

Environmental and ecological considerations for orange-spotted grouper (*Epinephelus coioides*) cage culture in Qeshm Island, based on GIS

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Abstract

Statistics and all of that global governance the demand for its use in the den or tool is increasing rapidly. In Iran, most of it in the areas of population away from the work of the twenty of the month and those of the other tool except it was not different items, due to the growth of public awareness and disseminating information about the properties in use of the tool and its use is growing. Fish in cage one of these measures more effective tool in the development of its reserves and the impact of these the efficiency of these proteins in human society is taking. The system of the location information into the database as a centralized access to, stored building, to update the facade of the use of different forms of static data and other dynamic made possible with the help of the technology and the technology of obtaining information such as the burning of the land in both the surveyor, satellite geodesy is, however, the photogrammetry, remote sensing away and it is the policy of the database, members of the information (cartographer of elevation and computer graphics) and is now one of the modes and methods of the information, today as a powerful tool in the process are the reference location data (points geographic) to raise the maximum. In this paper, the positioning of *Epinephelus coioides* (Orange-spotted grouper) in waters surrounding the southern Qeshm Island of forwarding an analysis model management (SWOT) and GIS.

Key words: Site selection, Cage culture, Orange-spotted Grouper, ecological assessment, GIS, Qeshm Island.

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Introduction

The aquaculture involves the requirements, capacities and opportunities that their management ensures the success of the project. Aquaculture in cages is one of the most effective measures for the development of aquifer stocks and the supply of marine protein consumed by the human community, which has completely eroded its environmental disadvantages in the coastal districts. Promotion of the aquaculture industry in marine cages can play an important role in creating employment and sustainable economies for our country's lowlanders (especially the lowlanders in the South of the country) as well as preserving aquatic resources and provide a suitable solution for creating income, job creation and providing security on the coast of our country. (Owfi, 2007).

At present, scientific efforts about the promotion and rearing of marine fish are focused on three axes (Owfi, 2013). Aquaculture in the cage has grown rapidly over the past 20 years and is currently undergoing rapid changes in response to the pressures of globalization and growing demand for developed and developing countries (Owfi, 2014). According to the United Nations Food and Agriculture Organization (FAO), the global aquaculture catch has reached a level that cannot expect more production with the current method of stock management, and on the other hand demand for fish and other seafood is increasing (FAO, 2015).

Over the past two decades, aquaculture has grown at around 8% of

its fastest and most stable growth rate in animal protein production in the world (FAO, 2015). In 2015, the production of aquaculture has risen to 83.7 million tons, including 20.97 million tons stench and 62.73 million tons of quantic animals. Countries such as China, Indonesia, India, Vietnam and Philippines are among the largest aquaculture producers (FAO, 2015). Iran's ranking among aquaculture producers was 21st in 2015 (FAO, 2015).

In Iran, due to the growing awareness of the public and the dissemination of information about the properties of aquaculture, its consumption is increasing, but due to the limitation of water resources in the interior water and the reduction of the catching of some marine species, the cultivation of fish and other marine fish has been introduced as a reliable and cost-effective solution for provision of required protein (Boryj, 2013).

In terms of diversity, 40 families of fish are grown in cages, but only 6 families of Salmonidae, Sparidae, Serranidae, Carangidae, Pangasiidae, and Cichlidae account for 90% of the total production, meanwhile Salmonidae family dedicate 66% of the total production. Aquaculture systems in cages and pens compared to on-land activities face the challenge of having fewer options to make mistakes. In cages and pens, if the Site selection is very exposed to storm and wave and the water change is low or if its water quality is not suitable, much measure cannot be done. Based on the documentation and done researches, the

most suitable aquaculture species in the cage for the southern waters of our country, Iran (Persian Gulf and Oman Sea waters) which the studies on reproduction and growing and feasibility of introducing them into the marine cages system is ongoing.

Meanwhile, *Epinephelus coioides* which are from the native fish of the southern waters of the country, with a significant economic value, are a good option for cage aquaculture. The aquaculture in the past two decades has been considered as one of the potential of aquaculture development, and, given the general and climatic conditions and the presence of some natural and human infrastructure, continues to be one of the intact areas of development.

