Spatial Analysis of Mollusk Culture at Santa Catarina Island Using Law and GIS

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Key words: Legal Viability, GNSS, Mollusk Cultivation

SUMMARY

The mollusk production in Santa Catarina is characterized by the small-scale production, and the activity has a representative social participation in the economy. Because it is made in the sea and occupies Federal bodies of water, norms and laws must be obeyed, however, some legislation items of the current legislation are not complied. The main disobeyed item is the process of obtaining concession of public water usage issued by the federal government. With the lack of the document in the legal condition, all areas of mollusk cultivation are irregular according to the law. Aiming at seeking a solution and diagnosing the current situation of regular and irregular mollusk cultivation areas, as well as providing spatial planning and management tools, the project used Geographical Information Systems (GIS) tools. Along the development of the project, a topographic study of twenty cultivation areas in the south of Santa Catarina Island was made with the aid of GNSS receptors. The ArcGIS 9.2 software was used to manage the geographical data through a Geodatabse file. The Geodatabase was structured with the data from the topographic study and vectorial data from the photogrammetric restitution of the studied area. A set of aerial photographs from 2002 was photointerpretated, and sandy beaches and rocky coasts were identified. These environments are factors cited in the activity legislation about positioning of cultivation areas, another parameter approached was bathymetry through the Nautical Chart No1904. The GIS subsidized the diagnosis of the positioning of the aquacultural areas in relation to the laws and pointed that there are areas in places with improper depth, distance of low-tide line and rocky coasts. The results of the diagnosis were represented cartographically and in charts, making reference to the names of the respective owners. At last, it was concluded that the activity needs an interdisciplinary and interinstitutional work developed in a single georeferred data base and with measuring methods which reach out to the real positioning need of the aquacultural areas and the cartography must be updated and official field overview must be done often in order to manage the dynamics of the marine occupation.

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1. INTRODUCTION

Aquaculture is an activity which is considered new in Brazil, in which we include the cultivation of marine or freshwater aquatic organisms. The cultivation of marine mollusks has the State of Santa Catarina as the largest provider in Brazil, the main cultivated species are: oyster (*Crassostrea gigas*), mussel (*Perna perna*), and the scallop *(Nodipecten nodosus)*. The beginning of the production took place in the 90's, however, it was only in the end of the decade and beginning of the new millennium that production increased significantly. Currently there are more than 700 producers in the State. (Oliveira Neto, 2005).

The production of mollusks is developed in the sea, sheltered or semi-sheltered bays and sites close to estuaries. These places are public areas administered by the Federal Government according to the 1988 Federal Constitution. As every productive activity, and for being developed in a public place, the cultivation of mollusks is oriented and regulated by laws aiming at ordering the maritime space, as well as delimitating areas destined to the productive activity.

Despite the existence of the legislation and its comprehension of all sectors of activity, in practice, it's possible to note that there are cases of not complying with some legal requirements. One of the main items which halt the expansion of mollusk cultivation is the disobeying of one of the laws, which orient the producer to make the request for concession of usage of physical space from the Federal Government for aquacultural ends.

The concession of usage of physical space in Federal waters is the authorization document which producers must have to be able to make use of the marine resource aimed at production. Nevertheless, the process of occupation mollusk cultivation areas took place in a way which currently the active producers are not complying with the legislation, that is, the producers are farming, but without authorization or concession of public water .

To organize the current producers, funding and management organs attempted to regulate the activity and to plan its future, however, the process is slow and delicate since the irregular marine occupation is consolidated and wasn't accompanied when installation happened.

One of the actions which started the process of organization and legalization of the activity and of the producers was made by the Research and Management Center of Fishery Resources of the Southern and Southeastern Coast at the Brazilian Environment and Renewable Natural Resources Institute – CEPSUL/IBAMA. Aiming at ordering the activity, in 2003 the Conduct Adjustment Term – CAT (Rodrigues, 2007) was published. The CAT has as its main objective giving judicial basis for the producers and IBAMA itself, until the producers obtained the concession of usage of Federal waters and, from this moment on, no other area was liberated for occupation. However, the request processes for concession of the areas were not sent by the producers and the CAT was renewed, waiting for a plan from the Federal Government.

Following this event, the Aquaculture and Fishing Special Office, currently Ministry, published the legislation for the orientation in delimiting the mollusk cultivation areas. This

law creates the Local Mariculture Development Plan – LMDP – which gives directions for a planning. The LMDP began in a reordering project through the use of geotecnologies and wide discussion but it did not reach the main objective of ordering the physical space and aiding the producers in starting the request for concession of usage of public waters. Nevertheless, fomenting and environmental organs work in search for adequation having as its goal ordered and sustainable growth of the activity, trying to develop directed and works in an integrated way, but the difficulty of managing the discussion between producers and institutions makes the job harder. The public institutions have relationship issues among them, and the producers have relationship issues with the public institutions. However, the only way to bring reordering of mollusk cultivation to reality is through a legal principle. The laws made and published by the organs directly involved with aquaculture and other activities on the coastal zone are the directives for the legalization of the activity and may be considered as the beginning of spatial planning of the activity in marine environment under the Federal Government domain.

