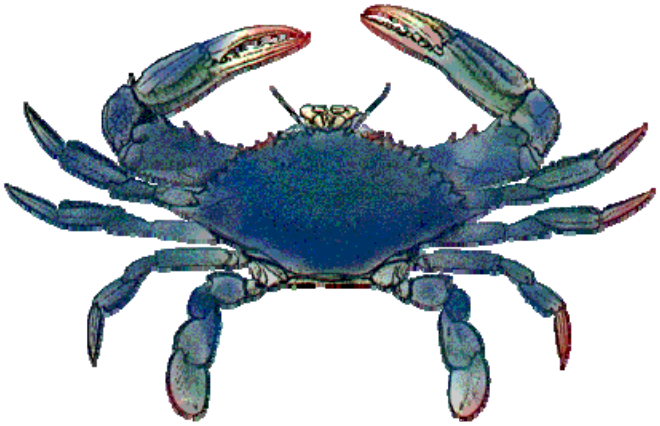
Seafood Watch
Seafood Report:
Crabs
Volume I



Blue Crab
Callinectes sapidus

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About Seafood Watch® and the Seafood Reports

Monterey Bay Aquarium's Seafood Watch® program evaluates the ecological sustainability of wild-caught and farmed seafood commonly found in the United States marketplace. Seafood Watch® defines sustainable seafood as originating from sources, whether wild-caught or farmed, which can maintain or increase production in the long-term without jeopardizing the structure or function of affected ecosystems. Seafood Watch® makes its science-based recommendations available to the public in the form of regional pocket guides that can be downloaded from the Internet (seafoodwatch.org) or obtained from the Seafood Watch® program by emailing seafoodwatch@mbayaq.org. The program's goals are to raise awareness of important ocean conservation issues and empower seafood consumers and businesses to make choices for healthy oceans.

Each sustainability recommendation on the regional pocket guides is supported by a Seafood Report. Each report synthesizes and analyzes the most current ecological, fisheries and ecosystem science on a species, then evaluates this information against the program's conservation ethic to arrive at a recommendation of "Best Choices", "Good Alternatives" or "Avoid." The detailed evaluation methodology is available upon request. In producing the Seafood Reports, Seafood Watch® seeks out research published in academic, peer-reviewed journals whenever possible. Other sources of information include government technical publications, fishery management plans and supporting documents, and other scientific reviews of ecological sustainability. Seafood Watch® Fisheries Research Analysts also communicate regularly with ecologists, fisheries and aquaculture scientists, and members of industry and conservation organizations when evaluating fisheries and aquaculture practices. Capture fisheries and aquaculture practices are highly dynamic; as the scientific information on each species changes, Seafood Watch's sustainability recommendations and the underlying Seafood Reports will be updated to reflect these changes.

Parties interested in capture fisheries, aquaculture practices and the sustainability of ocean ecosystems are welcome to use Seafood Reports in any way they find useful. For more information about Seafood Watch® and Seafood Reports, please contact the Seafood Watch® program at Monterey Bay Aquarium by calling 1-877-229-9990.

Disclaimer

Seafood Watch® strives to have all Seafood Reports reviewed for accuracy and completeness by external scientists with expertise in ecology, fisheries science and aquaculture. Scientific review, however, does not constitute an endorsement of the Seafood Watch® program or its recommendations on the part of the reviewing scientists. Seafood Watch® is solely responsible for the conclusions reached in this report.

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Introduction to Series on Crabs:

This is Volume I in a series of seafood reports covering the crabs most frequently found in United States markets and restaurants.

Volume Index:

General Crab Biology

Crabs belong to the order Decapoda, a crustacean order that also includes the lobsters, shrimps, and hermit crabs. All decapods possess a full carapace or head shield and five pairs of walking legs[1]. Their first three pairs of thoracic appendages are modified into maxillipeds, or feeding legs [1]. In crabs and lobsters, the very first pair of these feeding appendages are sizable claws that serve for defense and to grasp and manipulate food [1].

There are more than 4,500 living species of crab worldwide [2]. Many are tiny, or inhabit niches unsuited to mass harvest [2]. The "true" crabs, a group which includes the market species discussed in these reports, are distinguished from other decapods by having a greatly shortened abdomen--the part known as the "tail" in lobsters and hermit crabs. In the true crabs, the abdominal segments are greatly shortened and tucked under the carapace. This characteristic earns the true crabs their sub-order name of Brachyura, or "short-tailed" crabs [2].

As arthropods, all crabs have a chitinous exoskeleton, which must be shed repeatedly as the animal grows. The hormonal control of shell-shedding is one of the most intricate physiological processes known to marine science [2]. Among the true crabs, females can mate only immediately after they have shed their old shell, while their new exoskeleton is still soft [2].

The sexes are separate in crabs. After mating, females store sperm until conditions are right for egg laying. The female retains the fertilized eggs on her abdomen for weeks or months until they hatch [2]. Females bearing fertilized eggs are called "sponge crabs".

Executive Summary:

The blue crab *(Callinectes sapidus)*, native to Western Atlantic nearshore habitat from Nova Scotia to Argentina, has historically supported one of the United States' largest and most valuable fisheries. Reaching maturity in one to two years, utilizing a wide variety of habitats and food sources, and reproducing prolifically, blue crabs can support substantial fisheries. However, habitat loss, pollution, and heavy fishing have impacted the stocks. There are three centers of blue crab fishing in the United States: Chesapeake Bay; the Southeast Atlantic coast; and the Gulf of Mexico. Each region supplies about a third of total domestic landings. Blue crab populations are in decline in the Chesapeake Bay, stock status is unknown along the Southeast coast, and stocks may be declining in the Gulf of Mexico. Managers consider the fishery overcapitalized throughout its range, and there are troubling instances of interactions with protected species (including the diamondback terrapin) and heavy loss of juvenile crabs as bycatch in the directed crab fishery and in Gulf shrimp fisheries. While management is moving to address these issues, their job is made harder by a lack of basic science on the parameters that influence blue crab abundance. The management regime in the Chesapeake Bay region is most highly developed, because of the historic importance of blue crab in this region and its long-term decline. Management in the Gulf is fairly well developed, though not as comprehensive as the Chesapeake regime. Management in the emerging fishery of the Southeast region is comparatively minimal.

List of Five Component Ranks	Conservation Concern			
	Low	Moderate	High	Critical
Inherent Vulnerability	√			
Status of Stocks		√		
Bycatch	√			
Habitat Effects		√		
Management Effectiveness		√		

Overall Seafood Rank: Good Alternative

Seafood Watch is indebted to the outside experts who graciously volunteered their time to review the facts presented in this report for completeness and scientific accuracy: Dr. Anne McMillen-Jackson, Florida Fish and Wildlife Conservation Commission; Tom Wagner, Texas Parks and Wildlife Department; and an anonymous reviewer. **It is important to note that scientific review does not constitute an endorsement of Seafood Watch on the part of the reviewing scientists; the Seafood Watch staff is solely responsible for the conclusions reached in this report.**

Blue Crab

Callinectes sapidus

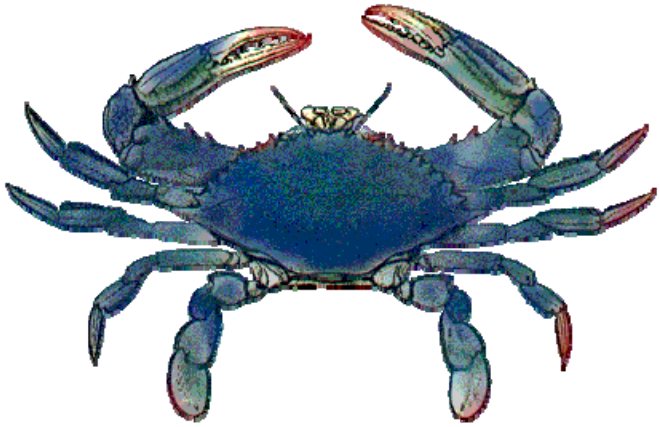


Image courtesy University of Maryland Center for Biological Science/Chesapeake Biological Laboratory

Distribution and Habitat:
The blue crab is native to the coastal waters of the western Atlantic, from Nova Scotia to northern Argentina, including waters around Bermuda, the Antilles, and in the Gulf of Mexico (GSMFC, 2001; MDDNR 2001). This species is most abundant in brackish estuaries and bays from Massachusetts to Texas (SCDNR 2002). The blue crab has also been successfully introduced into coastal habitats in Asia and Europe (SMS 2001).

