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DEPARTMENT OF COMMERCE

National Oceanic and Atmospheric Administration

[Docket No. 1206013478-4863-03]

RIN 0648-XB140

Endangered and Threatened Wildlife and Plants: Notice of 12-Month Finding on a Petition to List the Queen Conch as Threatened or Endangered Under the Endangered Species Act (ESA)

AGENCY: National Marine Fisheries Service (NMFS), National Oceanic and Atmospheric Administration (NOAA), Commerce.

ACTION: Notice of 12-month finding.

SUMMARY: We, NMFS, announce a 12-month finding and listing determination on a petition to list the queen conch (Strombus gigas) as threatened or endangered under the Endangered Species Act (ESA). We have completed a comprehensive status report for the queen conch in response to the petition submitted by WildEarth Guardians. Based on the best scientific and commercial information available, including the status report (NMFS, 2014a), we have determined that the species does not warrant listing at this time. We conclude that the queen conch is not currently in danger of extinction throughout all or a significant portion of its range nor is it not likely to become so within the foreseeable future.

DATES: This finding was made on [insert date of publication in the FEDERAL REGISTER].

ADDRESSES: Documents associated with this determination and reference list – are available by submitting a request to the Species Conservation Branch Chief, Protected Resources Division, NMFS Southeast Regional Office, 263 13th Avenue South, St. Petersburg, FL 33701-5505, Attn: Queen Conch 12-month Finding. The reports are also available electronically at:

http://sero.nmfs.noaa.gov/protected_resources/listing_petitions/index.html

FOR FURTHER INFORMATION CONTACT: Calusa Horn, NMFS, Southeast Regional Office (727) 824-5312.

SUPPLEMENTARY INFORMATION:

Background

On February 27, 2012, we received a petition from WildEarth Guardians to list the queen conch (Stombus gigas) as threatened or endangered under the Endangered Species Act of 1973. The petitioner also requested that critical habitat be designated for this species concurrent with listing under the ESA. The petition stated that overfishing is the greatest threat to queen conch and is the principal cause of population declines. It also argued that the existing regulations are ineffective and unable to prevent the unsustainable and illegal harvest of queen conch. The petitioner asserted that biological characteristics (e.g., slow growth, late maturation, limited mobility, occurrence in shallow waters, and tendency to aggregate) render the species particularly vulnerable to overharvest, and that Allee effects are preventing the recovery of overexploited stocks. The petitioner also argued that degradation of shallow water nursery habitat and water pollution, specifically high concentrations of zinc and copper, reduces juvenile recruitment and causes reproductive failure.

On August 27, 2012, we published a 90-day finding with our determination that the petition presented substantial scientific and commercial information indicating that the petitioned action may be warranted (77 FR 51763). The 90-day finding requested scientific and commercial information from the public to inform a status report of the species. We requested information on the status of the queen conch throughout its range including: (1) Historical and current distribution and abundance of this species throughout its range; (2) historical and current population trends; (3) biological information (life history, genetics, population connectivity, etc.); (4) landings and trade data; (5) management, regulatory, and enforcement information; (6) any current or planned activities that may adversely impact the species; and (7) ongoing or planned efforts to protect and restore the species and its habitat. We received information from the public in response to the 90-day finding, and relevant information was incorporated into the status report.

Listing Species under the ESA

We are responsible for determining whether queen conch are threatened or endangered under the ESA (16 U.S.C. 1531 et seq.). To make this determination, we first consider whether a group of organisms constitutes a "species" under Section 3 of the ESA, then whether the status of the species qualifies it for listing as either threatened or endangered. Section 3 of the ESA defines species to include "any subspecies of fish or wildlife or plants, and any distinct population segment [DPS] of any species of vertebrate fish or wildlife which interbreeds when mature." Thus, as an invertebrate, the queen conch can only be considered for listing as a taxonomic species or subspecies. The species diagnosis for the queen conch has been established since its original taxonomic description in Linnaeus (1758). While some higher taxonomic changes have been considered, the classification as a separate species has not been debated. Therefore, based on the best information available, the queen conch (S. gigas) constitutes a "species" under the ESA.

Section 3 of the ESA also defines an endangered species as "any species which is in danger of extinction throughout all or a significant portion of its range" and a threatened species as one "which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range." In the context of the ESA, NMFS interprets an "endangered species" to be one that is presently at risk of extinction. A "threatened species" is not currently at risk of extinction, but is likely to become so in the foreseeable future. The key statutory difference between a threatened and endangered species is the timing of when a species may be in danger of extinction, either now (endangered) or in the foreseeable future (threatened).

We have followed a step wise approach in making this listing determination for the queen conch. First we conducted a biological review of the species' taxonomy, distribution, abundance, life history, biology, and available information on threats affecting the species' status was compiled into a status report (NMFS, 2014a). In this report we also defined the foreseeable future for our evaluation of extinction risk. Then we established a group of biologists and marine mollusk experts (hereafter referred to as the Extinction Risk Analysis (ERA) group) to conduct a threats assessment for the queen conch, using the information in the status report. The ERA group was comprised of six ESA-policy experts from NMFS' Office of Protected Resources and the Southeast and Southwest Regional Office's Protected Resources Divisions, three biologists with fisheries management expertise from NMFS' Southeast Region's Sustainable Fisheries Division (SFD), and two marine mollusk biologists from NMFS' Northwest and Southeast Fisheries Science Centers. The ERA group had expertise in marine mollusk biology, ecology, population dynamics, ESA-policy, and fisheries management. The group members were asked to independently evaluate severity, scope, and certainty for each threat currently and in the foreseeable future (15 years from now).

In addition to the ERA group's assessment, we undertook additional analysis to help us better consider the species' current status and extinction risk, beyond the information in the status report alone. The Southeast Fisheries Science Center (SEFSC) and the Southeast Region's Sustainable Fisheries Division (SFD) provided: (1) queen conch abundance estimates; (2) a meta-analysis of factors affecting the status and health of queen conch; (3) a mapping of queen conch densities and oceanographic currents for evaluating dispersal and recruitment of queen conch; and (4) a sustainability index. The ERA group did not take into account this information, because it was prepared after the extinction risk analysis was conducted. Next, we used the information generated by the status report, the ERA, and other information to make a final determination on the severity, scope, and certainty of the extinction risk of threats across the species' range, now and over the foreseeable future.

Then we determined whether the queen conch qualifies for threatened or endangered status throughout all or a significant portion of its range. The statute requires us to determine whether any species is endangered or threatened as a result of any one or a combination of the following five factors: The present or threatened destruction, modification, or curtailment of its habitat or range; overutilization for commercial, recreational, scientific, or educational purposes; disease or predation; the inadequacy of existing regulatory mechanisms; or other natural or manmade factors affecting its continued existence (ESA, section 4(a)(1)(A)-(E)). After conducting the five factor threat analysis we evaluated the available information to determine whether there is a portion of the species range that is "significant" in light of the use of the term in the definitions of threatened and endangered. To do so we followed the final policy interpreting the phrase "significant portion of its range" (79 FR 37578; July 1, 2014). The policy states that a portion of the range of a species is significant if the species is not currently endangered or threatened throughout its range, but the portion's contribution to the viability of the species is so important that, without the members in that portion, the species would be in danger of extinction, or likely to become so in the foreseeable future, throughout all of its range. We were unable to identify any significant portion of the species' range, where its status is different than that we identified for the species rangewide.

Taxonomy

Strombus gigas is a mollusk in the class Gastropoda, order Neotaenioglossa and family Strombidae. Synonyms include Lobatus gigas (Linnaeus, 1758), S. lucifer (Linnaeus, 1758), Eustrombus gigas (Linnaeus, 1758), Pyramea lucifer (Linnaeus, 1758), S. samba (Clench, 1937), S. horridus (Smith 1940), S. verrilli (McGinty, 1946), S. canaliculatus (Burry, 1949) and S.pahayokee (Petuch, 1994).

The queen conch is a large gastropod mollusk that is identified by its large, whorl-shaped shell with multiple spines at the apex and by the pink interior of the shell lip. The outside of the shell becomes covered by an organic periostracum layer as the queen conch matures, which can be much darker than the natural color of the shell. Shell morphology is highly plastic and environmental conditions appear to be a strong influence on shell morphology and growth (Martin-Mora et al., 1995; McCarthy, 2007). Therefore, shells of the same age can vary in size due to habitat and geographic nuances. Characteristics used to distinguish S. gigas from other conch in the family Strombidae include: (1) large, heavy shell; (2) short, sharp spires; (3) brown and horny operculum and; (4) bright pink shell interior (Prada et al., 2008), as well as differences in geographic distribution and maximum size (Simone, 2005).

Distribution

The geographic distribution of queen conch ranges from Bermuda to the north, Panama to the south, Barbados to the east, and the Gulf Coast of Mexico to the west. The queen conch occurs throughout the Caribbean Sea and the Gulf of Mexico. It has been reported from the following countries and territories: Antigua and Barbuda, Aruba, Anguilla, Barbados, Bahamas, Belize, Bermuda, Caribbean Netherlands, Colombia, Costa Rica, Cuba, Curaçao, Dominican Republic, French West Indies, Grenada, Haiti, Honduras, Mexico, Montserrat, Nicaragua, Panama, Puerto Rico, St. Maarten, St. Kitts and Nevis, St. Lucia, St. Vincent and the Grenadines, Trinidad and Tobago, the Turks and Caicos, the United States (Florida), the U.S. and the British Virgin Islands, and Venezuela (Theile, 2001). The species has been reported from most islands within its geographic range at some time (Appeldoorn and Baker, 2013).

Diet, Habitat, and Movement

Queen conch are herbivores and benthic grazers (Randall, 1964; CFMC, 2005) that feed on diatoms, seagrass detritus, macroalgae and epiphytes (Stoner et al., 1995;

Stoner, 2003). Adults forage on different types of filamentous algae (Ray and Stoner, 1994; Creswell, 1994). Green algae (Batophora oerstedii) may be a preferred diet item as higher conch densities are correlated with its presence and a conch aggregation was noted as modifying movement toward it (Stoner and Ray, 1993). About 60 percent of juvenile conch diet is composed of seagrass detritus (Stoner, 1989b; Stoner and Waite, 1991), with seagrass epiphytes providing additional nutrition (Stoner, 1989a). In sand habitat, juveniles also feed on diatoms and cyanobacteria that are found in the benthos (Creswell, 1994; Ray and Stoner, 1995).

Queen conch change habitats as they grow. During the early planktonic life stage, queen conch larvae (called veligers) feed on phytoplankton in the water column. Larvae must receive the right amount of nutrition during this stage, or development can be delayed (Brownell, 1977). Larvae then settle in seagrass to metamorphose into juveniles. These seagrass nursery areas need physical and oceanographic processes to ensure larval settlement and retention and abundant prey to support early development (Stoner et al., 1998; Stoner et al., 2003). Larvae settle and bury themselves in the sand until they approach a year in age, then they emerge during warmer summer months and disperse throughout seagrass (Iversen et al., 1986; Stoner et al., 1988; Jones and Stoner, 1997).

