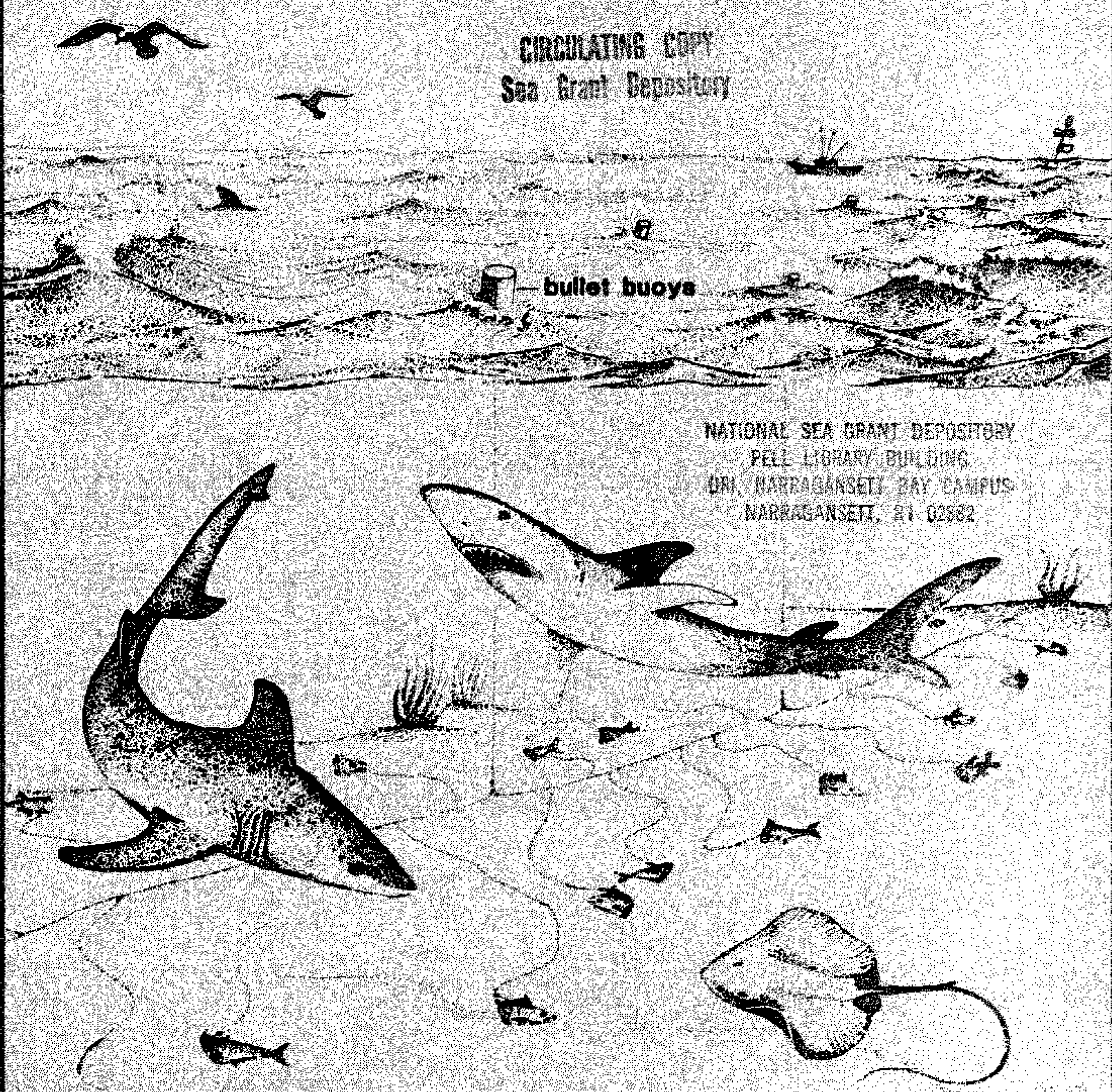
SGR-73

# MANUAL ON SHARK FISHING





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# MANUAL ON SHARK FISHING



A compilation of papers by:

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## INTRODUCTION

Jeffrey A. Fisher

This manual was undertaken out of a recognition that potential alternative shark fisheries in Florida need additional understanding. During the past few years, Florida Sea Grant Extension personnel have fielded frequent requests for information about shark which indicates a continuing interest to initiate a fishery. Sharks are always appearing on underutilized species lists destined for fishery development efforts, and several government agencies have been involved in various development projects that are adding to our understanding of the "shark fishery" (see Additional References). Recently, a Fishery Management Plan for sharks has been prepared by the Gulf of Mexico Fisheries Management Council (1979). Thus discussion for development of a Florida shark fishery is not new.

Indeed during the period of 1938 to 1950 the Gulf of Mexico and South Atlantic waters were the center of a substantial shark fishery. In Florida, the main center of activity was Port Salerno. Also an early report by the Anglo-American Caribbean Commission (1945) pointed out "there are many places in this area where people can make money fishing for sharks." The report also noted the multitude of products that come from sharks such as oil, leather, meat and fins. Only the jaw market was omitted probably because Peter Benchley had not written his now famous book "Jaws" until some 30 years later. Curiously the 1945 report pointed to the two reasons why shark fishing in the "Caribbean area" had not really progressed. They were simply (1) improper handling of the products on the boat and dock and (2) low economic returns with lack of available information on how to improve efficiency. These are precisely the reasons that motivated the writing of this manual!

The primary reason for the World War II era rise of the fishery was that shark livers are high in oil, a good source of Vitamin A. The demise of the fishery in the U.S. was also linked to Vitamin A. By 1950 an inexpensive synthetic Vitamin A became available and the U.S. commercial shark fishery declined to a very low level. Throughout Europe the decline in the fishery never took place simply because the shark meat was regarded with favor. Americans have never relished shark meat and it is only the past few years that we see scattered efforts to market the meat in the U.S.

A small scale upswing in the commercial shark fishery occurred in Florida during 1964 through 1968 along the southeast coastal counties and in the Keys. Once again however, it was not meat that motivated the upswing. The reasons were twofold: (1) leather from hides became more valuable, and (2) shark attacks on Florida's flourishing commercial mackerel fishing operations. But any fishery is probably destined to failure when it is being undertaken solely as a control measure for the problems of another fishery. The promise of leather value was not enough and once again the fishery declined.

Since the later 1960's there has not been a commercial shark industry of any size in Florida. It has been reported that by 1978 fewer than 25 full-time jobs were involved in the harvesting, handling, and processing of sharks in the Gulf of Mexico. Coincident with this "final" decline in the late sixties of the commercial industry has been a steady, strong growth in the recreational sector. During 1978 it is believed that recreational shark fishing in the Gulf of Mexico generated $3,500,000 in business receipts and approximately one million dollars in personal income. Most of the activity occurred in Texas and Florida.

Today there are markets for shark fins, hides, teeth and jaws, and to some extent, meat. Unfortunately, as our brief historical sketches have shown us, along with our knowledge of problems in the fishery, we are forced to note that probably the single most important factor accounting for a low level of success in U.S. commercial shark fishing is that a strong domestic demand for edible shark meat has never materialized. While sharks represent a unique fishery in that so many products are available from one organism, the lack of consumption of shark as food remains the marketing hurdle.

Throughout the history of the industry other problems have evolved that remain with us today. These include:

(1) shark meat requires special handling both on the boat and in the fishhouse,

(2) other product (hides, fins, jaws) handling is equally specialized and tedious,

(3) meat price is low and prices for by-products are highly variable.

Today, sufficient interest has developed in all aspects of the shark fishery to the point where a federal preliminary Fishery Management Plan has been written. Late in 1983, a set of formal federal regulations went into effect that were stated to be designed to increase the availability of sharks to U.S. fishermen and to reduce gear conflicts between domestic and foreign fishermen. A foreign commercial fishery and demand is already upon us. We have the opportunity in the U.S. in general and in Florida specifically to once again attempt to develop a shark fishery--a truly undeveloped Florida commercial potential. Twenty years from now, only history will proclaim our success or failure.

## Literature Cited

Draft Environmental Impact Statement for the Shark and other Elasmobranch Fisheries of the Gulf of Mexico. Gulf of Mexico Fisheries Management Council, Lincoln Center, Suite 881, 5401 West Kennedy Blvd., Tampa, FL 33609.

Anglo-American Caribbean Commission. 1945. Guide to Commercial Shark Fishing in the Caribbean Area. U.S. Fish and Wildlife Service, Fishery Leaflet No. 135, 149p.

# BIOLOGY OF SHARKS AS RELATED TO COMMERCIAL SHARK FISHING

George H. Burgess, Jr.

Information on the biology and ecology of sharks in the Gulf of Mexico and south Atlantic region is scattered and largely incomplete. A series of publications by Stewart Springer over a 25 year period form the basis of much of our knowledge of southeastern exploitable sharks. Of particular importance are his papers covering the life history of the sandbar shark (Carcharhinus plumbeus) (Springer, 1960), still the only complete life history on any shark in the southeast area, and field observations of large sharks of the Florida-Caribbean region (Springer, 1963). Clark and von Schmidt (1965), and more recently Dodrill (1977), Branstetter (1981), Snelson and Williams (1981), and Snelson et al. (1984) have further contributed to our knowledge of sharks (Table 1), but there is still much to be learned. In particular, we know very little about population dynamics (factors that influence the population size) of virtually all harvestable shark species, and life history data, including details of migrations, is sorely lacking for many important species. The following discussion is based primarily on Springer's (1963) observations gained through long term association with Florida commercial shark fishing ventures.

