EXECUTIVE SUMMARY

Queen conch (Strombus gigas) resources occur throughout the Caribbean Sea and in the Atlantic Ocean northward to Bermuda, but populations in certain areas are decidedly overfished and in need of management. Conch are edible marine gastropods that move inshore and aggregate along areas of the insular platform to spawn. Therefore, they are extremely vulnerable to harvest especially during the spawning season. At a recent workshop in Caracas, Venezuela, the participants filled-out questionnaires to provide landings estimates of the most recent year available (Appeldoorn, 1992b). The estimates covered a range of years (from 1988 through 1991), and represented annual landings for most of the major conch producing nations of the area. The resulting total was 4,168 metric tons or 9,169,600 lbs. The information indicated: (1) that over one-third of the catch was used solely in the Cuban bait fishery, and (2) that landings from Colombia, Mexico, and Puerto Rico all declined considerably (47-140 percent) in recent years. Cuba led the area in production and was followed in order of decreasing landings by Jamaica, Turks and Caicos Islands, Bahamas, Venezuela (all illegal), Colombia, and Belize; landings by other nations were substantially lower than 100 mt each.

To curb overfishing (defined as a population level that is below 20 percent of the unfished spawning stock biomass per recruit) of queen conch the CFMC has proposed a management program designed to reduce the mortality on spawning adults and prevent the harvest of immature individuals. The management program contains provisions for total or areal closures, but favors effort reduction as the socio-economic impacts are less severe. The program would: (1) impose a 9-inch overall minimum size limit or 3/8-inch shell-lip thickness limitation on the possession of queen conch; (2) require that all species in the management unit be landed in the shell and prohibit the sale of undersized queen conch and queen conch shells; (3) establish a bag limit of 3 queen conch/day for recreational fishers, not to exceed 12 per boat, and 150 queen conch/day for licensed commercial fishers; (4) close the harvest season from July 1 through September 30 of each year coincident with the peak spawning period; and (5) prohibit harvest of queen conch by HOOKAH gear in the EEZ to protect deep-water spawning stocks. These measures should resolve overfishing problems in the queen conch fishery and optimize production in the management area. However, if recruitment is dependent on nations in the eastern arc of the Caribbean Basin (which is highly likely) cooperative efforts by other communities will be required to effectively manage queen conch resources throughout their range. Landing conch and other species in the management unit in the shell is an enforcement tactic designed to protect immature or juvenile queen conch. Other problems in the fishery, such as insufficient data, information dissemination to educate the public, and habitat degradation will require additional efforts by both local and federal entities.

DEFINITIONS

Biomass: The amount of organisms present in a particular habitat expressed as weight. It may be used to include all living material or be restricted to a single species.

Caribbean Fishery Management Council (CFMC): One of eight regional councils established under the Magnuson Act and responsible for developing management plans for the fisheries within that portion of the U.S. exclusive economic zone (EEZ) under its jurisdiction.

Center Director: The Director, Southeast Fisheries Center, NMFS, 75 Virginia Beach Drive, Miami, Florida 33146; telephone 305-361-5761, or designee.

Commercial Fisher: An appropriately licensed person who derives income from catching and selling resources taken from inland or marine waters.

Dealer: Person who first receives by way of purchase, trade or barter, fish from a commercial fisher.

Domestic Annual Fishing Capacity (DAC): This is the total potential fishing capacity of the U.S. fleet, modified by logistic factors. The components of the concept include (a) an inventory of total potential physical capacity, defined in terms of appropriate vessel and gear characteristics (e.g., size, horsepower, hold capacity, and gear design) and (b) logistic factors determining total annual fishing capacity, (e.g., variations in vessel and gear performance, trip length between fishing locations and landing points, and weather constraints).

Domestic Annual Processing Capacity (DAPC): The capacity and extent to which United States fish processors, on an annual basis, will process that portion of such optimum yield that will be harvested by fishing vessels of the United States.

Exclusive Economic Zone (EEZ): Area adjacent to the islands of Puerto Rico and the U.S. Virgin Islands which, except where modified to accommodate international boundaries, encompasses all waters from the seaward boundary of each of the islands to a line on which each point is 200 nautical miles from the baseline from which the territorial sea of the United States is measured (Federal waters).

Executive Director: Director of the Caribbean Fishery Management Council, 268 Muñoz Rivera Ave., Suite 1108, San Juan, Puerto Rico 00918-2577, telephone, (809) 766-5926, or a designee.

Expected Domestic Annual Harvest (DAH): The domestic annual fishing capacity as modified by such factors that determine estimates of what the fleets will harvest (e.g., how fishers will respond to price changes in the subject species and other species) constitutes DAH.

Fish: Finfish, mollusks, crustaceans, and all other forms of marine animal and plant life other than marine mammals, and birds.

Fishery Management Plan (FMP): Plan and other required documents prepared by a Regional Fishery Management Council or by NMFS (if a Secretarial Plan) to manage a particular fishery in accordance with the Magnuson Act.

Fishery Management Unit (FMU): Includes all conchs of the genus Strombus, and other edible species that appear in the landings from the shoreline of Puerto Rico and the U.S. Virgin Islands to the outer limits of the EEZ (Table 1).

Fishing: Any activity, other than scientific research conducted by a research vessel, which involves:

a. The catching, taking, or harvesting of fish;
b. The attempted catching, taking, or harvesting of fish;
c. Any other activity that can be reasonably expected to result in catching, taking, or harvesting of fish; or
d. Any operations at sea in support of, or in preparation for, any activity described in paragraphs a, b, or c of this definition.

Fishing Vessel: Any vessel, boat, ship or other craft including aircraft that is used or equipped to be used for, or of a type which is used for:

a. Fishing; or
b. Aiding or assisting one or more vessels at sea in the performance of any activity related to fishing, including, but not limited to, preparation, supply, storage, refrigeration, transportation, or processing.

Gastropods: Members of the Class Gastropoda; the snails, slugs, whelks, etc., usually a univalve with a spirally coiled shell.

Growth overfishing: The harvesting of a fish stock to the point that the harvest is less than the maximum possible by weight with constant recruitment.

Incidental Catch: Catch of other than the target species; also called bycatch.

Magnuson Act (MFCMA): Magnuson Fishery Conservation and Management Act of 1976, as amended.

Maximum Sustainable Yield (MSY): The MSY from the fishery is the largest average annual yield in terms of weight of fish caught by both commercial and recreational fishers that can be taken continuously from a stock under existing environmental conditions.

Mollusk (Mollusc): Member of the Phylum Mollusca - the clams, snails, squids, and octopods; for gastropod mollusks (snails) the characteristic organ is a ventral muscular foot.

National Marine Fisheries Service (NMFS): A component of the National Oceanic and Atmospheric Administration (NOAA), Department of Commerce, responsible for conservation and management of marine fisheries.

Optimum Yield (OY): The Magnuson Act defined "optimum" with respect to the yield from a fishery as the amount of fish "(a) which will provide the greatest overall benefit to the Nation, with particular reference to food production and recreational opportunities; and (b) which is prescribed as such on the basis of the maximum sustainable yield from such fishery, as modified by any relevant economic, social or ecological factor."

Overfishing: Overfishing is a level or rate of fishing mortality that jeopardizes the long-term capacity of a stock or stock complex to produce MSY on a continuing basis.

Recreational Fisher: One who harvests marine organisms but does not sell the catch or otherwise derive economic benefit directly therefrom.

Recruitment overfishing: Harvesting of a stock to the point that reproduction by the remaining spawning stock is inadequate to produce as many fish as the habitat can support.

Regional Director: Director of the Southeast Regional Office, National Marine Fisheries Service, and voting member on the Caribbean Fishery Management Council.

Secretary: Secretary of Commerce or a designee, usually a Regional Director of the National Marine Fisheries Service.

Total Allowable Level of Foreign Fishing (TALFF): OY minus DAH establishes the surplus available for foreign fishing.

Trip: A fishing trip regardless of number of days duration that begins with departure from a dock, berth, beach, seawall or ramp and terminates with return to a dock, berth, beach, seawall, or ramp.

1.0 INTRODUCTION

As mandated by the Magnuson Fishery Conservation and Management Act (Magnuson Act), the Caribbean Fishery Management Council (CFMC) is responsible for managing marine resources in federal waters surrounding Puerto Rico and the United States Virgin Islands. Recognizing, however, that many of the most important fisheries inhabiting these insular areas occur in waters under jurisdiction of the local governments, the CFMC has long since advocated a cooperative approach to management that includes resources in state and federal waters. All Councils were initially expected to operate in this manner, but it is especially imperative for the CFMC because of the distribution of the resources. The local governments have acknowledged the CFMC as central to the development of management programs for all marine resources.

The Magnuson Act requires Councils to prepare a Fishery Management Plan (FMP) for any fishery, within its geographical area of authority, in need of management. The fishery under consideration in this FMP comprises the queen conch (Strombus gigas Linnaeus) resources of Puerto Rico and the U.S. Virgin Islands. The queen or pink conch, pronounced "konk," are edible marine mollusks (snails) that are highly esteemed as food in many regions of the world, including the Caribbean. The colorful shells also are prized by collectors and are used extensively in the jewelry trade. Unfortunately, there has been a general and widespread decline in queen conch resources through their range in the western Atlantic. While decline began prior to 1960, most authorities and fishers did not acknowledge overharvesting as the cause until the 1980's (Iversen and Jory, 1985). Conch fisheries off Florida, Cuba, and Bermuda, virtually have collapsed because of overharvest, and conch resources throughout the Caribbean are in desperate need of management. The CFMC has designed the management program contained in this FMP in response to the apparent resource decline in Puerto Rico and the U.S. Virgin Islands and to avoid stock collapse similar to those noted elsewhere.

Although at one time harvest occurred predominantly in state waters, in many areas the resource has diminished to the extent that queen conch are taken principally by SCUBA divers from deeper waters under federal jurisdiction. The management measures developed by the CFMC are designed to restore overfished conch resources.

In addition to a problem of overharvesting, there is concern regarding the growing negative impact of human activities (e.g., coastal development) on the condition of habitat important to the queen conch resources. Required habitat for juvenile conch includes among other things a delicate balance between seagrass beds and the surrounding sandy areas. The degradation of these habitats worsens the problem of overfishing since for juvenile settlement

the presence of other juveniles seems to be required (Stoner and Ray, 1993). Thus, if the adult population is overfished and juvenile habitat is threatened, a long term sustainable queen conch fishery is not possible. The CFMC throughout this FMP strongly encourages the protection and conservation of seagrass beds and areas surrounding the nursery habitats for queen conch.

Queen conch is a renewable resource. To maintain a viable fishery, and lacking the information required (e.g., effort) to obtain good estimates of maximum sustainable yield (MSY), protection of adult spawning populations and protection of juveniles to be recruited into the fishery is needed. The objectives of the Queen Conch FMP are to optimize the production of queen conch while ensuring the conservation of the resource, to reduce the adverse impacts on queen conch through the regulation of fishing effort and wasteful harvest practices (e.g., harvesting of juvenile conch), to promote through education the adoption of functional and dynamic management measures locally, to promote international cooperation in managing the queen conch resources, to identify data gaps and help generate a database needed for stock assessment and fishery evaluation (SAFE) reports, and to provide relevant recommendations to the local governments to curb habitat degradation and loss.

The management measures proposed allow for the conservative harvest of queen conch.

2.0 DESCRIPTION OF RESOURCE

The term "conch" usually refers to gastropods of the family Strombidae (genus Strombus), but is often applied to other large, usually edible, gastropods that belong to the families Melongenidae, Fasciolariidae, and Buccinidae (Darcy, 1981). In the tropical western Atlantic, conch usually refers to Strombus gigas, the queen conch, which is a staple food in many Caribbean nations. In addition to its use as food, the queen conch is an important trade item; shells and shell products are often sold as tourist items and the meat is exported to foreign markets. Because of their smaller size, other species of strombids are less important economically. However, some, such as S. costatus and S. pugilis, as well as certain other marine gastropods, also are used for food, but to a lesser extent than queen conch.

The queen conch is the most coveted of the marine gastropods, and the focal point of the management program described herein. Since other marine gastropods are occasionally marketed, they must be included in the fishery management unit (FMU) to preserve the integrity of the management program. The management program limits the harvest of

immature queen conch by imposing a minimum shell length and/or shell-lip thickness restriction, and requires conch to be landed in the shell. If the other less economically important species were not required to be landed in the shell, the meats of immature queen conch could be removed from the shell and landed as one of these other species. Applying restrictions to other species, even though they are not the focus of the management thrust, requires that they be included in the FMU.

2.1 THE FISHERY MANAGEMENT UNIT

Table 1 of this FMP contains all species in the FMU. Other species, similar to queen conch (Strombus gigas) that occur in the landings or that may in the future be in need of management have been included in the FMU. There is demand for the shells of such species as Charonia variegata (Triton's trumpet) and Cassis flammea (flame helmet) among others. Other species may be added or deleted from the FMU following the procedure established in Section 6.7.

The Council does not have sufficient information on the other species in the FMU to preclude fishing for these other species.

2.2 ABUNDANCE AND DISTRIBUTION

The queen conch is an edible marine gastropod (snail) that is attractively packaged. The beautiful shell is not only valued by collectors but is used extensively in manufacturing cameos and other forms of jewelry (e.g., FAO, 1978). The family Strombidae occurs in warm waters throughout the world, and several species of strombid snails, or conchs, are found in the western north Atlantic. From northern South America, through the Caribbean and the Bahamas, to south Florida and Bermuda (FAO, 1978; Figure 1), the queen conch was once abundant throughout its range. Now, overharvest has jeopardized the commercial viability of this highly desirable mollusk in many areas. Even before 1960 there was evidence of overharvest, and it became obvious that conch populations in the Bahamas and much of the Caribbean were struggling to sustain local market demands (Iversen and Jory, 1985).

Conch generally occur on expanses of shelf in tropical or subtropical waters from a few inches in depth up to about 250 feet. This is a limiting factor to population size in most insular areas of the Caribbean, such as Puerto Rico and the U.S. Virgin Islands, where shelf areas are narrow.

Another limiting factor to the abundance and distribution of queen conch is habitat condition, specially at the time of juvenile settlement (see Section 2.6). Unique sets of conditions are required for successful and sustained settlement in nursery grounds (Stoner et al., 1994).

The abundance of queen conch larvae could be related to physical environmental phenomena such as currents, affected by quality and quantity of food which during the critical larval period could play a role in population size (Iversen and Jory, 1985; e.g., more food, better survival). Smaller islands generally have a low rate of stream discharge compared to large islands and continental land masses with rivers carrying heavy sediment loads and concentrations of nutrients to fertilize the shelf area. Consequently, waters of the Caribbean eastern island arc are exceptionally clear with low biological productivity. The result is a low volume of phytoplankton for conch larvae to feed upon. In summation, a combination of narrow shelves, and clear waters that attract divers but are low in productivity, and habitat conditions are factors that could limit the population size of conch on insular platforms of the Caribbean (Iversen and Jory, 1985).

