The Origin, Evolution, and Demise of the U.S. Sea Turtle Fisheries

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"While I gazed on the large one, I thought of the soups the contents of its shell would have furnished for a 'Lord Mayor's dinner,' of the numerous eggs which its swollen body contained, and of the curious carriage which might be made of its shell,—a car in which Venus herself might sail over the Caribbean Sea, provided her tender doves lent their aid in drawing the divinity, and provided no shark or hurricane came to upset it."

— John James Audubon, 1832

Introduction

Fishing was America's first industry, and turtling played an important role in the nation's developing fisheries. However, before the European settlers arrived in the New World, Native Americans had already developed spiritual and gastronomic relationships with sea turtles. There are indications that ancient Florida tribes had eaten sea turtles and then placed the skulls in burial mounds (Johnson, 1952).

Sea turtle meat and eggs were also important foods for the early settlers long before turtle soup became a favorite of European royalty, and captive turtles expedited the exploration and colonization of the New World by providing larder for long sea voyages. Early explorers were particularly thankful for the turtles which ". . . often came as a Godsend in times of hunger and scurvy . . ." (Munroe, 1898).

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Turtling was undoubtedly one of the first commercial fisheries in the southeastern United States not only because sea turtles were abundant, but also because of the relative ease of capture when laying eggs on deserted beaches. Also, no boats, nets, or other expensive equipment were needed, and the turtles could be easily kept alive until sold.

The commercial fisheries for the now threatened and endangered species of sea turtles in U.S. waters have been neither adequately described nor analyzed in detail. Descriptive historical accounts of the southeastern regional sea turtle fishery were presented by True (1884, 1887), Schroeder (1924), and Ingle and Smith (1949), revised by Rebel (1974). Also, many detailed accounts of more localized sea turtle fisheries have also been published (Table 1). Many of these articles, particularly those written near the turn of the century, provide colorful commentary on the lives of early Americans. Additionally, for a brief period at the turn of the century, a San Diego, Calif., factory reportedly canned an estimated 1,000 green turtles per month (Cliffton et al., 1981). However, since those turtles were captured on Mexico's Baja peninsula, it is not considered here as a U.S. fishery.

Early commercial sea turtle landings data were collected sporadically and published in a series of U.S. Government fisheries documents from 1890 to 1930. From 1930 to 1974 sea turtle landings were routinely reported with all other commercially important fishery resources. In this paper, I describe the U.S. sea turtle fisheries and summarize the commercial sea turtle landings reported in Federal fishery documents for the continental United States, Puerto Rico, and Hawaii. These important baseline fisheries data on threatened and endangered species of sea turtles provide considerable insight into the sociology and economics of the U.S. sea turtle fishery. Additionally, these data also provide basic biological information, such as species composition, relative abundance, and temporal and spatial distributions. These factors are required to understand the ecology of

Table 1. — Published accounts of localized sea turtle fisheries.

Location	Citation
Florida	De Brahm (1764) *In* De Vorsey (1971)
	Audubon (1832)
	Smallwood (1842) *In* Tebeau (1981)
	Collins (1887)
	Murphy (1890, repr. 1987)
	Smith (1896)
	Brice (1898)
	Wilcox (1898)
	Carr and Caldwell (1956)
	Caldwell and Carr (1957)
	Ingle (1972)
	Ehrhart (1983)
	Witzell (1987)
Texas	Stevenson (1893)
	Hildebrand (1981)
	Doughty (1984)
Puerto Rico	Wilcox (1900, 1904)
Hawaii	Hendrickson (1969)
	Balazs (1980)
	Markrich (1983)

these unique reptiles and to enable resource managers to formulate sound management and conservation strategies, as mandated by the Endangered Species Act of 1973 and subsequent amendments. The entire historical data set was only recently assembled and published by Witzell (1994).

The Turtles

Five sea turtle species (Fig. 1) commonly frequent U.S. coastal waters: green, *Chelonia mydas*; loggerhead, *Caretta caretta*; Kemp's ridley, *Lepidochelys kempi*; hawksbill, *Eretmochelys imbricata*; and leatherback, *Dermochelys coriacea*.

Green Sea Turtle

The green is a large (90–136 kg) herbivorous turtle that primarily inhabits tropical waters. Juveniles, however, often frequent subtropical coastal bays and lagoons. Commercially, the green was the turtle of choice. The meat was flavorful, and the fatty tissue found under the shell, called calipee and calipash, was dried and used to make the turtle soup so popular with European royalty in the 18th and 19th centuries. The name "green turtle" refers to the color of this fat, not the shell. Because the green turtle could be carried alive for extended periods, some believe it may have provided the meat needed to enable early sailors to explore, colonize, and exploit the New World on their extended voyages (Parsons, 1962; King, 1981). Islands with large numbers of turtles, such as the Cayman Islands and Jamaica, became very important, and English, Spanish, and French fleets vied for control of these important victualling stations. The U.S population of green turtles in Florida is currently on the endangered species list.

Loggerhead Sea Turtle

The loggerhead, a large (90–180 kg) carnivorous turtle inhabiting subtropical and temperate coastal waters, is the most common sea turtle encountered in the southeastern United States (Thompson, 1988). The loggerhead was apparently less desirable because of its dark oily meat, although smaller loggerheads were reportedly more palatable (True, 1884; Munroe, 1898). True (1884) colorfully stated: "The flesh of the adult is leathery and oily, and smells very strongly of musk; it is, therefore, not generally eaten, although some pretend that they have partaken of it when fresh without nausea."

Loggerhead oil, while unfit for cooking because of its strong odor, was brushed on the bottoms of fishing vessels to prevent worm damage and used as a leather softener. Large turtles, in the early 1800's, were reportedly salted and fed to slaves in the West Indies (True, 1884). More recently, they were sold as "turtle balls" or "turtleburgers" to tourists in the United States (Caldwell and Carr, 1957). Although not the main target species, loggerheads became more important as greens became scarce, and they were probably taken whenever encountered. Loggerheads are currently listed as threatened.

Kemp's Ridley Sea Turtle

The Kemp's ridley is a small (36–45 kg) carnivorous turtle that primarily inhabits tropical, subtropical, and temperate coastal waters of the Gulf of Mexico and the U.S. Atlantic coast. The Kemp's ridley is unique in that the entire nesting aggregation emerges together from the sea to lay eggs during the day. Also, the species only nests at Rancho Nuevo in Tamaulipas, Mexico. The area was so remote that the nesting site was only discovered by scientists in 1961.

Although reportedly once the most abundant turtle in the Gulf of Mexico (Marquez-M., 1990), ridleys were not sought commercially (True, 1884), but the apparent distaste was not explained. However, although there are no ridley landings recorded, Caldwell and Carr (1957) reported the ridley to be almost as important as the green in the west Florida fishery and that it was not marketed but consumed locally. Today, because of historically intense egg exploitation and incidental captures in commercial fishing gear, the Kemp's ridley is the most endangered of all sea turtles.

Hawksbill Sea Turtle

The hawksbill is a small to medium (45–57 kg) carnivorous turtle inhabiting coastal tropical seas and has a fairly common distribution adjacent to tropical reefs. The hawksbill was not actively sought for food because, like the loggerhead, the flesh was dark, oily, and strong tasting. In fact, True (1884) stated that the hawksbill meat in the West Indies possessed distinct "cathartic qualities in a high degree." The hawksbill, however, was eagerly taken when encountered owing to its valuable "tortoise shell" used in the jewelry trade (Witzell, 1983). The very light, or "blond," shell was preferred, and a large hawksbill could provide 6–7 kg of shell (True, 1884). The worldwide exploitation of hawksbills for their shells hastened the decimation of this species.

Leatherback Sea Turtle

The leatherback is the largest (450–635 kg) sea turtle. This turtle nests on tropical Central and South American beaches and ranges along the Gulf and Atlantic coasts as far north as Canada. The leatherback is unique because it apparently feeds almost entirely on large pelagic jellyfish, and because it is able to maintain an internal temperature above ambient (Frair et al., 1972). The shell is soft and leathery and the meat is very oily and considered unpalatable. Consequently, the leatherback was never an important commercial species in the turtle fishery, although the eggs may have been collected and consumed locally in Puerto Rico.