## Populations

As hypothesized by Springer (1963), the total population of each migratory species of large shark in Florida can be divided into two parts. The largest group, termed the "principal population", consists of the main breeding population. This core population is responsible for reproductive maintenance of the total population, and follows regular patterns of distribution (including migrations) and habitat. The remainder of the population, called the "accessory population", is that which is lost through wandering from the usual geographic range of the species or through becoming out of phase in migratory (and therefore reproductive) behavior. Members of the accessory population occasionally achieve reproductive success, but contribute little to the gene

Table 1. Alphabetical listing of sharks most frequently entering Florida's inshore and offshore fisheries.

| Inshore | Offshore |
|---|---|
| Atlantic sharpnose (*Rhizoprionodon terraenovae*) | bigeye thresher (*Alopias superciliosus*) |
| blacknose shark (*Carcharhinus acronotus*) | bignose shark (*Carcharhinus altimus*) |
| blacktip shark (*Carcharhinus limbatus*) | dusky shark (*Carcharhinus obscurus*) |
| bull shark (*Carcharhinus leucas*) | great hammerhead (*Sphyrna mokarran*) |
| dusky shark (*Carcharhinus obscurus*) | longfin mako (*Isurus paucus*) |
| great hammerhead (*Sphyrna mokarran*) | night shark (*Carcharhinus signatus*) |
| lemon shark (*Negaprion brevirostris*) | oceanic whitetip shark (*Carcharhinus longimanus*) |
| nurse shark (*Ginglymostoma cirratum*) | scalloped hammerhead (*Sphyrna lewini*) |
| sandbar shark (*Carcharhinus plumbeus*) | shortfin mako (*Isurus oxyrinchus*) |
| scalloped hammerhead (*Sphyrna lewini*) | silky shark (*Carcharhinus falciformis*) |
| spinner shark (*Carcharhinus brevipinna*) | thresher shark (*Alopias vulpinus*) |
| tiger shark (*Galeocerdo cuvieri*) | tiger shark (*Galeocerdo cuvieri*) |

pool of the total population. The size of the accessory population is small and fluctuates with losses due to death and increases through recruitment from the principal population.

The distinction between the principal and accessory populations is of utmost importance to the commercial fisherman. Members of the accessory population are easy to catch in a given area, taking even spoiled bait readily, but their numbers are small and individuals are scattered. Individuals are characteristically either young or very old, and are frequently malnourished, malformed, or injured. Females are almost always non-gravid (not bearing young). The commercial venture Springer represented found that fishing the accessory population was never economically sound, since the sharks would soon be fished out. Only by moving gear 20-30 miles along the coast daily, and spreading out longer groundlines, could reasonable catches be made.

Fishing the principal population was clearly the optimal strategy. Fishing was carried out in somewhat deeper water, usually in areas where sharks were not locally known to be abundant. Catches were monitored to determine if fishing was sampling the principal population or if this group had migrated out, leaving only accessory sharks (called "bank loafers"). Smart fishermen stayed with the migrating main aggregation and exercised special care in using fresh cut bait and bright, well sharpened hooks; the latter was especially important since these sharks were more "hook-shy" than the rogues comprising the accessory group.

Springer's commercial experience with sharks occurred during a time when liver oil, with its oil soluble Vitamin A, and hides were the targets of shark fishing. It is reasonable to assume that today's economics of harvesting sharks for their flesh do not alter this strategy. Fishermen should not fall into the trap of fishing for members of the accessory population. Initial catches of bank loafers may be high, but subsequent fishing will fall flat. Sightings of sharks by non-shark fishermen, reports of shark damage to nets and other fishing gear, and reports of concentrations of sharks near harbor mouths are all unreliable indicators of principal population sharks. Rather, they indicate the presence of the accessory population, which frequents nearshore areas around human activity.

Virtually all large harvestable sharks of Florida probably have principal and accessory populations, although the precise definitions of these populations, their migrations and habits are poorly understood for most species. Springer suggests that Florida inshore captures of the white shark (Carcharodon carcharias) and mako (Isurus oxyrinchus) are members of accessory populations, and the limited experience of the author with these species in other inshore southeastern areas suggests this may also hold true elsewhere. Tiger sharks (Galeocerdo cuvieri) do not seem to show any population patterns, do not appreciably school, and have not demonstrated large-scale migrations. It is possible that this species permanently acts like an accessory population. Catches of tiger sharks must essentially be regarded as bank loafers in assessing the nature of a catch since they are easily caught and are quickly fished out of an area.

## Distribution and Movements

While it is generally acknowledged that most large shark species are capable of large-scale migrations, the exact patterns of migration by each species are virtually unknown. We do know that certain species with nursery areas in northern latitudes, such as the sandbar shark and the sand tiger shark (Odontaspis taurus), have well defined north-south movements. For other species data is lacking, although captures of single sex or single size class groups at a given locality or during a given season indicates some migration pattern is present.

What factors influence a shark's distribution or initiate migration? Temperature is surely important, but since sharks can satisfy temperature preferences by simply moving into deeper (cooler) or shallower (warmer) waters, one must consider vertical as well as lateral movements. Water temperature alone cannot be used to predict shark distribution. Springer notes that sudden cold upwellings off Salerno, Florida resulted in the best shark fishing of the year, and that during still, hot weather all large sharks, except possibly the nurse shark (Ginglymostoma cirratum), leave the shallows. Dissolved oxygen levels, of course, are intimately related to water temperature. Combinations of high temperatures and low oxygen levels may be more important than high temperature alone. Light level is certainly a factor influencing distribution of sharks, with certain deep water species, such as the night shark (Carcharhinus signatus) and the bigeye thresher (Alopias superciliosus), never taken near the surface in daylight. Currents are perhaps the single most important factor that the commercial fisherman needs to consider. Lines set parallel to current margins or between faces of opposing currents are the most successful.

Some movements are specifically induced by biological considerations. Availability of food, of course, is extremely important, and shark densities are greatly influenced by local abundances of their prey items. Prey abundances often exhibit marked seasonal changes, and shark densities usually follow suite. The fall mullet "run" along Florida's east coast, for example, is accompanied by increased shark feeding activity. Seasonal movements related to spawning and pupping (birth of young) are also important. Most shark species probably have discreet areas in which mating and pupping activites occur. Careful monitoring of sex ratios and reproductive condition (mating scars, presence of pups, etc.) provides insights into localized movements, and therefore abundances. Feeding behavior is also affected by reproductive state (see Food Habits).

## Food Habits

The notion that sharks are all omnivores (eat anything) is not entirely correct. While it is true that the tiger shark falls into this category, most species of sharks are far more selective. Most are fish eaters. Lemon sharks (Negaprion brevirostris), spinner sharks (Carcharhinus brevipinna), blacktip sharks (C. limbatus), blacknose sharks (C. acronotus), silky sharks (C. falciformis), dusky sharks (C. obscurus), sandbar sharks (C. plumbeus) and sand tiger sharks, are primarily fish consumers. The first three species also eat crustaceans, especially shrimp. Large dusky sharks frequently capture sea turtles, porpoises and small sharks. Hammerheads (Sphyrna spp.) also eat fish and crustaceans, but large (10 foot or more) individuals, usually the great hammerhead (S. mokarran), have a more diverse diet, including small sharks and stingrays. In inshore waters scalloped hammerheads (S. lewini) tend to eat mostly free swimming fishes such as herrings and bluefish, while the great hammerhead prefers bottom dwellers, including sea catfishes, drums and flounders. Bull sharks (C. leucas) prefer small sharks, rays, sea turtles, and frequently eat sea catfishes. Nurse sharks differ from the aforementioned species in feeding on bottom invertebrates (shrimps, sea urchins, squids, spiny lobsters), but they too will take a fish bait.

Fishing experience in Florida suggests sharks apparently are repelled by, or do not feed near, decomposing sharks (Springer, 1963). Thus the loss of a longline with its catch is a particularly devastating event, for not only is the fisherman out the cost of his equipment, but the area for a radius of about five miles is unfishable for several weeks. Post gravid females do not feed in the nursery grounds of their own species, therefore captures of young of the year indicate an area of poor fishing. Males do not feed during courtship, also affecting fishing success.

## Summary

Even though commercial shark fishing in Florida has traditionally been, and will probably continue to be, a multi-species fishery, it is important to understand that the resource is not a homogenous one. Commercial fishing for sharks requires good knowledge of the habits and population characteristics of the species involved since at any given point in time certain species will be found in greater abundance, and if fished correctly, will dominate the catch. To be profitable any such operation must acknowledge the behaviors of individual species (eg. food preferences, movements, day vs. night activity, reproductive season, preferred habitat) while seeking sharks of the principal population. Almost any fisherman can make reasonable short term catches of accessory population sharks ("bank loafers"), but any attempt to center a fishery on this group is doomed to failure. Attention to details such as fresh bait, sharp and shiny hooks, and proper placement of longlines are essential for profitable long term commercial operations.

## Literature Cited


Branstetter, S. 1981. Biological notes on the sharks of the north central Gulf of Mexico. Contrib. Mar. Sci. 24:13-34.

Clark, E. and K. von Schmidt. 1965. Sharks of the central Gulf coast of Florida. Bull. Mar. Sci. 15(1):13-83.

Dodrill, J. W. 1977. A hook and line survey of the sharks found within five hundred meters off shore along Melbourne Beach, Brevard County, Florida. M.Sc. Thesis, Florida Institute of Technology, 304p.

Snelson, F. F. and S. E. Williams. 1981. Notes on the occurrence, distribution and biology of elasmobranch fishes in the Indian River lagoon system, Florida. Estuaries 4(2):110-120.

Snelson, F. F., T. J. Mulligan, and S. E. Williams. 1984. Food habits, occurrence and population structure of the bull shark, Carcharhinus leucas in Florida coastal lagoons. Bull. Mar. Sci. 34(1):71-80.

Springer, S. 1960. Natural history of the sandbar shark, Eulamia milberti. Fish. Bull. (U.S.) 61(178):1-38.

Springer, S. 1963. Field observations on large sharks of the Florida - Caribbean region, pp 95-144. In: Gilbert, P. W. (ed.), Sharks and Survival, D.C. Heath and Co., Boston.

## Shark Fishing Methods and Gear

Frank J. Lawlor

Sharks are taken around the world with a variety of different gear types. The most common types of gear utilized are gill nets and longlines, although they are also harvested with seines, trawls and handlines. The optimal method varies with the species sought, local bottom conditions and the economic capabilities of the participants in the fishery.