Juveniles occur primarily in back reef areas (i.e., shallow sheltered areas, lagoons, behind emergent reefs or cays) in areas of medium seagrass density, at depths between 2 to 4 m, with strong tidal currents (at least 50 cm/s; Stoner, 1989b) and frequent tidal-water exchange (Stoner and Waite, 1991; Stoner et al., 1996). In experimental conditions, juvenile queen conch actively selected seagrass plots with intermediate densities of seagrass biomass. This density of seagrass is thought to provide both nutrition and protection from predators (Ray and Stoner, 1995; Stoner and Davis, 2010). In one study, all juveniles were found within 5 km of the Exuma Sound inlet, Bahamas, emphasizing the importance of currents and frequent tidal water exchange on both larval supply and their algal food (Jones and Stoner, 1997). Juveniles have also been found in deeper, open shelf areas, but little is known of settlement dynamics in these deeper waters. Conch nursery areas typically occur in shallow seagrass meadows of intermediate densities (Jones and Stoner, 1997) and support juvenile conch in densities of 1,000 to 2,000 individuals per hectare (Wood and Olsen 1983; Weil and Laughlin 1984).

Juvenile conch are gregarious; solitary individuals move toward juvenile aggregations, and individuals within these aggregations remain there until close to adulthood (Stoner and Ray, 1993). Juvenile queen conch within dense aggregations have higher survivorship, supporting a predator avoidance role of aggregation behavior (Stoner and Ray, 1993). Aggregations of juvenile conch are found in water depths of less than 4 m year-round, peaking in March. Well-defined aggregations can remain together for at least 5 months, but they usually last for 2 to 3 months (Stoner and Lally, 1994). There may be some seasonality in the direction of movement (Stoner and Lally, 1994). Movement of juvenile aggregations increased with low food supply, decreased when heavy algal mats were encountered, and may temporarily stop during high wave action and low temperatures which occur during winter months (Stoner, 1989a; Stoner and Lally, 1994).

Adult queen conch tolerate a wider range of environmental conditions compared to the specific habitat requirements of juveniles (Stoner et al., 1994). Adults prefer sandy algal flats but can also be found in areas of seagrass meadows, gravel, coral rubble, smooth hard coral, or beach rock bottoms (Torres-Rosado, 1987; CFMC, 1996a; Acosta, 2001; Stoner and Davis, 2010). Adult queen conch are rarely, if ever, found on soft bottoms composed of silt and/or mud, or in areas with high coral cover (Acosta, 2006). Females laying egg masses are generally found in coarse sandy habitats or patches of bare sand, but occasionally in seagrass (Glazer and Kidney, 2004; McCarthy, 2008).

Adult conch are often found in clear water of oceanic or near-oceanic salinities at depths generally less than 75 m and usually less than 30 m (McCarthy, 2008). It is believed that depth limitation is based mostly on light attenuation limiting their photosynthetic food source (Randall, 1964; McCarthy, 2008). The average home range size for adult queen conch has been measured at about 5.98 ha in Florida (Glazer et al., 2003), 0.6 to 1.2 ha in Barbados (Phillips et al., 2011), and 0.15 to 0.5 ha in the Turks and Caicos Islands (Hesse, 1979). Adult males and females have no significant difference in movement rate, site fidelity, or size of home range (Glazer et al., 2003).

The seasonal movements of adult conch are associated with summer mating and egg-laying (Stoner and Sandt, 1992). During the summer months, queen conch move from feeding habitats to mating and egg-laying habitats in shallow water (Stoner and Sandt, 1992). Several studies have reported that adult queen conch move to nearshore habitats during their reproductive season, but return to feeding habitats after mating and egg-laying (Stoner and Sandt, 1992; Hesse, 1979; Glazer et al., 2003). These movements are well known and are associated with factors like change in temperature, available food resources, and predation. This seasonal movement pattern has been documented in Venezuela, the U.S. Virgin Islands, and the Bahamas (Weil and Laughlin, 1984; Coulston et al., 1988; Wicklund et al., 1988; Stoner et al., 1992). Not all conch move into shallow waters during the reproductive periods; conch found in the deeper waters near Puerto Rico and Florida are geographically isolated from nearshore shallow habitats and remain offshore year round (Glazer et al., 2008; Garcia-Sais et al., 2012).

Reproductive Biology

Mating occurs in the summer when adult conch move to shallower water to form mating aggregations and find mates as the species is an internal fertilizer (Appeldoorn 1988c; Stoner and Sandt, 1992). Mating success and egg-laying are directly related to the density of mature conch (Stoner and Ray-Culp, 2000; Stoner et al., 2011; Stoner et al., 2012). At low densities, the probability of encounters between males and receptive females is significantly reduced and overall reproductive success is impacted (Stoner and Ray-Culp, 2000). The effects of density on reproduction are discussed below.

Queen conch have a protracted mating season, with maximum mating and egg laying occurring during summer months (Appeldoorn, 1988c; Berg et al., 1992a). Aggregations form in the same location year after year (Posada et al., 1997; Glazer and Kidney, 2004; Marshak et al., 2006). The length of the breeding season varies geographically according to water temperature, but it generally occurs during the months of April to October (Avila-Poveda and Baqueiro-Cardenas, 2009), with conch copulation occurring both day and night (Randall, 1964).

Females can store fertilized eggs for several weeks before laying eggs (David et al., 1984), and multiple males can fertilize a single egg mass (Medley, 2008). Egg masses are deposited through the egg groove in the shell over 24 to 36 hours (Randall, 1964). Queen conch are highly productive, with each female laying millions of eggs each year. When adequate food is available, female conch can lay an average of 13.6 egg masses, containing about 750,000 eggs each; resulting in about ten million eggs produced per individual per reproductive season (Appeldoorn, 1993). Female conch that had less food available produced 6.7 egg masses, containing 500,000 eggs, resulting in about 3.3 million eggs per individual per reproductive season (Appeldoorn, 1993). Egg masses have been found in water depths ranging from 3 to 45 m (Tewfik et al., 1998; García-Sais et al., 2012). Clean, low organic content, coarse sand flats are the preferred habitat for reproduction and egg laying (Randall, 1964; Glazer and Kidney, 2004). Adherence of sand grains to the egg mass may provide camouflage and discourage predation (Randall, 1964).

Life Stages and Growth

Female queen conch deposit eggs in strings that hatch after 3 to 5 days as veliger larvae (Weil and Laughlin 1984). The queen conch veligers have wing-like lobes covered with bristly hairs, called cilia – which aid in locomotion and direct microscopic algae to their mouth (FFWCC, 2006). These veligers are planktonic for generally 14 to 28 days, up to 60 days (D'Asaro, 1965). The larvae suffer high mortality rates (Chávez and Arreguín-Sánchez, 1994). These veligers are found primarily in the upper few meters of the water column (Posada and Appeldoorn, 1994; Stoner and Davis, 1994; Stoner, 2003) in densities ranging between 0-9.1/100 m^3 in the Florida Keys to 2.3-32.5/100 m^3 in the Exuma Cays, Bahamas (Stoner et al., 1996). Depending on local currents, the veligers can settle locally or drift to other locations (CFMC, 1999). Metamorphosis is known to be induced by a chemical cue often associated with red algae or a similarly polar molecule (Myanmanus, 1988; Davis, 1994). The preferred habitat for larval queen conch settlement is shallow back reefs areas and sand bars near seagrass (Stoner et al., 1994). Larval settlement also occurs in deeper areas (CRFM, 2004). After settling, the post-larvae bury themselves into the sediment for about 1 year (Stoner, 1989a), after which they emerge as juveniles with a shell length around 60 mm. It is difficult to survey conch during this submerged life phase and therefore juveniles are often under-sampled (Hesse, 1979; Appeldoorn 1987b).

Growth of queen conch is seasonal and is positively correlated with water temperature and food availability. Summer growth rates are faster than winter growth rates (Stoner and Ray, 1993). Juvenile growth rates in the Bahamas were 4.4 to 16.3 mm per month in the summer and 1.8 to 3 mm per month for the reminder of the year (Iversen et al., 1987). Shell length continues to increase until the onset of sexual maturation. The queen conch reaches sexual maturity at around 3.5 to 4 years, about the time when the edge of the shell lip turns outward to form the flared lip (Stoner et al., 2012a). Once the shell lip is formed, shell length does not increase (Appeldoorn, 1997; Tewfik et al., 1998). Appeldoorn (1988b) observed that, for thin-lipped males in Puerto Rico, true reproductive maturity occurred 2 months after the lip flares outward, at about 3.6 years of age. Based on histological examinations, Appeldoorn (1993) found that 100 percent of conch are not fully mature until over a year after complete lip formation. Shell thickness of at least 15 mm seems to be a better indicator of sexual maturity than the presence of the flared lip (Stoner et al., 2012b; Appeldoorn, 1994; Clerveaux et al., 2005; Stoner et al., 2009; Stoner et al., 2012b).

With the onset of sexual maturity, growth of somatic tissue within the shell will begin to decrease with increasing gonadal weight. Eventually, the volume inside the shell can no longer accommodate somatic tissue growth and the tissue weight will start to decrease (CFMC, 1999). Stoner et al. (2012b) found that both soft tissue weight and gonad weight started to decrease when shell lip thickness reaches 22 to 25 mm. Growth rate and shell morphology of queen conch can vary depending on sex, depth, latitude, food availability food, age class, and habitat. On average, female queen conch grow more quickly than males (Alcolado, 1976), and to a bigger size (Randall, 1964). The life span of queen conch is about 30 years (McCarthy, 2007).

Larval Dispersal and Population Connectivity

Queen conch veligers remain in the water column for up to 60 days. They are photopositive so they remain in surface waters and will be primarily distributed by surface currents (Barile et al., 1994). Dispersal of the planktonic veligers via the currents is the primary mechanism for maintaining genetic connectivity of queen conch throughout the Caribbean Sea (Appeldoorn et al., 2011). The regional hydrodynamics and circulation patterns in the Caribbean are complex, with numerous gyres and fine-scale features. Surface currents in the Caribbean Sea generally flow from east to west through the Yucatan Strait into the Gulf of Mexico and the Florida Straits, turning north and moving up the east coast of Florida. In addition, some current flow occurs from east to west along the Greater Antilles and northwest through the Turks and Caicos and the Bahamas' (Stoner and Banks unpublished, 2013). These current patterns are believed to link queen conch populations in the Caribbean into one large mixed population with little or no population structure or mating restrictions in the population with some local anomalies (Morales, 2004).

Nonetheless, there are restrictions governing larvae transport and recruitment. Geographic areas near strong currents are dependent on queen conch recruits that are susceptible to changes in currents. The circulations patterns in the Caribbean Sea are complex with numerous gyres and fine-scale features that can restrict larvae dispersal, retaining larvae within close proximity to the parental stocks, which can create patterns of localized self-recruitment marine species (Cowen et al., 2006; Kool et al., 2010). The available information on the gene flow of queen conch is limited, but some studies have shown that queen conch populations may be more distinct and ecologically separated from one another than initially believed. Perez-Enriquez et al. (2011) analyzed mitochondrial DNA markers among queen conch populations in Mexico. This study indicated that queen conch at the Alacranes Reef were genetically distinct from conch populations at Cozumel and Banco Chinchorro in Mexico that were separated by 450 to 643 km, respectively. Similarly, in the Bahamas, preliminary data detected genetic separation in queen conch populations that were located approximately 500 km from one another (Banks et al., 2014). In addition, two nearby populations of queen conch in St. Lucia were found to be genetically different from each other, most likely a result of the east and west currents that prohibit the exchange of larvae between the two locations (Mitton et al., 1989).