Turtle Fishing Methods

The U.S. sea turtle fishery varied considerably and consisted of several directed and nondirected methods. Directed sea turtle fisheries consisted primarily of gill netting, seining, harpooning, diving, and turning—flipping turtles on their backs on the beach. Gill netting was the most common turtle fishing method. These special nets varied but were usually 60–80 m long, 4–5 m deep, with heavy 30 cm twine mesh, and were often set in shallow coastal channels and lagoons (Fig. 2, 3). These nets may have been actively fished by encircling an area suspected of containing turtles and then immediately retrieving them (runaround netting), or they may have been passively fished for sev-

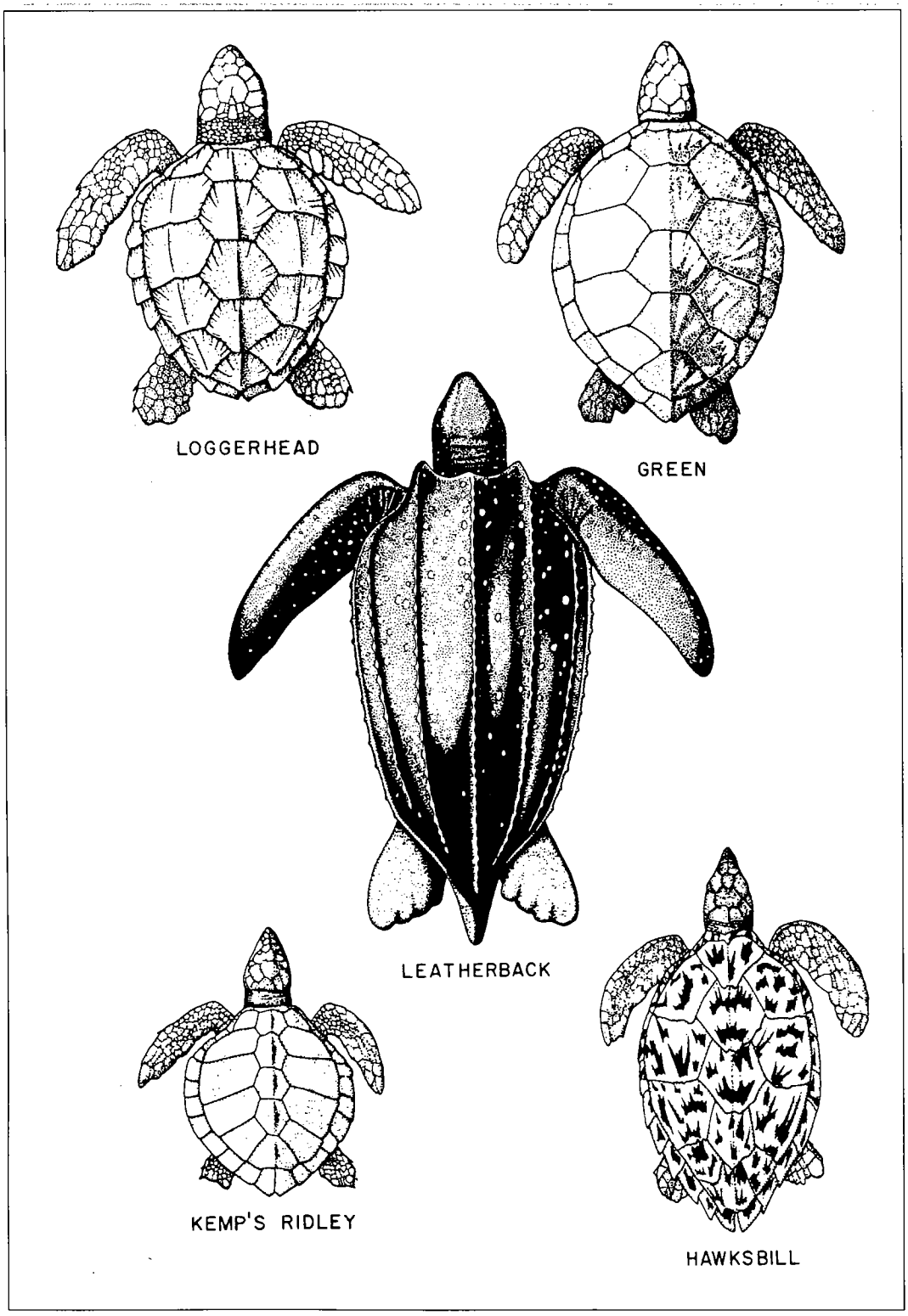

Figure 1. — The five sea turtle species commonly found in coastal U.S. waters.

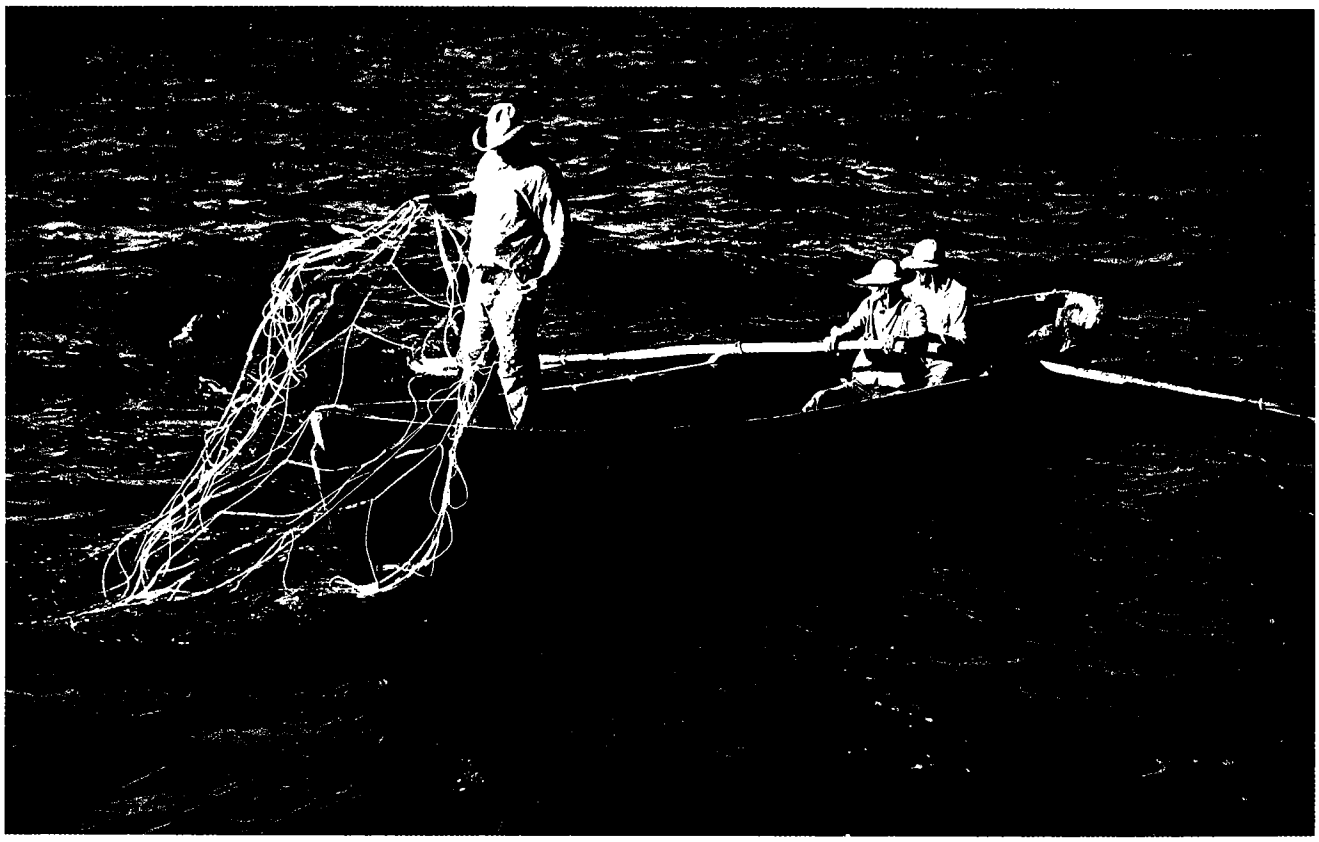

Figure 2. — Turtle fishermen setting a typical turtle net. Photo courtesy of National Geographic Magazine.

eral hours (anchor or drift netting). Several passive nets were sometimes fished simultaneously by larger sailing vessels (Fig. 4).

