Whale Shark *Rhincodon typus*

Policy and research scoping study

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1. Acknowledgements

In June 2000, the American Elasmobranch Society held a Symposium on the Natural History of the Whale Shark during its Annual Meeting in La Paz, Mexico. This provided a unique opportunity to contact a large number of international experts (researchers, managers and representatives of non-governmental organisations) for their advice on drawing up an international strategy for research and data co-ordination and the development of new collaborative research proposals for this species.

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2. Background

The economic importance of the Whale Shark *Rhincodon typus* for ecotourism operations and target fisheries expanded rapidly in several parts of its range during the late 1990s. Its increased economic importance and recognition that such a migratory species cannot successfully be managed by single range states has stimulated new scientific research and management activity. International management initiatives have included a 1999 listing on Appendix II of the Bonn Convention for the Conservation of Migratory Species of Wild Animals (see section 5.2.1). This identifies the Whale Shark as a species whose conservation status would benefit from the implementation of international co-operative Agreements. A proposal to add the Whale Shark to Appendix II of the Convention on International Trade in Endangered Species (section 5.2.2) was rejected following debate by the XIth Conference of Parties to CITES in April 2000. If passed, this proposal would have required States to monitor trade in the species and ensure that such trade was not detrimental to wild populations. A proposal for an Appendix III CITES listing for Whale Sharks is now under consultation and should come into force later in 2000. Whale Sharks should also receive attention under the FAO International Plan of Action for Sharks (section 5.2.6).

Although Whale Sharks are now the subject of increased research activity, this is not well coordinated. Scientific knowledge of their biology and life history remains inadequate to enable conservationists and fisheries managers to determine the carrying capacity of fisheries or non-consumptive ecotourism operations, and hence their management requirements. Improved data on Whale Shark biology, life history, population and stock structure, migration patterns, and exploitation (both consumptive and non-consumptive) are required in order to determine future management priorities.

This study was undertaken in order to identify, with the assistance of Whale Shark researchers and managers, existing Whale Shark research programmes, gaps in current research coverage, and priorities for new collaborative research. The aim was to draw up and agree an international strategy for research and data co-ordination, and develop new collaborative research proposals that would yield at least some of the information needed by Whale Shark managers. The scope of the study was drawn widely, not only covering scientific research, but also fisheries and trade monitoring, conservation, and ecotourism programmes. It was discussed during the American Elasmobranch Society's Annual meeting in June 2000 (which included a one day international Whale Shark symposium), and by email. The assistance of the numerous individuals who generously contributed time and expertise is gratefully acknowledged.

This report presents the results of the study, including agreed research priorities, future project proposals (with rough indications of likely costs), recommendations for the development of an international Whale Shark research network, and suggestions for implementing the 1999 Bonn Convention listing and FAO IPOA–Sharks.

3. Biology and Status

The dearth of information on the status, biology and ecology of the Whale Shark *Rhincodon typus* (Smith, 1828) was reviewed by Castro and Clark at the American Elasmobranch Symposium in June 2000 (see Appendix 2). Colman (1997) and Norman (in press) have also produced reviews. The following sections briefly summarise current information on the species, commencing with the status assessment prepared by the Shark Specialist Group for the IUCN Red List of Threatened Species, 2000. Recommendations for additional research are given in bold at the end of some sections.

Only a few citations are given in the following brief text (readers should see Colman (1997) Norman (in press) and papers summarised in Appendix 2 for additional details), but there is a detailed bibliography at the end of this report.

3.1 Taxonomy

The Whale Shark *Rhincodon typus* is the sole representative of family Rhincodontidae, one of seven families and about 33 species within the Order Orectolobiformes, carpet sharks. Related families in this Order include the wobbegong sharks (Orectolobidae), longtailed carpetsharks (Hemiscyllidae), nurse sharks (Ginglymostomatidae), and Stegostomatidae, a monotypic family containing the Zebra Shark.

