ISSN: 2320-5407 Int. J. Adv. Res. 6(9), 726-735

Journal Homepage: -www.journalijar.com
INTERNATIONAL JOURNAL OF ADVANCED RESEARCH (IJAR)

Article DOI:10.21474/IJAR01/7730
DOI URL: http://dx.doi.org/10.21474/IJAR01/7730

RESEARCH ARTICLE

ANALYSIS OF FISH COMMUNITY AT THE FIRST ARTIFICIAL REEF IN MOROCCO (MARTIL, MEDITERRANEAN).

El mdari m., idhalla m., tamsouri n., kaddioui a., nhalla h., hilmi k., el hamoumi r..

1. HASSAN II University , Faculty of science Ben M’sik, Laboratory of Ecology and Environment.
2. INRH : National Institute of fisheries research
3. HASSAN II University, Faculty of science Ain Chock, Laboratory of aquatic Ecology and Environment.

Manuscript Info

Manuscript History

Received: 22 July 2018
Final Accepted: 28 August 2018
Published: September 2018

Keywords:-
Artificial Reef, Biodiversity, fish, Mediterranean, Coastal Management.

Abstract

A pioneering project of artificial reefs was deployed in the northern Morocco (Mediterranean) for the first time in 2012 as a innovative marine natural resources management measure aiming to protect coastal habitat, conserve biodiversity but most importantly improve fisheries catches for an eventual socio- economical impact on the locals.

To assess the reef attraction of fish fauna to the structure and understand the assemblage structure post deployment, Seasonal samplings were conducted from July 2012 to June 2014 in 6 different stations of the Martil Artificial Reef. The present study aims to analyze the artificial reef of Martil after two years of scientific monitoring by obtaining a first assessment of the fish assemblage in terms of species composition, abundance and biomass.

A total of 16 fish species were identified. The abundance and biomass of the identified species shows a variation in evolution, the Shannon-wiener and evenness indexes have gradually increased indicating that stabilization of the Martil artificial reef community is a slow and long term process. For some species, the reef acts as a protection area, for others, it is a reproduction area.

Introduction:-

In Morocco, fishing activity is an essential component of the national economy. However, the fishery resources are at a fragile state. The coastal strip is subject to multiple anthropogenic pressures causing damage to the marine environment, and amplified by poor resource management and extensive destruction of natural habitats.

Indeed, it is approved that all Moroccan fisheries resources have reached the stage of full exploitation. Therefore, it is necessary to preserve and value the marine resources to ensure a sustainable and beneficial use by current and future generations.

Artificial reefs are considered to be important elements of integrated fishery and aquatic management plans in different countries (*Christian et al. 1998, Seaman & Jensen 2000) (Seaman & Hoover 2001, Anon 2003, Wilson et al. 2003)* because they have broad applications, to primarily enhance commercial and recreational fisheries or mitigate marine habitat losses *(Bohnsack & Sutherland 1985, Pickering et al. 1998, Santos & Monteiro 1997, 1998, Pondela et al. 2002, Stephens & Pondela 2002).*

Corresponding Author:- El mdari m..
Address:- HASSAN II University , Faculty of science Ben M’sik, Laboratory of Ecology and Environment.

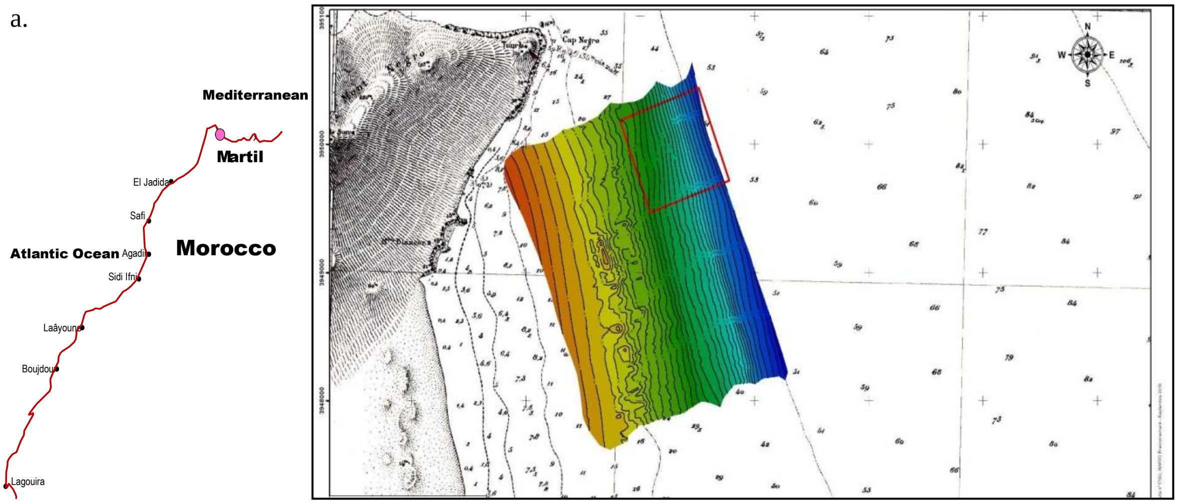
Based on feedback from international experiences, Morocco recently adopted the concept of immersion of artificial reefs and implemented a large scale artificial reef project northern country on the Mediterranean as a tool for fisheries resources sustainable management to ensure a sustainable coastal development, destined to conserve natural resources and sustain human coastal activities.

The present study aims to analyze the fish assemblage of the artificial reef of Martil in terms of species composition, abundance and biomass after two years of scientific monitoring.