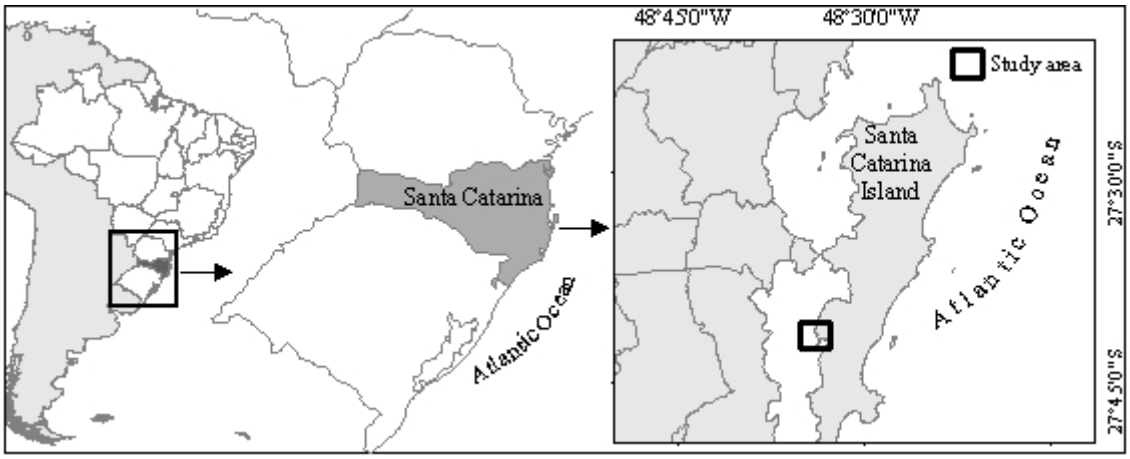
The potential for production expansion is great, because of the diversity of environments which the coast of the Santa Catarina State presents, as inlets and bays sheltered or semi-sheltered, and with water quality which makes viable the production of mollusk is possible to visualize the increase in production and the generation of jobs and wage, but first legislation must be studied to verify if the places with environmental and technical potential are allowed for this activity. The study of the laws must be the first one made in a process of determination of viable places for mollusk cultivation.

The objective of this work is to present a diagnosis between the real occupation and the legal parameters in a Geographic Information System environment – GIS, as well as proposing a construction method of legal viability map so that the other studies of viability of mollusk cultivation can be made with a legal cartographic basis for the activity.

2. STUDY AREA

The study area of the research is the region of Bairro da Tapera da Base and Alto Ribeirão, located at the South Bay of the Santa Catarina Island – Florianópolis/SC. The geodesic coordinates which delimit the study area are in the South American Datum 1969 - SAD 69 reference system, and are: latitude 27º40’35”S and longitude 48º35’31”W, latitude 27º43’02”S and longitude 48º35’31”W, latitude 27º40’35”S and longitude 48º31’58”W, latitude 27º43’02”S and longitude 48º31’58”W (Picture 1).

The Tapera region presents traditional fishing activity, which geographically fit in its marine environment with some diversities, such as small coastal islands close to the beach, rocky coasts and sandy beaches and a visual indicative of the existence of mollusk cultivation areas which are located near the shoreline.



Picture 1: Map of the location of the study area

3. MOLLUSK CULTIVATION SYSTEM AND LEGISLATION REVIEW

In the study area there are two cultivation systems. The first system in *Long Line*, in which a main cable is tied in concrete anchor or stake, which and put and fixed to the bottom of the sea and suspended by buoys. Picture 2 presents a *Long Line* system scheme.

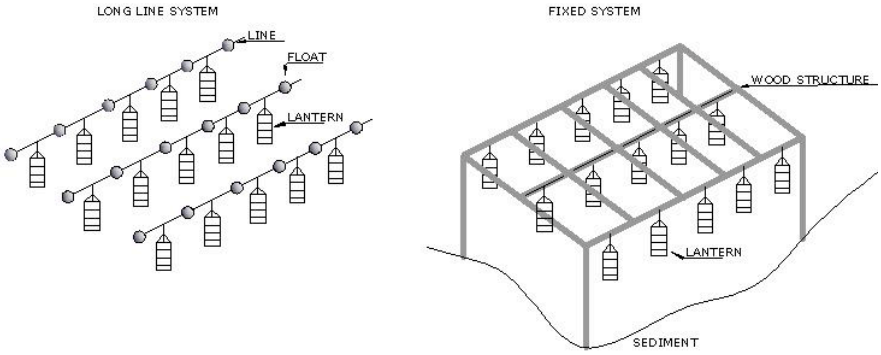
The cultivation system used in Santa Catarina is denominated fixed system, generally used in low depth places. The fixed system is made up of a wood structure or PVC tubes filled with concrete, in which the bases of the structure are buried in the bottom of the sea (Poli et al, 2004). The fixed cultivation system is used by a minority of the producers that do not own the *Long Line* system, especially the oldest producers. Picture 2 presents a fixed mollusk cultivation system scheme.

