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I. Final Report Title: Bycatch Study of the Puerto Rico's Marine Commercial Fisheries

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II. Abstract.

"Bycatch Study of the Puerto Rico's Marine Commercial Fisheries" was realized in Puerto Rico from February 2004-May 2005. This is the first bycatch study of Puerto Rico's fishery. Non-commercial species, commercial species small size individuals with no market value and discarded individual of illegal sizes were considered bycatch. Bycatch captured by very common fishing gears as beach seines, trammel nets, fish traps and hand lines was collected and studied. Project results, bycatch composition, effort and recommendations to decrease the byactch capture are including in this final report.

III. Executive Summary

Bycatch is defined by the Magnuson-Stevens Act (MSA) Section 3(2) (1996) as "fish which are harvested in a fishery, but which are not sold or kept for personal use, and includes economic discards and regulatory discards. Such term does not include fish released alive under a recreational catch and release fishery management program". In this project all the bycatch consisted of the individuals discarded by the commercial fishers (returned to the sea dead or alive or kept for personal use). No reptiles, birds or marine mammals were caught during the project. During the project period commercial fishers were angry with the DNER because of the implementation of Puerto Rico Fishing Regulations #6768. Due to this fact commercial fishers were unfriendly and uncooperative with the project personnel. In spite of the mentioned problems, project personnel were able to interviewed 71 commercial fishing trips to collect the bycatch data. Six trips of beach seine were interviewed, 27 trips for trammel nets, 13 trips for fish traps and 25 trips for hand lines. Biostatistics data was collected for most of the bycatch caught. In Puerto Rico during 2003-05, a total of 10 shellfish species and 96 fish species were considered bycatch. This list includes many species that are considered important part of the commercial fishery but due to the small size or the legal size at the moment of the catch were discarded and considered bycatch.

IV. Purpose

A. Description of the Problem:

The Fisheries Research Laboratory (FRL) of the Puerto Rico Department of Natural and Environmental Resources (DNER) monitors the commercial landings of fish and shellfish in Puerto Rico. The FRL's Commercial Fisheries Statistics Program (CFSP) maintains reported services on the landings on the commercial finfish and shellfish resources of Puerto Rico. CFSP reaches his mission by collecting landings data, determine total weight of principal finfish and shellfish landed, collect CPUE data and collect and analyze biostatistics data of Puerto Rico's commercial fishery. The data collected by the CFSP shows that Puerto Rico's fishery resources has been overexploited (Matos-Caraballo, 2004).

Most of the fish landed are sold or kept for personal use; consequently there is no action to minimize bycatch. However, the CFSP data only reflects the commercial landings reported, so bycatch information is not obtained. Puerto Rico needs to know the amount of bycatch in order to do a wise management of the commercial fisheries resources.

Bycatch is a great issue in fisheries management. The Federal Government is issuing regulations to reduce bycatch mortality. Under the Magnuson Act 1996 National Standards it is emphasized that "conservation and management measures shall, to extend practicable, (a) minimize bycatch, (b) to extend bycatch cannot be avoided, minimize the mortality of such bycatch". The NOAA/NMFS Caribbean Fisheries Management Council (CFMC) mentioned in his "Sustainable Fisheries Act", that the US Caribbean needs to collect and analyzed bycatch data. The results and conclusions of this project will help NOAA/NMFS/CFMC and DNER in their mission to identify, protect and conserve the species that constitutes bycatch in the US Caribbean.

B. Project goals and objectives

This is the first bycatcth study of Puerto Rico's commercial fishery. It will serve to identify the bycatch and how diminish and/or eliminate this practice. The biological impact from the information collected by this project will improve significantly the data needed for fishery resources managers to take measures that will minimize bycatch. Fishing mortality on juveniles should be reduced, which will help managers to maintain the fishery resources in a healthy state.

The objective of this project is to describe the Puerto Rico's commercial fishery bycatch in their biological aspects. The commercial fishing gears of the Island don't discriminate between target species and those that live in close association with them. The goals of this project are:

1. Determine the magnitude of bycatch and bycatch mortality.
2. Identify bycatch composition by most used fishing gears.
3. Direct participation of commercial fishers in this project.

4. Opportunity to obtain bycatch independent data from commercial fishers that collaborated with this project. The independent data included biological fish and shellfish at species level, biostatistics data and habitat related (e.g. invertebrates).
5. Evaluated all different fishing gears in order to reduce the impacts of bycatch.
6. Recommended conservation and management measures to minimize bycatch.