The gill nets used for shark fishing are typically of large mesh size (7-25 inch stretch mesh) and are used in California and Oregon for the capture of thresher and blue sharks, and in Chile and Peru for the capture of mako sharks. Gill nets are currently being reintroduced along Florida's east coast. Gill nets set for sharks in inshore waters are usually fixed in position with anchors, while those fished offshore are usually suspended from flotation buoys and allowed to drift. Gill nets can be more effective than longlines at moderate to high shark population densities, particularly when chummed or baited, however they are more cumbersome and expensive. Gill nets may be used to catch any size shark depending on the mesh size.

Longlining involves the attachment of baited hooks at regular intervals along a line or wire mainline which is deployed behind a moving vessel. Basically, a longline consists of a mainline, usually several miles long, from which baited hooks are suspended. The baited mainline is either supported in the water column by floats (surface longline) or fished on the bottom with one or more marker buoys. Longlining may be carried out over a wide variety of vessel capabilities ranging from a small boat with a manual process setting about 100 hooks, to a fully automated, multi-thousand hook large vessel operation. Longlining is particularly effective for capturing large species of shark. Both surface and bottom longlining have been used successfully in the shark fishery in Florida. Many sharks are taken as an incidental catch to the swordfish longline fishery and because of this incidental catch, many fishermen have taken an interest in the possibility of a directed fishery for sharks.

There does not appear to be large populations of small sharks on Florida's East Coast such as associated with dogfish fisheries in New England, thus trawling has not been employed to harvest sharks in Florida. In Florida, small sharks are often caught inshore in small mesh gill nets as an incidental catch to fisheries for pompano, spot, croaker, Spanish mackerel, mullet, bluefish, etc. They often cause extensive damage to gill nets and have been known to completely destroy monofilament gill nets. These sharks are often discarded by the fishermen because of a lack of market.

## Gear Description

In the past several years, 1980-84 a small scale directed fishery for sharks has developed on the Florida East Coast. The following description is largely based on this current fishing activity. The vessels used in this fishery usually participate in other seasonal fisheries to supplement their annual income. The vessels range from 35 to 50 feet in length and use surface and/or bottom longlines (Fig. 1). The typical longline operation fishes one or two days per trip and carries a crew of two to four men. The longline consists of one primary mainline varying from 1 to 6 miles in length, made of 1/4" to 3/16" hard-lay tarred nylon. The mainline is stored on a hydraulically operated spool (Fig. 2) and strung with pulleys (Fig. 3) to facilitate set and retrieve. Hook lines (called gangions) usually are made of 2 fathoms of multistrand steel cable ahead of the hook (Fig. 4). The gangions are usually stored in barrels and are attached to the mainline with snap-on connectors (Fig. 5). Loop protectors are used at the connection of the hook and gangion and sacrificial anodes (zinc) are placed on the hook to minimize corrosion. Hooks are usually large, 3/0 or 3.5/0 shark hooks. Between 300 and 500 hooks are set and the vessels usually make one or two sets per day. Hooks are spaced relatively close together (between 100 and 300 feet apart). Bait is extremely variable. Bluefish, bonita, mackerel, mullet, and squid are common, however, the fishermen often use other types of bait depending on their availability. Buoys are usually a combination of high density bullet-shaped foam and polyethylene balls attached directly to the mainline with snap-on connectors with 15-60 fathom leaders. When bottom longlining, the leaders are of

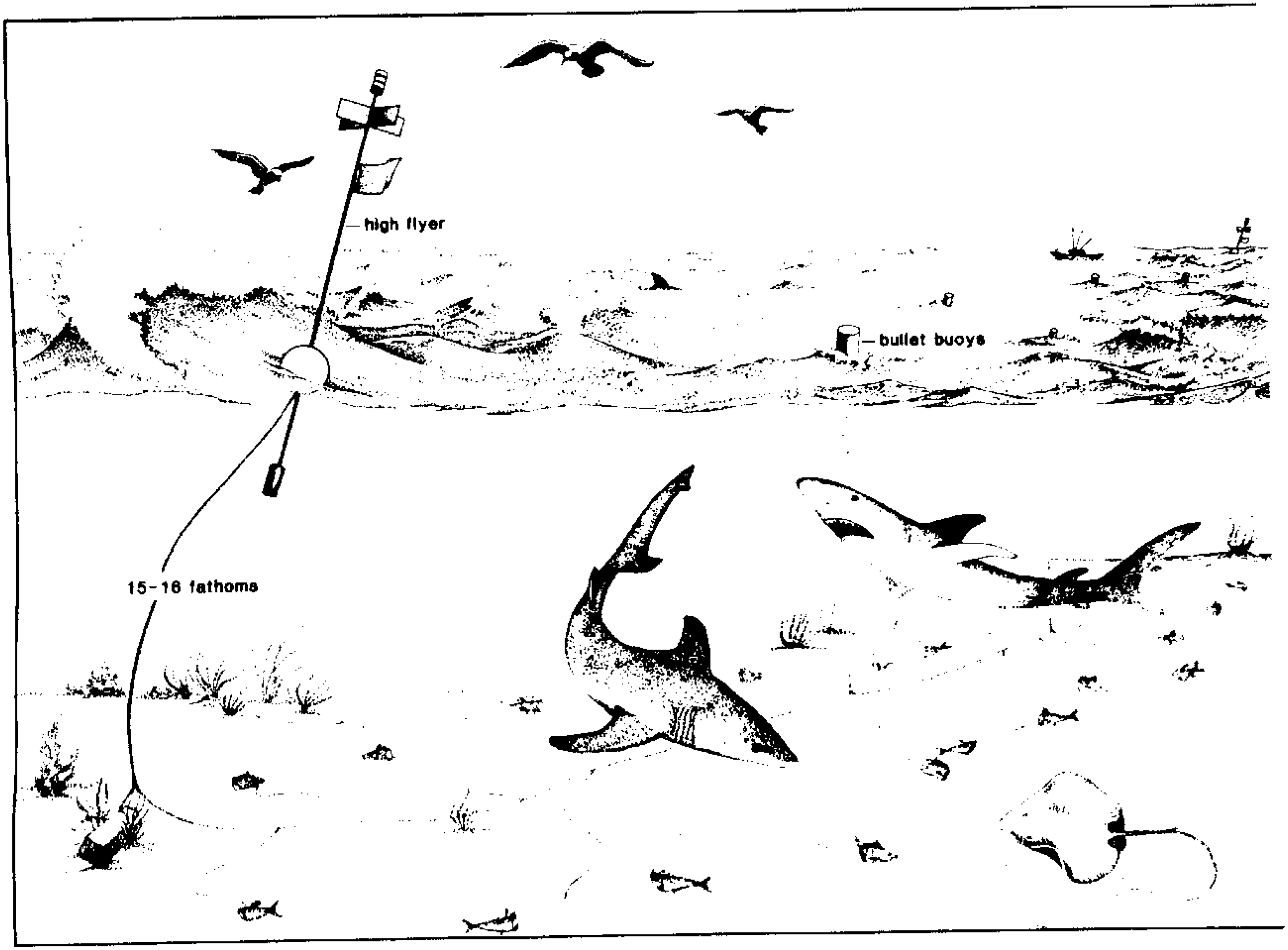


Figure 1. Illustration of shark longline gear set on the bottom.

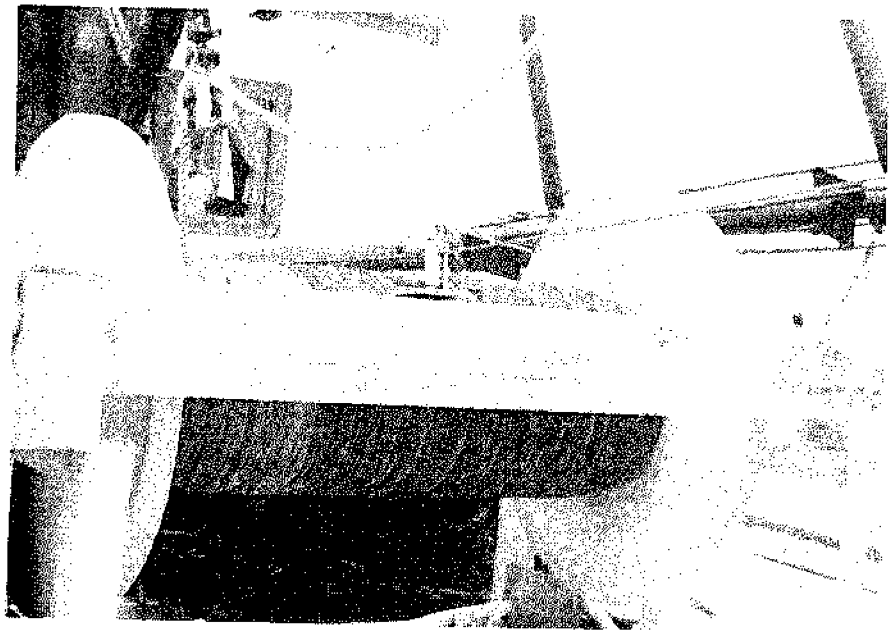

Figure 2. Hydraulically operated spool for hauling and storing the mainline

Figure 3. Pulley arrangement used to retrieve the mainline.

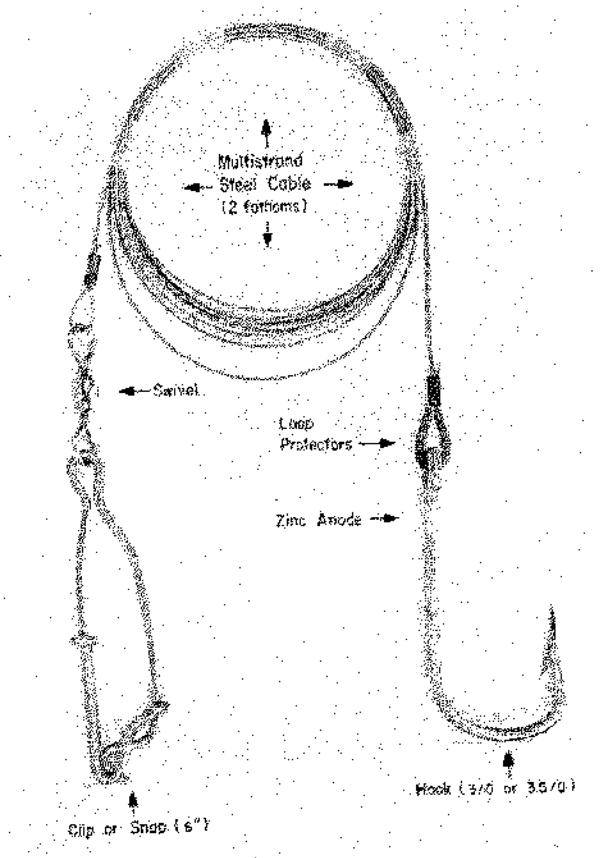


Figure 4. Hook and gangion arrangement for shark longlining.