Most members of the Order are small, benthic species, generally with a limited distribution within tropical and temperate Indo-Pacific waters. The Whale Shark, Zebra Shark and two of the three species of Nurse Sharks are unusual in that they are geographically widespread and much larger species. The degree of isolation of different populations of Whale Sharks has not been assessed, but could be important information for management of the species. The Whale Shark is the only pelagic species within the Order, and the only member to feed on plankton. (Plankton-feeding evolved independently in both the Basking Shark and the Megamouth Shark.)

DNA analysis would enable researchers to compare the degree of relatedness between Caribbean and Indo-Pacific Whale Sharks, and possibly of populations in different areas of the Indo-Pacific.

3.2 Description

The Whale Shark is the largest fish in the world, reaching a length of 15-20 m. It has very distinctive colour markings of pale spots and stripes against a dark background (fading to a pale underside). These patterns appear (on the basis of short-term studies) to be unique to each individual and can be used for their re-identification. The head is broad and flattened with a large almost terminal mouth and its teeth are minute. There are prominent longitudinal ridges on the dorsal surface. This impressive but harmless species is unlikely to be misidentified.

3.3 Distribution and migration

Whale Sharks are widely (but usually sparsely) distributed in all tropical and warm temperate seas except the Mediterranean, mainly between latitudes 30^{o} N and 35^{o} S, but occasionally to 41^{o} N and 36.5^{o} S. They have been reported from deep and shallow coastal waters, within reef lagoons, and migrating long distances across the open ocean. Some researchers consider that the relative scarcity of records in the literature may indicate that, despite their wide-spread distribution, populations may be small. Whale Sharks are recorded in surface sea water temperatures of 18^{o} to 30^{o}C, with most reported at 21^{o} to 25^{o}C. Initial tagging data indicate that they do, however, dive into very much colder, deeper water for short periods, presumably to feed (see Graham *et al* in Appendix 2).

The migration patterns of Whale Sharks are very poorly understood. Some locations report Whale Sharks year-round, albeit in different areas depending on prey densities at particular times of year (e.g. in the western Maldives during the Northeast Monsoon, and in the east during the Southwest Monsoon, Anderson and Ahmed 1993). Alternatively, regular seasonal aggregations, sometimes in relatively large numbers, may occur for only a few months of the year while food is seasonally abundant. These aggregations usually occur at different times in widely separated locations. Further research may show that, like some other large sharks, this species is resident at some stages in its life cycle (e.g. while immature), and migratory at others, with large-scale migrations taking several years to complete (see Eckert *et al* in Appendix 2). Young pups may be oceanic (see next paragraph). It is also possible that male and female sharks have different patterns of migratory behaviour and distribution.

Research to determine migration patterns and stock structure should be a high priority. This information is of vital importance for the development of international sustainable management strategies and assessment of potential conflict between different forms of Whale Shark resource exploitation in different range states.

3.4 Ecology

The Whale Shark is one of only three known filter-feeding sharks, suction feeding by gulping in dense aggregations of zooplankton, or passive feeding when plankton density is lower. Prey items range in size from very fine zooplankton (1 mm diameter) to small fishes, squid and crustacea. Predation of young Whale Sharks by a blue marlin and a blue shark (both of which are pelagic oceanic species) has been reported and some Whale Sharks carry scars that may have been caused by shark attack. One large adult in the Gulf of California was attacked and consumed by Orcas *Orcinus orca* (O'Sullivan and Mitchell, Appendix 2).

3.5 Life history

Whale Sharks are ovoviviparous (eggs hatch and develop in the uterus), with one female from Taiwanese waters bearing about 300 embryos of 48-58 cm TL in a single litter (Joung *et al*. 1996). The reproductive cycle may be similar to that of the relatively closely related ovoviviparous nurse shark *Ginglymostoma cirratum* which, during a short pregnancy, produces one large litter of small but rapidly growing young every three years in the US Atlantic. This strategy might explain the small number of pregnant females and very small Whale Sharks reported in literature (Castro 2000). Other than the Taiwanese litter, and anecdotal reports by Philippine Whale Shark fishers of pregnant females, there is no information on location of pupping grounds.