Various types of *E. coioides* have been identified, most notably in terms of economic and cultivating, commonly known as marine cages *Epinephelus coioides* and the English name (Orange-spotted grouper), which are the most dominant species in most aquaculture of marine cages *Epinephelus coioides* countries of the world. This is a very popular market place in the southern provinces of Iran, and it is one of the most important breeding grounds in the pool and marine cages.

This research is aimed at identifying suitable areas for aquaculture development and identifying suitable places for the establishment of marine cages for *E. coioides* or orange-spotted grouper in the waters around the Qeshm Island, with an attitude on environmental considerations and the approach of aquaculture development. In this regard, determining the

ecological conditions of the studied area for the purpose of introducing *E. coioides* for aquaculture in marine cages, determining the suitable areas for the establishment of marine cages will be done through hydro biological, hydrography, geomorphology studies, by using geographic information system (GIS) as an applied model in determining the suitable site selection for deploying marine cages and prioritizing and ranking the selected areas based on the (SWOT) management analysis model.

Considering the fact that less than the recent decade, aquaculture development has been taken into consideration in marine cages, it is evident that in the first step, the most important issue is the selection of suitable places for the deployment and development of marine resources and identifying the intended sites and determining the priority of spotting (site selection). The second step should also assess the effects of development and aquaculture activities in the cage, which ultimately led to the presentation of an analytical report on the assessment of impacts and the selection of suitable places with an emphasis on danger risk prioritization. This issue, in addition to the government's emphasis, has been given particular attention to custodial organizations such as the Environmental Protection Agency, the Iranian Fisheries Organization and the Institute of Fisheries Research.

Therefore, considering the development of aquaculture in marine cages, the issue of selecting the appropriate station for cage deployment

based on standard criteria for native sea species is of particular importance, which has less been dealt with so far and accordingly, the usual *E. coioides* is considered in this research. Identification of suitable places for the establishment and deployment of advanced marine cages for the purpose of using the new technology with the least risk of destruction and destroy the structure in Mahshahr Bay and Bahrakan Bay was evaluated according to the hydrological conditions of the area by the Southern Aquaculture Research Institute (2004). Based on the documentation and background of the study, the proposed research has a noticeable innovation due to the enjoyment and utilization of new models of evaluation and research.

Methodology

Studied area

The evaluation period of this research lasted 16 months and continued from October 2016 to January 2017. The studied area is Site selection in Hormozgan province, the peripheral waters of Qeshm Island. Considering that according to the presented documentation provided by the Qeshm Free Organization, the Environmental Protection Agency, the Iranian Fisheries Organization and the Institute of Fisheries Research in the northern part of Qeshm Island, including the watershed of the Strait bay virtue of its proximity to the protected area of the international wetland, the geosite of the mangrove forests, as well as the development region of industries and the site of industrial towns and northern

quays of Qeshm Island are lack of suitable condition and, naturally, the relevant permit has not been issued due to the lack of suitable environmental conditions, therefore, in this research, the waters around Qeshm Island in the South part of Island is highlighted in this study.

Evaluation of site selection using by Pastakia matrix rapid assessment

One of the most important stages of Site selection studies is the analysis of information and data that should be used by special models. The concept of a rapid matrix was defined by Pastakia in 1998. The rapid combined matrix methodology is one of the most important criteria for evaluation. Semi-quantitative values can be adjusted for each of these criteria to assign a valid and independent score for each situation. In the rapid matrix, we need the elements and factors of the environment and evaluation specific factors that are obtained through a survey process.

Each of these environmental elements is in one of the four physical / chemical groups (PCs): includes the physical and chemical aspects of the environment; biological / ecological (BE): includes the biological, social / cultural aspects (SC): includes the human aspects of environment, along with the cultural and, ultimately, economic / operational aspects (EO): the economic factors of the environment change, whether permanent or temporary. The evaluation of criteria for management decision making in this matrix is described in Table 1.

Table 1: Evaluation of criteria for management decision making in the Pastakia rapid matrix.