At least five species of strombid conchs are known to occur in the Caribbean, and are included in the FMU (FAO, 1978). Queen conch, Strombus gigas, is the largest and reaches a length of 6 to 12 inches (15-30.5 cm). The milk or harbor conch, S. costatus, (4 to 6 inches (10-15 cm)) is widely distributed throughout the Caribbean basin and ranges northward through the Bahamas to Bermuda. The milk conch and the West Indian fighting conch, S. pugilis (2-3 inches (5-7.6 cm)) are sometimes utilized as food (Reed, 1992). Other species known from the Caribbean are hawkwing conch, S. raninus, (2.5 to 3.5 inches (6.4-8.9 cm)) and the rooster conch, S. gallus, (3.5 to 5 inches (8.9-12.7 cm)) (Abbot, 1968). These species generally parallel the distribution of the queen conch and inhabit seagrass meadows and sand flats, often around patch reefs. The goliath conch, S. goliath, is the largest and rarest of the strombids. This species may reach 15 inches (38 cm) or more, but is confined to waters off Brazil. According to Darcy (1981), forms of S. gigas have been recognized by various workers, but their taxonomic status is not certain; synonymies for S. gigas were presented in Dodge (1956) and include S. g. "horridus," S. g. "canaliculatus," S. g. "verrilli," and S. g. "samba."

2.3 REPRODUCTION AND EARLY DEVELOPMENT

Queen conch generally spawn during the summer (Randall, 1964; D'Asaro, 1965; Brownell, 1977), however, in some areas reproductive activity may occur throughout the year (Blakesley, 1977; Stoner et al., 1992).

The spawning season for the queen conch extends for May and November in Puerto Rico (Appeldoorn et al., 1987) and spawning has been reported between February and November in the U.S.V.I. (Randall, 1964; Coulston et al., 1987). Peak spawning activity in the management area appears to occur from May through September. Maximum spawning in a controlled experiment conducted off La Parguera, Puerto Rico occurred during August and coincided with maximum temperatures (Appeldoorn, 1993). Migration to sandy areas and into shallower water have been reported as indications of the beginning of the spawning season in many of the areas where queen conch occur (Hesse, 1979; Weil and Laughlin, 1984; Appeldoorn, 1985; Coulston et al., 1987; Stoner et al., 1992). Queen conch aggregate during the spawning period (Appeldoorn, 1988b). This aggregating behavior in addition to the migration to shallower waters make the queen conch an easy target for fishers (both commercial and recreational). This vulnerability has rendered them susceptible to overfishing.

The reproductive behavior of queen conch has been scantly described (Randall, 1964). Sexes are separate and fertilization is internal in the queen conch and copulation can precede spawning by several weeks (D'Asaro, 1965). Spawning begins when the female has selected the proper substrate. Egg masses generally are produced in clean coral sand with low organic content (D'Asaro, 1965, Brownell and Stevely, 1981, Davis et al., 1984), although queen conch occasionally have been observed laying eggs in seagrasses (Randall, 1964). The egg mass, which consists of a long continuous tube that folds and sticks together in a compact mass, takes 24 to 36 hours to produce (Randall, 1964; D'Asaro, 1965). Females cover the egg mass with sand grains that adhere to the sticky mass providing camouflage and discouraging predation. Estimates of the number of eggs contained in an egg mass range from 310,000 to 750,000 (Robertson, 1959; Randall, 1964; D'Asaro, 1965; Weil and Laughlin, 1984; Berg and Olsen, 1989; Appeldoorn, 1993). This highly variable range in eggs per mass was derived for egg masses collected in the wild and egg masses spawned in experimental enclosures stocked at various densities. The number of egg masses produced per female is also highly variable. Most reports in the literature are from controlled experiments in which enclosures were constructed in natural spawning sites and then stocked at different densities. The total number of egg masses produced varies between 1 and 25 per female per season for experiments performed in different areas throughout the queen conch range (Davis and Hesse, 1983; Weil and Laughlin, 1984; Davis et al., 1984; Berg and Olsen, 1989; Appeldoorn, 1993). Females commonly spawn 6-8 times per season. Differences can be attributed to spawning site selection, stocking densities, food selection and availability, among others.

Production of egg masses has been correlated to temperature and weather conditions. Maximum number of egg masses occurred when the highest temperatures and longest photoperiods were recorded; stormy weather decreases egg laying activity (Davis et al.,

1984; Stoner et al., 1992). This results in potentially reduced recruitment to the adult population.

After an incubation period of about 5 days, the larvae emerge and immediately assume a pelagic lifestyle, feeding on small phytoplankters (D'Asaro, 1965). The larvae, called veligers, have two minute ciliated lobes used to propel them near the surface. The veligers continue to add velar lobes to sustain them in the upper water column as they grow. Larvae spend between 18 and 40 days in the water column before settlement and metamorphosis (Chaplin and Sandt, 1992, Davis and Dalton, 1991). In general, larval development can be extremely slow if the appropriate food supply is not available (Brownell, 1977). Under proper conditions, the veligers, settle to the bottom 17 to 22 days after hatching, although they continue to feed on plankton.

Most if not all of the information available regarding any aspect of the life of queen conch larvae (veligers) has been derived from laboratory and hatchery work. In culture, metamorphosis is complete (the proboscis develops and the velar lobes disappear) 28 to 33 days after hatching, but it might be completed faster in the field (Davis, 1994). The young conch develops a small white shell and is known as a "creeker."

Conch larvae control their position in the water column near the surface during the day. A greater number of larvae are found during the day than at night (Chaplin and Sandt, 1992). In order to understand recruitment, information is needed on the abundance, distribution and ecology of larvae. The information available still does not make it clear if most recruitment to specific areas is local or of a remote origin. A case can be made for local recruitment since laboratory reared larvae in controlled experiments have been shown to be competent for only 6 days. However, information is lacking regarding the physical environment (e.g., currents and water circulation) surrounding the larvae (i.e., in 6 days larvae can be transported a long distance depending on the current). Posada and Appeldoorn (1994) conclude that although larvae are found far offshore, the majority of the larvae are retained locally (i.e., within the area where they are spawned). Davis et al. (1993) reported that queen conch veligers "could be transported 43 km per day (26 miles) or 900 km (540 miles) during the 3 week larval period."

Little is known about juveniles in the wild. Juveniles are found buried in the sediment, the burial depth changing with size. For example, conch 35-54 mm are found buried 3-4 cm in the sand. Predation is very high at this early stage (e.g., 50% survival reported by Sandt and Stoner, 1993; see Section 2.8). Information is available from laboratory and hatchery reared juveniles that includes a complete description of development, growth, and stocking densities. Field releases of juvenile conch reared in the laboratory have not been as successful as expected.

Important juvenile life history factors for which information is needed include: habitat conditions for settlement and metamorphosis; relationship between temperature and feeding; abundance and distribution of smaller sizes in the wild (i.e., 50-60 mm); and the effect of currents (surface to bottom) and water circulation on the distribution of larvae.

2.4 GROWTH AND MATURATION

Growth in queen conch is deterministic. Queen conch grow in shell length until the onset of sexual maturity at which time it starts building the flaring lip. Growth is then in shell-lip thickness. This change in growth explains why most studies on queen conch growth are for juveniles. Average growth rates of young queen conch (ages 1-3) have been calculated for Puerto Rico (Appeldoorn, 1990), Venezuela (Brownell, 1977), St. John, U.S.V.I. (Berg, 1976; Brownell et al., 1977), and Cuba (Alcolado, 1976) using size frequency distributions, von Bertalanffy growth curve analyses, and mark-recapture studies. Estimates of mean length (tip of spire to distal end), summarized from the studies cited above, range from 7.6 to 10.8 cm (3.0 to 4.3 inches) for conch one year of age, from 12.6 to 17.0 cm (5.0 to 6.7 inches) for conch two years of age, and from 18.0 to 20.5 cm (7.1 to 8.1 inches) at the end of three years. Berg (1976) estimated that at an age of 2.5 to 3.0 years the conch stops building the shell in a spiral fashion and starts building the flaring lip. Sexual maturity is reached after the flaring lip is well developed at an age of 3.0 - 3.6 years (Berg, 1976; Appeldoorn, 1988a). However, age at maturity can be highly variable. A complete lip can be formed in queen conch in less than 3 months, during this time queen conch also continue to grow in shell length (Appeldoorn, 1988a). Determination of the age-lip- thickness relationship is from tag-recapture studies conducted in La Parguera (Appeldoorn, 1988a). For conch in the vicinity of La Parguera, Puerto Rico, 100 percent maturation was not attained until over one year after the onset of lip formation; or at approximately 4.0 years of age (Appeldoorn, 1993).

Berg (1976) estimated that queen conch reach an acceptable market size at 17.8 cm (7.0 inches) or at an age of about 2.5 years. At 7 inches mean length queen conch yield about 100 g (3.5 ounces) of meat. Unfortunately, marketable size is reached well in advance of sexual maturity (Hesse, 1975; Berg, 1976; Appeldoorn, 1988b).

The variability of growth and maturation among areas has been attributed to environmental factors, among them the amount and quality of the food present (Alcolado, 1976). The onset of sexual maturity has been reported to range between ages of 2.3 and 4+ years (Appeldoorn, 1990). In Puerto Rico the onset of maturity has been reported at an average age of 3.2 years (Appeldoorn, 1988b) and in St. John, U.S.V.I. at 3 years (Berg, 1976; Randall, 1964).

Studies estimating the life span of queen conch report ages between 7 to 12 years (Berg, 1976; Wefer and Killingley, 1980; Coulston et al., 1987). Recently it has been reported that queen conch can live upwards of 20 years (as cited in Appeldoorn, 1994) and "may survive as adults for 40 years (Berg et al., 1992 cited in Berg and Glazer, in press).

2.5 MOVEMENT AND MIGRATION

Although veligers maintain their position in the upper water column where they feed upon phytoplankton, their ultimate distribution is largely determined by currents that transport the larvae. Since two to three weeks are required for the larvae to settle to the bottom, they may be transported a considerable distance from the locus where the eggs were hatched. Therefore, eggs hatched off Puerto Rico and the U.S. Virgin Islands may supply conch to areas located downstream, such as Haiti, Dominican Republic, and Cuba. Conversely, islands situated upstream in the Caribbean arc may provide the source for most conch settling in Puerto Rico and the U.S. Virgin Islands. To the extent that larval transport occurs, pan-Caribbean efforts would be required to effectively manage queen conch resources. For example, spawning season closures would have little impact upon the resource in the immediate management area unless that population were dependent upon local recruitment to some degree. The importance of local recruitment versus remote recruitment for the queen conch fishery is still unknown. Fortunately, spawning area closures are a widely deployed management tactic in most areas of the Caribbean, therefore, any adverse effects as a result of larval drift are largely canceled.

Movement of conch after metamorphosis occurs but it is rather limited when compared to its planktonic life stages. Benthic movement is progressively greater with increasing size. The first year of life is spent buried in sand emerging at 50-70 mm mean length (Iversen et al., 1986). Mass emergence and migration of juveniles have been documented in the Bahamas (e.g., Stoner et al., 1988). Migration is from sandy areas to sea grass beds. Aggregations of juveniles (average size was 101 mm) of over 100,000 individuals have been reported in the Bahamas (Stoner et al., 1988). These juveniles migrate in the direction of the ebb tidal current at a rate of 4.8 m/day. Stoner et al. (1988) hypothesized that the emergence of juveniles from sandy habitats and the migration onto seagrass beds is an ontogenetic shift of habitat. The areas where queen conch settle are rather specific and are areas where settlement occurs year after year. There are some of these areas (e.g., El Negro on the West Coast of Puerto Rico) that have a sustained juvenile population whereas other known nursery areas are no longer viable (e.g., La Parguera, R.S. Appeldoorn, pers. comm.). If the requirements for settlement are very specific, yet not well understood, and the habitats that meet these criteria are being destroyed, there will be no recruitment to the adult

population. The consequence in the long term would be a complete collapse of the fishery (See Section 2.6).

Movement in adult queen conch has also been documented. All strombids, including the queen conch, have a unique form of locomotion (Parker, 1922). The conch thrusts its foot against the substrate, causing the shell to be lifted and thrown forward; whereas most gastropods glide along by muscular waves of the foot, leaving a slime trail that allows predators to track them. The characteristic movement of the conch does not result in a clear trail for predators to follow and may have adaptive significance (Berg, 1975) (see Section 2.8).

In the Virgin Islands, Randall (1964) found that tagged juveniles moved a maximum distance of 12.2 m (40 ft) from the point of release after 24 hours; most had moved only a few feet. After two months at large, the maximum distance reported was 29 m (95 ft) for juveniles from the point of release.

Hesse (1976, 1979) found that tagged adults moved up to 2 km (6,562 ft) in as little as two months, and commonly moved a linear distance of 50 to 100 m (164 to 328 ft) a day. Randall (1964) also estimated a "home range" (area over which a conch habitually traveled when not involved in seasonal migration) for different size classes. Juveniles 10 to 13 cm (3.9 to 5.1 inches) in length usually remain within an area of 1,000 m^2, while conchs 13 to 16 cm (5.1 to 6.3 inches) exhibited ranges from 2,500 to 5,000 m^2. Conchs over 17 cm (6.7 inches and more) moved out of the survey area so frequently that meaningful "home ranges" could not be determined. In larger conch, a low percentage of tag returns was related to more extensive movement.

Migrations of queen conch to deeper waters as they grow in size and age have been documented (Randall, 1964; Hesse, 1979; Weil and Laughlin, 1984; Stoner et al., 1988). Seasonal migrations of adults from deeper to shallower waters, in summer, during the reproductive period and to deeper waters in winter have also been documented (Robertson, 1959; Randall, 1964; Hesse, 1979; Weil and Laughlin, 1984; Appeldoorn, 1985; Coulston et al., 1987). Temperature and photoperiod have been correlated with seasonal migrations of the queen conch (See Section 2.3). Emigration out of the sandy summer spawning grounds to the hardground winter habitats has been correlated with photoperiod (Stoner et al., 1988).

2.6 HABITAT

Queen conch commonly occur on sandy bottoms that support the growth of seagrasses, primarily turtle grass (Thalassia testudinum), manatee grass (Syringodium filiforme), shoal grass (Halodule wrightii), and epiphytic algae upon which they feed (Randall, 1964). They also occur on gravel, coral rubble, smooth hard coral or beach rock bottoms and sandy algal

beds. They are generally restricted to waters where light can penetrate to a depth sufficient for plant growth. Queen conch are often found in sandy spurs that cut into offshore reefs. Since conch share habitat with the reef fish and coral reef resources that are already under management, the reader is referred to those FMPs for a more complete description of habitat.