The blue crab is a bottom-dweller, occupying a variety of benthic habitats in fresh, brackish, and shallow oceanic waters (GSMFC, 2001; MDDNR 2001). Juveniles generally prefer shallow salt marsh habitats; mature males, lower-salinity habitats, such as creeks, rivers, and upper estuaries. Except when mating, mature females prefer higher-salinity areas, such as lower estuaries and surrounding waters (Van Den Avyle 1984).

Life History:
Blue crabs begin life as fertilized eggs, carried under the mother's abdomen until they hatch (usually about two weeks after extrusion) (GSMFC, 2001; MDDNR 2001). Eggs hatch into pelagic larvae that more closely resemble shrimp than adult crabs [2]. Crab larvae undergo a series of molts before manifesting the characteristic short-tailed form of a juvenile crab [2]. After a period of development in high-salinity offshore waters, crab larvae gradually migrate into bays and estuaries of intermediate salinity, where they grow and mature (GSMFC, 2001; Van Den Avyle 1984). Scientists believe that the majority of larvae settle on seagrass beds in the general region where they were spawned (MDDNR 2001). Molting is a normal part of the growth and development process of blue crabs, which are particularly susceptible to predation when in the softshell form. Small crabs molt frequently, but the frequency of molting decreases as crabs grow bigger (GSMFC, 2001; Van Den Avyle 1984). Male crabs molt and grow throughout their lives, while females generally stop molting and growing after they undergo a terminal, “maturity” molt (MDDNR 2001; Pellegrin et al. 2001). A few studies in the Gulf have observed mature females in the process of molting, but this is believed to be a rare occurrence (GSMFC, 2001).

Determining the age of crabs is difficult, as they lose in the molting process many of the characteristics that scientists use to define age. Blue crabs in the Gulf reach sexual maturity within 10-12 months (GSMFC, 2001; Matherne 1995; Pellegrin et al. 2001); those in Chesapeake Bay and off North Carolina, within 12-18 months (MDDNR 2001; NCDMF 2001). Although the maximum lifespan of the blue crab is believed to be 5-8 years, (Guillory 2001a; NCDMF 2001; Pellegrin et al. 2001), blue crabs in Chesapeake Bay and off the Carolina coasts usually do not survive longer than 2-3 years (CBC 2001; MDDNR 2001; Pellegrin et al. 2001, NCDMF 2002; SCDNR 2002; Van Den Avyle 1984). Scientists measuring concentrations of lipofuscins, chemicals which accumulate over time in the eyestalks of blue crabs, found that most adults in the Chesapeke Bay were less than 2 years old [Ju, Secor and Harvey, 2003]. Adult crabs, in this study, were defined as those of at least 120 mm carapace length [Ju, Secor and Harvey, 2003].The maximum age of Florida's blue crab is estimated as 4 years; that of the blue crab in the Gulf of Mexico, 6 years (GSMFC, 2001). Blue crabs grow faster in warm water. Thus, Gulf crabs might reach maximum size within one year's time, whereas Chesapeake Bay crabs may not achieve maximum size until their second summer (Pellegrin et al. 2001).

Blue crabs are sexually dimorphic, making identification easy for fishermen, managers and crab consumers. Males have blue claws and a narrow abdominal apron. Females have red-tipped claws (referred to by fishermen as "painted fingernails") and a broad abdominal apron (Blue Crab Archives/Crab ID http://www.blue-crab.org/crab_identification.htm).

Male blue crabs (top) have blue claws and a narrow abdomen. In watermen's lore, the male's abdomen is said to resemble the Washington Monument (top left). Females (bottom) have red-tipped claws and a broad abdomen reminiscent of the Capitol Building. Images courtesy Blue Crab Archives, www.blue-crab.org

Male blue crabs practice mate guarding. They cradle their mate for a few days before she undergoes her final maturity molt, and stay with her after mating until her shell has hardened to ensure that she does not mate with other males (GSMFC, 2001; MDDNR 2001).

In Chesapeake Bay, blue crabs mate and spawn from May to October. The spawning season becomes longer and less distinct further south, extending from March to November in the Gulf of Mexico, and lasting throughout the year where winters are mild (GSMFC, 2001). Females mate just once in their lives, but store sperm for future spawnings; they may spawn several times in a season (CBP 1997; GSMFC, 2001; MDDNR 2001; Van Den Avyle 1984). Females extrude fertilized eggs 2-9 months after mating. Fecundity increases with size. Estimates range from 750,000-8,000,000 eggs per brood for blue crabs in the Chesapeake (CBP 1997; MDDNR 2001) and from 2,100,000-3,200,000 eggs per brood for those in the Gulf of Mexico (GSMFC, 2001). Van Den Avyle (1984) reports that, on average, only one out of every 1,000,000 eggs survives to become a mature adult.

Female crabs return to high-salinity waters after mating. While blue crab movements are generally considered localized, these spawning migrations of females can be extensive. Tagged individuals in the South Atlantic Bight have been observed to travel more than 500 km after mating and prior to spawning (Van Den Avyle 1984). Female blue crabs on Florida's west coast also migrate long distances along shore (GSMFC, 2001; Van Den Avyle 1984); these are believed to be associated with major spawning events in the Apalachicola Bay (GSMFC, 2001). Males remain behind in brackish waters (MDDNR 2001a; GSMFC, 2001). In Chesapeake Bay, this migration pattern tends to place more male crabs in Maryland waters and more female crabs in Virginia waters. Consequently, the Maryland fishery largely depends on male crabs; the Virginia fishery, on female crabs (CBC 2001).

Blue crabs are voracious, opportunistic predators, eating just about anything they can successfully capture or scavenge, including fish, blue and other crabs, clams, oysters, shrimp, mussels, snails, worms, insects, aquatic plants, and detritus (MDDNR 2001, Guillory 2001a). Blue crab predation has been described as "the most important biotic determinant of community structure" in soft sediment habitats in Chesapeake Bay (GSMFC, 2001).

Blue crabs are also vital prey for many species (Guillory and Elliot 2001). Their sponge-like egg masses are a favorite food of many fishes (Van Den Avyle 1984). Fish, shellfish, jellyfish, shrimp, juvenile blue crabs, and other organisms consume larvae. Juvenile and adult crabs are preyed upon by a variety of fishes, including eels, bass, croakers, drums, toadfish, sharks, rays, trout, weakfish, catfish, and gars, by other blue crabs, and by turtles and alligators, seabirds, raccoons and river otters (GSMFC, 2001; MDDNR 2002b; Van Den Avyle 1984). In addition, blue crabs are hosts to a number of commensal organisms (Gannon et al. 2001).

Predation is believed to play a major role in influencing the size of blue crab populations, particularly in the Gulf of Mexico. Red drum are commonly blamed for recent declines in blue crab catch rates in that region (GSMFC 1995; Guillory 2001a). Striped bass (along with red drum and croaker) have been blamed for depleting the blue crab population in the Chesapeake Bay (Greer 2000). Scientists continue to study the impacts of predation on blue crabs and have recommended that managers develop multi-species management approaches that incorporate these and other ecological impacts on blue crab populations (CBC 2001).

Blue crabs occupy a wide variety of offshore and estuarine habitats throughout their life history, including intertidal marshes, sub-tidal seagrass beds, and unvegetated, soft-sediment shorelines (GSMFC, 2001). These ecosystems are threatened by human population growth and coastal

development. Habitat loss and increased nutrient loading probably present the greatest threats to blue crab populations. Seagrass beds have disappeared from many areas of Chesapeake Bay, raising concerns that blue crabs might not have the high-quality habitat needed to support their various life stages. Management advisors have recommended the creation of "corridors" or "sanctuaries" that would protect blue crabs as they travel among nursery, feeding, and spawning grounds (CBC 2002b). Virginia has established a seasonal 661-acre sanctuary to serve this purpose (CBC 2002b). Worldcatch.com reported on March 28, 2002 that fishery managers are currently considering expanding this sanctuary to cover 947 acres in the main stem of the Chesapeake Bay, including a portion of Maryland's waters. North Carolina has closed 200,000 acres of submerged aquatic vegetation to trawling, and has established seasonal gear limits to protect 147,000 acres of coastal wetlands designated as nursery areas (NCDENR 1999). Habitat loss has also been cited as a problem in the Gulf of Mexico, and has reached "crisis levels" in some estuaries (GSMFC, 2001). Eutrophication from nutrient loading presents a real threat to blue crabs, as eutrophic waters are characterized by frequent algal blooms and low levels of dissolved oxygen (Guillory 2001a). A large outbreak of *Pfiesteria piscidida* affected estuarine and coastal areas in Maryland, Virginia, and North Carolina in the summer of 1997 (NMFS 1999). Guillory et al. (2000) report seasonal hypoxic conditions in deeper waters of the Chesapeake Bay and also incidences of high blue crab mortality associated with periodic low-oxygen conditions.

