Applying Current Data Management Practices to a Marina Inventory

An Interdisciplinary Qualifying Project

Submitted to the

Puerto Rico Department of Natural and Environmental Resources

And to the faculty
of the

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Abstract

Puerto Rico's Department of Natural and Environmental Resources has requested that an inventory be taken of marinas located on Puerto Rico. The data collected then needed to be placed into a database that can assist the DNER in conducting a number of analyses. This study examines background information associated with marinas such as ramps, docks, pump out stations and slips, the methods of data collection and evaluation that we used as well as our finding, conclusions and results. As part of our project we traveled to every marina, collect data through interviews and observation and then place that data into our database. By using our database as an analysis tool we were able to determine that the largest boat concentrations were in the east and that some of the most polluted areas are in the north. Using these tools the DNER can then make policy recommendations for future marina expansion and concession payment.

Executive Summary

The goal of our sponsor, the Department of Natural and Environmental Resources Marine Resources Division, was to gather a wide variety of information regarding all of Puerto Rico's recreational marinas. We were not only required to conduct amenity and boat size inventories at each site, but also to record its GPS location, and finally gather the necessary concession information about each one. Through a series of field visits to each marina where both interviews and observations were conducted, we were efficiently able to gather the information previously requested by the DNER.

After the complete set of information was gathered for the 33 recreational marinas of concern, we created a user-friendly database to display the data. Using Microsoft Access, we were able to present all information for any given marina on its own page, while still being able to generalize and analyze data about all marinas by using reports. Also included on each individual page is an Environmentally Sensitive Index (ESI) map that shows a visual representation of the specific marina, and the sensitive ecological areas surrounding the marina within a 2-mile radius. For each ESI map, there is a corresponding Benthic map that displays the sub surface inhabitants. With both of these maps, the DNER now has the ability to see all surrounding species that may be in danger because of the neighboring marina. The ability for the database to turn raw data into useful information was of great importance to the DNER. It is important for them to not only manage these marinas most efficiently, but also protect the natural and environmental resources that could be affected.

The database can be used as a tool to analyze any part of the recreational marina program, and is undoubtedly a step towards a more organized recreational marina management system.

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Coastal Applications of GIS _____
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ESI Maps in Puerto Rico _____

Background Summary: Matt Guigli / Bertrand Carrie _____

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Develop Observation Criteria _____
Conduct On-Site Observation _____

Data Collection Sheets _____

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Introduction

With an increasing number of recreational and commercial boats using waterways, it is becoming more and more difficult to avoid polluting our seas. Oil spills, illegal dumping, human waste, and toxic chemicals are a threat to aquatic life. The growing trend in recreational boating in Puerto Rico, as throughout the world, presents a danger to the island.

Puerto Rico has become one of the most popular tourist spots in the Caribbean in the last forty years because of their warm weather, beautiful beaches and pristine waters. Due to the increasing popularity of this island, the number of recreational water vessels has consequently grown as well. There are over 30 marinas along with an estimated 60,000 registered boats (Boating Commissioner's Office, 2003) on the island.

The DNER currently has a marina information systems database that is in need of updating due to recent marina growth. As a result of their inaccurate records they do not have a complete understanding of the current and future direction of the marina system. Consequently, the current system needs review and modernization.

To resolve this problem, The DNER wanted part of our work to include the creation of a Microsoft Access database. The database includes individual marina amenities; such as pump station information, restrooms, gas pumps, etc., along with information about boat distribution sizes, Environmental Sensitivity Index (ESI) maps, and aerial photographs. The DNER felt that this information would help them understand and asses current and future recreational boating trends. This information will help the

DNER plan for future management, while not disturbing the island's sensitive ecosystem and beautiful natural resources that draw so many people to Puerto Rico.

During the data collection phase of our project we visited all of the current marinas and recorded information about their amenities, boat size distribution, as well as compiling visual documentation using digital images. We also recorded the GPS coordinates of each marina. This information is displayed through the creation of an island-wide GIS layer map within our database, showing the geographic location of each marina and nautical facility. This information makes up our user friendly database that members of the DNER can use for a reference tool, and also to make policy recommendations regarding future development of marinas and nautical facilities in Puerto Rico.

Background

The DNER believes there are over 60,000 recreational vessels registered to the island of Puerto Rico, and greater than 30 recreational marinas currently operating. Puerto Rico's marinas are becoming overcrowded, and ecologically sensitive areas may be at risk. The DNER needs a better understanding of the entire marina system in order to confront the problems resulting from increases in recreational boating.

The DNER has asked our group to compile relevant background information about the marina situation in Puerto Rico. We have compiled relevant information on specific topics such as boat emissions data, fuel additive pollutants, boat sewage, point and non-point source pollution, factors influencing vulnerability to adverse impacts from pollution, marina inventories, boat storage, boat size distribution, laws and regulations, concession fees, vessel registration, databases and Microsoft Access, GPS (Global Positioning System), GIS (Geographic Information Systems), and ESI (Environmentally Sensitive Index).

Boat Emissions Data

Boats are the leading polluters to the waters of Puerto Rico. This is largely in part due to the fact that there are currently in excess of 60,000 active recreational watercraft in Puerto Rico. Although not all of these crafts are motorized, pollutants are not necessarily always generated solely from engine emissions. Other pollutants include those coming from various paints used on the hull and human waste. However, engine emissions are the most prominent and detrimental to the environment and ecosystem. For this reason, it will be necessary to examine the levels of pollution emitted by various watercrafts and their impact on the ocean and its ecosystem.

Fuel additive Pollutants

The Clean Air Act Amendments (CAAA) of 1990 addresses the use of oxygenates in gasoline. The fuel additive oxygenate methyl tert-butyl ether (MTBE) has been added to internal combustion engine fuels since the 1970's. However, its use has increased dramatically since the CAAA deemed this a more efficient way for combustion that reduces carbon monoxide emissions that are harmful to the ozone layer (Joo-An et al., 2001).

The dilemma is that by solving one problem, the CAAA has inadvertently caused another. It is evident that we need to curb ozone destruction, but another potential

ecological and perhaps economic catastrophe is emerging for small tourist islands such as Puerto Rico. MTBE (methyl tert-butyl) is volatile organic compound that is highly soluble in water. MTBE binds quickly to soil and does not readily biodegrade in the environment (Brown et al., 2001). MTBE is approximately 10-15% of gasoline by volume (Joo-An et al., 2001), and two-stroke engines discharge up to 30% of their fuel, unburned into the environment (ARB, 1999). This is an obvious crisis for a coastal ecosystem highly populated by motorized watercraft. This problem does not only exist in Ocean Waters, many lakes experience much of the same problem.

Boat Sewage pollution

An important factor influencing coastal ecosystem health is improper disposal of waste into the water. According to the Environmental Protection Agency (EPA), recreational pleasure and fishing boats are probable sources of human fecal contamination in coastal marinas. However this problem is either underestimated or ignored by the public. There are a number of environmental concerns that can arise due to the fecal contamination from boats. Algae growth can be stimulated thus reducing the oxygen supply needed by fish and organisms. Sewage can cause serious human health concerns by elevating biological containments that have been linked to such illnesses as infectious hepatitis, diarrhea, bacillary dysentery, skin rashes, and even typhoid and cholera. Economic losses can also occur as a result of sewage contamination. The closure of valuable shellfish beds, as well as fishing and swimming areas can many times be traced back to impacts caused by sewage pollution (The Ocean Conservancy, 2001).

It is important to remember that boat sewage is more concentrated than household sewage due to the fact that people on boats use less quantities of water for hygienic purposes than people do on land. However, a single boat releasing the contents of its tank into the harbor may be no harm to the environment, if several hundred boats are docked in a harbor with poor flushing rates, and they dump their toilet waste directly overboard it will become a pollution problem that can have dire effects on the surrounding population and environment (EPA Ocean Regulatory Program, 2004).

Because of this growing sewage problem many regulations have been setup to govern the disposal of boat sewage. EPA regulations require that fecal matter and solid waste from boats be contained in a U.S. Coast Guard-approved marine sanitation device (MSD) and discharged upon docking into approved pump-out stations (EPA, Non-point Source Pollution, 2003).

Whether marinas are equipped or not with sewage collection facilities, boat owners are likely to continue dumping fecal waste into the ocean if an education program is not implemented. Fees to pump out the sewage might also encourage boaters to dispose sewage illegally, when they could easily dispose of it for free on the open sea. In an effort to educate boaters as to the benefits of proper sewage disposal, the Ocean Conservancy began the “Good Mate” program. This program outlines a number of steps that both boat owners and marina owners can take to ensure that they are using the proper methods when disposing of boat sewage. Government agencies such as the U.S. Fish and Wild Life Service have started to offer services to boaters such as a toll free line to boaters helping them locate pump out facilities in their area. This will hopefully encourage

boaters to use such pump out facilities. Marina owners are also receiving government grants through the CVA to assist them in purchasing and maintaining proper pump out stations (The Ocean Conservancy, 2001). These new efforts in education and government support are intended to reduce problems that are occurring from boat sewage pollution and reduce the effects it is having on our environment.

Point and Non-Point Source Pollution

When addressing the problem of pollution it is crucial to understand the primary problem at hand and identify where the majority of the pollution is coming from. Not all pollution is generated by *point-source pollution* at marinas and other nautical facilities. As in a study conducted by the San Juan Bay Estuary Program, it was found that *non-point sources of pollution* accounted for the majority of the flow and suspended solids in the SJBES watershed.

It is important to distinguish the difference between non-point and point sources of pollution. A non-point source would be one where pollutants indirectly and inadvertently enter the environment. Examples are from parking lot run-off or hazardous boat repair materials or fluids getting washed into the water. Examples of point sources are storm water drains, sewer outlets, as well as marina pump out stations. However, although these point sources account for a great deal of pollution, they are not as large of a concern as non-point sources were found to generate between 50 and 90 percent of the harmful ammonia and nitrogen loads as found above.

Unsewered areas produced more than half of the biochemical oxygen demand (BOD) loads and over 90 percent of the ammonia nitrogen loads within the watershed."

(Point and Non-point Source Pollutants Loading Study of the San Juan Bay Estuarine System, Puerto Rico, 2000)

Factors Influencing Vulnerability to Adverse Impacts from Pollution

There are three significant factors that are taken into consideration when determining the vulnerability of a particular area or marina to pollutants; the depth of the water within the marina, the seasonal boating activity, and the degree of tidal mixing.

Two studies, Marina Del Ray, California (Zuccarello et al., 2002), and Lake Texoma, Texas (Joo-An et al., 2001) support the belief that pollution levels are a function of depth. These studies were conducted in locations and seasons that represent conditions similar to those in Puerto Rico. The highest levels of pollution were found on the surface. Perhaps this is the most encouraging discovery because most marine life lives subsurface. However, the pollution is not limited to the surface; it is just most concentrated there. The depth of the water within the marina is a major factor that must be considered when analyzing the possibility of a successful ecosystem in a marina.

Most pollution is generated when a boat engine is started. The reason for the high levels expelled is because typically 20-30% of the incoming fuel is discharged without having a chance to sufficiently combust (Boughton and Lico, 1997). Due to the fact that most cold starts occur upon initial entrance into the water, surface water at launches and ramps are particularly vulnerable. This is such a problem because the depth of the water is very shallow at launches and ramps, enabling boaters to back their trailers into the

water to launch their boats. The high levels of pollution sitting on the surface make it nearly impossible to sustain any marine life. There is not enough depth for there to be sufficient clean water below. Shallow water habitats such as egg hatcheries will be susceptible to these pollutants because they are in the most vulnerable areas.

The degree of tidal mixing is also an important factor when analyzing an areas vulnerability to pollution. If there is not sufficient tidal mixing, the pollutants remain in the water centralized to that location and are never dissipated. The obvious problem here is that the levels become very concentrated and leave no opportunity for any marine life to survive in the vicinity.

Need For and Use of Marina Inventory

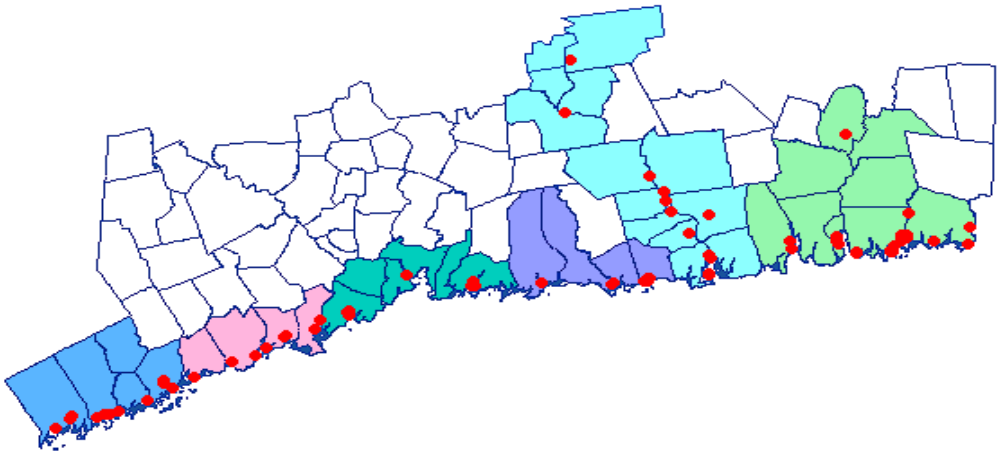
There are a number of topics included in a well-organized marina inventory survey. Questions can range form ones that seem very insignificant (i.e. Does the marina have a parking lot and public telephone?) to the more important and complex issues (i.e. pump-out station types, gas pump locations). Information about marinas can be used in two different ways. Marina planners can use this information when deciding where to locate future marinas and the boating public can use this information to locate amenities useful to each individually. After reviewing marina inventories that have been completed by the Florida Department of Environmental Protection (Florida DEP, 1999) and taking into consideration the Clean Marina Guide Books from Florida, Virginia, Texas, Massachusetts, Connecticut and Maryland we have identified a number of features that should be included in an inventory taken of any marina facility.

Contact Information

Basic contact information should be provided about marinas included in the inventory. Address, primary contact person, phone number, and geographic location are all extremely important to any boater and would have to be included in a well planned marina inventory.

Boating Amenities

A major marine pollutant around many marinas in the United States is human waste, which is also known as grey water. Pumping stations offer the ability for boaters to pump out their grey water systems at a dock so that there is no need for them to dump their waste while at sea. When examining the Florida DEP survey these locations are indicated only by an address. However, after further research it appears that many other states, such as Connecticut, have created GIS map layers to indicate pumping stations. Such maps can be a useful visual aid to boaters as shown in figure 1.



(Figure 1 A GIS map from the Connecticut Department of Environmental Protection that shows the locations of pump out stations along the coast. http://dep.state.ct.us/olisp/cva/pumpmap.htm)

The map in figure 1 is an example of one such map. Any type of systems containing maps like these could be very useful to the recreational boaters of Puerto Rico.

Dockside power is a necessity for many boats that are forced to recharge their batteries as well as for boaters who choose to dock for the night and use the amenities onboard that require electricity. Clean drinking water is also many times accessible to boaters who have docked at a marina. This is done through a dockside water faucet that boaters can attach to their boat while they are docked at a marina.