Queen conch larvae require certain substrate conditions to metamorphose and settle to the bottom. Habitat condition at this stage seems critical although the requirements are largely unknown. In laboratory experiments, it has been shown that larvae are competent (i.e., have the ability to metamorphose) for 6 days. If the appropriate settling habitat is not found during that time period, larvae die. Juvenile conch are found in sandy areas and seagrass beds (Randall, 1964; Sandt and Stoner, 1993). Still, very little is known about the size distribution of conch in relation to specific habitat requirements.

In the Bahamas, Stoner et al. (1994) found that areas of strong tidal circulation contain a higher number of juveniles. "The occurrence of sandbars, where larval settlement may occur, adjacent to seagrass meadows as nursery areas is potentially significant" at least in Lee Stocking Island (Stoner et al., 1994). Stoner and Waite (1990) suggested that seagrass biomass, as well as sea grass shoot density were critical features in these nursery habitats. However, areas with optimal sea grass biomass did not contain the populations of conch expected. A possible explanation is the lack of adequate numbers of larvae available for recruitment to prime settlement grounds. It also may be speculated that other more important aspects of the habitat needed for settlement were absent. Among these, are the overall condition of the habitat (e.g., increased sedimentation, sediment size and type, water quality, etc.), the availability of a required food, and the number of juveniles already present in the area. Davis and Stoner (1994) showed that for laboratory cultured conch, larvae metamorphose in response to algae, epiphytes and sediments found in natural nursery grounds. However, they reported that no conch metamorphosed when exposed to conspecifics.

Conch are more active or at least are found on the surface at night (Randall, 1964; Sandt and Stoner, 1993). Sandt and Stoner (1993) hypothesized that juveniles less than 30 mm are buried all the time, surfacing as they approach one year of age. Juveniles migrate from sandy areas to seagrass beds when they reach 35-54 mm mean length. This migration seems to be related to changes in food quality and quantity. Ontogenetic shifts in habitat by juvenile conch may be a function of size specific differences in mortality, habitat requirements and food preferences.

Not knowing the specifics of the habitat requirements for the settlement of queen conch makes it difficult to make recommendations. Of importance are: 1) the conservation and/or restoration of habitat where historically queen conch prospered and 2) the identification of juvenile habitat (as per Stoner's et al. (1994) work in the Bahamas) in Puerto Rico and the U.S.V.I.

2.7 FOOD

The queen conch is one of the largest of the herbivorous gastropods, and uses its highly extendable proboscis to graze algae and seagrasses (Yonge, 1932). In general, Randall (1964) found that the dominant plants within the community where conchs occur tend to be the principal foods. Although seagrasses, such as Thalassia and Halophila, are consumed to a certain extent, various species of algae appear to be the main components of the diet of S. gigas. Robertson (1961) observed conchs grazing on epiphytic algae on Thalassia, but did not find leaves of Thalassia in stomach samples. He noted that algae of the genera Cladophora, Hypnea, and Polysiphonia, in particular, were ingested. Conch accidentally may ingest considerable quantities of sand and small benthic animals while feeding on filamentous and unicellular algae. Feeding during the night was reported by Randall (1964). Immature conch, in particular, tend to feed most actively at night, often spending most or all of the day buried in the sand.

2.8 PREDATION

As a general rule, mortality rate in most animals decreases as the adult stage is approached, and there is no reason to suggest that the case is any different with queen conch. The larvae of queen conch likely are preyed upon heavily while they swim or drift near the surface; however, there is no information available on larval mortality rates. The mortality rate during the pelagic larval stage, therefore is assumed to be extremely high and is attributed to a combination of environmental conditions and predation by plankton-feeding organisms.

According to Stoner (1992) early post-metamorphic mortality also remains an unknown in the life history of queen conch, but it is believed to be substantial. Small predators, such as nereid and glyceride polychaetes, readily consume 1-2 mm conch, and dredge samples contain numerous shells apparently broken by crab chelae. Small xanthid crabs are suspect, because as many as 300/m^2 have been found in certain seagrass habitats.

Randall (1964) reported 22 species of animals with remains of conch in their stomachs, or that were observed feeding on queen conch. Three (3) were other gastropods: Fasciolaria tulipa, Pleuroploca gigantea, and Murex pomum. The latter was seen feeding on freshly dead conchs, but may not have killed them. Two (2) of the predators were crustaceans; the hermit crab (Petrochirus diogenes) and the spiny lobster (Panulirus argus). Conchs were found in the stomachs of fifteen (15) different fishes, of which the most significant was the spotted eagle ray, Aetobatis narinari (the stomach of one 118 pound ray contained 40 half-grown queen conch and no fragments of shell or opercula). Four of the fishes, permit, Trachinotus falcatus; hogfish, Lachnolaimus maximus; queen triggerfish, Balistes vetula; and porcupine fish, Diodon hystrix, are known to feed in part by crushing mollusks. Eight of the

fishes (groupers, snappers, and grunts) do not have dentition suitable for crushing large shells and may have obtained their meals of queen conch after some other predator made their soft parts available. The loggerhead turtle, Caretta caretta, was the only animal found that was capable of crushing adult queen conch for food.

Hesse (1975) indicated that octopus and perhaps nurse sharks also prey upon queen conch. Once queen conchs are fully mature, the number of predators is reduced and probably includes rays, large hermit crabs, certain sharks, and sea turtles (particularly loggerheads) and possibly large octopi. Long before maturity (perhaps starting at a length of about 12 cm, or 4.7 inches) the most dangerous queen conch predator is man (Brownell and Stevely, 1981).

3.0 DESCRIPTION OF FISHERY

3.1 HISTORY OF EXPLOITATION

The queen conch ranks second only to spiny lobster in terms of export value of Caribbean fishery products, and second only to a variety of finfish (primarily reef fish) in terms of local consumption. Its importance as a source of protein has been recognized since the area was first settled. Archeological evidence indicates that queen conch constituted an important food for the Indians that frequented the area long before the discovery of the New World (Stevely, 1979).

According to Stevely (1979), sailing sloops 20 to 35 feet in length historically were used for transportation to and from the fishing grounds. The sloops would sail to prime fishing areas where several men were deployed in small dinghies to fish. The fishers would scan the bottom through a glass-bottomed bucket until a conch was spotted. A long pole was then used to hook the conch and bring it to the surface. Fishing grounds generally were located about a one-day sail away, and trips usually ranged from 3 to 5 days in duration. Conchs were kept in corrals or in live-wells aboard the sloop after being tied in bunches of four to seven with palm strands laced through a hole knocked in the lip of the shell. The meat was removed from the shell while sailing to port; sometimes they were taken to market in the shell.

Currently, small outboard motorboats have become popular for reaching the increasingly distant conch fishing grounds; however, sailing vessels are still used in some areas of the Caribbean because of the added expense of the engine. Despite increasing prices for conch, the profit margin remains low as fuel consumption and other expenses continue to rise with diminishing resources.

Most fishers today are divers. Free-diving, using a face mask and fins, became popular after World War II; however, many fishers have since converted to SCUBA to pursue diminishing conch resources in waters up to 40 or more meters in depth. Gear used by SCUBA divers consists of standard underwater equipment, such as air tanks, watches for measuring time and depth, fins, and face mask (Valdés-Pizzini, 1992).

Generally, divers work alone or in pairs consisting of a diver and pilot for the vessel. In Puerto Real, Puerto Rico, the diver is usually the owner of the vessel, and the SCUBA equipment; the pilot is usually employed by the diver. The pilot is responsible for navigation, locating the fishing grounds, hauling the catch, and protecting the diver. The diver is responsible for conduct of fishing operations. Multiple gears (spearguns, gaffs, and hook and line) are frequently deployed on the same trip. Divers generally use their hands for capturing conchs and lobsters, gaffs for octopi, and spearguns for reef fishes. When capturing lobsters or conchs, the diver places them in a mesh sack tied to the vessel. When the sack is filled, the diver and pilot haul it aboard.

Nearly all present-day fishers remove the conch from the shell in the proximity of the fishing grounds. This allows more meat to be carried to market, and at a greater speed. This practice will be prohibited under the management program for Puerto Rico and the U.S. Virgin Islands as it creates an enforcement loophole. In Puerto Rico, 85% of the divers employ multiple gear on a trip. On average, divers fish about 5 days per week; however, since multiple gear is used, all trips are not devoted to diving for conch. Decompression sickness (bends) is becoming increasingly more prevalent as divers are fishing deeper waters. González Román (1991) reported that ten (10) out of 37 diving accidents have resulted in the commercial fisher being paralyzed. A more complete description of the sociological structure of the conch fishery was prepared by Dr. Manuel Valdés-Pizzini for the CFMC, and is appended to the FMP to aid in assessing the impacts of the management program (Appendix 1).

3.2 PROCESSING AND MARKETING

The meat of the conch is removed by knocking or cutting a small elongated hole between the third and fourth whorls of the spire. A narrow sharp blade is inserted and the animal is cut free by severing its attachment musculature and removed by hand with a twisting motion. The viscera and other soft parts are removed from the muscular foot, which is utilized as food. The tough dark skin is often peeled from the foot leaving only the muscular white meat. The waste is sometimes used as bait for fish traps (Brownell and Stevely, 1981).

In the early days, most conch were sun-dried or salt-dried aboard the sloop mainly for interinsular or pan-Caribbean transport. After drying, conch could be kept for five or six weeks without danger of spoilage (Stevely, 1979; Brownell and Stevely, 1981). Most of the dried meats were shipped to Haiti in the late 1800's principally from fisheries in the Turks and Caicos Islands (Doran, 1958). Following World War II, trade in dried conch began to decline as effort shifted towards the newly developed and more profitable spiny lobster industry. By the early 1970's, however, the conch industry was revived as technology in frozen products became more advanced. Frozen conch meat is usually shipped by air, although some is transported by lobster carrier boats or cargo ships. Most of the frozen product is shipped to the United States and enters the country primarily through Miami, Florida (Brownell and Stevely, 1981). Accessible stocks were rapidly depleted and, ironically, in 1979 the Turks and Caicos Islands issued a set of postage stamps commemorating endangered species; the queen conch was depicted on the 25 cent denomination.

The resurgence of the conch industry followed the migration of large numbers of Caribbean residents to the United States in the late 1960's. Burgeoning populations and tourism also increased demand in countries that traditionally consumed queen conch. These factors have combined to place added stress on a resource that in all likelihood has been overexploited throughout much of its range.

Part of the decrease of this dwindling resource may be attributed to the high ornamental value of the brightly colored shell, which is extremely popular with tourists, collectors, and jewelers. In the past, the shell was pulverized into lime for use in mortar and in the manufacture of porcelain (Boss, 1969). If the attractive shell is to be utilized in the tourist industry, however, the animal is usually removed by freezing rather than by the conventional method.

Occasionally, pearls are found in the mantle of the queen conch, and are formed in the same way that an oyster develops a pearl (Brownell and Stevely, 1981). An irritating particle becomes lodged between the animal and its shell causing the secretion of shell-building material around the particle, forming a pearl. Although conch pearls have some value in the jewelry trade, demand is limited since they fade with age.

3.3 CURRENT STATUS OF THE FISHERY

Once abundant throughout the Caribbean, queen conch have been fished to such low levels in many localities that a viable fishery no longer exists (Brownell, 1978; Brownell and Stevely, 1981; Appeldoorn, 1991a and 1992b; Appeldoorn and Meyers, 1993; and many

others). This is especially the case in nations where the fishery has been exploited by SCUBA diving. Because of overfishing, queen conch have been afforded "protected" status in Bermuda and Florida and the fishery has been closed for varying periods in Bonaire, Cuba (Berg and Olsen, 1989) and Venezuela. The fishery was also closed for 5 years off St. Thomas and St. John in the U.S. Virgin Islands. Regulations, such as size limits, catch quotas, closed seasons, closed areas, and gear restrictions have been employed by other nations.

According to Brownell (1978) and Appeldoorn and Meyers (1993) among others, conch production throughout the Caribbean has declined severely in recent years. Intense overfishing in all countries endowed with this resource has led to such depletion that conch populations in many areas are incapable of recuperating naturally, even if fishing were curtailed completely. Some grounds in Belize, Turks and Caicos, Bahamas, and Venezuela, which are far from human settlements, still do not appear overfished, but effective management and enforcement programs must be instituted immediately for continued production of a sustainable yield.

According to Appeldoorn (1992a), the queen conch was listed in Appendix II of the Convention on International Trade of Endangered Species (CITES) in March 1992. Appendix II lists species that are not threatened presently with extinction, but may become so unless trade of such species is subjected to strict regulation to avoid utilization incompatible with their survival. Trade in a listed species is allowed only under permit, and only if such export will not threaten its survival. Queen conch also have been included under Appendix III of the Specially Protected Areas and Wildlife (SPAW) protocol of the Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region. Species in Appendix III are considered in need of management for sustainable use, and member nations are obligated to enact such management. Relevant SPAW members include Antigua and Barbuda, Cuba, France, Great Britain, Jamaica, Mexico, Netherlands, United States, and Venezuela.

A survey of queen conch populations near Lee Stocking Island, Exuma Cays, Bahamas, showed that 74 percent of all adults occurred on the narrow island shelf, adjacent to Exuma Sound, in 10 to 18 m of water well within the range of SCUBA divers. None were found deeper than 25 m, and relatively few adults were found in waters less than 10 m in depth (Stoner and Schwarte, 1994). Since adult conch are no longer common in nearshore waters, because of pollution and more sophisticated fishing techniques, it becomes increasingly important to identify and protect critical inshore nursery habitat. In unfished areas of Isla Los Roques, Venezuela, Weil and Laughlin (1984) found that density of queen conch was greatest in 4 m of water and decreased with depth to 18 m. This likely represents the natural

distribution of queen conch in a relatively undisturbed area. At depths of 4 m in areas not protected from fishing, densities were 5 times less than in protected areas. According to Stoner and Schwarte (1994), Torres-Rosado also reported maximum densities of adult queen conch between 10 and 20 m in Puerto Rico (La Parguera) where fishing effort is heavy in shallow waters.

In summary, adult queen conch have been displaced from shallow waters in areas where fishing intensity is high. In many areas of the Caribbean, this has occurred so extensively that adult conch now reside only in offshore waters - a consideration in devising an effort reduction management program for queen conch.

Trends in queen conch landings since the early 1980's generally indicate decreased abundance in both Puerto Rico and the U.S. Virgin Islands (Tables 2 and 3). In Puerto Rico, landings have declined from slightly over 400,000 pounds in 1983 to 100,000 pounds per year in 1992. West coast landings generally account for more than one-half of the total harvest of finfish and shellfish off Puerto Rico and may be attributed to the more extensive shelf area along that coast (Collazo and Calderón, 1988). Landings appear to be greater in May and August than in other months (Table 4). In their overview of Puerto Rico's fishery statistics for 1988 and 1989, Matos and Sadovy (1990), remarked that diving accounted for 19 percent and 13 percent of the total harvest in 1988 and 1989, respectively, largely through the use of SCUBA. Major changes in production by gear have occurred since 1978. The production from fish traps has decreased sharply, and the use of fishing lines, gillnets, and trammel nets has increased. There is particular concern that the use of beach seines is increasing in mangrove areas and grass beds, where they remove the juveniles of many species of fish and shellfish. Also, there has been a marked increase in the use of SCUBA. This is likely a reflection of the rapid increase in market value and harvesting of conch, of which more than 90 percent of the landings were by SCUBA.