Statement on the Availability of Science:
In Chesapeake Bay, the first comprehensive blue crab stock assessment was completed in 1996 by the Technical Subcommittee of the Chesapeake Bay Stock Assessment Committee, with the support of NMFS. The survey was based on both fishery-dependent and –independent data derived from trawl, dredge, pot, and other surveys (MDDNR 2001). But, as noted in the monitoring section, data are still considered lacking (NOAA 2001), as is information on the relative influence of fishing mortality, natural mortality, pollution, and habitat modification on patterns and trends in stock abundance.

In North Carolina, fishery managers conduct an annual review of blue crab stock status, using both fishery-dependent and fishery-independent data. But the reliability of these assessments is questionable due to data deficiencies. Managers plan to conduct a more complete assessment when they have improved data on commercial and recreational catches (NCDMF 2001).

In the Gulf of Mexico, the first region-wide blue crab stock assessment was conducted in 1999. But this assessment, like the others, was limited by a lack of reliable fishery-dependent data. There are no reliable Gulf-wide commercial and recreational catch and effort data, no data on size and sex composition of commercial landings, and no information on age structure. Guillory et al. (2000) state that "responsible management of the Gulf blue crab fishery will require continuation and improvement of ongoing long-term fishery dependent and fishery independent sampling programs." They suggest a need to standardize sampling protocols to allow development of a consistent regional database that will permit more effective stock assessment and Gulf-wide data comparability.

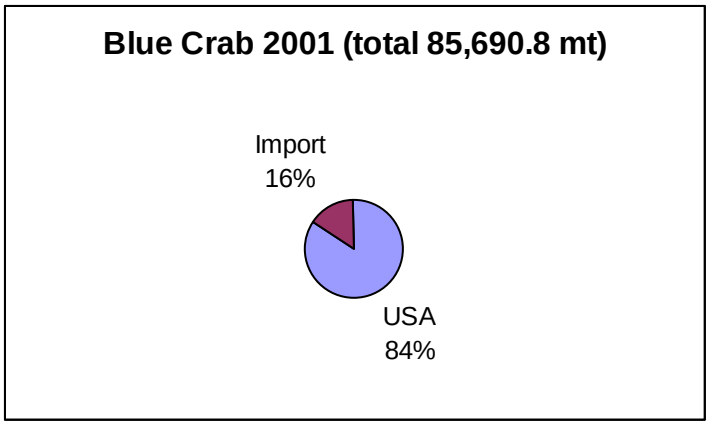
Market Information:

Market Names: Hardshell crab; softshell crab; blue-claw crab; blue swimming crab. The different life stages of the blue crab are named as follows: jimmies or jimmy-dicks (adult male hard crabs); sooks (adult female hard crabs); she-crabs or sallies (immature female hard crabs), sponge crabs (adult female hard crabs carrying extruded eggs); peelers (crabs with a soft shell fully developed under the hard shell); busters (crabs that have begun to shed their old shell); softshells (crabs that have recently shed their old shell)**.** When used for sushi or sashimi, blue crab is commonly sold as *kani*.

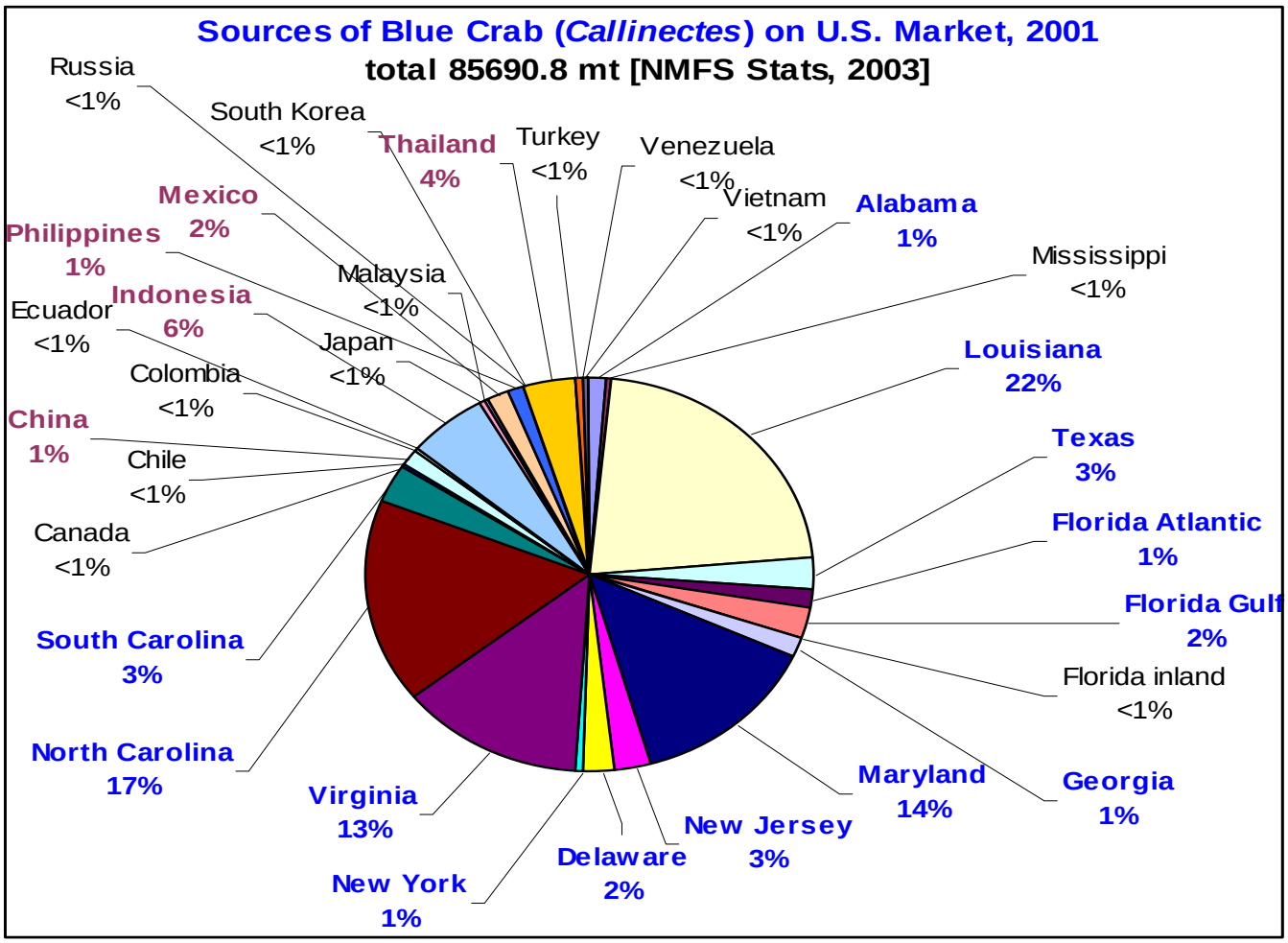
Seasonal Availability:
Varies.

Product Forms:
Some meat is pasteurized, but most blue crab is sold live, or as a fresh, ice-pack product. Specialty products include crab claws, deviled crab, crab cakes, crab patties, stuffed crab, and softshell crab (GSMFC, 2001).

Import and Export Sources and Statistics:
In 2000, domestic and imported blue crab products totaled 86,559 metric tons (mt). Domestic landings of *Callinectes sapidus* comprised 93% of that 2000 total; imported *Callinectes* species, 7%. In 2001, the total blue crab market declined slightly to 85, 690.8 mt, but of that total, imports comprised 16% , and the U.S. fraction had declined to 84%. In both 2000 and 2001, Indonesia supplied the majority of imports (6% of the total U.S. market in 2001), followed by Thailand (4%), Mexico (2%), and China and the Philippines (each 1%). Eleven other countries were responsible for the remaining imported product (NMFS Stats 2003). No data exist on blue crab exports, which usually consist of softshells (personal communication, NMFS Office of Industry and Trade, 3-18-02).



The total supply of blue crab products on the U.S. market, both domestic and imported, was 86,690.8 metric tons (mt) in 2001 (NMFS Stats, 2003). Recent declines in U.S. catches have left a gap in the market, increasingly filled by imported crab. While imports of *Callinectes* species still make up just 16% of the U.S. market, several Asian species in the same family are similar in appearance and marketability. Populations of these Asian crabs are reportedly abundant and underutilized, which makes them fierce competitors in the U.S. market (CBP 1997). Latane (2001) reports that imports were priced as low as $9/lb in 2001, compared to $17.50/lb for domestic product.