V. Approach.

A. Detailed description of the work that was performed.

1. Project personnel developed a survey to interview experienced commercial fishers and collect data to estimate the bycatch for the last 30 years and if any changes have been occurred.
2. Select commercial fishers to be contracted to collaborate with the project. This participation helped to obtain independent data. These commercial fishers were contracted to work with DNER.
3. The following gears were investigated for this project to obtain the bycatch collected: fish traps, trammel nets, beach seines and hand lines.
4. Personnel of the project tried to sample 30 trips per gear, with commercial fisher collaborators to collect the independent data.
5. The following data were collected for every single fishing trip for discarded fish, shellfish, or invertebrates:
   a) Identify fishing bycatch at species level and obtain length of all individuals (fish in fork length in mm crustaceans in carapace length).
   b) Account the bycatch by number of species caught and total catch weight.
   c) Collect the biostatistics data from the commercial total landings by species and if possible collect individual weight.
   d) Collect the following fishing gear information by trip:
      <u>Fish trap</u> – number of crew, trap size, depths, mesh size, # of traps hauled, soak time (days), fishing time (hours), catch per unit effort (CPUE).
      <u>Trammel net</u> – number of crew, gear length in fathoms, height, mesh sizes, soak time (hours), and CPUE data.
      <u>Beach seine</u> – number of crew, gear length in fathoms, height, mesh sizes, soak time (hours), fishing time (hours) and CPUE data.
      <u>Hand line</u> – number of crew, fishing time, line resistance number and size of hooks size, fish time (hours), depth and CPUE.
   e) All data was enter in computers using Microsoft Access and Microsoft Excel.

f) Data was analyzed and will include bycatch composition by gear, also recommendations to reduce or eliminate the bycatch.

The major product of this research is this report that contains quantitative and qualitative information describing the bycatch in Puerto Rico and the biological and consequences that it could have. Federal and local agencies that work as fishery managers will be able to use this report as a useful tool.

B. Project management: List individuals and/or organizations actually performing the work and how it was done.

DNER Personnel

The personnel to performance this project were located at FRL, Cabo Rojo, Puerto Rico. The personnel working in the project were:

Aida Rosario- Director of the FRL. She supervised the principal investigator and provided administration support to the project. Ms. Rosario has been working in the FRL during the last 22 years. She has experience in scientific and administrative issues.

Daniel Matos-Caraballo – Principal investigator of this project. That means that he was responsible of supervising all the personnel in this project. Also, he will wrote the progress reports and final report. During the last 17 years he has been the principal investigator of Puerto Rico/NMFS CFSP.

Milagros Cartagena – Assistant biologist. She was responsible to collect data, edit data, enter the data in electronic file and help principal investigator in the preparation of progress and final report. Mrs. Cartagena has worked for the CFSP for the last 3 years.

Noemí Peña – She is an Assistant biologist. She was responsible to collect data, edit data, enter the data in electronic file and help principal investigator in the preparation of progress and final report. Mrs. Peña has worked for the CSP for the last 3 years.

DNER Rangers – Assistant biologists travel with the DNER Rangers during their patrolling around commercial fishers at fishing banks. Assistant biologists collected bycatch data from fishers on the field.

DNER Financial, Budget and Purchase Division: This division was responsible to account all salaries and other expenses of the project. Also, this division prepared and sent all the progress and final finance reports.

Other Organizations:

Commercial fishers from the community were contracted to collaborate with the project. Other commercial fishers helped to collect the data but not received financial aid from the project.

VI. Findings.

A. Actual accomplishment and findings.

1. Survey to interview experienced commercial fishers and collect data to estimate the bycatch for the last 30 years and if any changes have been occurred.

Biologist assistants visited the fishing villages of Puerto Real, Cabo Rojo; Corozo, Cabo Rojo; El Seco, Mayagüez; El Maní, Mayagüez; Tres Hermanos, Añasco; Barrero, Rincón; Estela, Rincón; Espinar, Aguada; Higuey, Aguadilla and Playuela, Aguadilla. Three experienced fishers (ten year or more as active commercials fishers) per fishing village were interviewed by the assistant biologists assistances about what was their perception about bycatch composition in the past and what is the present bycatch composition. It was amazing that all the interviewed commercial fishers mentioned that most of the bycatch is used. The non sell products were used by the fishers for their own consumption or as bait. If the fishers did not have use for the bycatch, then they gifted to a friend. The interviewed fishers mentioned that some species considered as bycatch 30 or more years ago are easily sold today as food, for example coral crabs (*Mythrax sp*), marine crabs (Brachiura), squirrelfishes (Holocentridae) and sharks (Hexanchidae). Others are sold as bait, for example, sandtilefish (*Malacanthus plumieri*), skipjack tuna (*Euthynnus pelamis*) and starfishes as *Oreaster reticulatus*. Juveniles commercial fishes caught and considered bycatch because of the size sometimes are use to bait hooks or traps.