Materiels and methods:-

The Martil Artificial reef is located south east of the Negro cape, approximately 1km from the coast, occupying a total area of 52 ha (730 x770 m) on a sandy bottom and a depth ranging from 21m to 40 m (Figure 1). The purpose being to take advantage of the slope of the seabed to create a reef area on a bathymetric gradient. The geographical boundaries of the concession area are: A : 35° 40.455' N / 5° 16.019' O ; B : 35° 40.601' N / 5° 15.570' O ; C : 35° 40.215' N / 5° 15.382' O ; D : 35° 40.070' N / 5°15.836' O.

a.

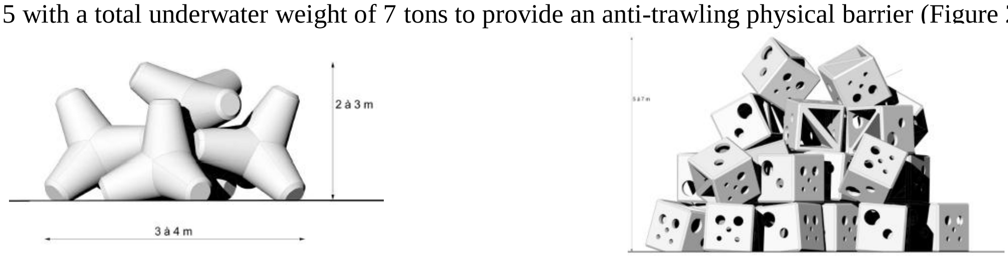


b.

Figure 1:-Location of the Martil artificial reef (Mediterranean); a.:Artificial reef site, b. immersion zone.

The Martil artificial reef was deployed during 2012 with the aim, to enhance traditional fisheries, protect biodiversity and protect the coast against illegal trawling.

The Martil artificial reef architecture uses two types of structural units: a production reef unit, in the form of a cubic concrete block (1.5 m^3) with different diameter perforations on 4 sides. A central part is added to the middle to enhance the unit's resistance and increase colonisable potential surface: along a protection reef unit, the tetrapod grouped in 5 with a total underwater weight of 7 tons to provide an anti-trawling physical barrier (Figure 2).



A: protection unit; a cluster of 5 tetrapods

B: production unit; a chaotic pyramid of 36 cubic blocks

Figure 2:-Martil artificial reef structure units characteristics and architecture

The Martil artificial reef area is arranged in two ellipsoidal circles, a median circle within 25 m depth and a deeper one within 40 m depth (Figure 3). Each circle is composed of an external belt of 22 clustered tetrapods. An internal belt of 22 chaotic pyramids of 36 cubic blocks, as studies demonstrated positive correlation between structural complexity and fish abundance (Spieler *et al. 2001*). The center of the internal belt is composed of 12 chaotic pyramids of 36 cubic blocks plus a grid of 17 individual cubic units. The two ellipsoidal circles are linked using a corridor of two rows of 10 clusters of tetrapods.

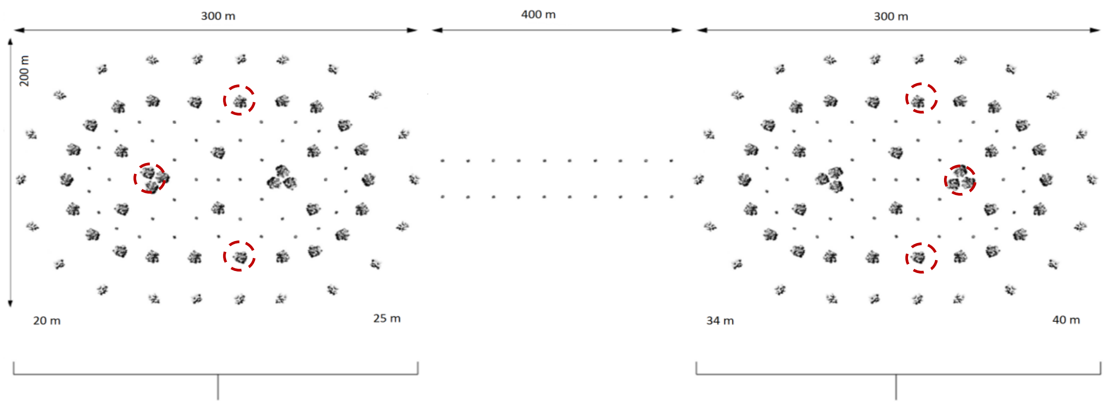


Figure 3:-Artificial reef of Martil Architechture and sampling plan; 6 circled pyramids.

Three pyramids (stations) on each circle were sampled during 2 years: July and December 2012, September and December 2013, April and June 2014. Two samplings were conducted in April and July 2013 but will not be analyzed in this work due to the difficult meteorological conditions at the time rendering the sampling very difficult.
Fish aggregations were surveyed by visual census techniques, which are the most common techniques used to characterize fish aggregations and their evolution (*Barans and Bortone 1983, Bohnsack 1996, Bortone & Kimmel 1991, Bortone et al. 2000, Harmelin-Vivien et al., 1985, Tresher & Gunn 1986, Samoilys 1997*). They are minimally disruptive to the marine organisms and do not disturb the habitat (*Harmelin-Vivien et al. 1985, Bortone & Kimmel 1991*), they are less selective when compared to most other sampling methods (*Brock 1954*) and can be repeated in the same place with brief intervals between samplings (*Bortone et al. 2000*). With the advent of digital devices, video recording has become an appropriate tool for fish surveys (*Michalopoulos et al. 1992, Potts et al. 1987, Tipping 1994).*

The diver browsed the sampled pyramid, at varying elevation, speed, and angle and zooming when needed (S-type transect) (*Pelletier et al. 2011*). To avoid bias due to time variations, the study was conducted under limited time in situ. Data were recorded using an HD SonyTM camera. The camera records a signal that follows the 1080i standard, i.e., with a resolution of 1920×1080 pixels (Full HD), and that is saved on the internal hard drive using the AVCHDTM format which is based on the MPEG-4 AVC/H.264 for image compression. Videos were analyzed using standard viewing software that enables slow view and zooming.