Fishery Information:

Fishery Range and Distribution:
Domestic blue crab fisheries operate along the Mid- and South Atlantic coasts of North America and in the Gulf of Mexico. The crabs are found near shore, within brackish estuaries, bays and sounds. The Chesapeake Bay fishery has traditionally accounted for most domestic landings (CBP 1997; MDDNR 2001). However, fisheries in the South Atlantic and Gulf states have been increasing their contribution to the national catch, and recent catches can be roughly divided in thirds among the three regions. North Carolina's Albemarle and Pamlico Sounds are the major production areas in the South Atlantic region (NCDMF 2002). Louisiana's coast is the major production area in the Gulf region (GSMFC, 2001).

Chesapeake Bay fisheries generally operate from April through October or November (MDDNR 2001; VMRC 2002a), with the exception of a winter dredge fishery, which operates in the lower Virginia portion of the Bay (Greer 2001). North Carolina crab fisheries are open year-round (NCDMF 2001), but peak landings occur from May through October (NCSU 2002). In the Gulf of Mexico, commercial crab fishing generally begins in March or April. Greatest commercial catches usually occur from May through August, with peak catches in June or July. A secondary Gulf peak may occur in October, but landings generally decline after that, along with water temperatures (GSMFC, 2001).

Recreational Fisheries
The blue crab supports significant recreational fisheries in Chesapeake Bay (MDDNR 2001), North Carolina (NCSU 2002), and the Gulf of Mexico (GSMFC, 2001). However, recreational catches are largely unmonitored and unaccounted for (GSMFC, 2001; MDDNR 2001; NCSU 2002). Not all recreational users are required to be licensed. In several states, only large-scale recreational fishing is license-controlled; smaller-scale recreational fishers do not need a license. Alabama does not require that any recreational users be licensed.

Maryland's 1990 recreational catch was estimated at 11,500,000 pounds--more than one-third the size of the commercial catch, which totals about 30,000,000 pounds (NCSU 2002). In 1999, Maryland licensed 29,000 recreational crab fishers. Their license permits them to deploy up to 1,200 feet of trotline[1] or as many as 30 pots to catch crabs for personal use (CBC 2001).

Estimates of recreational catches in the Gulf range from 4%-20% of the reported commercial catch (GSMFC, 2001). The number of licensed recreational pot fishermen in Louisiana increased from 224 in 1988 to 3,328 in 1995. The number of recreational crab fishermen using other gear is also believed to have increased (Guillory 2001a).

Fishing Methods:
Hard crabs are taken primarily with baited wire crab pots, but also with trotlines, dredges, and trawls. Softshell crabs and peelers are taken with scrapes, peeler pots, bank traps, trawls, and as bycatch in the hard crab fishery.

Most of the Chesapeake Bay catch is taken in baited wire crab pots (60% of Maryland's hard crab catch; 80% of Virginia's hard crab catch). Trotlines are used primarily in Maryland. Dredge gear is used exclusively in Virginia to target crabs that are buried during the winter season (CBP 1997). Softshell and peeler crab fisheries use scrapes (hand-hauled devices), peeler pots (traps baited with live adult male crabs), and "pounds", which are maze-like devices that direct crabs into a submerged trap. Peelers are also taken as bycatch when they enter hard crab pots (MDDNR 2001; VMRC 2002a). Recreational gears used in Chesapeake Bay include hand lines, mesh rings, collapsible traps, trotlines, dip nets, and crab pots (MDDNR 2001).

In North Carolina, crab pots presently account for about 95% of the total blue crab catch. The remaining catch is taken primarily with trawl gear. Peelers are targeted in a directed trawl fishery and are also taken as bycatch by trawlers targeting hard crabs and shrimp. Recreational fishermen take blue crabs with crab pots, crab and shrimp trawls, handlines, and dip nets (NCSU 2002).

In the Gulf of Mexico, hard crabs are taken almost exclusively with pots. Most peelers and softshells are taken as incidental catch in the hard crab fishery. In the Gulf, large numbers of blue crabs are taken as incidental catch in other trawl fisheries; however, most of that catch is discarded (GSMFC, 2001).

Bycatch in Blue Crab Fisheries
Bycatch in blue crab fisheries includes sublegal-sized blue crabs, finfish, turtles, and mammals. At least 23 species of fish (including spotted sea trout, red and black drum, and southern flounder) and four species of invertebrates have been observed in blue crab pots in the Gulf of Mexico. Diamondback terrapins, river otters, and raccoons have been found in lost and discarded traps (GSMFC, 2001). The impact of this bycatch on ecosystems and on blue crab populations is unknown. Mortality from incidental catches and from lost and discarded traps ("ghost fishing") has generally gone unmonitored

and unaccounted for (Guillory 2001b). However, new trap-removal programs recently put in place in four of the five Gulf states may lessen this problem (Wagner, 2004; VanderKooy, 2004). More than 18,000 derelict traps have been removed from Gulf waters by state programs in Alabama, Mississippi, Louisiana, and Texas, Data is being collected on the numbers and types of animals released from these "ghost" traps (Wagner, 2004; VanderKooy, 2004).

Guillory (2001b) reports that pots are inefficient with respect to size selection and may retain excessive numbers of sublegal blue crabs. For example, the percentage of undersized crabs taken in pots exceeds 50% in some areas of Louisiana. Guillory notes that, contrary to the popular perception that culled sublegal crabs are released unharmed, 6% to 8% of undersized crabs die before release from injuries sustained in the pot or during handling. Other released crabs may die after release from injuries or capture-related stress (Guillory 2001b). However, Guillory (2001b) reports that mandatory use of escape rings in crab pots has reduced the bycatch of sublegal crabs. A 1993 study reported mortalities of 17.3 crabs/pot without escape rings and 5.3 crabs/pot with escape rings in Louisiana's fishery (GSMFC, 2001).

Blue Crabs as Bycatch in Shrimp Fisheries

A substantial number of blue crabs are taken in Gulf of Mexico shrimp fisheries – a number that greatly exceeds the commercial blue crab catch. This bycatch is particularly high in Louisiana and Texas, where shrimping effort is high (Guillory 2001b). The annual blue crab catch in the Texas inshore shrimp fishery is estimated at 85,000,000 *crabs*; that in the Louisiana shrimp fishery is estimated at 20,500,000 *pounds*. The average mortality rate of blue crabs captured in trawls has been estimated at 36% overall – 26% during the winter months and 80% during the summer (GSMFC, 2001). Guillory (2001b) suggests that even those discards that survive trawling and culling, and that escape initial predation by birds, marine mammals, and fishes, may have higher mortality rates after release because of injury or capture stress (Guillory 2001b).

Derelict Traps and "Ghost Fishing"

Traps which have been lost, stolen, or intentionally discarded are identified as a problem in blue crab fisheries. "Ghost fishing" refers to catches made by these untended traps. Guillory et al. (2001) report that derelict pots contribute to blue crab mortality, create visual pollution, and may be damaging sensitive habitats by smothering aquatic vegetation. Estimates of total annual "ghost fishing" mortality range from 20 to 60 crabs per pot per year. In Louisiana alone, an estimated 50,000 crab pots are lost each year (Guillory, 2001b). Based on a conservative annual mortality rate of 25 blue crabs per pot, Guillory (2001b) estimates that ghost fishing could kill 1,250,000 blue crabs each year in Louisiana waters. In addition, derelict pots swept up in shrimp trawl nets may reduce shrimp catch and block turtle-excluder devices, thereby preventing sea turtles from escaping the nets. Such problems with discarded crab traps have contributed to conflict between crabbers and shrimpers (GSMFC, 2001).

Interactions with Protected Species

Occasionally, sea turtles and sea mammals become entangled in crab pots or buoy lines (GSMFC, 2001). Seven bottlenose dolphins recovered in the Gulf of Mexico were marked by rope burns, or had rope or pots attached to their carcasses (GSMFC, 2001); these entanglements were attributed to blue crab gear, although crab pots are far from the only source of derelict rope in the Gulf of Mexico (Guillory, 2004). However, in 2000, one dolphin was freed from entanglement in a blue crab pot (GSMFC, 2001). Manatees in Florida have been injured after becoming entangled in crab pot buoy lines (GSMFC, 2001). River otters have drowned in crab pots as well (GSMFC, 2001). In some areas, drowning in crab pots is a major threat to diamondback terrapin populations (GSMFC, 2001). Maryland

requires all recreational crab fishers include devices on their crab pots to prevent the death of terrapins and other air-breathing animals accidentally caught (MDDNR, 2001).

