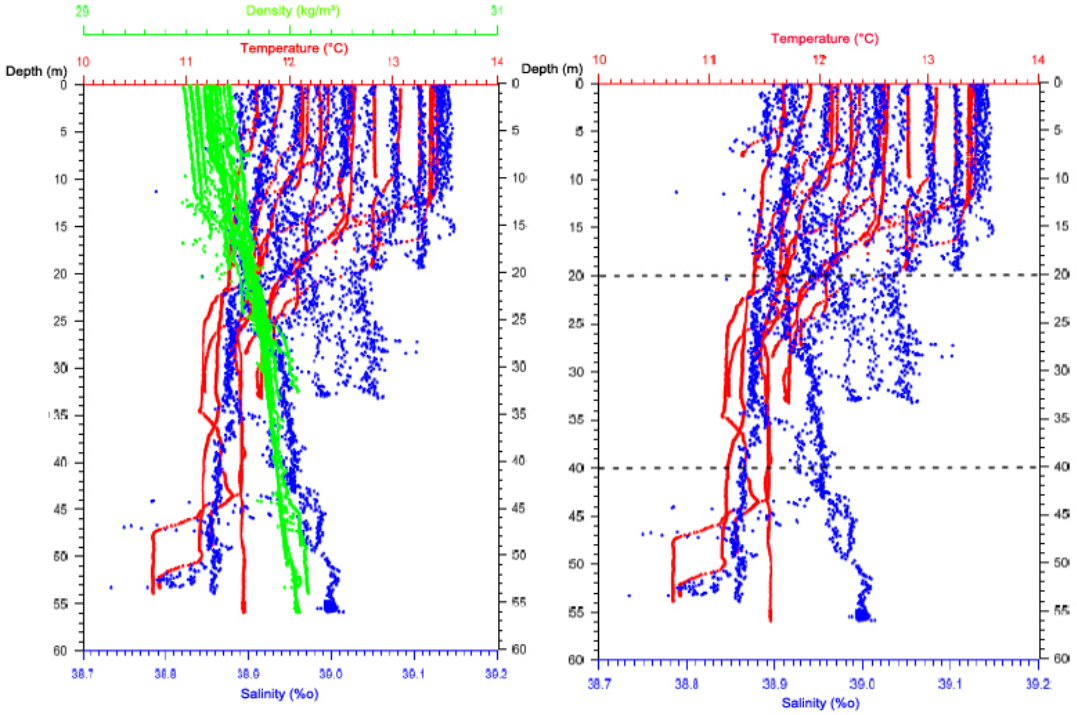

Figure 6. Depth dependent temperature, salinity and density graphics

Table 2. Secci depth values measured at stations with sediment particle size data

Station Number	East	North	Latitude	Longitude	Depth (m)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Marine Shell (%)	Secchi (m)
RE-1	473023.3	4259679	38.46969	26.69088	14.4	-	33.55	56.03	10.42	10.99	8.5
RE-2	4744226	4257984	38.45445	26.70472	28.5	0.85	78.72	16.41	4.02	17.17	11
RE-3	475120.2	4256366	38.43991	26.71503	33.2	3.43	61.04	25.81	9.72	6.51	11
RE-4	477621.9	4254385	38.42212	26.74374	27.3	0.3	50.35	39.63	9.72	8.12	10.5
RE-5	478951.3	4251964	38.40035	26.75904	19.4	-	14.68	65.68	19.64	3.86	10.6
RE-6	479830.6	4249073	38.37432	26.76919	16.9	0.39	54.97	36.03	8.61	17.04	7
RE-7	481916.9	4247783	38.36275	26.79309	7.5	-	46.58	49.17	4.25	1.24	6
RE-8	477490.6	4258129	38.45585	26.74212	9.7	-	38.36	52.91	8.73	19.09	7
RE-9	479253.3	4255455	38.43180	26.76239	25	1.29	72.98	20.32	5.41	12.08	6.4
RE-10	480924.6	4253084	38.41048	26.78160	34	0.2	9.14	67.77	22.89	1.28	8.8
RE-11	482474.4	4250623	38.38834	26.79940	33.3	2.59	45.07	41.11	11.23	3.55	6
RE-12	483996.2	4248249	38.36698	26.81687	11.1	-	34.21	56.66	9.13	0.65	6.3
RE-13	480134.5	4259618	38.46933	26.77237	48.8	-	2.83	80.63	16.54	0.55	5.7
RE-14	481897	4257096	38.44664	26.79263	54.5	-	1.3	81.85	16.85	0.66	7
RE-15	483355.7	4254756	38.42559	26.80939	55	0.1	1.64	79.69	18.57	0.22	8
RE-16	485020.1	4252417	38.40455	26.82850	53.2	0.64	2.5	81.76	15.1	0.45	5.8
RE-17	486546.6	4249802	38.38102	26.84603	28.9	-	1.75	90.46	7.79	0.23	6

When all analyzes were evaluated, the region shown in Figure 7 was determined as the potential artificial reef area.