At the laboratory, videos were analyzed by two persons, and analysis lasted from 45 min to 1 h and 30 min, depending on fish abundance and diversity. All fish were identified and counted per species and size class.
Species richness was calculated for each season and for the overall survey period. The percentage of occurrence of each species was obtained using the scale proposed by Charbonnel et al. (1995): permanent species (>75%), frequent species (50–74.9%), scarce species (25–49.9%), and rare species (<25%). The relative class composition provides a measure of the temporal variability of the fish assemblage.

The number of individuals was enumerated directly up to 30 individuals, beyond, abundance was than estimated according to Harmelin –Vivien & Harmelin (1975).

To estimate fish size, species were clustered into three size intervals according to their maximum length cited in literature: small 0 to 1/3 of L.max; medium 1/3 to 2/3 of L.max and large 2/3 to L.max (Bauchot & Pras 1980, Whitehead et al. 1986, Fisher et al. 1987).

Fish biomass was estimated for class 1 and class 2 species (frequency of occurrence ≥50%) using abundance and fish size data. Biomass is estimated in g/Mh using fishbase.org LWR. For each size class (Small, Medium and

Large) a median weight is calculated corresponding to the arithmetic average of the size class limits (Harmelin – Vivien et al 1985).

Shannon wiener diversity index (H') and evenness index J' were calculated for each season.

Results:-

During the 36 videos transects conducted, 5845 individual fish were observed corresponding to 16 species from 11 families of which Sparidae are the most dominant represented by 5 species followed by Labridae represented by two species (Table1). Over the 16 observed fish species during the two year survey, 7 have a frequency of occurrence >75%, considered so far permanent residents of the Artificial reef.

Seasonal variation of species richness shows the existence of a nucleus of more than 60% of permanent species on the Martil artificial reef, plus 7 rare species, only observed on one season at a time (Figure 4).

Table1:-Species richness of the Martil artificial reef during a two year assessment and respective frequency of occurrence.

FAMILLY	SPECIES	OCCURRENCE FREQUENCY	CLASSIFICATION
Sparidae	*Boops boops*	100%	P
	Diplodus vulgaris	100%	P
	Diplodus sargus	100%	P
	Spondyliosoma cantharus	50%	F
	Lithognathus mormyrus	17%	R
Blenniidae	*Parablennius pilicornis*	83%	P
Labridae	*Coris julis*	83%	P
	Ctenolabrus rupestris	17%	R
Phycidae	*Phycis phycis*	17%	R
Pomacentridae	*Chromis chromis*	17%	R
Octopodidae	*Octopus vulgaris*	17%	R
Moronidae	*Dicentrarchus labrax*	17%	R
Tripterygiidae	*Tripterygion tartessicum*	17%	R
Scorpaenidae	*Scorpaena notata*	33%	S
Serranidae	*Seranus cabrilla*	100%	P
Mullidae	*Mullus surmuletus*	83%	P

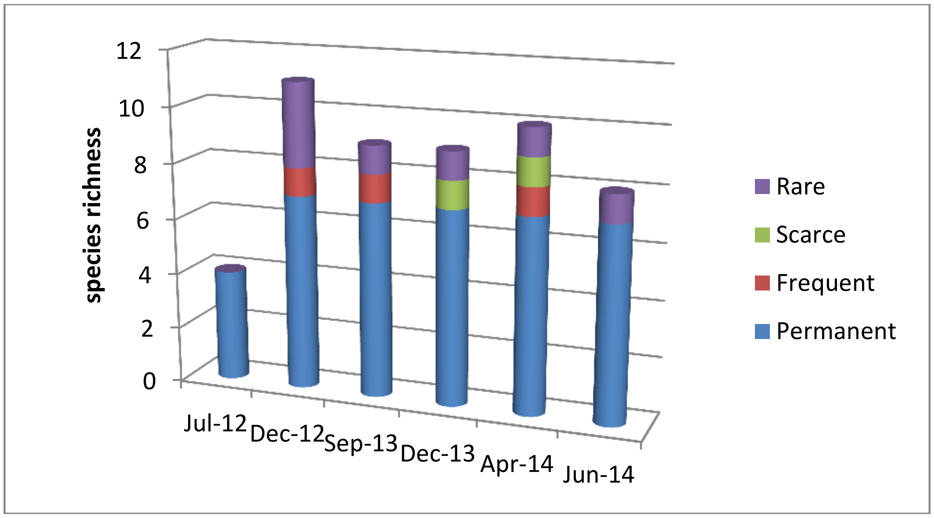


Figure 4:-seasonal species richness over the two year period survey by class of occurrence as proposed by Charbonel et al 1995.

On the first survey following implementation of the Artificial reef, were recorder the most fish individuals over the whole two year period belonging to only four species while in the following seasonal surveys fish abundance seemed to decrease and species richness increased. Another peak in number of individuals recorded in December 2013 is explained by relatively high abundance of *Boops boops* a species known to swim in large schools. Surprisingly in June 2014, after two year of existence, was recorded the lowest abundance of fish (Figure 5).