The fishermen usually remained near the nets, sometimes for several days, and periodically removed struggling turtles before they drowned. True (1887) aptly described this as "the dullest of all fishing, and unending patience and considerable skill are required to make it successful." Wooden decoy turtles were often used to attract hawksbills to the nets in Puerto Rico (Wilcox, 1900, 1904). Seines typically had finer meshes than turtle gillnets, and they were either fished from two small boats in shallow water or fished directly off the beach using a small skiff to encircle the turtles (Fig. 5). In addition to turtles, these nets caught a wide variety of commercially important fin fishes.

Turtles captured alive in nets were preferred because they could be kept in pens (kraals) indefinitely until processing, usually canning or shipping alive on steamships to the New York, Philadelphia, and Baltimore fish markets (Fig. 6). Until shipment, the turtles were fed "turtle grass, sweet-potato vines, and sometimes morning-glory vines and mangrove leaves" (Wilcox, 1898). The net fisheries were historically localized in areas with turtle concentrations: Indian River Lagoon, Fla.; Lake Worth, Fla.; Key West, Fla.; Cedar Key-Crystal River, Fla.; and Aransas Bay, Tex.

Harpoons using detachable spearheads or "pegs" were sometimes used to capture turtles floating on the surface (Audubon, 1832). These "pegs," short steel barbs attached to a line, were designed to pierce the carapace but not to reach the turtle's vital organs and kill it. The peg, loosely fitted on a spear shaft and then plunged into the carapace, would then detach from the shaft and the line was used to haul in the turtle. Copulating turtles were particularly susceptible to harpoon fishing because of their apparent preoccupation with mating. Harpooned turtles were primarily for local consumption, and less frequently for commercial purposes because the harpooned turtles would eventually die of their wounds and spoil while awaiting shipment to northern markets. This method was most popular in the Caribbean.

Diving to capture turtles either by spear or by hand was a simple method that required little or no special equipment. The spear was either a length of wood or iron, depending on the available materials. This method was most effective on smaller specimens and was commonly used by native islanders for immediate local consumption. However, the more recent introduction of inexpensive snorkeling and scuba gear, complete with an entire arsenal of high-tech spear guns, has changed the nature

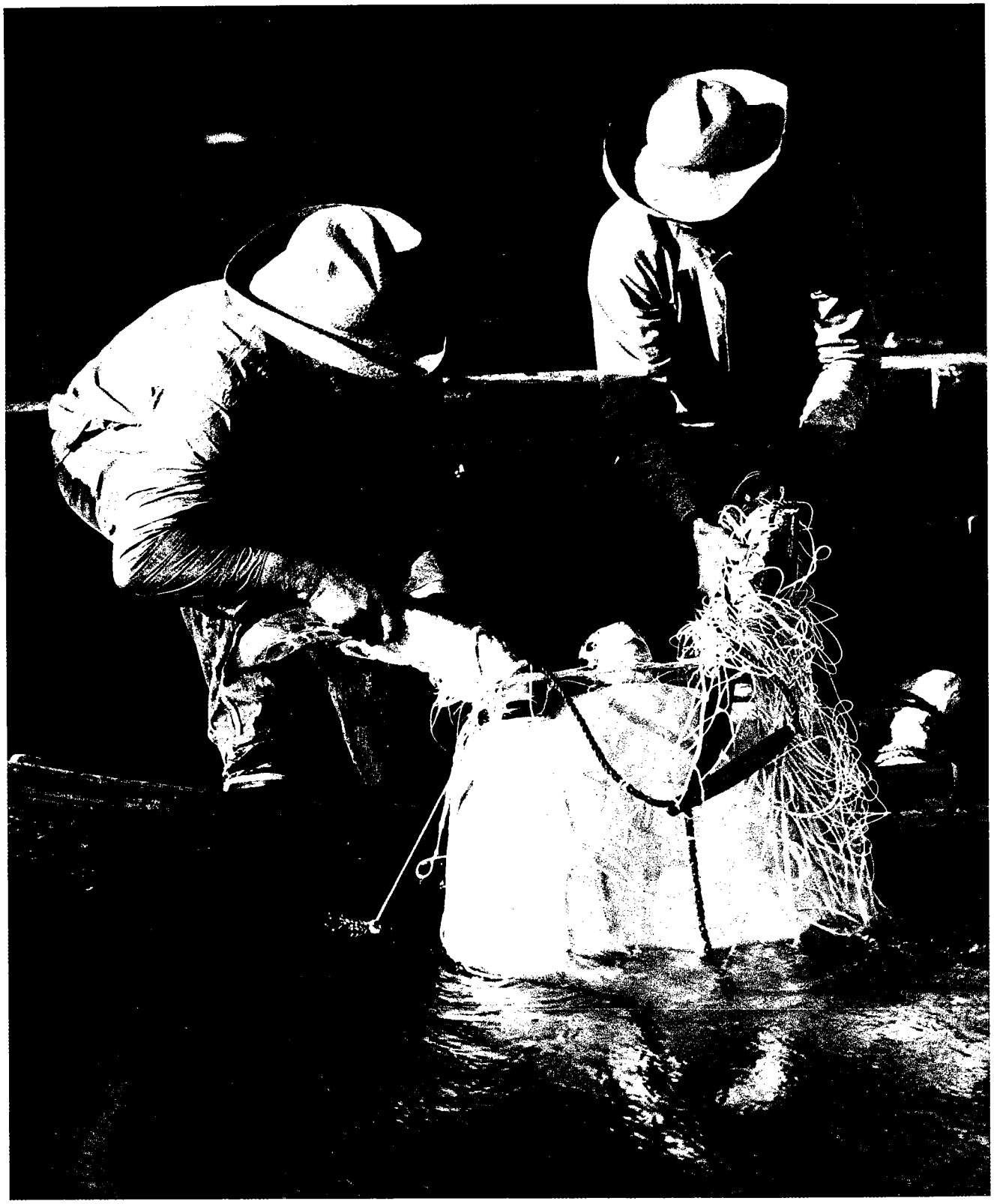

Figure 3. — An entangled green turtle being removed from the net. Photo courtesy of National Geographic Magazine.

of this fishery. Spear fishermen on tropical coral reefs have increased the harvest of juvenile turtles that were previously difficult to get, particularly the valuable hawksbill.

Additionally, to avoid injuring the turtle to keep it for live shipment, fishermen at the turn of the century devised a unique capture method by tying the boat painter to their leg and diving onto basking turtles (Fig. 7). True's (1887) caption for this figure reads "Diving for loggerhead turtle, Morehead City, North Carolina," but the animal is clearly a leatherback. The diver would seize the anterior edge of the carapace with one hand, the posterior with the other, and steer the turtle to the surface. This adventurous method was always exciting, but unfortunately sometimes dangerous. It was not unusual for fisherman to suffer lacerations, bruises, and even broken bones.

Turning female turtles on nesting beaches, particularly greens and hawksbills, occurred whenever possible. No special equipment was necessary and, like net-caught turtles, they could be held alive in kraals while awaiting sale. Historically this was probably the predominant harvesting method employed by fishermen around the world, and, combined with egg harvesting, contributed significantly to the rapid decline of sea turtle populations. However, there is no evidence that large numbers of loggerheads were turned, although they nested in considerable abundance along the U.S. southeast coast. This may have been due to their poor marketability.