A newborn Whale Shark of 58 cm from the Taiwanese litter grew very rapidly in captivity, reaching 143 cm TL in 143 days (Leu *et al*., 1997). Growth rates in captivity in Japan of larger (3.5-5.0 m) immature sharks ranged from some 20 to 30 cm per annum (Uchida *et al*. Appendix 2). Growth would slow gradually at maturity (see Pauly in www.fishbase.org/manual/FishbaseThe_MATURITY_Table.htm). These appear to be the only validated growth data. Pauly (in press) has suggested a slow growth rate and a 5-6% annual natural mortality rate for adult *R. typus*.

Calculated life history parameters from the 'Key Facts' table for Whale Sharks in <www.fishbase.org>, the Fishbase database, are given in the central column of Table 1 (next page). These do not take account of a report in Chen *et al*. (in press) of a Whale Shark landed in Taiwan that was 20m long and weighed 34t. If the figure for Linf (second row in the data table) is altered to 2,000 cm TL, based on this observation, Fishbase recalculates the theoretical life history parameters to those shown in the right hand column.

The recalculated length at maturity in the right hand column of the Table more closely matches observations reported by Norman (in press) of the size at which male Whale Sharks at Ningaloo Marine Park, Australia, appear to reach maturity. Scarring has only been observed on the claspers of animals over 900 cm TL in this population, which suggest that sexual activity commences at a much larger size than indicated in the original Fishbase data, and closer to the size indicated by the revised data. Some of the other data, however, such as a maximum age of 147 years (rather than 59) and a generation time of 63 years (rather than 24) are much higher than would readily be accepted for a warm water species, although they do occur in Sturgeons (Rainer Froese pers. comm.). Rainer Froese also pointed out that the estimation of r_{max} in the Key Facts is based mainly on growth parameters and does not account for the low fecundity of sharks and rays.

In conclusion, virtually all figures presented in Table 1 are theoretical. They should therefore be treated with caution until more size and growth data are available for this species.

Table 1: Estimated Life History Parameters for the Whale Shark (from www.fishbase.org)

	Fishbase key facts data	**Recalculated data using new Linf**
Maximum length (Lmax)	2,000 cm TL	2,000 cm TL
L infinity (Linf)	1,400 cm TL	2,000 cm TL
K (very approximate)	0.05	0.02
Natural mortality (M) *	0.07/year (s.e. 0.04-0.10)	0.03/year (s.e. 0.02-0.05)
Life span (approx.)	58.8 years	147.1 years
Generation time	24.3 years	63.0 years
Age at first maturity	8.9 years	21.4 years
Length at maturity (Lm)	558.6 cm TL (s.e. 417-748.4 cm)	769.5 cm TL (s.e. 574.4-1,030.9 cm)
L max. yield (Lopt)	1,010.1 cm TL (s.e.853.8-1195 cm)	1,464.9 cm TL (s.e.1,238.2-1,733 cm)
Intrinsic rate of increase (rm)	0.22/year	0.08/year
Resilience/productivity	Very low; decline threshold 0.70.	Very low; decline threshold 0.70.

* @ 23^{o}C mean annual temperature

Research into the biology and life history of Whale Sharks and publication of data in peer-reviewed journals should be a high priority for researchers.

3.6 IUCN Red List Assessment

The latest IUCN Red List assessment for this species (in press, 2000) is Vulnerable (A1 bd, A2d). IUCN Criterion A, the basis for this assessment, refers to declining populations. Sub-criterion 1 indicates that population reductions have been observed, estimated, inferred, or suspected in the past, based on b) an index of abundance appropriate for the taxon [in this case declining CPUE] and d) actual levels of exploitation. Sub-criterion 2 indicates that a population decline is projected or suspected in the future, based on d) potential levels of exploitation. The Vulnerable assessment indicates that the estimated and projected scale of this population reduction is between 50 and 20% of the population over a ten-year or three-generation period, whichever is the longer. (The generation period for the Whale Shark is conservatively estimated as 24 years – see Table 1.)