In addition to the dockside amenities listed above many marinas offer some type of assistance to boats that might have broken down on the water. These nautical repair facilities can take on many forms of maintenance and repair, such as performing minor engine repair while the boat is still in the water to repairing a damaged hull while a boat is dry-docked. By placing this information into our survey the DNER knows the location of repair facilities and the extent to which the facility operates. It should also allow them to identify if the repair facilities might be contributing to a pollution problem through non-point source pollution. Chemicals used while performing such maintenance as hull sanding, painting, as well as fuel and oil spills that may occur during engine repair are contributors to pollution.

The need to purchase supplies and fuel for a boat will always exist for the recreational boater. Marina stores offer a variety of supplies such as ropes, boat parts, and other accessories that make operating a boat both safe and possible. Of course fuel is also necessary for boats to continue operating and this can usually be purchased at most marinas especially those which also operate marina stores.

All of these amenities are important to the operation of a boat while it is both on the water as well as while it is docked at the marina, and should be included in a marina survey. All of this information would also be of concern to the DNER as they give permits to expand the boating facilities in a given area.

Non-Boating Marina Amenities

Many small recreational vessels that can be found at marinas around Puerto Rico may not be large enough to contain their own restrooms and shower facilities. Therefore, boaters are interested in knowing information about marinas that have showers and restrooms. Restrooms and shower facilities can also generate other forms of pollution that affect the surrounding ecological areas.

The presence of a parking lot at each marina is actually a very important amenity to include in a marina inventory. Having parking at a marina can contribute to areas such as the amount of tariffs levied on each particular marina, as well as water pollution due to non-point source pollution occurring through water run-off into the ocean. (See section on non point source pollution for more information)

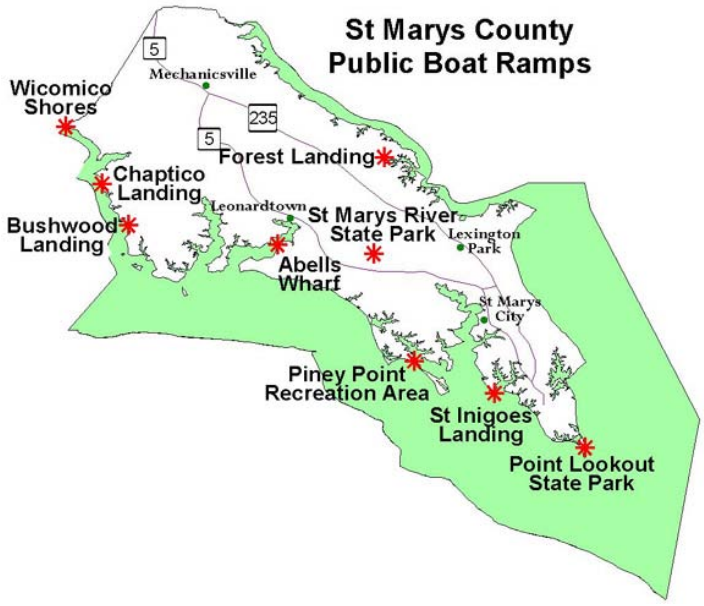
As with any other type of recreational vehicle there are safety issues associated with the operation of a watercraft. The presence of safety devices such as fire extinguishers as well as first aid kits is something that should be taken into consideration in any marina inventory, due to the fact that boaters as well as emergency agencies are interested in knowing what safety measures are available, and where they are located in case of an emergency. In addition to the location of safety measures the availability of a

public telephone can be important information for someone to have if they ever need to make a phone call from a marina, especially in the case of an emergency. Although many of these amenities are not directly related to the operation of nautical vessels, they are necessary additions that should be included in a marina inventory.

Boat Storage and Ramps

One of the many reasons that marinas exist is that boaters need somewhere to dock their boats when they are in the water and when they are not in the water. The most common of which when the boat is not in the water is the dry stack storage. If boats are stored in the water the most common type of storage is wet slip or mooring buoy. These various types of boat storages offer different advantages and disadvantages depending on size of boat they, and frequency of use.

Boats are usually placed into the water through the use of a boat ramp. Whether it is for repairs or transportation of boats, boats are often taken in and out of the water by use of these ramps. Knowledge of the location of current boat ramps can help boaters find a location to place their boat into the water and help any planners know where access to boat ramps is lacking, and help them identify locations in need of a ramp. Ramps can also serve as a vital outlet to the ocean for emergency response vehicles if an emergency should arise at sea. The Maryland DEP uses a set of interactive maps as shown in Figure 2. These maps are available online for boaters to use in order to find a place to launch their boats.



(Figure 2 a GIS map from the Maryland Department of Environmental Protection that shows the locations of public boat ramps http://mddnr.chesapeakebay.net/fish/Cntyramps/SM.html)

Boat Size Distribution

The inclusion of boat size distribution information in a marina inventory provides valuable information concerning boat sizes at each marina location to the DNER. When it comes time to evaluate the need for new nautical facilities, a determination can be made if more wet slips are needed or if the boat population consists of smaller boats that can be stored upland in dry stacks. This data is also useful to anyone conducting any type of pollution or ecological impact analysis based on the fact that different size boats tend to emit different levels of pollution. Larger boats for the most part put out a greater amount of pollution because they have larger engines as well as onboard restrooms; both of these factors effect water pollution. Knowing the number and size of boats in a given

area can also be important in making policy recommendations and future marina development (expansion of existing facilities and building of new facilities).

There are numerous amenities that should be included in any comprehensive marina inventory that is going to provide useful information to those collecting the data. Each of the marina topics listed above provide important information concerning the operation and regulation of marinas.

Puerto Rico's Policy, Laws, and Regulations

Concession Fees

The Consultant and Endorsement Division (CED) of the Department of Natural and Environmental Resources were established as a permitting division for anyone wishing to use an aquatic public domain, in addition to tracking, collecting, and administering all concession fees from marinas on the island. The CED must permit a marina because it is using submerged land, which is a public domain. There is a strict process to apply for a permit. Due to the fact that it is a *joint* permit application not only must a federal permit be filed, but also a local one as well. In addition the application must also pass through three major organizations; The Planning Board, Environmental Quality Board (EQB) and the DNER all must approve the application. This system of checks and balances ensures that the land is properly zoned, and that the proposed marina will not adversely affect the community, local habitat, or environment. After the Planning Board approves the permit application, the application for a permit is open for a thirty-day public appeal period. If no appeal is made, the application must then pass through the EQB and DNER. If the EQB and DNER see a need for the facility, and feel

it will cause no adverse effects on the community or environment, a letter is sent to the applicant notifying him or her of the approval. This letter states that a professional land appraisal must be made for the value of the land and submerged land without any structures on it.

The two primary ways of appraising the land is by comparing it to other similar plots of land and giving the land a comparable value, or base the land value on a projected possible income received from using the land. Professional agencies will typically perform these appraisals. The reason for the appraisal is that ultimately after the permit is approved, the concession fee for the use of the public domain is an annual 8% of that appraised value. It is also not uncommon for a marina to be operating while not paying the appropriate fees. In these cases, the marinas are liable to be back-charged for all indebted money. The money that is owed must then be paid within one calendar year from the notification. If the back concessions are not paid to the DNER then the marine maybe be subject to sanctions that could includes being shut down. .

Pollution Regulations

Puerto Rico is regulated by the same boating laws and regulations as the continental United States. These laws are important for the tracking and identification of boats, along with the pollution regulations for the prevention of polluting coastal waters and preserving sensitive ecosystems.

A major legislation dealing with water pollution is the Refuse Act of 1899. "The federal water pollution control act prohibits the discharge of oil or oily waste into the navigable waters of the United States, or the waters of the contiguous zone, or which may affect natural resources belonging to, appertaining to, or under the exclusive management of the United States, if such discharge causes film or discoloration of the water, or causes a sludge or emulsion beneath the surface, Violators are subject to substantial civil penalties and/or criminal sanctions including fines and imprisonment"(The Refuse Act of 1899, Federal Water Pollution Act).This document is the largest and most meaningful of any legislation, regardless of age, in terms of water pollution prevention. This sets forth laws and regulations that all U.S. States and territories must abide by. Without this document it would be legal for boats to dump trash, oil, and other pollutants into the ocean regardless of location of the boat. Even though this document is over one hundred years old it still bears much relevance and is still looked upon as a major legislation dealing with pollution regulations.

The Ocean water discharge criteria are covered in Title 33, Chapter 26, Subchapter IV, Sec. 1343 of the legislation. A brief overview or list of what the discharge regulations look like posted at a marina, with relevance to mileage within the coast, is below in figure 3.

It is illegal to dump:
Inside 3 miles and in U.S. Lakes, Rivers, Bays and Sounds and anywhere on the Great Lakes no matter how far from shore:
Plastic, dunnage, lining, and packing materials that float and any garbage except dishwater/graywater/fresh fish parts.
3 to 12 miles
Plastic, dunnage, lining, and packing materials that float and any garbage not ground to less than one square inch.
12 to 25 miles
Plastic, dunnage, lining, and packing materials that float.
Outside 25 miles
Plastic

Figure 3: Ocean Discharge Criteria in terms of mileage from the United States and United States waters. ("Basic Boating Safety" (Chapter IV Legal Requirements))

Regulations issued under the Federal Water Pollution Control Act require all vessels with propulsion machinery to have a capacity to retain oily mixtures on board. A fixed or portable means to discharge oily waste to a reception facility is required. A bucket or bailer is suitable as a portable means of discharging oily waste on recreational vessels. No person may intentionally drain oil or oily waste from any source into the bilge of any vessel.

Section 1342 of the legislation is titled "National pollutant discharge elimination system." This is an extensive section covering topics of permitting the discharge of substances; permit programs, how to issue permits, and limitations on partial permits.

Another of the most relevant sections is Section 1343 titled "Ocean Discharge Criteria." The legislation states clearly that in any situation where insufficient information exists on any proposed discharge, in order to make a reasonable judgment on

any of the guidelines a pursuant must be established to this subsection and no permit shall be issued under section 1342 of the title.

Relevant regulations set forth by the Federal Water Pollution Act are; Certification (Sec. 1341), National pollutant discharge elimination system (Sec. 1342), and Ocean discharge criteria (Sec. 1343). (See Appendix C for relevant legislation)

Pollution Regulations in terms of Development

Development issues are also of a particular concern. The Certification section for a states compliance with applicable requirements, application procedures, and license suspension are all necessary. Also, "any applicant for a Federal license or permit to conduct any activity including, but not limited to, the construction or operation of facilities, which may result in any discharge into the navigable waters, shall provide the licensing or permitting agency a certification from the State in which the discharge originates or will originate, or, if appropriate, from the interstate water pollution control agency having jurisdiction over the navigable waters at the point where the discharge originates or will originate" (The Refuse Act of 1899, Federal Water Pollution Act).

Some unacceptable coastal development sites include sites within designated coastal forest areas, within designated natural reserve areas, within designated National Estuarine Research Reserve, within critical wildlife areas, at or near sea turtle nesting beaches, over coral reefs, over sea grass beds, in areas traditionally used for public access

to the coast, in areas extraordinarily susceptible to risks such as heavy swells or flooding, and also in areas where a marina may affect navigation or safety (Guias Para La Ubicacion De Marinas En Puerto Rico (Ramon F. Martinez) Deciembre 1988). These regulations are crucial in preserving the coastline and keeping marina development safe not only for boaters but also for the environment.

Boating Regulations

By law, all motorized vessels must be registered. These regulations can vary from state to state. When in Puerto Rico, U.S. citizens aboard US registered vessels, checking in with the US Customs office is not necessary if this is the first port of call since leaving the US. For all others, whether an international boat, or a U.S. vessel that has been through an international port on its last stop, their captains must check in by telephoning the Customs office. At any marina office, you will find a copy of the Customs notice listing the current telephone numbers to call. When calling, it is necessary to give the Customs officer your vessel registration number, the serial numbers of any firearms aboard, and the names of each person and some form of identification such as passport numbers. Vessel inspection may be necessary, but is not usually required.

This is relevant in case more boating traffic than currently registered in Puerto Rico arrives at marinas, leading to even more boating traffic and overcrowding. Vessel registration, which is important in terms of marinas tracking all boats in it can be found in Appendix D. This can be helpful in forming a database, and also in terms of tracking

boating density therefore creating backing for recommendations for the placement of new marinas.

Vessel Registration

Vessel registration means you must apply for and receive a certificate of number and the number itself. The number is a combination of letters and numbers and usually begins with the state in which the boat is registered. It is necessary to have the certificate onboard, and you must place decals on the vessel as shown in figure 4.

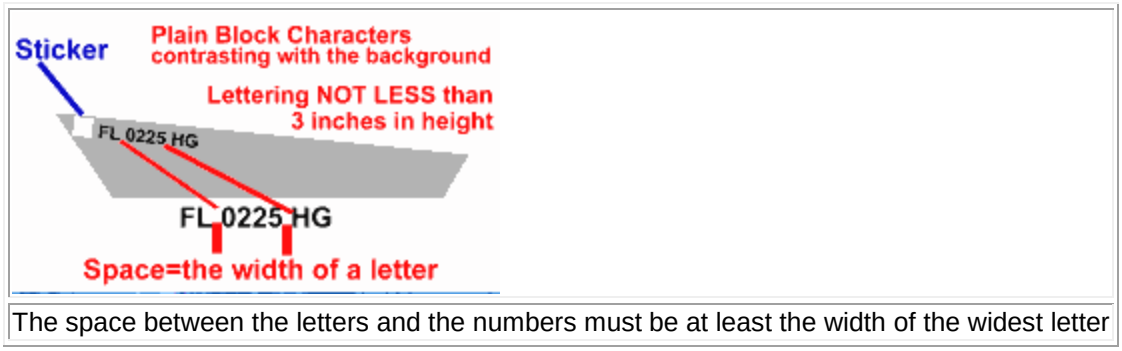


Figure 4. Showing proper display of vessel registration numbers ("Basic Boating Safety" (Chapter IV Legal Requirements))

Proper display of boat numbers:

-The figures are read from left to right.

-They must be displayed on the forward half of each side of the bow of the boat.

-Numbers must be in bold, block letters of good proportion.

-Numbers must be not less than three inches high.

-They must be of contrasting color to the boat hull or background.

-They must be as high above the waterline as practical.

-No number other than the number assigned can be displayed on the forward half of the vessel.

-Letters must be separated from numbers by spaces or hyphens.

-The validation decal must be displayed within six inches of the number.

This information is vital if any marina system wishes to be able to identify and keep track of all boats registered in the marina, and in the creation of a better database. The information can be used on many different scales; first, on the smaller scale of individual marina organization, and more largely on the scale of total registered boats. If all boats abide by the regulations set forth in the vessel registration then all boats will have a sort of “license plate”. This can be used to assess penalties for violated regulations. In addition this can be used for tracking boat growth in certain regions. If boating traffic can be monitored in certain regions then recommendations can be made for placement of new facilities.