Sea turtles were also captured incidentally by various commercial fishing gears: Haul seines, gill nets, and shrimp trawls in the southeastern and Gulf areas, and pound nets in the U.S. northeast and middle Atlantic areas. Although the turtle by-catch from these individual fisheries varied considerably, the total catch from all the fisheries combined was significant. Shrimp trawls were particularly successful at capturing sea turtles (Fig. 8). With the exceptions of some early directed gillnet fisheries (e.g. Texas and east central Florida), and the lingering fishery at Cedar Key, Fla., the U.S. commercial sea turtle fishery probably consisted mainly of turtles taken incidentally.

Some evidence suggests that sea turtle eggs were collected in considerable abundance whenever possible in the southeastern U.S. and Gulf of Mexico areas and were considered a delicacy. Eggs were collected by intercepting females nesting on the beach, butchering reproductive females captured by net or harpoon, and by probing nest sites with "a light stiff cane or a gun rod" (Audubon, 1832). Schroeder (1924) reported that there was a great demand for eggs, selling at $0.25/dozen, and Smith (1896) reported that loggerhead eggs in south Florida were harvested heavily by "fishermen and by predaceous animals, such as bears and raccoons, which walk the beach incessantly at night." Murphy (1890) reported that hunting turtles and eggs at Indian River, Fla., was dangerous because of the large numbers of bears foraging that were ". . . likely to display a pugnacious spirit . . ." if disturbed while eating turtle eggs.

The only turtle eggs recorded as commercial landings were for Monroe County, Fla., (Brice, 1898), where the 3,062 kg collected in 1895 were worth $810 (3,062 kg of eggs is equal to about 76,550 eggs at 40 g/egg). Neither the species nor the area of this egg harvest was given.

Turtle eggs were considered aphrodisiacs in some locations when eaten raw, but were probably better known for the moistness imparted to baked goods because the yolk did not solidify when cooked. True (1884) reported that green,

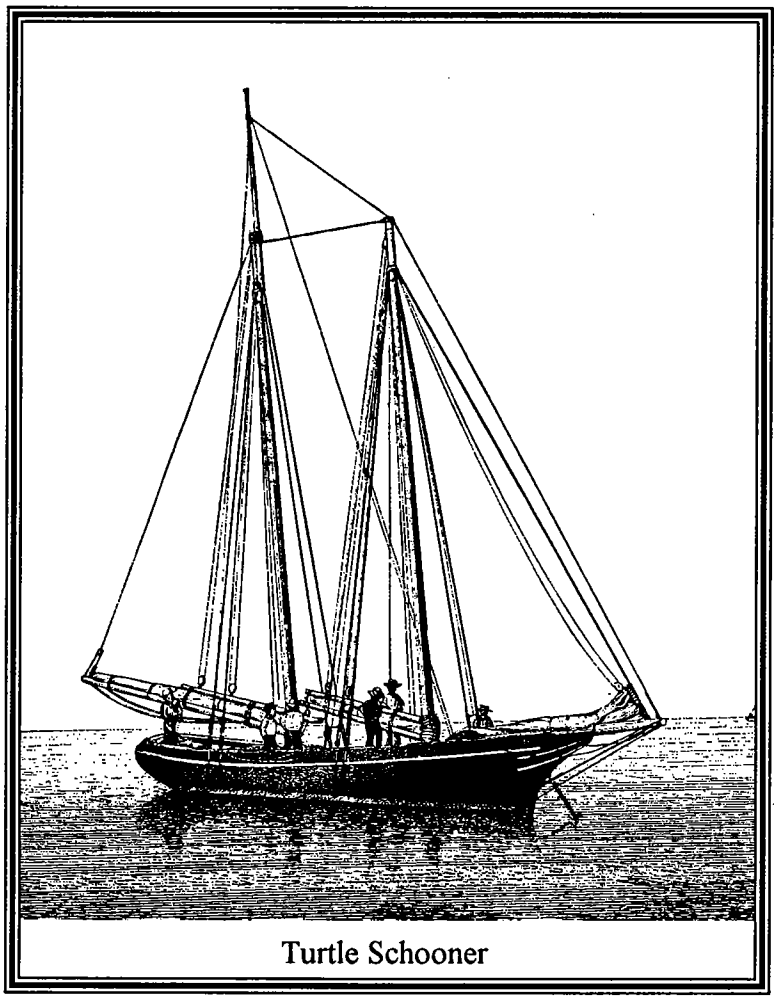

Figure 4. — A typical turtle schooner used throughout the southeastern U.S. and Caribbean (Collins, 1887).

Figure 5. — Successful turtle fishermen near Miami, Fla., who used a beach seine deployed by two skiffs. Photo from *Scene* magazine.

loggerhead, and hawksbill eggs were collected for the oil they produced that was "used in cookery and the arts." Consequently, although few egg harvest records exist, it appears that eggs from all sea turtles were frequently collected and used for local consumption. Additional summaries with information on the harvesting and exploitation of hawksbills, loggerheads, and Kemp's ridleys are reported by Witzell (1983), Dodd (1988), and Marquez (1994), respectively.

The Turtle Fisheries

Landings Data

The landings and values reported in this paper are from U.S. Government fisheries publications. The earliest material, generally titled "Fishery Industries of the U.S.," was incorporated in the annual reports of the U.S. Commissioner of Fisheries from 1873 to 1939. These early reports described the coastal marine resources and fisheries reported by the fledgling U.S. Fish Commission (USFC), originally an independent agency. In 1903 the USFC was renamed the Bureau of Fisheries under the Department of Commerce and Labor and remained in the Department of Commerce after 1911. The Bureau was placed under the Department of the Interior in 1939, and finally became the National Marine Fisheries Service (NMFS) under the Department of Commerce in 1970. Reports after 1939 dealt mostly with fisheries statistics. These publications, titled "Fishery Statistics of the U.S.", were produced by the Division of Statistics for the years 1940 to 1977, and summarized all of the individual states' detailed landings into a single volume. Turtle data, however, ended shortly after passage of the Endangered Species Act of 1973.

The U.S. Fish Commission/Bureau of Fisheries reports did not differentiate between turtle species from 1897 to 1930, and those landings data were lumped in the category "turtles," except for terrapins. The "turtle" data for that period were edited to avoid substantial landings of freshwater snapping and softshell turtles by using only those turtle landings reported from coastal counties with gill nets and trawls. Consequently, some sea turtle data were undoubtedly lost, particularly in the northeastern United States and on Florida's east coast. In 1930, the "turtles" category was split into loggerhead, green, hawksbill, snapping, and softshell turtle categories. However, from what we presently know about the distribution and abundance of sea turtles, the BCF/NMFS port agents responsible for the collection of landing statistics were probably unable to accurately identify sea turtle species, and there is a likelihood that many of the earlier identifications were incorrect. For instance, from 1942 to 1978, the "hawksbill turtle" illustration in the statistical pictorial section of the "Fishery Statistics of the United States" is clearly a Kemp's ridley turtle.

Commercial sea turtle landings data were originally collected by interviews with fishermen and later directly from dockside seafood dealers. Unfortunately, there may have been some reluctance to report accurate landings in the late 1800's because the fishermen and seafood dealers may have been suspicious of government officials (Doughty, 1984). It is probable that many additional turtles were landed and directly consumed by vessel crews and not officially recorded, particularly the less marketable loggerheads and ridleys. Therefore, while these figures should be considered minimum harvest estimates, they do reflect trends in the fishery. Also, the Kemp's ridley, or "bastard" turtle as it was called in the 1800's, seems to have fallen through the statistical cracks. Although recognized as a species of little importance in the Gulf of Mexico by True (1884), it is likely that ridleys were landed as either greens, hawksbills, or "sea turtle," or were consumed locally. All weights in this pa-

Figure 6. — The famous turtle "kraals" of Key West, Fla. Photo courtesy of National Geographic Magazine.

per have been converted from pounds to kilograms.

Total sea turtle landings were considerable (Fig. 9), and they often contributed significantly to rural coastal fishing communities, both culturally and economically. Turtles were taken along their entire U.S. coastal range and undoubtedly provided local sustenance at an affordable price. Landings averaged near 10,000 kg, with obvious peaks at the turn of the century and at 1970, just prior to passage of the Endangered Species Act. The low during 1943 is possibly related to World War II, and the intensive German U-Boat offensive in the western Atlantic.