Fishing Effort and Trends:
The blue crab supports the largest single-species crab fishery worldwide, in terms of landings (CBP, 1997). Catches are composed of hardshell crabs, peeler crabs (taken just prior to molting), and softshell crabs (taken immediately after molting).

Total U.S. blue crab landings equaled 78,104 metric tons (mt) in 2002; 68,509 mt in 2001; 80,392 mt in 2000; and 89,141 mt in 1999 (Johnson & Associates, 2003).

Fishing Effort in Chesapeake Bay
The blue crab fishery is the Northeast's largest nearshore fishery in terms of landings, and Chesapeake Bay has traditionally supplied about 85% of this region's crab (NMFS 1999). However, Chesapeake Bay catches are declining. The highest catch on record was 51,257 mt, landed in 1993 (NOAA 2001). But catches in the last three years (1998-2000) averaged only of 27,216 mt/year. That is well below the long-term (1968-2000) average of about 34,020 mt/year. The year 2000 catch of 23,043 mt was the lowest recorded since Maryland's record-keeping system was modernized in1981. Preliminary data for Maryland and Potomac river fisheries indicate that 2001 landings were also well below the long-term average, with the exception of peelers in the Potomac, which were not far below the 15-year average for that area (Greer 2001).

In Chesapeake Bay, the average fishing mortality *F* was 0.91 in 2000--below the overfishing threshold rate of 1.0. However, in 2001, NMFS scientists commented that an alternative method of calculating *F* indicated that fishing mortality is increasing and may be substantially higher than the overfishing threshold (NOAA 2001). Fishery managers have agreed to adopt management measures designed to reduce fishing mortality by 15% over the next three years to achieve the target rate of 0.7 (Greer 2001; MDDNR 2001).

Managers consider the Chesapeake Bay crab fishery overcapitalized (too many fishing boats). Regulations are designed to achieve a gradual 15% reduction in fishing effort to stay within the target fishing mortality rate of $F_{20\%}$. Fishery advisers have identified several additional needs, including limiting access to the fishery (MDDNR 2001), addressing "latent effort", and improving scientific understanding of ecosystem-based interactions (CBC 2001). To address the decline in crab spawning stock, fishery managers are currently considering expanding a no-fishing zone in the main stem of Chesapeake Bay and banning the take of sponge crabs (Worldcatch.com, 2002).

Fishing Effort in North Carolina
The blue crab supports North Carolina's largest commercial fishery in terms of total landings and economic value (NCSU 2002). Statewide, commercial landings averaged 23,119 mt between 1991 and 2000 (NCDMF 2001), although annual catches for years prior to 1994 are believed to be seriously underestimated (NCSU 2002)). Preliminary data indicate that 2000 landings were slightly below average at 18,390 mt. This decline has been attributed to lingering effects of 1999's hurricanes on habitat and water quality in Pamlico Sound (NCDMF 2001).

North Carolina catches have exceeded the estimated maximum sustainable yield (MSY) in two of the last five years (NCDMF 2001). Preliminary stock assessment data indicate that current catches are probably either at or above MSY (NCSU 2002).

Fishing Effort in the Gulf of Mexico

The blue crab supports one of the largest commercial and recreational fisheries in the Gulf of Mexico (GSMFC, 2001). Under-reporting is believed to be a major problem in Gulf fisheries, so these landings data should be considered conservative estimates of catch (GSMFC, 2001). Gulf hard crab landings have increased from about 8,165 mt/year prior to World War II to record landings of 35,381 mt and 35,834 mt in 1987 and 1988, respectively. Landings declined slightly after 1988, ranging from 22,680 mt to 31,752 mt between1989 and 1997, and remaining above the 15-year (1983-1997) average of 27,533 mt in all years except for 1989, 1990, 1994, and 1995. In 1997, reported landings totaled 28,467 mt. Louisiana was responsible for the vast majority of blue crab landings in the Gulf (69%), followed by Florida (15%), Texas (9%), Alabama (6%), and Mississippi (1%). Softshell landings averaged about 85 mt annually during the 1990s (GSMFC, 2001).

Gulf fisheries are reportedly fully utilized and severely overcapitalized (GSMFC, 2001).
The overcapitalization of Gulf fisheries has led to many conflicts (GSMFC, 2001; GSMFC, 1995). "Turf wars" between blue crab fishermen have resulted in reported theft of crabs and pots. Some commercial crabbers claim that others are capturing undersized crabs. Crabbers complain that shrimp trawling damages their pots. Shrimpers complain that crab pots get caught in their trawl nets. Commercial crabbers complain of damage to pots due to recreational boating and fishing; in turn, some property owners complain that they are unable to get out of their docks because the crab pots are so thick (GSMFC, 2001).

Gulf fishery managers have identified a need to reduce the number of blue crab fishermen and the number of pots fished. Texas has implemented a limited-entry program and set aside 20% of commercial license fees to buy back licenses from willing holders. Texas has also instituted a 200-pot limit per fisherman (GSMFC, 2001). Florida is currently considering a license moratorium (GSMFC 1999). There are no provisions for limited entry in the Louisiana fishery, but there was a commercial crab pot license moratorium from 1996 to 1998 (GSMFC, 2001).

Management:

Individual states regulate blue crab fisheries under various state laws, regulations and policies. To improve coordination between the states of Maryland and Virginia, the Bi-State Blue Crab Advisory Committee was established under the Chesapeake Bay Commission (CBC 2002b). The Gulf States Marine Fisheries Commission serves a similar function for states bordering the Gulf of Mexico (GSMFC, 2001).

Management of the Chesapeake Bay Fishery

The Chesapeake Bay Blue Crab Fishery Management Plan, developed in 1989 and revised in 1997, is designed to assist the Maryland Department of Natural Resources, Virginia Marine Resources Commission, and the Potomac River Fisheries Commission in developing complementary management strategies for the Chesapeake Bay fishery (MDDNR 2001). Both biomass and fishing-mortality thresholds have been defined and reviewed for this stock (NOAA 2001). The biomass threshold is set as the lowest stock biomass on record that subsequently sustained a fishery as recorded by fishery-independent survey data; the 1968 low, from which the stock recovered, is used as this benchmark. The fishing mortality *target* is $F_{20\%,}$ meaning that managers aim to preserve 20% of the stock's spawning potential when they set yearly catch limits (CBC 2002b). An additional safeguard is the fishing mortality *threshold* of $F_{10\%:}$ if the stock drops below 10% of its unfished spawning potential ($F_{10\%}$), fishing must be halted.

Management measures in place include:
Maryland:
- Licenses (commercial; limited recreational)
- Minimum size limits for hard crabs, peelers, and soft-shells
- Seasonal, daily, time, and area restrictions
- Prohibition on possession of sponge crab

Maryland sets strict size limits on its blue crab fishery. There is a 3-inch limit for peelers with a limit of ten peelers per bushel of crabs harvested; a 4-inch limit for softshells; and a 5-inch limit on male hard crabs and immature females with a limit of five of each per bushel of crabs harvested(MDDNR 2001). Maryland also enforces seasonal, daily, time, and area restrictions, including shortened workdays and standardized days off. Additional regulations include a prohibition on the possession of sponge (egg-bearing) crabs. These regulations apply to both commercial and recreational fishermen (MDDNR 2001). Maryland does not require the use of escape rings in the commercial pot fishery, but requires that all recreational pot fishers include devices on their traps to prevent the incidental take of air-breathing animals, such as turtles and muskrats (MDDNR 2001).

Virginia:
- Licenses (commercial and limited recreational; commercial moratorium in effect)
- Minimum size limits
- Prohibition on retention of dark sponge crabs
- Bycatch limits
- Seasonal daily catch limits
- Gear restrictions (including mandated use of escape devices)
- Seasonal, daily, time, and area restrictions (including crab sanctuaries)

Commercial measures include a license moratorium until May 2004; minimum size restrictions (a 5-inch minimum for male and immature female hard crabs; a 3 ½-inch minimum for softshells, and a 3-inch minimum on peelers, with an allowance of no more than 10 peelers per bushel or 35 per barrel). Fishermen are prohibited from retaining "dark sponge" crabs (egg-bearing females whose eggs are near hatching). Virginia also enforces bycatch limits; seasonal daily catch limits; gear restrictions (including pot limits and mesh size restrictions). Crab pots are required to have escape devices, and pot buoys must be marked. There are seasonal, daily, and time restrictions, including shortened workdays and standardized days off. Area closures apply (VMRC 2002a), including a seasonal 661-acre spawning sanctuary (CBC 2002b). Recreational measures are the same as for commercial crabbers (VMRC 2002b). Virginia sets limits on the amount of oysters and clams that crab dredgers may retain as bycatch. Crab pot fishermen have a retainment limit on channeled whelks. Virginia also manages incidental catch through seasonal and area closures that restrict fishing in important spawning and nursery grounds (VMRC 2002a).