Databases and Microsoft Access

Data by itself is almost always of very little use. It is possible to have all of the data on a particular topic in the world, however that data will be meaningless if there is no way to analyze and interpret it. A Database Management System (DBMS) such has Microsoft's Access or Sun's Oracle are tools that can be used to take data, interpret it, and develop it into a useful form of data known as information. (Adamski, Finnegan 2002, p. 1.06)

A database works by storing any data that you enter into it in a spreadsheet known as a datasheet or a table. Tables can be linked together through the use of primary and foreign keys, primary keys are used to identify a specific entry while foreign keys establish a link between tables, so that they can share data between each other and reference attributes of separate tables. The data that is stored in these datasheets can be pulled out and displayed for the user by entering any search parameters the user desires. This process of displaying data is known as a query. Queries are usually written in the computer language SQL; however, many database systems such as Microsoft's Access automate this process for you making them simpler and more user friendly.

For our project we chose to use Microsoft Access, which has a few more features that we interned to utilize. With Access it is possible to use files called forms that can be linked to a datasheet. The user can use these forms to input data into the database as well as view any information in the database. Access also has a report feature that allows the

user to generate custom reports to display the information in the database in a useful fashion.

Database systems are powerful tools with a wide range of applications that can be applied to almost any problem where data storage and interpretation is needed.

Global Positioning System

A global positioning system, or GPS, is a device used to locate the global coordinates of a particular GPS unit on the ground, water, or in the air. A GPS device works through satellite transmissions from space. Using at least three satellite transmissions at once, the unit is able to triangulate the global coordinates of the hand held GPS unit on earth. It displays the latitude, and longitude in the following format as an example. 00d00m00s N, 00d00m00s W, where (d) is degrees, (m) is minutes, (s) is seconds, and (N) stands for the direction, which in this case is North or W for West. From this triangulation, the GPS locater is also able to calculate elevation, velocity, and course heading. Most hand held units such as the Garmin "GPS 12", the GPS unit that we are using, are accurate to within 20 feet. The Global Positioning System has truly revolutionized navigation and the validity of global positioning.

Geographic Information Systems

In our original letter that we received from our sponsors (the DNER) we were asked to create and update maps of Puerto Rico with the additions of new Marinas that had been built as well as to make recommendations for future marina placement. The tool

that was chosen for us to use to accomplish these tasks is known as a Geographic Information System or GIS. GIS is a powerful tool and allows its users to display and analyze spatial data.

Geographic Information Systems is an extremely useful tool when developing any type of map, and are much more flexible then traditional or automated cartography methods. Maps of any type can be digitized and placed over each other in GIS layers making the functionality of a GIS map almost limitless. Objects can be easily created and placed anywhere on the digitized map and in addition to that they can be linked to a database that can store and then display information about a specific object on any map. Anything on the map can be manually selected or queried through the database portion of GIS, making searching maps for specific instances of an object simple (GIS.com).

How GIS works

The maps provided to use by the DNER currently use a software package known as Arc View and is one of the leading GIS packages on the market. With Arc View, as well as with most GIS software packages, the map begins with a base layer map of the area that the map is intended to display. This base layer map is usually imported into the program from AutoCAD, an aerial photo or another type of digital map. Additional layers can be added displaying useful information such as roads, buildings, bodies of

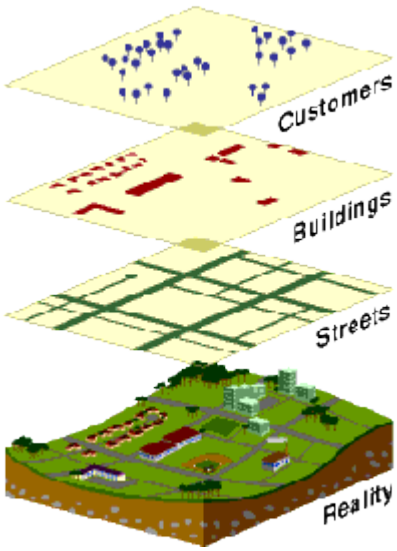


Figure 5 A diagram displaying different layers of a GIS map (http://www.gis.com)

water, or in our case marinas (see figure 5.). This is all done in a process known as Geocoding, where the geographic information is entered for each data point that has to be added to the map at which point Arc View takes that information and places the object in the corresponding location on the map. After information is Geocoded it can be applied to the map as a GIS layer.

Coastal Applications of GIS

Programs that evaluate the coastline require a large amount of data to be collected, interpreted, and displayed in a way that makes the data useful. A GIS system accomplishes all three of these and is therefore a perfect choice for coastal mapping and planning applications. There are many advantages to using GIS in a coastal environment. Darius Bartlett (1990) identified several benefits of a GIS approach to coastal management, including:

(1) The ability to model, test, and compare alternative scenarios - before the proposed strategy is imposed on the real world;

(2) The ability to handle much larger data bases and to integrate and synthesize data -- leading to a more holistic and coordinated management strategies; and

(3) Enhanced capacity for data exchange. (Bartlett, 1990)

Geographic information systems also offer the ability to take in information and use it to model future effects such as the ecological impact that a marina might cause if it was to be either built or expanded. “The integration of model systems with GIS derives benefits in terms of visualization and analysis of results, but increasingly the spatial

analysis capabilities of the GIS are being used to enable decision making within the modeling environment."(Gilman, 1999) By taking this information into consideration a group such as the DNER could take into account any type of changes that might occur and possibly damage the valuable natural resources of Puerto Rico.

GIS offers a wide range of tools and capabilities that are perfect for an application such as charting and planning marina development on an island such as Puerto Rico. By mapping out and displaying information in the GIS system anyone using it would be able to access a vast amount of information concerning these marinas, with very little software training needed.

Environmental Sensitivity Index

The current system that the DNER is using to keep track of its resources such as marinas on Puerto Rico and its surrounding islands is known as an Environmental Sensitivity Index or an ESI (NOAA, 1995). ESI maps were developed by the NOAA (National Oceanic and Atmospheric Association) in 1995 to help combat the environmental effects that an ecological disaster such as an oil spill might have on the environment. Currently ESI Maps are the leading mapping system used in the United States to map out environmentally sensitive areas. An ESI system collects and displays ecological, biological, and

environmental resources on a mapping system similar to GIS. Most ESI maps will contain three different types of information: shorelines, biological resources (such as fish, mammals, invertebrates and plant life), and human use resources (like marinas, towns, roads and or other constructed facilities). All are usually color coded and expressed as a variety of different symbols as seen in figure 6 (NOAA). ESI maps are extremely useful for identifying sensitive environmental resources that could be affected by a type of pollution such as a chemical spill before that spill could occur so that the protection priorities can be established for a sensitive area and cleanup strategies are able to be designed in advance. Using Environmentally Sensitive Indexes in ecological disaster response and planning, environmental consequences of a disaster and clean up time of a disaster can be reduced.

ESI Maps in Puerto Rico

Due to the large amount of sensitive coastline in Puerto Rico, coupled with the fact that boating is a primary means of recreation on the island, the Department of Environmental Resources has created an ESI map for Puerto Rico and its surrounding islands to assist clean up efforts in the event of an ecological disaster such as an oil spill. It contains all of the locations of human resources, the known locations of biological resources, and the migration patterns of the animal life as well as the mating seasons. As of right now the Puerto Rico ESI maps use MARPLOT as its map viewing software and a custom database package that stores all of the biological and human resource information. With this mapping system, information about each particular resource cannot be viewed directly from the mapping software forcing users to toggle between two

different programs to view any of the already out dated resource data. Both the maps and the database are linked together using Arc View. Currently the system is outdated due to the rapid expansion of the island especially in the human resource area. Updating and remapping this system will be one of the primary tasks of our project.

Background Summary

There are a number of important factors that came into play during our marina inventory. Pollution regulations, marina amenities, boating regulations, and a number of data organization techniques such as GIS and ESI maps all played a role in our project. There were also different types of databases to consider for organizing the information. As we moved forward into our study having the necessary background, allowed us to conduct a more thorough, educated, and concise research.

Methodology

To gather the information required for us to populate our database for the DNER, we visited each marina to gather information about their amenities, and also the number and sizes of boats stored at each marina. This information presented to the DNER allows them to draw their own conclusions in terms of policy recommendations and future expansion.

Interviews

By visiting each marina, we were able to interview the respective managers, gather data about the amenities at each marina along with other specific pieces of information.

Conducting Interviews

The best way to gain qualitative information was to ask the managers themselves. We met with each manager and requested information pertaining to his or her respective marina. Included in our interviews were questions about various amenities, safety precautions and boat-sizes. The interview simplified our task and guaranteed the best quality of data. Interviews allowed the managers to give us the number of boats within each of the predetermined boat-size ranges. This was done by simply accessing a database that contained every account held in the marina that included boat size, intern

saving us the tedious task of counting and measuring the length of every boat at each marina. This would have been nearly impossible considering the size of the marinas and time constraints involved. Amenity information questions were asked in a way that could be answered by yes or no responses to make interviews more efficient, and add a qualitative aspect to our quantitative interviews allowing there to be no misunderstanding in the questions asked. For example, we asked questions such as "Do you have a fuel pump, sewage pump out station, fire extinguisher…etc?", and get simple yes or no answers

Develop Observation Criteria

The development of a new database immediately made it important for us to formulate useful and relevant criteria for the database. The way in which we went about doing this was through existing marina database precedent. We researched topics about marinas in areas with similar environmental sensitivities and usages to extract all of the applicable criteria from their databases.

Conduct On-Site Observation

Another valuable data collection method was through observation. We felt that each topic included in our database criteria effects the administrative management of a marina as well as the surrounding ecosystem of each. The data collection was subdivided into three main categories. The collection of information about the amenities of the marina, GPS coordinates, and also took photographs of each marina. It was

necessary to rely on observational data collection wherever information was missing from the interviews.

Collect Observational Data about Marina Amenities

After our database criteria were decided upon, we used a checklist on-site at each marina to organize our daily findings. By visually crosschecking the data received during our interview with the marina manager we were able to ensure the validity of our data. Any information missing from the interviews could also be gathered through observation.

Compile Observation Data

The database will help the DNER compare marinas and identify fundamental differences between these facilities. By recognizing the problems in certain marinas, the DNER will be able to use the database to analyze the ecological problems and prevent future detrimental planning to the environment.

Methodology Summary

Using a combination of interviews and on site observation at each of the marinas that we visited we were able to gather the data that we needed to populate our database. This data can then be analyzed using the tools provided in our database to make decisions concerning future marina management.

Analysis

The primary focus of The Marina Inventory Study that we worked on for the DNER Marina Resource Division was the collection and organization of data about marinas around the island. The information then had to be placed into a useful format that the DNER can use to make decisions on a case by case basis concerning future marina policy such as placement and taxation. To facilitate the decisions making process for the DNER we have built a number of analysis tools into our database that can be used to display and a compare a wide range of data that is of importance to the DNER.

Boat Size Distribution Reports

At each marina, data concerning the number and size of all the boats that currently reside at the marina were taken. The size distribution for the boats was organized as follows: 15 feet and under, 16 feet to 21 feet, 22 feet to 29 feet, 30 feet to 39 feet, 40 feet to 64 feet and 65 feet and over. The numbers of boats within these ranges for each marina were then placed into a table where they can be accessed either through the marina view page, or the boat size distribution reports as seen in Table 7.

The boat size distribution reports display the number of boats for each size in a specific region of the island or for all of Puerto Rico. The DNER can use this data to see where the higher densities of recreational boats are on the island and from there, make decisions on issuing expansion permits for specific areas.

Puerto Rico
Recreational Vessel Total Estimated Numbers

	Vessel Length					
Marina Name	Under 16ft	16ft-21ft	22ft-29ft	30ft-39ft	40ft-64ft	Great 65ft
Club Nautico de San Juan	1	1	3	30	50	12
Isleta Marina	1	1	1	1	1	1
Club Nautico de Arecibo	3	20	67	25	15	0
Asociacion de Pesca Torresillos	0	3	3	0	0	0
Sea Lovers Marina	1	0	59	44	4	0
Marina Puerto Chico	6	112	319	142	24	1
El Conquistador Resort & Marin	0	3	1	4	10	0
Arecibo Outboard Club	5	11	8	3	1	0
Club Nautico Villa Taina	9	87	62	9	0	0
Quality Marine	6	5	11	0	0	0
Marina Puerto del Rey	27	101	380	476	362	25
Club Nautico de Boqueron	3	16	46	36	11	0
Palmas Del Mar Shipyard	0	7	8	4	0	0
Totals	65	390	1043	814	492	39

Total Number of Boats in Region 2843

Table 7 Boat Size Distribution Report

The number of boats in a region can also have an effect on the surrounding environment. By comparing the boat data to other types of data such as an ESI or Benthic map, the DNER can make predictions as to pollution trends for that area or make a comparison to another similar area on the island.

Concession Information

One of the DNER's major concerns in regards to the marinas on the island at this time is the concessions that they must pay to gain access to the public water front. According the Mr. Edwin Bonilla, Director of the CED, the problem at this time is that many marinas are not paying concessions or are paying an insufficient amount. As part of the data that we collected we have the concession

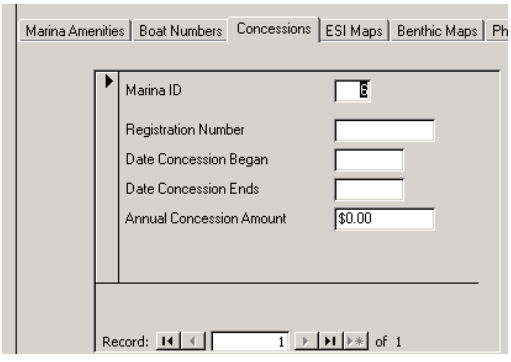


Figure 8 Concession View Window

information for each marina including its approval status, its amount being paid, its registration number, and the dates which the concession value is good for. All of this information can be easily accessed through the marina information view page in our database and can be simply updated by members of the DNER.

Amenity Queries

The amenities associated with each marina are also of particular concern to the DNER for many reasons. Effects on environmental areas and the impact that they have on the concession fee for a given marina are looked at. The DNER can easily analyze the amenity data that we have collected in two ways. The data for a specific marina can be viewed using the marina information view page which shows either a yes or no for each amenity whether it is available at that particular marina or not. The Amenity Queries section of the database also offers a number of analysis reports. By clicking on an amenity's button the user will see the number of marinas that have that specific amenity as well as the names of those marinas. A number of these query windows can be opened for easy comparison to other queries.