Sea turtle prices averaged $0.10/kg from the turn of the century to the end of World War II, $0.20–0.30/kg through the 1950's, and then steadily rose to about $0.50/kg in 1975 (Fig. 10). Although sea turtles may have commanded big prices in the New England and European fish markets, the average price to fishermen seems pitifully low by today's standards. Many of the following comments, particularly those regarding turtle landings by county, by gear, and by month are supported by the data documented in Witzell (1994).

The Northeast Fishery

Sea turtle landings have been reported from Massachusetts, Rhode Island, New York, New Jersey, Virginia, and North Carolina. Landings were limited and resulted primarily as by-catch from the pound-net fishery. Most were loggerheads, although the data indicated that some greens and hawksbills were taken. Current life history data indicates that these species identifications were probably incorrect, and the turtles were undoubtedly Kemp's ridleys, which frequent these waters every summer (Lazell, 1980; Morreale et al., 1992).

New Jersey and Virginia were the major sea turtle producing states in the northeast (Fig. 11, 12) but, because they were mostly loggerheads, their value was negligible. New Jersey and Virginia turtle landings were recorded from several counties, with Monmouth and Northampton being the largest producers, respectively. Many of these states still have active pound-net fisheries, and

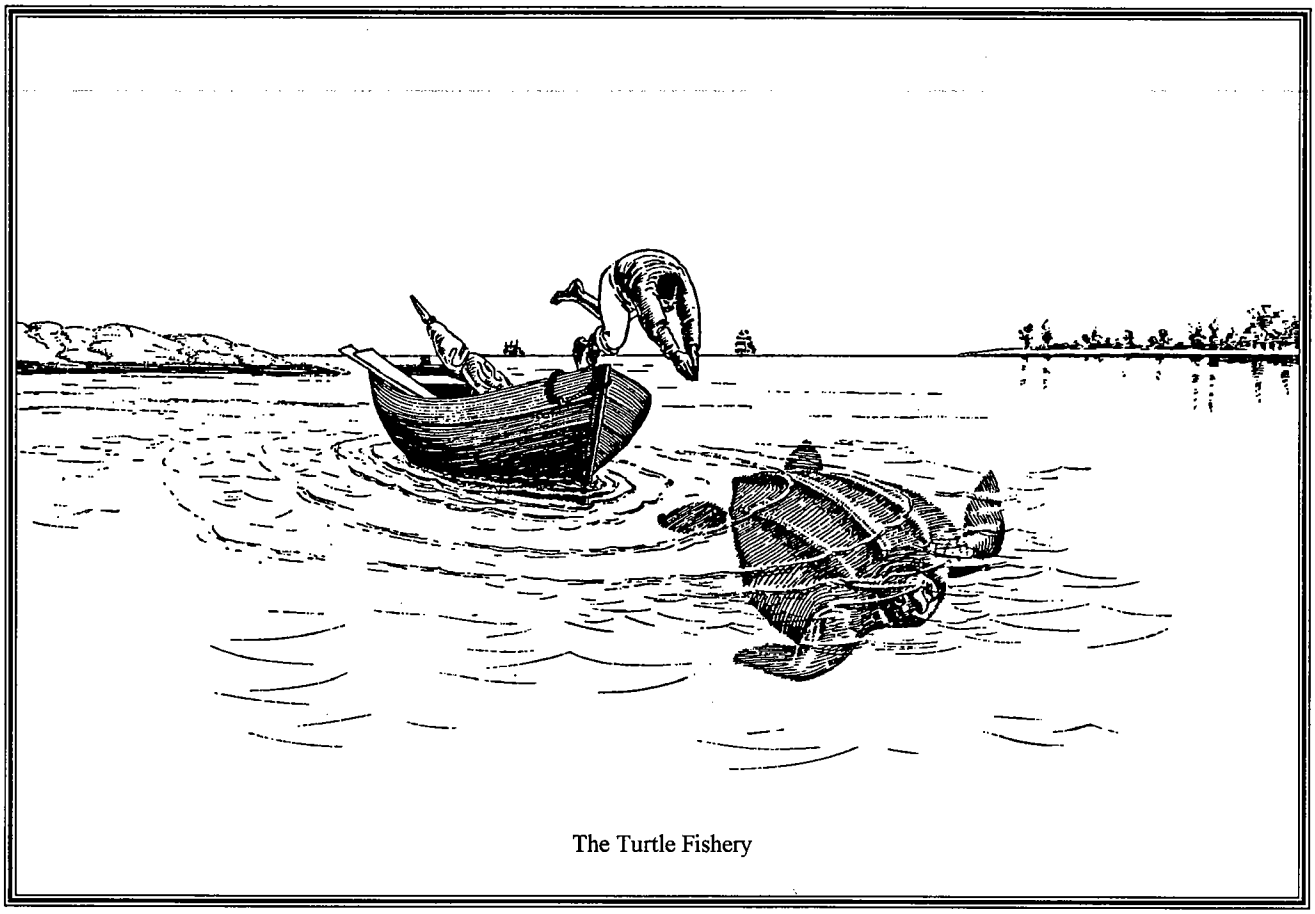

Figure 7. — Diving on basking sea turtles was an effective, but sometimes hazardous, method of capturing live turtles (True, 1887).

sea turtles are still incidentally captured in considerable numbers (Lutcavage and Musick, 1985; Burke et al., 1994).

The Southeast Fishery

Florida

The commercial sea turtle fishery was flourishing throughout Florida by 1890 (Fig. 13). The green turtle was originally the main target species, but there were also considerable landings of loggerheads as the greens became scarce in Florida waters. Landings were recorded from all months, but May and September were the most important. Gill nets (anchor, drift, and run-around) were the predominant gear for greens, while shrimp trawls were predominant for the loggerheads; Monroe and Levy counties were the largest sea turtle producers. The Levy County turtle fishery (Cedar Key) lasted the longest in Florida and consisted of locally caught greens and unrecorded Kemp's ridleys. The green turtle landings from Monroe County were originally from turtles captured in the Florida Keys. However, as the turtles became scarce in the early 1900's, large sailing schooners fished in Costa Rican and Nicaraguan waters and landed the turtles at Key West, Fla. By 1920, Key West turtle landings were predominantly imports (Rebel, 1974). A pictorial account of this colorful and exotic fishery is presented by Duncan (1943). Sometimes, according to Caldwell and Carr (1957), the schooners would stop at Grand Cayman to allow the turtles to fatten in large kraals before returning to Key West.

The Key West turtle kraals were established in the 1800's to facilitate live shipment of turtles to northern markets (Fig. 6). Early descriptions of the construction and operation of these kraals were detailed by Park (1912) and Schroeder (1924). The turtles were roped around the flipper, pulled out of the kraal, usually by a swimmer, and assembled on the dock for live shipment or canning. If they were to be shipped by steamer to New York, the flippers were often pierced and tied together with rope and the animals stored on their backs in the shade. Turtles stored "right-side up" suffocated because the weight of the animal on the lungs prevented them from breathing.

A small cannery was started in 1896, and the turtles to be slaughtered were lined up on the dock and the heads and flippers quickly removed with an axe. The plastron was cut off, and the meat was then removed, cleaned in seawater, hung on hooks overnight, and

Figure 8. — Loggerhead turtles captured in NMFS shrimp trawls in the ship channel at Cape Canaveral, Fla. Photo by L. Ogren.

canned into soup the following day. However, this was apparently not the classical gelatinous soup made from the calipee (Schroeder, 1924), but some concoction of meat and broth.