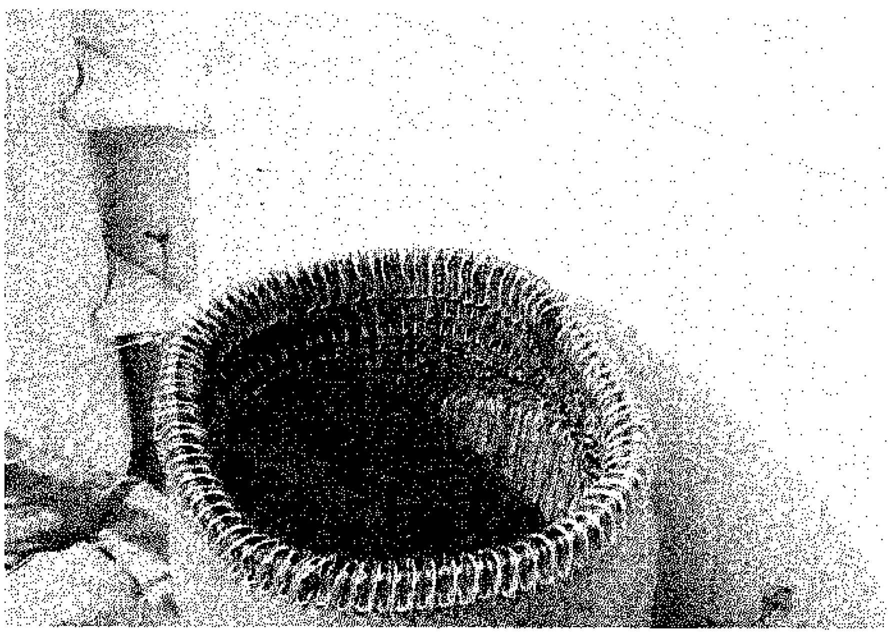

Figure 5. Barrel storage of the gangions with hooks and connectors placed along the top edge

sufficient length as the bouys will remain on the surface with the mainline on the bottom. Fifteen or twenty foot marker poles with strobe lights and radar reflectors called "high flyers" are attached at each end of the mainline.

## Fishing Methods

Longliners fishing on the East Coast of Florida usually begin a trip in the early evening. The fishing "grounds " are usually in 15-60 fathoms of water. Typically the longline gear is set after dusk. A set begins with baiting and placing the gear in the water, then retrieving the gear after 2 to 10 hours of soak. The soaktime varies depending on expected catch rate and intent to make additional sets.

The mainline is led off the spool and a high flyer is clipped to the first end and cast overboard. As the boat moves ahead, the mainline is fed off the spool. Hooks are baited and gangions are clipped on the mainline as it feeds over the stern. Buoys are clipped on the mainline at proper intervals as the line passes astern. Usually, a buoy is attached to every 10th hook. The setting operation takes from 30 minutes to 3 hours depending on length of mainline . Two or three men usually are required to bait hooks, uncoil and clip on gangions and buoys, and operate the hydraulic spool. After the line is set the vessel will usually anchor next to the high flyer for the evening and the crew sometimes will handline for snapper/grouper.

At dawn, the haul back begins. The highflyer is picked up and the mainline is attached to the spool, being fair led from amidships. As the vessel moves slowly along the line, the line is retrieved and the gangions and buoys are removed as they come aboard. When hooked sharks are brought alongside, the boat is stopped until the fish is gaffed and brought aboard. Dead sharks and hammerheads are usually cut free. The live sharks are hauled onboard with a winch onto the rail.

Butchering begins immediately and should be accomplished as soon as possible. The shark is first immobilized by severing the spinal cord, then the tail is cut off to allow bleeding. Some innovative fishermen have designed a

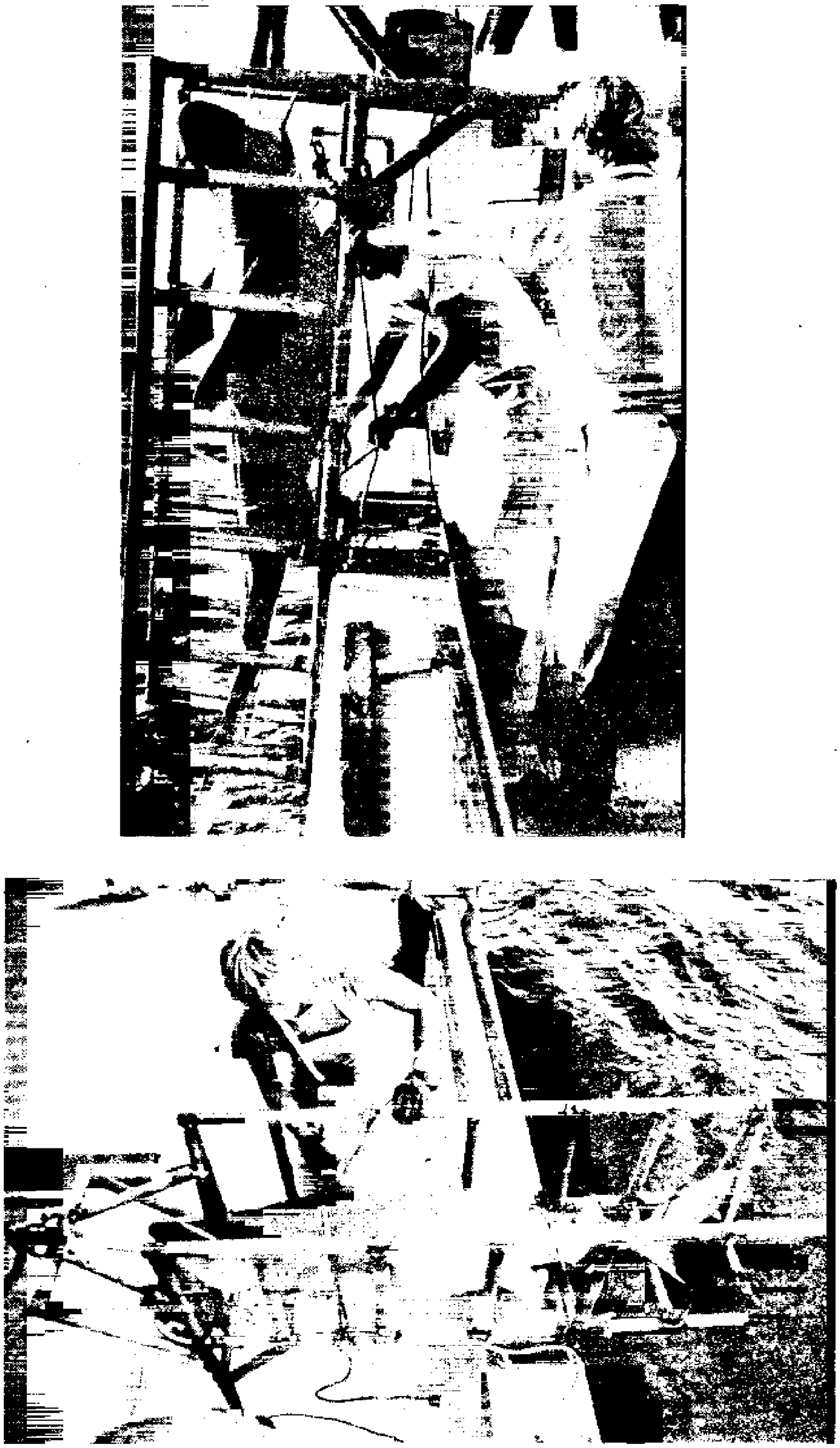

Figure 6. Innovative restraining device to assist handling and butchering sharks aboard the vessel. (Picture and gear design credit to Billy Sanderfur, fisherman, Ft. Lauderdale, Florida).

special lift and restraining device to assist this operation (Fig. 6). Care should be taken so as not to drop the tail overboard before recovering the lower lobe of the fin. After the flow of blood from the tail stops, the shark is gutted and brought aboard. The head and fins are cut off, the belly flaps are removed, the carcass is washed, and the belly cavity is cleaned and de-slimed. It is especially important to remove the blood line (kidney) along the roof of the belly cavity. At this stage, with the head and fins cut off, the product form is called a "log". In order to provide the best quality meat, the butchered shark can be immersed in a salt water ice slush. The most proficient crews take between 7-15 minutes from the time the shark is brought alongside to the time the logs are placed in the salt water ice slush.

The fins should be washed and trimmed of all meat and either iced or prepared for drying. The wet fins, while quite valuable ($3 - $6) are not as perishable as the flesh. After the haul back, the vessel either heads back to port or prepares for another set. The fish are usually left in the brine tank for 2 to 4 hours. If the vessel makes another set, the fish are taken out of the brine tank and stored in the hold belly side down packed in clean ice.

The fishery for sharks along the southeast Florida coast appears to be seasonal with the highest catch rates taking place during the fall and winter months from Sebastian to the upper Keys. Production for a vessel fishing 400 hooks during this time varies between 1,000 and 4,000 pounds per set. Catch rates or sharks caught per total hooks set typically range from 8 to 12 percent; however, up to 20 percent of the hooks may catch fish during the winter. During the summer, warmer water temperatures seem to cause the sharks to migrate to deeper water (cooler temperatures) or out of the area, and catch rates decline below profitable levels. At surface temperatures above 75$^{\circ}$F in 15-60 fathoms catch rates usually decline. Catch rates are also affected by the number of vessels fishing a given area. Catch rates decline by as much as 50 percent after a set has been made, therefore fishermen do not return to the same area until a suitable length of time has passed (several weeks to a month). Thus shark fishermen try to coordinate their fishing activity.