2. Select commercial fishers to cooperate with the project.

From February –March 2004, the project personnel identify 12 commercial fishers that were willing to cooperate with the CFSP and filled all the government requirements to be contracted. Then in March 12th, 2004, Hon. Luis E. Rodríguez-Rivera, then Secretary of the DNER, announced the implementation of the Puerto Rico's Fishing Regulations #6768. The regulations include legal minimum size for several species, closed seasons for other species and other management measures to protect the overfished resources. As a result of the

fishing regulations commercial fishers became angry with the DNER. .Immediately 50% of the commercial fishers that were working to complete contract with this project quit. The other 50% never completed the documents and never cooperated with this project. Project personnel started to find ten other commercial fishers willing to participate in the project. Finally five fishers completed the documents to cooperate with the project. However, only one helped the project, with only four trips interviews. Then project personnel with the help of CFSP's port samplers and DNER rangers collect data from other fishers that not received financial aid from the Project.

3. Bycatch composition

A total of 71 commercial fishing trips were interviewed to collect the bycatch data. The number of interviews was lower than expected due to the fact that commercial fishers did not cooperate with the project as was mentioned in the previous paragraph. Project personnel were able to interview six trips of beach seine, 13 trips for fish traps, 27 trips for trammel nets and 25 trips for hand lines. Biostatistics data was collected for most of the bycatch caught.

Table 1 shows the species caught by commercial fishers that were defined as bycatch by commercial fishers in Puerto Rico during 2003-05. A total of 10 shellfish species and 96 fish species were considered bycatch. This list includes many species that are considered important part of the commercial fishery but due to the small size or the illegal size at the moment of the catch were discarded and considered bycatch.

Beach Seine

Biologist assistants visited approximately 25 times the fishing village of Espinar, Aguada and El Combate, Cabo Rojo to intercept the beach seine fishers to collect the bycatch data. Only six trips were intercepted, although one commercial fisher had a contract and he was supposed to inform project personnel when he will go out to fish, but he never did. The beach seines used by commercial fishers were 100-150 fathoms length and the seine mesh size was 0.5-2.0 inches. The beach seine operation takes approximately two hours. The crew was 3-4 fishers. However some neighbors helped to haul the beach seine just to take some fishes. This data was obtained with high difficult. Biologist assistants observed that approximately 30% of the discarded individuals caught by beach seines were returned alive to the sea. Due to the fact that this fishery occurred on the shore a bunch of neighbors were close to the beach seine and collected the other 70% of the bycatch to consume at their homes. The CFSP collected data from beach seines that confirmed that individuals of *Scomberomorus cavalla, Scomberomorus regalis* and *Caranx latus* were sold at juvenile stages.

Table 2 shows the 35 species that composed the bycatch in the beach seine activity. From the total of 401 individuals caught by beach seine, the most common were *Vomer setipinnis* with 15%, *Ocyurus chrysurus* with 14%, *Gerres cinereus* with 13%, *Scoberomorus cavalla* with 12% and *Harengula jaguana* with 10%. Table 2 also shows

the mean average size by species when n >= 10. The Beach seine was sampled at estuary ecosystem area (Espinar) and at sea grass beds and coral reef area (El Combate). Both places were hatchery areas that contain many species at juvenile stages. Both areas are frequently fished by beach seine. Beach seine caught an average of 65.8 bycatch individuals per trip. The DNER Fishing Regulations will proscribe the use of beach seine after 2007. The catch per unit effort for beach seine was 0.07 pounds/fathom/hour.