Louisiana

Louisiana turtle landings were fairly substantial, staying at or near 1,000 kg per year (Fig. 14), and showed a sharp rise in price from 1960 to 1975. These turtles were primarily by-catch from the shrimp fleet and were recorded as mostly greens with a few loggerheads. However, from what we currently know about the ecology and distributions of sea turtles in the northern Gulf of Mexico, these "green" turtles were undoubtedly ridleys, the most common species in Louisiana inshore waters (Viosca, 1961; Hildebrand, 1981). Confusion about which sea turtle species were landed (green or ridley) probably resulted from the fact that the local name for ridley turtles is "white sea turtle", a name sometimes given to green turtles because of their white plastron. These turtles were frequently caught in shrimp trawls and taken home and eaten (Liner, 1954; Gunter, 1981). Landings were recorded year round from Jefferson, Orleans, Plaquemines, St. Barnard, and St. Mary parishes with most of these turtles being landed in April in Jefferson Parish.

Texas

The Texas green turtle fishery at the turn of the century did not last very long, but it was extremely intense (Fig. 15). The magnitude of the landings in such a short time-span quickly depleted the local stocks. Gill nets (anchor and drift) and haul seines were the most commonly used gears in seven Texas counties, with Aransas and Nueces being the most important. Turtle kraals and canning factories appeared near Corpus Christi, Tex., in the mid-1800's (Hildebrand, 1981; Doughty, 1984). Live turtles were shipped by schooner to New York or by steamship to New Orleans, although some turtles were canned as meat or soup and shipped elsewhere for consumption. These canneries also packed oysters, fish, game, and beef. Production, however, was interrupted by a devastating hurricane, the Civil War, and a yellow fever epidemic before starting up again in 1872. The last cannery at Fulton operated until 1896, when the lack of turtles forced operations to move to Tampico, Mexico.

Puerto Rico

The commercial turtle fishery in Puerto Rico was neither extensive nor intense, consisting of greens and hawksbills (Fig. 16). The landings data indicate that the fishery did not gain financial importance until just before the U.S. Endangered Species Act was passed in 1973. The fishery had, up until that point, been artisanal, capturing the turtles with reef-fish gill nets, spears,

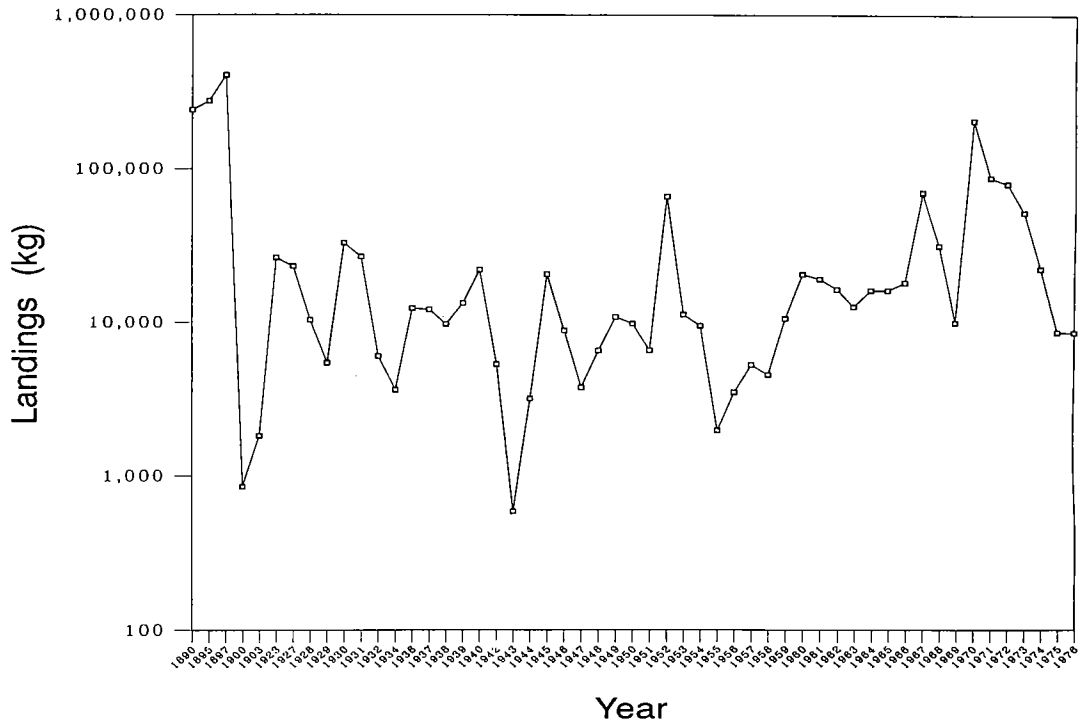

Figure 9. — The total commercial catch of sea turtles by year, all areas and all species combined.

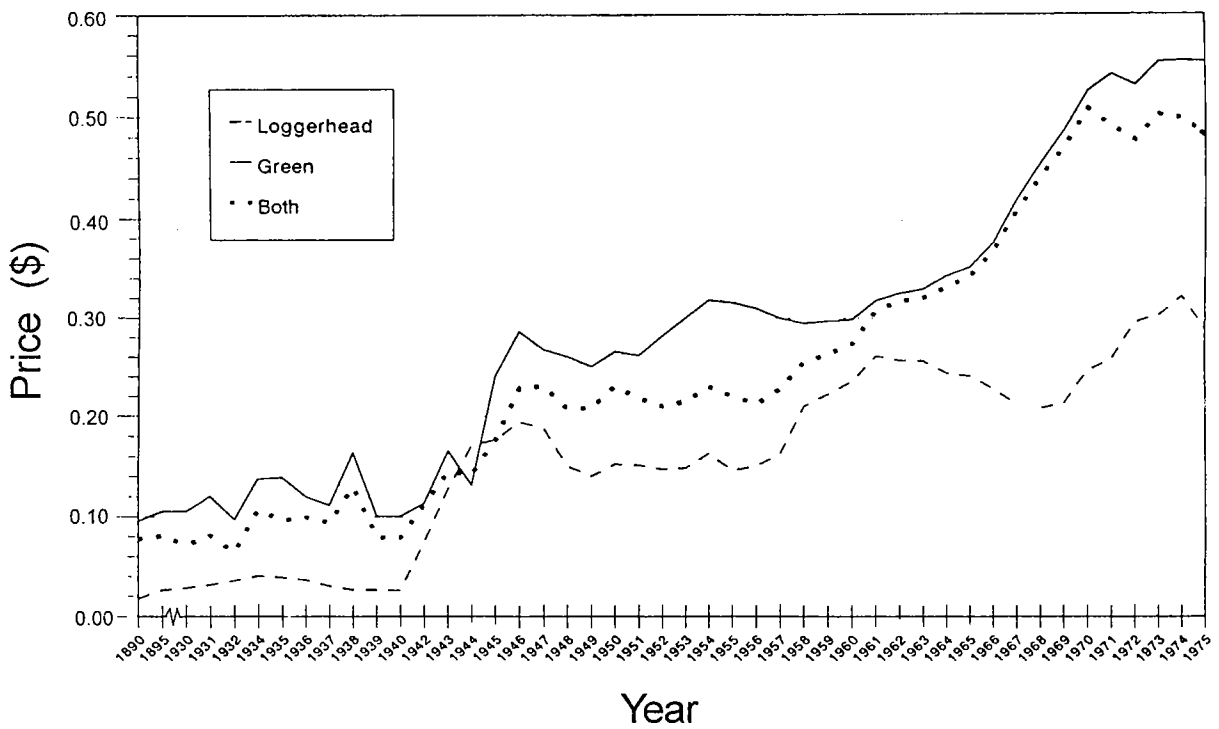

Figure 10. — The average price per kilogram of loggerhead and green sea turtles. A 5-point moving average was used to smooth the graph.