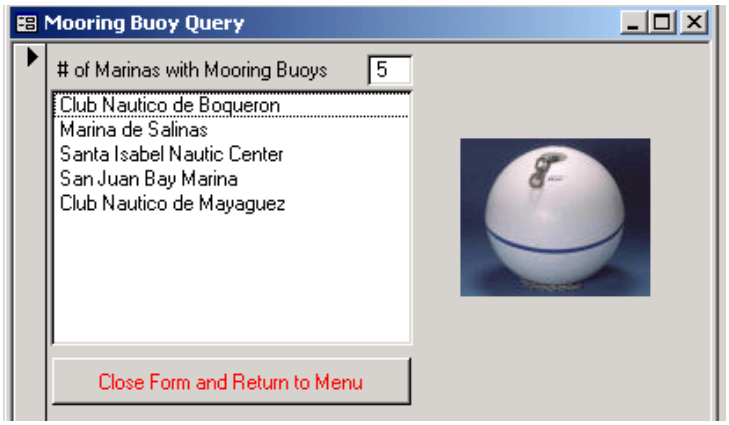


Figure 9 Amenity Query Window

ESI and Benthic Maps

Also included in the database that we have put together for the DNER is a number of ESI and Benthic Habitat Maps. These maps show a number of environmental features contained in the areas surrounding each marina. These maps can be compared to other data such as boat distributions to help predict environmental impact or assist in the analysis that must occur when issuing an application for the expansion of a marina.

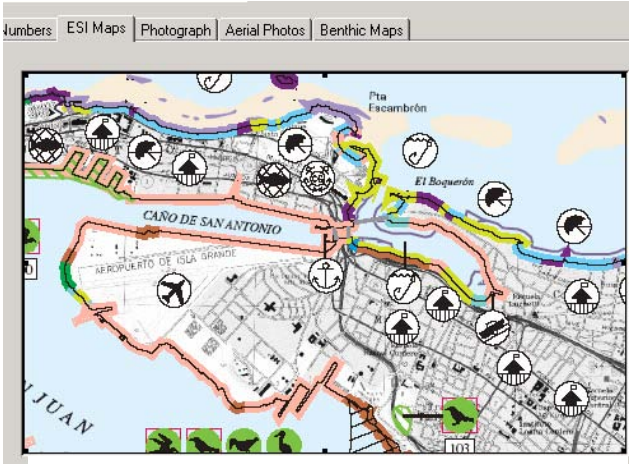


Figure 10 (An example of an ESI Map from our database)

The main concern that they have now is that the data is accurate and that they will be able to analyze it. Our database is the tool that we have provided for them to give them both the ability to store and analyze data about the marinas around the island. From our use of the ESI and Benthic maps in our database we have seen that there is a greater amount of pollution in areas where there is a greater concentration of both marinas and recreational boats such as the north and the east.

Analysis Summary

Using the analysis techniques outlined above members of the DNER will be able to view and manipulate the information inside of the database to assist them in making marina

management decisions. As long as the data is current these are powerful analytical tools that can greatly improve the productivity of both the Marine Resource Division and the CED

Findings

By visiting thirty-three (33) recreational marinas on the island during our time in Puerto Rico, we were able to collect a large amount of data for the DNER. We have seen a large spectrum of marinas ranging from unregistered fishing clubs that dock less than ten boats, to marinas holding over one thousand boats in their wet slips and dry stacks. In addition, we now know the boat distribution totals for the entire island, which marinas are more equipped with amenities than others, and what marinas are located in environmentally sensitive areas. All this is important information for the DNER to understand the current marina system, make new recommendations, and plan for future marina expansion.

We have surveyed many marinas with drastic differences in characteristics such as Cangrejos Yacht Club and Puerto del Rey. Cangrejos Yacht Club is a heavy polluter of an environmentally sensitive area, which was discovered through the use of our ESI and Benthic Maps and speaking with our liaisons at the DNER. Cangrejos is located in an estuary, which is a brackish mix of fresh and sea water that is inhabited by unique algae and other endangered species. Due to current legislation it is illegal to build marinas in locations such as estuaries, however, the marina at Cangrejos existed before

the DNER originated and its regulations existed At the same time, the Marina Puerto del Rey is the largest marina on the island and was still found to be one of the EPAs top ten cleanest marinas in the United States . This proves that a large marina can still be a clean marina. We have also traveled to Rincon, where a marina there has been shut down for the last three years because of its poor environmental management, and not obeying the regulations set forth by the DNER. Rincon was denied a permit when they applied for one until the EQB (Environmental Quality Board) and DNER finish evaluating and approve of their environmental coastal management.

In addition we have found that there are more than twelve marinas currently operating without a permit. This is extremely important information to the DNER, meaning the marinas are not paying concession fees and are liable for back taxing within the next twelve months. By discovering what marinas are not paying taxes, fishing clubs operating as marinas, many unknown mooring fields, and ramps, the DNER has discovered income it has not been receiving. No exact amount of income not being received can be predicted due to the different amounts of land appraisals. Land value can fluctuate from one extreme (30 cents per square meter) to the other (300 dollars per square meter), but there is no doubt the information we have gathered will generate revenue for the DNER.

One of our major findings that the DNER is extremely interested in is the distribution of boat totals throughout the island. Currently there are over 60,000 registered recreational vessels in Puerto Rico; however, we only inventoried 4,478 that are being stored at marinas. Additionally, we found that the majority of the boats are stored on the east coast, primarily in Fajardo.

Boat number statistics are far greater in and around Fajardo than in any other region. The total number of boats in and around Fajardo is 3,072. This is by far the highest density of boats on the island. Puerto del Rey, Puerto Chico, Isleta Marina, and Sea Lovers Marina are all located in Fajardo and Range from small marinas storing less than a hundred boats to extremely large marinas such as Puerto Del Rey with more than 1,000 boats.

In addition to the total number of boats in each region of Puerto Rico, we have compiled a boat size distribution chart. Boat totals can be calculated by length for each marina, or region (north, south, east, and west). The category sizes in feet are; less than 16', 16'-21', 22'-29', 30'-39', 40'-64', and greater than 65'. These findings enable the DNER to draw conclusions on what the distributions of boats are in a certain area and if the area is in need of more marinas or simply in need of upland dry stacks to store the smaller boats. The table displayed below is how the boat size distribution totals appear as seen in the database. It contains the current accurate numbers within the database upon completion of the project.

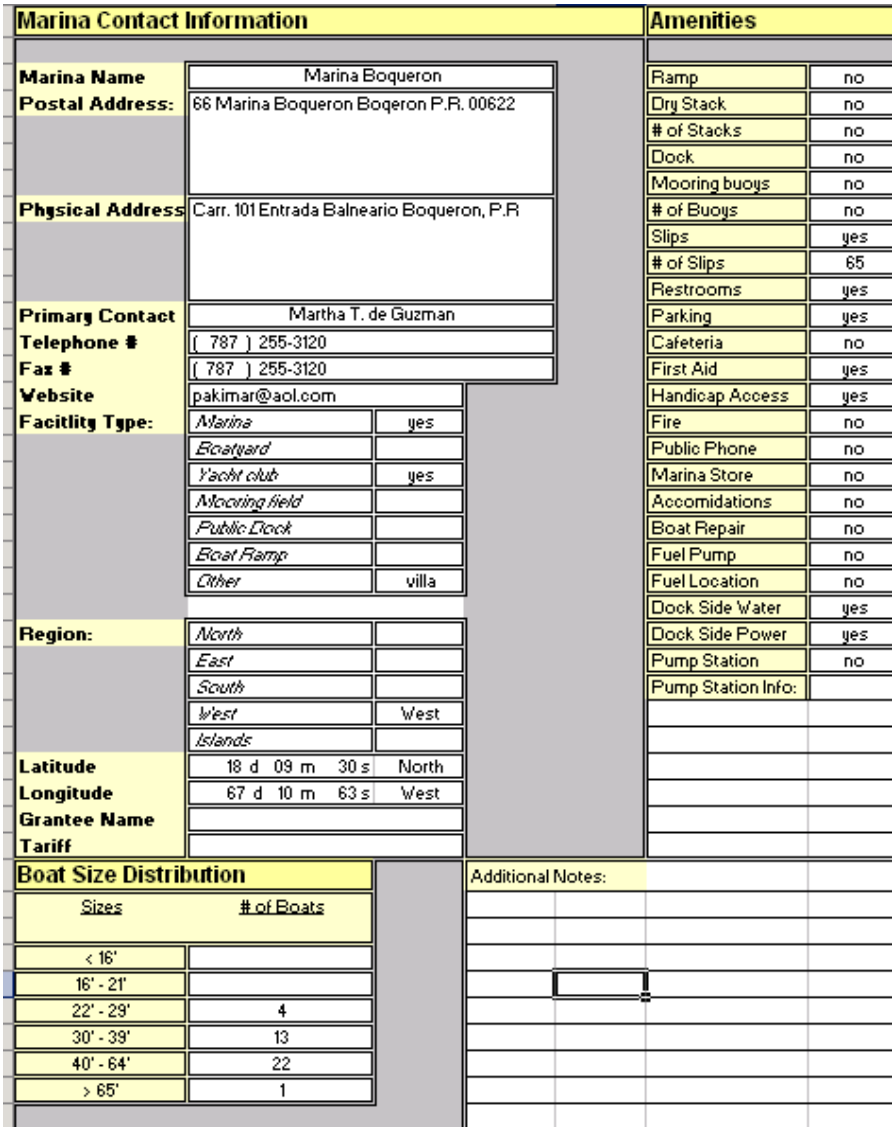
Puerto Rico East Coast
Recreational Vessel Total Estimated Numbers

	Vessel Length					
Marina Name	Under 16ft	16ft-21ft	22ft-29ft	30ft-39ft	40ft-64ft	Great 65ft
Isleta Marina / Cayo Obispo	16	5	57	73	45	1
Sea Lovers Marina	1	0	59	44	4	0
Marina Puerto Chico	6	112	319	142	24	1
El Conquistador Resort & Marin	0	3	1	4	10	0
Marina Puerto del Rey	27	101	380	476	362	25
Palmas Del Mar Shipyard	0	7	8	4	0	0
Villa Marina	34	133	346	170	71	1
Totals	84	361	1170	913	516	28

Total Number of Boats in Region 3072

Figure (11) Screen shot from East Coast total boat size distribution table from database.

Through our observations and interviews at each marina we have also compiled data on the amenities (i.e. restrooms, fuel pumps, public phone) that are offered at each marina. An example of the data sheet used while interviews were conducted as well as while on site observation was being done can be seen in the figure to the left. This particular data sheet is from Marina Boqueron



Marina Contact Information

Marina Name	Marina Boqueron
Postal Address:	66 Marina Boqueron Boqeron P.R. 00622
Physical Address	Carr. 101 Entrada Balneario Boqueron, P.R
Primary Contact	Martha T. de Guzman
Telephone #	(787) 255-3120
Fax #	(787) 255-3120
Website	pakimar@aol.com

Facitlity Type:	
Marina	yes
Boatyard	
Yacht club	yes
Mooring field	
Public Dock	
Boat Ramp	
Other	villa

Region:	
North	
East	
South	
West	West
Islands	

Latitude	18 d 09 m 30 s	North
Longitude	67 d 10 m 63 s	West
Grantee Name		
Tariff		

Amenities

Ramp	no
Dry Stack	no
# of Stacks	no
Dock	no
Mooring buoys	no
# of Buoys	no
Slips	yes
# of Slips	65
Restrooms	yes
Parking	yes
Cafeteria	no
First Aid	yes
Handicap Access	yes
Fire	no
Public Phone	no
Marina Store	no
Accomidations	no
Boat Repair	no
Fuel Pump	no
Fuel Location	no
Dock Side Water	yes
Dock Side Power	yes
Pump Station	no
Pump Station Info:	

Boat Size Distribution

Sizes	# of Boats
< 16'	
16' - 21'	
22' - 29'	4
30' - 39'	13
40' - 64'	22
> 65'	1

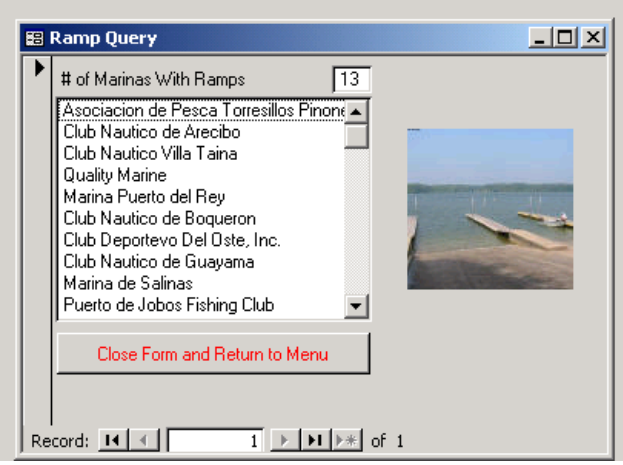
Additional Notes:

Figure (12) Data Collection Sheet used on location to record observational and Interview Data.

We have found that most medium to large sized marinas offer a wide array of amenities to their customers such as pump out stations, fuel pumps, marina stores, as well as dockside water and power. Many of the smaller marinas on the other hand may not have the resources or space to provide these amenities to their customers. It has also become apparent to us that the most popular type of boat storage is the wet slip. We have found these are at almost every marina regardless of size or location. After the slip, dry

stack is the next most popular means of boat storage. However, these require expensive machinery to run and are usually only found at larger marinas.

Figure (13) Ramp Query; searches all marinas entered into the database and list those which have a ramp.



Launch ramps were present at 12 locations that we have observed. Marinas that do not have a launch ramp use public ramps in different locations to launch their boats into the water. All of these ramps are of particular interest to the DNER. These ramps are not only important because of their effect on the environment, but they also offer a location to launch rescue and emergency boats in the case of an emergency at sea. A table displaying all marinas that have launch ramps can be seen in figure 13. Location of these marinas in terms of region and GPS coordinates can be found within the database.

In addition to marinas and ramps, we have also located a number of mooring fields throughout the island, many of which are located at marinas. These are simply calm water areas that have many boats anchored in them. The location of these mooring fields that are being used, but not recognized or known about by the DNER, is important information due to the fact that DNER is considering applying a concession fee for the use of mooring space.

The concept behind the taxation of the mooring fields is that the boat owners who simply anchor instead of docking in a marina are still using the submerged land owned by

the government of Puerto Rico. Therefore they can be taxed for the use of the land just as the marinas are taxed for their land both submerged and not. Currently 11 of the 33 inventories marinas are registered to be paying concessions. The 11 marinas generate $55,640 annually to the DNER, provided they are current with their payments. Because only 11 marinas are currently paying concessions, the other 22 must be investigated to ensure fairness of taxation among all of the island's marinas.

In addition to the information that we have gathered at each marina we have data that we have obtained from outside sources, such as maps and pamphlets. These coupled with the photos taken and data gathered ourselves at each marina amounted to a wealth of data that we presented to the DNER in the form of a database. These findings give the DNER the tool they needed to understand the current and future marina system.

Conclusions and Recommendations

After analyzing our findings and reviewing our results we have drawn these conclusions based upon our results. Overall, the Department of Natural and Environmental Resources was lacking a tool to optimize their marina management. Because of this problem, the DNER asked us to create a database to store and analyze marina data anytime that it is gathered. However, this database is only the beginning of the management problem solution. In order to further the organizational progress that has already been made regarding recreational marina management, the following recommendations should be considered.

We would like to recommend a more finite and specific definition for a "recreational marina" in addition to stating which marinas on the island are required to pay concessions. A more specific definition will help the CED keep closer track of the marinas that should pay concessions and those that are not required to. There will be less confusion about which marinas are supposed to pay concessions and those that are exempt.