# SHARK PROCESSING AND HANDLING

W. Steven Otwell

Shark processing can include total utilization of all body parts - fins, hide, teeth and liver oil, but current commercial interest is primarily concerned with use of the edible flesh or shark meat and fins. Regardless of which shark product is used, quality is a crucial factor. Good shark meat can offer a nutritious boneless meal with pleasing eye appeal, mild flavors and tender texture, but poor shark quality can leave a lasting, unfavorable impression. Poor quality shark is usually reported to have strong 'sharky' odors and flavor, discolored meat, tough texture and/or separations in the flesh. These objectionable attributes are often a result of wrong and careless handling. Most consumers unfamiliar with shark meat would interpret poor quality as an inherent characteristic for all sharks. Poor quality has often been cited as a primary reason for the limited domestic and foreign markets for sharks caught in the United States. Thus, the reputation of the shark industry depends on correct and unique handling methods.

## Quality Considerations

Sharks are classified in the Elasmobranch group of fishes which also includes the skates and rays. All fishes in this group have a cartilaginous (soft) skeleton. The next main group of fishes is the Teleost or fishes with bony skeletons. This group contains most of the common food fish. Unlike most food fish, the muscle and blood of Elasmobranchs has a larger amount of non-protein nitrogen compounds (NPN), i.e., urea, trimethylamine oxide (TMAO), creatine, certain amino acids, etc... These NPN compounds are also produced by the bony fishes, but they are less concentrated and eliminated as waste products. The more primitive kidney system in the shark retains some of these compounds to increase the body salt levels such that the shark can survive in a saltwater environment. Thus, urea is a natural functioning compound in shark meat, whereas bony fishes must continually drink large amounts of water to remain in osmotic (salt) balance with their environment.

When a shark dies, the NPN compounds can be rapidly changed into odorous compounds with objectionable taste. Urea is converted to ammonia and TMAO is reduced to trimethylamine (TMA) (Fig. 1). These changes are caused by the chemical action of specific enzymes, urease and TMAO reductase, respectively. Studies have shown that only minute quantities of these enzymes are present in the muscle tissue (Simidu and Oisi, 1951; Tsuchiya et al., 1951; and James and Olley, 1971). Thus, before spoilage begins these specific enzymes must be produced by certain types and amounts of bacteria which begin to grow on the surface of the shark. Studies have shown that spoilage is first evident when the bacteria numbers on the surface reach $3.9 \times 10^4$ microorganisms /cm2 (Yap, 1979). These bacteria can include certain psychrotrophic types (cold temperature tolerant) which continue to slowly grow and produce the enzymes even in the presence of ice. Similarly, basic autolytic enzyme activity (self-digestion) will contribute to the spoilage process. Although ice and refrigeration can slow the enzymatic action, spoilage from the fresh state is inevitable.

$$\underset{\text{Urea}}{NH_2 - \overset{\overset{O}{\|}}{C} - NH2} + 2H_2O \xrightarrow{\text{Urease}} \underset{\text{Ammonia}}{2NH_3} + CO_2$$

$$\underset{\text{Trimethylamine Oxide}}{CH_3 - \underset{\underset{CH_3}{|}}{\overset{O}{N}} - CH_3} + NADH_2 \xrightarrow{\text{TMAO Reductase}} \underset{\text{Trimethalymine}}{CH_3 - \underset{\underset{CH_3}{|}}{N} - CH_3} + H_2O + NAD^+$$

Figure 1. Common enzymatic reactions which contributed to spoilage in shark flesh.

As spoilage progresses the accumulation of ammonia and other spoilage products will cause the pH of the shark flesh to increase. The muscle pH of fresh caught, well iced shark is near 6.0, whereas an ammoniated, spoiled shark has a muscle pH equal to or greater than 9.0. The first detectable changes in pH occur at cut surfaces, mainly where the head has been severed from the body. Using this basic information, researchers have tried to develop simple pH scales for monitoring shark quality (Waller, 1978 and 1980A; and

Bilinski et al., 1983). They proposed simple litmus or pH paper, with a specific pH range (6.0 to 9.0), can be used to measure the surface pH of the flesh to determine the expected shelflife (Table 1). Their results were somewhat variable and would require more work before practical application, but they can be a more definite measure than general appearance alone.

Table 1. Recommended quality scale using surface pH measurements (litmus paper) taken from flesh at the head cut to predict shelflife of fresh shark. (Source: Waller, 1980A).

| Surface pH | Visual Quality | Expected Fresh Shelf-life |
|---|---|---|
| 6.0-7.0 | good | 10-12 days |
| 7.0-8.0 | apparently good | 4-6 days |
| 8.0-9.0 | poor | 0 |

The most popular method for detecting spoilage is sensory judgements. Humans can detect a faint taste of urea in cooked shark meat when it contains a urea concentration in excess of 1200 mg percent (Gordievskaya, 1971). The urea concentration in raw shark meat can vary from 1.0 to 2.5 percent by weight (Simidu, 1961). Even at the lower levels of urea, enzyme activity can produce ammonia. Sensory perception of ammonia is more acute. The detectable spoilage level caused by ammonia in shark meat is 0.03 percent (James and Olley, 1971). Thus, a portion of the urea must be removed and the production of ammonia must be prevented to assure an acceptable shark meat.

Bleeding is the best method to remove NPN compounds from the live shark meat (See Onboard Handling). After proper bleeding, a variety of dips or soaking solutions have been tried. The most practical method for onboard use has been soaking in an icy water slush or salt brine. The soaking action rapidly cools the meat and will remove some of the water soluble compounds (urea, ammonia, TMAO, etc.) from the surface. Salt brine will extract fluids from deeper in the meat thus removing more compounds and possibly leaching out darker colors in the flesh. Unfortunately, shark meat readily absorbs salt. Thus careful use of brine is necessary to prevent toughening or excess salt taste.

Organic acid solutions, i.e., lactic acid, citric acid (lemon juice) and acetic acid (vinegar) are thought to neutralize the basic ammoniation compounds, remove urea, decrease bacteria, and prevent enzyme activity. These acids also provide some firming of the flesh. Gordievskaya (1971) indicated a 1.5 percent lactic acid solution could remove 64 percent of the urea from five pound pieces of shark soaked in a 1 to 4 ratio (meat to solution). His recommended soak temperature, 14 to 16$^{o}$C (57 to 61$^{o}$F) is too high for reliable commercial use. Vyncke (1978), using meat from the wings of rays, recommended a soak procedure with a 0.5% citric acid solution for 5-15 minutes at 5$^{o}$C(41$^{o}$F). His treatment decreased ammonia production and extended iced shelflife from 10 to 14 days. The citric acid provided the additional benefit of a slight bleaching action. If the citric acid was used in the form of lemon juice it may flavor the flesh. Excessive concentrations or prolonged soak time could impart bitter tastes. Thus, acid soaks can offer advantages, but they are not recommended because careful application is necessary to yield an acceptable product.

Color and texture will also influence acceptance. The preferred shark meat is white and tender. The color of shark meat will vary per species. The pink-red or darker colored flesh has a higher concentration of NPN compounds, stronger taste and spoils more rapidly. If the darker colors can not be leached from the flesh, then fishermen may want to avoid harvesting such species. Similarly, the texture of shark meat will vary with species and size. Larger sharks typically have a slightly tougher texture but not necessarily an objectionable texture. Regardless of species or size, careless handling can cause adverse textural changes. Tossing, bruising, gouging and excess pressure on the carcass can cause meat separation (Waller, 1978). This problem is further accentuated with poor icing and/or improper freeze, thaw and refreeze practices.

If some urea and TMAO has not been removed from the flesh and initial spoilage has begun, freezing can not preserve the quality of the shark. The products of enzyme activity will continue to accumulate causing odors which could contaminate other frozen products. Subtle changes may cause increased meat toughness. Since researchers were not able to account for increased meat toughness as a result of dehydration during frozen storage (Waller, 1980B) then further degradation of TMA to dimethylamine (DMA) and formaldehyde may be the cause of toughening as commonly noted in certain bony fishes. It will suffice to say moderate quality shark will continue to spoil in frozen storage. Thus, the occasional retail practice of freezing unsold fresh fish should not be used for shark.

## Onboard Handling

Fresh caught sharks can not be handled in the same manner commonly used for most food fish. Simple icing or frozen storage alone will not preserve the quality in shark. Due to the unique quality considerations previously discussed, the shark must be handled in a specific manner without delays. To prevent delays, considerations must be given to allow for ample deck space and crew to properly handle sharks. Special considerations should provide shading to protect the product from direct sunlight. A fishing schedule must be arranged to avoid landing dead sharks. After death sharks retain their blood which contains the urea and other NPN compounds which contribute to spoilage . Experience will indicate the proper harvesting schedule. Hooked sharks can struggle for a considerable period of time after catch. Netted shark drown more quickly. Avoid using more fishing gear than can not be effectively fished to prevent harvesting dead sharks.

Live sharks should be immobilized for easier handling. Use of guns can be expensive and dangerous. Solid persuasion and restraining gear are recommended. When immobilized the shark must be bled. If bleeding is delayed the pumping action of the heart will weaken or stop and the blood can clot, darken the flesh and deposit NPN compounds for spoilage. The most effective method for bleeding is to remove the caudal fin (tail) which severs the central, caudal vein allowing free flow of blood (Fig. 2). Studies have shown that different cuts result in different amounts of blood loss (Table 2; Gordievskaya, 1971). Removing the caudal fin from the small sharks typically caught in large schools (i.e., dogfish) would be impractical. If a few small sharks are caught, some fishermen recommend cutting the branchial region through the gills.