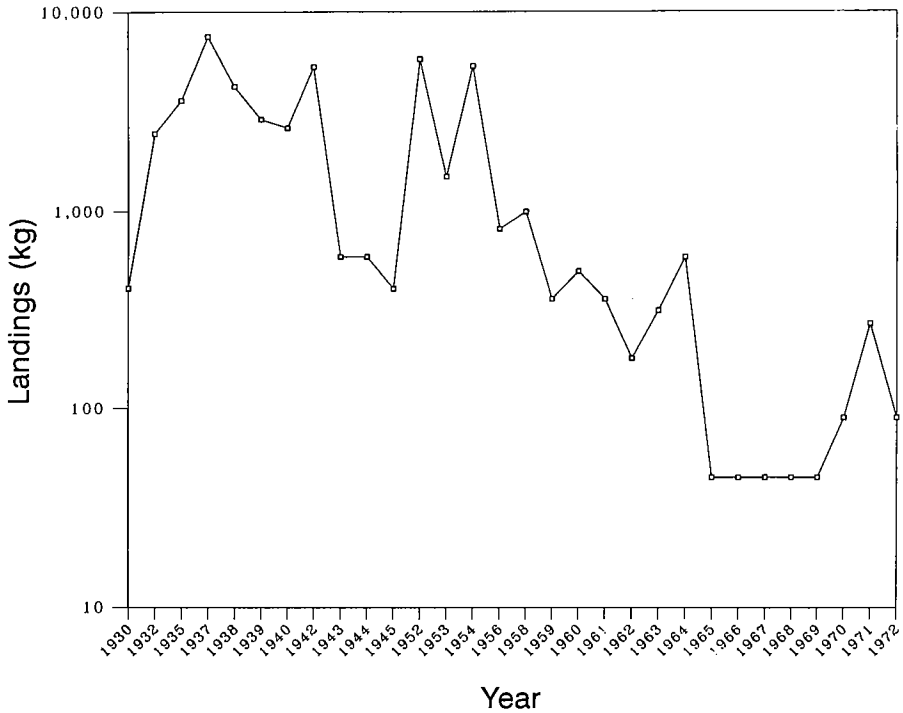

Figure 11 . — Reported New Jersey commercial sea turtle landings (all species combined).

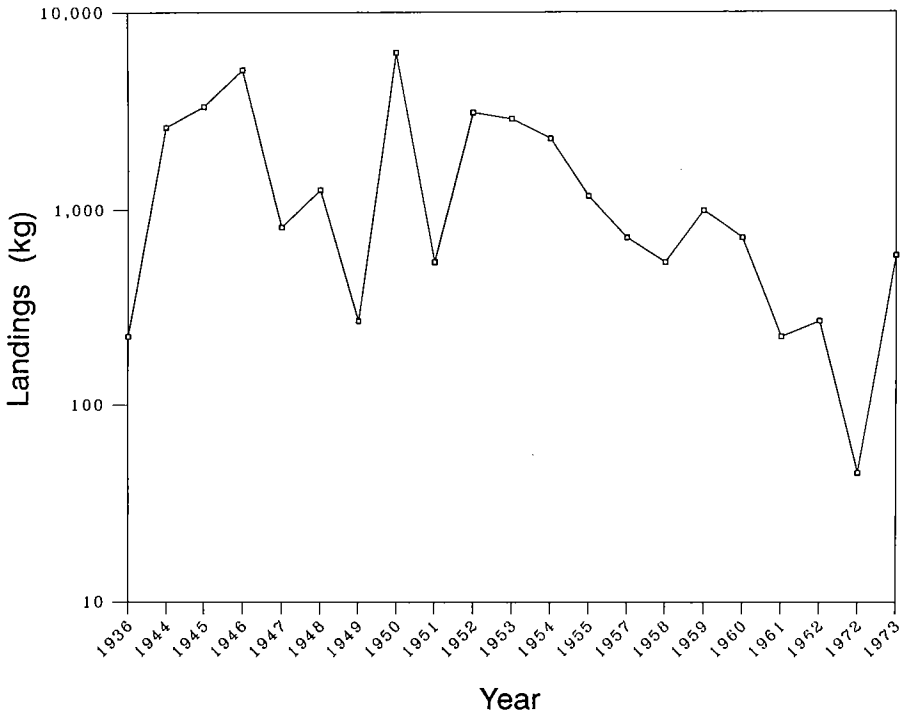

Figure 12. — Reported Virginia commercial sea turtle landings (all species combined).

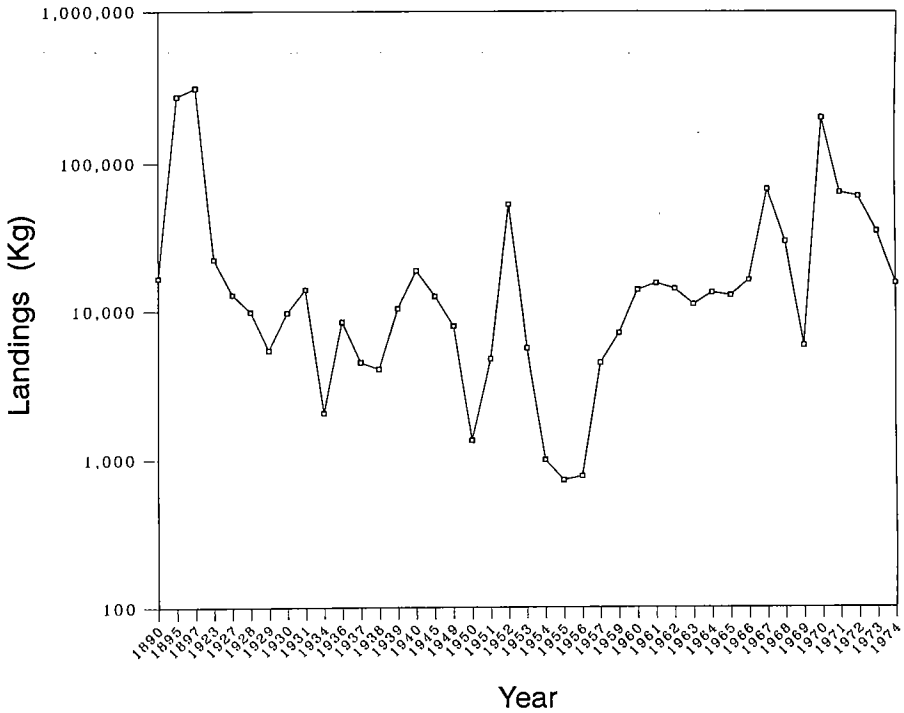

Figure 13. — Reported Florida commercial sea turtle landings (all species combined).

Figure 14. — Reported Louisiana commercial sea turtle landings (all species combined).

and by hand while diving. These turtles were usually butchered and sold to villagers on the beach. Unfortunately, commercial fishery landings data of local catches were not reported in detail by the NMFS until 1971. The south and west coasts were the most important turtling districts.

The Hawaiian Fishery

The Hawaiian turtle fishery was also artisanal, but, unlike Puerto Rico, it eventually achieved considerably more commercial importance (Fig. 17). Green sea turtles were most frequently landed, and they were taken with an impressive array of methods ranging from gill nets (anchor and drift), seines (haul and common), spears, traps, miscellaneous undetermined gear, and by hand. Early on, sea turtles played an important role in Hawaiian cultural history and were depicted in native song and dance (Markrich, 1983). Turtles were also an important source of protein for Polynesians since at least 600 A.D., and Native Hawaiians would capture then alive and hold them in special fish ponds until needed. Turtle landings were reported year round from the five main Hawaiian Islands, but Maui was the most important island and September and October were the most important months.

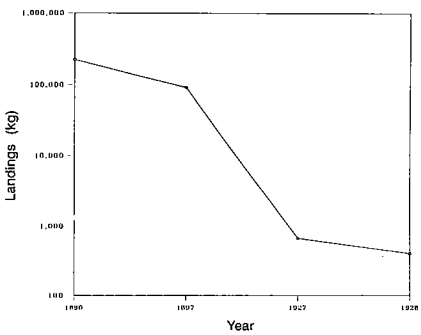

Figure 15. — Reported Texas commercial sea turtle landings (all species combined).

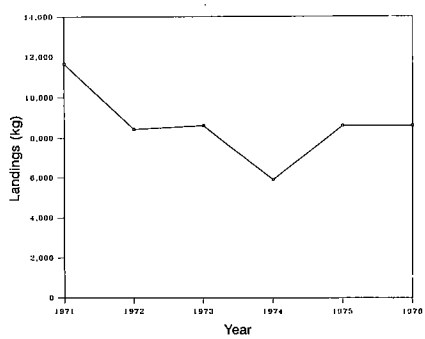

Figure 16. — Reported Puerto Rico commercial sea turtle landings (all species combined).

