FLORIDA SEA GRANT PROGRAM

CONFERENCE PROCEEDINGS:

SHARKS AND MAN: A PERSPECTIVE

Edited by
William Seaman, Jr.

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SHARKS AND MAN -- A PERSPECTIVE

Proceedings of a conference
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FOREWORD

Through the ages sharks have played an important role in the natural balance of the oceans. Man has viewed them as part nuisance, part destructive, and part dangerous, yet they have also contributed to recreation, food supplies and commercial products.

The objectives of the Conference to view sharks and man in perspective were to assess the shark hazard problem, review anti-shark measures, consider ways to increase commercial utilization, evaluate legal liabilities, and identify needs for followup actions, whether research, industry, or public information-oriented.

The Conference had its genesis in a resolution passed July 11, 1975, at the eighth annual convention of the Organized Fishermen of Florida, who sought relief from chronic shark damage to gear and catch. Coupled with this was phenomenal public interest in sharks and their ecology and behavior, particularly as they relate to man-in-the-sea.

This report is one way of informing interested persons of the many aspects of interactions between sharks and man. Concurrently, popular news accounts of the Conference, the opening of business negotiations between parties interested in a shark fishery, another look at repelling sharks from fishing gear, and preparation of a factual information leaflet for the public have resulted from the sessions.

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CONFERENCE OVERVIEW

Highlights and Significant Information

Sharks and man are both top predators, that is, carnivorous animals that kill other animals for food. In perspective, however, people can and do actively seek out sharks and other fish for food; sharks usually leave man-in-the-sea alone. Indeed, in recent years the number of known shark attacks on people has averaged 26 worldwide with less than one-fifth being fatal. Man, on the other hand has harvested in recent years several hundred thousand metric tons of shark annually.

Although only a small fraction of shark is landed in the United States, there is increasing recognition of its value as a source of meat, hides, liver oil, jaws and teeth. As a seafood, shark is comparable to other fish in taste and nutritive qualities, and it is relatively inexpensive. Shark has recently been introduced into school lunch programs in Louisiana. Restaurants are becoming interested.

Sharks cause man concern not only when they frequent waters that man chooses or is forced to occupy, where they may attack man, but also when they interfere with commercial fishing. In contrast with well-publicized accounts of shark incidents along tourist and recreational beaches, chronic losses by fishermen are less sensational but are more widespread and are significant economically. Mackerel fishermen of the lower east coast of Florida may suffer up to 100 holes in one gill net due to sharks, or even complete loss of the net. The cost of repairing a "hole" is two dollars; nets cost up to several thousand dollars. Fishermen may become more conservative in fishing too. Up to one-fourth of income may be lost to sharks. From $62 per day with no shark interference, fishermen's income drops with interference, and a fisherman who goes out but does not fish loses about $30 daily.

In Florida it appears that the impact of "sharks" on tourism is indiscernible at the state level, although individual communities such as Daytona Beach may have lost considerable business in the last tourist season, and there is some concern for long lasting effects due to popularized accounts of sharks and spectacular publicity concerning actual shark attacks.

Local authorities and interests in the best position to know of local beach conditions are obliged to provide information to the beachgoing public. Sharks are but one of a number of beach hazards, for which communities could provide adequate information and medical facilities. Concerning legal liabilities, an utter lack of precedent characterizes the legal framework connected with shark incidents.

One formal source of information on shark attacks has been the "Shark Attack File," for which continued support is being sought. Based on

analysis of well over one thousand reported attacks worldwide in the past three decades, it has been concluded, for example, that perhaps 50 to 75% of shark attacks on humans have no direct relationship to feeding. Divers, particularly spearfishermen, incur more attacks, although their mortality rate is lower than non-divers. Recent findings suggest that other aspects of human behavior such as using bright, shiny colors or swimming at night, increase the risk of shark attack.

Sharks need to be recognized as an "underutilized" fishery resource that can support multiple uses. As a resource package sharks may support both commercial ventures and sport fishing in areas where they are not now caught.

Indeed, sharks may even be discarded when caught incidental to commercial fishing for other marketable species, such as swordfish. Present commercial problems are primarily organizational and are characterized by a fragmented approach to marketing, product utilization and transportation.

There may also be the opportunity to combine the commercial aspects of the shark fishing industry with control of population size in areas where sharks may be considered a safety hazard. That is, fishing can produce both marketable products and reduced shark populations.

Sport or bounty fishing may be employed to keep population size low. Although sharks are regarded as a nuisance by many fishermen, they are increasingly popular with many other individuals and shark fishing clubs, and one survey reveals that 27% of all fish mounts in taxidermy shops are sharks.

To protect areas such as bathing beaches both complete enclosures, which are costly, and observers spotting from towers, who require clear water, have been employed successfully. The effectiveness of a third measure, gill nets, is dramatically illustrated by their use in Natal, South Africa, where both the shark population and the statistical possibility of shark attack have been reduced significantly. Nearly all sharks are caught in the mesh at dusk, night, and dawn.

No foolproof way exists to provide individual protection from sharks in the open water. A dye and chemical long thought to be an effective shark repellent does not, in fact, deter sharks (although it did provide psychological relief to persons stranded at sea). In terms of realistic quantities and exposure time chemical deterrents are impractical. Although physical devices exist that deter sharks, they may also be dangerous to people. Wide angle face masks and armored wetsuits are two innovations for divers. A floatation bag, or "shark screen" is large enough to contain a person, and drifting as a dark, drab, large object it seems to intimidate or deter sharks.

Conversely, bright reflective colors may attract sharks, a finding of significance to sporting goods, apparel, and gear design. That spearfishermen incur one-fourth of all attacks attests that man can attract sharks by his behavior. Man has control of the situation in other ways,

for example through the knowledge that shark attack may be more likely in murky or turbid waters, and at night, dusk, or dawn.

Of 250 to 300 species of sharks in the world one-fourth occur in Florida, and only 25 of them regularly swim in waters shallower than 10 fathoms (1.83 meters). In Florida five species (white, tiger, dusky, bull, and great hammerhead sharks) seek large prey. Fishing, although it can reduce any population in size, will not by itself exterminate a population of sharks. With few exceptions, the main population of sharks lives offshore.

Research on shark abundance along the U. S. eastern coasts reveals that in the northeast the blue shark and the sandbar shark are most common. In the southeast, including Atlantic, Gulf, and Caribbean waters, the silky shark is most common in scientific collections, followed by the white tip and dusky sharks.

Limitations to laboratory and field studies of these large and mobile animals include the difficulty and expense of maintenance in the laboratory, and of course the danger. Nonetheless, through a limited number of investigations the ability of sharks to complete conditioning exercises successfully is becoming known. Also, although shark behavior is not as well understood or studied as shark sensory functions, knowledge of postures and patterns such as "hunching" and "give-way" may lead to prediction of shark behavior as it bears directly on human activity in the sea.

Parallels between the behavior of sharks and land dwelling wild animals contribute to man's appreciation of why sharks may be irritated by those who enter the sea.

That various business interests are now seeking sources of both shark meat and hides attests to the enhanced prospects for commercial shark fishing in the United States. With studies proposed to examine consumer acceptance of shark, industry also needs to consider quality control of the product, such as in sufficient removal of urea. As a seafood shark may be processed as fresh and frozen fillets and portions that currently wholesale at 75 to 85¢ per pound.

Compared to domestic opportunities, overseas shark fishing operations may be more promising and offer more diversity to U. S. investors. There is, for example, the possibility to develop technological procedures for export. Also "turn key" plants are available for purchase abroad.

Besides many detailed individual conclusions and recommendations presented in the following abstracts, upon which this overview is partially based, the conference participants reached a consensus on several key issues:

1. Tales of man-eating sharks are mostly myth, and publicity of actual attacks and generally popularized fictional accounts have been overdone and overly sensational.