Table 2. Blood loss caused by cuts in different regions of a shark.

| Region Cut | *Blood Loss (%) |
|---|---|
| Caudal Fin (Tail) | 5.2-6.1 |
| Pectrol 'bones' (Sides) | 2.0-2.5 |
| Parietal region (Head) | 3.5-3.8 |
| Heart | 1.9-2.1 |

*Basis for determination of percent blood loss was not cited in the original source, Gordievskaya, 1971.

Regardless of which bleeding method is used, fishermen must remember the blood contains compounds which can cause spoilage, odors and bacterial growth which can contaminate the deck and hold. Bleeding must be arranged to drain from the deck along with continuous washing and complete deck washdowns, as necessary, to prevent dried stains. Special care is necessary to prevent blood contamination of the ice supply. Onboard cleanliness is crucial to assure good quality shark and to prevent an aromatic vessel.

After bleeding, the shark is butchered to a "log" form or carcass without head, belly flaps, guts, or fins. The head should be removed first with a smooth cut beginning from the pectoral fins, cutting away the branchial zone or gill cavity. The head cut should be clean and smooth to minimize exposure of flesh and blood. The shark is then gutted. The belly flaps are removed because they rapidly spoil and have little market value. Livers, if marketable, should be washed and stored separately. The belly cavity is carefully washed and brushed to remove excess blood, kidney line at the top of the belly cavity and any traces of discoloration. Finally remove the fins. Valuable fins should be trimmed to remove pieces of muscle tissue, then stored dry or wet depending on the market.

Recovering the hide is a specialized process only used for larger sharks. Hides must be recovered immediately after catch (within 24 hours), properly cut, fleshed, and preserved with salt. Most fishermen are reluctant to market

Figure 2. Cutting the shark head (above) and caudal fin (below) to allow bleeding.

hides because the extra required care is not thought to be worth the potential value and meat quality suffers.

Immediately after butchering, the carcass should be washed then rapidly prechilled in an ice water slush. The recommended shark to water ratio is 1 to 4. Temperature of the water should be maintained at $0^{o}C$ ($32^{o}F$) with additions of clean ice. An internal dial thermometer with metal probe can be used to check the cooling rate of the meat. Although the prechill will extract some urea and other NPN compounds, the primary purpose of the soak is to rapidly cool the meat. Additions of salt in the water can increase the cooling capacity and help extract additional amounts of blood and urea. The recommended salt concentration is 2.5 to 5.0 percent (approximately 2 to 4 pounds of salt per 10 gallons of water). The salt should be added before the ice. The salt should be non-iodized to avoid discoloration problems. Also, use of ocean water (3.0 to 3.5 percent salt) is a common practice. When using seawater excercise care to avoid contaminated water nearer shore and about docks. Maintaining an effective salt concentration is usually a difficult judgement which depends on the amount of product cooled. A 2 to 4 hour soak time should provide sufficient cooling before removing the carcasses for packing in ice. Place carcasses bellyside down and pack with at least 2 parts ice for 1 part shark. Empty the water as necessary to avoid accumulation of slime and blood which would contaminate other sharks.

Brine tanks with mechanical refrigeration can also be used for prechilling. This system is best suited for freezing. Due to the large size and thickness of certain sharks, the brine tank could only provided the initial chill or surface freeze. Storage in a freezer would be necessary to complete freezing.

Use of chemical dips or special solutions is not recommended for onboard handling. Chemicals are an additional expense which do not provide cost effective benefits unless properly used. Chemicals are not effective in treat ing a whole shark carcass. Mixing and maintaining proper concentrations, and monitoring soak time are impractical problems for routine use. In some cases improper use of certain chemicals can be more detrimental than poor handling.

During the entire onboard operation fishermen should avoid excessive, rough handling. The carcass should not be thrown about the deck and packed under excess pressure. Bruising and pressure can cause meat separation which becomes more obvious during further butchering and handling.

Records of the catch by species, size, location and time can be extremely important. In addition to providing direction for future harvests, detailed records can indicated handling problems for specific species and sizes of shark. Records may lead to economic decisions to avoid certain shark to assure better quality and price.

## Dockside and Retail Handling

Careful handling should continue when the product is unloaded at the dock. The product should not be unloaded until arrangements are made to continue cold storage. Temporary warming of the 'logs' between unloading and storage will decrease the quality of the shark meat.

Grading dockside quality usually depends on sensory judgements. Detection of ammoniacal 'sharky' odor and discolored meat denotes poor quality which should be rejected. Condition of the cut carcass at the head region is the best measure of quality. The exposed flesh and blood vessels promote more rapid spoilage. A simple litmus paper test for surface pH may be a useful method to assist grading (See Quality Considerations; Table 1). A detrimental practice of 'cutting back' at the head may improve the apparent quality, but initial spoilage in the remaining carcass will continue.

A whole fresh shark carcass, or 'log' should be stored between 0 to 4$^{o}$C (32 to 39$^{o}$F) with skin or hide on. The carcass should remain intact until ready for sale as butchered cuts. Custom butchering to steaks or fillets would depend on the size shark and market situation. A cut for 3/4 or 1-1/2 inch thickness is suitable for most recipes and is best for effective presoaking to improve taste and color. Steaks should be sold skin-on with excess belly flap trimmed. The salesman should explain the skin holds the cut intact and it can be easily cut away after cooking. Fillets should be skinless and cut to avoid excess darker tissue. Fillets or steaks should not be cut to include the pre-exposed meat at the head. Typically this meat is the first to show signs of spoilage.

Before packaging or display, fresh shark fillets or steaks should be soaked to remove more urea and ammonia, and to leach blood color from the flesh. The most practical soak is ice water with or without salt. Previously mentioned meat to water ratio, salt concentrations, and soak times are recommended. Remember, soaking is <u>not</u> a salvage operation for poor quality shark, but a preventative step to maintain the quality of good shark meat.

Soaking in dilute concentrations of citric acid or lemon juice could provide some flavoring, firming of the flesh and additional leaching of off colors. The citric acid solution should be applied as an icy slush at a concentration not to exceed 0.2 percent (approximately 0.15 pounds per 10 gallons). A 15-minute soak time in a solution to meat ratio of 1 to 4 should be sufficient. Care is necessary to prevent over soaking which would cause bitter taste or yellowing of the meat. If lemon juice is used read the contents label and dilute citric acid to the recommended concentration.

If the shark meat, whole or butchered, is intended for frozen storage it must be of excellent quality and packaged and frozen immediately. The recommended storage method should provide packaging to prevent dehydration and oxygen exposure. The recommended storage temperature should never exceed 10$^{o}$C (0$^{o}$F). Unnecessary thawing and refreezing can cause meat separation. The common practice of freezing unsold fresh fish can not be used for sharks. Even in fresh shark meat the initial stages of spoilage have begun and will progress the longer the meat remains unfrozen. When the apparently good meat is frozen, the spoilage process continues. The results could be contamination of other frozen products and unacceptable products when thawed.

Finally, salesmanship can be one of the most important factors during handling at the wholesale and retail level. The salesman must provide extra buyer education. Most consumers are not familiar with differences between shark and common food fish. To assure a successful sale the buyer should be advised about the special quality considerations for shark and provided recommended methods for handling and preparation.

## Literature Cited


Bilinski, E., R. E. E. Jones and M. D. Peters. 1983. Factors controlling the deterioration of the spiny dogfish. Squalus Acanthias, during iced storage. J. Food Sci. 48:808-812.

Gordievskaya, V. S. 1971. Shark flesh in the food industry. Pacific Scientific Research Inst. Marine Fish. and Oceano. (TINRO), Vladivostok, Russia, 26p. (Transl. from Russ. by Isral Prog. Sci. Transli., Jerusalem, 1973).

James, D. G. and J. Olley. 1971. Spoilage of shark. Australian Fish. 30:11-13.

Simidu, W. and K. Oisi. 1951. Studies on the Putrefaction of the Aquatic Products I. The mechanism and the speciality of development of ammonia in the shark muscle. Bull. Jap. Soc. Sci. Fish. 16(4):47-51.

Simidu, W. 1961. Nonprotein nitrogenous compounds. Borgstrom, G. ed. Fish as Food, Vol. I. Academic Press, NY, pp. 353-384.

Tsuchiya, Y., I. Takahashi and A. Yoshida. 1951. Studies on the formation of ammonia and trimethylamine in shark. Tohoku J. Agric Research II. (1):-119-126.

Vyncke, W. 1978. Influence of sodium tripolyphosphate and citric and on the shelf life of thornback Ray (Raja clavata L.) Z. Lebensm. Unters. -Forsch. 166(204-286).

Waller, P. F. 1978. Results of shark handling and processing study. Australian Fisheries, October, 22-27.

Waller, P. F. 1980A. Spoilage and spoilage indicators in shark held in ice. Food Tech. in Australia. 32(3):161-166.

Waller, P. F. 1980B. Spoilage and spoilage indicators in frozen shark. Food Tech. in Australia 32(4):184-187.

Yap, A. S. J. 1979. Results of shark handling and processing study. Australian Fisheries, October 22-27.

## SHARK FINS

John M. Stevely

Shark fins are highly regarded by the Chinese and provide the basic ingredient for shark fin soup and other Chinese dishes. By weight, shark fins are the most valuable part of the fish. The dorsal, pectoral, and lower lobe of the tail fin from all other species, except nurse sharks, are commercially acceptable; however, some fin buyers will only accept the lower lobe of the tail fin from mako, thresher, and blue sharks

Occasionally, fishermen and fish houses can sell small quantities of fresh, frozen, or dried fins directly to Chinese restuarants. More commonly fins are sold to dealers who either export fins or supply restuarants. Hong Kong with a population of over 5 million Chinese is one of the most important markets for shark fins. In 1982 Hong Kong imported 2,746 tons of fins (Ka-keong, 1983) valued at $32.6 million U.S. (based on international monetary exchange rates as of May 22, 1984).

### Cutting the Fins

All fins must be properly trimmed until white noodle-like tissues appear. (Fig. 1). If done correctly, the fins will have been cut with a slight curve into the fin. Otherwise the fins will be less valuable and, if dried, will continue to produce odors and attract flies. As a general rule of thumb, pectoral fins larger than the size of your hand (approximately 8 inches from tip to base) will command top price. The dorsal fin and particularily the lower lobe of the tail fin can be smaller and still be acceptable. In general you will receive full value for fins from sharks at least 5 feet in length (around 60 to 80 lbs total weight). Fins from smaller sharks may still be acceptable, but at a much lower price.

