Sharks in Danger

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Many shark populations are in danger of extinction as a direct result of man's activities. A change in attitude and a greater understanding of species' requirements are needed to prevent further destruction and replenish numbers, thus sustaining trade, fisheries and sport activity.

Three hundred and seventy separate shark species have so far been recorded, ranging in size from the whale shark (at a massive 13.7 m maximum measured length) to the dwarf dogfish (fully grown at as little as 15 cm). Some sharks are specialised for the ocean surface habitat, others live in the furthest depths. Still others, such as the bull shark and Ganges shark, spend long periods in freshwater rivers. The basking shark, despite its large size, is a filter feeder, feeding exclusively on plankton. The tiger shark, at an average of three metres, is an apex predator.

Shark species display different reproductive strategies with varying fecundity. Reproductive rate is generally highest for oviparous species (see Box 1) and lowest for viviparous species, although species variation within each strategy is such that overlap exists. Sharks also exhibit different breeding cycles. Some species reproduce throughout the year, whilst others have a seasonal cycle. Some species have ova ripening in the ovary while embryos are developing, so the female is ready to ovulate again after birth. In other sharks, only a proportion of the mature females breed each year, the others enter a resting stage for a year or possibly longer.

Current Threats

Fishing

Published data from the Food and Agriculture Organisation of the United Nations (FAO) show that shark catches have been rising steadily since the 1940s. The Marine Conservation Society estimates that drift gill nets alone kill 3000 sharks daily. Most sharks are K selected, in that they have a large body size, few natural predators, slow rates of growth, late onset of maturity and small numbers of well-developed young. As a consequence, they cannot withstand high levels of predation or other mortality (Gruber, 1990).

Most commercial and recreational shark catches are unregulated and unmonitored, such that available data does not truly reflect worldwide landings and the true picture may be worse than shown. The development of successful management plans will require much more

Box 1. Shark reproductive strategies

Oviparous sharks (Orectolobiformes, Heterodontidae, Scyliorhinidae) deposit eggs on the ocean floor and take several months to hatch depending on the water temperature. Brood size varies with species.

Ovoviviparity involves live birth with the eggs developing within the shark's body. The piked dogfish produces ten or so young after a gestation period of 22 months.

Viviparity (Squaliformes, Carcharinidae, Sphyrnidae) involves live birth with the young obtaining food from the mother during gestation. Gestation periods are nine – 12 months with litters between two and 16, although the sand tiger shark has a litter of one, as the first embryo to hatch within the uterus consumes its siblings before feeding on maternal eggs (Gilmore, 1980).

Box 2. Shark navigation

Many shark species are migratory, moving through national boundaries and exclusive economic zones (EEZ). International cooperation is needed to ensure that protective measures undertaken in one country are not undone in another. Conservation of sharks requires verification of migration and population trends in order to convince other nations to participate in their management.

Most sharks can be categorised as:

1) highly pelagic – ranging over broad geographical areas;

2) coastal pelagic – generally confined to continental shelves but have shown movements exceeding 1000 miles;

3) resident – range of a few hundred miles or less.

In 1962, the US Government initiated a volunteer shark tagging and release programme. Maximum straight-line recorded distance for a tagged blue shark (pelagic) is 3740 miles, yet multiple recaptures suggest blue sharks may make round-trip movements between North America and Europe that exceed 10 000 miles (Casey and Kohler, 1990).

Sharks generally segregate by size and sex, so different segments of the population will have different migration patterns. Sharks may be divided into isolated breeding populations, which must be identified, through tagging or genetic studies, to elucidate vulnerable life stages and to determine whether locally-depleted regions can be replenished from other areas.

accurate catch data and greater research funding. Similar shark species command similar prices, so fishermen regard mixed shark species as one generic stock. This means that a particular species could become severely depleted before the fishery is aware of its condition.

Sharks are also caught as incidental by-catch in virtually every commercial fishery and are rarely released. Greenpeace Australia calculated that, in 1988 alone, Taiwanese and Korean squid fleets killed over 2.25 million blue sharks in the North Pacific. Increases in vessel numbers and capability have increased global pressure. China's distant-water fleet has rapidly expanded from one vessel in 1976, to 64 vessels in 1996 in the North Pacific, Atlantic and Indian Oceans. (For detailed fisheries data the reader is referred to Rose 1996b, and Sant and Hayes 1996.)