Management of the North Carolina Fishery
The management goal for the North Carolina fishery is to maintain catch at maximum sustainable yield (F_{msy}). But managers caution that F_{msy} is difficult to estimate and the current value of 21,773 mt to 27,216 mt may not be reliable (NCDMF 2001).
Management measures in place include:
- Licenses (commercial; limited recreational)
- Minimum size limit
- Gear requirements (including mandated use of escape devices)
- Seasonal and area closures

Primary management measures include a 5-inch minimum size limit on male hard crabs and immature female hard crabs (with a 10% by number tolerance limit) (NCDMF 2001); mandated use of escape rings in pots (except when catching peelers) (NCSU 2002); and area closures to protect habitat and juveniles (NCDENR 1999). Trawling is prohibited in about 200,000 acres of areas containing SAV habitat, considered to be critical nursery grounds for the blue crab. And managers have afforded various protections to almost 150,000 acres of wetlands and marshes. The use of trawl nets, seine nets, dredges, and any other mechanical methods used to take clams and oysters is prohibited in areas designated as Primary Nursery Areas. Trawling is permanently prohibited in Secondary Nursery Areas, and is seasonally prohibited in Special Secondary Nursery Areas (NCDENR 1999). The bag limit on recreationally caught crabs is 50 per person per day, not to exceed 100 crabs per vessel. NCSU (2002) reports that additional regulations may be necessary as fishing pressure increases. Regulators have mandated the use of escape devices in crab pots since 1989 and have instituted a number of area closures to protect habitat and juveniles. Trawling is prohibited in about 200,000 acres of areas containing SAV habitat, considered to be critical nursery grounds for the blue crab. Almost 150,000 acres of wetlands and marshes are under some form of habitat protection. The use of trawl nets, seine nets, dredges, and any other mechanical methods used to take clams and oysters is prohibited in areas designated as Primary Nursery Areas. Trawling is permanently prohibited in Secondary Nursery Areas, and is seasonally prohibited in Special Secondary Nursery Areas (NCDENR 1999).

Management of the Gulf of Mexico Fishery

A regional management plan for the Gulf fishery, developed in 1990 and revised in 2001, was created to coordinate management of blue crab fisheries among the five Gulf states. However, data are inadequate to determine reliable biological reference points for the Gulf stock (GSMFC, 2001). Fishery managers based the latest assessment on four indicators of stock status, including landings history, estimates of relative abundance, total mortality rates, and mean carapace width (GSMFC, 2001).

Management measures vary by state, but include:

- Licenses (commercial; limited recreational in FL, LA, TX, MS)
- Limited entry (TX only)
- Minimum size limit
- Prohibition on retention of egg-bearing females, with tolerance limits (all states except AL)
- Gear requirements (FL, TX, LA require escape devices; FL, TX, degradable panels)
- Time and area restrictions
- Gear restrictions
- Area closures/sanctuaries (FL, LA, MS)
- Recreational catch limits (FL, LA)

All Gulf states have established a 5-inch minimum size limit (with various exemptions/tolerance limits), and all but Alabama prohibit the retention of egg-bearing females. Guillory et al. (2000) report that there is no biological justification for current prohibitions on the take of sponge crabs, as the Gulf population is not recruitment limited, but is limited by post-settlement biotic processes that influence the survival of small juveniles. They suggest that protecting essential habitat and minimizing sources of juvenile blue crab mortality would provide better protection.

Additional regulations include gear requirements (e.g., marking requirements, mandated use of escape devices and degradable panels) and restrictions (e.g., legal gear types; maximum number of commercial pots in Texas; maximum number of recreational pots in all states), and area closures/sanctuaries in some states. Some states have established recreational catch limits; others have not. The minimum size limit applies to recreational catches only in Mississippi and Texas (GSMFC, 2001).

The capture of undersized crabs is considered to be a serious problem, and has been exacerbated by the increased use of 1.5-inch square mesh pots in Louisiana and other areas. Guillory (2001b) reports that this mesh takes significantly higher numbers of undersize crabs than hexagonal mesh pots. The states of Florida, Texas, and Louisiana mandate the use of escape devices in crab pots. And Florida has instituted a minimum mesh restriction for hard crab pots. Florida and Texas regulations also mandate the use of degradable panels to reduce the impacts of ghost fishing (discussed further in the section on other controversial issues). Louisiana requires that fishermen remove unserviceable pots from the water (GSMFC, 2001).

Monitoring/Enforcement:

Monitoring of the Chesapeake Bay Fishery
Virginia and Maryland instituted mandatory commercial reporting systems in 1993 and 1994, respectively (CBP 1997). But current data do not include information needed to develop accurate estimates of catch-per-unit-effort. Stock assessment scientists have identified as a critical need a comprehensive Bay-wide program that will provide improved information on catch and effort, and data on the age, size, sex and maturity composition of catches (NOAA 2001). Scientists and managers have also recommended aggressive actions to improve recreational catch data (CBC 2001).

Fishery participants indicate that crabbers may not be adhering to gear limits, and that future estimates of gear use will likely be inaccurate without substantial additional monitoring and enforcement (CBC 2001). The Congressional Research Service's Daily Summary reported in September 2000 that two Virginia seafood distributors pled guilty to selling illegally captured blue crabs out-of-state, and that more cases were anticipated as a result of a summer 1999 enforcement effort on Virginia's eastern shore.

Monitoring of the North Carolina Fishery
Catch reporting was voluntary prior to 1994, but is now mandatory at point of sale. Pre-1994 landings data are considered unreliable. Recreational catches are generally unaccounted for, but could be significant (NCSU 2002).

Monitoring of the Gulf of Mexico Fishery
Guillory et al. (2000) report that there are inadequate catch data and no reliable effort data in the Gulf commercial and recreational fisheries. All states except Texas have commercial trip ticket programs in place, but at least one of those programs has been in place for only three years (GSMFC 1999). Florida is the only state that collects data on fishing effort (GSMFC, 2001). Many managers believe that this fishery has a serious problem with unreported landings (GSMFC, 2001). Actual soft crab production in recent years is estimated to be 14-19 times greater than reported production (Guillory 2001a). Recreational catches are substantial, but also inadequately documented. The state of Alabama does not require that recreational fishermen be licensed (GSMFC, 2001). Fishery managers recommend that existing monitoring programs be expanded in each state to provide consistent data on commercial and recreational fishing effort, participation, and catches. Florida's trip ticket system is cited as a model (GSMFC, 2001).

Guillory et al. (2001) report that the capture and subsequent sale of sublegal crabs have become more prevalent in recent years, and continue to be the most conspicuous enforcement problems in the crab industry. Some states have adopted escape ring requirements, regulations extending liability to dealers and processors, and higher enforcement penalties (GSMFC 1999). For example, Louisiana's penalty for possessing more than 20% undersize crabs is suspending the license for 6 months (first offense),

suspending the license for 12 months (second offense within a five-year period), and permanently revoking the license (third offense within a five-year period). In Texas, licenses may be suspended or revoked if the license holder is convicted of two or more flagrant offenses. But the capture and sale of sublegals is still recognized as a serious problem, particularly because protection of juveniles has been identified as a critical component of management in that region. Unreported catch is also identified as a serious problem in this region (GSMFC, 2001). There are reports that it is difficult to get violations prosecuted in some Gulf states (Buckson 1995; Matherne 1995). Substantial problems with theft of pots and/or crabs and damage to pots by other crabbers, shrimpers, and recreational fishermen have been reported in Gulf fisheries, particularly since the mid-1980s when the fishery expanded. Guillory et al. (2000) report that these "turf wars" have created serious enforcement problems.

Status of the Stocks:

Blue crab abundance is highly variable and appears to fluctuate cyclically, with years of peak abundance followed by years of declining abundance before the trend reverses. Causes of these fluctuations are still not fully understood. But the Chesapeake population appears to be most limited by spawning stock abundance/larval recruitment, whereas the Gulf population appears to be most limited by post-settlement biotic processes that affect juvenile survival (Guillory 2001a).

Status of the Stocks in Chesapeake Bay

The abundance of this population is well below average. 2000 assessment data indicate that the stock is just slightly above the overfished threshold, which is defined as the lowest exploitable stock biomass observed in fishery independent surveys since 1968. Stock assessment scientists report that spawning stock abundance is at a historical low. The biomass of age 1+ crabs is approaching a low not seen since the late 1960s (NOAA 2001).