The cultivation system, as well as its structure, possesses legal regulation. The GIS was used to assess the parameters related to the cultivation, likewise the reviewing of the legislation of the items directly connected to matters of spatial ordering. This review provided the parameters for the spatial analyses and, consequently, for the diagnosis of the real situation in comparison to the legal situation. The main observed parameters in the legislation which were used in the work are the distance of sandy beaches and rocky coasts which the mollusk cultivation must obey, as well as the minimum depth for the installation of the structures. According to the 2006 Normative Instruction No105, mollusk cultivation must be installed at a minimum distance of two hundred meters from sandy beaches, considering the medium line of the low tide, and fifty meters from rocky coasts.

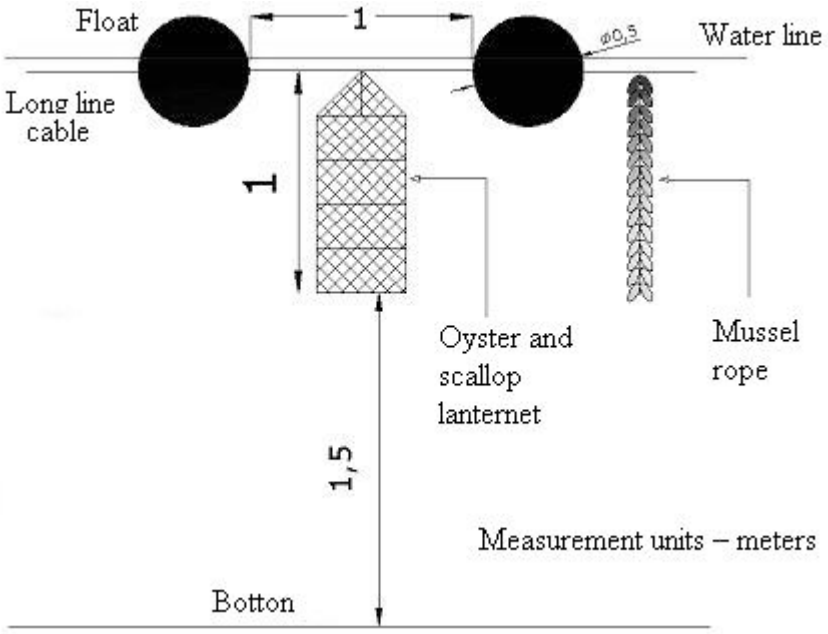
The depth is also established in the same law. According to the legal parameters, the mollusk cultivations must be installed in a depth which provides an open space from under the structure to the bottom of the sea. This open space must be of one and a half meter for structures which bear up to one and a half meter high, and heights over this value must have an open space complying with the 1:1 scale.

After the legal parameters were conceded, it was necessary to measure the height of an oyster lantern, which is tied to the long line or in the fixed system, as well as knowing the average size of the mussel ropes. Both structures are home-made and may present few variations, but both were around one meter high. So, one meter was considered the reference size of the structure for the comparative analyses. Picture 3 presents a scheme of the structure and of the spacing between the lower part of the lantern or mussel rope and the bottom of the sea.

Knowing the cultivation system and the legal parameters, it was possible to make the spatial analyses and diagnose the positioning of the mollusk cultivation areas compared to the law.



Picture 2: Systems of cultivation used in the study area



Picture 3: Structure of cultivation in relation to the legal parameter.

4. MATERIAL AND METHODS

4.1 Input Data

The geographic input data were provided from several sources since all public institutions from Florianopolis work with the South American Datum 1969 - SAD 69 geodesic reference system, so the work was developed in the same system. Table 1 presents the collected data and the respective source.

Table 1: Data source for the development of the research

Data	Source
Aerial photo of the Santa Catarina Island from 2002 in the flight scale 1:8000	IPUF – Urban Planning Institute of Florianopolis
Stereoplotter of the Santa Catarina Island from 2002 in the scale 1:2000	IPUF – Urban Planning Institute of Florianopolis
Nautical Chart no. 1904 in scale 1:49.875	Board of Hydrography and Navigation of Brazilian Navy.
Cartographic Basis on the scale 1:50.000 in *shapefile* format with the limits of the cities of Santa Catarina State.	IBGE – Brazilian Institute of Geography and Statistics.
Georeferred Topographic Survey	Field Survey
Notes on the names of the producers of the surveyed area	Field Survey
Bathymetric Survey	Field Survey

4.2 Georeferred topographic Survey

After collecting the spatial data from the institutions, it was necessary to make a georeferred topographic survey to obtain the coordinates of the extremities of the mollusk cultivation areas.