Recreational take is regulated in some zones, *e.g.,* the United States Atlantic coast, but developing countries attract tourists by advertising unrestricted game fishing, so exerting further strain on already exploited populations.

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Box 3. Aims of a national shark plan (from the FAO International Plan of Action for Sharks)

1. Ensure that shark catches from directed and non-directed fisheries are sustainable.
2. Assess threats to shark populations, determine and protect critical habitats and implement harvesting strategies consistent with the principles of biological sustainability and rational long-term economic use.
3. Identify and pay special attention, in particular, to vulnerable or threatened species.
4. Improve and develop frameworks for establishing and coordinating effective consultation involving all stakeholders in research, management and educational initiatives within and between States.
5. Minimise unutilised incidental catches of sharks.
6. Contribute to the protection of biodiversity and ecosystem structure and function.
7. Minimise waste and discards from shark fisheries in accordance with paragraph 7.2.2g of the Code of Conduct for Responsible Fisheries (*e.g.*, requiring the retention of the sharks from which fins are removed).
8. Encourage full use of dead sharks.
9. Facilitate improved species-specific catch and landings data and monitoring of shark fisheries.
10. Facilitate the identification and reporting of species-specific biological and trade data.

Shark finning

Shark fins are harvested as a highly lucrative by-catch with little directed effort and few storage problems. Since shark meat has a low value, due to its high urea content, fishermen utilise their refrigerators for more valuable catch and discard the shark carcass once the fins have been removed. The high value of shark fins has led to the launch of thousands of directed shark fin longlining vessels with Taiwanese, Japanese, South African and Spanish operators extending from Morocco to Ghana.

More than 150 countries trade in shark fins. Hong Kong customs data show total imports of shark fins rose from 2.7 million kilos in 1980 to 6.1 million in 1995. However, re-exports are not recorded, and Hong Kong often exports raw fins to China, which are returned after processing for re-export. Hong Kong dealers note that Japan and Spain are major suppliers of blue shark fins, the Philippines and the Middle East of blacktip reef shark fins, Mexico of hammerhead fins and Mexico, Brazil, the Philippines and Venezuela of oceanic whitetip and tiger shark fins (Phipps, 1996). Fins from piked dogfish and porbeagle are exported to Asian countries from Norway, Germany and the UK (Traffic, 1995). Retail prices in Hong Kong range from US$40 to $564 per kilo according to species, fin type, condition and regional preference.

From 1991 to 1998, the number of sharks killed solely for their fins in waters off Hawaii increased by 2500%. On 22 June 2000, a state bill was passed to prohibit the landing of any shark fins in the state of Hawaii unless the shark is landed whole. In December 2000, the USA introduced the Shark Finning

Prohibition Act making it illegal to remove shark fins and discard the carcass at sea or land, or have fins on board without the corresponding carcass. The Act also provides for initiation of related international negotiations and authorises shark fishery and population research. Prior to this law, finning was permitted in the US Pacific, yet prohibited since 1993 in the US Atlantic, Gulf of Mexico and the Caribbean Sea. Regulations to implement the new finning legislation were released for public comment in June 2001. Legislation banning shark finning already exists in Brazil, Costa Rica, Oman, South Africa and Australia. Similar legislation is necessary in fisheries where sharks are targeted, or taken incidentally, to reduce this practice and enable catch to be monitored and fisheries managed.

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Shark cartilage industry

In 1996, shark cartilage was a $50 million a year industry with between 25 and 100 thousand people purchasing dozens of brands for their reputed cancer-curing properties. Today, turnover is probably even greater, due to supply through high street shops and increasing usage by European veterinary practices. Cartilage can account for up to six per cent of shark body weight, but twenty-seven pounds of shark cartilage only produce one pound of extract. One US-owned cartilage-extracting plant in Puntarenas, Costa Rica (Corporacion Procesadora Cartilago, SA) exported 131 275 kg of cartilage chips between 1 August 1994 (opening of plant) and 30 September 1995. Ninety percent was shipped to US and European markets, where capsules sell for over $40 per 100 pills. It was estimated that at least 235 000 large coastal sharks are being processed each month at this plant. Four other plants in Puntarenas also process cartilage. As sharks are becoming scarcer, Costa Rican fishermen are fishing off Guatemala and illegally fishing in the Galapagos Marine Reserve. Cartilage production is not restricted to Costa Rica. The *New Zealand seafood exporters directory* lists two companies exporting shark cartilage to the US (Sant and Hayes, 1996).