2. Specific resort communities have been affected adversely in revenue due to public concern with the popularized shark menace.

3. Commercial fishermen suffer chronic economic loss due to shark damage of gear and catch.

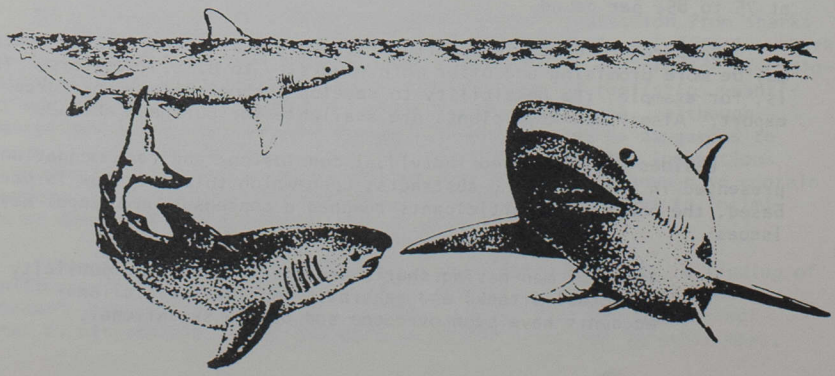
4. Continued efforts to improve protective measures for bathers, divers, and fishermen are encouraged.

5. Especially significant as a means of controlling shark populations is fishing, whether sport or commercial. Renewed domestic interest in shark meat as a seafood is supporting a fishery that has significant potential.

6. Factual public information on sharks is needed in response to widespread interest. Continuation of the Shark Attack File as a source of documented information is recommended; one outlet for such information is a leaflet condensing this overview, now in preparation.

Dr. Hugh Popenoe, director of the Florida Sea Grant Program, and chairman of the conference summed it up as follows:

"We will no doubt always have the sharks with us, and I don't think we would want it any other way. Elimination of the sharks could very well upset the delicate balance in the marine environment and we would have far greater problems than we now have with shark attacks. What we must do is educate people to respect the sharks, but not to fear them. I believe this conference has succeeded in placing the problem in its proper perspective and I would hope that we can now begin to move into an action role--not a defensive or emotional one--and that those of you who are in positions where you can do so, will begin prescribing courses of action in terms of management of shark populations, protection of ocean recreational areas, and commercialization of a shark fishery."



I. SHARKS AND MAN

THE SHARK RESEARCH PANEL AND ITS SHARK ATTACK FILE

Perry W. Gilbert
Mote Marine Laboratory

Early in 1958, a small group of scientists met at the Office of Naval Research, in Washington, D. C. to briefly review the shark hazard problem as it related to both Navy and civilian personnel. They concluded that more effective shark deterrents than those presently employed were badly needed. This need was dramatically underscored by the many documented shark attacks on service personnel during World War II. It was agreed that a conference dealing with basic research approaches for the development of more effective shark deterrents would be of value and timely. The conference took place in New Orleans from April 8 to 11, 1958, sponsored by Tulane University and the American Institute of Biological Sciences and supported by the Office of Naval Research and the Navy Bureau of Aeronautics. Participants included representatives from Australia, Japan, Union of South Africa, and the United States.

After considerable discussion it was generally agreed that we knew too little about the nature of "the enemy" and a series of recommendations were prepared (see AIBS Bulletin, Vol. 8, No. 3, pp. 17-19, 1958). It was the conviction of those who formulated the recommendations that basic studies dealing with the biology and behavior of sharks were essential to an understanding of the shark hazard problem in general and the development of more effective shark deterrents in particular. To promote and coordinate these basic studies on a world wide basis the AIBS Shark Research Panel was established on June 25, 1958. Members of the Panel included Sidney R. Galler, John R. Olive, Leonard P. Schultz, Stewart Springer and Perry W. Gilbert, chairman. Subsequently, Albert L. Tester and H. David Baldridge became members of the Panel.

During the period 1958-1970 the Shark Research Panel held 31 meetings, including 6 symposia, and effectively catalyzed and coordinated more than 100 studies dealing with the biology and behavior of sharks in many parts of the world. In addition to conducting their own basic researches, several panel members tested more than 200 chemical compounds, biological products, and physical devices for their deterrent effect on sharks and the results have appeared in numerous publications and reports.

One of the important activities of the Shark Research Panel was the development of an International Shark Attack File, initially maintained at the Smithsonian Institution in Washington, D. C.

HISTORY OF THE SHARK ATTACK FILE OF THE WORLD

Leonard Schultz
Port Republic, Maryland

Although a small subject file on shark attacks had been maintained by me, as Curator of Fishes, Smithsonian Institution, and by other scientists interested in the subject, no concerted and coordinated effort to develop a comprehensive file existed until 1958.

My part in the program of the Shark Research Panel established that year concerned promotion of research in the taxonomy of sharks and maintenance of the Shark Attack File of the World at the Smithsonian. During the next 10 years this research was supported by the U. S. Office of Naval Research, the National Science Foundation, and the Smithsonian Institution. Taxonomic research was performed by Dr. Victor G. Springer on several genera of sharks, and Dr. Carter R. Gilbert prepared a revision of the hammerhead sharks. Dr. J. A. F. Garrick is continuing a revision of the carcharinid sharks of the world.

The Shark Attack File was maintained in the Smithsonian Division of Fishes beginning in mid-1958 and a duplicate working file was maintained at Cornell University. The Shark Research Panel soon began receiving worldwide reports of shark attacks from divers, scientists, physicians, and five news clipping services. When an attack occurred anywhere in the world a physician or scientists in the area of attack was immediately contacted by myself or Dr. Perry W. Gilbert of Cornell, and assistance in securing documentation of the details of the attack was solicited. Cooperation was splendid in all parts of the world.

A two-page form was prepared by the Panel, requesting information concerning location of attack, environmental conditions, kind of shark, nature and treatment of wounds, type of activity the victim was engaged in at the time of the attack, and numerous other details.

The Shark Attack File was divided into five categories; (1) unprovoked attacks, (2) provoked attacks, (3) doubtful attacks, (4) air and sea disasters, and (5) boat attacks.

After documentation had been received on over 1000 attacks, Mrs. Marilyn H. Malin and I attempted to organize and analyse the data to see if there were evident any patterns of attack by sharks. We also searched the literature and prepared a bibliography on shark attacks, which appeared in the book, SHARKS AND SURVIVAL, published in 1963 and 1975 by D. C. Heath and Company, Boston, Massachusetts. Although certain trends and patterns were detected by manual treatment of the attack case history data, it soon became evident that complete objective analysis would require the information to be handled by automatic data retrieval systems and that tabulations be made by computer. This effort was initiated with the assistance of the Shark Research Panel and statisticians from the Smithsonian Institution and the U. S. Navy. Upon my retirement, this analytical task fell to Dr. H. David Baldridge.

To serve as a data base for these analyses, the entire Shark Attack File was, in 1968, microfilmed for security and record purposes by the Smithsonian. The original file was then shipped to the Mote Marine Laboratory in Sarasota, Florida, where it now reposes.

WHAT THE SHARK ATTACK FILE TELLS US

H. David Baldridge
Mote Marine Laboratory

In the late 1960's, attention of the Shark Research Panel was directed increasingly to the need for analysis of data held in the Shark Attack File to assess the significance of factors associated with known instances of predaceous shark behavior towards man, and evaluate present methods of gathering data on shark attack and thereby determine the requirement for maintaining such an effort in the future.

The Shark Attack File is a collection of many hundreds of file folders filled to widely varying degrees with newspaper clippings, data forms, letters, photographs, etc. To reduce the data for analysis using automatic data retrieval systems,we developed a set of 87 questions touching on every matter for which information was available in a significant number of case histories. To complete about 350,000 data entries on almost 4700 code sheets took well over a year of concentrated effort by two persons.