Decision making criteria	Quantitative criterion	Effect description
No need for managerial actions (negligible)	0-25	Low
Need managerial measures	25-50	Average
Replacing malicious activities	50-75	Much
Invalid	75-100	Very much

Preparation of information and drawing maps in the GIS system

Due to the variety of basic software of information evaluation, ArcGIS 9.2 software was used for this information in the geographical information system in Iran. The purpose of this section is to prepare basic maps and document ecological and environmental status by using this software for geographical management and planning. The geographical information system (GIS) and encrypted wide-spread systems facilitate data processing. GIS is also effective in updating maps, counting and tracking changes in a variety of habitats. Using Excel software and GPSU 4.10, the geographic coordinates of each region were entered and the unit was converted to UTM for data entry into the GIS system. In order to prepare the map in the ArcGIS environment, the ArcMap environment was first added to the required layers, then the layers were drawn based on the defined color scheme in the design system and in the TIF outlet of the regions, and since two distinct regions were identified, it was necessary to coordinate the distribution and layers in the two regions in terms of comparison.

Fisheries Assessment through combined management analysis

Strategic planning model (SWOT) strengths, weaknesses, opportunities, threats, are in fact a way of deciding and choosing a solution and order in various affairs, and in the scientific discussions is the series of decision models which are designed to determine long-term or short-term strategy, and to make major and key decisions about different issues and problems. This model can be designed for a specific geographic area or topic and problem that we are actually involved with, which is to determine the strategy for improving performance or status. The SWOT analysis method is a concise and useful analytical model that systematically analyzes the identified strengths, weaknesses, opportunities, and identified threats and reflects the appropriate strategy.

This model consists of two internal and external factor matrices. Internal factors related to weaknesses (W) and strength (S) are a set or region or subject and external factors related to opportunities (O) and threats (T) are a region or system. In this method, the process of the central analysis of these factors is determined and evaluated by the process of the questionnaire, and four types of strategy (aggressive, defensive, competitive and conservative) are appointed and their status is determined on the axis.

In the SWOT model, after identifying the external and internal factors affecting the project, each factor is assigned a weight coefficient between zero (non-significant) to one

(very important), which sum of internal factors and external factors should be 1, and to determine the weight of each factors and decisions about the factors of high or low importance are used by experts and managers. The current status is a score of between 1 and 5, which the scores determined according to the current status of the region and the environment and the ecological conditions governing it. Weighted scores are the result of multiplying the obtained weight in the current status score. The strategies are achieved from the intersection of external and internal factors. This matrix leads to four categories of ST, WT, WO,

SO strategies. Confronting internal and external factors and formulating WT, SO, ST, WO strategies is one of the most difficult parts of the SWOT matrix and needs to a high judge and analyze. In assessing if the final aggregate is greater than 2.5, the strengths are greater, and if the aggregate is less than 2.5, then the weaknesses are greater. A list of different strategies is developed by using the SWOT matrix that addresses the development and improvement of environmental management conditions and the conditions of the region (Table 2).

Table 2: Specification of measurable parameters for implementation of the present project.

Grouping Information and data	Data and information	Application Information and data	Descriptions
Fish species biology	Nutrition	Recognizing the biological characteristics of the species	Collection of archival documents
	Reproduction		
environment Coastal - Marine	Habitat	Understanding the characteristics and structure of the habitat of the area	Collecting archival documents and surveying information
	Substrate		
	Beach slope		
Most biological communities	herbal	Recognizing the dominant biodiversity of animal and vegetation groups	Collection of archival documents and field information surveys
	Beast		
Climate and weather	Rainfall	Understanding the climate of the region	Collect archival documents
	Wind		
human geography	social	Characteristics of human societies, Socio-economic factors of the region	Collection of archival documents and field information surveys

Results

Coast of Hormozgan Province

This province is very suitable for building a fish breeding in a cage, and polyethylene cages with resistance of 5 meters can be used. In this province, in

terms of water quality, proper depth and distance from the coast, kuhestak coastal areas, Lark Island (north + northwest and northeast), Faro Island, Qeshm Island (southeast), Faro Island, Hondurabi Island, Chark, Gorzeh,

Hosineh, Shirooyeh ports, Kish Island, Javad Alaemeh port suitable for fish breeding in cages.