Over the past decade there has been a pronounced decline in reported landings of conch in Puerto Rico. The decrease has been attributed to population declines as a result of increase use of SCUBA, increase in market value, and a decrease in rate of catch reported by fishers. These are classic signs of overfishing.

In the U.S. Virgin Islands, the queen conch fishery generally has experienced declines in St. Thomas/St. John, and on St. Croix landings in 1991/92 were down more than 50 percent from 1981/82. Overfishing in St. Thomas/St. John led to a 5-year closure of the conch fishery through December, 1992. Unfortunately, when the fishery was reopened more restrictive measures were not implemented, and the resource was depleted within a short period of time (Mr. Roy Adams, Commissioner, U.S.V.I. Department of Planning and Natural Resources, pers. comm.) A review of available landings over the past decade

indicates that overfishing is an apparent problem in the U.S. Virgin Islands as well as in Puerto Rico, and has led to the adoption of new conch regulations throughout the U.S. Virgin Islands (Section 4.2). New regulations are being developed for Puerto Rico and, in general, will parallel those adopted by the U.S. Virgin Islands.

The shortage of local conch resources is substantiated by the record of imports of frozen meats since 1986 (Office of Statistics, Department of Agriculture, Puerto Rico; Mr. Roberto de Jesús, pers. comm.). Similar information was not available from the U.S. Virgin Islands. From July through December of 1986, foreign imports (source unidentified) of conch meats into Puerto Rico amounted to 69,127 pounds (31,350 kg.) valued at $132,562 at the port of origin. In 1990, foreign imports were 70,009 pounds (31,750 kg.) valued at $100,000. In 1991, 361,962 pounds (164,155 kg) were imported from the U.S. mainland and 197,753 pounds (89,684 kg) from Jamaica with a total value of $745,890. A total of 226,103 pounds (102,541 kg.) of conch were imported from the U.S. mainland between January 1992 and July 1993 and 677,954 pounds (307,462 kg.) were imported from Jamaica during the same period of time. Conch imports for 1992-1993 (904,057 lbs.) had a total value of $1,553,345. Since the fishery off Florida was closed to all harvest during this period, imports showing the U.S. as the source in all probability, were trans-shipped from other countries. Regardless, the information on imports indicates that the local supply cannot meet market demands, and serves to substantiate overfishing.

3.4 FLORIDA'S MANAGEMENT PROGRAM

The following account of Florida's queen conch management program was excerpted largely from manuscripts by Glazer and Berg, Jr., 1994; Berg, Jr. and Glazer; and Stoner, Barile, Glazer, and Lee. Two articles currently are in press.

Florida has never had a large queen conch fishery; however, a moderate commercial fishery existed through the mid-1900s to supply shells to the curio market. Throughout the 1960s and into the 1970s, Florida's conch resources declined substantially and, in 1965 the state enacted legislation that prohibited the harvest of queen conch unless the meat was used. Ironically, the following year harvest reached record proportions with 25,563 kg taken from Florida waters. Conch harvest then declined dramatically until 1975 when the state limited harvest to 10 conchs/person/day. In 1985, legislation was enacted to prohibit all harvest of queen conch in state waters. In 1986, the ban was extended to include adjoining federal waters. Since that time (roughly two generations) there has been little change in abundance of the resource. In 1990, queen conch was designated a "protected species" to increase public awareness of the status of the species in Florida waters.

There has been considerable speculation as to the lack of response by Florida's queen conch resource to rebound after such a long period of closure. Low numbers of adults and early stage larvae in Florida, and high concentrations of late-stage veligers associated with the Florida Current, suggest that conch populations in the Florida Keys depend upon larvae transported from the Caribbean Sea, possibly from Cuba, Mexico, or Belize. In the Exuma Cays (Bahamas) nurseries, where populations are relatively undisturbed, veliger concentrations were 5.7 times those found in historically important nurseries in the Florida Keys. The lack of recovery in Florida's severely reduced populations, despite implementation of a fishing moratorium in 1985, appears to be associated with low larval supplies. Exuma Cays populations appear to be more dependent upon local spawning and recruitment. The lack of recovery is poorly understood because of a limited knowledge of early life history, larval abundance, and recruitment processes.

Aside from the fact that queen conch larvae spend three or more weeks in the water column and may drift hundreds of kilometers before settling to the substrate, the proper environs must be present where the larvae settle. In other words, habitat could play an important role in the success of recruitment, whether it be local or from an upstream source. Settlement of veligers on oil-covered seagrass beds or other unfavorable habitat will not result in successful replenishment of the population regardless of where the recruitment originates.

The marginal abundance of queen conch in Florida waters may be due to its occurrence on the northern fringe of the range. With marginal growing and spawning conditions, it may be overly presumptuous to expect the resource to rebound so rapidly without some type of assistive reseeding (mariculture) program. The merits of such a program are presently being examined. Such programs, if successful, could also prove useful elsewhere in restoring depleted conch populations.

The discussions narrated above certainly support a coordinated pan-Caribbean effort in managing queen conch and other shared resources throughout the Basin. Also, it adds credence to the CFMC's management style for rebuilding overfished queen conch resources, while minimizing economic burdens on the fishers. Fishing moratoria may not be necessary closer to the center of the range should effort (mortality) reduction programs restore overfished resources. If not, the FMP contains provisions for implementing areal closures.

3.5 CATCH AND CAPACITY DESCRIPTORS

Maximum Sustainable Yield: Maximum Sustainable Yield (MSY) was estimated for queen conch in Puerto Rico and the U.S.V.I. by Appeldoorn (1987), under the assumption that conch resources were overfished.

MSY is defined as the largest average annual yield in terms of weight of fish caught by both commercial and recreational fishers that can be taken continuously from a stock under existing environmental conditions.

Appeldoorn (1987) analyzed catch and effort data from the West coast of Puerto Rico and reanalyzed Wood and Olsen's data (1983) from the USVI to estimate MSY. The overall MSY for Puerto Rico and the U.S. Virgin Islands were estimated for the total shelf areas of the regions thus assuming that all shelf areas are fished equally. The data reported for the West coast of P.R. represent the largest percentage of conch landings in Puerto Rico and are therefore the most reliable.

Estimation of MSY: Analysis of the Puerto Rican West Coast Conch Fishery

An analysis was made of Puerto Rico's West coast conch landings data (Table 5). This subset of data was chosen because it represents the vast majority of Puerto Rico's conch landings, the data are the most reliable, and are most comparable to studies conducted at La Parguera, an area primarily fished by West coast fishermen. Also, using a subset of the data, could eliminate some variability. Data are taken from Appeldoorn (1991c); a detailed review of these data that should be consulted in conjunction with the analysis presented below. In particular, it should be noted that effort for all areas is measured as number of full-time west coast fishermen. One assumption is that the ratio of conch fishermen to others has remained fairly constant. This is probably not the case, particularly during the late 1970's and 1980's when landings increased substantially. Greater effort was probably spurred by a greater demand for conch, and the dominance of the 1980 year class that could temporarily support increased effort. The effort data also do not account for possible increases due to fishing longer hours, more days, further offshore, or in deeper waters.

Two stock production models were applied, each to the whole data set and each to the data for the 1970's. The reason for the latter was to remove those years in which effort data were most suspect. The two models used were the Schaefer and Gulland-Fox models. The Schaefer model assumes catch-per-unit effort (U) declines linearly with increases in effort, resulting in a parabolic relationship between yield and effort. The Gulland-Fox model assumes an exponential relationship between U and effort, and results in an asymmetric relationship between yield and effort with maximum yield being shifted to the left. The latter model is thought to be more appropriate when effort in previous years affects current yield and when yield is expressed in biomass. Both models have been used reliably for other species; there is no a priori reason to suspect one to be better than the other with respect to conch. The Schaefer model was fit using a nonlinear regression of yield on effort. The

Gulland-Fox model was fit using predictive regression of Ln(U) on effort. Results of the analyses are given in Table 6 and shown in Figure 2.

The West coast landings data (see Figure 3) can be divided into two phases; one in which annual landings were fairly constant at about 145,000 lbs, and another starting in 1979 where landings increased dramatically over 450,000 lbs before collapsing in following years. The implication here, at least, is that during the period prior to 1979 the fishery was able to maintain its rate of harvest, although vagaries in the effort data prevent one from knowing if this was indeed the case. Nevertheless, it is assumed that the results of any analysis, to be accepted, must be consistent with a sustained fishery during the 1970's.

The analyses using all the data show MSY below peak landings, but values are also substantially above landings for the 1970's. More critical to their acceptance are the predictions for effort at MSY (Es) and catch-per-unit effort at MSY (Us). At MSY, Us is predicted to be twice the values observed during the 1970's, with effort being only one-half that employed during the same time. In fact, if the proposed guideline for a threshold of one-half the biomass at MSY (Bs) (estimated by ½ Us) were invoked, the fishery during this time would be predicted below threshold, and closed. Subsequent high landings indicate the fishery was anything but threatened at this point. Thus, these analyses are inconsistent with the reported landings.

Analyses restricted to the 1970's data have better statistical fits, as would be expected, and their predictions are quite similar. MSY values are slightly above average for the 1970's, which is consistent with these data, especially the decline in U during 1977 and 1978. Predictions of Es and Us are also consistent with these data.

Although the second set of analyses are consistent with these data, but because true effort is not known, model predictions apply only to the state of the fishery during the 1970's. If the fishery at this time were limited to shallow waters or areas closer to port, implying that much of the increased landings in the 1980's came from exploiting previously unfished areas, then model predictions would apply only to the areas being fished at that time, and MSY values for the entire shelf would be higher. Unfortunately, there is no way to determine if this indeed happened (although it is suspected that it did) and to what degree caution would advise that, at least, true MSY levels would not be higher than those predicted for the full data set (i.e. about 200,000 lbs) and they most probably would be much less than that.

Estimation of Biomass and Catchability (q)

Estimates of conch abundance in the area of the La Parguera shelf in 1985-1986 indicated an average density of 8.11 individuals/ha, with 32.33% adults and 67.67% juveniles. Samples from August-September 1985 indicated that average adult meat weight was 252.88 g (8.8 oz) and that the average juvenile meat weight was 78.38 g (2.7 oz). This gives a biomass estimate (meat weight) of 2.405 lb/ha (1.09 kg/ha). If exploitable biomass is somewhat arbitrarily defined as only individuals >19 cm (7.5") in shell length, then the estimate is 2.044 lb/ha (0.93 kg/ha). The catch by area for the west coast in 1985 was 2.360 lb/ha (1.07 kg/ha) or 98.1% of the calculated total biomass (i.e., F=0.981) and 115.4% of the exploitable biomass (F=1.154). No effort level is available for 1985, but data show little change between 1983 and 1986. To calculate catchability (q) (defined as part of the stock caught by a defined unit of effort) a value of E (effort) of 180 is used; effort is number of full time fishermen. This yields estimates of q of 0.00545 and 0.00641, respectively, using the two estimates of F. Appeldoorn (1987) estimated F for a region off La Parguera at 1.14, identical to that calculated above for the west coast. This indicates a very high rate of productivity for queen conch.

As a check, the above q values can be used to calculate population biomass for an unexploited population (Bmax) and one at a level yielding MSY (Bs). Using, for example, q for the total population, predicted Bmax values are about 450,000 lbs (approximately 204,000 kg) and 210,000 lbs (about 95,000 kg) using all data and 1970's data, respectively. Respective Bs values are 160,000 lbs. and 88,000 lbs. However, expanding the population estimate for the La Parguera shelf yields a biomass estimate in 1986 of 1,400,000 lbs (about 635,000 kg), i.e., several times that for a virgin population. The obvious conclusion is that the estimate of effort (180) is far below true effort. Thus, the estimate of q calculated is far too large, but the magnitude cannot be ascertained. As such, biomass estimates cannot be reliably calculated for the entire shelf.

Analysis of U.S. Virgin Islands Conch Populations:

Estimation of Maximum Sustainable Yield
(A reanalysis using Wood and Olsen's 1983 approach and data)

Wood and Olsen's 1981 survey calculated abundances of adult conch on St. Croix and St. Thomas-St. John of 260,680 and 1,580,372 individuals, respectively. For average recruitment, 900,000 is used for St. Croix (=26 individuals/ha) and 5,500,000 for St. Thomas-St. John (= 33.8 individuals/ha).

Wood and Olsen's Yield Per Recruit analysis (YPR) predicted that 80 g/recruit could be achieved (about 3 oz). This would result in MSY values of 158,400 lbs (4.62 lb/ha; about 72,000 kg and 2 kg/ha) for St. Croix and 968,000 lbs (5.94 lb/ha; about 439,000 kg and 2.7 kg/ha) for St. Thomas-St. John. However, their value of M used (from analysis of juvenile length-frequencies) was much too low. A recalculation (Appeldoorn, 1988b) yielded M=0.85. This level was used in a YPR analysis presented by Appeldoorn (1991c). Using this as a close approximation to the situation in the Virgin Islands one would expect values of 30 g/recruit (about 1 oz) for reasonable values of F and age-at-recruitment. MSY values of roughly 60,000 lbs (1.73 lb/ha; about 27,000 kg and 0.8 kg/ha) for St. Croix and 363,000 lbs (2.23 lb/ha; about 165,000 kg and 1 kg/ha) for St. Thomas-St. John were estimated.

However, Appeldoorn (1988b) has shown that natural mortality is not constant, but steadily decreases over time. A further YPR analysis incorporating variable mortality (Appeldoorn, 1991c) showed that yields could be substantially reduced, down to 1/3 to 1/6 of previous estimates. If this is so, then predicted MSY values would have to be correspondingly reduced.

Estimation of Biomass and Catchability (q)

In 1981 commercial landings for St. Croix were estimated at 45,000 lbs (about 20,400 kg), and effort was 500 trips. In a survey of St. Croix populations, Tobias (1987) reported an average meat weight of 320 g/adult (about 11.3 oz/adult). Given the estimate of 260,680 adults, yields an adult biomass of 183,518 lbs (about 83,200 kg). This results in F=0.245. In St. Thomas mortality rates from size-frequency analysis yielded an F value of 0.49 from F = Z-M. The area sampled was supposed to be lightly fished as it was accessible only by SCUBA.

Yield-per-recruit analysis does not allow the biomass estimates Bs and Bmax to be made.