Although the data were carefully screened for correlations between occurrence of shark attack and a number of environmental and behavioral parameters, it was considered of greater importance that patterns or relationships be identified that distinguished victims from non-victims among exposed populations. Numerous matters were examined in the light of previously accepted correlations and popular beliefs. Wound characteristics and other considerations suggested that perhaps 50-75% of shark attacks on humans have no direct relationship to feeding. A number of popular concepts linking shark attack to environmental parameters, including water temperature, appear to be casual relationships having to do more with determining bathing pressure at beaches.

Contrary to current ideas, divers appear attack prone with a strong relationship to spearfishing. Trends indicate that, in the 1970's, attacks upon divers will average at least one-third of all reported cases. One out of four cases analyzed was against a spear fisherman. Yet, divers show fewer, less damaging injuries than swimmers and enjoy a far lower mortality rate. Worldwide,about 26 documented cases of shark attack are reported yearly, with less than one-fifth being fatal.

Numerous other probes of the data included such matters as shark and victim behavioral patterns and the effectiveness of a variety of weapons and diversionary actions.

Results of these analyses have been used to update advisories for bathers and swimmers, divers, and attack victims. Perhaps the most important question raised by the analyses is that of shark motivation in human attack, for response to the hunger drive is clearly not as important as heretofore believed.

The U. S. Office of Naval Research recently evaluated the present status and future direction of shark research. Results of my studies on attack data were partially responsible for the Navy officially recommending:

1) "The establishment and maintenance of an effective reporting system

for shark incidents".

2) "Re-establishment of the Shark Attack File with its attendant function of analysis and reporting".

3) "Dissemination of information regarding need for treatment at the recovery site of shock and trauma from shark-attack injury".

Sources of funds with which to implement these recommendations are now being actively sought.

IMPACT OF SHARKS ON TOURISM

Dean Gaiser
Florida State Division of Tourism

There has been no survey to determine if, indeed, sharks have had an impact on tourism in Florida. It is difficult to assess whether fewer bathers are entering the water, yet people generally seem to be more aware that sharks exist. We are not aware that there are fewer visitors due to sharks.

In 1974 over 24 million visitors spent $6.7 billion in Florida, and in the first half of 1975 $6.2 billion was spent by tourists. The prime reason for their visits is Florida's beaches and climate. Eighty-five percent of tourists are repeat visitors to Florida. Nearly one-fourth of the work force, i.e. 400,000 people, is employed in a tourist-related occupation.

Local authorities are charged with providing up-to-date information on a variety of natural potential hazards. Communities aid bathers by providing medical facilities and lifeguards to respond to these situations.

HOW A TOURIST CENTER REACTS TO SHARK ATTACK PUBLICITY

James F. Bullion
Daytona Beach Area Chamber of Commerce

The center of the Volusia County, Florida seashore resort industry is the Daytona Beach Resort Area, with 21 miles of coastline. Daytona Beach is primarily a summer tourist center, with 60% of its 3,500,000 annual visitors coming between mid-June and Labor Day. The area's economic dependence on tourist is documented by the statistic of 25,000 guest rooms and 10,000 people directly affected by the tourist industry. Over one million dollars per year are spent on promotion.

The shark attack on a youth surfing off New Smyrna Beach in late spring, 1975 became a national story that was linked to remarks on a television program that alleged Daytona Beach to be one of the world's most dangerous beaches for sharks. The attack and subsequent publicity, combined with widespread interest and concern with sharks caused many people from across the country to write or call Daytona concerning sharks.

It is extremely difficult to determine how many tourists left early or canceled visits. However the summer 1975 tourist season was shortened by three weeks. Predictably those dependent on tourist trade are sensitive about such publicity and are concerned with not only immediate but also long lasting effects on potential or annual visitors.

Reaction to shark attack publicity was compounded by (1) ill effects of the 1974 fuel shortage on area visitors, 85-90% of whom arrive via automobile, and (2) to a lesser degree, overbuilding of guest rooms.

To address the situation both the city's 40 year old Beach and Water Safety Committee and a new advisory committee of the Chamber met with local and state experts. A report dated September 5, 1975, acknowledged the shark hazard possibility while citing a stable area shark population and a twenty-fold increase in bathers in the last 20 years; it characterized shark attacks in the area as being historically of a single rather than multiple bite nature. On the average in the past 20 years two attacks per year are recorded. Recommendations included warning bathers of sharks just as runouts, lightning and other hazards are identified, increasing beach emergency and medical facilities in response to these hazards, and investigating other preventive measures.

Also, rules and warnings are explained to potential tourists and swimmers, and are enforced by the lifeguards.

SHARKS: THEIR IMPACT ON COMMERCIAL FISHING

D. Douglas Coughenower
Florida Marine Advisory Program

&

Thomas Groover
Florida Fishermen's Marketing Association

Most fisheries around the U. S. and probably around the world can cite cases when sharks have caused fishermen to lose gear and pounds of catch. In most fisheries around the U. S. these losses are infrequent enough not to be taken seriously or they have happened for so long that they are taken for granted. However, if better records were kept some fishermen might be surprised at the actual economic impact of shark encounters.

One Florida fishery, the east coast Spanish mackerel industry always has been particularly hard hit by sharks. In the last few years spiraling costs in fuel and nets (40-60% increases) without a corresponding increase in fish prices (received by fishermen) have increased the significance of damage and losses due to sharks. A survey of mackerel fishermen in the Port Salerno area provided enough information to approximate the scope of the problem.

The commercial mackerel fisherman (actually Spanish mackerel and bluefish) can suffer several types of losses as a result of shark encounters. Damage to nets, as sharks remove gilled fish, is the most obvious. It is estimated that it costs the fisherman approximately $2.00 to repair an average shark hole. Reports of 50, 75, or 100 holes in one incident are not uncommon. Occasionally nets are ruined beyond repair. In these cases the loss to the fisherman can run from $500 to $10,000 depending on the size of the net.

Perhaps the biggest loss fishermen suffer due to sharks is the fish not caught because of the presence of sharks. This is also the most difficult factor to estimate. When sharks are known to be present in an area fishermen become very conservative in their fishing efforts. Nets are left in the water for shorter periods or not put in the water at all. On an average day during mackerel run season (November-March), with no shark interference a commercial fisherman can expect to net about $62 per day. With some shark interference this can drop to $9 per day; and on a day when he goes fishing but does not put his net in the water because of sharks a fisherman can expect to lose about $30. Over an entire run season the presence of sharks could reduce a fisherman's net income to one-quarter of what it would be without the shark problem.

Several possible solutions are offered but their implementation will require expert assistance. 1) A net insurance program might be developed to offset major losses. 2) An active commercial shark fishing industry might reduce shark populations to an acceptable level. 3) An increased sports fishery for sharks might accomplish the same thing. 4) Stable and higher fish prices would eliminate the need to be concerned about nets. 5) Development of effective anti-shark devices. These must meet criteria which include: if attached to the net, must be rugged and dependable; if an area device, must be effective over a 1000' radius; cost must not be prohibitive.

SHARKS: THE SPORT FISHERMAN'S POINT OF VIEW

Bob Stearns
Outdoor Life Magazine

The sport fisherman views sharks from two entirely different perspectives: (1) as a nuisance, an unwelcome catch when other gamefish are being sought; or a hindrance that often attacks more desirable hooked gamefish, and (2) a game fish in its own right, a prize to be deliberately sought for the sporting aspect of the catch, and even occasionally for food.

Even the same angler may view sharks from both perspectives alternately, depending upon which "gamefish" he happens to be seeking at the moment. However, sport fishing for sharks has long been a popular pastime, going back in time a half century or more. There are even active fishing clubs in many parts of the world that specialize almost entirely in shark fishing.