Additionally, we feel that updating the database annually will keep the data current enough for the needs of the DNER. A systematic way of collecting the necessary data should be established through a series of annually scheduled visits to each marina. By notifying the marinas ahead of time, the DNER should be able to request that the necessary information already be completed for when they arrive on site for their visit. This also gives the DNER the opportunity to verify the accuracy of the information visually while on site. All marinas should be visited no less than once a year to ensure data currency.

Lastly, we suggest that a set date be established on which the database is deemed current and is completely updated for the given year.

Many of these recommendations depend on the completion of one another, but will not be difficult to achieve. A concerted and sincere effort to keep the database current will not only help the DNER in their marina management, and the CED fairly collect concessions, but will hopefully preserve and protect the ecologically sensitive species and their habitats around Puerto Rico.

In the two months that we spent in Puerto Rico hopefully we have given the DNER enough information and the necessary tool to optimize their marina management. We not only inventoried all recreational marinas on the island, but also entered that data into a database that analyzes and displays the collected information in a number of ways. By doing this, we were able to give the DNER not only the raw data that we collected, but also a tool that draws conclusions from this data. The DNER can now see a number of important conclusions drawn from the data that we collected. They now know how many boats are at each marina and what sizes these boats are, how many boats are in each region and what sizes they are, how many total boats are on the island in total and what sizes they are, as well as which marinas are currently registered with the CED to pay concessions and how much they owe annually, the total amount that the CED is owed annually, and lastly which marinas have certain amenities. By having this information at their disposal, hopefully the DNER can use it as a tool to place marinas in the future so that they will have the least possible impact on the surrounding environment. The

database can not only be simply used as a tool just to display data and images, but also a way to compare current marinas to ones that will be proposed to be constructed in the future. By looking at an existing marina that is most similar, the DNER can anticipate the negative impact that a future marina could have if built in a certain location similar to the one that is existing. By analyzing all environmental aspects and the impact that a marina may have on a certain area, the DNER should be able to preserve the resources which make the island so unique. Although we only spent a short time in Puerto Rico, hopefully the tool that we have given them will be a useful continuation of what we have begun.

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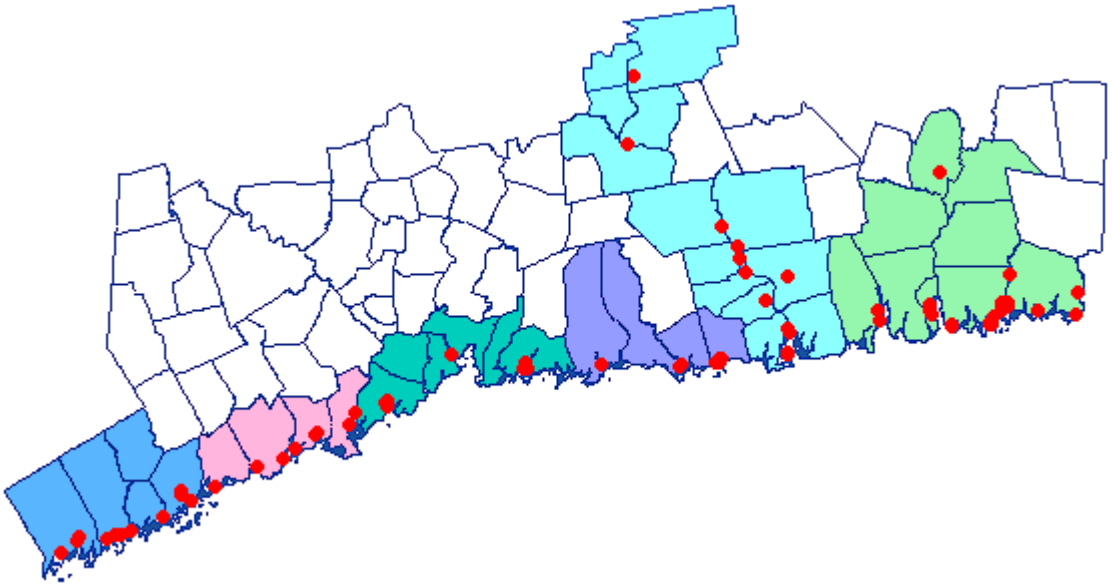
Appendix A

Charts, Tables, Maps, and Visual Aids



(Figure 1 http://dep.state.ct.us/olisp/cva/pumpmap.htm)The map in figure 1 is an example of one such map. Any type of systems containing maps like these could be very useful to the recreational boaters of Puerto Rico.

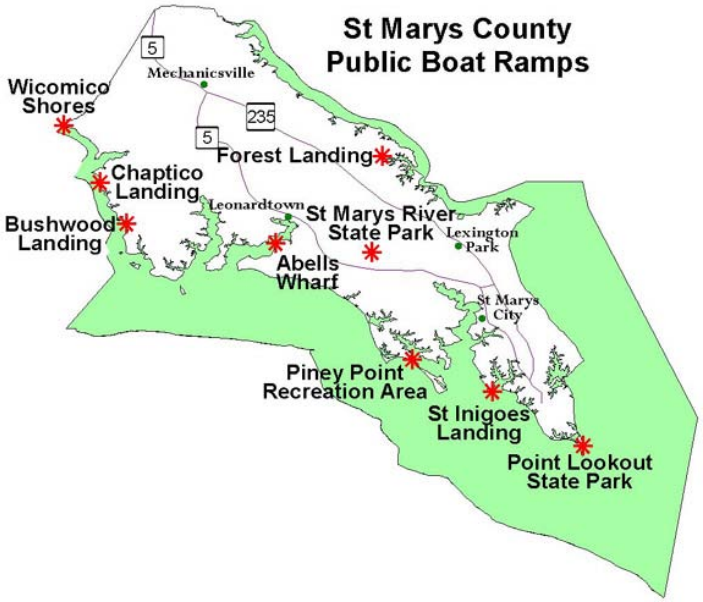
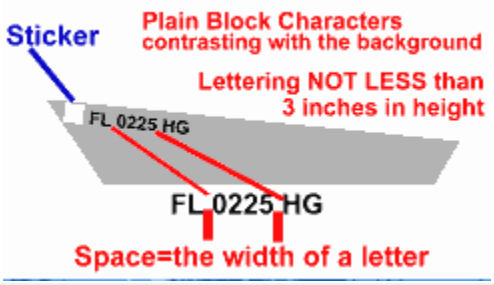


figure 2 http://mddnr.chesapeakebay.net/fish/Cntyramps/SM.html)

A collection of maps such as this worked into the GIS maps that we are developing for the DNER could be extremely useful for recreational boaters and marina planners.

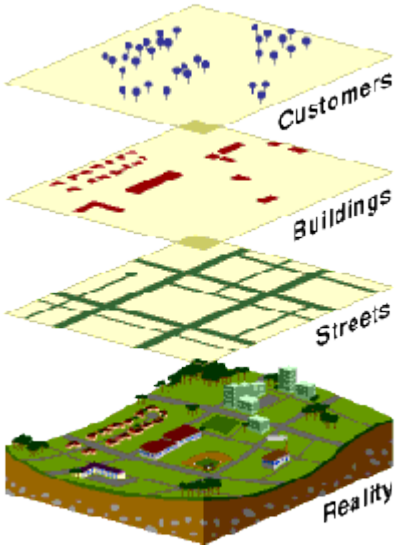
It is illegal to dump:
Inside 3 miles and in U.S. Lakes, Rivers, Bays and Sounds and anywhere on the Great Lakes no matter how far from shore:
Plastic, dunnage, lining, and packing materials that float and any garbage except dishwater/graywater/fresh fish parts.
3 to 12 miles
Plastic, dunnage, lining, and packing materials that float and any garbage not ground to less than one square inch.
12 to 25 miles
Plastic, dunnage, lining, and packing materials that float.
Outside 25 miles
Plastic

Figure 3: Ocean Discharge Criteria in terms of mileage from the United States and United States waters. ("Basic Boating Safety" (Chapter IV Legal Requirements))



The space between the letters and the numbers must be at least the width of the widest letter

Figure 4. Showing proper display of vessel registration numbers ("Basic Boating Safety" (Chapter IV Legal Requirements))



Additional layers can be added displaying useful information such as roads, buildings, bodies or water, or in our case marinas (see figure 5.).

Figure 6 (NOAA) Most ESI maps will contain three different types of information: shorelines, biological resources and human use resources. All are usually color coded and expressed as a variety of different symbols (see figure 6) (NOAA).

Puerto Rico
Recreational Vessel Total Estimated Numbers

	Vessel Length					
Marina Name	Under 16ft	16ft-21ft	22ft-29ft	30ft-39ft	40ft-64ft	Great 65ft
Club Nautico de San Juan	1	1	3	30	50	12
Isleta Marina	1	1	1	1	1	1
Club Nautico de Arecibo	3	20	67	25	15	0
Asociacion de Pesca Torresillos	0	3	3	0	0	0
Sea Lovers Marina	1	0	59	44	4	0
Marina Puerto Chico	6	112	319	142	24	1
El Conquistador Resort & Marin	0	3	1	4	10	0
Arecibo Outboard Club	5	11	8	3	1	0
Club Nautico Villa Taina	9	87	62	9	0	0
Quality Marine	6	5	11	0	0	0
Marina Puerto del Rey	27	101	380	476	362	25
Club Nautico de Boqueron	3	16	46	36	11	0
Palmas Del Mar Shipyard	0	7	8	4	0	0
Totals	65	390	1043	814	492	39

Total Number of Boats in Region 2843

Figure 7 (Boat Size Distribution Report)

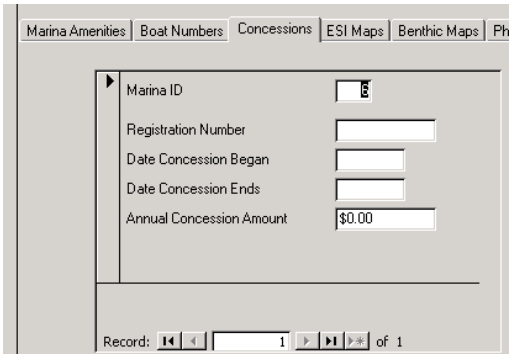


Figure 8 (Concession View Window)

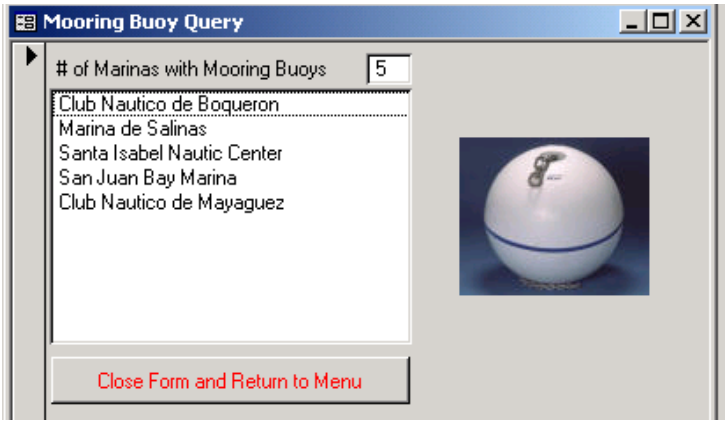


Figure 9 (Amenity Query Window)

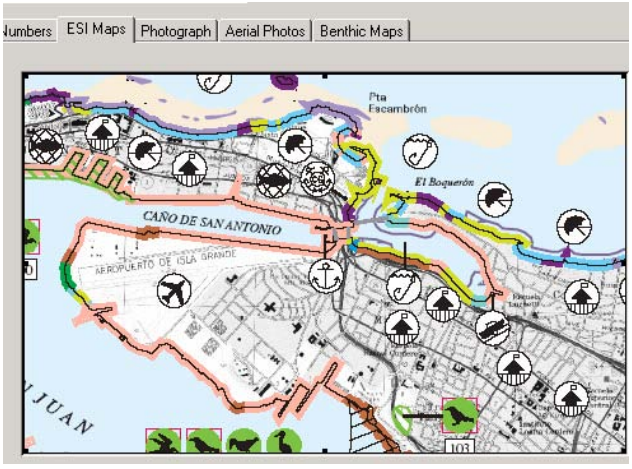
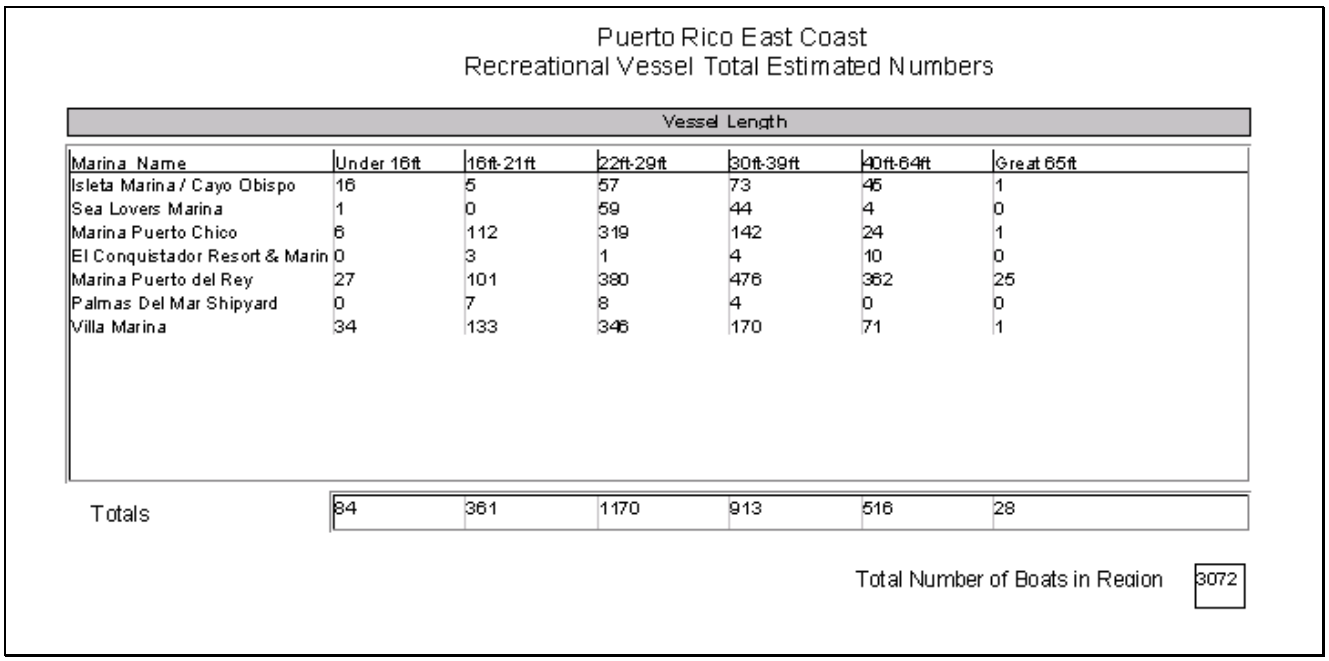