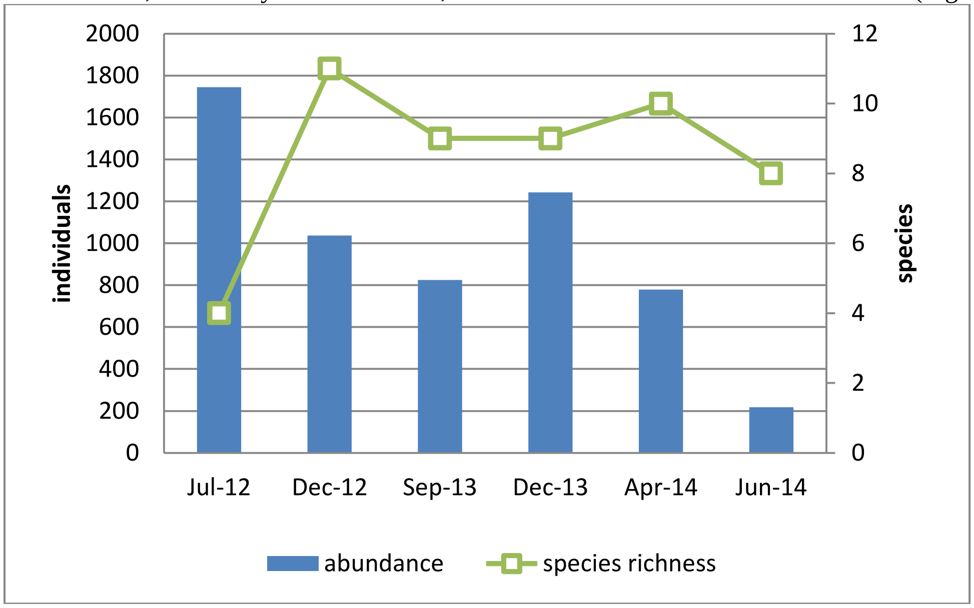


Figure 5:-Fish abundance and species richness of the sampled pyramids of the Martil artificial reef during a two year assessment.

Out of the 16 fish species recorded, 8 Species were selected based on their frequency of occurrence (≥50%) for further analyses: *Boops boops, Diplodus vulgaris, Diplodus sargus, Seranus cabrilla, Coris julis, Mullus surmuletus, Parablennius pilicornis, Spondyliosoma cantharus* (Figure 6).

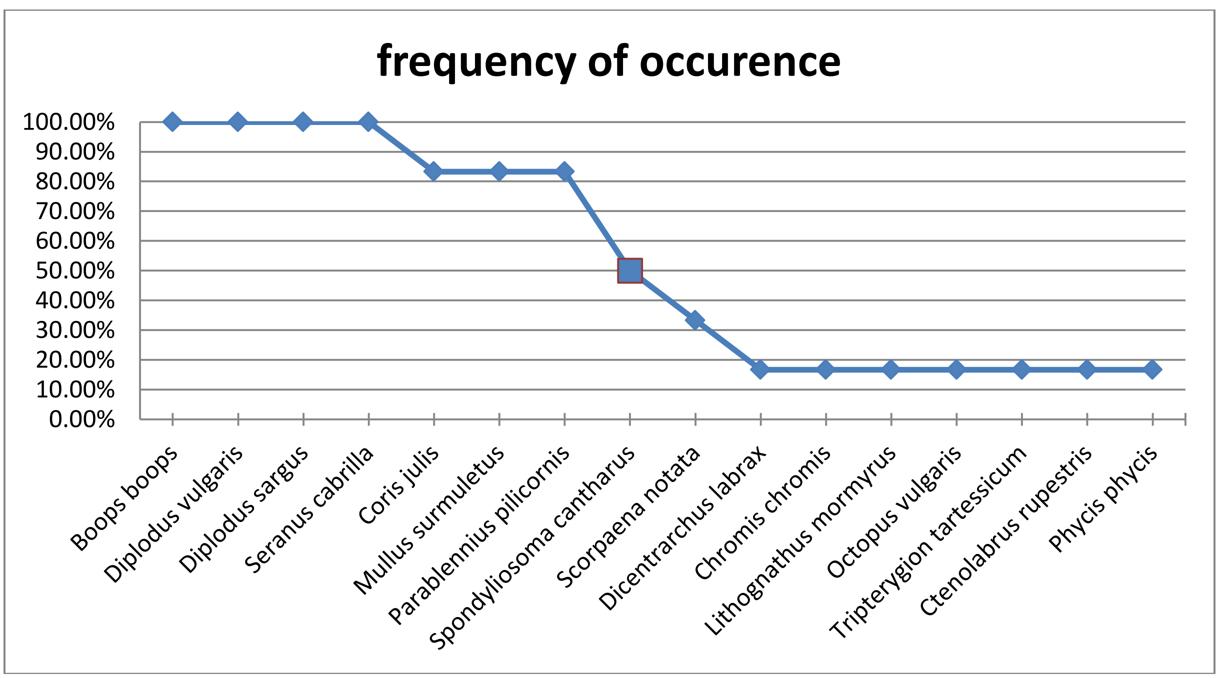


Figure 6:-Frequency of occurrence of fish species identified on the Martil artificial reef survey during two years

The figure 7 shows the abundance of the 8 species of which the frequency of occurrence is ≥50% and which constitutes 99% of the total number of individuals recorded over all the survey period, alongside the abundance of the species *Boops boops*. The abundance of the selected 8 species and *Boobs boops* apart show the same tendency as the later species constitutes quantitatively 71% of the total individuals censused. So the seasonal variation of *boops boops* abundance influences the total abundance variation.

The Figure 7 presents the estimated biomass for the same previous designated 8 species of which Sparidae constitutes 96%. In the first survey following the immersion of the Artificial reef of Martil, though the abundance is highest, the estimated biomass on the other hand is lowest due to the size of counted individuals newly attracted to the structures, all estimated to be small.