## Handling Fins

Fins can be prepared for shipment by either drying or freezing. For drying, the fins should be cleaned in saltwater or a 3 percent brine solution to remove slime and blood. Drain the fins for at least one hour by standing them upwards in a milk or fish box. The fins can then be spred out on a wire rack in the sun. An alternative is to punch a small hole near the fin tip, pass a string through the hole, and then hang the fins in the sun to dry (Fig. 2). The fins should be taken under shelter during the night and also when it is raining. After the fins are somewhat dried, dew or a little rain will not hurt them. During warm summer weather the fins will be dried in a few days. Under less than ideal conditions it may take 12 or more days. If the weather is bad you may be able to dry them by standing the fins upwards in a milk or fish box placed in a warm room such as the vessel engine room. Care should be taken to avoid any contaminates. Properly dried and cut fins can be held for months before shipping.

For freezing, washed fins can be kept on ice and then frozen on return to port. Frozen fins are sold for approximately 1/2 the price of dried fins, but realizing an approximate 50% weight loss when drying there is essentially no price difference. The decision of whether to either freeze or dry the fins is simply based on which method suits the particular situation for handling, storing, and shipping the fins.

## Processing Fins

Shark fins command a high price and consequently buyers are very conscious of the quality, processing method, and appearance of the final product. Most processors prefer to buy raw shark fins (dried or frozen) and do all further processing themselves. Since individual fishermen usually deal only in small quantities, it is highly unlikely that a fisherman would find it desirable to process raw fins.

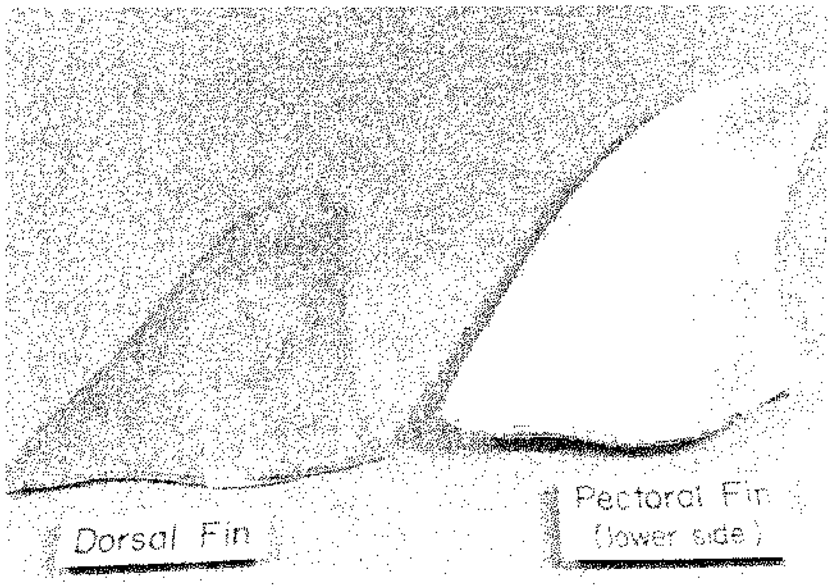


Figure 1. Properly cut and trimmed shark fins

Figure 2. Sun-drying shark fins

The following processing procedure is taken from Ka-keong (1983).

Initial Processing

Step 1: Preliminary

a) Frozen fins are thawed in water and soaked for 8 to 9 hours.

b) Wet fins are washed and soaked for 8 to 9 hours.

c) Dry raw fins are put into water and soaked for about 16-20 hours to make them soft.

Step 2: Descaling and skinning

Fins are further soaked in water pre-heated to 80-90$^{0}$C. This warming loosens the scales and skin. This step is carefully controlled to avoid spoiling the fin needles. A metal brush is used to assure the scales are sufficiently loosened. The fins are then dipped into chilled water and a metal scraper is used to completely remove the scales and underlying skin. Finally, the fins are washed again with fresh water.

Step 3: Removing the Meat

Any remaining meat attached to the fin and base of the cartilaginous platelets is cut away.

Step 4: Removing Blood and Bleaching

The fins are then put into running water, soaked and hand washed several times. The blood in the cartilaginous base of the shark fin is difficult to wash away, so bleaching is necessary. Sometimes, 3% hydrogen peroxide solution is used for bleaching for 30-40 minutes after which the fins are thoroughly washed in fresh water. Half a liter (2 gallons) of the hydro gen peroxide solution is sufficient to treat about 9 kg (20 pounds) of fins.

Step 5: Drying

Processed fins are put on bamboo mats and sun-dried. The fins must be turned once or twice a day. They must not be exposed to rain or dew. In sunny weather, it will take 4-5 days to dry the fins. Some processed fins are dried by electric oven, especially in wet weather.

The final product is a skinless fin with some original shape. Shark fins May be marketed in this form. However, additional time consuming preparatory work is required before final the processed fins are ready to be cooked. Final processing includes the following steps:

Final Processing

Step 1: Soaking

Processed fins are soaked in fresh water for 8 to 12 hours to make them soft.

Step 2: Second Bleaching

Bleaching, as described above, is repeated if necessary.

Step 3: Boiling

Fins are boiled for about five minutes until the fin needles expand and are exposed. Boiling the fins dissolves the gel of the membrane. At this time, the fin needles will usually curl slightly. The fins are then taken out of the hot water and quickly put into chilled water.

Step 4: Removing the Membrane

The bases of the fin strands are kneaded and softened by hand to separate the fin needles from the membrane. The remaining membrane is peeled off to enable the fin needles to stand out. These are sold as wet fin need les. Lower grade fins or small fins are further processed to make fin nets.

Fin nets facilitate cooking and increase the value of the raw material. The additional processing includes:

Step 5: Arranging Fin Needles

Washed fin needles are placed on bamboo mats, previously oiled with edible oil, and arranged into moon shaped or net shaped lots of around 100 g each.

Step 6: Bleaching by Reduction

The shark fins are then bleached by a reduction method in a "sulphur box" in which sulphur is burnt beneath trays of fins for about 20 minutes. This bleaching process must not be too long as otherwise the fin needles will curl up and turn brown.

Step 7: Drying

The fins are then sun-dried.

## Shipping Fins

Obviously shipping procedures should be discussed directly with the buyer. In general, air freight will be too expensive if you are shipping less than 80 pounds. Batches of properly dried fins can be shipped by truck. However, care must be taken to seal the fins in plastic wrap and to seal the box with tape. The box should be labeled "dried marine specimens". If there is any odor coming from the box, most likely it will not be accepted for shipment.

Occasionally, it is possible to sell directly to a local Chinese restuarant and avoid problems with shipping.

In 1983 prices as high as $5.00/lb for frozen fins and $11.00/lb for dried fins were sometimes quoted. As previously stated, the size of the fins and the care taken in cutting the fins will affect the price you receive. In addition, if the fins are not completely dry, the price will be lower as additional weight would be lost by further drying. You will become more familiar with what the buyer is looking for after the first few shipments. Local middle-man buyers often offer prices substantially lower than prices offered in distant markets. In this case the fisherman must decide whether a higher price is worth the expense and trouble of shipping.

## Literature Cited

Ka-keong, Edward Lai. 1983. Shark fins-processing and marketing in Hong Kong. Info Fish Marketing Digest, May, p. 35-39.

## MARKETING AND ECONOMIC ASSESSMENT

Fred J. Prochaska

The commercial shark industry is generally small scale and is a fragmented industry which overlaps other fisheries. Little direct economic information in the form of raw statistics or formal economic or market research is available for a complete market or economic assessment. Current informtion from the limited successful ventures in Florida is considered sole-source and confidential. As a consequence, some of the following discussion and conclusions with respect to Florida shark production and marketing are based on inferences drawn from national and regional markets and isolated observations in Florida.

### Production

Landings of sharks (other than dogfish) by U.S. fishermen have gradudally increased since 1971 and exceeded the 5.0 million pound mark in 1982. Due to an apparent increase in demand, dockside shark prices increased along with the increased supply and reached a record $.63 per pound in 1982 (NMFS, a.). Dogfish landings have generally been three to four times the volume of other shark landings. In 1982 dogfish landings were at a record of 19.4 million pounds but were of considerably lower value than other sharks with an average dockside price of only 8 cents per pound. Dogfish are generally a smaller species of shark that are used primarily for food.

Gulf of Mexico and South Atlantic landings of all sharks averaged 209,000 pounds at an average annual dockside value of $21,000 during 1975, 1976 and 1977 (latest published regional data, NMFS, b.). During those years Florida's average production of 103,121 pounds was 49 percent of the total produced in the Gulf and South Atlantic fisheries. During the decade of the 1970's Florida production of sharks was quite eratic, ranging from low a of 9,448 pounds in 1970 to highs of over 300,000 pounds in 1973 and 1978 (NMFS, c.). Florida shark landings during 1981 and 1982 averaged 603,122 pounds annually and were nearly twice as large as previous peak years during the 1970's. The 1982 dockside price was $.50 per pound. Over 80 percent of Florida shark landings occurred on the West Coast with Lee County accounting for between 50 percent and 66 percent of total Florida shark production during 1980 and 1981.

Longlines account for the majority of commercial shark landing in Florida. Until recently the Florida commercial shark fishery was an incidental fishery: that is, sharks were caught and landed when fishermen were targeting other species. The latest published catch by gear type indicated 73 percent of Florida shark landings were from longline fishermen in 1976 (NMFS, b.). An additional 21 percent were caught with handlines that year. A recent study (Cato and Lawlor, 1981) of cost and earnings in the Florida swordfish longline fishery provides some estimate of profitability of shark fishing (at least as an incidental catch). In the Florida swordfish fishery, the average cost of all fish landed was $1.16 per pound. This is considerably above the dockside price received for shark. Therefore, a directed fishery for sharks incurring these costs therefore would not be profitable. However, if all costs normally incurred in the directed fishey are allocated to the directed species (swordfish in this case) then shark landings may be viewed as a supplemental source of income as long as additional costs directly associated with handling sharks are less than approximately 40 to 50 cents per pound (current shark prices).