Figure 10 (ESI Map)

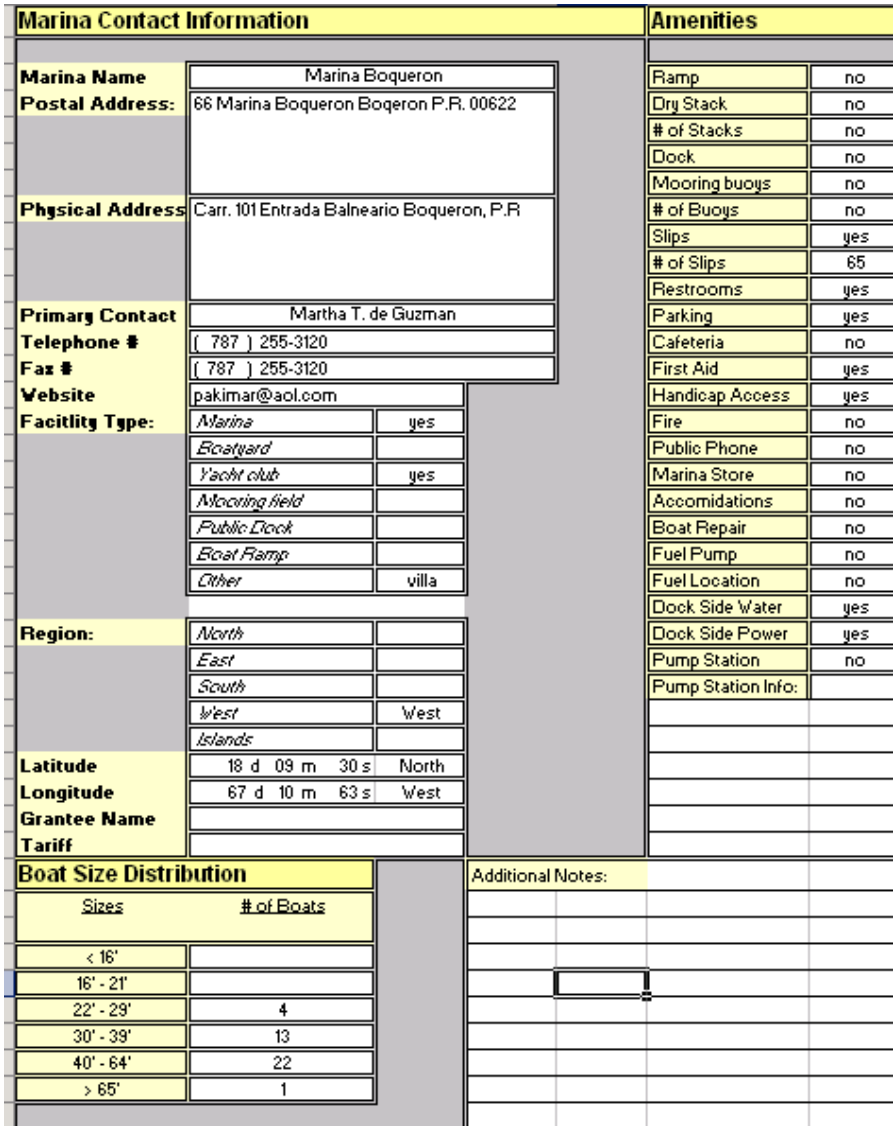


Puerto Rico East Coast
Recreational Vessel Total Estimated Numbers

	Vessel Length					
Marina Name	Under 16ft	16ft-21ft	22ft-29ft	30ft-39ft	40ft-64ft	Great 65ft
Isleta Marina / Cayo Obispo	16	5	57	73	45	1
Sea Lovers Marina	1	0	59	44	4	0
Marina Puerto Chico	6	112	319	142	24	1
El Conquistador Resort & Marin	0	3	1	4	10	0
Marina Puerto del Rey	27	101	380	476	362	25
Palmas Del Mar Shipyard	0	7	8	4	0	0
Villa Marina	34	133	346	170	71	1
Totals	84	361	1170	913	516	28

Total Number of Boats in Region 3072

Figure (11) Screen shot from East Coast total boat size distribution table from database.



Marina Contact Information		
Marina Name	Marina Boqueron	
Postal Address:	66 Marina Boqueron Boqeron P.R. 00622	
Physical Address	Carr. 101 Entrada Balneario Boqueron, P.R	
Primary Contact	Martha T. de Guzman	
Telephone #	(787) 255-3120	
Fax #	(787) 255-3120	
Website	pakimar@aol.com	
Facitlity Type:	*Marina*	yes
	Boatyard	
	Yacht club	yes
	Mooring field	
	Public Dock	
	Boat Ramp	
	Other	villa
Region:	*North*	
	East	
	South	
	West	West
	Islands	
Latitude	18 d 09 m 30 s	North
Longitude	67 d 10 m 63 s	West
Grantee Name		
Tariff		

Amenities	
Ramp	no
Dry Stack	no
# of Stacks	no
Dock	no
Mooring buoys	no
# of Buoys	no
Slips	yes
# of Slips	65
Restrooms	yes
Parking	yes
Cafeteria	no
First Aid	yes
Handicap Access	yes
Fire	no
Public Phone	no
Marina Store	no
Accomidations	no
Boat Repair	no
Fuel Pump	no
Fuel Location	no
Dock Side Water	yes
Dock Side Power	yes
Pump Station	no
Pump Station Info:	

Boat Size Distribution	
Sizes	# of Boats
< 16'	
16' - 21'	
22' - 29'	4
30' - 39'	13
40' - 64'	22
> 65'	1

Additional Notes:

Figure (12) Data Collection Sheet used on location to record observational and Interview Data.

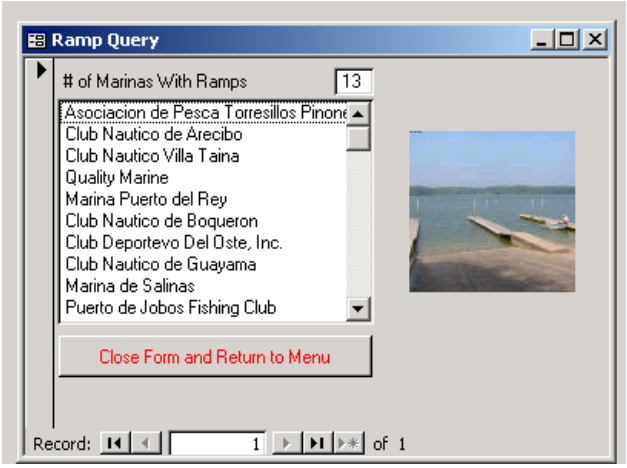


Figure (13) Ramp Query; searches all marinas entered into the database and list those which have a ramp.

Appendix B

Marina Manager User Manual

Marina Manager Users Manual

Version. 1.2.0

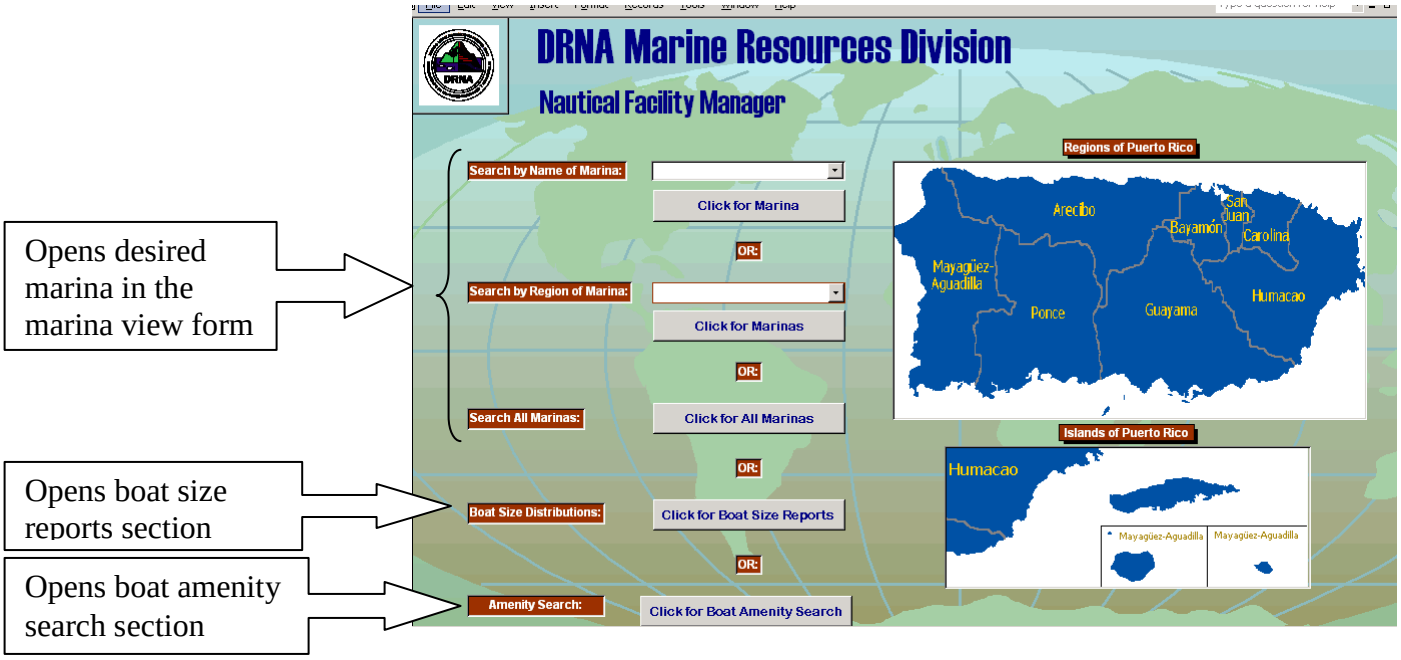
Written for the Department of Natural and Environmental Resources for use with the Marina Manager Database by Matthew Leach, Matthew Guigli, Ryan Jennettte and Bertrand Carrie all students of Worcester Polytechnic Institute

Marina Manager

The Marina Manager Database was created by Matthew Leach, Matthew Guigli, Bertrand Carrie, and Ryan Jennette as part of a project for Worcester Polytechnic Institute in association with the Department of Natural and Environmental Resources. It was created using Microsoft Access XP and written in SQL. All of the information contained within the database is up to date as of May 1, 2004.

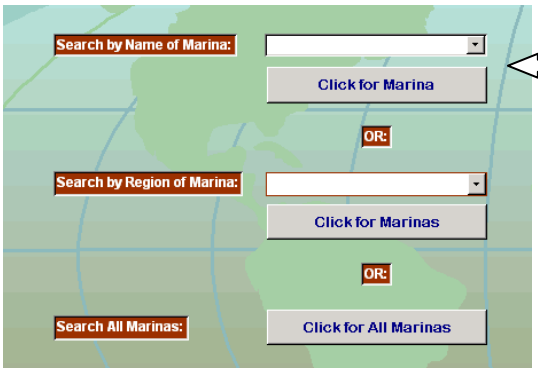
Main Menu

Upon opening the marina manager program you will be given a view of the main menu. From here you access all of the functions contained within the marina manager program. Each function of the program can be used by clicking on the appropriate button. These functions are described in detail in the following sections. Select either a way to view marinas, the boat number reporting section, or the amenity search section to get started.



Finding a Marina

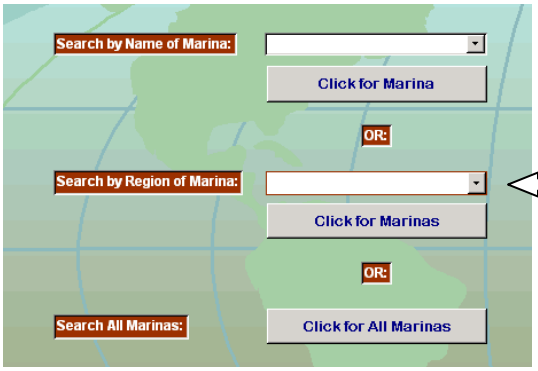
There are three ways to search for a marina using the Marina Manger software. You can search by marina name, by region, or you can display all of the marinas. Searching by marina name will give you the information of one specific marina, selecting to search by region will give you the information of all the marinas in the specified region and searching for all marinas will display the information of all the marinas contained in the database. To get started go to the main menu and choose your desired method of finding a marina.



To Search by Marina Name

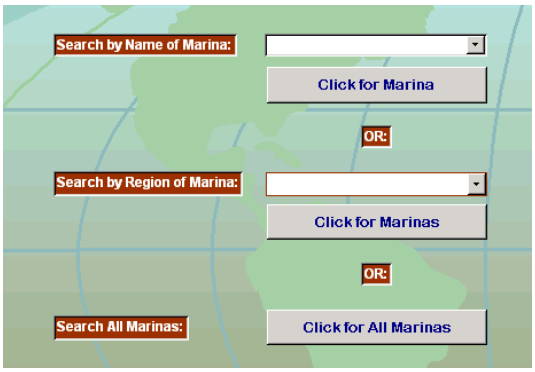
- Go to the drop down menu labeled "Search for Marina by Name.

- Select the name of the marina that you wish to view
- Click on the button below labeled “Click for Marina”



To Search by Region of Marina

- Go to the drop down menu labeled “Search by Region of Marina”.
- Select the name of the region of the marinas that you wish to view.
- Click on the button below labeled “Click for Marinas”



To Search All Marinas

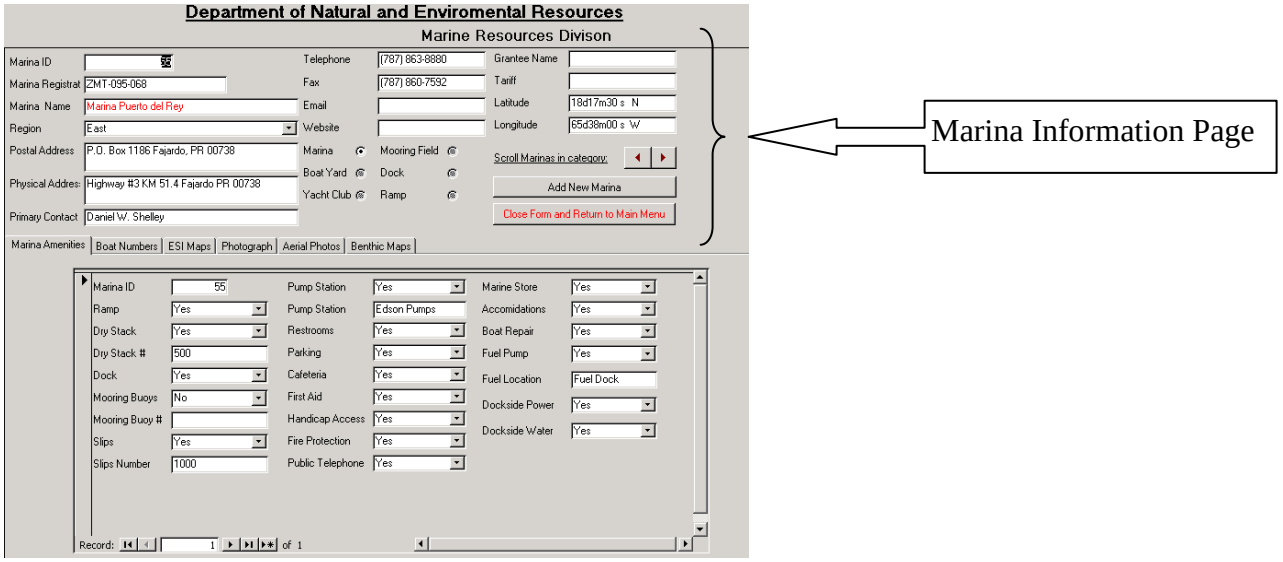
- Click on the button labeled “Click for All Marinas”

Marina Information View

The Marina Information Section is where all information about a particular marina can be edited, added or deleted. This information includes amenity information, boat size distribution as well as an assortment of maps of the area surrounding the marina. To access the Marina Information View search for the marinas that you wish to view from the Marina Manager Main Menu.