The georeferred topographic survey had as objective measuring the cultivation areas individually, with the identification of each producer or occupant. The names of the producers were preserved and are represented by alphabet letters. In Oliveira Neto 2005, the survey of the areas was made considering large areas viable for cultivation, but an individual treatment by producer was not given, and the disposition of the productive areas with the larger area, therefore there is no cartographic representation or a list of producers who occupy them.

Measuring was made through the Global Navigation Satellite System – GNSS. The used equipment was a pair of high frequency (L1/L2) GNSS receptors, from Topcon, model *Hiper Lite Plus*. The device presents the following nominal precisions: ± 3 mm + 5 ppm in the static mode at 95% of the tracking time and 10 mm + 1 ppm for the Kinematic method, with real time correction RTK (Real Time Kinematic. Even though the legislation allows a twenty meter margin of error, high geometric precision equipment was used not to occur overlapping of nearby areas, which could have occurred with navigational GNSS equipment, which bears an average positional margin of error of fifteen meters.

The UTM coordinate system was used in the Datum SAD 69 and the survey method used with the double frequency GNSS receptor was the kinematic with real time correction (RTK), using the bearer phase. All surveying started from a transporting coordinate from the net of the Brazilian Geodesic System for the area of study.

The field work was executed on Dec. 12th, 2007, from 9 a.m. and 1 p.m. The time spent in each spot was fifteen seconds, recording every five seconds. Data collection was made on the buoys on the extremities of the mollusk cultivation areas and under guidance of a local mollusk producer, along with the UTM coordinates, information about the names of the occupants, which are theoretically the owners of the mollusk cultivation zones and occupant of areas of other producers were obtained.

The data were downloaded on the TopconTools software and exported for the *shapefile* format. The average precision of the survey of the mollusk cultivation areas reached two centimeters. The coordinates (spots) were transformed in polygons, so that each area was closed, so each polygon received a numeric code starting at one and going to twenty, considering the North orientation towards the South, and it was possible to calculate the areas (Table 2). At the moment of the field collect some features were noted, which are cited in the laws, decrees and normative instructions in effect (Picture 3). The features are:

- Type of buoy where the spot was being collected, specific area demarcating buoys, cultivation extremity without specific demarcation or, when the cultivation was fixed and not floating;
- Name of the producer;
- Local bathymetry;
- Cultivation system;
- Colors of the buoys which were within each area.

Table 2: Area Table of the Mollusk cultivation areas and their producers

CODE	NAME	ACRES
1	PRODUCER A	0.3635
2	PRODUCER B	0.1955
3	PRODUCER C / PRODUCER A	0.8420
4	PRODUCER D	0.9954
5	PRODUCER E	0.4776
6	PRODUCER F	0.5427
7	PRODUCER G – Occupied by PRODUCER H	0.5640
8	PRODUCER H	0.8490
9	PRODUCER I	1.2778
10	PRODUCER K	2.3415
11	PRODUCER L	1.2372
12	PRODUCER H	1.8167
13	PRODUCER M	0.5040
14	PRODUCER M	0.0090
15	PRODUCER M	0.0082
16	PRODUCER M	0.0131
17	PRODUCER N	0.0161
18	PRODUCER O	0.0806
19	PRODUCER P	0.0155
20	PRODUCER Q	0.2173

4.3 Data Processing

The objective of the data processing was to organize the input data for the crossing of the information and production of thematic maps. The ArcGis 9.2 software was used.
Boyes et al. (2007) used GIS in a marine zoning in Ireland's sea, considering the legal aspects, in which a legal viability map of the region was elaborated. Guneroglu et al. (2005) used GIS to determine the adequate places for the cultivation of sea fishes in Turkey. The Food and Agriculture Organization of the United Nations – FAO (2004) and GESAMP (2001), recommend the use of GIS for the studies and management of marine activities.