There are tournaments that offer prizes for various species of sharks, and many anglers feel a shark is prize enough in its own right to bear the significant expense of having it mounted. During the past year the popularity of sport fishing for sharks has increased sharply. This is reflected in the increasing number of professional fishing guides who specialize in shark fishing charters, and the almost doubled volume of sharks to be mounted by marine taxidermy firms. As the abundance of other large gamefish continues to decline in coming years, it is very likely the overall popularity of shark fishing will continue to increase.

SHARK ATTACK: BAIT FOR LEGAL ACTION?

Thomas A. Harris
Florida Department of Legal Affairs

The increase in publicity about shark attacks created by recent motion pictures and books may well result in an increasing number of lawsuits arising out of these attacks. In the United States, the Law is founded upon the principle of stare decisis, prior decisions providing the guiding principles for resolution of pending suits. The utter lack of precedent in suits arising out of shark attacks renders impossible a precise prediction of the outcome of future suits. In any event, it is clear under principles of tort law, each such case will turn on its own facts.

Some predictions, however, are reasonable to make based upon principles applied to other types of personal injury cases. The most broad of these predictions is that as knowledge increases as to what human activities will create greater hazard of shark attack and as to what measures can be taken to decrease the hazard of attack, people will be expected to act in reasonable accord with such knowledge and any failure of a person to do so may result in liability for harm resulting from their acts.

Courts, however, will impose liability only upon those persons whose acts are in fact a legal cause of injury to another. Hence, one major obstacle to any plaintiff in a shark attack suit will be the burden of proving that the acts of the defendent caused the injury of the plaintiff. In light of the present lack of reasonably certain scientific knowledge about shark behavior, this burden will be, at best, difficult to carry.

II. SHARK POPULATION DYNAMICS

SOME ECOLOGICAL FACTORS CONCERNING SHARKS AND MAN IN THE LITTORAL ZONE

Stewart Springer
Mote Marine Laboratory

The littoral zone, defined here as the seashore within the ten-fathom curve, is of interest to two classes of top predators -- people and sharks. Many people and most sharks have little interest in the littoral and never go there. Some people, however, have traditionally made their living directly from the littoral by fishing, and increasing numbers are establishing shore residence or promoting beach and surf use (selling of ocean front lots being one typical example). Some sharks -- only a few -- live in the littoral. Competition develops since both sharks and people get important foods as a result of the enormous productivity of the littoral zone. The logical question arises as to what could and should be done to protect people's interest.

Each of the 250 to 300 kinds of sharks is well adapted to a specific environment. Half of them live in deep water and rarely come within 250 feet of the surface. About 25 are midwater species, little known and very difficult to catch. Seventy-two kinds are known from Florida, but only about 20 large species (six feet or more in total length) and five small species (about three feet long) come inside the ten-fathom curve with any regularity. In most Florida areas, only 12 large and four small species are ordinarily present in inshore waters. Two large and two small species may spend as much time inside the ten-fathom curve as outside -- the lemon shark and the nurse shark being the large species and the blacknose shark and the bonnethead representing the small. These figures are estimates, but it is reasonably certain that, with few exceptions, the main population of sharks lives outside the ten-fathom curve and may come inshore to find food, to give birth to young, or in response to yet undefined needs. It is questionable whether any action man exerts directly to sharks within the ten-fathom curve, except pollution, carries any threat of extinction to the larger and more dangerous species.

Five kinds of sharks habitually seek large prey. These are the white shark, the tiger shark, the dusky shark, the bull shark, and the great hammerhead. In Florida waters, all of these sharks, when adult, weigh 500 pounds or more. Indirectly, competition with man has already consigned the white shark to oblivion by destroying seals, sea-turtles, and whales which are the white shark's natural food. Indirectly, by killing off small sharks in inshore waters, people might threaten populations of bull sharks; or, by removing all the conchs and horseshoe crabs, eliminate a secondary or reserve food supply for tiger sharks. However, the dusky sharks, hammerheads, makos, white-tips, and other primarily offshore sharks are possibly helped as a species by the removal of maverick large individuals that break the "rules" and wander into shore waters.

It is my opinion that people cannot bring any shark species to extinction except by using poisoning methods which are as damaging to people as to sharks, but I have also concluded that inshore populations of sharks can be reduced with safety to both sharks and people by commercial or sport fishing, including subsidized or contract fishing when there is neither economic, nor sporting incentive.

MIGRATIONS AND ABUNDANCE OF SHARKS ALONG THE ATLANTIC COAST

John G. Casey
U. S. National Marine Fisheries Service

Results of longline fishing by research vessels, together with tournament data and information generated by National Marine Fisheries Service (NMFS) cooperative shark tagging studies, are used to examine the distribution, abundance, and migration of Atlantic sharks.

From 1961 through 1972 NMFS biologists participated in longline cruises during which a total of over 400 sets of longline yielded over 5,000 sharks. Fishing effort was primarily concentrated in the Middle Atlantic Bight between 33° and 42° N latitude (Cape Hatteras to Cape Cod); and from inshore to the northern margin of the Gulf Stream. Overall catch per 100 hooks was 6.3 sharks of 22 species. The blue shark (Prionace glauca) was the most predominate species of large shark (62% of total catch); followed by the sandbar shark (Carcharhinus milberti) (10%), dusky (C. obscurus) (5%), hammerhead (Sphyrna sp.) (5%), and mako (Isurus oxyrinchus) (3%). Distribution patterns with respect to temperature, distance from shore, and annual changes in shark abundance are discussed and compared with sportsmen's catches.

Results of the Bay Shore (N.Y.) shark tournament (1965-75) are used to examine annual changes in species composition, and relative abundance of sharks off the Long Island coast. An average of 150 boats annually compete in this two-day tournament during late June. A total of over 3700 sharks representing 8 species have been landed during the tournament. Blue, mako, and sanbar sharks are the most common species. Blue sharks dominated tournament catches during years when June surface water temperatures were below 18° C (64° F); other species were represented in warmer years when temperatures were above 19° C (66° F).

Migrations of several species of sharks are discussed on the basis of results from the NMFS cooperative shark tagging program. Over 1500 U. S. and European fishermen currently participate in this study. Approximately 14,000 sharks of 32 species have been tagged under this program (1963-75). Four hundred and twenty-eight tages (3%) have been recovered from 19 species; primarily from blue (210) and sandbar (150) sharks. Recaptures have been made from sharks at liberty for over 10 years and over distances of 3,000 miles. An overview of shark migratory patterns is presented with emphasis on the sandbar shark (the most abundant inshore species along the Atlantic Coast); and the blue shark (the most abundant offshore species).

Tag recoveries from sandbar sharks shows young sandbar sharks move to inshore nursery grounds including bays and sounds along the middle Atlantic states during spring and remain there until late fall after which they move offshore and south to wintering grounds between North Carolina and Florida. This cycle may be repeated for up to five years. As they increase in size sub-adults move further offshore and undertake longer North-South migrations, which for the adult sizes, extends from southern New England to southern Florida and Cuba. Tag recoveries suggest this overall cycle may take up to 10 years to complete .

Blue shark tag recoveries show inshore-offshore movements between the Gulf Stream and Northeast Coast from North Carolina and Nova Scotia. However at least a part of the population makes long distance migrations from New England to the Sargasso Sea, the Caribbean, and northern South America. Trans-Atlantic movements are demonstrated by tagged blue sharks that travelled from southern New England to the Cape Verde Islands off Africa; and from the Canary Islands to the offings of South America. A proposed model of blue shark migrations in the North Atlantic is offered.