The more recent efforts in a directed shark fishery are generally supplemental to other fisheries for part of the total fishing year. Although no formal economic studies have been made, some information exists to make economic decisions. One producer (Heerin, 1976) estimated that bait, fuel and supplies for a 10 hour trip would cost about $100.00. This was for a 25 to 45 foot bottom or crawfish type boat, fishing a main cable up to 3/4 mile long with hooks suspended at 10 to 12 foot intervals. The cost of fishing gear and winch was estimated at $4,260 which has to be depreciated over the life of the equipment. It was estimated that with an average catch rate of 10 percent the 400 hook line would yield a dockside value of $345.00, assuming the sharks caught are eight feet long and in good condition. This would leave approximately $245 to cover crew-shares, gear repair and depreciation and other fixed costs (such as boat and engine depreciation) that are not prorated to other fishing enterprises.

## Marketing

Sharks represent a rather special type of resource in that virtually the entire organism can be utilized. The skins, fins, meat, liver, and teeth are major end products which all have significant commercial value. However, it is difficult, if not impossible, to simultaneously maximize returns with respect to each individual end product that can be produced from sharks. The highest food value is generally derived from smaller sharks but the small sharks generally have lower valued hides and fins compared to those from larger sharks. Individual end products are also competitive with respect to product care or processing technique. For example, it is recommended that sharks not be iced prior to skinning but this procedure results in lower quality meat. In general, the total value of a shark is highly variable; it depends on size, handling techniques, and species (Kreuzer and Ahmed, 1978). The shark fishermen cannot achieve maximum returns for all possible products. The end products are competitive and trade-offs are required.

Published statistics do not allow determination of the volume and value of all individual shark end products processed on a national or local level. In 1980, 6.9 million pounds of fresh processed and frozen shark steaks valued at $3.6 million were reported for the United States with all processing reported in the New England and in the Pacific fishery regions (NMFS, d.). In 1981, 2.1 million pounds of fresh and frozen steaks and fillets valued at $1.1 million were reported for the U.S. with all processing having taken place on the Pacific Coast. Salted, smoked and leather products were reported as unclassified products. Substantial, but undetermined amounts of shark end products obviously go through market channels not covered in the statistical reporting system for processed fishery products.

Historically vitamin A derived from shark livers, was one of the most valuable end product produced from sharks. In 1941 dockside prices peaked at $2,000 per ton of shark in the round and at $15 per pound for male soupfin shark liver in 1943 (Stuster, 1982). However, since the development of a synthetic Vitamin A, shark livers are no longer a source utilized in most developed countries (GMFMC, 1980).

Shark fins represent profitable uses of expanded shark production. A large shark (eight feet) may yield two and one half pound of dried fins which are valued as an ingredient in oriental cuisine. U.S. dealers paid as much as $7.50 per pound for number 1 fins and $2.50 per pound for number 2 fins in 1978 (GMFMC, 1980). Currently, wet fins bring Florida fishermen between $3.00 to $6.00 (see above section by Lawlor).

Markets for shark teeth and jaws have been substantial. Whole jaws of larger sharks, when cleaned, sold for between $20 to $200 per jaw in 1978. Currently, however, this market appears to be limited with respect to significant expansion potential. It has been estimated that the sale of roughly 10,000 shark jaws on the Gulf Coast in one year would clearly depress the price (GMFMC, 1980).

The sale of shark hides, it has been concluded, is not profitable for U.S. fishermen due to the large amount of labor involved and the relatively low prices paid to fishermen. Hide prices to fishermen appear to be relatively low because shark tanning technology is possessed by very few companies. There is currently a buyers market for hides (GMFMC, 1978).

Food for human consumption appears to offer the greatest potential for expanded marketing of shark products. It has been pointed out in other sections of this report that considerable care and attention must be given during both onboard and onshore processing to produce a palatable product. Processing development and education in this area have been successful and must be continued and expanded if a sizable shark food market is to develop. A recent survey of 162 firms and individuals (26 producers, 36 wholesalers and distributors, 46 restaurants, 23 super market chains and seafood markets and 30 federal and state statistical agents) concluded that in general the market for shark as a food product in the U.S. should continue to gradually expand (Slosser, 1983). The results of this survey, as well as experiences throughout the country, emphasize the extreme importance of marketing, promotion, and education if the shark food market is to reach anywhere near its full potential (WCFDF, 1981; Mangan, 1983, and Stuster, 1982 to mention a few). Demand and price at both producer and all market levels will have to be expanded to more substantial volumes of shark meat through the food market place.

The potential payoff to market expansion activities has been noted by numerous authors. Gillespie and Brandon (1976) found consumers to be unfamiliar with shark meat. Consumers studied showed no definite aversion to taste or health/nutrition aspects of shark meat. However, uncertainty was most often noted. Consumers seemed to be curious about shark meat and desired information to satisfy their curiosity. The Gillespie and Brandon study noted several demographic factors which should be considered in market development activities. Marital status, number of children less than 18 years of age and income appeared to offer little or no relationship to the consumer's willingness to try shark meat. Sex, age, education, race and number of individuals in the household did, however, appear to affect consumers' attitude toward shark meat: (1) male consumers appeared more likely to eat shark meat than did the female, (2) people between the ages of 26 and 35 tended to be most likely to eat shark meat, (3) households consisting of three members or less seemed to be more likely to try shark meat than larger households, (4) people with more education tended to view the idea of eating shark more favorably than people with lower education, and (5) black households appear to be less likely to eat shark meat than other races. Attention to these factors, other socio-economic factors and product quality in marketing activities should provide for expanded shark markets. The domestic processing capacity for sharks on the Gulf Coast is highly flexible and basically is limited only by the demand for and/or supply of shark products (GMFMC, 1980).

## Conclusions

For the most part, shark fishing will likely remain an incidental and/or supplemental fishery in the near future. This conclusion is based on the estimated high cost of production compared to current dockside shark prices and profitability of the alternative fisheries. Substantial increases in shark prices resulting from significant market expansion would tend to weaken this conclusion. However, rapid market expansion does not seem likely. Existing markets for fins and jaws appear sufficient to support existing production. The markets for jaws and teeth appear to have reached their limits. Although, tanned shark hides are valuable products, there does not seem to be much of a market potential for Florida or U.S. fishermen with this product unless world supplies decline and/or more final market value is passed back to fishermen. The greatest potential for increased demand for sharks is with expanded food markets for shark products. This, however, will likely be a gradual process in the near future. Continued product quality research and education and expanded food market development activities are necessary to maintain existing growth rates in total shark sales. The current increase in shark landings appears to be at a healthy pace considering prices have continued to increase even with the increased production.

## Literature Cited


Cato, James C. and Frank Lawlor. 1981. Small Boat Longlining for Swordfish on Florida's East Coast: An Economic Analysis, Fla. Coop. Ext. Serv., MAP-15, Gainesville, August.

Gillespie, Samuel M. And Ronnie D. Brandon. 1976. An Analysis of Consumers Attitudes and Perceptions Toward Shark Meat In Texas Households, Center for Marine Resources, Texas A&M University, College Station, Texas.

GMFMC (Gulf of Mexico Fishery Management Council). 1980. Environmental Impact Statement for the Shark and Other Elasmobranch Fishery of Gulf of Mexico, Lincoln Center, Suite 881, 5401 West Kennedy Blvd., Tampa, Florida.

Heerin, James. 1976. "Commercial Shark Fishing From the Producer's View," in Sharks and Man -- A Perspective (ed. by William Seaman, Jr.). Florida Sea Grant College, University of Florida, Gainesville.

Mangan, Andy. 1983. "Elusive Texas Sharks Present Marketing Problems," National Fisherman, Vol. 63, No.11.

NMFS, a. (National Marine Fisheries Service), Annual Issues. Fisheries of the United States, U.S. Dept. of Commerce, Washington, D.C.

NMFS, b. Annual Issues. Fishery Statistics of the United States, U.S. Dept. of Commerce, Washington, D.C.

NMFS, c. Annual Issues. Florida Landings, U.S. Dept. of Commerce,Washington, D.C.

NMFS, d. Annual Issues. Processed Fishery Products. U.S. Dept. of Commerce, Washington, D.C.

Slosser, Virginia. 1983. A Study of U.S. Shark Markets, National Marine Fisheries Service, 9450 Koyer Boulevard, St. Petersburg, Florida.

Stuster, Jack. 1982. "Once Booming Shark Fishery Revived on the West Coast," National Fishermen Year Book, Vol. 62, No. 13.

WCDF (West Coast Fisheries Development Foundation). 1981. A Report on the Pacific Blue Shark as a Commercial Fishery. 812 S.W. Washington, Suite 900, Portland, OR.

## ADDITIONAL REFERENCES


Anglo-American Caribbean Commission. 1945. Guide to Commercial Shark Fishing in the Caribbean Area. U.S. Fish and Wildlife Service, Fishery Leaflet No. 135, 149p.

Beaumariage, D. S. 1968. Commercial Shark Fishing and Processing in Florida. Florida Bd. of Conservation Education Series No. 16, 21p.

Colvocoresses, J. A. and J. A. Musick. 1980. A Preliminary Evaluation of the Potential for a Shark Fishery in Virginia, VA., Inst. Marine Science and Ocean Engineering No. 234, 39p.

Ingle, R.M. 1975. The Florida Shark Story. Florida Dept. Natural Resources. Your Florida Education Series No. 26, 12p.

Kreuzer, Rudolf and Rashid Ahmed. 1978. Shark Utilization and Marketing. Food and Agriculture Organization of the United Nations, Rome, Italy. 180p.

Ronsivalli, L. J. 1978. Sharks and Their Utilization. Marine Fisheries Review 40(2):1-13.

Schwartz, F. J. and G.H. Burgess. 1975. Sharks of North Carolina and Adjacent Waters. N.C. Department Natural and Economic Resources Information Series, 57p.


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