Habitat degradation

Nursery and mating zones are important for the replenishment of shark populations and these coastal and estuarine zones are vulnerable to destruction from human settlement and development. Nearshore decline of smooth hammerheads in central Mediterranean sites has been attributed to this type of development. School sharks have declined due to degradation of seagrass meadows in bays around Tasmania. Anthropogenic activity (such as dam building, irrigation water usage, and pollutants from mining operations, industry, agriculture, sewage and deforestation) could be devastating to freshwater elasmobranches in restricted bodies of water. The bull shark population in the Essequibo River, Guyana, has been depleted due to a cyanide waste spill. In addition, the rise in popularity of scuba diving and cage diving has increased the potential for human damage to the marine environment. However, these activities have a positive effect on the public perception of sharks and guidelines could be developed to decrease damage.

Protection measures

Beach nets and drumlines intercept and catch sharks on their regular feeding and territorial routes, with the intention of making beaches safer for bathers. The annual catch of the Natal Shark Board nets totals 1345 large sharks of 14 species, of which about 13% are tagged and released. Nets have a selective impact upon sharks. They pose no barrier to smaller sharks. Bottom dwelling sharks display a higher survival rate when caught in nets than surface or middle depth sharks. Also, rates of inshore-offshore movements, seasonal and along-shore migration patterns, and amounts of time spent by certain species inshore affect

Table 1. Fisheries where collapses have occurred

Porbeagle fisheries in the Northwest Atlantic (1968–1972)
California Soupfin Shark Fishery (1930–1944)
Australian School Shark Fishery (1927–1956)
Scottish-Norwegian Spiny Dogfish Fishery (1946–1986)
British Columbia Spiny Dogfish Fishery (1907–1949)
Basking Shark Fisheries off Northeast Atlantic and Eastern and Western Pacific

Source: Anderson (1990)

Table Top exporters and importers of shark fins in 1990

Exporters	Quantity (million tons)	Importers	Quantity (million tons)
Hong Kong	1,609	Hong Kong	3,838
China	809	China	1,335
Singapore	806	Singapore	1,006
Indonesia	558	USA	192
Japan	451	Malaysia	92
Others	1,172	Others	143

Source: FAO Fisheries Statistics (1994)

Table 3 CITES Appendices

Appendix I – lists species threatened with extinction and subject to international trade. Trade in artificially propagated or captive-bred specimens is allowed subject to license. Requires both an export and an import permit.

Appendix II – lists species that may become threatened with extinction if trade is not regulated. Trade in wild, captive-bred and artificially propagated specimens is allowed subject to license. Requires an export permit.

Appendix III – lists species not threatened worldwide but protected within individual party states. These states need the help of other parties to control trade in the affected species. Requires export permits.

Source: Anon, 1996f

trends in catch per unit effort (CPUE). Nevertheless, CPUE trends indicate that the shark meshing programme in North Queensland, Australia, has reduced populations of hammerhead, blacktip and whaler sharks by up to 80% (catches were highest in spring and summer, indicating nearshore migrations for pupping and mating) but has had little effect on tiger sharks. Netting restricts access to nursery and mating areas, which impacts heavily upon recruitment rates.

Conservation initiatives

The success of future management actions will depend on a better understanding of the biology and behaviour of each shark species. Management plans depend on stock assessments and a knowledge of growth rate, age at maturity, longevity, and mortality rate, all of which provide an insight into a species' ability to sustain a fishery. Stock assessment of shark fisheries is difficult. Catch data often fail to differentiate between species and not all catches are reported. In practice, size limits are rarely employed due to a lack of life history information and the use of fishing gear that does not allow live release of undersized sharks. Catch limits are difficult to enforce, and closed areas and seasons have not been widely used because mating and nursery zones are not known for most shark species.