Choosing the GIS was determinant in this work because the system provided agility in the spatial analyses and support for the organization of the geodatabase and elaboration of the thematic maps.
For the organization of the geodatabase, a *Personal Geodatabase* file, in extension .mdb, was created in ArcGis's ArcCatalog. This file received all the input data and allowed the management of spatial information. After the geodatabase was configured, data edition began. Firstly, the ortophoto of the study area along with the photogrammetric restitution were analyzed and the rocky coasts and the sandy beaches were identified. After the visual identification, the polyline of the coastal line was edited with the information about the features of the rocky coasts or sandy beaches (low tide line). The legislation addresses the distance of the average low tide line but the year is not cited and no organ possesses the mentioned line as standard. Therefore the ortophoto was used as reference and the variation of the tide in the study area is around one meter, and the horizontal variation of the low and high tide line do not have a distance which make not viable the present study, however, the results would be more precise if there were measurement by tidegrapher and, consequently, the low tide line would be more trustworthy.
After the edition of the coastal line, a polygon file was created in the Personal Geodatabase to represent the areas with distances of fifty meters away from the rocky coasts and of two hundred meters from the sandy beaches (low tide line), a buffer of the edited polyline with the distances cited before was made.
The next step was the edition of the bathymetric data. The Nautical Chart (NC) No1904 was the basis for the bathymetric data of the whole south bay and, consequently, of the study area. As the material was acquired in analogical medium, the CN was scanned and, after that, the georeferrencing and geometric correction of it was made using the ERDAS Imagine 9.1 software.
After the georeferrencing and geometric correction, the process of vectoring the bathymetric data was started, that is, transforming the raster data into vectorial. The vectorial file of spots was created in geodatabase and edited in the software through the *Editor* tool, in which each spot of the NC was drawn and the value of the bathymetry was inserted in the attribute field of the data base.
Following all the edition of the vectorial file related to the area of the NC, it was used as the basis for the generation of the triangular gridding (TIN) of the surface of the bottom of the sea, in which the final product generated was an image (raster), in the TIFF format, of all bathymetry of the South Bay of Florianópolis. The study area had its gridding not too dense in terms of spots in the NC, so at the moment of the topographic survey some bathymetric spots were measured with a rope graded at every five centimeters, aiming at improving the data gridding related to the study area. These data were corrected according to the tide chart and the measurement time filed in the GNSS receptor. Finally, a new triangulation in the study area was made and, consequently, the study area was bathymetry better than NC.

4.4 Processing Data For Diagnosis

To make the diagnosis of the positioning of mollusk cultivation areas in relation to the legislation, the data from the georeferred topographic survey and the data generated from the legal parameters were used.

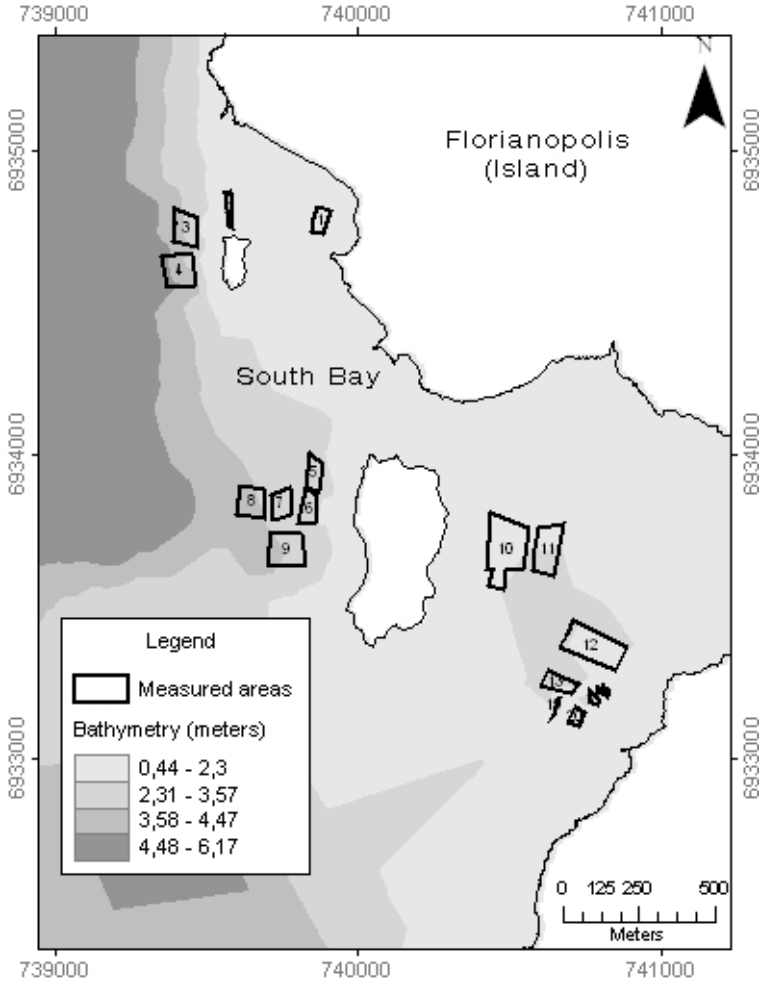
First the positioning of the mollusk cultivation areas comparing to the distances mentioned in the law was analyzed, then the positioning of the cultivation areas in comparison to the bathymetry was analyzed, where the locales under two and a half feet deep were considered illegal, and the ones above this value were considered legal. At last, there was the junction of the parameters for the production of the legal viability map, considering the crossing of the positioning of the cultivations and the referred map.
To make the analyses of overlapping between information of bathymetric data (raster) and the polygons of the mollusk cultivation areas (vector), the *Spatial Analyst* from ArcGis in the option *Zonal Statistics* was used. For the analyses of overlapping between the vectorial information (distance from sandy beaches and rocky coast and legal viability map) and the polygons of the mollusk cultivation areas, the *Clip* function of the *ArcToobox* from ArcGis was used.