Comparison of Yields and Adjustments to MSY

For tropical species most calculations of MSY are likely to be overestimated. The degree of bias is unknown, but it is estimated that true MSY is one third less. Appeldoorn (1987; 1992c) attempted to estimate MSY for the 1970's data from the west coast of Puerto Rico. Model estimates of yield for the Puerto Rican west coast were 1.22-1.26 lb/ha (about 0.57 kg/ha) using the 1970's data. Assuming that area fished has increased, this would represent a slight underestimate. Therefore, the estimate of 1.26 lb/ha was chosen (0.57 kg/ha). Data from other coasts show that during the period 1978-1984 constant yields were harvested from the south and east coasts, averaging about 90,000 lbs each (40,800 kg). Corresponding

areal yields are, respectively, 0.73 lb/ha (0.33 kg/ha) and 0.35 lb/ha (0.16 kg/ha). Both estimates are lower than for the west coast indicating either lower productivity or that yields during this time were below MSY. These yields may have been near MSY as indicated by the decrease in yield on the south and east coasts after landings significantly increased above these levels in 1984 and 1985 respectively; however, again the exact level here cannot be ascertained. The particularly low areal figure for the east coast may result from the large amount of area above the 100-fathom isobath, much of which is not fished for conch. If half the area is fished the predicted yield would be similar to that for the south coast. The south coast estimate is considered reasonable as the shelf is particularly narrow with respect to the west coast.

MSY for the Virgin Islands is more difficult to estimate, as they vary depending upon the assumptions of the YPR analysis. Estimates of 1.73 lb/ha (0.79 kg/ha) for St. Croix yield a total of 60,000 lbs (about 27,200 kg). This level was harvested in 1979, but landings have decreased steadily and in 1985 were 34,000 lbs (about 15,426 kg). Either effort is greater than that for MSY or the MSY figure is too high (or both). Without historical records of landings and effort it is impossible to tell which occurred. However, it is safer to assume the latter, i.e., MSY is too high. This is consistent with YPR analyses.

Variations in yield/ha among areas can result from differences in levels of recruitment and differences in the amount of productive habitats (e.g., algal plains, grass beds). However, nothing is known of recruitment for any conch population.

St. Croix and St. Thomas-St. John have a similar distribution of bottom habitats; therefore, the two areas are considered equal in potential yield. Differences in predicted yield between the two areas result directly from the lower density of conchs on St. Croix. This may be explained by fishing mortality being slightly higher on St. Croix, or simply by inherent variation in the estimates. Since good estimates are not available but should be lower than calculated, the estimate obtained for Puerto Rico's west coast (1.26 lb/ha or 0.57 kg/ha) will be used.

Total MSY values can be calculated by multiplying the estimates by shelf areas. Using a value of 1.26 lb/ha (0.57 kg/ha) for Puerto Rico's west coast and 0.73 lb/ha (0.33 kg/ha) for the north, east and south coasts yields an MSY for Puerto Rico of 227 mt or about 500,000 lbs. This assumes all areas will be harvested equally, which will not happen. For example, the estimate for Puerto Rico's north coast, 48,000 lbs (22,000 kg), has never been approached, probably because of a reduced resource (due to unfavorable environment), poor weather or poor access for fishing. For the USVI a value of 1.26 lb/ha (0.57 kg/ha) yields 43,000 lbs (19,500 kg) for St. Croix and 205,000 lbs (93,000 kg) for St. Thomas-St. John,

totalling 248,000 lbs (112,500 kg) for the U.S.Virgin Islands. Total potential yield for Puerto Rico and the U.S.V.I. is estimated at 738,000 lbs (335,000 kg).

Present Problems

The queen conch fishery in St. Thomas/St. John was closed in 1988 for 5 years. However, there were no management measures in place until 1994. St. Croix had size limit regulations in place since 1988. No regulations have been implemented in P.R. for the queen conch fishery.

Although Appeldoorn (1987; 1992c) attempted to estimate MSY and estimated total yield for Puerto Rico at 227 mt (more than twice the actual landings) it was not possible to determine the reduction in effort necessary to achieve the estimated total yield. There is no good information on effort available. Since no additional data exist to improve the estimate of MSY, conservative management measures appear prudent (see Section 6.0). These management measures address the following problems in the queen conch fishery: (1) declining trends observed in the commercial landings; (2) indications of recruitment overfishing; (3) apparent increase in effort into the fishery; and (4) increased fishing mortality (peak landings) at the time of reproduction.

Optimum Yield: OY is defined in this FMP as all queen conch commercially and recreationally harvested from the EEZ landed consistent with management measures set forth in this FMP under a goal of allowing 20% of the spawning stock biomass to remain intact. This definition of OY and the management measures proposed should serve to protect both the juveniles and the spawning population of queen conch and to prevent overfishing in areas still not fully exploited. Additionally, habitat conservation concerns are addressed, as recommendations, to the local governments regarding the rehabilitation and conservation of near shore habitat critical for recruitment and reproduction of the queen conch.

Because of the uncertainties surrounding the catch/effort data, the Council feels that the estimates of MSY are not reliable. It is generally conceded, however, that the queen conch resources are severely overfished throughout much of the range, including the waters around Puerto Rico and the U.S. Virgin Islands. Taking these vagaries into account, the CFMC has recommended a mortality/effort reduction management program, in the form of the proposed management measures, designed to restore diminishing conch resources. Although catch/effort are largely unknown, the CFMC does not recommend harvesting at levels

beyond the scope of the management program, as levels in excess of those recommended could deter rebuilding efforts. The recommended management program allows levels of harvest to reduce economic impact associated with total closures, but has the flexibility to adjust management measures (including seasonal and areal closures) should the resource fail to respond favorably (see Section 6.7).

Total closures are not recommended immediately, despite overfishing, because (1) the Council wants to minimize the significant and disruptive socio-economic impact this would have on the commercial fishers and their families; (2) of their lack of proven success in other areas, such as Florida and Bermuda. The Council understands that these two areas are fringe fishing grounds and that conch populations in Puerto Rico and the U.S. Virgin Islands may be responsive to closures because they are centrally located within the range of the species, or because recruitment patterns and habitat conditions may be more favorable. However, the economic burden (hardship) of this very restrictive management strategy is too damaging to the commercial fishers.

Total Allowable Level of Foreign Fishing (TALFF)

Since the domestic fleet already has demonstrated the capacity to harvest and process the entire stock of queen conch, as evidenced by overfishing in some areas, there is no surplus available for foreign fishing.

4.0 PROBLEMS IN THE FISHERY

4.1 OVERFISHING

Title 50 CFR 602 of the Magnuson Act contains guidelines that require an objective and measurable definition of overfishing be prepared for each stock or stock complex managed under an FMP. The definition of overfishing is required to guide management in determinations of whether the capacity of a stock to maintain itself through reproduction might be destroyed by fishing. The ultimate goal of a definition of overfishing is to produce MSY on a continuous basis.

Overfishing in this FMP is defined in terms of a minimum level of spawning biomass (see Section 5.1). Appeldoorn (1993) concluded that the overfishing definition based on a spawning potential ratio (SPR) of 0.2 is sufficient to protect the spawning population. The SPR analyses indicated that without management, the conch stock can be expected to decline to a point were the SPR declines below 0.2. The proposed size limits for queen

conch could maintain the population above an SPR of 0.2. The key factor in the proposed management program is compliance; without compliance with the proposed measures the benefits of management to the stock might not be achieved.

Practically everyone who has studied queen conch resources in the Caribbean attests to overfishing as being a significant problem since the late 1960's. In many areas, fishers themselves have acknowledged overfishing as a serious problem and indicated that the resource is noticeably declining (Appeldoorn, 1987). Accordingly, the management program described herein is designed to restore overfished conch resources through a reduction in fishing effort (rather than total closure of the fishery), and is presumed to have the support of the fishing industry. Nearly every nation in the Caribbean has acknowledged that overfishing has led to decreased harvest levels and has taken actions to reduce effort and subsequent fishing mortality. Some of the restrictions imposed by various Caribbean nations include: seasonal closures to protect spawning populations; shell or meat size limits or flared-lip restrictions to protect immature conch; limited access and quotas on allowable catch; prohibitions on the use of SCUBA gear to protect deep-water reproductive populations; areal closures to rebuild populations and guard against local stock declines; and, in some areas, the initiation of mariculture programs to rear conch to sizes suitable for replenishing impoverished areas.

According to Appeldoorn (1993) conch fisheries in the northern fringe areas of the range (i.e., Florida and Bermuda) have shown little or no improvement despite total closure for many years. Fisheries in Bonaire and Cuba also have been closed for extended periods because of severe overfishing (Berg and Olsen, 1989). Appeldoorn (1993) reported that in the absence of management, spawning potential ratio (SPR) for the queen conch stock can be expected to decline below the 20 percent level. In the mid-1980's off La Parguera, Puerto Rico, fishing mortality was estimated at 1.14 with an SPR value of 0.09 or less than one-half the recommended value of 0.2, (20 percent), and landings declined substantially (80 percent) during that period. There is no evidence that such high fishing mortality rates are unique to this area of Puerto Rico, or that mortality rates have since declined; therefore, it is likely that the SPR for queen conch is below the recommended value of 0.2 or 20 percent, throughout much of the management area. Closures may be an aid to restoring conch populations in areas where local overfishing is known to occur, and there are provisions in this FMP to effect such closures should the recommended management program prove ineffective.

4.2 MANAGEMENT/ENFORCEMENT

In recognition of declining conch resources, the U.S. Virgin Islands government placed a 5-year moratorium on harvesting queen conch from waters surrounding St. Thomas and St. John. However, when the ban was lifted, there were insufficient harvest restrictions to

protect the resource from a reoccurrence of overfishing. Consequently, benefits to the population that resulted from the moratorium were erased almost immediately (Mr. Roy Adams, Commissioner DPNR, U.S.V.I., pers. comm.).

The government of the U.S. Virgin Islands recently (April 26, 1994 and amended on July 12, 1994) promulgated rules and regulations pursuant to Title 12, Chapter 9A, for the commercial fishing of conch and whelk. Regulations governing the harvest of conch from waters under jurisdiction of the Territory are (a) an annual closed season from July 1 through September 30; (b) all conch landed in the "Regulatory Area" must be alive and in the shell; (c) all conch harvested must be at least 9 inches in length or at least 3/8-inch in lip thickness in any location; (d) conch harvested for personal use must not exceed 6 per day or 24 per boat, unless the person has a commercial fishing permit that entitles the fisher to a maximum of 150 conch per day; and, (e) conch or conch shells that do not conform to the minimum size requirements may not be sold. These restrictions have been promulgated in the U.S. Virgin Islands and the CFMC has proposed compatible, but even more restrictive regulations for the EEZ, including a ban on the use of HOOKAH gear (see Section 6). Puerto Rico has not yet enacted but is considering similar legislation. Companion regulations must be in effect in all these areas to enhance enforcement efforts. Without effective enforcement, conch resources cannot be expected to rebuild or improve.

In recognition of enforcement limitations in the U.S. Caribbean, the NMFS entered into separate tripartite cooperative agreements with the U.S. Coast Guard (Department of Transportation) and the local natural resource agencies of Puerto Rico (DNER) and the U.S. Virgin Islands (DPNR) to enhance enforcement capabilities throughout the management area (Michael Christian, NMFS Asst. Spec. Agent in charge of Enforcement in the U.S. Virgin Islands, pers. comm.). The agreement authorizes all agencies involved to enforce regulations in waters under state and federal jurisdictions. This cross-deputization increases enforcement capabilities throughout the management area as NMFS's resources are extremely limited and Coast Guard has higher priorities than fisheries investigations; the DPNR has approximately 25 natural resource enforcement officers (vigilantes) while DNER has an estimated 75 enforcement agents (rangers).

The U.S. Virgin Islands has separate agreements for the enforcement of Marine Mammals and Endangered Species regulations, Magnuson Act regulations, and Atlantic Tunas. The first agreement (Marine Mammals and Endangered Species) was signed into law on January 31, 1986, while the two latter agreements were signed on January 19, 1988. The tripartite agreement with Puerto Rico was signed on November 23, 1991, and covers all of the Acts and Conventions noted above. The NMFS is responsible for conducting periodic workshops to keep the other agencies up-to-date on regulatory changes.

4.3 DATA BASE

As with most fishery resources, the scientific data base required to formulate workable management programs is insufficient. There is a paucity of reliable data or data collection mechanisms to accurately assess the current condition of resources, evaluate the success (impacts) of management measures, or to estimate the social and economic values of the resource.

It is generally acknowledged that conch are over-exploited (e.g., Appeldoorn and Meyers, 1993), however, the extent of overfishing is unknown and could vary from area to area. Recruitment overfishing is known to occur in parts of Puerto Rico and the U.S. Virgin Islands (Appeldoorn, 1993). Therefore, the proposed minimum size limits are based on preventing the harvest of immature individuals to reverse recruitment overfishing. To guard against recruitment overfishing, information on size at maturity, and reproductive output at various size/ages is required. Gear limits and seasonal/areal closures may require different pieces of information to evaluate their effectiveness. To require more sophisticated management approaches such as limited access, quotas, etc., would demand more labor and data intensive efforts.

4.4 INFORMATION/EDUCATION

For any fishery management program to be successful, it must have the support of the fishing industry. Industry must be educated as to the purpose of all management options. Industry must be an integral component of the plan and be kept informed of progress and changes that occur throughout the developmental process. Without such a close working relationship, credibility is lost and the management plan is destined to failure. The Magnuson Act requires scoping or fact-finding meetings and public hearings to ensure that the fishing industry and general public are part of the management process.

4.5 HABITAT DEGRADATION

Habitat loss and degradation may occur from sources largely beyond the control of fishery managers; however, resulting environmental stress may critically affect the fishery resources. Queen conch larvae, juveniles, and adults are ecologically dissimilar and have discrete habitat requirements. The larvae are planktonic for about three weeks. Juveniles inhabit shallow coastal areas, such as seagrass meadows and nearshore reefs where they burrow during daylight. As they grow, they move into deeper areas and return to nearshore areas as the reproductive season approaches (Section 2.0). Degradation or loss of critical habitat

can negatively impact recruitment to the fishery and result in severe declines in landings over time. Conch management therefore, requires that critical habitat somehow be protected. Such critical habitats may be threatened, among others, by tourist activities, urban coastal development, all permitted and unpermitted point source discharges, residual insecticides, and oil spills or leakages. All of these anthropogenic impacts, which are largely beyond the control of fishery managers, place extensive demands on conch resources and their critical habitat, and must be regulated through other governmental channels.

5.0 MANAGEMENT OBJECTIVES

The basic objectives of the FMP are geared to the previously identified problems in the conch fishery.

Objective 1. To optimize the production of queen conch in waters surrounding Puerto Rico and the U.S. Virgin Islands through implementation of a management program, while ensuring the conservation of those resources throughout their range and in a manner consistent with other management programs currently in effect.

Objective 2. To reduce adverse impacts on queen conch through regulation of fishing effort and wasteful harvest practices, such as harvesting immature and reproducing individuals and exhausting deep water spawning reserves.