OBSERVATIONS ON THE PELAGIC SHARKS OFF THE SOUTHEASTERN UNITED STATES

Harvey R. Bullis, Jr.
U. S. National Marine Fisheries Service

Although exploratory fishing off the southeastern United States by the National Marine Fisheries Service in the 1950's and 1960's did not specifically seek sharks, catches from longlining, trawling, and other operations contributed to a data base of over 4,700 observations of sharks. The Southeast Fisheries Center recorded captures of 14 families, 30 genera, and 73 species from the Gulf of Mexico, Caribbean Sea, and southeast U. S. Atlantic Ocean.

Three species of sharks constituted 75% of all pelagic shark catches made incidental to pelagic longline exploratory fishing for tuna and swordfish. The most abundant and ubiquitous species were the silky shark (Carcharhinus falciformis), followed by the oceanic white tip shark (C. longimanus), and the dusky shark (C. obscurus). The silky shark occurred in every area fished in all seasons, frequently in depths less than 50 fathoms (92 m.). They are concentrated in large numbers along continental shelf margins, unlike the oceanic white tip, which is most abundant beyond shelf depths. The dusky shark also tended to concentrate along the outer shelf and over the slope.

Exploratory fishing took place during the day for tuna and at night for swordfish. The average set of hooks numbered 700, which soaked an average of nine hours. Total effort was 2.8 million hook-hours. In all areas, the highest catch rates for silky sharks exceeded 10 per 100 hooks, reaching 12.2 in the Bahamas and southeast U. S. Atlantic Ocean area. This area also supported the highest catch rate for the dusky shark (4.1), whereas the maximum rate for oceanic white tip shark was in the Caribbean area (6.6).

When data from the exploratory fishery were extrapolated to the seasonal commercial swordfish fishery of the southeast Atlantic coast and north central Gulf coast, it was calculated that the probable value of shark products now being discarded daily ranges from $362 to $738 per vessel in the respective areas. (This assumes that exploratory catch rates are similar to commercial catches; testing of the assumption is required in developing a commercial shark fishery.)

The meat of some inshore demersal species has been examined for mercury content. Preliminary examination indicated that there may be a potential problem, although the three species previously discussed have not been examined. Three trends in mercury content are suggested: (1) Larger and older individuals have the highest mercury levels; (2) Concentration of mercury in the same species is higher for individuals from the Mississippi Delta than from southeast Florida; and (3) Medium to large demersal species have higher mercury levels than similar-sized pelagic species.

III. SHARK BEHAVIOR

BEHAVIOR OF SHARKS--A CONTINUING ENIGMA

Arthur A. Myrberg, Jr.
University of Miami

The aggressive behavior of sharks towards humans and their possessions has been of great concern for many years. Although our knowledge about various morphological and physiological functions of selected species has, without question, increased significantly in recent years, our greatest ignorance about sharks still centers on that aspect of their biology that relates most directly to their hazardous nature--behavior.

Reasons for this ignorance include: (1) the extreme difficulties in maintaining most species under laboratory or semi-natural conditions, (2) the lack of suitable facilities for observing animals of their size and mobility, (3) the high cost of field studies on free-ranging requiem sharks when direct observations are required, (4) the present inability to apply sophisticated behavioral methodology and analysis due to the wide ranging movements of free-ranging animals and, finally, (5) the inevitable danger that is associated with long-term, close-in observations of large sharks in their natural state. These and other limitations and restrictions hinder adequately controlled and repeatable behavioral observations. In turn, very few scientists direct their interest and efforts toward these enigmatic animals.

Despite these difficulties, and the "limited work force," various important and, in fact, rather startling finds have recently come forth, centering on the behavior and sensory biology of these animals. To date, the findings have been documented in only a few species. A summary of the work of various investigators in studying primarily young or juvenile animals indicates the sophistication of this group of fishes. Direct knowledge of the gray or requiem sharks, i.e., those of greatest interest to man, is scarce for the reasons noted previously.

For example, young lemon and nurse sharks do well in conditioning situations, events typically associated with birds and mammals. That sharks possess numerous species-typical postures and patterns of behavioral activities may serve as a basis for prediction of behavior. For example, the "hunch" posture has been noted in members of three species under similar circumstances--the presence of a nearby intruder. "Give-way" behavior in bonnethead sharks and smooth dogfish indicates clear social organization operating in groups of these animals.

Facts about the sensory biology of sharks continue to be uncovered, and in the species studied, sensitivity to pulsed low sounds, excellent nocturnal and diurnal vision, biorhythmns, and electrical sensitivity have been described.

ANTI-SHARK MEASURES AS PRACTICED IN NATAL, REPUBLIC OF SOUTH AFRICA

B. Davis & T. S. Wallett
Natal Anti-Shark Measures Board

A brief historical introduction is given regarding the initial Durban net installation (1952), followed by extensive application of off-shore gill nets along the Natal coastline as a direct result of the establishment of the Natal Anti-Shark Measures Board (NASMB) in 1964.

A detailed description of the materials used and of the structure of a standard NASMB net is given. Each bathing beach is assessed individually for net installation. The methods employed in this assessment are described, as well as the manner in which nets are set off-shore.

All net installations are serviced by ski-boats which launch and beach through the surf at or near to all meshed stations. Captured sharks in fresh condition are returned to the Board's Headquarters for scientific analysis, followed by processing for commercial utilization.

In time all contractual meshers will be replaced by NASMB Field Officers, in pursuance of the Board's new policy to assume complete control of all meshing activities.

A historical analysis of subsidy allocation to Local Authorities is given, as also one of meshing and repair costs per net per month. A detailed schedule of total monthly costs for each station for 1975/76 is presented.

Nets are also used as biological monitoring and sampling devices. Meshing Return Forms were introduced in 1966 and scientific data collection has continued ever since. Data collected from 1966 - 1972 was processed for computer analysis.

A brief review of the results so obtained is given. Nine species of sharks are caught regularly, and a total of sixteen species recorded. The most important biological findings are itemized. Environmental data accruing from Meshing Return Forms provide comprehensive information regarding conditions leading up to, during and after a shark attack.

There is a dramatic reduction in the number of sharks caught per station against time.

Prevention of shark attack is discussed and the use of gill-nets as Natal's anti-shark measure is evaluated in relation to the incidence of shark attacks along the Natal coast prior to and subsequent to their installation; the 50:50 ratio of sharks caught from the shoreward/seaward side of nets indicates that their effectiveness is not due to their physical presence. Off-shore gill-nets have never been regarded as being infallible.

The reduction in annual catches, despite the relative increase in unit catch effort, supports the view that minimization of local inshore shark populations, relative also to increased bathing pressure, reduces the statistical possibility of a shark attack occurring at a netted beach.

The only two shark attacks which have occurred since the inception of the NASMB in 1964, and which took place at a netted beach in 1974, are reviewed. Operational precautionary procedures routinely enforced at all netted beaches are detailed.

Although the statistical records and financial implications prove beyond question the effectiveness of the anti-shark measures employed by the NASMB over the past decade, the Board is deeply conscious of the need to investigate other avenues which may be developed to increase the safety factor for bathers; it is simultaneously equally conscious of the need to ensure the vital ecological niche which sharks must occupy if the delicate balance in the marine ecosystem is to be maintained.

In conclusion, the records show that off-shore gill-nets, as operated and administered by NASMB, while undoubtedly not 100% safe, remain for the present, the most practical, efficient and economic anti-shark measures in operation, provided that their utilization is strictly controlled and based upon accredited scientific discipline and the unquestioned dedication to their duties on the part of the Field Staff of the NASMB.