Fishery Declines

Sea turtles are slow growing, long-lived animals that reach sexual maturity between 15 and 50 years (National Research Council, 1990). They are extremely difficult to manage, particularly as a sustainable resource. A stage-based population model for loggerheads indicated that rapid declines in subadults would adversely impact the population to a greater extent than would a similar decline in eggs and small juveniles (Crouse et al., 1987). Unfortunately, it was these large juvenile turtles that were often commercially harvested (Table 2) because the directed turtle fisheries frequently concentrated on those turtles readily captured in lagoonal areas (e.g. Mosquito Lagoon, Fla., and Aransas

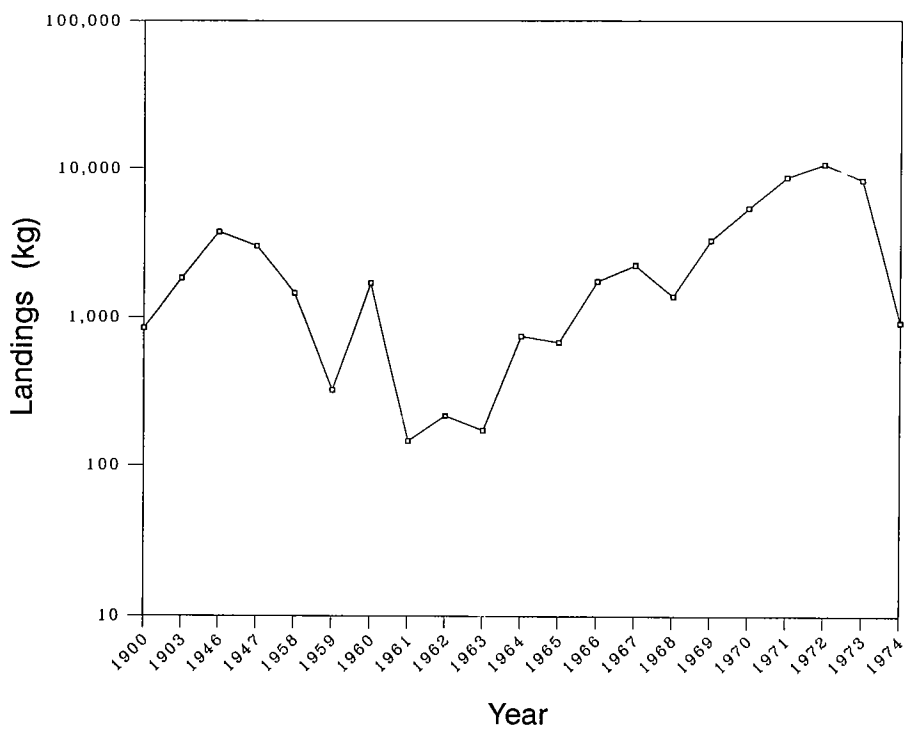

Figure 17. — Reported Hawaii commercial sea turtle landings (all species combined).

Table 2. — Average weights[1] of commercially caught sea turtles.

Species	Location	Weight (kg)	Citation
Green	Beaufort, N.C.	4	True (1884, 1887)
Green	Charleston, S.C.	2-7	True (1884, 1887)
Green	St Augustine, Fla.	9-11	True (1884, 1887)
Green	Halifax River, Fla.	16	True (1884, 1887)
Green	Indian River, Fla.	23-27	True (1884, 1887)
Green	Indian River, Fla.	16-23	Wilcox (1898)
Green	Cedar Keys, Fla.	272-363	True (1884, 1887)
Green	Crystal River-Cedar Keys, Fla.	20	Ingle (1972)
Green	Key West, Fla.	18-45	True (1884, 1887)
Green	Biscayne Bay, Fla.		Smith (1896)
	Inside	11	
	Outside	27-34	
Green	Aransas Bay, Tex.	122	Stevenson (1893)
Green	Hawaii	7	Cobb (1905)
		14-45	Hendrickson (1969)
Loggerhead	Beaufort, N.C.	23	True (1884, 1887)
Loggerhead	Biscayne Bay, Fla.	136	Smith (1896)
Hawksbill	Mona Island, P.R.	11-34	Wilcox (1904)

[1] Weights were converted from pounds to the nearest kilogram.

and Matagorda Bays, Tex.). These lagoons appear to be important developmental habitats for green, loggerhead, and Kemp's ridley turtles (Ehrhart, 1983), and it is not surprising that harvests exceeded recruitment and that these slow growing populations were rapidly depleted.

Additionally, not only were these juvenile turtles readily available, they may have been more valuable than adult turtles when captured far from distant northeastern markets with no transportation readily available (Audubon, 1832; Collins, 1887; Schroeder, 1924). This is because very large turtles were undoubtedly more difficult to handle, transport, and keep alive than smaller turtles. Audubon (1832) found that "the smaller the turtle, the dearer they were, and I could have purchased one of the loggerhead kind that weighed more than seven hundred pounds for little more money than another of thirty pounds." Apparently these very large turtles soon spoiled without refrigeration or ice unless quickly consumed. Several smaller turtles could be kept alive and enjoyed one at a time.

The decline, however, was attributed to several reasons. The Texas canneries experienced sharp declines in turtle supplies by 1895, that were attributed to the capture of nesting females in Central America. Thus, Texas enacted minimum weight and closed season regulations in 1895. Smith (1896) noted that the green turtles in Biscayne Bay, Fla., had already disappeared because of intense fishing pressure from Bahamian sailing vessels, and he suggested that protective measures be passed to save them from extermination.

The disappearance of juveniles from Florida waters was also noticed by Munroe (1898), who believed that this was not due to excessive fishing pressure, but to the gradual captures of adult females that nested on Bahamian and Central American shores. He suggested that a captive breeding and hatchery program was necessary or, failing that, the importation of eggs from foreign rookeries. Brice (1898) reiterated Munroe's opinions, but went even further by suggesting that nesting females and eggs should be left undisturbed and that there should be a legal minimum weight in order to protect the commercially important subadults.

The turtle fishery in Indian River, Fla., had declined since 1886 (Wilcox, 1898), and that was attributed to the increased presence of steamboats, which supposedly frightened off the turtles, and to a 1894–95 cold-stunning event. Egg harvesting was blamed for the overall decline in turtle abundance in Florida by Townsend (1900), who also believed that these eggs should be protected and never harvested. The Texas green turtle fishery decline in the later 1800's was blamed on a combination of overfishing, jettying of the lagoonal passes, and the severe freeze of 1894–95 (Hildebrand, 1981).

Whatever the reasons, it was obvious that the U.S. commercial sea turtle fishery was in serious trouble by 1900, and would remain so. With the exception of the small targeted fishery at Cedar Key, Fla., the fishery existed almost entirely as by-catch in other, more important, fisheries.

Summary, Current Status, and Outlook

Commercial fisheries, habitat destruction, and pollution has had a devastating impact on both U.S. and world sea turtle populations. The U.S. Endangered Species Act of 1973 and subsequent amendments has provided the legislation needed to prevent the extinction of these magnificent animals in the northwestern Atlantic Ocean. The NMFS Southeast Fisheries Science Center (SEFSC) is presently conducting research to determine growth, migration, and developmental habitats of sea turtles in the southeastern United States. The SEFSC is also developing methods to mitigate the incidental turtle catch in commercial trawl and pelagic longline fisheries. The turtle excluder device (TED) was developed by the SEFSC to reduce the capture of turtles in shrimp trawls, and is constantly being modified to operate effectively in different trawl fisheries under various conditions. These TED's are now being developed for use in most Latin American countries and in the some Indo-Pacific countries.

International conservation efforts are aimed at preventing the extinction of sea turtles and helping populations to recover. Sea turtle recovery plans have been developed and are now being implemented, and the NMFS is responsible for research and management of sea turtle populations in U.S. waters. In spite of these efforts, however, it is unlikely that there will ever be another turtle fishery for any sea turtle species in the United States.

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