Numerous patterns of queen conch larval dispersal have been described. Queen conch larvae can either be transported long distances via currents (Posada et al., 1997) or can supply local recruitment via retention in gyres and eddies (Appeldoorn, 1997). Areas that supply large numbers of larvae are known as sources; areas where large numbers of larvae settle are known as sinks. Drift vials have been used to explore patterns of larval dispersal via currents. Delgado et al. (2008) released vials along the Yucatan coast and suggests that most queen conch larvae remained local or were transported north.

Transport of queen conch veligers from Yucatan to West Palm Beach, Florida, could occur based on recovery of one drift vial (Delgado et al., 2008). Some locations, such as Banco Chinchorro, an atoll reef off the southeast coast of Quintana Roo, Mexico, are known to supply, receive, and retain planktonic larvae within close proximity to the parental stocks (Cowen et al., 2006; Kool et al., 2010). Specifically, Banco Chinchorro receives queen conch veligers via westerly currents from locations to the east such as Jamaica and supplies larvae westward to Quintana Roo, Mexico, with a small percentage moving to Florida, Texas, Cuba, and the Bahamas (de Jesús-Navarrete and Aldana Aranda, 2000; Delgado et al., 2008; Paris et al., 2008).

The Windward Islands, Belize, and Pedro Bank, Jamaica, have both been hypothesized to be sources of queen conch larvae (Posada et al., 1997; Stoner, 2006). A large-scale gyre in the Belize-Honduras bight is thought to transport larvae from the deep fore-reef and connect queen conch populations throughout Belize (CRFM, 2004). Annual variations in queen conch larval recruitment in Roselind Bank, Colombia are influenced by its proximity to the Caribbean Current (Regalado, 2012). In Colombia, the recovery of queen conch on Serrano Bank after a 5-year closure is thought to be the result of immigration of larvae from Roncador Bank (Prada et al., 2008). In the Exuma Cays, Bahamas, queen conch larvae appear to be local and transported from the southeast to the northwest, moving through the island passes and settling on the west side of the island chain (Stoner, 2003). Larval density data from the Bahamas support this distribution pattern with high densities of early stage larvae in the north near Waderick Wells and lower densities in the south near Cat Island (Stoner et al., 1998), as well as high densities at both the northern Exuma Cays and south coast of Eleuthera (Posada et al., 1997).

In the eastern Caribbean, a survey by Posada and Appeldoorn (1994) found no queen conch larval movement between the islands of Martinique and St. Lucia or between St. Lucia and St. Vincent. High concentrations of larvae are found in the vicinity of the Grenadines which indicates larvae are being retained there. Nevis has been identified as a regional queen conch larvae settlement sink (CFMC, 1999). Elsewhere in the eastern Caribbean, local influxes of queen conch larvae must occur, given there are no possible upstream currents for larvae immigration (Stoner, 2006).

Bermuda, Florida, and Barbados represent the range limits of queen conch distribution, and they may also be areas isolated from external sources of larvae. Bermuda, a volcanic sea mount, is at the northern extent of the range. Most queen conch breeding aggregations in Bermuda have been located on the edge of the reef platform, adjacent to high current that would potentially carry the larvae away (Berg et al., 1992a). These two factors, geographic isolation and limited larval recruitment, are thought to have limited the recovery of queen conch in Bermuda. In Florida, the Gulf Stream prevents larval inputs from the Bahamas and the Greater Antilles, so there are few larval inputs (Posada and Appeldoorn, 1994; Delgado et al., 2008), except for an occasional eddy of the Florida Current that brings in queen conch larvae from Belize, Mexico, and Honduras (Stoner et al., 1997). Because recent data suggest the population in Florida is increasing, local recruitment may be significant (Delgado et al., 2008; Glazer and Delgado, 2012). Barbados, at the eastern edge of the range, is thought to have a self-sustaining population, given its isolation from other breeding populations. Queen conch larvae may be retained near Barbados, similar to damselfish (Cowen and Castro, 1994), by local circulation patterns that keep marine larvae close to the point of origin (Mitton et al., 1989).

Density and Abundance

Density is likely the single most important criterion affecting conch productivity throughout its life-history, as it affects growth, successful reproduction, and fecundity. Density is one of the most easily measured and monitored attributes for assessing the status of queen conch populations (Appeldoorn et al., 2011). Research has shown that there is a density-dependent effect on reproduction, with low densities inhibiting reproduction, and potentially causing a decline in recruitment. At density levels less than the critical threshold discussed below, conch mating will not occur at the frequency needed to sustain the population, which can lead to recruitment failure and population collapse (Stoner and Ray-Culp, 2000); this is known as an Allee effect.

It is well documented that the density of adult queen conch directly impacts reproductive success (Appeldoorn, 1988; Stoner and Ray-Culp, 2000; Gascoigne and Lipcius, 2004; Stoner et al., 2011; QCEWR, 2012). Stoner and Ray-Culp (2000) documented a complete absence of mating and spawning behavior at densities less than 56 and 48 adult conch/ha, respectively. Recent research suggests that a mean density of 56 adult conch/ha is too low since mating activity ceased at that level, putting recruitment at risk (QCEWR, 2012). In 2012, the Queen Conch Expert Workshop recommended a mean density of 100 adult conch/ha be used as a reference point for queen conch surveys to ensure that populations are not at risk. The expert workshop conclusions indicated that conch fisheries should manage stocks at the higher density of 100 adult conch/ha, finding that there was a significant risk to recruitment when densities fell below this level

(QCEWR, 2012). We believe that the best available science shows that there is a significant risk to recruitment and consequently population sustainability when queen conch densities fall below the 100 adult conch/ha threshold.

In an effort to assess the species' status throughout its range we compared two data sets: (1) queen conch density information; and (2) habitat information that was developed using bathometry/depth contour data. These data were available for 40 range States throughout the greater Caribbean. In the assessment below, the total area of 0 to 30 m depth habitat was measured for each range State. The assessment assumes that the species is evenly distributed between 0 to 30 m in depth. We realize that the species is not spread uniformly in the 0 to 30 depth range, and is unlikely to have ever been. Queen conch naturally exist in patches where they are found in much greater density than they are in other areas, or across the entire range of potentially suitable habitat. They prefer sandy substrate, algal flats, and seagrass. As such, the densities in the surveys used in this analysis may not be an accurate reflection of the status of the species relative to requisite densities. Absent additional information on the methodologies used in each of the individual surveys, there is no way to know how representative the densities are of actual conch populations. Therefore, while the assessment may be a useful analytical tool generally, it should not be interpreted as a reliable indicator of the population status of the species in those specific range States.

Next, the appropriate conch density was then assigned to each range state. The most recent density information for each range State was used. Using each range state's habitat area and each range state's conch density; we were able to evaluate the percentage of the species' entire range which falls below or above the critical threshold (i.e., 100 adult conch/ha) required for successful mating, recruitment, and sustainable conch populations.

The best available information showed that 60.81 percent of the 0 to 30 m habitat is below the critical threshold, but as discussed previously, the accuracy of the density estimates, from which this percentage is derived, is highly uncertain. The range states whose conch densities are below 100 adult conch/ha include: Aruba, Antigua and Barbuda, Barbados, the Bahamas, Belize, the British Virgin Islands, Bonaire, Colombia, Costa Rica, Curaçao, Dominican Republic, Guadeloupe, Haiti, Puerto Rico, Mexico, Martinique, Panama, Saba, Turks and Caicos, United States (Florida), and Venezuela.

There are three range states (i.e., Jamaica, Nicaragua, and the U.S. Virgin Islands) that have conch densities above 100 adult conch/ha. Together they comprise 14.08 percent of the 0 to 30 m habitat available to the species.

There are two range states (i.e., Cuba and Honduras) that recorded conch densities above the 100 conch/ha and they comprise 22.55 percent of the 0 to 30 m habitat. The available information did not indicate whether the conch recorded during the surveys are adult, juvenile, or both. Juvenile conch can form dense aggregations that can number in the thousands and their inclusion (combining adult and juvenile) can bias densities by increasing the numbers of individuals included within the survey (A. Stoner, Community Conch, pers. comm. to C. Horn, NMFS, March 24, 2014). As a result, we are unable to determine whether these populations are above or below the critical threshold of 100 adult conch/ha.

We were unable to find queen conch population density information for the Cayman Islands, Grenada, Montserrat, Saint Lucia, Saint Vincent and the Grenadines, and Trinidad and Tobago, but all these locations have reported population declines. However, we are unable to determine whether the referenced declines have decreased those populations below the critical threshold for these locations. These range states represent 1.89 percent of the 0 to 30 m habitat available to the species.

Lastly, we were not able to find any information on the status of queen conch populations in Anguilla, Dominica, Guatemala, Saint Kitts and Nevis, Saint-Maarten, and Saint Eustatius. These range states encompass 0.67 percent of the 0 to 30 m habitat available to queen conch.

The best available conch density data indicate that the majority of queen conch populations in the greater Caribbean region are well below or now within the range where negative population growth or recruitment failure is a significant risk. The sample area for conch surveys is restricted by the depth limit for SCUBA diving safety (less than 30 m), they are generally limited to areas which are actively fished, and in most cases interviews with fishers have been used to define the area over which the survey will take place (QCEWR, 2012). Consequently density can be biased, since unexploited parts of a population at depths below typical human SCUBA diving limits (eggs masses have been found at 45m) or unknown to fishers are not counted (QCEWR, 2012). However, adult conch primarily aggregate to mate and lay eggs in waters from 0-30m, and they are also depth restricted because their food sources are photosynthetic, requiring light attenuation (Randall, 1964). Therefore, densities at greater depth are likely lower.

An additional source of uncertainty is that the density estimates from smaller spatial surveys may not be fully representative of a range state’s conch population, especially if surveys are conducted in areas of lesser or greater fishing pressure and unexploited parts of the population are not counted. In comparison, surveys that are repeated every few years and are conducted over wide-geographic areas are likely to provide a more representative density of the overall conch population. Nevertheless, the information presented above is the best available scientific information we have on the current density of conch throughout its range and despite questions raised relative to the accuracy of the densities we must consider this information in assessing the species' status.

Now, we will use the information generated by the status report, the ERA group's threats assessment, and the information provided by the Southeast Region's SDF to evaluate and summarize the species' threats, by the five ESA factors listed in section 4(a)(1), to determine the severity, scope, and certainty of the extinction risk of those threats across the species' range, now and over the foreseeable future.

Threats Evaluation

As previously explained, the ERA group members conducted their individual threats assessment. This section discusses the methods used to evaluate each threat and its effect on the species' extinction risk. As explained below, the ERA group did not take into account the information provided by the Southeast Region's Sustainable Fisheries Division (SFD) because it occurred after the threats assessment was conducted. We have separately taken into account the ERA group's threat assessment and the information provided by SFD in evaluating the overall extinction risk to the species under the five ESA Section 4(a)(1) factors.