ANTI-SHARK DEVICES AND TESTING METHODS AT NAVAL UNDERSEA CENTER *

C. Scott Johnson
U. S. Naval Undersea Center

The U. S. Navy is interested in protecting its working divers, and victims of accidents at sea, from shark attack. A variety of protective and defensive devices tested to date include: a relatively safely operated drogue dart, in essence a small parachute attached to a shark; a CO_2 dart that injects gas into a shark to upset the hydrodynamic capability; powerheads, of varying explosiveness and operating danger; and electrical devices. Based on testing results, the Air Force plans to stop using a chemical and dye previously thought to be an effective repellant; the chemical did provide psychological comfort to personnel at sea.

Diver equipment tested or developed includes striped wet suits, now considered ineffective in camouflaging divers, and a panoramic face mask that provides a greater field of vision for divers. (About one-half of divers attacked do not see the shark prior to the attack.) Armored wet suits of layered plastic "scales" and neoprene are being evaluated to prevent cutting from shark bites .

A "shark screen", essentially a plastic bag large enough to accomodate a person floating upright at the sea surface, is quite effective as a protective device. Contained in a small package prior to use, the screen is thought to deter sharks because of its dark, dull color and size. Indeed, bright reflective colors appear more likely to attract sharks, a finding confirmed in studies of other floatation devices, including infant floatation bags with neoprene bottoms to maintain body warmth, (since exposure to cold is a greater lethal hazard than sharks).

* Accompanied by movie

A REMINDER OF THE IMPRACTICABILITY OF CHEMICAL SHARK REPELLENTS

H. David Baldridge
Mote Marine Laboratory

To protect a potential shark attack victim, an effective chemical repellent field would have to be established and maintained in the water. Potential repellents fall into two general categories: (a) pharmacologically active materials (drugs, poisons, irritants, etc.) to which response is involuntary; and (b) other chemicals (odors, deeply colored dyes, etc.) that elicit aversive, perhaps conditioned, responses. Effectiveness of both types depends on being able to put enough material into the water to cause rapid behavioral changes in the shark. It is a matter of practicability rather than possibility. Obviously, there would be no problem in creating chemical environments unacceptable to sharks in the absence of concern for the quantity and nature of the chemicals employed.

A pharmacological barrier would produce in a shark physiological changes so profound that it would be rendered physically incapable of further aggressive behavior. To analyze such a system,a mathematical model was developed to describe a highly idealized field of drug in the water about a potential shark attack victim. A hypothetical shark was made to approach the victim at a reasonable swimming speed through the ever increasing concentration of drug. Integrated exposures experienced by the approaching shark were related to requirements for drug-induced incapacitation based upon earlier laboratory studies. Results of such analyses clearly indicate that, because of the very large quantity of toxicant required, incapacitation of a threatening shark by absorption of a drug from the water would be completely impractical.

Of course, some extremely potent drug might some day be found that would overcome the problem of quantity indicated by this analysis. To be effective as a shark deterrent, such a drug would have to be several orders of magnitude more toxic to sharks than cyanide, in both dose and speed of action. Unfortunately, it very likely would be equally effective against the life of the person in the water.

Visual and olfactory deterrents, such as presented by a dense cloud of dye or odorous material in the water, would be subject to the same considerations in terms of impractical quantities of material. There would also be the matter of relative ineffectiveness of visual deterrents at night and in turbid or murky water.

There always remains the remote possibility of finding in the future a highly effective chemical shark repellent in the classical sense, i.e., one that acts in low concentration to trigger a desirable behavioral response before the shark becomes excited and perhaps irreversibly committed to the attack. Such a repellent might be based upon unacceptable food sources or otherwise hazardous marine life recognized by sharks in a particular geographical area. Unfortunately, such conditioned responses would not be likely to occur in other shark populations. Beyond that, incapacitation would probably be required for terminating preattack behavior by chemical means, and mathematical analyses clearly indicate that this is not likely to be realized in terms of realistic quantities of drug and available exposure times.

AN EVALUATION OF SOME CHEMICAL, BIOLOGICAL, AND PHYSICAL AGENTS TESTED FOR THEIR EFFECTIVENESS AS SHARK DETERRENTS

Perry W. Gilbert
Mote Marine Laboratory

Tests of possible shark deterrents have been conducted during the past 15 years in the open sea in both Pacific and Caribbean waters, as well as under controlled conditions at the Lerner Marine Laboratory on Bimini, Bahamas; the University of Hawaii Marine Station on Eniwetok; and the Mote Marine Laboratory. Results of many of these tests have been summarized in an illustrated article by Gilbert and Gilbert entitled, "Sharks and Shark Deterrents" that appeared in Underwater Journal, Vol. 5, No. 2, 1973.

The usefulness of any chemical, biological, or physical agent as a shark deterrent depends in great part on the care with which it has been tested and its effectiveness evaluated. Recently, a number of commercial preparations for repelling sharks have been advertized and, although extravagant claims in many instances have been made for these products, very few have been rigorously tested. If this unrestrained practice is continued, disillusionment with the effectiveness of the product and serious damage of the reputation of the commercial firm that produces it are inevitable. It is important therefore that methods be as objective as possible when testing the effectiveness of various substances and devices that may inhibit the feeding activity or actually repel sharks. It is equally important to test the product on several individuals of a given species as well as on several species of sharks. When such tests are conducted by impartial observers one may not only more reliably assess the deterrent effectiveness of a given substance or device, but also learn much about the feeding activities and behavior of sharks.

Since 1960 we have tested more than 100 different chemical substances in the open sea, and under controlled laboratory conditions, for their effectiveness as shark deterrents. For such tests we have followed the methods summarized by Gilbert and Springer (Testing Shark Repellents, Chapter 19 in Sharks and Survival, D. C. Heath and Company, Boston, Massachusetts). Some of the chemical compounds deployed in the water were so noxious, or irritating to the human skin and central nervous system, that it would have been impractical for man to employ them - yet hungry sharks swam repeatedly through clouds of the chemical and readily accepted food proferred them. Our conclusions agree in all essential respects with those of Baldridge that an effective chemical shark deterrent is impractical at this time.

There are many products of biological origin that sharks avoid or find unplatable. Dr. Thomas Eisner of Cornell University has found that several species of sharks avoid ingesting small peices of the swimming mollusc known as the sea hare (Aplysia). Yet these same sharks consume the fish in which small pieces of sea hare have been embedded. Recently Dr. Eugenie Clark has found that the secretions from the skin of the Moses sole (Pardachirus) are avoided by some species of sharks in the Red Sea. While it is possible and even probable that the skin secretions of the sea hare and Moses sole have survival value for these animals, rigorous tests on several species of sharks are required before any claim can be made that such a secretion is a practical shark deterrent. There then must follow the very time consuming efforts by

chemists to isolate, chemically characterize, and possibly synthesize the active principal.

Dolphins have long fascinated those who spend time on or near the sea and many believe that one is safe from sharks in their presence. An investigation of the dolphin-shark relationship has recently been conducted at the Mote Marine Laboratory. It was found that bottlenosed dolphins (Tursiops truncatus) actually got along quite well with four species of large sharks known to be dangerous to man and that no aggressive behavior was evident on the part of either the dolphins or the sharks. We then conditioned a dolphin, on command from a sound signal, to aggressively approach, harass, and drive a sandbar shark (Carcharhinus milberti) right out of the pool in which the experiment took place. These results are promising but further experiments with other species of sharks are called for before we can confidently suggest that a properly trained dolphin might protect man from sharks.

Some of the physical devices, (such as the Shark Screen, Bang Stick, Gas Gun, and Striped Wet Suit) for deterring or immobilizing sharks have been commented on in other conference abstracts (Johnson). Additional physical methods we have observed such as the Bubble Curtain, Infant Floatation Device, Shark Alarm Systems, Shark Fences, Meshing in Australia and South Africa, and the Electric Shark Shield are treated in our article in Underwater Journal entitled, "Sharks and Shark Deterrents" referred to above. Anti-shark meshing measures are effectively employed in South Africa (Davis) and I have observed their effectiveness personally in both South Africa and Australia. Of the many types of electric devices for repelling sharks we have rigorously tested, the Shark Shield is thus far the most promising. It has been used effectively on shrimp trawls to protect the cod end of the net, and has promise as a method for protecting a limited beach area or members of an underwater salvage crew from the intrusion of sharks.