Many shark species are migratory, moving through national boundaries and exclusive economic zones (EEZ). International cooperation is needed to ensure that protective measures undertaken in one country are not undone in another. Verification of migration and population trends is required in order to convince other nations to participate in shark management.

In 1998, the FAO commissioned several studies in different regions on shark stocks and fisheries. This led to the production, in 1999, of the voluntary United Nations International Plan of Action for the Conservation and Management of Sharks (IPOA-Sharks) to ensure the conservation and management of sharks and their long-term sustainable use. Under this Action, each applicable State is responsible for developing, implementing and monitoring a shark plan.

The United Nations Environment Programme World Conservation Monitoring Centre (UNEP-WCMC) compiles the Red List of Threatened Animals, which lists species according to threatened status. The list has no legal force but is used by conservation bodies when setting priorities. The shark species listed on the 2002 Red List do not differ from those listed on the previous Red List (issued in 2000). The Shark Specialist Group (SSG) advises on shark species listings. UNEP-WCMC also issue Guidelines for Protected Area Management Categories, which may indirectly assist in the conservation of some shark species. A copy of the red list is available with the online version of this article at www.iob.org/biologist.

The United Nations Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) came into force in 1975. It regulates international trade in animal and plant species through import and export permits. At present, 151 countries are party to CITES. The species protected are listed under three appendices, which are based on scientific criteria, and proposals to amend the appendices, and new resolutions on the implementation of the Convention, are considered at biennial conferences. The 9th Conference of the Parties (1994) passed Resolution Conf 9.17 on the Status of International Trade in Shark Species to improve international shark-data collection and review the biological status of sharks and the effects of global trade. At the 10th Conference of the Parties (1997), a document was submitted by the Animals Committee on the biological and trade status of sharks, and recommendations were endorsed to implement Resolution Conf 9.17.

The 11th Conference of the Parties (2000) received three proposals for shark listings that were supported by TRAFFIC and the IUCN Shark Specialist Group. All three were rejected, despite the great white shark proposal being resubmitted as an Appendix II listing. One reason for the rejection of these proposals is that some countries argued that the FOA, not CITES, is the appropriate forum for managing sharks. However, CITES can play a complimentary role to fisheries management, as it is the only body capable of monitoring and regulating international trade in threatened species.

Species can be added to Appendix III, at any time, on the request of an individual party if that party needs the cooperation of other parties in the control of trade in that species: no discussion of the proposal is required. Following a request from the UK, the basking shark was accepted onto Appendix III on 13 September 2000. This requires that all parties report their trade in, and issue export permits for basking shark. The trade data generated will aid discussion on whether the basking shark should be listed on Appendix II or I. However, reservations by Japan and Norway mean that these countries will not declare their international trade in this species. Following a request from Australia the white shark was accepted onto Appendix III on 29 October 2001. This listing will support its domestic legislation by ensuring that illegally exported jaws, teeth and fins are not imported by other CITES Parties. Japan submitted a reservation against this listing on 22 October 2001.

The UK resubmitted its Appendix II proposal for the

Table 4. CITES 2000 Shark Proposals at the 11th Conference of the Parties

Species	Country	Proposal	Result
Prop. 11.47 *Rhincodon typus* Whale shark	USA	Include in App. II	REJECTED
Prop. 11.48 *Carcharodon carcharias* Great white shark	AUSTRALIA, USA	Include in App. I Resubmitted as inclusion in App. II	REJECTED on on both proposals
Prop. 11.49 *Cetorhinus maximus* Basking shark	UNITED KINGDOM	Include in App. II	REJECTED