The Chesapeake Bay population enjoyed above-average abundance in the 1980s, but began to decline in the 1990s (NMFS 1999) and is currently well below the long-term average. Exploitable stock abundance, spawning stock abundance, and recruitment are all showing declining trends (NOAA 2001). The decline has been attributed to a number of factors, including overfishing, predation, habitat degradation, and environmental factors (Greer 2000). 2000 stock assessment data indicated that the stock was below the action threshold for the fourth consecutive year, an indication that the fishing mortality rate was inappropriately risky, given the status of the stock (NOAA 2001). But managers have since implemented new regulations aimed at reducing fishing effort to target levels. Based on the 2000 assessment, the stock biomass and fishing mortality rate are within established thresholds, but far from target levels. Importantly, in 2000, stock assessment scientists commented that exploitation rates could be substantially higher than the overfishing threshold, based on an alternative calculation of fishing mortality (NOAA 2001). However, managers have since implemented new regulations aimed at reducing fishing effort to target levels.

Chesapeake Bay stock assessment surveys indicate a decreasing percentage of legal-size crabs and a decrease in the average size of crabs. CBC (2002b) warns that the reproductive potential of this population may be compromised due to the smaller size and lower abundance of mature males and females. The biomass of the Chesapeake Bay stock remains slightly above the "overfished" threshold. Fishery managers have responded to the observed decline by conducting a comprehensive assessment to examine the biological status of the stock. Managers have determined optimal catch levels, established biological reference points (MDDNR 2001), created a 661-acre sanctuary to protect the spawning stock (CBC 2002b), and, most recently, implemented regulations designed to reduce fishing effort to target levels within a three-year period (MDDNR 2001).

Status of the Stocks in North Carolina

Some catch-per-unit-effort data suggest that the North Carolina stock is declining. Other data show no clear trend. Landings have exceeded the estimated maximum sustainable yield in two of the last five years (NCDMF 2001). Preliminary stock assessment data indicate that current catch levels are probably either at or exceed this target level (NCSU 2002). But the MSY target is difficult to estimate and may not be reliable (NCDMF 2001). Given five classifications ranging from "viable," to "recovering," to "concern," to "overfished," to "unknown," fishery managers have classified North Carolina's blue crab as a species of "concern" (NCDMF 2001). Preliminary stock assessment data indicate that current catch levels are probably either at or exceed the maximum sustainable yield (NCSU 2002). But this benchmark is difficult to estimate and may not be reliable (NCDMF 2001). Juvenile abundance indices in 1999 and 2000, as measured by time/effort catch surveys, were 10.8 crabs per minute and 4.4 crabs per minute, respectively, compared to a 1987-1998 average of 7.29 crabs per minute. Despite variability in the abundance of juveniles, there is no clear downward or upward trend in recruitment (NCDMF 2001). Preliminary stock assessment data indicate that current catch levels are probably at or above maximum sustainable yield (MSY) (NCSU 2002). But, given the lack of basic population data in this fishery, MSY is difficult to estimate and may not be reliable (NCDMF 2001).

Status of the Stocks in the Gulf of Mexico

Based on an assessment of four indicators of stock status (landings history, estimates of relative abundance, total mortality rates, and mean carapace width), the Gulf's blue crab population is reported to be biologically stable. But managers caution that fisheries are operating at excess capacity (GSMFC, 2001). No biomass or fishing mortality thresholds have been established for this population. The most recent estimates of relative abundance in each Gulf state fishery follow:

- Texas (1998): 2.288 individuals per tow, compared to a 17-year mean of 3.133 individuals per tow.
- Louisiana (1998): 5.337 individuals per tow, compared to a 32-year mean of 7.241 individuals per tow
- Mississippi (1998): 2.229 individuals per tow, compared to a 25-year mean of 5.290 individuals per tow.
- Alabama: (1997): 0.374 individuals per tow, compared to a 15-year mean of 0.478 individuals per tow.
- Florida (1998): 14.383 individuals per tow, compared to a 10-year mean of 3.722 individuals per tow.

Scientists caution that some of the annual values used in the calculation of long-term means are anomalies. For example, the current estimate for the Florida fishery is more than three times greater than the next highest estimate in the 10-year time series. This value was derived from data collected in a reduced sampling effort, and probably does not accurately reflect current conditions (GSMFC, 2001). Data show no significant long-term trends in the overall relative abundance of populations fished off Louisiana, Florida, Alabama, and Mississippi, if annual values recognized by scientists as anomalies are omitted from the analyses. If these anomalies are not omitted, data indicate that the relative abundance of the population off Florida tripled between 1997 and 1998; that the relative abundance of the population fished off Alabama has been below average in recent years; and that the relative abundance of the population off Mississippi is at a significantly lower level than that observed in the late 1970s. Indices of overall relative abundance for the Texas fishery have been below average since 1995 (GSMFC, 2001). Stock assessment data indicate that smaller, younger crabs have grown to comprise a greater proportion of Louisiana's catch over time as the relative abundance of recruits has increased and the relative abundance of post-recruits has decreased. Scientists speculate that the increase in recruits may be due to the short-term effect of estuarine degradation, which is to increase shallow marsh-edge habitat, providing a favorable area for growth and survival of early juvenile blue crabs. The decline of post-recruits is attributed to a significant increase in fishing mortality (GSMFC, 2001).

According to one report, between 1999 and 2002, Florida's blue crab catches declined by 23% on the Atlantic coast and 29% on the Gulf coast [McRae, pers. comm., as cited in Pittman, 2003].

Guillory et al. (2000) caution that current fishing practices could cause a decline in the size-at-maturity and the average maximum size of female Gulf crabs. Capturing some fraction of the population prior to maturing and reproducing could cause natural selection to favor those crabs that reproduce at a sublegal size, resulting in a decrease in the size-at-maturity of females. And, because growth generally terminates at the maturity molt, the average maximum size of females could eventually decrease as well.

In short, blue crab abundance, as measured by fishery-independent means as well as landings, appear to be stable in some areas of the Gulf of Mexico, but declining in others [Guillory, 2004]. CPUE is on the decline in many areas, but this is likely because fishing effort has increased more than because total landings have decreased [Guillory, 2004].

Recommendations:

Blue crabs support one of the United States' most valuable fisheries. In 2000, domestic and imported blue crab products totaled 86,559 metric tons (mt). Domestic landings of *Callinectes sapidus* comprised 93% of that 2000 total; imported *Callinectes* species, 7%. In 2001, the total blue crab market declined slightly to 85,690.8 mt, but of that total, imports comprised 16% , and the U.S. fraction had declined to 84%.

Chesapeake Bay Blue Crab

The historic heart of the U.S. blue crab fishery—the Chesapeake Bay region—is now under threat from habitat loss, pollution and overfishing. Once the nation's major source of crab, the Chesapeake Bay now supplies only about one-third of U.S. blue crab. Chesapeake blue crab stocks are in noticeable decline; according to some management models, the population is overfished. In addition, interactions with protected aquatic mammals and reptiles are significant in some parts of the Chesapeake Bay. Managers are attempting to reduce fishing effort in Chesapeake Bay, and new habitat protections have recently been implemented.

North Carolina/Southeast Coast Blue Crab

The blue-crab fishery has expanded southward in recent years, and about one-third of domestic blue crab is now caught off the North Carolina coast. The North Carolina fishery lacks basic data on populations, effort and trends.

Gulf of Mexico Blue Crab

The Gulf of Mexico now supplies the remaining third of domestic blue crab production. The Gulf fishery "boomed" in the 1980s and has seen turf wars and enforcement problems, as well as ongoing conflict with shrimp trawlers who take massive amounts of juvenile blue crab as bycatch. The Gulf fishery is fairly well monitored, but managers caution that their working estimates of abundance maximum sustainable yield (MSY) are likely inaccurate. Abundance, as measured by fishery-independent means as well as landings, appears to be stable in some areas but declining in others [Guillory, 2004]. CPUE is on the decline in many areas, but this is likely because fishing effort has increased more than because total landings have decreased [Guillory, 2004]. Managers consider the Gulf fishery overcapitalized and are attempting to reduce fishing effort.

Imported Blue/Swimming Crab

In both 2000 and 2001, Indonesia supplied the majority of imported "blue" or swimming crab (6% of the total U.S. market in 2001), followed by Thailand (4%), Mexico (2%), and China and the Philippines (each 1% of the market in 2001). Eleven other countries supplied the remaining imported product (NMFS Stats 2003). These are emerging crab fisheries, often unregulated and poorly known to science or management.