In summary, it would appear that the most practical way of reducing the shark hazard at present is by physical means. Commercial fishing, sports fishing, and meshing procedures serve to significantly reduce the number of sharks in a given area and thereby the likelihood of shark attack. In isolated areas where fishing methods are not employed, the Shark Screen, Infant Floatation Device, Bang Stick, and Shark Shield provide promising methods for protecting man from sharks.

V. COMMERCIAL UTILIZATION OF SHARKS

MARKETING SHARK MEAT AS SEAFOOD

Charles B. Davies
Florida Department of Natural Resources

As a seafood, shark meat has good vitamin and excellent mineral content, and is an excellent source of protein with values slightly less than those of bony fish. It is lean, with most species containing less than 1.6% fat. Nitrogen content is high but reflects both protein and urea; (whereas the ratio of non-protein nitrogen to protein nitrogen is about one to nine in bony fishes, in sharks it is about one to one). Depending on the species, from 25% to 50% of the urea must be removed to make the meat palatable. The threshold below which urea could not be detected in flavor tests was 1200 milligrams per 100 grams. Meat yield when the shark is filleted averages about one-third, with a range from 20 to 56% of total body weight.*

Although the development of synthetic vitamin A eliminated a major portion of the U. S. shark fishery, there is still activity on the Pacific Coast, and the food fishery is active in Texas in supporting exports to Mexico. In New Orleans Batistella Seafoods, Inc., introduced shark meat into restuarant and school markets. In Florida, Rayen's Shark World International, Mr. Ray Cora, and a few other fish dealers are handling sharks.

Dockside, fishermen receive about 10 cents per pound for eviscerated sharks. Products include frozen or fresh whole fillets and portions which wholesale at 75 to 85 cents per pound, and dried, salted fillets.

Marketing faces two problems, namely consumer acceptance and product quality. Both a taste test series and survey of potential retain customers have been proposed by Mr. Bill Schwartz of the Texas Parks and Wildlife Department. Concerning quality, high urea content of sharks and Florida's warm climate dictate extra care in handling. On board bleeding, eviscerating, washing and icing are critical requirements. Also, dealer needs for size, species and on board handling must be determined before fishing.

Avantages of shark meat in the marketplace are an excellent, mild flavor, a highly nutritious composition, no waste, and low price. It should be considered an "underutilized" species, and therefore a prime project for marketing and technical assistance. Profit of a shark fishery can be enhanced if maximum utilization of the product is sought.

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* The Russian publication "Shark Flesh in the Food Industry," by V. S. Gordievskaya (and translated in 1973 by the Israel Program for Scientific Translations) provides comprehensive information on the chemistry and composition of sharks.

INDUSTRIAL USAGE OF SHARK PRODUCTS

Dale S. Beaumariage
Florida Department of Natural Resources

In 1964 mackerel fishermen in the Florida Keys suffered sufficient gear damage from sharks that they asked the Florida Department of Natural Resources (DNR) to "control sharks." The initial DNR response was to propose a technical assistance program based on commercial fishing as a shark population control measure. In view of the use of shark meat in seafood items such as fish and chips in England, for example, DNR encouraged a Florida shark meat fishery, and also proposed to assist processors with possible problems associated with urea content of the meat. Ultimately, DNR marketing personnel would become involved. Despite some production of smoked shark meat, problems such as lack of butchering space on board the fishing boats and reluctance of fishermen to process freshly landed shark stymied efforts to develop the fishery.

Therefore industrial uses of shark hide, teeth, jaws, and flesh were considered to promote the fishery. As a bait shark lasts twice as long as other baits, is equally effective, and thus reduces costs; stone crab fishermen were particularly receptive to its use. Use of shark as an ingredient in fish meal for fertilizer and animal food showed potential but could not be tested when a Gulf coast tendering plant closed. Demand for hides came from Ocean Leather Corp. However industrial usage of sharks precludes use of the meat as seafood.

The key to a successful shark fishery is total resource use; and the fishery must be willing to be mobile enough to shift exploitation among populations if overfishing of individual populations occurs, not only to secure a consistent supply but also to insure a quality product through prompt skinning of the carcasses. Also, a mobile factory such as a barge might avoid local objections to the siting of foul-smelling rendering plants.

Based on the work initiated in 1964 a paper * was published in 1968 with a summary that still applies, although the outlook for shark meat products may be more optimistic today. The summary follows:

> Ideally, a commercial shark fishery should achieve the fullest possible utilization of each shark taken. This would entail, in the following order: skinning and curing the hides for shipment to a leather tannery; removing and drying the fins for shipment to oriental food suppliers; freezing the choicest meat for an export market, or smoking it for a specialized local market; using the remaining carcass meat for crab bait, or selling it to a fish reduction plant for fish meal production; and selling the jaws and/or teeth to novelty shops for the tourist trade. Not all these goals are attainable due to the nature of the meat, the limited facilities presently available for shark exploitation, and the economic structure of commercial fishing in Florida. However, a profitable shark fishery can be established by using just

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* Beaumariage, D. S. 1968. Commercial shark fishing and processing in Florida. Fla. Bd. Cons. Marine Research Lab. Ed. Series No. 16. iv + 21 p.

the hides and fins. The meat could also be used as crab bait or fish meal, depending upon the promimity of consumers and the cost of handling the raw material.

Essentially, the successful revival of commercial shark fishing in Florida is dependent upon: 1) well organized, shore-based management; 2) establishment of markets; 3) enterprising, professional fishermen. The shore-based management should be responsible for supporting equipment requirements necessary for catching sharks, supplying the labor and materials for processing the catch, and supervising the quality of the materials produced. The fishermen should be responsible for maintaining sustained landing requirements commensurate with processing capabilities. This requires selective and exploratory fishing for principal populations. The consumer should cooperate through prompt and fair payment for products received and support of the major suppliers. This would include the expansion of markets for associated by-products beyond the local demand. The physical requirements for establishment of a shark fishing station are: 1) personnel with adequate knowledge of commercial fishing; 2) location of the processing station on an isolated tract of land adjacent to deep water; 3) necessary capital for obtaining vessels, gear, and labor.

COMMERCIAL SHARK FISHING FROM THE PRODUCER'S VIEW

James Heerin
Sea Farms, Inc.

A "producer" purchases sharks, either whole or skinned, from fishermen, and prepares the product only to the extent necessary to ship it to a processor for conversion into leather, oil, etc. Sharks are attractive to producers because so many parts of the animal -- fins, hide, meat, liver oil, jaws and teeth -- can be utilized. Producers buy sharks on the basis of length and species. For a six-foot shark the fisherman currently receives between $3.35 and $8.25. Eleven-foot sharks may bring between $6.26 and $12.55.

Often a 25 to 45-foot bottom or crawfish boat, with a low or cut out transom or side port, is used in the fishery. Larger boats permit on board skinning, etc. Fishing will employ a main cable up to 3/4 mile long, with six-foot drop cables and hooks suspended at 10 to 12-foot intervals. Baited lines should be pulled within 24 hours. A line of fishing gear (i.e., main and drop cables, swivel snaps, hooks) and a winch may cost $4260, and bait, fuel and supplies may cost $100 per 10 hour trip.

At an average catch rate of 10%, such a 400-hook line might yield a catch with a dockside value of $345.60, assuming the sharks are eight feet long and in good condition.