Table 4 Sharks on the 2002 Red List

Order: Carcharhiniformes	
Family: Carcharhinidae	
Graceful shark (Carcharhinus amblyrhinchoides) – LR/nt	Grey reef shark (Carcharhinus amblyrhynchos) – LR/nt
Pigeye shark / Java shark (Carcharhinus amboinensis) - DD	Borneo shark (Carcharhinus borneensis) – EN C2b
Spinner shark (Carcharhinus brevipinna) – LR/nt	Silky shark (Carcharhinus falciformis) – LR/lc
Pondicherry shark (Carcharhinus hemiodon) – VU C2a	Smoothtooth blacktip shark (Carcharhinus leiodon) - VU B1+2c, C2b
Bull shark (Carcharhinus leucas) – LR/nt	Blacktip shark (Carcharhinus limbatus) – LR/nt
Oceanic whitetip shark (Carcharhinus longimanus) – LR/nt	Blacktip reef shark (Carcharhinus melanopterus)- LR/nt
Dusky shark (Carcharhinus obscurus) – LR/nt	Sandbar shark (Carcharhinus plumbeus) – LR/nt
Tiger shark (Galeocerdo cuvier) – LR/nt	Ganges shark (Glyphis gangeticus) - CR A1cde+2cde, C2b
Speartooth shark (Glyphis glyphis) - EN C2a	Lemon shark (Negaprion brevirostris) – LR/nt
Blue shark (Prionace glauca) – LR/nt	Atlantic sharpnose shark (Rhizoprionodon terraenovae) – LR/lc
Spadenose shark (Scoliodon laticaudus) – LR/nt	Whitetip reef shark (Triaenodon obesus) – LR/nt
Family: Leptochariidae	
Barbeled houndshark (Leptocharias smithii) – LR/nt	
Family: Scyliorhinidae	
Puffadder shyshark (Haploblepharus edwardsii) – LR/nt	
Brown shyshark (Haploblepharus fuscus) – LR/nt	Pyjama shark (Poroderma africanum) – LR/nt
Narrowmouth catshark (Schroederichthys bivius) – LR/nt	Yellowspotted catshark (Scyliorhinus capensis) – LR/nt
Family: Sphyrnidae	
Scalloped hammerhead shark (Sphyrna lewini) – LR/nt	
Great hammerhead shark (Sphyrna mokarran) - DD	Bonnethead shark (Sphyrna tiburo) – LR/nt
Smooth hammerhead shark (Sphyrna zygaena) – LR/nt	Family: Triakidae
Whiskery shark (Furgaleus macki) – LR/cd	School shark/ Tope shark (Galeorhinus galeus) - VU A1bd
Whitefin topeshark (Hemitriakis leucoperiptera) - EN B1+2ce, C2b	Blacktip topeshark (Hypogaleus hyugaensis) – LR/nt
Gummy shark (Mustelus antarcticus) – LR/cd	Starry smoothound (Mustelus asterias) – LR/lc
Dusky smoothound (Mustelus canis) – LR/nt	Rig (Mustelus lenticulatus) – LR/cd
Common smoothhound (Mustelus mustelus) – LR/lc	Flapnose houndshark (Scylliogaleus quecketti) - VU B1+2c, C2b
Sharpfin houndshark (Triakis acutipinna) – VU C2b	Spotted gully shark (Triakis megalopterus) – LR/nt
Leopard shark (Triakis semifasciata) – LR/cd	
Order: Heterodontiformes	
Family: Heterodontidae	
Horn shark (Heterodontus francisci) – LR/lc	Port Jackson shark (Heterodontus portusjacksoni) – LR/lc
Order: Hexanchiformes	
Family: Hexanchidae	
Bluntnose Sixgill shark (Hexanchus griseus) – LR/nt	Broadnose Sevengill shark (Notorynchus cepedianus) - DD
Order: Lamniformes	Family: Alopiidae
Thresher shark (Alopias vulpinus) - DD	Family: Cetorhinidae
Basking shark (Cetorhinus maximus) - VU A1ad + 2d	
Family: Lamnidae	
Great white shark (Carcharodon carcharias) – VU A1bcd + 2cd	Shortfin mako (Isurus oxyrinchus)- LR/nt
Salmon shark (Lamna ditropis) - DD	Porbeagle (Lamna nasus) – LR/nt
Family: Megachasmidae	
Megamouth shark (Megachasma pelagios) - DD	
Family: Odontaspididae	
Bigeye sandtiger (Odontaspis noronhai) - DD	
Family: Pseudocarchariidae	
Crocodile shark (Pseudocarcharias kamoharai)- LR/nt	
Family: Odontaspididae	
Sand tiger shark/ Grey nurse shark (Carcharias taurus) – VU A1ab + 2d	
Order: Orectolobiformes	
Family: Brachaeluridae	
Bluegray carpetshark (Heteroscyllium colcloughi) – VU C2b	
Order: Orectolobiformes	
Family: Rhincodontidae	
Whale shark (Rhincodon typus) – VU A1bd + 2d	
Order: Pristiophoriformes	
Family: Pristiophoridae	
Common sawshark (Pristiophorus cirratus) – LR/nt	
Order: Squaliformes	
Family: Dalatiidae	
Kitefin shark (Dalatias licha) – DD	
Order: Squaliformes	
Family: Centrophoridae	
Gulper shark (Centrophorus granulosus) – VU A1 abd + 2d	
Order: Squaliformes	
Family: Squalidae	
Piked dogfish/ Spiny dogfish (Squalus acanthias) – LR/nt	
Order: Squatiniformes	
Family: Squatinidae	
Argentine angel shark (Squatina argentina) – DD	Pacific angel shark (Squatina californica) – LR/nt
Angular angel shark (Squatina guggenheim) – VU A1bd + A2d	Smoothback angel shark (Squatina occulta) – EN A1 abd + A2d
Angel shark (Squatina squatina) – VU A1 abcd + A2d	