The following summary introduces the IUCN status report for the Whale Shark (Norman in press):
The life history of this relatively scarce but cosmopolitan tropical and warm temperate species is poorly understood, but it may be relatively fecund and certainly migrates extremely large distances. Catches have declined and populations have apparently been depleted in several countries by harpoon fisheries targeting localised concentrations of this huge, slow-moving and behaviourally vulnerable species. There is also incidental capture in other fisheries. Directed fisheries, high value in international trade, a K-selected life history, highly migratory nature, and low abundance make this species vulnerable to exploitation. In recent years dive tourism involving this species has developed in a number of locations.

4. Exploitation

4.1 Fisheries and trade

Small harpoon and net fisheries targeting vulnerable, slow-moving Whale Sharks have been reported from India, Pakistan, Taiwan, Indonesia, the Philippines (fisheries banned in 1998) and the Maldives (prior to protection in 1995). Meat (fresh, dried or salted) and liver oil were traditionally used by local fishermen, who either utilised incidental bycatch or targeted small numbers of individual sharks. For example, fishermen in the Maldives used to take 20-30 Whale Sharks a year, using the liver oil to treat their boats, but reported declining numbers and catches of Whale Sharks during the 1980s to early 1990s. Philippine fishermen in some former whaling villages took small numbers of Whale Sharks for subsistence and a small amount of local trade.

Whale Shark fisheries have expanded significantly within the past decade (in some states during the last few years), mainly due to a booming meat and fin market in Taiwan. This demand resulted in an increased fishing effort and falling catches in the Philippines fishery, culminating in the 1998 fishery ban, although some poaching and illegal export reportedly continues on a small scale (Yaptinchay and Alava, Appendix II).

Chen *et al* (in press) report declining landings at one Taiwanese landing site from 50-60/year in the mid 1980s, to 10 in the 1990s and fewer than this in 1994-95, although it was impossible to determine whether this was due to overfishing, environmental changes or changes in catch effort. The current status of the domestic Taiwanese fishery is unknown, due to lack of recent data. Quantities and values of Whale Shark products imported are not reported by Taiwanese Customs, but anecdotal information suggests that total Taiwanese landings (formerly 250-300/year) have fallen while market size remains unchanged, indicating increased levels of imports (Vincent Chen, pers. comm.). Information is lacking on quantity, origins and trade routes of imported Whale Shark meat (not recorded by Taiwanese Customs and possibly originating from poaching and illegal exports). DNA analysis may be able to identify the genotype and possibly the source of the Whale Shark meat sold in Taiwan.

Demand in Taiwan has stimulated a recent huge increase in effort and landings in the Indian fishery. A report by Hanfee, TRAFFIC India (in preparation), on trade in Whale Shark products in the coastal state of Gujarat, India, notes that the value in Veraval of landed Whale Sharks increased steeply in the 1990s, particularly after Whale Shark meat began to be utilised in 1994. Prices have been particularly high since 1997. Landings increased markedly in the late 1990s, but fell significantly (despite continued high market demand and a possible increase in fishing activity) in the 2000 season.

Whale Shark fisheries managers should note the figures calculated for L max. yield or L_{opt}, in Table 1 (third row from the bottom): an estimated 1,000 cm TL and 1,465 cm TL. This represents the length class with the highest biomass in an unfished population. In theory, fisheries obtain the maximum sustainable yield if they only catch fish of this size. It would be extremely interesting to be able to compare the length frequency of Whale Shark catches in Taiwan and India (and formerly the Philippines) to see how closely the mean length of these catches approached this range of values.

Overall, there are very few data available on fishing effort, landings, catch per unit effort (CPUE), Whale Shark products, prices or markets. Neither are detailed data available on the volume and value of products in domestic and international trade. Most studies undertaken date from the early-mid 1990s. The status of Whale Shark fisheries cannot be described accurately until more of these data are collated for historic and present directed and bycatch fisheries, to enable trends to be assessed.