A peak of biomass is registered at December 2013, also due to large *Boops boops* Schools encountered during the census. By the last season surveyed the biomass seems to drop drastically and *Boops boops* biomass tendency still affects the biomass tendency of the 8 analyzed species.

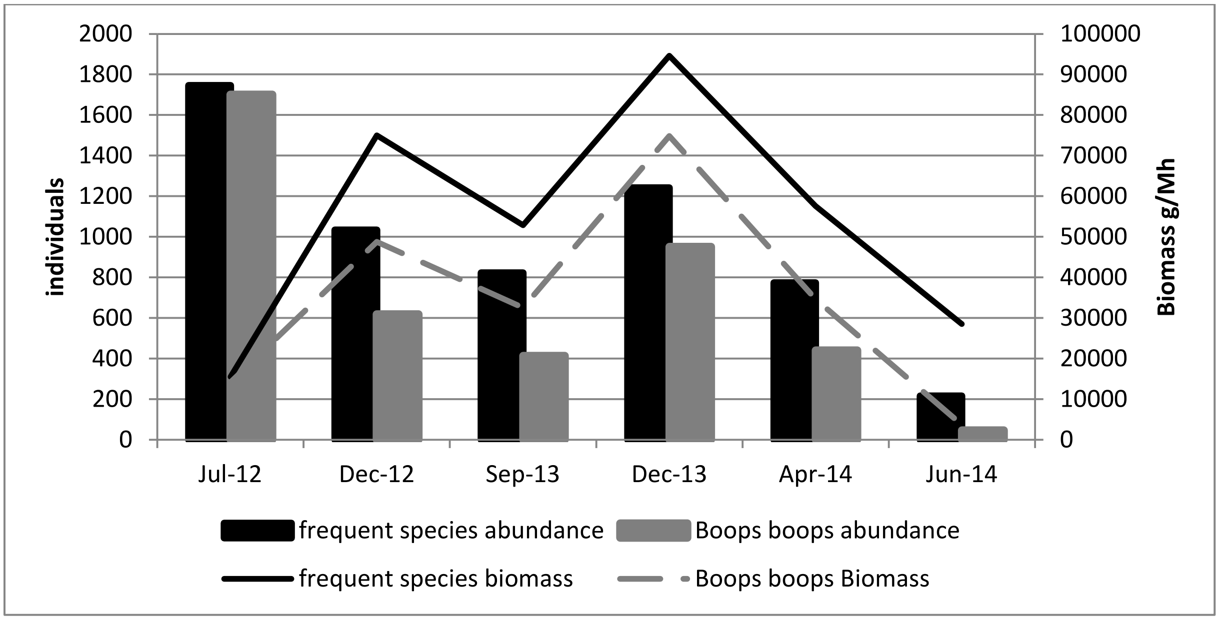


Figure 7:-Abundance and estimated biomass of the 8 species with frequency of occurrence ≥50% and of Boops boops.

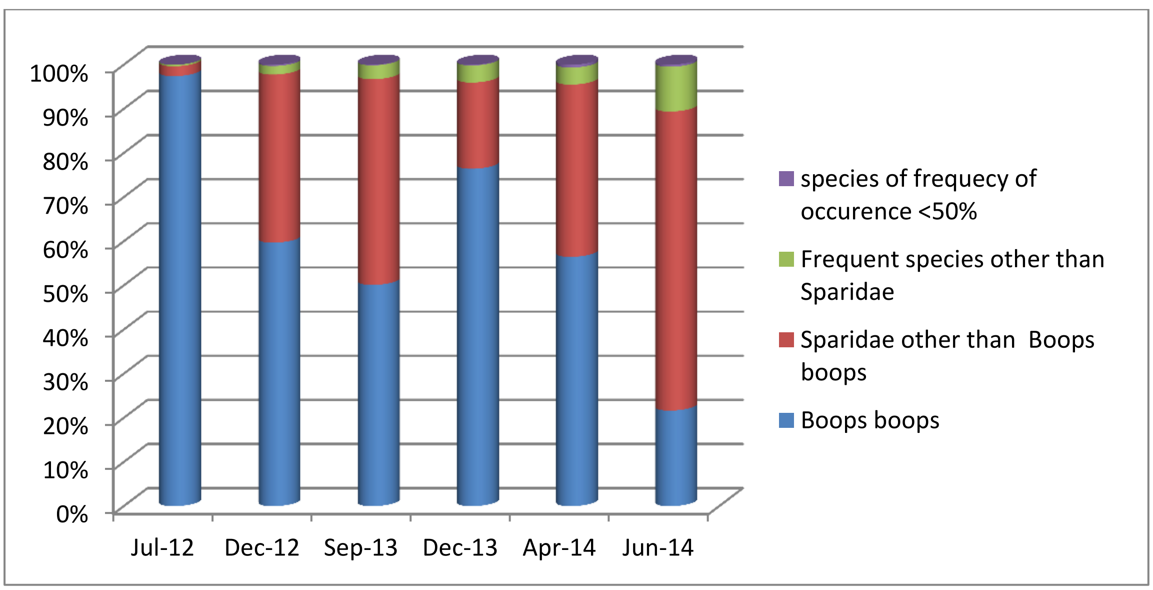


Figure 8:-Analyse of selected species relative abundance variations throughout the study period.