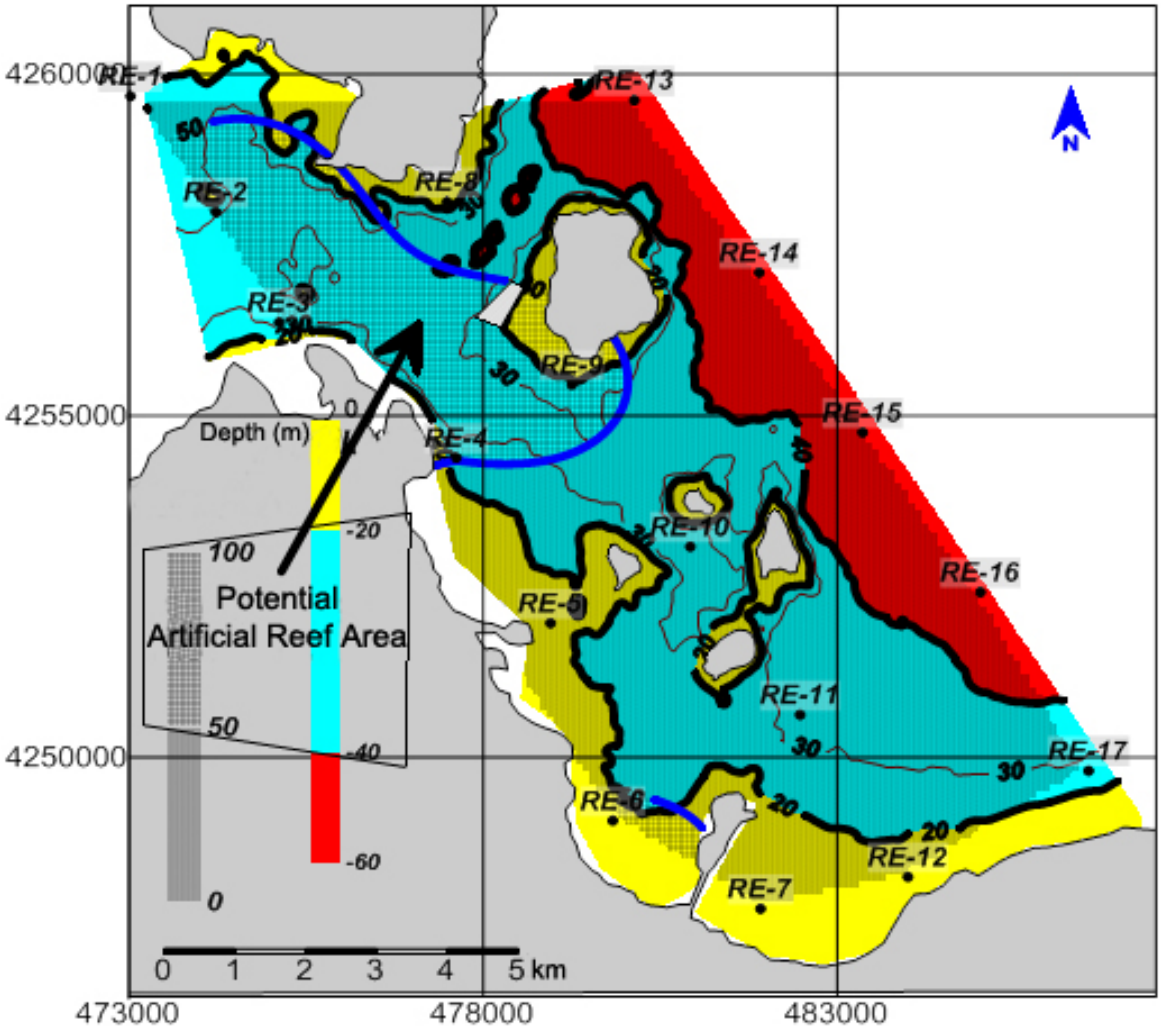

Figure 7. Map of potential artificial reef area (area covered by blue line)

CONCLUSION

Artificial reefs have been applied for many different purposes in the last 50 years in America and Europe. Artificial reefs built especially in the Mediterranean and on the Atlantic coasts of the Iberian Peninsula are used for the purposes of protecting and restoring living and non-living life in the sea, increasing fish stocks and improving fisheries management, aquaculture, research and recreation. In the meetings of the scientists, local governments and the private sector who are experts in the field, it was concluded that the implementation of artificial reef applications on a world scale in coastal areas would be the best solution for the seas. The area where the artificial reef will be built should be selected after all the parameters have been determined, and the planning of how much of it will be applied should be done with precision. Reefs should not be placed in areas where sedimentation is intense, such as river deltas and discharge areas. Reefs should not be placed in areas with seagrass meadows. The height of the blocks to be built during the artificial reef application should not be more than 1/3 of the water depth and the placement of these reef blocks should be limited to a maximum water depth of 50 m.

Compliance with Ethical Standards

Conflict of Interest

The author declare that there is no conflict of interest.

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