Objective 3. To promote the adoption of functional management measures that are practical and enforceable from the standpoint of conservation, in terms of education in general and the promotion of international cooperation in managing queen conch resources.

Objective 4. To generate a data base that will contribute to the knowledge and understanding of queen conch biology and other elements needed to improve management efforts, such as SAFE reports, monitoring of the resource, and determination of recruitment sources.

Objective 5. To recommend habitat improvements to federal and local governments and other entities responsible for curbing environmental degradation and loss.

Objective 6. To provide as much flexibility as possible within the management program to ensure that actions occur on a timely basis and in a manner consistent with the involved interests (See Section 5.2 below).

5.1 OVERFISHING DEFINITION

A queen conch stock is overfished when it is below the level of 20 percent of the spawning stock biomass per recruit that would occur in the absence of fishing.

When a queen conch stock is overfished, overfishing is defined as harvesting at a rate that is not consistent with a program that has been established to rebuild the stock to the 20 percent spawning stock biomass per recruit level.

When a queen conch stock is not overfished, overfishing is defined as a harvesting rate that if continued would lead to a state of the stock or stock complex that would not at least allow a harvest of OY on a continuing basis.

5.2 REBUILDING PROGRAM

The CFMC has proposed the following management program to rebuild conch resources in waters surrounding Puerto Rico and the U.S. Virgin Islands. Some of these measures were recently adopted (April 26, 1994 and amended on July 12, 1994) by the government of the U.S. Virgin Islands and will extend to federal waters throughout the CFMC's area of authority. The government of Puerto Rico is expected to enact similar legislation soon.

a. Establishment of a 9-inch minimum size limit (total length) or a 3/8-inch (9.5 mm) lip thickness for queen conch landed in Puerto Rico and the U.S. Virgin Islands. Total length is the measurement from the tip of the spire to the distal end of the shell. All species in the fishery management unit must be landed in the shell to facilitate enforcement.

b. Prohibition on the sale of undersized queen conch and queen conch shells.

c. Establishment of a daily bag limit of three (3) queen conch per trip for personal-use fishers, not to exceed twelve (12) per boat. Licensed commercial fishers will be limited to a total of one hundred and fifty (150) queen conch per day.

d. The fishing season for queen conch will be closed annually from July 1 through September 30; i.e., the first three months of the fiscal fishing year, which coincide with the peak of the reproductive season.

e. In addition, the harvest of queen conch with HOOKAH gear is prohibited in the EEZ. A similar prohibition will be recommended for adoption in state waters by both local governments.

It is expected that either of the above size restrictions will maintain the spawning potential ratio (SPR) above the 20 percent level selected for management of most fisheries in U.S. federal waters (Appeldoorn, 1993). Although the current level of SPR is unknown, historical evidence suggests that SPR for queen conch likely is less than 20 percent in some areas. Measuring spawning potential as a function of size/age at maturity and fecundity at size/age is probably a more reliable index than using biomass, especially for organisms such as conch. Appeldoorn (1993) examined equilibrium SPR for alternative fishing mortality rates with a 9-inch minimum size limit (total length) and a 5 mm lip thickness noting that the 9-inch overall size limit marginally maintains an SPR greater than 20 percent for fishing mortalities of 2.0 (Figure 4). The 5 mm lip thickness analysis was even more conservative, with values never approaching critical levels of SPR. Adjusting the lip-thickness measure to 9.5 mm would result in even more conservative harvest levels. Since it takes about 3.0 years for queen conch to achieve maturity, it would require about ten (10) or more years to replenish the conch stock in a depleted area; this approximates 1.0 generation times.

Surveys conducted in the U.S.V.I. in 1981, 1985, and 1990 showed a decline in conch densities from 37 to 11 conch/ha (Friedlander et al., 1994). The conch fishery was closed in the U.S.V.I. in 1988. There is no information to determine whether the resource recovered or not after the closure. Size limits were imposed for queen conch for the island of St. Croix since the conch fishery remained open.

The requirement for landing all species in the fishery management unit in the shell, and the prohibition on sales of undersized queen conch and undersized queen conch shells are added measures to promote enforceability of the size limits.

The daily bag limit and commercial landing limit are designed to further reduce fishing mortality, just as the annual seasonal closure and the HOOKAH gear prohibition. These measures, coupled with the size limits, should be more than adequate to restore overfished conch resources. Procedures for adjusting these measures are discussed in section 6.7.

The success of the proposed rebuilding program depends upon several factors, not the least of which is the condition of the resource in regions responsible for recruitment to the management area, and the extent to which critical habitat has deteriorated, as well as the enforcement efforts and compliance with the proposed measures. Closures likely would benefit conch populations to the extent that local recruitment occurs; however, if the area is dependent upon recruitment from upstream, then management practices by source nations becomes an important factor. Recall that the fishery in Florida has been closed for 9 years and has not responded positively. This may be due to depletion of the spawning stock by upstream Nations, or possibly to habitat deterioration, or a combination of both. Also,

conch resources in Florida might not have shown the expected increase in conch abundance as a result of it being a fringe area. Thus, even with adequate recruitment, the resource will not rebound beyond the limits of habitat capability. Florida is presently exploring the feasibility of restocking aquacultured queen conch.

6.0 MANAGEMENT MEASURES AND ALTERNATIVES

Many managers are inclined to defer action until a substantial data base is available; however, the Magnuson Act (U.S. Dept. of Commerce, 1990) requires that fisheries be managed on the basis of the best available information. In the case of a resource that is clearly overfished and highly valuable, such as queen conch, steps to reduce fishing effort can be taken in the absence of a detailed assessment. The proposed management approach, taken while data are being gathered to develop a more sophisticated management program, such as limited access, may be what is necessary to recover the resource to acceptable levels. The program developed by the CFMC is designed to reduce fishing effort and may be sufficient for rebuilding the resource to acceptable levels of abundance. In each instance, Option A is intended to represent the preferred alternative of the CFMC.

6.1 SIZE LIMITS

6.1.A Prohibit the possession of undersized queen conch defined as less than nine (9) inches total length (22.9 cm)(as measured from the tip of the spire to the distal end of the shell) or with less than a 3/8-inch (9.5 mm) lip thickness measured at the thickest point of the lip. Queen conch less than nine (9) inches total length will be considered illegal if it does not have at least one area of the shell lip measuring 3/8-inch. All species in the fisheries management unit must be landed still attached to the shell.

Discussion: Minimum size limits generally are based upon preventing the harvest of immature individuals and thereby protecting the spawning stock. The success of measures designed to protect the spawning stock varies with recruitment patterns.

If the insular platform is of adequate size and currents are favorable to ensure substantial self-recruitment, then the effects are immediate and local. If recruitment to the area is dependent upon egg and larval transport to a large degree, then management practices in neighboring regions may have significant implications.

Although queen conch in some areas may mature at smaller, and less restrictive sizes, nine inches total length or 3/8-inch lip thickness were selected because they are the most conservation oriented and would ensure a larger spawning reserve than smaller size limits. Requiring species in the FMU to be landed in the shell not only closes an enforcement loophole by protecting immature queen conch, but also reduces the number that can be housed aboard a fishing vessel. Therefore, the requirement will reduce fishing mortality to the extent that vessel holding capacity is reduced, to the benefit of the resource.

Appeldoorn (1993) noted that for the La Parguera population, application of the nine-inch minimum size limit would maintain the population above a spawning potential ratio (SPR) of 0.2 at reasonable levels of fishing effort. The La Parguera population consists of relatively large individuals; therefore, a lower percentage of individuals would be protected under the nine-inch size limit than in other areas. Consequently, this indicates that the nine-inch size limit may adequately conserve the spawning stock in accord with the 0.2 criterion throughout Puerto Rican waters. The management strategy based on lip thickness was the most conservative method tested with respect to SPR, with values never approaching critical levels (Figure 4). The results of both the lip thickness and the nine-inch total length size limit analyses indicate the effect that fishing juveniles is having on the future reproductive potential of the population. Therefore, compliance with either of these restrictions should guard against overfishing of queen conch throughout the management area.

The minimum shell lip thickness of 5 mm, tested by Appeldoorn (1993) for La Parguera, was increased to 9.5 mm as a high proportion of conch, previously thought to be mature on the basis of lip thickness, were found to be still immature. Of nine males under 10 mm lip thickness, seven were found to be immature, while of eleven females under 10 mm in lip thickness, four were immature. Therefore, lip thickness was increased from 5 mm (value tested) to 9.5 mm (3/8 inch) to ensure that even a greater proportion would be mature at harvest.

The Government of the U.S.V.I. (DPNR, DFW) designed a gauge for measuring queen conch, lobster and whelk (Figure 5). This gauge helps fishers in harvesting only those individuals of legal size thus complying with the law and protecting as well as preserving the resources. The gauge is provided free of charge.

6.1.B Establish a less restrictive minimum size limit of seven (7) or eight (8) inches total length for queen conch.

Discussion: The CFMC also considered size limits of seven and eight inches, as nine inches would practically eliminate a fishery in areas such as the shelf around Caja de Muerto Island in Puerto Rico, where most conch mature at less than nine inches total length (Appeldoorn,

1991b). This would result in a reduction in yield, thereby increasing the economic burden on fishers in those areas. Fishers in such areas have access to other areas where conch mature at nine inches. Establishing a nine-inch minimum size ensures greater spawning potential through recruitment of larger individuals in the gene pool, thereby guarding against a genetic shift towards a fishery composed of smaller individuals. The less restrictive size limits would not ensure spawning. Besides, many of the conch in such areas could meet the lip-thickness requirement, thereby making them eligible for harvest. In the Appeldoorn (1991b) study, samples of queen conch at only two of nine areas averaged less than nine inches total length; the other area was south of Culebra Island.

6.1.C Establish a minimum size limit for queen conch of eight (8) inches in Puerto Rico and nine (9) inches total length in the U.S. Virgin Islands.

Discussion: The differential size limit between Puerto Rico and the U.S. Virgin Islands was proposed by the fishers in St. Croix (where most conchs are harvested in the U.S.V.I.) and supported by the Division of Fish and Wildlife. St. Croix fishers contended that a nine-inch minimum size would not create a significant economic impact and would ensure spawning.

Differential size limits, however, would open an enforcement loophole, the extent of which cannot be ascertained. Fishers could catch eight-inch conch in the U.S. Virgin Islands and land them in Puerto Rico. If this occurred extensively, spawning potential of the Virgin Islands stock could be reduced.

Much of the discussion under 6.1.B also applies here.

6.1.D Control the harvest size of queen conch through meat count size (2 uncleaned or 3 cleaned to the pound) rather than shell length.

Discussion: This method was used in St. Croix and was seriously considered by the CFMC as a replacement measure to overall shell length. Variability in meat weight due to cleaning practices as well as variability of meat size as related to shell size, precluded adopting this alternative in lieu of shell length and lip thickness measures. Also, immature queen conch could be landed as other species if meats were allowed to be removed from the shell. Besides, the conch must be sacrificed before it can be determined whether the weight of a particular meat meets the specified criteria.

6.1.E No Action.

Discussion: The consequences of taking "no action" would result in the continued historical pattern of stock depletion. Recovery in depleted areas would be unlikely and resource conditions worsen. Continued harvest of undersized and immature individuals would eventually and substantially diminish recruitment. "No action" would not be responsive to the problems in the fishery.

6.2 PROHIBIT SALE OF UNDERSIZED QUEEN CONCH

6.2.A Prohibit the sale of undersized queen conch and queen conch shells as defined.

Discussion: This measure is a corollary to the preceding size limit measure and is prescribed as an added control. Prohibiting the sale of these items would serve to further discourage their harvest. Queen conch is listed on Appendix II of CITES. As such, import/export of queen conch products is regulated and there are specific requirements for establishing a paper trail. The Council expects that the documents relevant to the queen conch cargos be available for inspection.

6.2.B No Action.

Discussion: The rationale underlying this prohibition is to discourage a market for products made illegal through the size limit. Development of a black market for these products could hamper enforcement of the minimum size requirements.

6.3 HARVEST LIMITS

6.3.A Establish a bag limit for personal-use fishers of three (3) queen conch per day, not to exceed twelve (12) per boat; licensed commercial fishers may land one hundred and fifty (150) queen conch per day for the first year. The commercial fishers' quota will be lowered to one hundred (100) queen conch for the second year and to seventy-five (75) the third year. The quota reduction is subject to review upon receipt of empirical information on which to base the decisions for new limits. All conch harvested under these provisions must conform to minimum size specifications and be landed still attached to the shell.

Discussion: The impacts of the bag limit cannot be assessed since there is currently no information on harvest by the recreational (personal-use) sector. The intent of the measure,

however, is to somehow restrict the take by personal-use fishers to a reasonable level. A boat limit may be possessed only if four or more fishers are aboard and fishing.

Commercial harvest was originally limited to 75 queen conch per day in the U.S. Virgin Islands to reduce fishing mortality over what would be expected under unlimited or less restrictive harvest. Lobbying by commercial fishers in St. Croix (R. Boulon, pers. comm.) resulted in changing the bag limit to 150 per fisher per day (see Section 8.2 (B)). Puerto Rico is expected to take similar action to the CFMC and the United States Virgin Islands.

At present data shows that commercial fishers land approximately 75 pounds of conch meat per trip. If it assumed that there are 2 conch to the pound this is equivalent to 150 conch. The controversy surrounding this measure revolves around having to bring the conch in the shell. The economic hardship of restricting the number of queen conch further is offset by the fact that 150 conch with the shell will be restrictive enough for the size and type of fishing boats used in the area.

6.3.B Establish a bag limit for personal-use fishers of six (6) queen conch per day, not to exceed twenty four (24) per boat; licensed commercial fishers may land seventy-five (75) queen conch per day. All conch harvested under these provisions must conform to maximum size specifications and be landed still attached to shells.

Discussion: These less restrictive bag limits for personal-use fishers were considered by the CFMC, but were rejected as not being conservative enough to protect the resource against overfishing, especially when the numbers of recreational fishers and the quantity they harvest are unknown.

The more restrictive commercial limit was considered excessive at present, but it is in the preferred option for year three after implementation of the FMP. That is, if the empirical data show that a reduction in the quota is needed. This restrictive limit might also have a negative effect in that effort might increase substantially over a short period of time.

6.3.C No Action.

Discussion: The CFMC thought that no sector of the fishery should be allowed to indiscriminately harvest conch. The magnitude of the recreational and commercial fishing sectors are unknown, and indiscriminate harvest could undermine rebuilding efforts.

6.4 SPAWNING SEASON CLOSURE

6.4.A Establish an annual closed harvest season from July 1 through September 30 for queen conch.

Discussion: This time of the year corresponds to the peak spawning season around Puerto Rico and the U.S. Virgin Islands. Since queen conch are reported to aggregate in shallower waters during the reproductive period, they become more vulnerable to harvest at that time. Therefore, a closure at this time may offer more protection to the resource than closing at some other time. Also, many fishers identify with the conservation ethic of protecting reproducing organisms, and are supportive of spawning season closures. Landings data from 1983-1992 suggest that August is the peak harvesting period; i.e., conch are available in greater numbers at that time (Table 4). August is included in the annual seasonal closure. The commencement date of July 1 also corresponds with the beginning of the fishing year for queen conch.