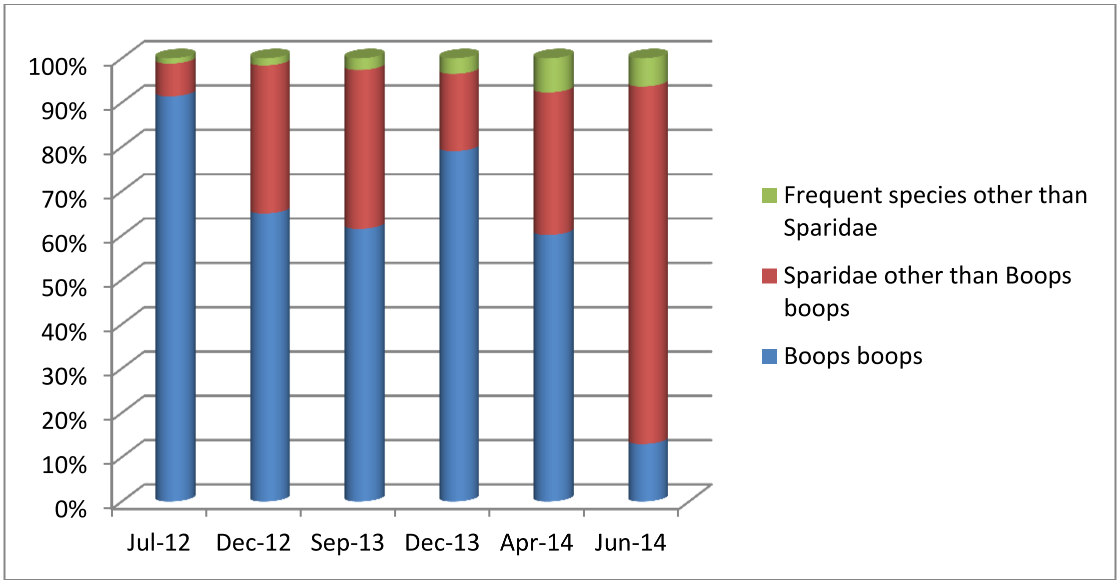


Figure 9:-Analyse of selected species biomass variations throughout the study period.

In terms of abundance, though the results for all species combined show a decrease towards the last season surveyed, if we exclude *Boops boops* for being a species mobile in large Schools thus affecting the global results, we find that the number of individuals of the Sparidae family (dominant family qualitatively and quantitatively) actually increases as does their biomass. The same tendency of progressive increase in abundance and biomass is observed for *Seranus cabrilla*, *Coris julis*, *Mullus surmuletus*, *Parablennius pilicornis*,

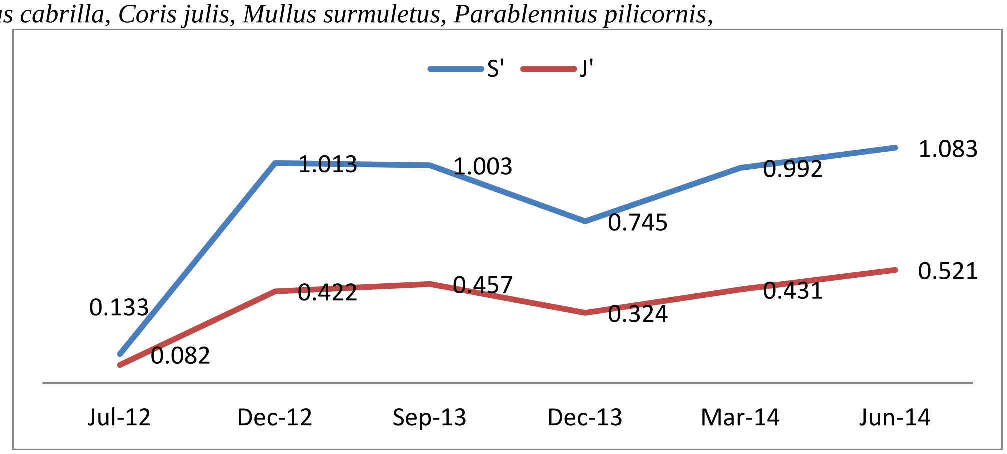


Figure 9:-Shannon index S'and evenness index J' of Martil artificial reef fish population during study .

Over a period of 2 years since immersion, considered to be short compared to the time necessary for an ecosystem to reach maturity, the seasonal Shannon diversity index continues to increase, and the evenness index also demonstrate a tendency toward a more balanced state.

Discussion:-

The Mediterranean sea is one of the most impacted marine ecosystems worldwide (Costello et al. 2010, Coll *et al.* 2010, Lotze et al. 2011). Exploitation and habitat loss being the most impacting human activities shaping biodiversity and abundance of its marine resources (Roux et al. 2013, Coll & Libralato 2012).

It is in the context of the global inshore fishing crisis that Morocco proceeded to the use of artificial reefs as a tool management of coastal areas, reconciling conservation of coastal marine ecosystems and improvement of productivity to sustain fishing activities within a sustainable management approach as instructed by the National maritime strategy “Halieutis”.

The Artificial Reef program on the western Mediterranean Moroccan coast is the first project of its kind in the country and with the aim of increasing colonization of marine biota. The projectwas developed taking into account the need for an integrated management strategy for the local fishery resources and is object to a scientific monitoring since immersion. Our objective from this study was to assess the fish population at the Martil artificial reef within two years of deployment..

The artificial reef of Martil went from very few rare species observed in situ pre-deployement to 16 species of which 7 are permanent residents. Our results show that the number of fish species observed on the Martil Artificial Reef using visual census is within acceptable range of other Mediterranean artificial reef species richness: Fregene – 10 species (central Tyrrhenian Sea, Italy; Ardizzone *et al.*, 1997); Senigallia– 15 (Adriatic Sea, Italy; Bombace *et al.* 1997); Tabarca – 21 (Alicante, Spain; Bayle-Sempere *et al*. 1994).