For the purpose of the extinction risk assessment, the term "foreseeable future" was based on 3 queen conch generations, or 15 years (a generation time is defined as the time it takes, on average, for a sexually mature female queen conch to be replaced by offspring with the same spawning capacity) and our ability to reliably predict threats that impact the species' status. After considering the life history of the queen conch, availability of data, and types of threats, we determined that the foreseeable future should be defined as approximately 15 years. This timeframe (3 generation times) takes into account aspects of the species' life history and also allows the time necessary to provide for the recovery of overexploited populations.

The queen conch is an early-maturing species, with a high fecundity and population growth rate, and larval dispersal over large spatial scales. As such it is likely that the results of recommended management actions being considered by fishery managers, developed by several working groups and international conferences (discussed below), would also be realized, and reflected in population within a 15-year time period. The foreseeable future timeframe is also a function of the reliability of available data regarding the identified threats and extends only as far as the data allow for making reasonable predictions about the species' response to those threats. We believe that the impacts from the threats on the biological status of the species can be confidently predicted within this timeframe.

Often the ability to measure or document risk factors is limited, and information is not quantitative or very often lacking altogether. Therefore, in assessing extinction risk, it is important to include both qualitative and quantitative information. In previous NMFS status reviews, Biological Review Teams and ERA teams have used a risk matrix method to organize and summarize the professional judgment of a panel of knowledgeable scientists. This approach is described in detail by Wainright and Kope

(1999) and has been used in Pacific salmonid status reviews as well as in the status reviews of many other species (sees http://www.nmfs.noaa.gov/pr/species/ for links to these reviews).

The members of the ERA group were asked to provide qualitative scores based on their perceived severity of each threat. The members were asked to independently evaluate the severity, scope, and certainty for these threats currently and in the foreseeable future (15 years from now). The scoring for each threat corresponds to the following five levels of extinction risk: (1) no or very low risk - unlikely that this threat affects species' overall status; (2) low risk - this threat may affect species' status, but only to a degree that it is unlikely that this threat significantly elevates risk of extinction; (3) moderate risk - this threat contributes significantly to long-term risk of extinction, but does not constitute a danger of extinction in the near future; (4) increasing risk - present risk is low or moderate, but is likely to increase to high risk in the foreseeable future if present conditions continue; and (5) very high risk - this threat indicates danger of extinction in the near future.

The ERA group used the "likelihood point" method for ranking the threat effect levels to allow individuals to express uncertainty. For this approach, each member distributed 5 `likelihood points' among the five levels of extinction risk. If a threat was categorized as unknown, all 5 points were required to be assigned to that category alone. This approach has been used in previous NMFS status reviews (e.g., Pacific salmon, Southern Resident killer whale, Puget Sound rockfish, Pacific herring, and black abalone) to structure the team's thinking and express levels of uncertainty when assigning risk categories. The ERA group did not make recommendations as to whether the species should be listed as threatened or endangered. Rather, each member of the ERA group drew his or her own scientific conclusions, based on the information in the status report, about the risk of extinction faced by the queen conch under present conditions and in the foreseeable future based on an evaluation and assessment of threats.

Summary of Factors Affecting the Queen Conch

As described above, section 4(a)(1) of the ESA and NMFS implementing regulations (50 CFR part 424) state that we must determine whether a species is endangered or threatened because of any one or a combination of the following factors: the present or threatened destruction, modification, or curtailment of its habitat or range; overutilization for commercial, recreational, scientific, or educational purposes; disease or predation; inadequacy of existing regulatory mechanisms; or other natural or man-made factors affecting its continued existence. This section briefly summarizes the ERA group's findings, the SFD assessment, and our conclusions regarding threats to the queen conch.

<u>The Present or Threatened Destruction, Modification, or Curtailment of its Habitat or Range</u>

Habitat alteration and water pollution were considered as threats under this factor; this included habitat loss or degradation from anthropogenic or natural causes (e.g., hurricanes) and the threat of water pollution which is caused by the introduction of toxic chemicals and pollutants into the species habitat. The ERA group ranked the threat of habitat alteration an "increasing risk" and the threat of water pollution a "low risk."

The queen conch's habitat can be negatively affected by destruction of near-shore aggregation and juvenile nursery areas, as well as degraded water quality. Localized nutrient enrichment can affect the coastal habitats where juvenile conch live. Nutrient loading from coastal development, marinas and recreational boating, sewage treatment and disposal, industrial wastewater and solid waste disposal, ocean disposal, agriculture, and aquaculture can accumulate in the soil and then run off into streams and coastal waters. Nutrient enrichment is known to stimulate overly-rapid growth of phytoplankton that subsequently consume oxygen as they decay, which leads to low dissolved oxygen (i.e., eutrophication) that can cause fish kills (Correll, 1987; Tuttle et al., 1987; Klauda et al., 1991b). Nutrient enrichment can also trigger algal blooms which can block sunlight from reaching submerged aquatic vegetation, including seagrass. Seagrass, an important component of juvenile conch habitat, requires sunlight for photosynthesis. Seagrasses die with inadequate sunlight. The loss of seagrass would increase the vulnerability of juvenile queen conch as they rely on seagrass habitat for protection from predators.

The destruction of coastal seagrasses can also negatively affect queen conch recruitment. Juvenile conch nursery areas, which are comprised mainly of seagrass habitats, can be destroyed by coastal development, prop scarring from recreational or commercial boat traffic, and boat groundings. Habitat destruction was considered a cause for the initial decline in conch populations in Montserrat (Posada et al., 1997). There has been a significant amount of seagrass loss on the west and south coast of Barbados. This loss likely contributed to low conch densities (Stoner, 2003; Valles and Oxenford, 2012). The declines in the queen conch populations reported in Saint Kitts and Nevis in 2002 have been linked to habitat degradation, dredging, and hurricane impacts on habitat (CITES, 2012). Similarly, the declines in queen conch populations in the Turks and

Caicos have been related to habitat degradation and two hurricanes that impacted the area in 2008 (DEMA, 2012).

Seagrass is important to the ecosystem because it improves water quality (Carter et al., 1991). In addition to providing cover and prey for juvenile conch, seagrasses transport nutrients into the water column and through primary production and respiration improve dissolved oxygen and carbon dioxide concentrations, alkalinity, and pH. Seagrass can also improve water clarity by binding sediments to the benthos.

Increased sedimentation as a result of coastal influxes can impact conch habitat. Adult conch aggregation habitats are characterized by coarse, low organic content sand, and if these shallow, coastal areas are subject to deposition of fine sediment or sediment with high organic content, these habitats could become unsuitable (Appeldoorn and Baker, 2013). For example, the main island of Trinidad does not have a significant queen conch population, in part because the habitat is unsuitable due to the low salinities and high turbidity associated with continental rivers and streams (CITES 2012). In addition, habitat loss was identified by Gore and Llewellyn (2005) as a possible factor that contributed to the decline of queen conch in the British Virgin Islands.

The run off of toxins and chemicals from upland areas into coastal waters may have negative effects on the development of the queen conch's reproductive system. The Florida Fish and Wildlife Conservation Commission (FFWCC) and other researchers have documented a population of non-reproducing queen conch in the Florida Keys (Glazer and Quinterro, 1998; Delgado et al., 2004). Several studies have demonstrated that the conch found in nearshore locations of the Florida Keys do not have normal gonadal development (FFWCC, 2012). This reproductive impairment is limited to queen conch in the nearshore waters and is theorized to be related to exposure to toxins and chemical pollutants in their habitat. Specifically, Spade et al. (2010) suggested that the halt in reproductive maturation of queen conch in nearshore areas in the Florida Keys was possibly a result of exposure to high levels of zinc and copper. Other gastropod studies have related heavy metal exposure, particularly copper and zinc, to reduced fecundity (Laskowski and Hopkin, 1996; Snyman et al., 2004; Ducrot et al., 2007; Coeurdassier et al., 2005). The concentration of copper and zinc in the Florida Keys nearshore conch population's tissues was found to be similar to those found in other gastropods studies in other locations where fecundity was reduced (Spade et al., 2010). In the Florida Keys, queen conch with gonad deficiencies were experimentally transferred from nearshore areas to deeper offshore areas where they developed functional gonads. Likewise, viable queen conch from the deeper offshore areas became reproductively incompetent when moved inshore, showing that exposure to an environmental factor in the nearshore environment is causing the reproductive damage, and that it is reversible (McCarthy et al., 2002; Glazer et al., 2008; Spade et al., 2010). Impaired reproduction from water pollution is a potentially serious threat, increasing extinction risk, but the best available information indicates that these negative effects are only occurring in the nearshore waters of the Florida Keys, a relatively small proportion of the species' range. We could not find any information regarding elevated concentrations of zinc or copper anywhere else in the Caribbean Sea, so we cannot generalize this threat beyond a small part of the species' range.

Two chemicals associated with mosquito control, naled and permethrin, were tested in the laboratory on early life stages of conch, and both embryos and larvae experienced chronic, sublethal effects. Larvae exposed to these pesticides were slow-growing, which in the wild would result in an extended pelagic stage with higher total mortality before they reached recruitment size (Delgado et al., 2007). When queen conch embryos and competent larvae (i.e., capable of undergoing metamorphosis) were exposed to concentrations of naled and permethrin, development slowed and irregularities occurred during embryogenesis (McIntyre et al., 2006). Defects were positively correlated with concentration and resulted in deformed embryos that would not be viable (FFWCC, 2012). The pesticides may also sensitize queen conch larvae to metamorphosis-inducing cues, which could result in early metamorphosis, premature settlement on suboptimal habitat, and decreased survival (FFWCC, 2012). These lab results demonstrate only potential habitat-related impacts of pesticides on early life stages of queen conch; however, absent actual exposure information we cannot gauge the severity or certainty of impacts on wild populations and cannot project them to assess population risk. The concentrations of naled and permethin used in the lab experiments were at concentrations used for terrestrial mosquito control and did not take into consideration the dilution effects that would occur with runoff and mixing with seawater. Because effects were limited to larval development, and given the infrequent and limited larval recruitment into Florida, potential effects of the chemical as an extinction risk to the continued existence of the species are difficult to realize.

In summary, the members of the ERA group ranked the threat of habitat alteration as an “increasing risk” which indicates that the members thought that the present risk of extinction to queen conch resulting from habitat alteration is low or moderate, but is likely to increase to high risk in the foreseeable future if present conditions continue. The members of the ERA group ranked the threat of water pollution a “low risk.” This ranking indicates that the group members thought that water pollution may affect the queen conch’s status, but only to a degree that is unlikely to significantly elevate extinction risk. Currently, there are numerous potential threats to coastal habitat as identified above; however, we believe that the one most significant threat is habitat loss.

<u>Overutilization for Commercial, Recreational, Scientific, or Educational Purposes</u>

The threats of commercial harvest and historical harvest include the removal of individual conch under the current regulatory mechanisms and the effects of prior harvest on the current species’ status. The ERA group ranked overutilization for commercial purposes as an “increasing risk” threat, which indicates that the members thought that the present extinction risk is low or moderate, but is likely to increase to a high extinction risk in the foreseeable future if present conditions continue. The threat of historical harvest was ranked as a “moderate risk” threat to the species, indicating that the members thought the threat of historical overharvest contributed significantly to long-term risk of extinction, but does not constitute a danger of extinction in the near future.