Physical and chemical properties of water in the Persian Gulf

Salinity

- Average annual salinity is 39.88 ppt
- Average salinity at water level is 67/39 ppt
- The average salinity at a depth is 1 / 40ppt
- Minimum salinity in spring is 7 / 38ppt
- Maximum salinity in summer is 1 / 40ppt
- Changes ranged from 4 to 1.8 mg / L
- Lowest range of changes in autumn between 3 and 5/5 mg / L
- Maximum amount of oxygen related to the depth layer is 10 to 30 m

Relatively high levels in deep layers during the year except for relative reduction in autumn

Generally, the concentration of nutrients in the northern part (coast of Iran) of the Persian Gulf is richer than the southern part (the Arabian coast). The main reasons for this situation can be the higher rainfall on the northern coast than the southern shores, as well as the sea currents.

Sediment

Sediment is distinguished in the northern part along the coasts of Iran towards its southern part. While the northern part of Bed Gender is more muddy and fine-grained, it is a southern part of sandy or a mixture of fine grains and coarse grains. Parts of the sea bed are covered with coral beds Site

selection on the islands or some beaches. Overall, with the studies conducted by the environmental organization, the closer to the west towards the Strait of Hormuz, the percentage of fine grains in the bed sediments increases as it reaches the maximum in the Strait of Hormuz. Based on the measurements, the percentage of particles smaller than 63 microns in sediments in the south of Hormoz Island is mature to 100 percent of the total bedding sediment. The bed structure is within the scope of the Fish breeding scheme in the cage of the mud type.

The wave characteristics along the coast of the province in positions A to Q are presented in the following way. To explain the characteristics of the waves in this range, it is possible to divide the coast of the province into three parts of the western coast (positions A to F), the Strait of Hormuz or the middle beaches (G to M positions) and the eastern coasts (N to Q) made within the Strait of Hormuz or the middle shores, between 65 and 79 percent of the year is in a quiet area. The dominant wave direction on the western side of the Strait of Hormuz is 2447 degrees and in the eastern part of the Strait of Hormuz is 270 degrees and its frequency varies from 4 to 22 percent of the year. The dominant elevation is between 0.5 and 1 m, which occurs between 16% and 32% of the year.

Wind

The wind profile on the coast of Hormozgan province is based on

ECMWF results. Wind in the province of Hormozgan mainly flows northwest, west and southwest. At the beginning of the western coast of the province, it was 315 degrees above the wind and it gradually rotated toward the southeastern part of the Strait of Hormuz towards 245.5 degrees. The wind speed is from 5 up to 7.5 m / s and varies between 16% and 24% of the time of the year. In this area, considering the wind speed (less than 5 m / s) as a condition of slow, between 65 and 78 percent of the year, the weather conditions of the region are calm.

In the G position (southwest of Qeshm island - Solkh port), the weather conditions of the region are calm in 66.96% of the year. In 10.3 percent of the year, the wind is dominated by 244.5 degrees. The maximum wind speed is 15 to 17.5 m / s, which occurs at 0.19% of the year. Also, in 0.8 percent of the year, the winds run at a speed of 12.5 to 15 meters per second, but the maximum wind speed is about 19.6 m/s.

In the H position (Sousa and the Mosen ports), the weather conditions of the region are calm in 79.79% of the year. The wind direction is 244.5 degrees and it occurs at 28.9 percent of the year. The maximum wind speed is 15 to 17.5 m / s, which occurs at 19.1% of the year. Also, in 0.8 percent of the year, the wind speeds from 12.5 to 15 meters per second, but the maximum wind speed is about 19.4 m / s.

In I position (Ramchah) the weather conditions in the region are calm in 73.27% of the year. The wind is

dominated by 244.5 degrees and occurs at 85.8% of the year. The maximum wind speed is 19 m / s and the winds are 15 to 17.5 m / s at 11.1% of the year.