Trammel Nets

Biologist assistants visited approximately 40 times the fishing village of Corozo, Cabo Rojo to intercept the trammel nets fishers to collect the bycatch data. They were able to do 27 interviews of this gear. The trammel net fishers cooperate with the program but did not permit the presence of the project personnel during their fishing trips. On the other hand, they bring the whole catch (bycatch included) to the landings area where the data was collected. Approximately trammel net five fishing trips were interviewed with the DNER Rangers that were intercepted at open sea (8-10 miles from Cabo Rojo's coast). Trammel nets use by commercial fishers during the data collection was 200-600 fathoms length, mesh sizes were six, four in and two inches. Trammel nets fished at depths between 15-20 fathoms. Trammel net fishers have different target species, parrotfishes (Scaridae), Trunkfishes (Ostracidae) and spiny lobsters (*Panulirus argus*). Parrotfishes trammel net fishers were hostile to project personnel. Project personnel were able to intercepted parrotfish trammel net only once at the sea with the help of DNER Rangers. Each target species change a little with the fishing depth and the period of gear soak time. However, the three target groups are fished around coral reefs and sea grass beds. Fishers mentioned that the trammel nets operation started around 1:00 AM and finished one hour after the sunrise, approximately 5-6 hours. Spiny lobster and trunkfishes trammel nets soak the trammel nets during 12 hours, starting one our before sunset and finished one hour after sunrise. Most times crew size was two fishers. Project personnel observed one fisher that worked alone.

Table 3 shows bycatch composition of trammel nets that includes 30 species during this project. A total of 131 individuals were counted as bycatch. The most common species in he bycatch composition were *Haemulon plumieri* (13%), *Dasyatis americana* (13%), *Carpilus coralinus* (11%), *Diodon hystrix* (8%) and *Mythrax spinosissimus* (6%). Trammel net caught an average of 4.9 bycatch individuals per trip. The project data shows that bycatch individuals caught by trammel nets is low, although the parrotfish trammel net fishers were interviewed only once. In the near future CFSP must continue the monitory of the parrotfishes trammel nets bycatch. The catch per unit effort for trammel net was 0.05 pounds/fathom/hour.

Fish Traps

The Puerto Rico commercial fishery census 2002, mentioned that since 1996-2002, the fish traps number were reduced in 2,385 units, by approximately 15% (Matos-Caraballo, 2004). However, the same census mentioned that 13,146 traps were active in

Puerto Rico's fishery. Fish traps are expensive and frequently stolen by other fishers. Principal Investigator talked with various fish trap fishers whom make criminal accusations thru Puerto Rico's Justice Department to other peers due to the fish trap robbery. However, fish trap continue to be a very important gear in Puerto Rico's fishery. Fish trap fishers target mainly two objectives, first lobsters and trunkfishes (90% of active fish traps) and second deep water snappers (10% of active fish traps). The lobsters and trunkfishes traps fished around coral reefs and sea grasses areas. The depth range of this activity is 10-30 fathoms. The deep water snappers category is fishing at top of sea mountains at open sea, at depth range of 90-150 fathoms. In this project only lobster and trunkfish category were studied. The deep water snappers fishers did not cooperate with the project. The Puerto Rico fishing census 2002 shows that fish traps are expensive, young fishers can not afford this gear, resulting that most owners are over 50 years old (Matos-Caraballo, 2004). On the other hand fish trap fishers mentioned that many SCUBA divers stole their lobster catch underwater. The fish traps commercial fishers lift between 30-60 traps per trip. Assistant biologists with the help of CFSP's port samplers and DNER Rangers were able to interviewed 13 trips to collect bycatch data. Fish trap's crew sizes were two fishers.

Table 4 shows bycatch composition of fish traps that includes 48 species during this project. Assistant biologists counted 340 individuals as bycatch. The most common species in the fish traps bycatch composition were *Acanthurus coeruleus* (21%), *Holocentrus adscensionis* (13%), *Calamus pennatula* (6%), *Panulirus argus* caught before reach the minimum legal size of 3.5 inches (6%) and *Holocentrus rufus* (5%). It was curious the catch of juvenile nurse shark *Giglymostoma cirratum,* when his head become stocked in the fish trap's door, then fishers were able to return alive to the sea. Other fish trap fishers mentioned to the principal investigator that this incident rarely occurred since most times the shark is able to break the fish trap door and eat the catch. Fish trap fishers reported that many of the bycatch is used as bait inside the traps. Fish traps fishers mentioned that when they catch *Panulirus argus* with eggs, they keep this organism in the trap to attract larger males. CFSP port sampler reported that few fish trap fishers catch some fishes alive, for example butterflyfishes (Chaetodontidae) and angelfishes (Pomacanthidae) to sell in the ornamental fish trade. Fish trap caught an average of 27.6 bycatch individuals per trip. The catch per unit effort for fish trap was 1.5 pounds/trap/day.