The members of the ERA group ranked Allee effects and artificial selection as “increasing risk” threats, which indicates that the members of the group thought that the present risk is low or moderate, but is likely to increase to high risk in the foreseeable future (15 years) if present conditions continue. These threats are considered under Factor B, because they are caused by the overexploitation of reproductive adult conch and the targeted removal of large conch from within a population. Subsequently, these two threats are related to the principle threats of commercial harvest and the inadequacy of regulatory mechanism designed to control that harvest. As previously mentioned, the

Allee effect refers to biological processes in which the viability of a population is reduced as population density decreases (e.g., through reduced mate finding or increased predator vulnerability) and, in particular to queen conch, the major concern is with the minimum density of about 100 adult conch/ha; mate finding and recruitment is at risk when conch populations decline below this threshold. In addition, the artificial selection or the targeted removal of large conch can change the morphology of individuals in a population and is related to the primary threats of overharvest, as well as the level of protection from fishing mortality (regulatory measures and law enforcement).

In the Caribbean region, the queen conch is one of the most important fishery resources, both economically and culturally (Brownell and Steven, 1981; Appeldoorn, 1994; Asprea et al., 2009). The queen conch fishery encompasses the entire Caribbean region and consists of both industrial and artisanal fleets (Appeldoorn et al., 2011). The species is primarily harvested by free-diving, SCUBA diving, or the use of hookah,except in those range states where underwater breathing apparatus is prohibited.

The fishery has a long tradition in the region and the species has been valued, especially for its meat, for several centuries dating back to pre-Columbian times (Brownell and Stevely, 1981). The shells are also used for jewelry and as curios, but these uses are of secondary economic importance (Mulliken, 1996; Chakalall and Cochrane, 1996). Commercial harvest records and inter-island trade were known from the mid-18th century, when dried conch meat was shipped from the Turks and Caicos Islands to the neighboring island of Hispaniola (Theile, 2001). The fishery expanded in the early 20th-century with advances in freezer technology, causing the shift to trade in frozen meat, but conch meat continued to be of significant local importance until the mid-

20th century. Since the 1970s the commercial harvest has seen a drastic increase, largely driven by the increased demand overseas, as well as by the growing resident population and the fast developing tourism industry (Theile, 2001). Today the majority of queen conch meat harvested in the Caribbean is supplied to markets in the United States and Europe, but it is also imported by many Caribbean range states where their queen conch populations are no longer able to support their domestic consumption (Theile, 2001; NMFS, 2014a). Overharvest to meet current demand is considered the primary cause of declines that are reported in numerous range states throughout the Caribbean region. The population decline has largely been attributed to overfishing, a lack of adequate enforcement, and poaching according to a review by the seventeenth meeting of the Convention on International Trade in Endangered Species (CITES) Animals Committee (2001).

As discussed above in the Density and Abundance section, many range states throughout the greater Caribbean have experienced population declines or have reported low conch densities over the years. These declines are primarily due to intensive harvest by commercial fisheries. The primary threat to queen conch is commercial harvest and the related regulatory measures designed to control commercial harvest. Other threats, such as Allee effects and artificial selection are a direct consequence of overexploitation by fisheries. NMFS considers the queen conch fishery to be overfished throughout the U.S. Virgin Islands and Puerto Rico, and the best available information indicates that the queen conch is being overfished throughout the Caribbean (NMFS, 2014b).

We evaluated trends in landings, minimum population densities, and conch habitat (0 to 30 m), either on a Caribbean-wide basis or on a country basis, when that information was available. Literature was searched to determine the composition of juveniles versus adults in queen conch catches. Regulations and regulatory compliance were also evaluated to determine their adequacy with regard to their ability to prevent overharvest and harvest of juveniles, and included an evaluation of the amount of poaching and illegal harvest that may be occurring. These data were then used by the SFD to create a sustainability index which examined queen conch sustainability on a country by country basis, as well as Caribbean-wide (NMFS, 2014b).

The index was developed to assess the overall 'sustainability' of queen conch by the top producing Caribbean countries. Eleven countries were included in this analysis (e.g., Belize, the Bahamas, Colombia, Cuba, Honduras, Jamaica, Turks and Caicos Island, Mexico, Dominican Republic, Puerto Rico, Nicaragua). These countries were selected because they represented 92.4 percent of the queen conch landings between 1980 and 2011, and 91.6 percent of the landings from 2000 to 2011. The sustainability index results were weighted by the landings data for the period between 2000 and 2011. The conch density element received 50 percent of the total score, given the limitations on reproduction at low densities (Stoner et al., 2012) that could have negative effects on stock sustainability unless that stock is receiving larvae recruitments from other countries or unidentified reproductive deep water populations. The remaining 50 percent of the score was assigned to the management and regulations components (e.g., minimum size restrictions, annual catch limits or quotas, seasonal closures or marine protected areas (MPAs), prohibitions on SCUBA or hookah) and regulatory compliance (e.g., illegal harvest and poaching). The maximum score for the sustainability index was set at 20. Scores closer to the maximum 20 score indicate greater Caribbean-wide sustainability of queen conch and scores closer to zero indicate unsustainable harvest practices. A score closer to 10 would indicate that some harvest practices may be sustainable for some countries and unsustainable for other countries.

The sustainability index found that overall across the 11 countries reviewed in this assessment (e.g., Belize, the Bahamas, Colombia, Cuba, Honduras, Jamaica, Turks and Caicos Island, Mexico, Dominican Republic, Puerto Rico, Nicaragua) the index score was 8.55 of 20 when weighted by landings, and 8.90 out of 20 when weighted by amount of available habitat from 0 to 30 m deep.

The SFD also reviewed Food and Agriculture Organization (FAO) queen conch landings trends by country from 1950 through 2011 for the Caribbean (NMFS, 2014b). A total of 30 countries had reported and/or estimated queen conch landings during this time. Only two countries had landings for all 62 years in the time series. In many instances, landings were estimated by the FAO when a country did not report landings, and, for some countries, landings were not reported or estimated. The estimated landings typically represented a small portion of the total annual landings (less than 5 percent), so this likely does not bias the data or add significant variability. There was a rapid increase in landings from the mid-1980s through the mid-1990s, after which landings declined by 47 percent from the mid-1990s through 2011 (Garibaldi, 2012). However, this decline, as well as the increase in landings leading up to the peak, is confounded by several factors. First and foremost, improvements in data reporting have occurred over time. For example, from 1980 to 1990 the number of countries reporting landings increased from 8 to 15, including several states and territories with significant amounts of landings such as Jamaica, Colombia, and Puerto Rico. By the early 2000s, 19 countries were reporting landings. In addition, landings for 6 to 7 other countries were being estimated by the FAO (NMFS, 2014b). Although an increase in landings is apparent, this increase may not have been as substantial if landings were being reported by more countries leading up to the peak in landings.

The number of countries with reported or estimated landings reached a maximum of 24 in 1996 and has remained fairly constant since. Based solely on available landings, there was a 47 percent decline in landings from the peak observed in 1995 (40,835 tons) through 2011 (21,448 tons). However, this decline is confounded by several regulatory measures, as well as non-reporting. For instance, there are no reported or estimated landings for Mexico during 2006 to 2011, yet prior to that time Mexico was averaging over 6,000 tons of annual landings. The reason for Mexico not reporting landings has yet to be determined, but it is not due to a full moratorium on harvest as Mexico did not close Chinchirro Bank until 2012 (Aldana Aranda GCFInet communication). Closures off the Yucutan and Quintana Roo, Mexico were implemented in the late-1980s and early 1990s (CITES, 2012). Jamaica accounted for the largest amount of landings of any country from 1980 to 2011 (22 percent), but overharvest led to more restrictive management and implementation of harvest quotas or annual catch limits. Harvest off Jamaica was unregulated until 1994 (Murray et al., 2012). In 1994, the first harvest quotas were implemented. Jamaica began conducting scientific surveys and setting total allowable catches based on conch abundance that establish a required conch density at 70 conch/ha for the fishery (Murray et al., 2012). This led to considerably lower landings and fishing effort after the mid-1990s in response to more sustainable and scientifically based harvest practices. Similarly, following the Caribbean-wide peak in landings in the mid-1990s, two other countries saw major declines in landings. Landings from Honduras decreased in 2003 due to a moratorium on harvest imposed by the government in response to CITES concerns regarding the lack of information, high amount of exports, lack of landings records, illegal activity, and low population densities. Harvest and trade resumed in 2006, but only for conch collected through scientific surveys. The total allowable catch levels are considerably lower now than peak Honduran landings.

CITES also suspended exports from the Dominican Republic in 2003 due to high landings and a lack of current stock information (CITES, 2006). Exports were suspended from 2003 through 2012, during which time the fishery existed mostly for tourism and domestic consumption (Torres and Sullivan Sealy, 2002b; FAO report, 2012). If the landings from Jamaica, Mexico, the Dominican Republic, and Honduras are excluded due to confounding regulatory changes and missing landings, then the cumulative trend in landings appear to be stable (NMFS, 2014b). In fact, there is a stable trend in landings from 1993 forward, which also corresponds well with improvements in data reporting (NMFS, 2014b).

There were other regulatory changes that likely affected trends in landings from other countries, but none as significant as those observed for Jamaica, Honduras, Mexico, and the Dominican Republic. The above is not intended to assess the sustainability of queen conch, but merely point out that landings should be interpreted with caution and should be used with other sources of data to assess trends in population abundance, as reporting levels and regulations confound overall trends in landings. Regardless of improvements in reporting and regulations, landings alone may not be a useful indicator of stock health. Landings can increase, decrease, or remain stable for numerous reasons that do not necessarily reflect stock abundance or ‘sustainability.’ For instance, landings may be increasing because of increasing effort, but such harvest rates may not be sustainable. Similarly, hyper-stability may occur in which fishermen over time expend more effort to catch the same amount of conch. If this occurs, then catch per unit effort may decline while landings remain stable, leading to reduced population abundance. Landings may decline due to more sustainable harvesting practices, economic factors, or reduced stock abundance, so any declines should be carefully evaluated against fishery survey data and fishery-dependent data to determine the root cause of the decline.

Despite the concerns noted relative to relying on landings data, the observed high levels of relatively stable landings over the past two decades are inconsistent with the estimates of widespread low densities discussed previously. If the actual densities in the majority of the suitable habitat areas were actually below the density threshold necessary to support successful mating and reproduction, the species would be unable to support such high landings. Also, with conch being very fecund, stability of harvest over a long period of time may indicate recruitment from areas not fished, such as deep water stocks, or from areas with conch densities greater than 100 adult conch/ha, as larvae can disperse over a broad geographic range and can replenish overexploited populations.

In summary, we considered the ERA group rankings for those threats identified under Factor B. We also considered the SFD assessment, which reviewed the trends in landings and the sustainability of the largest conch fisheries (NMFS, 2014b). The sustainability index provided by SFD found that, overall, across the 11 major conch producing countries analyzed, the index score was 8.55 of 20 when weighted by landings, and 8.90 out of 20 when weighted by amount of available habitat from 0 to 30 m deep.