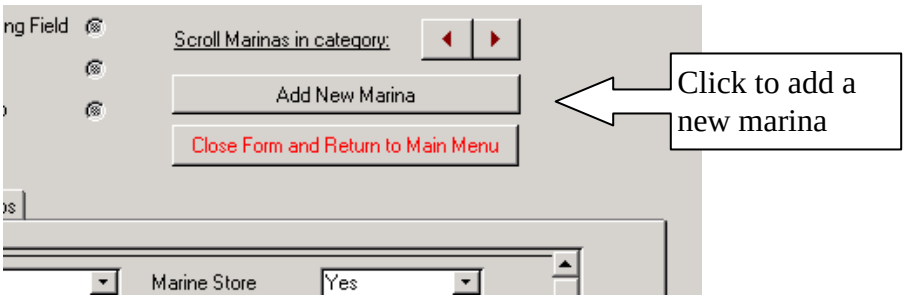
Marina Information Page

The Marina Information Page is the first page that you are going to see when viewing information on a marina and it is always in view when searching through the other pages containing different information and maps about the selected marina. The marina information page contains the marina ID, tax information, the physical and postal address, facility classification, the telephone and fax numbers, as well as the location both by region and in longitude and latitude. From the Marina Information Page it is also possible to scroll through marina listings, add a new marina and return to the Main Menu.



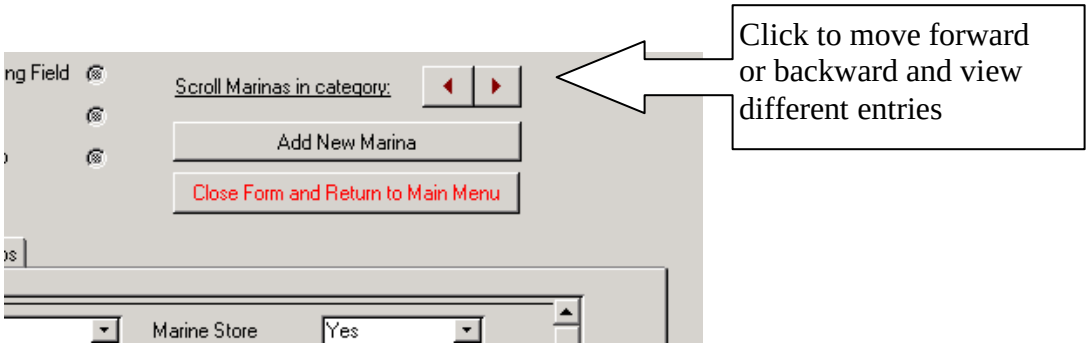
Adding a New Marina

To add a new marina go to the Marina Information Page and Click on the “Add New Marina” button. A new entry will automatically loaded and the Marina ID will be set. Enter all of the information that you have concerning the marina and close the form. The data will be automatically saved inside of the database.



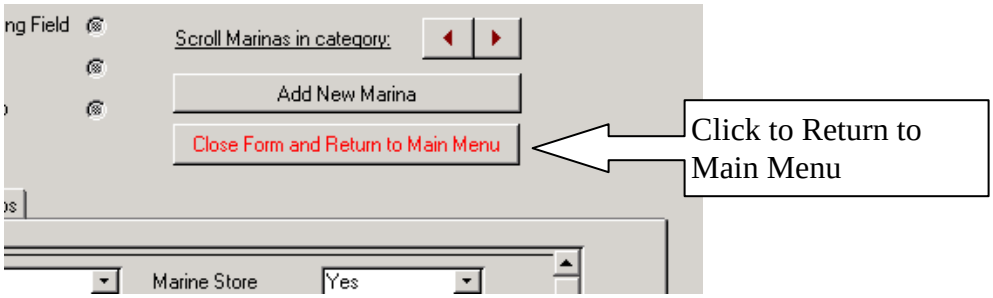
Scrolling Through Marina Entries

Unless you have selected a specific marina to view many times the marina manager program will pull up multiple marinas that fit your search. To scroll between the different marinas use the “Scroll Marinas in Category Function”. Use the two arrows located above the Add a New Marina Button to move forward or backward and view different entries.



Return to Marina Menu

To return to the Main Menu and start a new search or view different reports click on the Close Form and Return to Main Menu Button located directly below the Add New Marina Button.



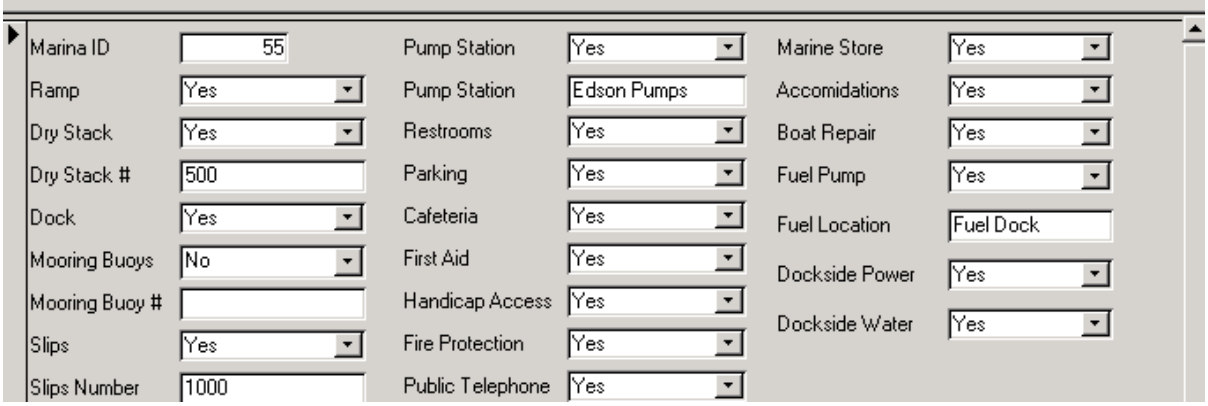
Marina Amenities Page

The Marina Amenities page contains all of the information available related to what amenities are offered at each marina and allows you to both view and change this information. All of the amenities have a drop down box containing either a yes or no depending on whether that specific amenity is offered at the particular marina which is currently being viewed. Below many of the drop down boxes is another field containing further information such as a number or a description of the amenity listed above it. The Marina Amenities Page also displays the Marina ID which associates the amenities being viewed with a specific marina.

Marina ID

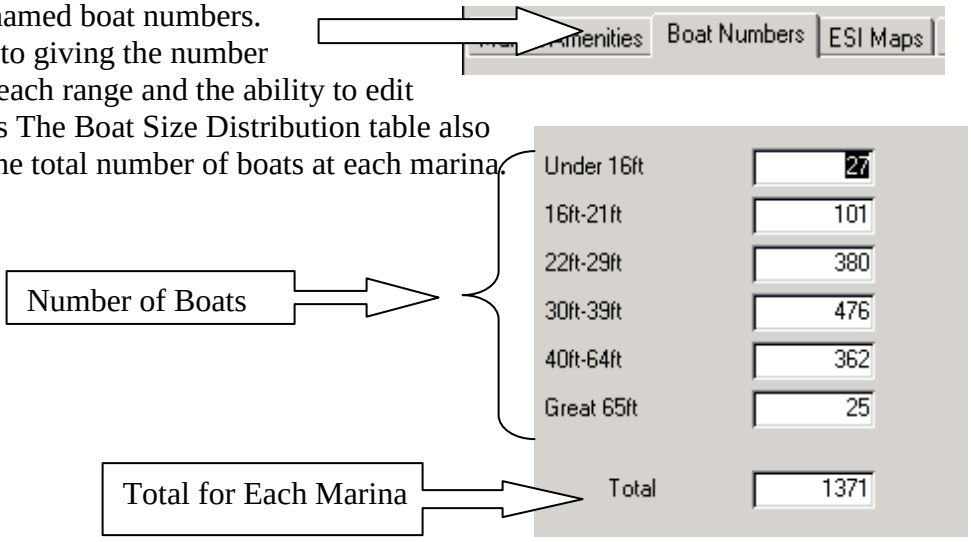
Drop Down Menu

Further Information



Boat Distribution

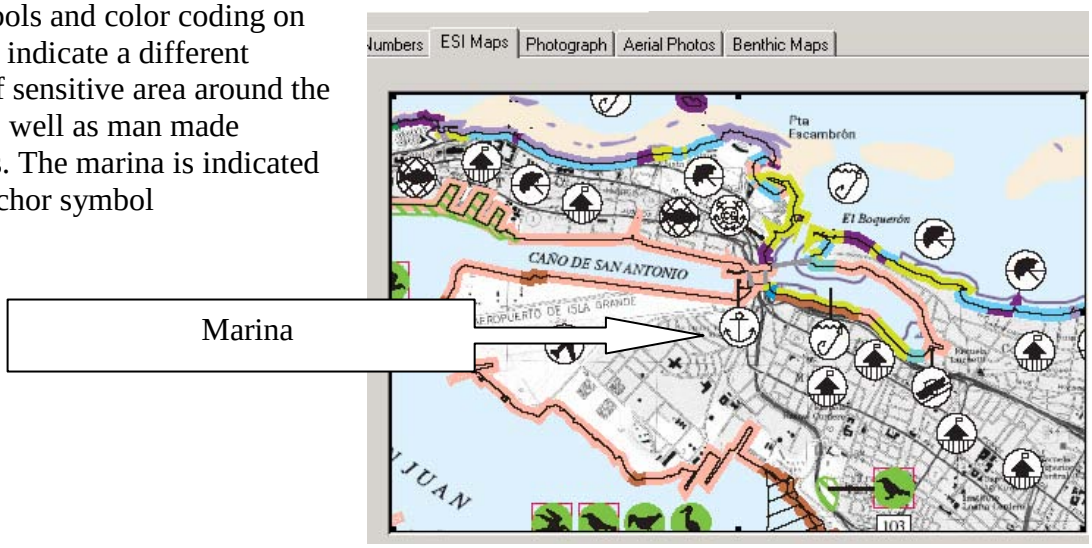
For each marina contained in the database there is a boat size distribution that displays the number of boats at each marina inside of a given size range. To access this page click on the tab named boat numbers.
In addition to giving the number of boats in each range and the ability to edit these values The Boat Size Distribution table also gives you the total number of boats at each marina.



ESI Map Page

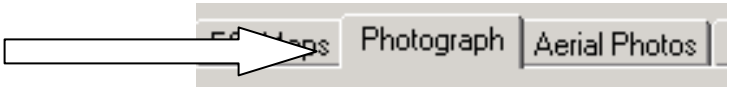
Environmental Sensitivity Index or ESI maps show the surrounding environment around each marina and can be displayed using the ESI Map Page. To view this page select the tab labeled ESI Maps.

The symbols and color coding on each map indicate a different species of sensitive area around the marina as well as man made structures. The marina is indicated by the anchor symbol



Marina Photograph Page

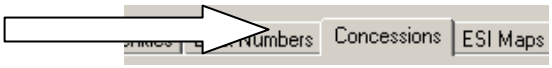
Included in each marina entry is a digital image taken at each marina. This picture can be viewed using the Marina Photograph Page. To access the Marina Photograph Page click on the tab labeled Photograph.



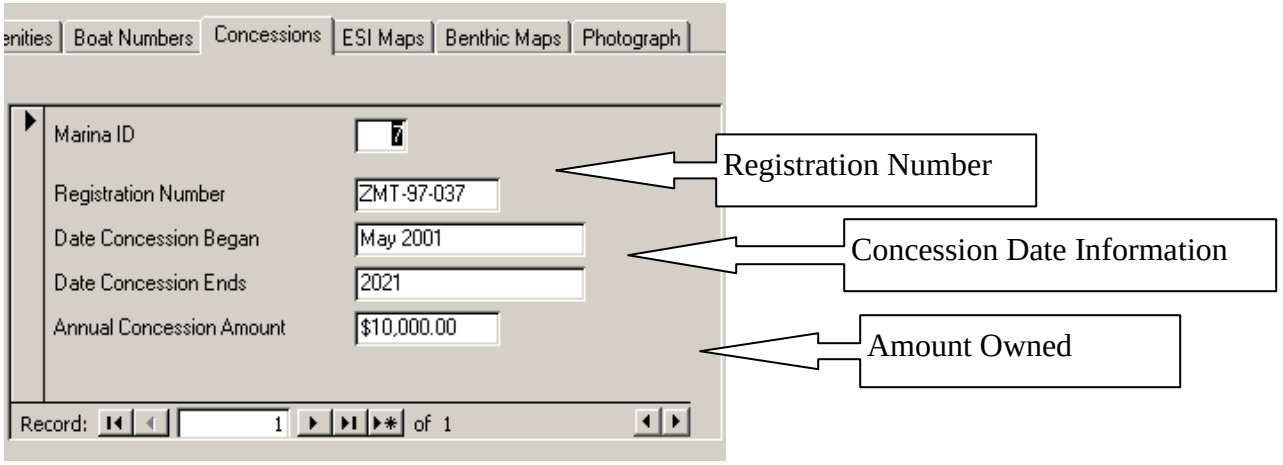
Concession Information Page

As part of the Marina Information View section we have included a section for Concession information that is collected by the CED.

To access the concession information got to the marina information view page and click on the concession tab.