The majority of fish species belonged to *Sparidae* and Labridae (44% of the species pool) in accordance to *Charbonnel et al 2002* results. An also a common characteristic with natural rocky protected area as stated by *Harmelin 1987*. 50% of the observed species were classified as permanent and frequent based on their frequency of occurrence, suggesting a higher temporal stability of the species assemblage.

It is worth mentioning that more than half of the observed species are of commercial interest to local fisheries. To ensure better conditions for the development of the Artificial reef of Martil, a decision of prohibiting fishing in the reef area for a period of three years post deployment was taken. Although this decision did not stop local fishermen from using the area. During seasonal surveys we encountered many Local fishermen using Hand-line fishing, their important catch was composed mainly of *Boops boops* and other *Sparids.* Considering the duration of survey is 5 days at most each three months, we are lead to believe that their fishing activity could in fact have affected the number of individuals censused, especially as we noticed relatively higher abundances in winter which might be caused by the difficult meteorological conditions rendering the fishing activity risky. Another argument supporting this theory is the end of the fishing prohibition on the artificial reef of Maril in June 2014, a season which recorded a sharp decline in total abundance.

Boops boops in spite of being a fairly mobile species, represented 71% of the overall abundance recorded, fluctuating between 97% to 22%.

Biomass was estimated for the permanent and frequent species (8 species). *Sparidae* clearly dominated (96%). When excluding *Boops boops*, the 4 remaining Sparids (a family of prominent commercial interest in the Mediterranean) increase considerably in terms of biomass over the two years going from 7% to 81%. The other species progressively increase over the course of the study also.

An advantage of video transects is that images can be reanalyzed and observers can spend more time identifying an individual from the guide books and differentiate between species, thereby allowing for more individuals to be identified at species level. It is also a cost-effective technique in terms of the human resources and time needed for field implementation. Therefore, video-based techniques have become commonly used tools for observing underwater macrofauna and habitat, in particular for fish (Tessier et al. 2005, Watson et al. 2005). Although as reported by Tessier et al (2005), using a video recorder narrows the field of view, which can than reduce the probability of detecting an individual (Bortone et al. 2000), especially with rare species.

After two years, the Martil Artificial Reef increased shelter because of the specific architecture of the production unit to increase heterogeneity. It also provides new trophic resources relative to the observed rich invertebrate fauna colonizing the structures, some other species are utilizing the reef for reproduction (observed cephalopods eggs). Though, as cited by Relini et al (2002), after 10 years of existence, the fish community had by no means stabilized by then and clear trends were still visible in the data, suggesting a slow and gradual process of colonization and maturation.

References:-

1. Anon. State of Florida artificial reef strategic plan. Florida Fish and Wildlife Commission. (Division of Marine Fisheries, 2003) 15 pp.
2. Barans, C.A., Bortone, S.A., 1983. The visual assessment of fish populations in the southeastern United States: 1982 Workshop.Technical Report 1 (SC-SG-TR-01-83), South Carolina Grant Consortium, Charleston.
3. Bauchot M.L., PRAS A., 1980. Guide des poissons marins d'Europe. Delachaux & Niestlé edit. Lausanne : 427pp.
4. Bayle-Sempere, J. T., Ramos-Espla´, A. A., and Charton, G. 1994. Intra-annual variability of an artificial reef fish assemblage in the marine reserve of Tabarca (Alicante, Spain, SW Mediterranean). Bulletin of Marine Science, 55: 824–835.
5. Bohnsack, J.A. et Sutherland, D.L. Artificial reef research: a review with recommendations for future priorities. *Bulletin of Marine Science* **37** (1985) 11-39.
6. Bohnsack, J.A. 1996. Maintenance and recovery of reef fishery productivity. In: Polunin, N.V.C., Roberts, C.M. (Eds.), Reef Fisheries. Chapman and Hall, London, pp. 283–313.
7. Bortone, S.A., Kimmel, J.J. 1991. Environmental assessment and monitoring of artificial reefs. In: Seaman Jr., W., Sprague, L.M. (Eds.), Artificial Habitats for Marine and Freshwater Fisheries. Academic Press, San Diego, pp. 177– 236.
8. Bortone, S.A., Samoilys, M.A., Francour, P. 2000. Fish and macroinvertebrate evaluation. In: Seaman Jr., W. (Ed.), Artificial Reef Evaluation with application to Natural Marine Habitats. CRC Press, Boca Raton, pp. 127–164.
9. Bortone, S.A., Samoilys, M.A., Francour, P. 2000. Fish and macroinvertebrate evaluation. In: Seaman Jr., W. (Ed.), Artificial Reef Evaluation with application to Natural Marine Habitats. CRC Press, Boca Raton, pp. 127–164.
10. Charbonnel, E., Francour, P., Harmelin, J.G., Ody, D. 1995. Les proble`mes d'e´chantillonnage et de recensement du peuplement ichtyologique dans les récifs artificiels. Biol. Mar. Mediterr. 2 (1), 85–90.
11. Christian, R. Steimle, F. et Stone, R., Evolution of marine artificial reef development – a philosophical review of management strategies. *Gulf of Mexico Science* (1) (1998) 32-36.
12. Coll, M., Libralato, S., (2012). Contributions of food-web modelling for an Ecosystem Approach of Marine Resource Management in the Mediterranean Sea. Fish and Fisheries. 13: 60–88.
13. Coll, M., Piroddi, C., Kaschner, K., Ben Rais Lasram, F., Steenbeek, J. (2010) The biodiversity of the Mediterranean Sea: estimates, patterns and threats. PLoS ONE 5: doi:10.1371
14. Costello MJ, Coll M, Danovaro R, Halpin P, Ojaveer H, et al. (2010) A census of marine biodiversity knowledge, resources and future challenges PLoS One 5: e12110.
15. Fischer W., Schneider M., Bauchot M.L., eds. 1987. fiches FAO d'identification des espèces pour les besoins de la peche. Méditerranée et mer noire : zone de pêche 37 (révision 1). Volume II. Vertébrés. Commission des communautés européennes and FAO. Rome, Italie.
16. Harmelin –Vivien, M. et Harmelin, J.G., Présentation d'une méthode d'évaluation *in situ* de la faune ichtyologique. *Trav. Sci. Parc Nation. Port-Cros*, **1** (1975) 47-52.
17. Harmelin, J. C. 1987. Structure et variabilite´ de l'ichtyofaune d'une zone rocheuse protégée en Méditerranée (Parc national de Port-Cros, France). P.S.Z.N.I., Marine Ecology, 8(3): 263–284.
18. Harmelin-Vivien, M.L., Harmelin, J.G., Chauvet, C., Duval, C., Galzin, R., Lejeune, P., Barnabé, G., Blanc, F., Chevalier, R., Duclerc, J., Lasserre, G., 1985. Evaluation visuelle des peuplements et populations de poissons: méthodes et problèmes. Rev. Ecol. (Terre Vie) 40, 467–539.
19. Lotze HK, Coll M, Dunne J (2011) Historical changes in marine resources, food- web structure and ecosystem functioning in the Adriatic Sea. Ecosystems 14: 198–222.
20. Michalopoulos, C., Auster, P.J., Malatesta, R.J., 1992. A comparison of transect and species time counts for assessing faunal abundance from video surveys. Mar. Tech. Soc. J. 26 (4), 27–31.
21. Pickering, H.D. et Whitmarsh, D., Artificial reefs and fisheries exploitation: a review of the 'attraction versus production' debate, the influence of design and its significance for policy. *Fisheries Research* **31** (1997) 39-59.
22. Pondela II D. J., Stephens Jr. J. S. et Craig M. T., Fish production of a temperate rtificial reef ased on the density of embiotocids (Teleotei: Perciformes). Journal of Marine Science 59 (2002) 88–S93.
23. Potts, G.W., Wood, J.W., Edwards, J.M., 1987. Scuba diver operated low-light-level video system for use in underwater research and survey. J. Mar. Biol. Assoc. UK, 299–306.
24. Relini, G., Relini, M., Torchia, G., and Palandri, G. 2002. Ten years of censuses of fish fauna on the Loano artificial reef. – ICES Journal of Marine Science, 59: S132–S137