Also, this analysis indicates that if the landings from Jamaica, Mexico, the Dominican Republic, and Honduras are excluded, due to confounding regulatory changes and missing landings (explained above), then the cumulative trend in landings appear to be stable (NMFS, 2014b). In fact, the analysis showed a stable trend in landings from 1993 forward, which also corresponds well with improvements in data reporting (NMFS, 2014b).

Based on this information, we believe that overutilization for commercial purposes is a significant threat to the species. However, based on the assessment conducted by the SFD (NMFS, 2014b) and restrictions on exports (e.g., embargos) of these fisheries due to CITES, we have determined that the current and foreseeable future impacts associated with these threats are not affecting the queen conch to such an extent that they represent a risk to persistence of the species.

Disease and Predation

Parasites and Predation were considered as threats under Factor C; this included the effects of parasites on various life-history stages and predation effects on the population and community structure. The ERA group ranked both parasites and predation as “low risk” threats. There is some information on the impacts of parasites and predation on queen conch, specifically related to the effects of a coccoidian parasite (apicomplexa) and the high rates of predation on the early life stages of queen conch.

Several studies report the presence of the coccoidian parasite in queen conch. The coccoidian parasite is dispersed through the feces of the host and may spread through consuming benthic detritus (Duszynski et al., 2004). The presence of this parasite has been linked to reduced gametogenesis and irregularities observed in the queen conch’s reproductive cycle (Aldana Aranda et al., 2009a). The geographic distribution and occurrence of the parasite was found to be "generalized and intense in various sites around the Caribbean" (Aldana Aranda et al., 2007). The infection increased across the Caribbean ocean from west to east (CITES, 2012). The lowest occurrence for this parasite was found in the Gulf of Honduras, Mexican Caribbean and Campeche Bank, followed by the Colombian Archipelago, and Venezuela Corridor, with the highest parasitism occurring at Martinique, Guadeloupe, St. Barthelemy, and Puerto Rico (Aldana Aranda et al., 2011). In Florida, the parasite was found at every location and in every conch sampled (Aldana Aranda et al., 2009b), but the median incidence of parasites per conch was observed to be similar to conch found in the Gulf of Honduras, Mexican Caribbean, and Campeche Bank (Aldana Aranda et al., 2009a). In San Andres, Colombia, and in Mexico, the presence of the parasite has been linked to irregularities in the reproductive cycle and reduced gametogenesis (Aldana Aranda et al., 2009a), but no correlation was found between the parasite and reproduction irregularities in Florida's offshore queen conch population (Aldana Aranda et al., 2009b). These studies indicate that the parasite could be responsible for irregularities in the reproductive cycle and reduced gametogenesis in queen conch, but we caution that it is necessary to further investigate the relationship (Aldana Aranda et al., 2009a, 2009b; FAO, 2012).

Similar to the larval stage of all marine organisms, the earlier life stages of queen conch are exposed to high rates of predation. The predation rate on juvenile conch is estimated to be about 60 percent annually (Iversen et al., 1986). Predation decreases as the shell grows to about 3.5 inches, when it is too strong to be crushed by the majority of predators (Davis, 1992), and the types of predators decreases to include only those able to destroy a strong shell, such as sharks, rays, turtles, octopi, and large hermit crabs (Brownell and Stevely, 1981).

In summary, the ERA group ranked the threats of parasites and predation a "low risk," which indicates that the members thought it is unlikely that these threats affect the queen conch's overall status. We acknowledge that there are high levels of predation on the earlier phases of the queen conch's life-history; however, there is no evidence that the current level of predation is unnatural or a threat to the species. As discussed above, there is a widespread disease that is infecting queen conch. While information is limited, the best available information suggests that reproductive problems in some cases correspond with the parasite infection, but this is not the case in other locations (e.g., Florida). At this time, there is insufficient information to evaluate the effects to queen conch resulting from parasites to determine whether it is a threat to the species continued persistence.

Inadequacy of Existing Regulatory Mechanisms

The inadequacy of existing regulatory mechanisms analysis included: international trade regulations, foreign nation regulations (i.e., domestic laws), law enforcement, U.S. Federal laws, and U.S. state and territorial laws. The ERA group ranked the existing conch fishery regulations employed by foreign nations to be "high risk" threat, which indicates that this threat poses a danger of extinction for queen conch in the near future. The ERA group rankings indicate that the law enforcement of the existing fisheries regulations, as well as international trade regulations, are "increasing risk" threats, indicating that they thought the present risk to queen conch is low or moderate, but is likely to increase to high risk in the foreseeable future if present conditions continue. Lastly the ERA group ranked the existing fishery regulations in the U.S. Federal and U.S. state and territorial regulations as a "low risk" threat, which indicates that the members thought that this threat may affect species' status, but only to a degree that it is unlikely that this threat significantly elevates risk of extinction.

In 1990, the Parties to the Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region included queen conch in Annex II of its Protocol Concerning Specially Protected Areas and Wildlife (SPAW Protocol) as a species that may be used on a rational and sustainable basis and that requires protective measures. In 1992, queen conch were added to Appendix II of CITES, which is an international agreement between governments established with the aim of ensuring that international trade in specimens of wild animals and plants does not threaten their survival. Appendix II includes species that are not necessarily threatened with extinction, but in which trade must be controlled in order to avoid utilization incompatible with their survival. International trade of Appendix II species is permitted when export permits are granted from the country of origin. In order to issue an export permit, the exporting country must find that the animals were legally obtained and their export will not be detrimental to the survival of the species in the wild (referred to as a "non-detriment finding").

The fishery management authorities (responsible for making non-detriment findings) of the states of export have found it difficult to make the required non-detriment findings necessary for issuing export permits under CITES Appendix II (Ehrhardt and Valle-Esquivel, 2008). The regional biological status and trade status of queen conch were reviewed by the CITES in 1995 and 2001 under the Significant Trade Review process. The Significant Trade Review process is required when there is concern about levels of trade in an Appendix II species. These reviews were initiated because of the continuing growth and export of the conch fishery and problems with enforcement in several range states. The latest review (Theile, 2001) concluded that the majority of queen conch populations were in decline due to over-exploitation. Some populations were showing little signs of recovery despite fishery closures and some showed signs of potential recruitment failure. Only a few countries had conch populations that were considered stable and information was lacking for a number of countries. The review characterized the majority of queen conch populations as over-exploited with harvest in some areas consisting of juveniles and an increasing shift in fishing effort to deeper waters. As a result of these reviews, queen conch trade was suspended for some countries. There are several countries whose exports of queen conch have been periodically banned by CITES: Dominican Republic, Honduras, Haiti, Antigua and Barbuda, Barbados, Trinidad and Tobago, and Grenada. Haiti and Grenada are the only two countries where suspensions remain in place (Meadows and Garcia-Moliner, 2012). Poaching and illegal trade in queen conch remains a significant problem in the wider Caribbean region (CITES, 2003; NMFS, 2014a; NMFS, 2014b). Recently, in a separate action, the European Union issued a ban on imports from any fish caught on Belize vessels, due to the country's inability to stem illegal fishing (Nielsen, 2014).

Although there have been difficulties in implementing CITES in relation to queen conch, CITES has proven to be a useful tool in conch harvest regulation. Through CITES a number of trade embargos have been implemented. These embargos do not stop all harvest in the affected countries, as there still is poaching and harvest for domestic consumption. However, we believe these embargos reduced the numbers of conch harvested due to limited markets, as the United States imports approximately 80 percent of the annual queen conch catch (Meadows and Garcia-Moliner, 2012). CITES, Article IV (related to Appendix-II species) states that, "an export permit shall only be granted when…a scientific authority of the State of export has advised that such export will not be detrimental to the survival of that species." There are no requirements regarding how a scientific authority should complete a "non-detrimental finding." However, in making their non-detrimental findings, exporting countries should consider total conch mortality, which includes domestic and export harvest, and illegal, unreported, and unregulated (IUU) fishing. Therefore, it is important that the scientific authorities follow the guidance on making non-detrimental findings (Rosser and Haywood, 2002), as well as documented methodologies, in order to facilitate the formulation of non-detriment findings, and to make more complete and scientifically sound the evaluations required to improve the implementation of the CITES. A number of countries and territories in the queen conch's range have regulatory mechanisms that are intended to manage harvest. They generally consist of minimum size or weight restrictions, closed seasons or spatial closures, harvest quotas, and gear restrictions, or a combination of these (Berg and Olsen, 1989; Chakalall and Cochrane, 1997).

The local overexploitation of queen conch stocks has resulted in total conch fishery closures in Aruba, Bermuda, Costa Rica, Florida (U.S.), and Venezuela. In 2012, the Mexican Government closed the Chinchorro Banks to conch harvest. This closure will remain in effect until February 2017 (Aldana Aranda GCFInet communication).

We attempted to compile regulations specific to queen conch harvest for all range countries, but we were unable to find regulations specific to queen conch harvest for Barbados, Brazil, Montserrat, Panama, and Trinidad and Tobago. Several patterns emerged from the compilation and evaluation of existing regulatory mechanisms. First, regulatory mechanisms vary between countries, with most including: export quotas and caps on harvest, ban on SCUBA and/or hookah gear, minimum size, minimum weight, seasonal and spatial closures or some combination of those. Almost all the countries with significant conch fisheries (e.g., Antigua and Barbuda, Belize, the Bahamas, Dominican Republic, Jamaica, Nicaragua, and Mexico) and some with limited or no harvest (The British Virgin Islands, the Cayman Islands, Colombia, Cuba, Puerto Rico, and U.S. Virgin Islands) have seasonal closures that vary in duration, but generally occurr during mating months to protect reproductively active stocks. There are a few countries that have significant conch fisheries, but do not have regulations that include a closed season (e.g., Honduras, St. Kitts and Nevis). The closed season in the Turks and Caicos only prohibits queen conch exports during conch mating seasons, but not does not ban harvest during that time. Several countries with limited conch fisheries do not have closed seasons (e.g., the Caribbean Netherlands, Grenada, Haiti, Martinique, St Lucia, and St. Vincent).

The restriction of SCUBA and hookah gear limits the depth of hand harvest and consequently protects queen conch that may be distributed in deep waters. It also limits the time a person can stay underwater to harvest conch, reducing catch rates. The use of SCUBA and hookah gears to harvest queen conch is prohibited in the Cayman Islands, Colombia, Cuba, and Turks and Caicos. There are no regulations that prohibit SCUBA or hookah to harvest queen conch in Antigua and Barbuda, Nicaragua, Mexico, Haiti, Honduras, Dominican Republic, Caribbean Netherlands (exception Saba Bank), Grenada, St. Lucia, and St Vincent and Grenadines. SCUBA is prohibited in Jamaica, Belize, and Martinique, but not hookah gear. Two countries allow the use of SCUBA or hookah, but only by permit: the Bahamas and St. Kitts and Nevis. Some areas have blanket prohibitions for the use of SCUBA or hookah in some locations while permitting it in others. In the U.S. Virgin Islands and Puerto Rico, SCUBA and hookah are allowed in territorial waters, but not Federal waters. The British Virgin Islands prohibits SCUBA in MPAs and Fishery Priority Areas. Seasonal and spatial closures and gear restrictions may reduce conch harvest, protect reproductively active stocks, and potentially conserve unexploited deep-water habitats; however, enforcement has been inconsistent to non-existent in many jurisdictions, which allows significant illegal collection and poaching.