Collection of data on Whale Shark fisheries and trade should concentrate on India and Taiwan, apparently now the main centres of supply and demand. Attempts should also be made to assess CPUE in small-scale artisenal fisheries.

Regardless of the paucity of data on fisheries, precautionary management is essential for this highly vulnerable shark.

4.2 Ecotourism

Recent ecotourism operations based on Whale Shark viewing are underway or commencing in Western Australia (Ningaloo Reef), KwaZulu Natal (South Africa), Mozambique, Philippines, Seychelles, Maldives, parts of the Caribbean, and Gulf of California (Mexico). These may have a very high economic value – about A$10 million annually in Western Australia, US$3 million in Thailand, and a potential value of up to US$5 million in the Seychelles (Newman *et al*. in press). There is considerable potential for non-consumptive, sustainable ecotourism elsewhere. Some operations run year-round, with Whale Sharks providing just one of several attractions for diving tourists, but most are seasonal, relying on the regular appearance of Whale Sharks to feed on aggregations of their planktonic prey. These regular seasonal appearances of sharks may occur at annual or multi-annual intervals during their very long-distance migrations, or represent aggregations of sharks resident within the region, or both.

Whale Sharks are protected in several States (see section 5) because of their importance for ecotourism and the increased revenue that this provides in comparison with fisheries. Regulations control human interactions with Whale Sharks in Western Australia and voluntary guidelines based on these are in use in parts of the Philippines.

Lessons learnt from the development, operation and management of Whale Shark ecotourism should be more widely disseminated to range states.

4.3 Sustainability

Both Whale Shark fisheries and ecotourism operations are undoubtedly of considerable existing or potential economic value to local communities and range states. Neither form of exploitation is well studied, however, and concerns have been raised over the long-term sustainability of both.

Case studies of other shark fisheries have demonstrated that large sharks cannot sustain or recover rapidly from directed fisheries. There are numerous examples in the scientific literature of shark fisheries that 'boomed' for up to ten years, followed by a steep decline (often to 30-10% of the original population size) and extremely slow recovery rates (typically some 1-5% *per annum*). Information on the life-history parameters of the Whale Shark (incomplete though they are), its possibly small populations and the very limited fisheries data available indicate that even relatively low catches of this species from a small population may not be sustainable for more than a few years. Catches might be maintained for a longer period if local fishermen are exploiting a migratory population of sharks that do not return every year to the site of the fishery, but this activity will likely detrimentally affect fisheries or ecotourism operations elsewhere (see next section: 4.4 Conflicts).

The potential impact of ecotourism operations on Whale Shark aggregations and behaviour, particularly in the absence or inadequate enforcement of interaction guidelines, has received some attention but very few scientific data are available. While non-consumptive ecotourism has a minimal impact on populations compared with exploitation by fisheries, there is still concern that unregulated ecotourism and harassment could interfere with the natural behaviour and approachability of Whale Sharks.

The need for data collection to enable an assessment of the sustainability of Whale Shark fisheries is outlined in section 4.1. Assessment of the impact and sustainability of ecotourism operations is also an important topic for investigation.

4.4 Conflicts

Recent anecdotal information from some East Asian dive operators indicates that Whale Shark numbers sighted during the usual diving season in the region have fallen from 60-85 sightings of sharks three years ago, to single figures during the past two years. Declines in numbers of sightings last year are also reported by Whale Shark tourism industries in South Africa and in Philippines. Too few data are available to determine whether these observations are the result of declining regional or global populations or natural variation in distribution patterns. It seems possible, however, that ecotourism operations and shark populations protected in state waters could be under threat from fisheries which take sharks elsewhere within the state or region, or even much further afield during their poorly understood migrations.

Conversely, a source of income and protein to some subsistence fishing communities that traditionally harvested small numbers of Whale Sharks (possibly at sustainable levels – although anecdotal data from the Maldives suggest perhaps not) has been affected in some states by the legal protection of the species. Bans on fisheries have usually arisen in order to protect and encourage new ecotourism operations. The economic benefits of these ecotourism operations and the extent to which they directly or indirectly benefit the fishing communities that are no longer permitted undertake these fisheries appear not to have been quantified.