The wind currents in the area include four types of wind blowing as follows:

- North wind: The wind that flows northwest as it flows during the summer and during the winter; the wind speed is also reported in the summer to 153 km / h. This wind is a source of sandstorms in the region.
- Arctic wind: This wind, which is the southeast of the south, is usually accompanied by a cold wind.
- Sea Breeze: usually created along the coast.
- Windy winds: Wind currents in the Western Sea that include the southwestern magnesium flows during the summer and northwest in the winter.

The above mentioned winds constitute the winds of Qeshm Island. According to the meteorological station of Qeshm Island, the dominant wind in the region is more affected by the north wind. Generally, the winds of the Qeshm Island are mostly northwest, and the winter season is the highest percentage of time of occurrence of the speed and the maximum duration of the wind in the region, the western winds may last for 5 days or more and within 24 hours or Most will reach a stormy stage. The northwest winds usually start at noon, and in the afternoon the speed increases and decreases at the beginning of the evening, due to the windy winds in the summer, they tend

to be more oriented towards the south east due to winds in the summer.

Wave

The information and statistics obtained from the Portland project reports calculated by various consultants in Bandar Basaeedov, Bandar Solek and Bandar Khamir are presented in the following tables. The calculations carried out at Basaeedov port for a 25-year return period show that waves with a height of 3.1 to 2.5 meters with a period of 1.4 to 5.9 seconds that are related to the north, northeastern and western directions. In the port of Solek, with a 25-year return period, waves with a height of 2 to 4 meters with a period of 24.5 to 7.83 seconds. In Bandar-Khemir, waves have a height of between 0.7 to 1.3 meters with a period of 4 to 5 seconds and are related to the directions of 60 and 90 degrees. (Tables 3 to 5).

Table 3: Specifications of the waves in the Solkh fishing port with a 25-year return period.

Wave period / seconds	Wave height	Wave direction
83.5	38.2	120
73.5	57.2	150
24.5	05.2	180
46.7	52.3	210
83.7	03.4	240

Table 4: Specifications of waves in the port of Basaeedou port with the return period of 25 years.

Wave Period / Seconds	Wave Period / Seconds	Wave height	Wave direction
2.6	9.5	5.2	5/67 ENE
6.5	3.5	2.2	45 NE
9.4	7.4	7.1	5/22 NNE
6.4	6.4	5.1	360 N
3.4	1.4	3.1	5/337 NNW

Table 4 continued:

6.4	6.4	6.1	315 NW
3.5	5	9.1	5/292 WNW
6.5	3.5	1.2	270 W

Table 5: Specifications of waves in the dough port.

Year	Wave Period / Seconds	Wave height	Wave direction
1	4	9.0	60
25	5.4	2.1	60
100	7.4	3.1	60
1	4.4	7.0	90
25	8.4	5.1	90
100	5	2.1	90

Tide

The tide on the coasts of Qeshm, and like other parts of the Persian Gulf, is a mixture of the Diurnal and Semidiurnal tidal patterns. The tidal fluctuations in the Persian Gulf range from 1.4 meters in Qatar to more than 3 meters in the northwest of the Persian Gulf. The amplitude of the fluctuations will be higher if the wind amplitude is accompanied by wind (Fig. 1). The tidal slopes on the coasts of Qeshm Island are 94.2 m and on the island at about 1.8 m. Because of the maximum flow of tidal water from the Strait of Hormuz, its dependent stream of speed may reach more than one meter per second in the Strait of Hormuz, whereas this figure in the canals between the islands and regions may range from about 0.3 to 0.4 m / s Reduced. The figure below shows the classification of the tide type in the study area.

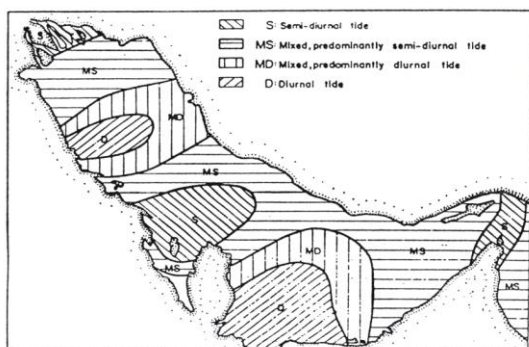


Figure 1: Classification of the tide type in the study area.