Source: Anon (2002). For further explanation of criteria and categories see Anon, 1994b.

Table 3. Structure of the Red List categories showing decreasing threatened status

- Extinct (E)
- Extinct in the Wild (EW)
- Critically Endangered (CR)
- Endangered (EN)
- Vulnerable (VU)
- Lower Risk (LR) either Conservation Dependent (cd), Near Threatened (nt) or Least Concern (lc)
- Data Deficient (DD)
- Not Evaluated (NE)

Source: Anon (1994b)

basking shark to be considered at the 12th Conference of the Parties from 3 to 15 November 2002 in Santiago, Chile. The deadline for Appendix I and Appendix II proposals was May 2002. At the time of going to press CITES proposals had yet to be published. However, it is likely that one of the states which currently protects its whale shark populations through domestic legislation will submit a proposal for this species. The CITES proposals should be published by the time this article is distributed and, if so, can be accessed on www.cites.org.

The present system for obtaining a listing on CITES seems less concerned with the scientific proof of stock depletion, which is contained in the proposals, than with the public perception of threats and extinctions. Trade data is often under-recorded and will be grossly lacking for rare species, as they cannot support a thriving trade, but these are the very species that must be protected.

Governments are required to submit reports on listed species, including trade records, to the CITES Secretariat in Switzerland. Changes in the global trade of species-specific products may make it possible to identify over-exploited shark populations. Listing a shark species on CITES would not eradicate the trade in shark parts, but it would make the trade less commercially viable. Driving the trade underground would increase the risks involved, which would make it less attractive for participants. However, it would also make enforcement and monitoring (*i.e.,* data collection) much more difficult. In March 1994, the USA imposed punitive trade sanctions worth $25 million a year on Taiwan for its failure to enforce CITES resolutions; but few such penalties are imposed. Conventions and voluntary management plans have no direct legal force. It may be more fruitful to draw attention to the benefits to be gained from adhering to the instrument, than the possible penalties other countries may impose on infringement.

Some countries have enacted legislation to conserve and manage shark stocks. In addition, legislation aimed at non-shark fisheries can have a positive effect upon shark conservation. (Legislation is beyond the scope of this article but I refer the reader to Cunningham-Day, 2001.)

Conclusion

Sharks are an economically valuable group requiring conservation for their sustainable use. Protection of individual species will benefit other species through habitat protection, reduction of fishery by-catch and maintenance of the marine ecosystem balance. International research should be promoted, particularly tagging programmes and collection of fisheries records, to elucidate spatial and temporal population trends and to develop population models. Without this information it would be very difficult for the FAO and other global bodies to influence legislation and management programmes.

Legislation and sustainable management plans are based upon life history information, which means that rare species are seldom considered. In addition, all stock assessments are merely estimates, so the Precautionary Principle (namely, thoughtful conservation action in the absence of scientific proof) should be employed if shark fisheries are to be managed sustainably.

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Useful Websites

CITESwww.cites.org

Fox Shark Research Foundation www.rodneyfox.com.au

IUCN Red List www.redlist.org

Shark Trust www.sharktrust.org

TRAFFIC www.traffic.org

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