Analysis of Criteria-Blue Crab

Criterion 1: Inherent Vulnerability to Fishing Pressure

Primary Factors to evaluate

Age at 50% sexual maturity
Low: 12-18 months in Chesapeake Bay and N.C., 10-12 months in the GOM

Maximum age
Low: 4 to 6 years

Is maximum age validated?
Yes, from lab studies

Reproductive potential (fecundity)
High (e.g. prolific egg layer or broadcast spawner)
Spawning several times per season, 750,000 to 3.2 million eggs (bigger broods in the GOM)

Additional Factors to evaluate
Species range
Limited (e. g. species exists in one ocean basin)

Evidence of special behaviors that increase ease, or population consequences, of capture (e.g. spawning aggregations, site fidelity, segregation by sex, unusual attraction to gear, etc.) No

Evidence of high population variability driven by physical environmental change (e.g. El Nino, Decadal Oscillations)
Yes
Reliance upon estuaries for breeding---estuarine water conditions heavily influece juvenile survival

Synthesis, analysis and evaluation of relevant factors

Inherent Vulnerability Rank
Conservation Concern Low

Criterion 2: Status of Wild Stocks

Primary Factors to evaluate

Classification status

Fully fished OR recovering from overfished OR unknown

Fully fished to overfished (depending on models used) in Chesapeake. Unknown in NC. Fully fished in GOM.

Current population abundance relative to BMSY

Close to BMSY (50 – 125%) OR unknown

Long term (greater than 10 years) trend in population abundance as measured by fishery independent means (i.e. stock assessment)

Trend is variable across areas. NC has not had a stock assessment..

Short term (less than 5 – 10 years) trend in population abundance as measured by fishery independent means (i.e. stock assessment)

Trend is down in Chesapeake and GOM. NC has not had a stock assessment.

Long term (greater than 10 years) trend in population abundance as estimated from catch per unit effort (CPUE)

Trend is down in Chesapeake

Trend is variable in GOM, unknown in NC

Short term (less than 5 – 10 years) trend in population abundance as estimated from catch per unit effort (CPUE)

Trend is flat or variable (among areas or over time) OR Unknown

Chesapeake and GOM fisheries are considered overcapitalized. NC fishery has exceeded MSY several times in the past few seasons.

Occurrence of overfishing (current level of fishing mortality relative to overfishing threshold)

Overfishing likely (mortality is near threshold) OR Unknown

Current age, size or sex distribution of the stock relative to natural condition

Distribution(s) is(are) functionally normal

Overall degree of uncertainty in status of stock

High (e.g. little or no current fishery dependent or independent information on stock status OR models/estimates broadly disputed)—North Carolina

Medium (e.g. Only limited, fishery dependent data on stock status are available)—GOM

Low (e.g. Current stock assessment and other fishery independent data are robust OR reliable long-term fishery dependent data available)---Chesapeake

Synthesis, analysis and evaluation of relevant factors

Status of the Stocks Rank Conservation Concern Medium

Criterion 3: Nature and Extent of Bycatch

Blue crabs are caught primarily with traps. The main bycatch is juvenile blue crabs, which can be released alive. However, in certain areas, there are interactions with the protected diamondback terrapin.

Primary Factors to evaluate:

Composition of the bycatch, including any species of "special concern" (i.e. those identified as "endangered", "threatened" or "protected" under state, federal or international law)

Bycatch regularly includes threatened, endangered or protected species

In some areas, bycatch of the protected diamondback terrapin has been impacting terrapin populations. Management is addressing this with bait and trap-placement regulations.

Population consequences of bycatch

Medium: Quantity of bycatch is thought to be negatively influencing the species population level OR Unknown

For bycatch species of similar or lower trophic level (relative to the targeted species): Quantity of bycatch relative to the quantity of targeted landings

Low: < 10% of the mass or number of the targeted species

Short and long-term trend in quantity and composition of bycatch as a result of management decisions (including gear innovations):

Trend in quantity and/or diversity of bycatch is down—new trap regs protecting terrapins are in place.

Additional Factor to evaluate

Evidence that the ecosystem has been or will likely be altered in response to the continued removal of the bycatch species

No evidence to date

Synthesis, analysis and evaluation of relevant factors

Nature and Extent of Bycatch Rank Conservation Concern Medium

Criterion 4: Effect of Fishing Practices on Habitats and Ecosystems

Trap fishery, often in nearshore/esturarine waters, but also offshore.

Primary habitat factors to evaluate:
Areal extent of cumulative fishing gear effects:
Medium area (e.g. footprint of dredge, gill nets or pots)

Effect of fishing gear on physical and biogenic habitats (known for specific fishery or inferred from other studies)
Moderate damage (e.g. from bottom gillnet or pots and traps)

Resilience of physical and biogenic habitats to disturbance by fishing method:
Moderate (e.g. mud and sand bottoms)

Primary ecosystem factors to evaluate:
Evidence that the removal of targeted species has or will likely substantially disrupt the food web
No evidence to date

Evidence that the fishing method has caused or is likely to cause ecosystem state changes, including alternate stable states or regime shifts.
No evidence to date

Synthesis, analysis and evaluation of relevant factors

Effect of Fishing Practices Rank

Conservation Concern Medium

Criterion 5: Effectiveness of the Management Regime

Primary Factors to evaluate

Stock Status: Management implements a stock assessment that seeks scientific knowledge related to the short and long-term status of the stock

Stock assessment is planned OR is underway but incomplete---GOM, North Carolina

Stock assessment complete---Chesapeake

Scientific Monitoring: Management regularly collects data and analyzes it with respect to stock abundance

Regular collection of fishery dependent data only--NC

Regular collection and assessment of both fishery dependent and independent data—Chesapeake, GOM

Scientific Advice: Does management ignore advice from its scientific advisors?

Occasionally

Bycatch: Management implements an effective bycatch reduction plan

Bycatch plan in place and reaching its conservation goals (deemed effective) OR no bycatch plan needed because bycatch is "low"

Fishing practices: Management addresses the effect of the fishing method(s) on habitats and ecosystems:

Mitigative measures in place and deemed effective OR no measures needed because fishing method is deemed to be "benign"

Enforcement: Management and appropriate government bodies enforce fishery regulations

Regulations regularly enforced by independent bodies, including logbook reports, sufficient observer coverage and dockside monitoring

Management Track Record: Conservation measures enacted by management have resulted in the long-term maintenance of stock abundance and ecosystem integrity

Measures have not prevented declines or were implemented only after significant declines

Synthesis, analysis and evaluation of relevant factors

Effectiveness of Management Rank

Conservation Concern Medium

Overall Evaluation and Seafood Ranking

Blue Crab

(all U.S. fisheries combined)

The blue crab *(Callinectes sapidus)*, native to Western Atlantic nearshore habitat from Nova Scotia to Argentina, has historically supported one of the United States' largest and most valuable fisheries. Reaching maturity in one to two years, utilizing a wide variety of habitats and food sources, and reproducing prolifically, blue crabs can support substantial fisheries. However, habitat loss, pollution, and heavy fishing have impacted the stocks. There are three centers of blue crab fishing in the United States: Chesapeake Bay; the Southeast Atlantic coast; and the Gulf of Mexico. Each region supplies about a third of total domestic landings. Blue crab populations are in decline in the Chesapeake Bay, stock status is unknown along the Southeast coast, and stocks may be declining in the Gulf of Mexico. Managers consider the fishery overcapitalized throughout its range, and there are troubling instances of interactions with protected species (including the diamondback terrapin) and heavy loss of juvenile crabs as bycatch in the directed crab fishery and in Gulf shrimp fisheries. While management is moving to address these issues, their job is made harder by a lack of basic science on the parameters that influence blue crab abundance. The management regime in the Chesapeake Bay region is most highly developed, because of the historic importance of blue crab in this region and its long-term decline. Management in the Gulf is fairly well developed, though not as comprehensive as the Chesapeake regime. Management in the emerging fishery of the Southeast region is comparatively minimal.

List of Five Component Ranks	Conservation Concern			
	Low	Moderate	High	Critical
Inherent Vulnerability	√			
Status of Stocks		√		
Bycatch	√			
Habitat Effects		√		
Management Effectiveness		√		

Overall Seafood Rank: **Good Alternative**

Supplemental Information

The Environmental Defense Fund has issued a consumption advisory for Blue crab due to elevated levels of PCBs contamination. Environmental Defense applies the same risk-based methodology as the U.S. Environmental Protection Agency (EPA) to data from government studies and papers published in scientific journals. More detailed information about the Environmental Defense advisory can be found at www.edf.org/seafoodfhealth.

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