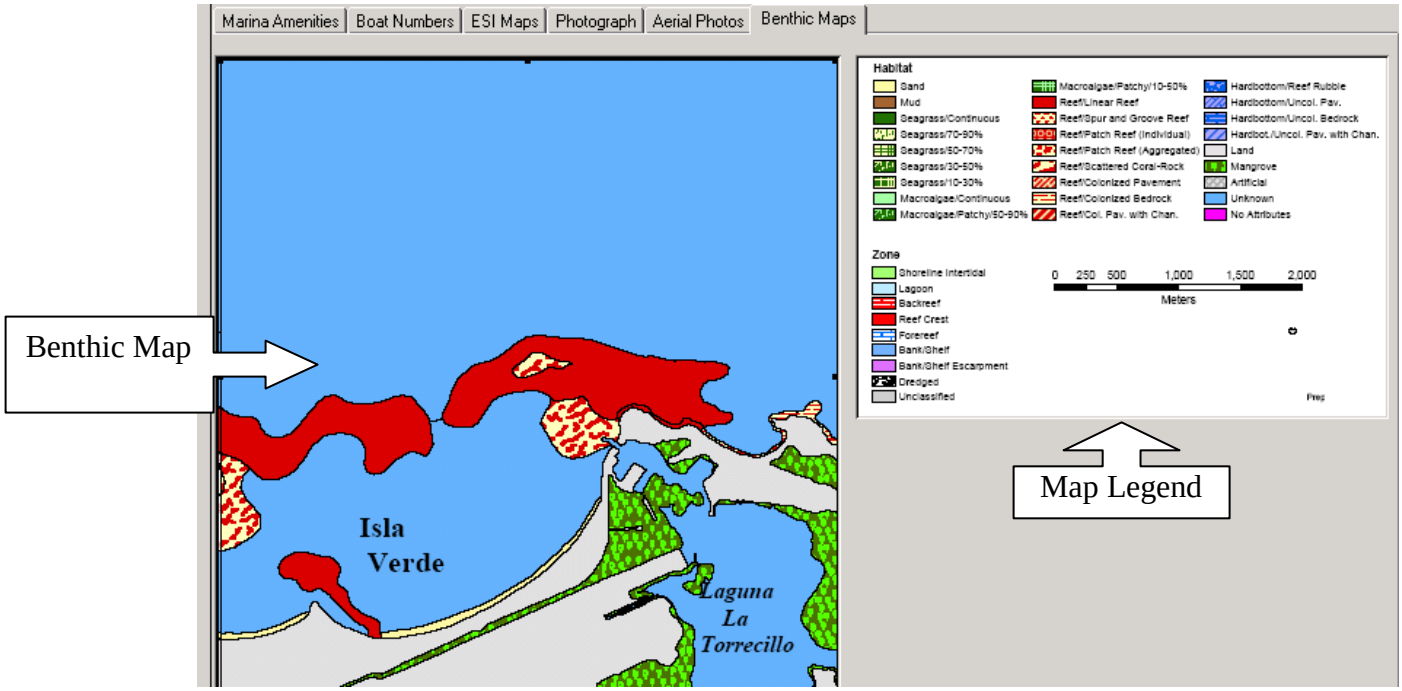
From the concession information page you can view information concerning a marinas Concession ID, the amount that a particular marina pays on a yearly basis to the DNER, the years from which that concession amount is valid for.



Benthic Map Page

Benthic Maps are used to display underwater habitats such as marina grasses or coral and have been included to display the areas surrounding the marinas in this database. These benthic maps were complied by the National Oceanic and Atmospheric Association in 1999. To view them click on the tab labeled Benthic Maps.

In addition to the benthic map a legend is also included to interpret the map.

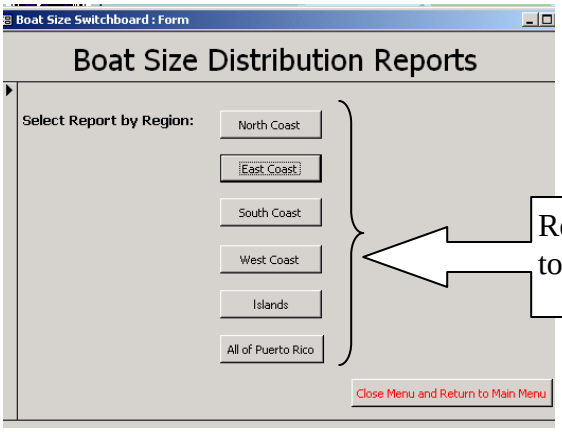


Boat Size Distribution Reports

Marina Manager gives users the ability to view a number of reports that display boat size distributions for different areas around the island. The reports page can be accessed by clicking on the Boat Size Reports button located on the main menu.

Reports Page

After clicking on the boat size distribution button you will be brought to the reports page where you can select which reports you would like to view. The reports are broken up by region: North, South, East and West Coasts, the Islands and a report can be run to view the totals for all of Puerto Rico. Click on a report button to view that report. To exit the reports click on the exit button located in the bottom right corner.



Report Buttons, Click to View Reports

Click to Exit and Return to Main Menu

Boat Size Reports by Region

The Boat Size Distribution Reports display the number of boats in each size category for each marina in a specific region and then total the entire number of boats for that category in the region and also give the total number of boats currently at the marinas in the particular region.

Puerto Rico East Coast
Recreational Vessel Total Estimated Numbers

	Vessel Length					
Marina Name	Under 16ft	16ft-21ft	22ft-29ft	30ft-39ft	40ft-64ft	Great 65ft
Isleta Marina	1	1	1	1	1	1
Sea Lovers Marina	1	0	59	44	4	0
Marina Puerto Chico	6	112	319	142	24	1
El Conquistador Resort & Marin	0	3	1	4	10	0
Marina Puerto del Rey	27	101	380	476	362	25
Palmas Del Mar Shipyard	0	7	8	4	0	0
Totals	35	224	768	671	401	27

Marina Name with Boat Totals

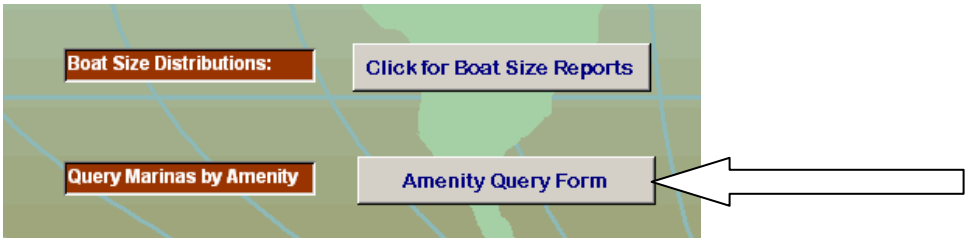
Totals for Region by Category

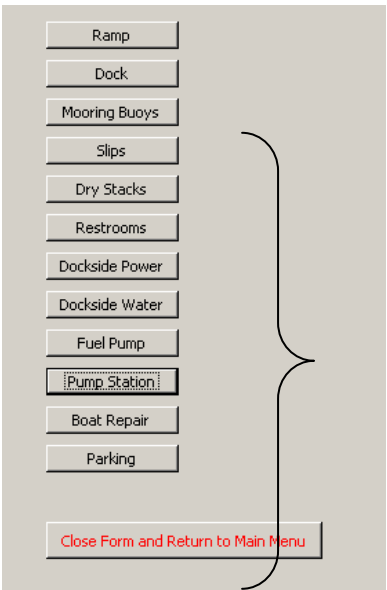
Total for Entire Region

Total Number of Boats in Region 2126

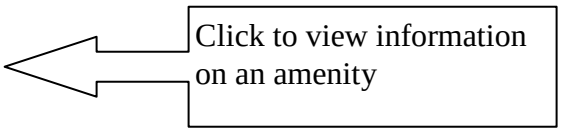
Marina Amenity Queries

The comparison of marina amenities is another important aspect of our database and this can be done through the marina amenity query section of our database. To access this section go to the main menu and click on the button labeled “Marina Query Form .



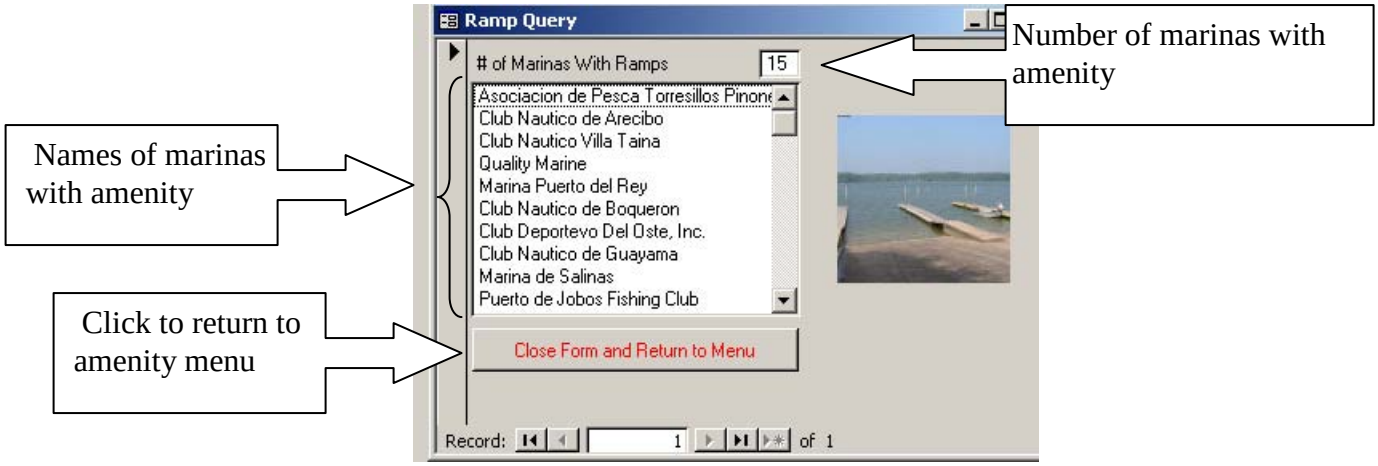


After clicking on the marina amenity query form button you will be brought to the amenity query form menu from here you can select which marina amenity you which to view information on or you can return to the main menu.



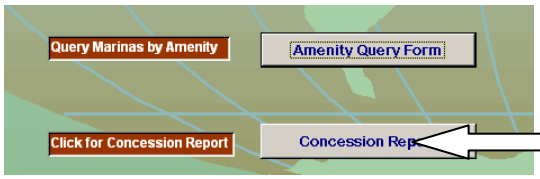
After selecting the marina amenity that you which to view information on and clicking the appropriate button you will be brought to a marina amenity query view page.

Displayed on this page is the number of marinas that have the amenity that you have chosen to view as well as a list of their names. To exit this query click on the close form button.



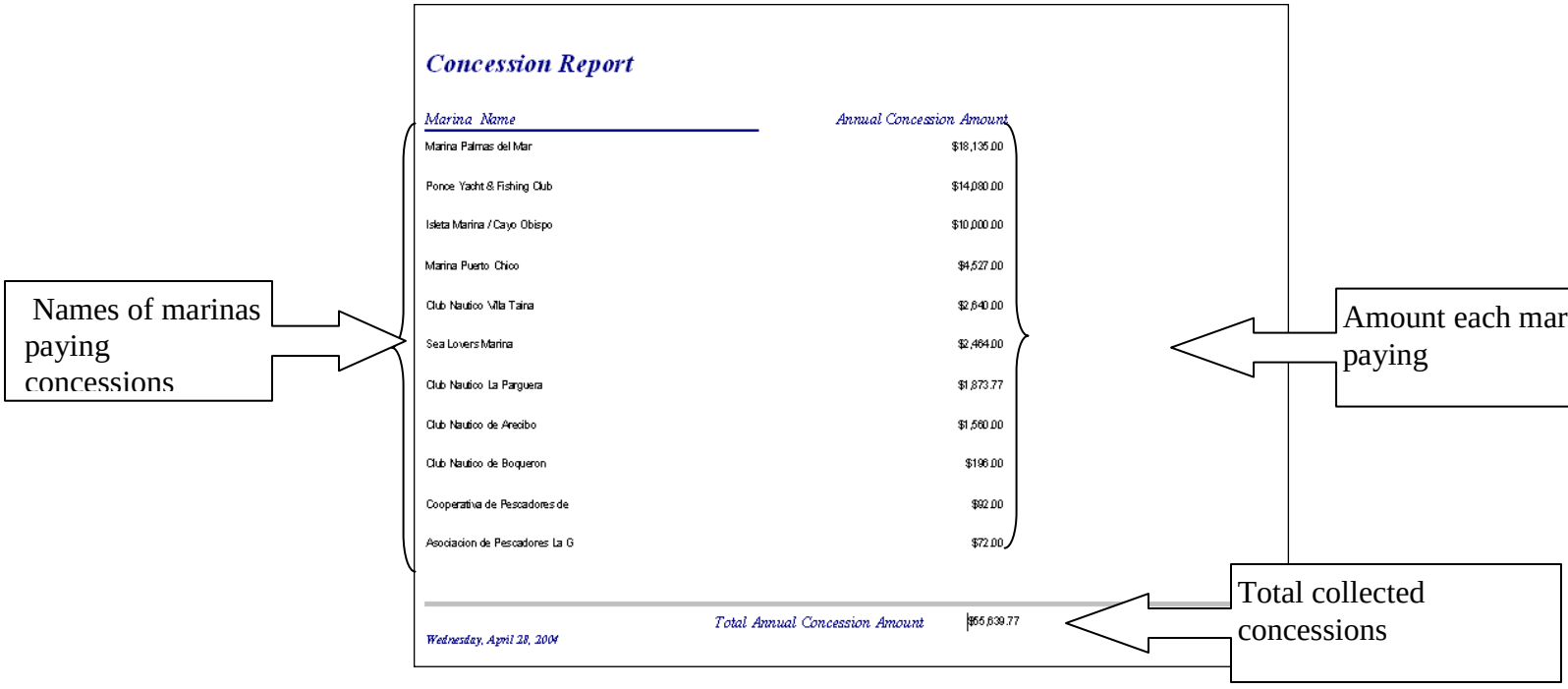
Concession Report

The concession report section of the marina manager database allows the user to view all of the marinas that are currently paying concessions, the amount which they are paying and the total revenue that is currently being collected by the DNER in recreational marina concessions.



To access the Concession report click on the concession report button located on the marina manager main menu. This will bring up the concession report page.

The concession reports page shows the user which marinas are paying concessions, how much they are paying, and the total amount of money that the DNER is currently collecting in recreational marina concessions.



In Conclusion

The marina manager database is a powerful tool for keeping track of information concerning recreational marinas around the island of Puerto Rico. The program is however only as good as the data contained within in. This information should be updated regularly to maintain the usefulness of this software.

Appendix C

Letter to Marinas

To Whom It May Concern:

Four college students from Worcester Polytechnic Institute will be performing an inventory of the marinas on the island. The goal of the Department of Natural and Environmental Resources Marine Division is to better manage the littoral and coastal resources of Puerto Rico. The purpose of this project as described below, is to assist the DNER to achieve this goal through an updated documentation of marina resources.

This project will inventory all of the current marinas and gather information about their amenities such as contact information, pumping station, gas stations, food and supplies market, etc. We will also record the exact GPS coordinates of each marina and survey ecologically sensitive areas surrounding these marinas. This information will be displayed through the creation of an island-wide GIS layer. Also showing on these maps will be the geographic location of each marina and nautical facility

We believe this information will help us understand current and future recreational boating trends. This information will also help plan for future expansion, while not disturbing the island's sensitive ecosystem.

Our inventory and research is strictly to update the inventory of all marinas on the island, to assist DNER with marine resource management.

Sincerely,

Craig Lilyestrom
Director
Marine Resources Division

Appendix D

Data Collection Sheets

Appendix in .mdb file
but password not supplied

IQP/MQP SCANNING PROJECT

George C. Gordon Library
WORCESTER POLYTECHNIC INSTITUTE