Hand Lines

In the Puerto Rico commercial fishery census 2002, it was reported a total of 9,306 units, increased 2,579 more units that 1996 (Matos-Caraballo. 2004). Hand line is a very important gear in Puerto Rico. Compared with nets, traps and SCUBA gear, hand lines have the lowest cost. The target species for hand lines are coral reef fishes mainly Serranidae (mostly *Epinephelus guttatus* and *Cephalopholis fulvus*) and Lutjanidae (mostly *Ocyurus chrysurus* and *Lutjanus analis*). This fishery occurred at a depth range of 10-30 fathoms), deep water snappers Lutjanidae (80-250 fathoms), coastal pelagic species Scombridae and Coryphaenidae (2-20 fathoms). Project personnel with the help

of CFSP's port samplers and DNER Rangers were able to interviewed 25 fishing trips to collect bycatch data.

Table 5 shows bycatch composition of hand lines that includes 31 species during 2004-05. Assistant biologists counted 161 individuals as bycatch. The most common species in the hand lines bycatch composition were *Malacanhus plumieri* (22%), *Caranx crysos* (20%), *Melichthys niger* (8%), *Tylosurus crocodilus* (4%). *Mustelus norris*i (4%), and *Caranx latus* (4%). The mentioned species were used as bait or for the fisher consumption. The project results show that 6.3 bycatch individuals were caught by trip. The number of species and individuals caught by hand lines is considered low. The catch per unit effort for hand lines was 0.8 pounds/hook/hour.

4. Recommendations for conservation and management measures to minimize bycatch.

This project shows that the Puerto Rico's bycatch can be considered low in species and number of individuals. However due to the overfished resource in Puerto Rico the DNER should try to reduce the current bycatch. The following recommendations would help to reduce the bycatch and improve the fishery resources resulting in better socioeconomics conditions to commercial fishers and will help in the recovery of fishery stocks..

1. DNER and NMFS should educates all commercial fishers to return juveniles fishes caught by fishing gears alive to the sea when possible.
2. The Puerto Rico DNER Fishing Regulations 6768 eliminates the beach seine gear in 2007. This action will contribute to conserve the small sizes fishes of many species and reduce the juveniles fishing mortality.
3. Educate trammel net fishers to reduce the soak time for this gear (frequently soak time reach 12 hours). This action will reduce the juveniles fishing mortality and bycatch and the probabilities to catch sea turtles.
4. Educate fish trap fishers to return the bycatch alive to the sea. Also educate them to use as bait only the death bycatch.or adult individuals.
5. The implementation of DNER Puerto Rico Fishing Regulations 6768 will reduce the bycatch with closed seasons for some species and minimum legal sizes for other species. Effective enforcement of the mentioned regulations are urgently needed to guarantee the success of the management actions.

B. Significant problems that affected the project development.

The project was affected due to the poor cooperation from commercial fishers that were angry and hostile with the project personnel for the reason of the implementation of the DNER's Puerto Rico Fishing Regulation 6768. This poor cooperation reduces the proposed number of fishing trip interviews. However the mentioned difficulties, project personnel, CFSP's port samplers, the valuable help of

the DNER's Rangers and a few cooperative commercial fishers, project personnel were able to intercept 71 fishing trips to collect the bycatch data.

C. No need to do additional work.

The project data collected and their analysis was enough to reach the goals and objectives for this project. However, due to the fact that fishing activity is in constant change, in the near future the CFSP should identify additional funds to continue the bycatch data collection.

VII. Evaluation.

A. Description of the extent to which the project goals and objectives were attained.

The objective of this project was to describe the Puerto Rico's commercial fishery bycatch in their biological aspect. The projects objectives were reached as was described in the Findings section. The goals of this project, as to collect information about bycatch per fishing gear and commercial fishers participation were reached too. However the fisher participation was low due to problems mentioned before. Collection of biostatistics data and recommendation for conservation were made and also mentioned in the Findings section.

B. Dissemination of the project results:

Copies of the final report will be sent to DNER Secretary, to the DNER Chief of the Bureau of Fish and Wildlife and to the DNER Fishing Advisory Panel . Also copies will be sent to NOAA Caribbean Fisheries Management Council and NOAA Caribbean SEDAR. A paper will be presented and publish in the Proceedings of the 58th Gulf and Caribbean Fisheries Institute (GCFI) meeting. The mentioned proceedings are distributed in universities, marine laboratories and government agencies of USA, Mexico, Canada, Venezuela, Colombia, Belize, Jamaica, Cuba, Dominican Republic, Puerto Rico, US Virgin Island, Lesser Antilles Caribbean Countries and the GCFI world wide web site.

VIII. Literature cited.

Matos-Caraballo, Daniel. 2004. Puerto Rico/NMFS Cooperative Fisheries Statistics Program 2001-04. Department of Natural and Environmental Resources. Final Report to the National Marine Fisheries Service. 229 p.