Restricting harvest to only larger queen conch conserves reproductive capacity by ensuring an individual can contribute to at least one reproductive season (Stoner et al., 2012b). Minimum size regulations for queen conch range from 18 to 22.9 cm in shell length across the Caribbean, with unprocessed meat (i.e., animal is removed from shell; meat is not cleaned or filleted) weight from about 225 to 280 gr. The size of a queen conch is known to vary given the species' highly plastic shell morphology, with variable growth rates across the range (SEDAR, 2007; Ehrhardt and Valle-Esquivel, 2008). Consequently, basic dimensions such as shell length and weight are not reliable indicators of queen conch maturity, and based on current literature, the existing shell size regulations in many range states would allow for the legal harvest of conch considered to be juveniles (Stoner et al., 2012b). A review of fishing regulations concluded that minimum sizes set by fishery managers are allowing immature queen conch to be harvested legally in most Caribbean nations, providing at least a partial explanation for overexploitation (Stoner et al., 2012b). In addition, the “flared lip” criterion for legal harvest does not guarantee that the conch is mature. Harvest of conch with a flared shell lip is required in a number of countries to ensure conch are mature (British Virgin Islands, Caribbean Netherlands, Grenada, Jamaica, Nicaragua, Martinique, Puerto Rico, U.S. Virgin Island, St. Kitts and Nevis, St. Lucia, St. Vincent and the Grenadines). Other countries require a shell-lip thickness between 5 to 10 mm (Antigua and Barbuda, Cuba, Martinique, Nicaragua, Puerto Rico, and the U.S. Virgin Islands).

Several studies have found that the shell thickness is a better criterion to ensure that those harvested are not juveniles (Appeldoorn, 1994; Clerveaux et al., 2005; Cala et al., in press; Stoner et al., 2012b). Recent information indicates that shell thickness at reproductive maturity is much higher than previous estimates. Stoner et al. (2012b) found that the minimum shell thickness for reproductive maturity was 12 mm for females and 9 mm for males, and 50 percent maturity for a population was attained at 26 mm for females and 24 mm for males. Based on these findings, a shell thickness of at least 15 mm was recommended to be set throughout the Caribbean region to ensure harvested individuals are mature.

The current lip thickness requirements in countries that regulate based on lip thickness are, therefore, less effective at ensuring sustainability of the population. Moreover, there are no accompanying regulations that require queen conch to be landed in shell. The majority of range states extract the conch from its the shell at sea. This makes it difficult to determine whether the minimum size requirements are adhered to by conch fisheries.

MPAs are another common regulatory measure. The level of regulatory protection varies by MPA. Reporting on the protection of coral reefs globally, Mora et al. (2006) reported 5.3 percent of global reefs were in MPAs that allowed take, 12 percent were inside multi-use MPAs that were defined as zoned areas including take and no-take grounds, and 1.4 percent were in no-take MPAs. The term MPA can be broadly applied to include a wide range of regulatory structures including marine reserves, marine parks, and protected areas. Many MPAs have now been established throughout the world with the primary goals of preserving natural community and population structures while helping to sustain harvested species. Specifically, some Caribbean countries (e.g., Jamaica, Turks and Caicos, Honduras, Belize, the Bahamas, and Cuba) that have extensive conch harvest have established no-take reserves or MPAs (NMFS, 2014b). There is evidence that no-take marine reserves can be successful fisheries management tools. Appeldoorn (2004) suggested that the most productive queen conch areas be included in MPAs to offer an added degree of precaution for stock conservation. Many have been shown to increase conch populations, either relative to areas outside of the reserves or to the same area before the reserve was established (Stoner and Ray, 1996; Tewfik and Bene, 2000; Grabowshi and Tewfik, 2000; Roberts et al., 2001; Glazer et al., 2003; Chan et al., 2013). An increase in abundance within an MPA can "spill over" into adjacent areas through emigration (Roberts, 1995; Glazer et al., 2003) and may also increase larvae supply to sink populations (Roberts et al., 2001; Glazer et al., 2003). An MPA may function as a "source" of recruits by protecting reproductive stocks and thereby reducing the likelihood of Allee effects occurring (Glazer et al., 2003). The effectiveness of an MPA depends on the implementation and enforcement of regulations, but also on reserve location (Halpern, 2003).

In summary, there are numerous regulatory strategies used by the various jurisdictions in the range of queen conch to regulate harvest, including seasonal and spatial closures, minimum size limits, MPAs and no take zones, and gear limits. The ERA group rankings indicate that regulatory enforcement and the inadequacy of existing fishery regulations in foreign countries were "increasing risk" threats. The members of the group also ranked the regulatory measures in foreign countries as an "increasing risk" threat. The ERA group ranking indicates that the members thought that the existing regulatory measures in the U.S. Federal and state waters were a "low risk" threat. The best available information indicates that most of the existing regulations designed to regulate conch harvest are inadequate and do not prevent overharvest or the harvest of juvenile conch. It is also difficult to measure regulatory compliance; it is likely that in some cases, enforcement is non-existent, which allows for significant illegal harvest, juvenile harvest, and poaching.

The creation of MPAs and no take zones have benefited queen conch stocks by protecting those areas from harvest (CITES, 2012). And although there have been difficulties in implementing CITES in relation to queen conch, CITES has proven to be a useful tool in conch harvest regulation. Through CITES a number of trade embargoes have been implemented. These embargoes do not stop all harvest in the affected countries, as there still is poaching and harvest for domestic consumption; however, these embargoes most certainly reduce the numbers of conch harvested. CITES member countries are also actively working together to improve data gathering and reporting and coordinating conservation efforts. We believe that the implementation of CITES adds an extra layer of conservation and protection that helps to reduce the impacts of the inadequate regulatory mechanisms found in countries.

The ERA group's "increasing risk" ranking indicate that members thought that international trade regulations, existing fishery regulations in foreign countries, and regulatory enforcement are significant threats, where the present risk is low or moderate, but is likely to increase to high risk in the foreseeable future if present conditions continue. We also believe that the inadequacy of existing regulatory mechanisms is a significant threat to queen conch. However, based on the seasonal fishery closures that protect the reproductive adults, the establishment of MPAs and no-take zones, and implementation of CITES in relation to queen conch, we have determined that the current and foreseeable future impacts associated with these threats are not affecting the queen conch to such an extent that they represent a risk to persistence of the species.

<u>Other Natural or Manmade Factors Affecting its Continued Existence</u>

Ocean acidification is a result of global climate change and is considered here because the effect is a result of human activity and affects individual animals. The ERA group ranked the threat of ocean acidification on the queen conch as a "moderate risk" indicating that the threat contributes significantly to long term risk of extinction, but does not constitute a danger of extinction in the near future.

Ocean acidification is a term referring to changes in ocean carbonate chemistry, including a drop in the pH of ocean waters, that is occurring in response to the rise in the quantity of atmospheric CO_2 and the partial pressure of CO_2 ($_pCO_2$) absorbed in oceanic waters (Caldeira and Wickett, 2003). As $_pCO_2$ rises, oceanic pH declines. Carbonate ions are used by many marine organisms to build calcium carbonate shells. One well-known effect of ocean acidification is the lowering of calcium carbonate saturation states (i.e., the concentration of carbonate ions in water needed to precipitate out of solution to create a shell), which impacts shell-forming marine organisms (Doney et al., 2009). Some molluscs' shells are formed with a particular calcium carbonate crystal called aragonite; the concentration of the carbonate ions in the ocean relative to this crystal is measured as the aragonite saturation state. Decreasing pH and aragonite saturation state are expected to have a major impact on shelled molluscs and other marine organisms this century (Fabry et al., 2008). Current atmospheric CO_2 levels have resulted in a Caribbean open-ocean aragonite saturation state of less than 3.8. A Caribbean open-ocean aragonite saturation state of 4.0 equated to an atmospheric CO_2 level stabilized at approximately 360 ppm, and models suggest a saturation state of 3.0 equates to an atmospheric CO_2 level of 530-570 ppm (Simpson et al. 2009).

The queen conch secretes a shell comprised of the aragonite form of calcium carbonate (Kamat et al., 2000). The queen conch begins to develop the shell during its larvae life stage; the shell thickens as the conch ages. The conch's shell supports its living tissue, protects against predators, and excludes sediments from entering its mantle cavity. The effects of ocean acidification on shell growth and production vary among molluscs (Gazeau et al., 2013). Increasing acidification can affect the conch's shell production in one of two, not mutually exclusive, ways. The first is by requiring more energy for shell formation, at a cost to growth rate (Doney, 2006). Alternatively, conch could incorporate the less available calcium carbonate in their shell, making a less dense and weaker shell (Doney, 2006).

We were unable to locate information related specifically to ocean acidification and its effects on queen conch, but we were able to locate some information on other strombids (e.g., Strombus luhuanus and Strombus alatis), which also form aragonite shells. Reduced shell growth was observed in Strombus luhuanus when grown in 560 ppm CO_2 over a 6-month period (Doney et al., 2013). Strombus alatis showed no effects of pH within the range of projected values for the end of the century, but significant effects are projected to occur by 2300 at pH levels between -0.6 and -0.7 below current levels (Gazeau et al., 2013).

Changing climate may also have other, more subtle effects that could impact queen conch larval dispersal and habitat availability. Currents are expected to be affected under future climates (Liu et al., 2012), which could change the rate and direction of larval dispersal and population connectivity. Effects of these changes are not known; results could be either positive or negative to conch populations. Habitat may change as a result of climate change and impact settlement rates. The increase in surface water temperature could influence the timing of conch reproduction. Hurricane activity has been found to negatively impact queen conch populations in Turks and Caicos (DEMA, 2012). If the frequency/intensity of extreme weather conditions increases with sea surface temperatures as some predict, reductions in the local queen conch populations may occur.

Life-history characteristics were also considered because there are certain characteristics that can increase the queen conch’s vulnerability to threats under this factor. The vulnerable life history characteristic of most concern for queen conch is the proximity of adult conch aggregation/mating/egg laying and juvenile nursery areas to the shore and in shallow waters. The close proximity to shore/shallow water locations makes the queen conch more vulnerable to fisheries during important stages of its life history, as these areas are accessible and easily exploitable. These life-history characteristics increase the species' vulnerability and have the potential to result in future, further population declines driven by the primary threats of overharvest and the inadequacy of the regulatory mechanisms designed to control harvest.

In summary, the ERA group ranked the threat of ocean acidification on the queen conch as a "moderate risk" indicating that the threat contributes significantly to long-term risk of extinction, but does not constitute a danger of extinction in the near future. The impacts from ocean acidification and climate change are not projected to affect aragonite saturation states to a point where queen conch will be threatened within the foreseeable future. While the threat of ocean acidification and climate change could represent a potential future threat, at this time, ocean acidification and global warming are not negatively affecting the species.