5. RESULTS AND DISCUSSIONS

With the data organized in the ArcGis program and the editions and processing of the achieved information, it was possible to cross the geographic information and produce the thematic maps. The crossing generated a diagnosis which is presented in three items: a) bathymetry, b) distance from coastal line, and c) legal viability map.

5.1 Diagnosis Related to Bathymetry

The bathymetry in the study area presented values between zero and six meters and seventeen centimeters of depth. The image of the bathymetry was reclassified in two intervals, one with values between zero and two and a half, and another with values over two and a half. After this process, the polygons made up by the surveyed areas in field were overlapped and the average depth by area was calculated.
Picture 4 spatially shows the overlapping of the mollusk cultivation areas surveyed in Field related to bathymetry. The light gray tons represent shallow bathymetric values and dark grey tons the areas with more depth and with the GIS software was possible to calculate the avarage bathymetry values were related to the polygons of the mollusk cultivation areas. The highest average value found was four meters deep and is related to the mollusk cultivation area coded 4, which is occupied by Producer D. The lowest bathymetry value found was eighty six centimeters and is related to the mollusk cultivation area number 2, which has as occupant Producer A.
According to Annex II from the 2004 Interministerial Normative Instruction No 06, the value of the average depth is one of the requirements demanded in the elaboration of the project for the request of concession of usage of Federal waters. It's opportune to remind that the bathymetric data used are part of the information found in the NC and the field survey through a graded rope, however, the values of average depth may vary if there is a more detailed and more precise bathymetric survey.



Picture 4: Surveyed areas and bathymetry of study area

5.2 Diagnosis in Relation to the Distance from the Low-Tide Line

In order to carry out the diagnosis of the location of the areas of mollusk culture in relation to the distance of the low-tide line established by the Normative Instruction No105 of 2006, the positioning data of mollusk cultivation areas were analyzed in relation to the distance from the low-tide line data (sandy beaches) and rocky coasts.

According to the overlapping analysis only 15.34% of the Producer B mollusk cultivation area, in the *long line* system, is located in a site mapped with a distance smaller than the fifty meters from the rocky coasts, the other mollusk cultivation areas are in suitable sites in relation to this parameter.

As seen on Table 3, two fixed suspended cultivation areas are less than two hundred meters from the average low-tide line. In the long line system there are three sites with high percentage of areas inside the illegal zone of the two hundred meters from the low-tide line. So, the code 1 mollusk cultivation area with 90.99%, the code 18 area with 85.72% and the code 20 area with 97.70% in the zone less than two hundred meters established by the law. Picture 5 (A) shows the map with the overlapping of the mollusk cultivation area and the illegal zone according to the distance.

Table 3: List of the producers and their areas located in the zone between the low-tide line and two hundred meters (illegal area).

Code	Name of the Producer	Area (acres)	System	%	Total Area
1	PRODUCER A	0.3307	LONG LINE	90.99%	0.3635
12	PRODUCER H	0.2506	LONG LINE	13.79%	1.8167
15	PRODUCER M	0.0082	FIXED SUSPENDED	100.00%	0.0082
16	PRODUCER M	0.0002	FIXED SUSPENDED	1.61%	0.0131
17	PRODUCER N	0.0161	FIXED SUSPENDED	100.00%	0.0161
18	PRODUCER O	0.0691	LONG LINE	85.72%	0.0806
20	PRODUCER Q	0.2123	LONG LINE	97.70%	0.2173

% in relation to the total area

These data show that when the law will be applied for obtaining the concession of usage, these producers may have problems in getting the legal document, even though they are old producers and installed there before the legislation.
The survey on the limits of the mollusk cultivation areas done individually, per producer, and not only on the large areas that include one or more mollusk cultivation areas, as it is done nowadays, may facilitate possible future conflicts. That is because the producers are working longer than some of the laws publications and the institutions that regulate the mollusk cultivation activity should take actions enabling producers to work legally.
However, the planning done up to the moment in Santa Catarina, aims at formulating and establishing the large areas, and little is done in relation to the individual areas, with an updated database and an attendance *in locu* of the area occupation. The individualized planning, done per producer, when carried out as support for the managing of the marine area occupation, may give the information related directly to the producers, that is, it is possible to identify the occasional problems and know the producer of the supposedly problematic area. So, the problems may be solved precisely in search for the regularization of the area and consequently the producer him/herself.
The planning of the large mollusk cultivation areas must be supported by an occupation plan, because if there is only the establishment of the large area and inside it a disorganized occupation, the problems will always exist.