6.4.B No Action.

Discussion: A closure during the reproductive period may serve to reduce overall fishing mortality, especially if conch are more vulnerable to harvest at that time. Efforts to protect spawners may advance the rebuilding schedule, insofar as recruitment is localized; whereas attempting nothing could delay rebuilding efforts. "No action" is not responsive to deteriorating resource conditions.

6.5 HOOKAH PROHIBITION

6.5.A Prohibit the harvest of queen conch in the EEZ using HOOKAH gear. Any person with queen conch and HOOKAH gear aboard a vessel in the EEZ will be presumed in violation of this prohibition.

Discussion: As nearshore populations of queen conch diminish, fishers are becoming more reliant on SCUBA or HOOKAH gear to exploit the resource in deep waters. Such relentless harvesting could result in the elimination of one of the few remaining sources of conch recruitment. The results could be devastating since there is concern that the resource already is believed to be recruitment overfished in some areas (Appeldoorn, 1993). The Council prohibits only HOOKAH gear at this time. The economic impact of banning SCUBA, specially if the local governments adopt compatible regulations, could be equated

to the closing of about 90% of the fishery. The effort would be shifted to shallow waters were queen conch can be harvested by free diving but also were the majority of the juveniles are typically found. The Council however has determined that at the end of three (3) years, if the empirical data collected show that SCUBA should be banned, it shall revise this measure as appropriate. At such time, a limited entry scheme will be implemented for the bona fide commercial SCUBA divers.

It is a rebuttable presumption that queen conch possessed aboard a vessel in the EEZ with HOOKAH gear aboard were taken in violation of this prohibition. The Council is aware of the practice, by commercial fishers, of carrying the diving gear in one vessel and the conch product in a separate vessel on the return trip to shore. This practice could present a potential problem in the enforcement of this management measure.

6.5.B Prohibit the harvest of queen conch in the EEZ using SCUBA gear.

Discussion: This measure was considered to be too restrictive since there are other 4 management measures that restrict the fishing of queen conch. The Council shall revise this measure as appropriate once the data are collected and analyzed.

6.5.B Prohibit SCUBA gear in waters less than 35 feet deep.

Discussion: This measure was considered impractical from an enforcement standpoint.

6.5.C No Action.

Discussion: Taking no action would be irresponsive to the problem of recruitment overfishing and could result in the demise of the resource.

6.6 OTHER MEASURES CONSIDERED AND REJECTED

6.6.1 Closing one-half of the waters around Puerto Rico for two years, then alternating.

Discussion: This measure would not ensure recovery of the stock, as fishing intensity would be expected to increase in the open areas. In addition, travel from closed to open areas would impose an economic burden on fishers. Other measures should achieve the objectives of the FMP.

6.6.2 Close all waters around Puerto Rico out to the 35-foot contour line.

Discussion: Although this measure was considered useful in rebuilding the population, enforcement would present an insurmountable problem.

6.6.3 Establish a size limit by sex.

Discussion: Although queen conch are sexually dimorphic, the differences are subtle and not readily recognizable by those outside the scientific community. Since growth rates are not significantly different, and both sexes mature at approximately the same size, there is little reason to attempt management through different size limits by sex.

6.6.4 Limited entry.

Discussion: This measure was deferred by the CFMC, largely because there is insufficient information to determine harvest levels of the different user groups. However, it is recommended that local governments institute programs that would provide the basis for such measures.

6.6.5 Prohibit imports during the closed season (July 1 to September 30).

Discussion: Attempting to prohibit imports introduces legal problems. Import prohibitions must respond to the objectives of the FMP and meet the requirements of the Magnuson Act and other applicable law. In this case the CFMC determined with the advice of NOAA Regional Counsel, that neither criterion was met. This would not preclude local governments from taking independent action in this regard.

6.6.6 Institute a five (5) year moratorium on the harvest of queen conch in the EEZ off Puerto Rico and the U.S. Virgin Islands.

Discussion: At one time, a moratorium on the harvest of queen conch in the U.S. Caribbean EEZ was considered. The approach was abandoned in lieu of an effort (mortality) reduction program because of the lack of a positive response of the resource in some areas that have been closed. For example, the Florida fishery has been closed for nine (9) years and has shown little or no sign of recovery. This may be due to resource depletion in areas responsible for recruitment to Florida, to habitat degradation, or to Florida's location on the northern fringe of the range, or a combination of the three. At any rate if mortality can be reduced sufficiently by decreased effort (i.e., sufficient to maintain population levels above

20 percent SPR--the level designated as overfished), then the population should recover under the harvest reduction program with fewer economic impacts than a total closure.

The U.S. Virgin Islands closed their conch fishery off St. Thomas/St. John for a total of five years, but any gains were liquidated before they could be measured as the fishery was reopened without more restrictive measures in place.

6.6.7 Establish an overfishing definition based on fishing mortality rate at maximum sustainable yield.

The Council rejected an overfishing definition based on fishing mortality rate at maximum sustainable yield due to lack of data for an accurate estimation of MSY Rather the best available data support an overfishing definition based on SPR (see Section 3.5, pages 42 to 53, for a full discussion of the rationale for rejecting this option).

6.7 Procedure for Adjusting Management Measures

A final rule revising the guidelines for fishery management plans became effective on August 23, 1989. Section 602.12(e) of the guidelines describes a Stock Assessment Fishery Evaluation (SAFE) report that is used by Councils to evaluate the success of management programs implemented for each FMP. The SAFE report should summarize the biological condition of species in the fishery management unit, contain information on the social and economic condition of the fishery, and provide information needed to determine harvest specifications. Each SAFE report should be updated periodically as new information becomes available, and reviewed annually by the Councils or as significant changes occur in the fishery. The SAFE report serves as one of the bases for making adjustments to the management program implemented under the FMP. Additionally, new reports or other information on species in the FMU may periodically become available to Council staff, committees, or members, and should be included therein.

Each group involved can evaluate alternatives for adjusting the management program and present them to the Council for consideration and action. The Council will conduct one or more public hearings, depending on the nature of the proposed adjustments, prior to taking final action. The Scientific and Statistical Committee (SSC) must advise the Council on the adequacy of all support analyses and whether they are based upon the best available scientific information, and on the efficacy of the proposed adjustments. The Advisory Panel (AP) and any other Council committee may be consulted. For adjusting measures within the regulatory scope of the FMP, a regulatory amendment, including a regulatory impact review (RIR), environmental assessment (EA), and a proposed rule, will be prepared for submission

to the Regional Director. After reviewing the proposed regulatory adjustment for consistency with the Magnuson Act, other applicable laws, and the objectives of the FMP, the Regional Director will forward the proposed rule for publication in the Federal Register. The proposed rule will describe the proposed change(s) and make the supporting documents available for public review and comment. After a 30-day comment period, public input will be addressed by the Council and the Regional Director and a final rule prepared for publication. In addition to overfished conditions of a resource, other concerns may trigger the need for timely adjustment of management measures. These concerns may involve a need to establish closed areas, address significant changes in fishing practices or environmental disasters, etc. Other adjustments that may be made by this procedure include changes to the FMU, harvest limitations, (including quotas, trip or daily landing limits), gear restrictions, and closed seasons or areas.

7.0 RECOMMENDATIONS TO LOCAL GOVERNMENTS AND OTHER AGENCIES

A) Mandatory Permitting and Reporting

Implicit in Management Measure 6.3.A (Harvest Limits) is the requirement for a permit (license) to commercially harvest and sell conch. This measure conforms to the harvest-limit restrictions recently adopted by the U.S. Virgin Islands; a companion regulation is expected to be implemented by Puerto Rico soon. Obtaining a commercial license from the government of the U.S. Virgin Islands is contingent upon fishers submitting periodic reports of harvest and fishing effort. Supposedly, a similar report will be required to obtain a commercial license for fishing in Puerto Rican waters as well. The CFMC recently proposed complimentary harvest restrictions in the EEZ so that local laws could be enforced effectively.

Equally implicit in this same measure is a requirement that would limit personal-use or recreational fishers to three (3) queen conch per day. However, there are no permitting or reporting requirements identified. It would appear just as important to be capable of identifying recreational effort and harvest, which is totally unknown but likely substantial, in the event the CFMC desires to implement any kind of effort limitation or allowable catch program for queen conch.

Recommendation 1. Require an annual permit for the commercial and recreational harvest of queen conch from the management area.

Discussion: Insofar as the majority of conch resources are taken in waters under local jurisdiction, it would be more expedient to require that laws implemented by the local governments be extended to federal waters, rather than require separate permitting and data

collection systems in the EEZ. The systems would be operated by the local governments, and they may charge appropriate fees for administering the programs. Relatively few conchs are expected to be harvested from the deeper waters in the EEZ, especially if the proposed prohibition on the use of HOOKAH gear is adopted. As long as administrative costs are not exceeded, NMFS could adopt the permits in federal waters and retain the flexibility to sanction them as an enforcement mechanism.

Requiring annual permits on both the commercial and recreational (personal-use) fishers would identify the universe of harvesters unique to each sector. This information is basic to establishing or refining an allocation system for managing the conch fishery as discussed under rejected measure 6.6.4.

Recommendation 2. Require periodic reports from those engaged in the commercial or recreational harvest of queen conch from the management area.

Discussion: Periodic reports would be required by the local governmental agencies responsible for administering the permit program to more accurately determine actual participation, as well as catch, and the amount of effort expended in the queen conch fishery. Data collected would allow fishery scientists and managers to better assess the condition of the resource in the management area and make informed judgements for conserving those resources. These data also may serve as a basis for developing effort limitation programs for the queen conch fisheries. Reporting intervals and other requirements may be patterned after systems already tested and proven successful in other fisheries.

(B) Adjustment of Management Measures

Recommendation 3. Closely monitor the status of queen conch resources from expanded data collection efforts to determine appropriate management needs.

Discussion: Section 6.7 contains a procedure for refining management actions adopted by the CFMC. Data used in making these adjustments are contained in a SAFE report that is updated as new information becomes available. Changes in the condition of the resource, changes in fishing practices, environmental disasters, etc., may trigger the need for management adjustments. Adjustments that may be made under this procedure include changes to the FMU, harvest limitations (such as quotas, trip or daily landing limits), gear restrictions, and seasonal or areal closures.

Also, continual vigilance or monitoring is necessary to determine the success of the rebuilding program designed to eliminate overfishing. Each management measure must be

continually monitored and assessed. The results of those assessments would be included in the SAFE report. The mechanisms for adjusting management measures are fully described in Section 6.7, and jointly enlists efforts by federal and local governments, as well as CFMC and affiliated committees.

8.0 RELATED MANAGEMENT JURISDICTIONS, LAWS, AND POLICIES

The Magnuson Fishery Conservation and Management Act of 1976 (also shortened to the Magnuson Act or simply MFCMA) administered by the U.S. Secretary of Commerce (Secretary) established eight regional Councils and required them to develop a management plan for each fishery in the fishery conservation zone or exclusive economic zone (FCZ or EEZ) in need of management (U.S. Dept. of Commerce, 1990). The boundary of the EEZ is a line coterminous with the seaward boundary of each of the coastal or insular states (3 nautical miles for the U.S. Virgin Islands and 9 nautical miles for Puerto Rico) and extends seaward to a maximum distance of 200 nautical miles or to a point that intersects the EEZ of another nation, whichever occurs first. The Caribbean Fishery Management Council (CFMC) consists of the U.S. Virgin Islands and the Commonwealth of Puerto Rico and has authority over the fisheries in the Caribbean Sea and Atlantic Ocean seaward of those states. The CFMC has seven voting members, including four appointed by the Secretary from a list submitted by each state Governor -- at least one representative is appointed from each state. The list submitted by the Governors must consist of qualified individuals knowledgeable of commercial or recreational fishery resources within the geographical area of concern. The other voting members consist of the principal state official with marine management responsibility and expertise, and the regional director of the National Marine Fisheries Service (NMFS).

The Magnuson Act sets forth seven National Standards that must be followed in developing any FMP. The Secretary also published broad guidelines to assist the Councils in the development of FMPs and programs designed to rebuild overfished resources. The Secretary reviews, approves, and implements FMPs developed by the Councils so long as they are consistent with the Magnuson Act and other applicable law. The National Standards are:

1. Conservation and management measures shall prevent overfishing while achieving, on a continuing basis, the optimum yield from each fishery of the United States fishing industry.

2. Conservation and management measures shall be based upon the best scientific information available.

3. To the extent practicable, an individual stock of fish shall be managed as a unit throughout its range, and interrelated stocks of fish shall be managed as a unit or in close coordination.

4. Conservation and management measures shall not discriminate between residents of different States. If it becomes necessary to allocate or assign fishing privileges among various United States fishermen, such allocation shall be (a) fair and equitable to all such fishermen; (b) reasonably calculated to promote conservation; and (c) carried out in such manner that no particular individual, corporation, or other entity acquires an excessive share of such privileges.

5. Conservation and management measures shall, where practicable, promote efficiency in the utilization of fishery resources; except that no such measure shall have economic allocation as its sole purpose.

6. Conservation and management measures shall take into account and allow for variations among, and contingencies in, fisheries, fishery resources, and catches.

7. Conservation and management measures shall, where practicable, minimize costs and avoid unnecessary duplication.

8.1 FEDERAL

(A) MAGNUSON ACT (MFCMA)

The Queen Conch FMP is the fourth to be developed by the CFMC under the Magnuson Act and, to the extent possible, the management program complements that of the other FMPs. The first plan developed by the CFMC was the Spiny Lobster FMP. This was followed closely by the development of a Shallow-Water Reef Fish FMP that was later amended to a Reef Fish FMP to include deep-water reef fish resources and tropical aquarium fishes. The Reef Fish FMP contains provisions to establish marine coral reef reserves -- an action that could benefit all reef inhabitants, including queen conch. The third plan developed by the CFMC was the Coral FMP, which is basically a habitat protection plan, and has provisions for establishing marine conservation districts (MCD's). Anchoring and harvest prohibitions apply to MCD's that should also prove beneficial to conch resources. The fourth plan developed by the CFMC is the Queen Conch FMP, designed to restore overfished conch populations though the diverse mix of management actions described herein. This FMP also contains provisions for closing areas to harvest in order to rebuild overfished conch resources.

In addition to the above four FMPs, the U.S. Caribbean EEZ is also managed under three other FMPs governing the harvest of highly migratory species; i.e., Swordfish, Billfishes, and Sharks.