25. Roux J-P, van der Lingen CD, Gibbons MJ, Moroff NE, Shannon LJ, et al. (2013) Jellyfication of Marine Ecosystems as a Likely Consequence of Overfishing Small Pelagic Fishes: Lessons from the Benguela. Bulletin of Marine Science 89: 249–284.
26. Samoilys, M., 1997. Underwater visual census surveys. In: Samoilys, M. (Ed.), Manual for Assessing Fish Stocks on Pacific Coral Reefs. Department of Primary Industries, Townsville, Australia.
27. Santos, M. N. et Monteiro C. C., Comparison of the catch and fishing yield from an artificial reef system and neighbouring areas off Faro (south Portugal). *Fisheries Research* **39** (1998) 55–65.
28. Santos, M. N. et Monteiro C. C., Olhao artificial reef system (south Portugal): fish fishing yield. *Fisheries Research* **30** (1997) 33–41.
29. Seaman, W et Jensen, A., Purposes and practices of artificial reef evaluation. *In:* Seaman, W. (ed) Artificial Reef Evaluation with Application to Marine Habitats. (CRC Press, Boca Raton, 2000), pp. 1-20.
30. Seaman, W. et Hoover, A., Artificial reefs: the Florida Sea Grant connection – science serving Florida's coast. (Florida Sea Grant, SGEF-144, 2001): 4 pp.
31. Spieler, R. E., Gilliam, D. S. et Sherman, R. L., Artificial substrate and coral reef restoration: what do we need to know to know what we need. *Bulletin of Marine Science*, **69** (2) (2001) 1013–1030.
32. Stephens, J. Jr. et Pondela II D., Larval productivity of a mature artificial reef: the ichthyoplankton of King Harbor, California. *ICES Journal of Marine Science* **59** (2002) S51–S58.
33. Tessier, E., Chabanet, P., Pothin, K., Soria, M., Lasserre, G., 2005. Visual census of tropical fish assemblages on artificial reef: slate versus video recording techniques. J. Exp. Mar. Biol. Ecol. 315 (1), 17–30.
34. Tipping, M.J., 1994. Measuring fish by video image processing. Progr. Fish Cult. 56, 299–300.
35. Tresher, R.E., Gunn, J.S., 1986. Comparative analysis of visual census techniques for highly mobile, reef associated piscivores (Carangidae). Environ. Biol. Fishes 17, 93– 116.
36. Watson, D.L., Harvey, E.S., Anderson, M.J., Kendrick, G.A., 2005. A comparison of temperate reef fish assemblages recorded by three underwater stereo-video techniques. Mar. Biol. 148, 415–425.
37. Whitehead P.J.P., Bauchot M.L., Hureau J.C., Nielsen J., Tortonese E., 1986, Fishes of the north eastern Atlantic and the Mediterranean. UNESCO, Paris. vol. I, II and III: 173 pp.
38. Wilson, K. D. P., Leung, A. W. Y. et Kennish, R., Restoration of Hong Kong fisheries through deployment of artificial reefs in marine protected areas. ICES *Journal of Marine Science* **59** (2003) S157–S163.