5.3 Crossing of the Mollusk Cultivation Area Positioning with the Legal Viability Map

The union of the cited legal parameters in the two diagnoses (items 5.1 and 5.2) originated the legal viability map. In this case, the overlapping analysis between the mollusk cultivation area positioning and the referred map was done.
Both previous diagnoses bring the legal and illegal areas in details of each parameter and the analysis with the legal viability map gives a general view. This map could include more parameters in case they were in study and if the data were available.
According to Table 4, there are situations in which the mollusk cultivation area is 100% in legal zone, 100% in illegal zone and partially in legal and illegal zones. The percentage of all researched areas is also represented.

Table 4: Table with the legal and illegal areas in relation to the mollusk cultivation area positioning and the mollusk culture legal viability map.

Code	Name of the Producer	Cultivation system	Area (acres)	Type of area	%
1	PRODUCER A	LONG LINE	0.363	ILLEGAL AREA	100.00%
2	PRODUCER B	LONG LINE	0.196	ILLEGAL AREA	100.00%
3	PRODUCER A / PRODUCER C	LONG LINE	0.842	LEGAL AREA	100.00%
4	PRODUCER D	LONG LINE	0.995	LEGAL AREA	100.00%
5	PRODUCER E	LONG LINE	0.002	ILLEGAL AREA	0.33%
5	PRODUCER E	LONG LINE	0.476	LEGAL AREA	99.67%
6	PRODUCER F	LONG LINE	0.543	LEGAL AREA	100.00%
7	PRODUCER G – Occupied by PRODUCER H	LONG LINE	0.564	LEGAL AREA	100.00%
8	PRODUCER H	LONG LINE	0.849	LEGAL AREA	100.00%
9	PRODUCER I	LONG LINE	1.278	LEGAL AREA	100.00%
10	PRODUCER K	LONG LINE	2.334	ILLEGAL AREA	99.70%
10	PRODUCER K	LONG LINE	0.007	LEGAL AREA	0.30%
11	PRODUCER L	LONG LINE	1.063	ILLEGAL AREA	85.96%
11	PRODUCER L	LONG LINE	0.174	LEGAL AREA	14.04%
12	PRODUCER H	LONG LINE	1.817	ILLEGAL AREA	100.00%
13	PRODUCER M	LONG LINE	0.367	ILLEGAL AREA	72.85%
13	PRODUCER M	LONG LINE	0.137	LEGAL AREA	27.15%
14	PRODUCER M	FIXED SUSPENDED	0.009	ILLEGAL AREA	100.00%
15	PRODUCER M	FIXED SUSPENDED	0.008	ILLEGAL AREA	100.00%
16	PRODUCER M	FIXED SUSPENDED	0.013	ILLEGAL AREA	100.00%
17	PRODUCER N	FIXED SUSPENDED	0.016	ILLEGAL AREA	100.00%
18	PRODUCER O	LONG LINE	0.081	ILLEGAL AREA	100.00%
19	PRODUCER P	LONG LINE	0.015	ILLEGAL AREA	100.00%
20	PRODUCER Q	LONG LINE	0.217	ILLEGAL AREA	100.00%

The mollusk cultivation areas with codes 1, 2, 12, 14, 15, 16, 17, 18, 19 and 20 are 100% in illegal zones, the mollusk cultivation area with codes 3, 4, 6, 7, 8 e 9 are 100% in legal zones and the mollusk cultivation areas with codes 5, 10, 11 e 13 are partially in legal and partially in illegal zones.