The ERA group ranked the species vulnerable life-history characteristics as "increasing risk," indicating that, at present, the extinction risk to queen conch resulting from vulnerable life-history characteristics is low or moderate, but is likely to increase to high risk in the foreseeable future if present conditions continue. As discussed above, the queen conch has some life-history characteristics that make it more vulnerable to overexploitation, but conversely, the species also has some life-history characteristics that function as a buffer against overexploitation. For example, it reaches reproductive maturity relatively early in age and is highly productive. The queen conch is long lived, up to 30 years, and reaches reproductive maturity relatively early at about 4 years of age. The queen conch is also highly fecund, producing up to 13 egg masses a year, with each egg mass containing anywhere from 500,000 to 750,000 eggs. In addition, conch larvae are planktonic and have high dispersal capabilities; which allows them to recruit and reestablish overfished populations. There are some aspects of the species life-history strategy that increase its vulnerability to the principle threat of commercial harvest, but the species' reproductive rate and larval dispersal make them more resilient to this threat. Therefore, we have determined that the current and foreseeable future impacts associated with threats due to other natural or manmade factors are not affecting the queen conch to such an extent that they represent a risk to persistence of the species.

Conservation Efforts

In May 2012, a Queen Conch Expert Workshop was convened to develop recommendations for the sustainable and legal management of the species. The results of the Expert Workshop included recommendations on data collection, harvest strategies, precautionary controls, fishing capacity, ecosystem management, decision-making and enforcement and compliance. In Panama City, Panama, in October 2012, these recommendations were reviewed and adopted by the Working Group on Queen Conch of the Western and Central Atlantic Fisheries Commission of the FAO (WECAFC), the Caribbean Fishery Management Council (CFMC), the Organization of the Fishing and Aquaculture Sector of Central America (OSPESCA) and the Caribbean Regional Fisheries Mechanism (CRFM). In the Declaration of Panama that resulted from the meeting, the group made further recommendations, including support of the development of a regional plan for the management and conservation of queen conch. The other main recommendation requires countries and inter-governmental organizations of the region to collaborate more closely with CITES to support the sustainable and legal harvest and trade of the species.

In March 2013, the Sixteenth Meeting of the Conference of the Parties to CITES (CoP16) adopted several decisions to promote regional cooperation on the management and trade of queen conch (CITES Decisions 16.141-16.148). Among the actions called for in these decisions, range states are encouraged to adopt the recommendations stemming from the meeting of the Working Group on Queen Conch (the Declaration of Panama) discussed above; participate in the development of national, sub-regional, and regional plans for queen conch management and conservation, including best practices and guidance for making non-detriment findings; develop and adopt conversion factors to standardize data reported on catch and trade of meat and other products of queen conch; explore ways to enhance traceability of queen conch in trade; and collaborate on joint research programs.

Recently, in March 2014, the 15th biennial meeting of the WECAFC was convened in Trinidad and Tobago. The WECAFC adopted specific management measures for queen conch that emulated the Declaration of Panama and recommended that members implement them. The WECAFC members considered IUU fishing of queen conch a major problem in the region, and requested members renew their efforts to deter fishers from IUU fishing (WECAFC, 2014; Daves, 2014).

In summary, there are conservation efforts and new management measures being considered that are expected to benefit the species. However, at this time, it is not possible to determine any future positive benefit to the species that may result from efforts currently being contemplated by fisheries managers. In addition, we cannot determine which range states/entities, if any, will implement these conservation efforts or new management measures. Due to uncertainties surrounding their implementation we cannot be reasonably certain that these benefits will occur.

Significant Portion of Its Range

The ESA definitions of “endangered species” and “threatened species” refer to two spatial scales: a species’ entire range or a significant portion of its range. Our framework initially evaluated the queen conch throughout its range to determine extinction risk. We have found that listing the queen conch is not warranted at the spatial scale of its entire range, so we must consider if a “significant portion of its range” is at higher risk, such that it elevates the entire species’ status to endangered or threatened. However, this evaluation can only be conducted if a “significant portion of its range” where the species’ status is more imperiled can be identified.

The U.S. Fish and Wildlife Service (FWS) and NMFS - together, “the Services"- have jointly finalized a policy interpreting the phrase "significant portion of its range" (SPOIR) (79 FR 37578; July 1, 2014). The SPOIR policy provides that: (1) if a species is found to be endangered or threatened in only a significant portion of its range, the entire species is listed as endangered or threatened, respectively, and the ESA’s protections apply across the species’ entire range; (2) a portion of the range of a species is “significant” if the species is not currently endangered or threatened throughout its range, and the portion’s contributions to the viability of the species is so important that, without the members in that portion, the species would be in danger of extinction or likely to become so in the foreseeable future, throughout all of its range; and (3) the range of a species is considered to be the general geographical area within which that species can be found at the time we make any particular status determination. We evaluated whether substantial information indicated that (i) the portions may be significant and (ii) the species occupying those portions may be in danger of extinction or likely to become so within the foreseeable future (79 FR 37578; July 1, 2014). Under the SPOIR policy, both considerations must apply to warrant listing a species as threatened or endangered throughout its range based upon its status within a portion of the range.

As discussed above, the available information on the gene flow of queen conch is limited, but there is some evidence of possible genetic separation occurring between some queen conch populations. Queen conch larvae transport models show that there is low probability of connectivity between queen conch in Caribbean Mexico, Alacranes Reef in the southern Gulf of Mexico, and downstream populations in Florida, Cuba, and northwest to the Bahamas (Paris et al., 2008). In Mexico mitochondrial DNA marker analysis showed that queen conch at the Alacranes Reef were genetically distinct from conch populations at Cozumel and Banco Chinchorro in Mexico that were separated by 280 and 400 miles, respectively (Perez-Enriquez et al., 2011). Similarly, in the Bahamas, preliminary data detected genetic separation in queen conch populations that were located approximately 310 miles from one another (Banks et al., 2014). In addition, two nearby populations of queen conch in St. Lucia were found to be genetically different from each other, most likely a result of the east and west currents that prohibit the exchange of larvae between the two locations (Mitton et al., 1989). However, we did not find that the available information supported a conclusion that the loss of genetic diversity from one portion would result in the remaining population lacking enough genetic diversity to allow for adaptations to changing environmental conditions.

The consequences of decades of overharvest have resulted in estimates indicating that over 60 percent of habitat, in the Caribbean, ranging from 0 to 30 m, have adult conch densities below the 100 individuals/ha threshold. However, as noted previously, there are significant questions regarding whether these densities are reflective of actual population status. If accurate, the extremely low density conch populations in these areas are at risk of depensatory processes or Allee effects (such as reduced likelihood of finding a mate and recruitment success). However, the SFD assessment (NMFS, 2014c) indicates that conch landings have remained stable from 2000 through 2011 at high levels, which is inconsistent with the low density estimates. Also, with conch being highly fecund (i.e., producing 3 to 10 million eggs per individual per season), stability of harvest over a long term may indicate that recruitment is occurring from areas that are not fished, such as deep water areas, or from areas where mating is occurring at a higher rate, because conch densities are above the 100 adult conch/hectare threshold, and conch larval can disperse over a broad geographic range. Based on the relative genetic homogeneity of the species, high fecundity/productivity, and expansive larval dispersal capabilities, even areas below the 100 adult conch/ha threshold are maintaining stable landings. Therefore, after a review of the best available information, we did not find substantial evidence that would indicate that the loss of queen conch in any portion of the species' range would limit the species to the point where it would be in danger of extinction throughout all of its range, or likely to become so in the foreseeable future. In addition, there is no evidence that suggests that there is a portion of the species' range which encompasses aspects that are important to the species' specific life history events, where the loss of that portion would severally impact the growth, reproduction, or survival of the species as a whole. We have evaluated the species throughout its range to determine if there is a portion that is significant and have concluded that the information does not indicate any portion's contribution to the viability of the species is so important that, without the members in that portion, the species would be in danger of extinction. Consequently, we are unable to identify a "significant portion of its range" for the queen conch that would change the determination relative to the status of the species rangewide.

Listing Determination

Section 4(b)(1) of the ESA requires that NMFS make listing determinations based solely on the best scientific and commercial data available after conducting a review of the status of the species and taking into account those efforts, if any, being made by any state or foreign nation, or political subdivisions thereof, to protect and conserve the species. We have independently reviewed the best available scientific and commercial information including the petition, public comments submitted on the 90-day finding (77 FR 51763; August 27, 2012), the status report (NMFS, 2014a), and other published and unpublished information. We considered each of the Section 4(a)(1) factors to determine whether it presented an extinction risk to the species. As required by the ESA, Section 4(b)(1)(a), we also looked at whether there are any conservation efforts to protect queen conch by states or foreign nations. We were unable to identify any conservation efforts that were reasonably certain to occur that would benefit the species. As previously explained, we could not identify a significant portion of the species' range, where its status is different than that we have identified for the species rangewide. Therefore, our determination is based on a synthesis and integration of the foregoing information, factors and considerations, and their effects on the status of the species throughout its entire range.

We conclude that the queen conch is not presently in danger of extinction, nor is it likely to become so in the foreseeable future throughout its entire range. The species is made up of a single population over a broad geographic range, and its current range is indistinguishable from its historical range and there is little evidence of significant habitat loss or destruction. The species possesses life-history characteristics that increase its vulnerability to harvest, but it also possesses life-history characteristics that are conducive to population resilience. While there are significant questions as to the reliability of the density estimates, the best available information indicates that there are localized population declines. The best available survey data also shows evidence that there are populations which are currently suffering from depensatory processes (such as reduced likelihood of finding a mate and recruitment success). Nonetheless, queen conch harvest has remained high, as indicated by the landings, indicating that conch mating and larvae recruitment is occurring, which further reinforces the questions regarding the accuracy of the density estimates.

The ERA group's threats assessment indicated that the primary threat to queen conch is harvest; however, taking into account regulatory changes and missing landings, the cumulative trend in landings appear to be stable (NMFS, 2014b). In fact, there is a stable trend in landings from 1993 forward, which also corresponds well with improvements in data reporting (NMFS, 2014b). There are existing regulatory mechanisms throughout the species' range – although catch limits and seasonal and spatial closures appear to be the most effective in addressing the primary threat to the species (harvest). There are also significant concerns related to the enforcement of existing regulations; however, CITES has embargoed many countries for not complying with their obligations under the treaty. In some cases, CITES references the lack of regulatory enforcement as a factor that contributed to embargo decisions. In addition, despite continued deficiencies related to enforcement and regulatory compliance in queen conch fisheries, this threat does not appear to be impacting the species' continued existence, as conch landings trends appear to be stable.

Although the global population has likely declined from historical numbers, the species still occurs over a broad geographic range, has dispersal mechanisms that have ensured high degrees of genetic mixing, and its current range is unchanged from its historical range. In addition, there is little evidence to suggest that disease or predation is contributing to increasing the risk of extinction of the species.

Based on these findings, we conclude that the queen conch is not currently in danger of extinction throughout all or a significant portion of its range, nor is it likely to become so in the foreseeable future. While ongoing conservation efforts could be more effective, since the queen conch is not currently in danger of extinction throughout all or a significant portion of its range or likely to become so in the foreseeable future, we do not need to rely on the effectiveness of conservation efforts to make this finding. Accordingly, the queen conch does not meet the definition of a threatened or endangered species, and our listing determination is that the queen conch does not warrant listing as threatened or endangered at this time.

References

A complete list of all references cited herein is available upon request (see FOR FURTHER INFORMATION CONTACT).

Authority

The authority for this action is the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 et seq.).

Dated: October 30, 2014.

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