Discussion and conclusion

Based on a series of done studies about the geomorphologic features of the coastal area and hydrographic of the studied area, which are presented and explained in the previous sections, it is clear that the intended areas include the southern coastal area of Qeshm Island in the western part, as well as the marine area of the island at appropriate and environmentally safe Site selection, which done measures will be successful in terms of deploying cage systems with respect to scientific management. The above result is consistent with the information provided by previous groups and consulting engineers regarding Site selection. On the other hand, in spite of being in the special zone due to the interference of the waters and surface flows from the Oman Sea through the Hormuz Strait with deep outflows from the area to the Oman Sea Among the strait islands that are oligo-marine and hydrographic due to Site selection disruption. The unique Site selection and coastal security of the area have made it suitable for sustenance systems for breeding cages due to its being Site selection between the islands, the small coastal gulf and

the creation of safe coastal zones. Therefore, due to the high confidence coefficient of the region's evaluation through the PASTAKIA presented model and the combined matrix method, gave high points to these areas. This criterion and score in the group is average effect description and quantitative criterion of 25 -50, which in terms of decision making and action requires the observance of management principles. It is obvious that the operation and deployment of coastal and maritime structures essentially have such a feature (Table 6).

Also, the study of high risk areas in the Iranian waters of the Persian Gulf, which is affected by inappropriate features with high risk marine pollution, indicates that the study area is Site selection in the boundary of the habitat security, which the main reason for this problem including isolated environments – sea isolated Sea in the Deyrestan Gulf and especially in the western part of Qeshm Island. On the other hand, the presence of permanent and constant populations of dolphins could also confirm the high marine environmental status of the area as a unique coastal safe harbor, which describes the marine habitat of the marine mollusks - dolphins, which are closely related to the proper habitat conditions of the region.

Table 6 :Final Evaluation of the criteria for management decision making of cage systems.

Criteria for decision making	Quantitative criterion	Describe the effect
Needing of management measures	25-50	medium

At the end, the most important features and indicators of environmental security of the study's area can be presented as follows:

- Proper view of the surface water flow caused by wind Rose and proper speed of surface waves
- Suitable surface temperature and air temperature above the surface of the water
- Good water clarity and lack of turbidity
- Non-adjacency with critical areas of delta and sedimentary beaches and sediment performance of permanent and Flood Rivers
- Lack of coastal flows - Rip current
- Appropriate depth (more than 1.5 m) and water exchange conditions in the desired sea area
- The lack of access to and the lack of communication with the industrial areas and focal and non-focal factors.

Recommended sites for development of aquaculture in sea cages (Qeshm area)

Since there are many factors have effect on choosing the Site selection of cage deployment:

Distance from the coast, depth A B, wind conditions in the area, wave height, the route of the ships, the status of bed topography, Bed gender, river mud pollution, the speed and direction of the see flows and pollutions, which, of course, the geographic information system (GIS) can be used to select the most suitable development areas for marine cages. By overlapping the map of different uses in one area, it is possible to determine the appropriate range. Therefore, by providing

topographic maps of the substrate, surface and subsurface currents, protected areas or natural habitats, military areas, fishing exploitation, tourism, marine waterways, the boundaries of the rivers, the quays and the developing range for sea cages in terms of distance from the coast, the depth of the area, temperature changes, dissolved oxygen status, intensity of waves, the status of the currents of the sea and eventually overlapping of all maps can be found in the most appropriate area.

According to the materials presented in the report, the geographic Site selection and coordinates of the proposed sites for the development of aquaculture in marine cages are as follows:

- Western site: Solkh – Kargah: $26^{\circ} 40' - 26^{\circ} 37'$ and $55^{\circ} 45' - 55^{\circ} 41'$
- Central site: Deyrestan: $26^{\circ} 44' - 26^{\circ} 37'$ and $55^{\circ} 45' - 55^{\circ} 46'$
- Eastern site: Mosen – Shibderaz: $26^{\circ} 44' - 26^{\circ} 42'$ and $56^{\circ} 02' - 55^{\circ} 58'$

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