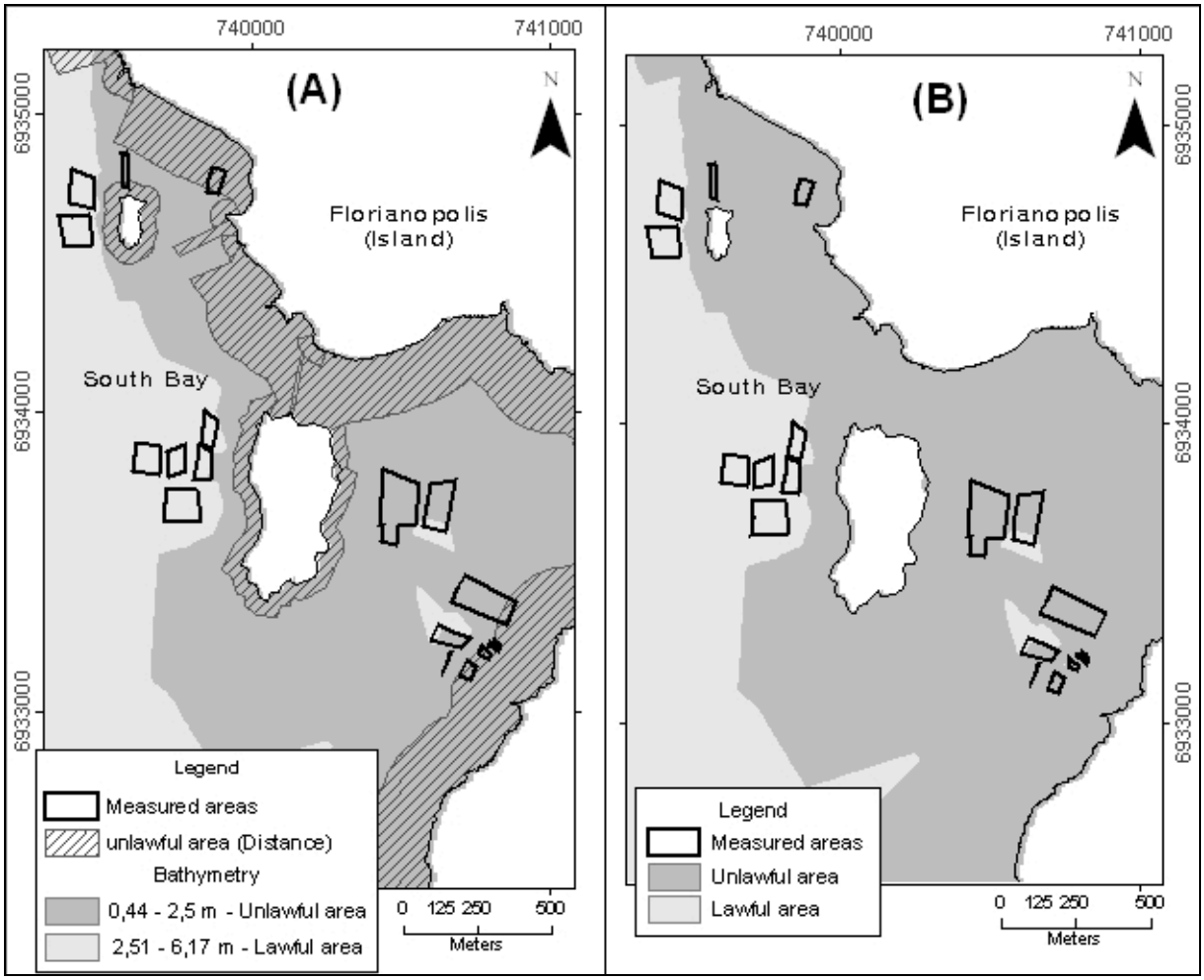
The cultivation area code 5 is 99.67% in legal area. Therefore, it can be considered as legal area. There must be a tolerance because the source of the data is the bathymetry of 1976. The area of cultivation 10 is 99.7% in legal zone, the cultivation area 11 is 85.96% in illegal zone and the cultivation area 13 is 72.85% in illegal zone. Both previous areas can be studied with more details and more updated data for the definition of lawfulness or occasional lawlessness. Picture 6 (B) shows the cartography of the overlapping of the areas with the legal viability map.

The information generated in the present diagnosis is important for the decision making in case of area relocating.

The regulating institutions must state a tolerance value to define which areas should be relocated if it is the case. The diagnosis also provides parameters for the definition of new legal demands, helping the environmental organs and regulating institutions for the activity.

In SEAP/PR (2008) all the mapping carried out in the Molusk Culure Developing Local Plan – MCDLP is not based on the individual survey of each State productive area. The MCDLP

was based in a model of probability to determine the viable places for mollusk cultivation where the legal parameters were excluded for being determinative rather than probabilistic (SEAP/PR, 2008), this way, the plan was elaborated without considering the laws as a main concern.



Picture 5: In (A) Lawful and unlawful area map according to the distance from beaches and rocky coasts and bathymetry and in (B) Lawful viability map and mollusk cultivation areas.

6. CONCLUSION

The developed study takes us to the conclusion that the mollusk cultivation areas must be mapped with techniques that make the planning and managing of the dynamics of the activity expansion possible. This mapping should also use updated cartographic basis in a suitable scale and be carried out according to legal parameters.

It is necessary to use equipments that enable more precise measures than the twenty meters established in the law for the survey of the extremities of the areas. This precision will be related with the distance between the areas and with the cartography used for the comparison. However, the proposal of this study is that the precision be around one meter.

The survey of the taken areas or the planning of the areas to be occupied must be carried out individually with a spatial database that contains at least the coordinates of the extremities of the areas, name of the producer, bathymetry of the place and kind of measure buoy.
The marine occupation must happen only in the places where there is the permission for the production activities. The map of the legal viability map may and must orient the studies of water quality, sedimentation and availability of food for the mollusk production.
In this way the legal viability map must be considered as the cartography basis for planning and managing the marine mussel cultivation.
The legal viability map may also help the decision making for the legal parameters determining in future legislations, as well as for the review of the coherence of the present legal parameters.
The accordance with the laws is needed in the legal viability map, as well as the attendance *in locu* of the dynamics of the cultivation areas. This attendance will certainly inhibit the ill-intentioned producers that illegally sell their areas or invade forbidden areas. On the other hand, the producer with legal attitude will be beneficiated and will have the territorial legal guarantee supported on the right of occupation/exploration of the space intended for the malacoculture cultivation.

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