Usually sharks cannot be iced or gutted on board. However they should be kept wet and shaded to retard spoilage. Boots and gloves should be worn when sharks are handled, particularly when the fisherman has scratches or open cuts.

As soon as sharks are landed at the dock and inspected, skinning should begin. Stepwise, the fins are first removed, the shark is skinned, and the hide is immersed in brine. After soaking, the hide is scraped, washed and salted for curing, which may take a week. Fins are dried for two weeks.

Butchering involves removal of two large slabs from each side of the backbone. The meat is washed in brine and then fresh water.

Problems in the shark fishery includes marketing, since the best outlet for meat may be as lobster or crab bait, or in limited amounts of smoked fish. Shark fishing is hard and involves physical risk. Skinning is tedious and messy. Skilled labor may be hard to find and keep. Waste disposal is a problem, and transportation may also present difficulties.

Continued development of products from sharks should make sharks more valuable to both fishermen and producers. For example, oil from the liver, which may constitute 20% of a shark's weight, has been tested as a base for perfume and insecticides.

COMMERCIAL SHARK FISHING: WORLD SURVEY AND PROSPECTS AS AN INDUSTRY FOR DEVELOPING COUNTRIES

John Moore
New York, New York

The world landed weight of shark (excluding dogfish, skates and rays) in 1973 was 191,900 metric tons, of which 500 metric tons were landed in the United States. (World catch of all fish exceeded 65 million metric tons in 1973.) Japan landed over 40,000 metric tons, followed by Nigeria, Russia and France. Japan exports some shark meat and dried fins (2100 and 800 metric tons, respectively, in 1973; valued at about $7.5 million), and also uses shark meat in "kamaboko" fish cakes. In Russia, shark is used as a waste product in fish meal, etc, with the exception of some used in smoked "balyki". Along with a general interest in information exchange, there is a particular interest in obtaining technology for processing shark skin into leather.

A pilot project to produce "tipo bacalao", a smoked dried product, was started in Panama, sponsored by a local fishing cooperative and the Food and Agricultural Organization of the United Nations. Demand exceeds supply, which is produced at 1000 pounds per week. In Mexico most shark plants are owned by a government agency, Productos Pesqueros Mexicanos, which also markets and conducts research. Products include frozen fillets, sausage, tipo bacalao, dried shredded meat ("machaca"), oil, skins, fins and fishmeal. Both Productos Pesqueros and Diez de Sollano, S. A. are prepared to offer "turn-key" integrated shark plants for sale.

As an industry for less developed nations shark fishing offers advantages that include low cost plants; potentially high return on investments; use of unskilled labor except for manager and boat captains; reduction of imports; creation of export commodity; use of underutilized resources; economical protein source; reduce damage to local fishermen's gear; and reduce potential hazard to swimmers. Such nations offer demand for shark meat, and provide financial labor and plant siting advantages. Risks may include the availability of sharks and domestic and export markets, proper financing, the question of a joint venture with government or a local fishing cooperative, and the possible consideration of fisheries as a national resource.

The United States does not offer as large a potential financial return as international prospects. Accordingly, the U. S. private sector should review these prospects, develop and market technology overseas, and also attempt to publicize specific projects to attract increased financial backing. Information is needed concerning worldwide market and price conditions, and availability of sharks. Also processing equipment can be more efficient.

CONFERENCE PROGRAM

SHARKS AND MAN--A PERSPECTIVE

A Conference coordinated by the Florida Sea Grant, Marine Advisory Program and jointly sponsored by The Florida Department of Natural Resources, National Marine Fisheries Service, Mote Marine Laboratory, Coastal Plains Center for Marine Development Services, and Office of Naval Research.

PROGRAM

Wednesday, November 19

8PM Film presentations by participants

Thursday, November 20

9AM Opening Remarks--Conference Chairman: Dr. Hugh L. Popenoe, Director, Florida Sea Grant Program

9:10AM General Session--Session Chairman: Harmon W. Shields, Executive Director, Florida Department of Natural Resources

Conference Background and Objectives; introduction of special guests.

9:30AM First Technical Session-Sharks and Man. Chairman: Harold B. Allen, Deputy Regional Director, National Marine Fisheries Service, St. Petersburg, FL.

The Shark Research Panel and its Attack File--Dr. Perry W. Gilbert, Director, Mote Marine Laboratory

A Brief History of the Shark Attack File--Dr. Leonard P. Schultz, Retired and Former Curator of Fishes, Smithsonian Institute

What Does The Shark Attack File Tell Us--Dr. H. David Baldridge, Senior Research Associate, Mote Marine Laboratory

Sharks-Impact on Tourism--Dean Gaiser, Assistant Director, Florida State Division of Tourism

How a Tourist Center Reacts to Shark Attack Publicity--James Bullion, Executive Manager, Daytona Beach Chamber of Commerce

2PM Shark Attack/Bait for Legal Action--Thomas Harris, Assistant Attorney General, Florida Department of Legal Affairs

Sharks - Impact on Commercial Fishing--Douglas Coughenower, Marine Agent, Florida Marine Advisory Program and Thomas H. Groover, Secretary and Treasurer, Florida Fishermen's Marketing Association

Sharks - The Sports Fisherman's Point of View--Bob Stearns, Boating Editor, Outdoor Life Magazine

3PM Second Technical Session - Sharks-Population Dynamics. Chairman: Dr. Carter Gilbert, Associate Curator, Florida State Museum, University of Florida

Sharks and Ecology--Stewart Springer, Senior Research Associate, Mote Marine Laboratory

Migrations and Abundance of Sharks Along the Atlantic Coast--John G. Casey, Fisheries Biologist, Northeast Fisheries Center, National Marine Fisheries Service, Narragansett, R.I.

Numbers and Availability of Commercially Useful Sharks--Harvey R. Bullis, Jr. Director, Southeast Fisheries Center, National Marine Fisheries Service, Miami, FL

5PM Third Technical Session--Shark Behavior Patterns. Chairman: Dr. Fred Kalber, Supervisor, Marine Research Laboratory, Florida Department of Natural Resources

Behavior of Sharks-A Continuing Enigma--Dr. Arthur Myrberg, Professor of Marine Science, University of Miami

7PM Leave for luau and social at Sea World (tickets on sale in lobby)

Friday, November 21

8:30AM Fourth Technical Session--Anti-Shark Measures. Chairman: Dr. Bernard Zahuranec, Asst. Program Director, Oceanic Biology Program, Office of Naval Research

Anti-Shark Measures as Practiced in South Africa--Ms. Beulah Davis, Director, Natal Anti-Shark Measures Board, Natal, South Africa

Anti-Shark Devices and Testing Methods at Naval Undersea Center--Dr. C. Scott Johnson, Naval Undersea Center, San Diego, CA

A Reminder of the Impracticability of Chemical Shark Repellents--Dr. H. David Baldridge, Mote Marine Laboratory

An Evaluation of some Chemical, Biological and Physical Agents tested for Their Effectiveness as Shark Deterrents--Dr. Perry W. Gilbert, Mote Marine Laboratory

1:30PM Fifth Technical Session-Commercial Utilization. Chairman: Dr. Robert E. Smith, Director, Institute of Oceanography, State University System of Florida

Marketing Shark Meat as Seafood--Charles B. Davies, Chief, Bureau of Marketing and Extension Services, Florida Department of Natural Resources

Industrial Usage of Shark Products--Dale S. Beaumariage, Chief, Bureau of Marine Science and Technology, Florida Department of Natural Resources

Commercial Shark Fishing from the Producers View--James Heerin, President, Sea Farms Inc., Key West, FL

An International Perspective of the Value of Shark Products--John M. Moore, Jr., Investment Consultant, New York City

3:30PM Summary by Session Chairmen and Comments from floor

5:00PM Conference Conclusion--Dr. Hugh Popenoe

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