(B) NATIONAL ENVIRONMENTAL POLICY ACT (NEPA)

The NEPA requires that federal agencies prepare an Environmental Impact Statement (EIS) before implementing major actions that may significantly alter the quality of the human environment. The EIS may be either a separate document or consolidated with the FMP but, at a minimum, must evaluate the consequences of undertaking all major federal actions and asses the impacts of any reasonable alternatives to the preferred actions. Unless there is compelling evidence to the contrary, the alternative having the least impact on the human environment should be selected.

(C) ENDANGERED SPECIES ACT OF 1973 (ESA)

The ESA provides for the listing of threatened or endangered species of plants and animals. Once listed as threatened or endangered, any taking or harassing of that species is prohibited. Each FMP must evaluate the effects of the proposed management program upon all endangered or threatened species that occur in the management area. Federally listed species of relevance to the Queen Conch FMP are:

Leatherback turtle, Dermochelys coriacea, (endangered)
Hawksbill turtle, Eretmochelys imbricata, (endangered)
Green turtle, Chelonia mydas, (threatened)
Loggerhead turtle, Caretta caretta, (threatened)
West Indian manatee, Trichechus manatus, (endangered)

The latter species is also afforded sanctuary under the Marine Mammal Protection Act, which follows.

(D) MARINE MAMMAL PROTECTION ACT OF 1972 (MMPA)

This Act makes it unlawful (except for some native Americans) to kill or attempt to kill, capture, or harass any marine mammal; prohibits the importation of pregnant, nursing, or illegally taken marine mammals; and prohibits whaling within waters under U.S. jurisdiction. If any marine mammal may be adversely impacted by the proposed regulatory regime, these impacts must be analyzed in the EIS, and alternatives considered to mitigate those actions. A biological opinion must be prepared for each FMP, and discuss any anticipated impacts that prosecution of the fishery may have relative to marine mammals, or endangered/threatened species, or their habitat. Only after a "no jeopardy" opinion is secured, can the proposed management program be approved and implemented.

(E) COASTAL ZONE MANAGEMENT ACT OF 1972 (CZMA)

The CZMA encourages coastal and insular states to develop management programs that establish unified policies, criteria, and standards for managing land and water use in their coastal zone. States also may regulate activities in estuarine areas to protect environmentally sensitive resources. The CZMA has been amended to include non-point source pollution originating in inland areas. Participating states are routinely invited to evaluate each federal management proposal for consistency with their extant CZM program. For approval, federal management proposals must be consistent with state CZM programs "to the maximum extent practicable."

(F) VESSEL SAFETY ACT (P.L. 99-659)

The Magnuson Act was amended to require that vessel and crew safety be considered in the context of proposed regulations in an FMP. In making this determination, Councils rely generally on advice from the U.S. Coast Guard representative. It would appear that conch harvest limitations would reduce hazards to vessels and crews resulting from over-loading; and that HOOKAH prohibition should reduce the hazards associated with harvest and protect deep-water reproductive stocks. The spawning season closure overlaps the hurricane season to a great extent, and therefore, would serve to protect fishers and their vessels during that period.

(G) PAPERWORK REDUCTION ACT (PRA)

The PRA is designed to control the paperwork burden on the public resulting from information collections by the federal government. The Queen Conch FMP will require the submission of periodic reports of harvest and effort. This information is necessary for proper management of the fishery. In addition to catch/effort information, other data will be required to improve and evaluate the socio-economic aspects of the management program. Those that fail to provide information on a timely and accurate basis may lose their permits. Permits would be issued and data collected by the local governments since the fishery is prosecuted almost entirely within state waters.

It is unknown how many fishers are likely to apply for permits to commercially harvest conch; however, the number is not expected to be large because of the condition of the resource -- landings have declined significantly in recent years. Other restrictions on the use of HOOKAH gear may also serve to reduce participation in the fishery. Overall, the total number of burden hours associated with the collection of additional information is expected to be small.

(H) REGULATORY IMPACT REVIEW (RIR)

With the emergence of a new administration in 1992 Executive Order (E.O.) 12291, "Federal Regulation," was changed to E.O. 12866, "Regulatory Planning and Review." The requirements for analyzing the benefits and costs of the proposed actions are the same in both the old and new orders, as the "Guidelines on Regulatory Analysis of Fishery Management Actions" remain unchanged. The National Marine Fisheries Service (NMFS) requires the preparation of a Regulatory Impact Review (RIR) for all regulatory actions that either implement a new FMP or significantly amend an existing FMP. The RIR is part of the process of preparing and reviewing FMPs and provides a comprehensive review of the changes in net economic benefits to society associated with proposed regulatory actions. The analysis also provides a review of the problems and policy objectives prompting the regulatory proposals and an evaluation of the major alternatives that would solve the problems. The purpose of the analysis is to ensure that the regulatory agency systematically and comprehensively considers all viable alternatives, so that public welfare can be enhanced in the most efficient and cost-effective way.

The RIR should also contain sufficient information to determine whether the proposed rule has a "significant economic impact on a substantial number of small entities" under the Regulatory Flexibility Act (RFA). The RIR appears in Appendix II.

(I) SOCIOLOGICAL IMPACT ASSESSMENT (SIA)

Recent Magnuson Act amendments require that proposed management actions also assess the impacts of an FMP or major amendment on society. Two documents prepared by Dr. Manuel Valdés Pizzini in 1992 summarize and analyze all of the available sociological data on the Conch Fishery. These documents are: "Social Impact Assessment on the Shallow-Water Reeffish, Queen Conch and Coral Fishery Management Plans," pages 99-104; and "Socio-Economic Documentation of the Puerto Rican Fishermen (Divers) for the Conch Fishery Management Plan", the latter one serves as SIA (Appendix I).

(J) FEDERALISM (EXECUTIVE ORDER 12612)

E.O. 12612, effective October 26, 1987, requires that 'federalism' principles be considered in the formulation and implementation of federal policies. This proposed action does not contain policies with federalism implications sufficient to warrant preparation of a federalism assessment.

8.2 LOCAL LAWS AND REGULATIONS

The Puerto Rico Department of Natural and Environmental Resources (DNER) and the U.S. Virgin Islands Department of Planning and Natural Resources (DPNR) are the state institutions responsible for the management of marine resources. Because the preponderance of fishery resources are taken from waters under state jurisdiction, both local governments have long since acknowledged the CFMC as their management authority and agreed to implement management measures that are compatible with those adopted by the Council. This arrangement is signified in letters from former Governors Juan Luis of the U.S. Virgin Islands and Carlos Romero Barceló of Puerto Rico (Tables 7 and 8).

(A) INDIGENOUS AND ENDANGERED SPECIES PERMITS--ACT 5665

This Act provides for the protection of indigenous, endangered and threatened fish, wildlife and plants in the U.S. Virgin Islands. It lists species that are of local interest and that are not protected under federal law. None of the species included in the fishery management unit of this FMP are listed in Act 5665. The only species managed by the CFMC and listed under this Act are the jewfish, Epinephelus itajara, and black corals (Order Antipatharia). Sea turtles, marine mammals, as well as certain other species are protected under federal law.

(B) RULES AND REGULATIONS COMMERCIAL FISHING TITLE 12 CHAPTER 9A VIRR, "CONCH AND WHELK HARVESTING" FOR THE UNITED STATES VIRGIN ISLANDS SUBCHAPTERS 301 TO 307, 316 AND 325, APRIL 26, 1994 (AMENDED JULY 12, 1994).

The purpose is to preserve, manage and protect the fishery resources, to regulate fishing and to secure its increase and development in all marine, estuarine and freshwater habitats. Subchapter 316 establishes a closed season for conch (Strombus gigas) to begin July 1 and end September 30 of each successive year; no possession or harvest is allowed during the closed season. No person is permitted to retain, remove, possess, sell, or injure conch that are less than 9 inches in length or less than 3/8 inch lip thickness. All conch landed must be alive and in the shell. Any person harvesting conch for personal use is allowed 6 conch per day, not to exceed 24 conchs per boat. Any person with a commercial fishing license may take a maximum of 75 conchs per day.

The closed season for whelk (Cittarium pica) begins April 1 and ends September 30 of each successive year. No person is permitted to retain, remove, possess, sell, or injure whelk that are less than two and seven/sixteenths inches. All whelk must be landed alive and in the shell.

The sale and transportation of preserved species during the closed season is allowed after notification and inspection by the Director of Enforcement.

The regulations were recently amended (July 12, 1994) to provide for the importation of frozen conch during the closed season and increase the commercial limit to 150 conch during the open season.

(C) THE FISHERIES ACT NO. 83 OF MAY 13, 1936, 12 L.P.R.A. #41 et seq. (LEY DE PESCA DE PUERTO RICO)

The Fisheries Act protects and promotes fish life. The statute declares that all species of fish (which includes mollusks, crustaceans, aquatic mammals and plants), and all other species comprising the marine, lacustrine and fluvial fauna and flora are property of the Commonwealth of Puerto Rico. The Act allows for management measures to be implemented by the Secretary of the Department of Natural Resources (under amendment) and prohibits the use of poisons and explosives. The Act includes the option of imposing closed seasons or fishing prohibitions to protect species during reproductive and young stages to restore the population in areas where it shows signs of decline. In addition the Secretary is authorized to establish size limits, gear limitations and in general regulate fishing activity on the Island. It also covers the licensing of fishers although it specifically excludes as fishers those who use the fishing boat and gear to feed their families, trade live fish for aquaria, or ornamental purposes.

(D) LEY ORGANICA DEL DEPARTAMENTO DE RECURSOS NATURALES, LAW 23 OF 20 JUNE, 1972, AND AMENDMENTS, 3 L.P.R.A., #151 et seq. (Puerto Rico)

This Law created the Department of Natural Resources and established its authority over the protection and management of water and natural resources in Puerto Rico. Specifically including the conservation and management of territorial waters.

(E) FISHING REGULATION OF JULY 11, 1984, DEPARTMENT OF STATE REGULATION NO. 3179 OF DECEMBER 6, 1984

The Secretary of the Department of Natural Resources may regulate commercial and recreational fishing with respect to gears, bag limits, sizes, and fishing areas.

(F) LEY DE VIDA SILVESTRE DEL ESTADO LIBRE ASOCIADO DE PUERTO RICO ACT NO. 70, MAY 30, 1976; 12 L.P.R.A., #81 et seq. (Wildlife Act of the Commonwealth of Puerto Rico)

This Law provides protection for federally and locally listed endangered/threatened species in Puerto Rico.

(G) LEY DE VIGILANTES DE RECURSOS NATURALES DEL DEPARTAMENTO DE RECURSOS NATURALES, LAW 1 OF 1 JULY, 1977, 12 L.P.R.A., #1201 et seq. (Puerto Rico)

The Ranger Corps is assigned to the Department of Natural Resources and is empowered to protect, supervise, conserve and defend natural resources. It is the principal body enforcing laws and regulations pertaining to natural resources in Puerto Rico. There are Cooperative Agreements concerning enforcement in state and federal waters currently in effect between the Coast Guard, NMFS and the Department of Natural Resources in the Puerto Rico/U. S. Virgin Islands area (See Section 4.2).

(H) REGULATION TO CONTROL THE EXTRACTION, POSSESSION, TRANSPORTATION AND SALE OF CORAL RESOURCES OF PUERTO RICO OF OCTOBER 11, 1979, DEPARTMENT OF STATE REGULATION NO. 2577 OF NOVEMBER 5, 1979

This regulation covers the extraction, destruction, transportation, possession or trade of any coral living or dead with exemptions provided for scientific and educational activities, and for commercial extraction, on approval of permitting by the Secretary of the Department of Natural Resources. Included under this regulation is damage to corals caused by anchoring, trap deployment or other destructive activities. Corals included are stony coral (scleractinians), horny corals (octocorals), black corals (antipatharians), and hydrocorals (hydrozoans with a calcium carbonate skeleton).

(I) LEY DE ARENA, GRAVA Y PIEDRA, LEY 132 DEL 25 DE JUNIO DE 1968, AS AMENDED, 28 L.P.R.A., #207-220F (Puerto Rico)

This Law regulates the extraction of components of the earth's crust on public and private land which have not been designated as economically valuable minerals, including sand, gravel, rock and earth. Extraction is only allowed under permit from the Department of Natural Resources, which has interpreted this law to include live-rock. Extraction is unlikely

to be permitted in reserves or reefs, or in swimming or recreational areas. The law has a citizen's clause which allows any citizen to denounce any other citizen who has infringed the law or the Secretary of the Department of Natural Resources if he does not conform to the law.

This Law prohibits the expedition of permits for the extraction, removal, excavation or dredging of the earth's crust in the public domain when the intent is export outside of the authority of Puerto Rico. It also prohibits such activities when these are deemed to damage fishing and recreation activities, the integrity of reef systems or a reserve area.
The law requires, for the purpose of giving or negating a permit, that the effects of the activity to be performed (extraction) in adjacent areas, erosion, the action of the waters, tides and changes in these which might affect the reefs, etc., be taken into consideration. Specific limitations are considered when the proposed activities are to be carried out in fishing areas, reefs, etc., and such activities will affect the integrity of the natural systems.

(J) LEY DEL PROGRAMA DEL PATRIMONIO NATURAL DE PUERTO RICO, LAW 150 OF 4 AUGUST, 1988, 12 L.P.R.A., #1225 et seq.

This Law provides a number of mechanisms for the protection of biodiversity and threatened areas. It covers the identification of areas where plants and animals are considered to be vulnerable or in danger of extinction. It also empowers the Department of Natural Resources to recommend Natural Reserve areas, and to acquire land to protect wildlife or habitats of concern.

(K) LEY DE MINAS, LAW 9 OF 18 AUGUST, AMENDED IN 1975, 28 L.P.R.A., #110 et seq. (Puerto Rico)

This Law establishes that the exploitation of mineral resources must be carried out in a manner compatible with the conservation of other resources of the Nation.

(L) LEY DE CONSERVACION Y DESARROLLO DE CULEBRA, LAW 66 OF 22 JUNE, 1975, 21 L.P.R.A., #890 et seq. (Puerto Rico)

This Law was enacted to protect and conserve the ecological integrity of Culebra and surrounding waters.

(M) LAW 67 FOR THE PROTECTION OF ANIMALS - PENAL CODE OF PUERTO RICO, MAY, 1973

This Law governs the handling and treatment of living animals and their maintenance while under captivity or undergoing transportation.

(N) REGLAMENTO PARA LA PESCA DE LA LANGOSTA (Panulirus argus) DEL DEPARTAMENTO DE RECURSOS NATURALES DEL 11 DE JULIO DE 1984 (Puerto Rico)

This Law establishes compatible regulations with the Fishery Management Plan for the Spiny Lobster Fishery of Puerto Rico and the U.S. Virgin Islands (1981). Establishes minimum size of 3 1/2 inches CL; a prohibition on the capture of berried female lobsters; a general permit and gear/boat owner identification; prohibits tampering with other fishers gear; lobster pots are required to have a self-destruct panel; restricts fishing gear to the use of snares or by hand (spearguns, hooks, explosives, drugs or chemical products are prohibited).