Studies are required of actual and potential revenues from ecotourism, in comparison with those from fisheries, and the relative sustainability and socio-economic effects and benefits of both activities.

5. Management initiatives

A number of management initiatives established at national and international level, summarised below, are or may be directed towards Whale Shark management. Because of the migratory nature of Whale Sharks, all initiatives require international collaboration between range states if they are to be successful. They also either require or will benefit from improved data on Whale Shark biology, life history, population and stock structure and migration patterns.

5.1 National

Whale Sharks are protected in Western Australia, the Maldives, Philippines, Honduras, Gulf of Mexico and US Atlantic waters, and in a small area of Belize. Proposals for the legal protection of the species are currently under consideration in other States. These initiatives have generally arisen because of concern that the life history and behaviour of this species makes it particularly vulnerable to fisheries, and/or in recognition of its potential or actual value for ecotourism. The effectiveness of national legislation may be limited if legal regulations are not effectively enforced or if fisheries in other states take sharks that migrate out of protected waters.

Range states should seek to cooperate with neighbouring states to improve management throughout the range of their Whale Shark populations. This may require investment in capacity-building to improve the ability of range states to enforce domestic legislation.

5.2 International

The United Nations Conference on the Human Environment in 1972 formally recognised the need for states to cooperate in the conservation and management of animals that migrate across national boundaries or between areas of national jurisdiction and the high seas. This concept has led to the establishment of several important intergovernmental wildlife and fisheries treaties. All of the following are of relevance to Whale Shark management, and all require international collaboration between range states.

5.2.1 The Convention on the Conservation of Migratory Species of Wild Animals (CMS)

The CMS (also known as the Bonn Convention) was signed in Bonn in 1979 and came into force in 1983. This International instrument includes 74 Parties and four signatories from Africa, America and the Caribbean, Asia, Europe and Oceania, over 30 of which are Whale Shark range states (Appendix 5). It provides a framework within which Parties may make tackle effectively threats that operate throughout a species' range. Two Appendices to the Convention list migratory species that would benefit from conservation measures taken by Range States. Strict protection measures are required for migratory species that have been categorised as endangered (listed under Appendix I). Species with an unfavourable conservation status (but not necessarily in danger of extinction) and that would benefit from the implementation of international co-operative Agreements for their conservation and management are listed in Appendix II. Range States need not be CMS Parties before acceding to such Agreements.

In November 1999 the 6th Conference of Parties to CMS approved the Philippines' proposal to list the Whale Shark on Appendix II (as a species whose conservation status would benefit from the implementation of international co-operative Agreements). The Conference also called for co-operative actions for the 2001-2002 biennium for the Whale Shark.

A draft Memorandum of Agreement Concerning Conservation Measures for Whale Sharks *Rhincodon typus* is given in Appendix 4 as an example of the type of Agreement that might be established under CMS.

Range states should determine the steps needed to develop co-operative actions under the CMS, bearing in mind that the next opportunity for Parties to discuss progress in this area will be at the April 2001 meeting of the CMS Scientific Council.

5.2.3 Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)

CITES was established to protect species of wild fauna and flora from over-exploitation through international trade. There are currently about 152 Parties to the Convention, over 90 of which are Whale Shark range states (Appendix 5). CITES operates by requiring these Parties to regulate international trade in specimens of species listed in three Appendices in accordance with the provisions of the Convention. The following text briefly summarises the procedures and outcomes of CITES listings. Interested readers are advised to consult the full text of the Convention and, for a more detailed and accurate discussion of procedures, the Species Survival Commission publication *CITES: A Conservation Tool* (www.iucn.org/themes/ssc/programs/cites).

Appendix I of CITES includes all species threatened with extinction which are or may be affected by trade. International trade in Appendix I species is strictly regulated and only authorised in exceptional circumstances. Appendix II includes all species which, although not necessarily now threatened with extinction, may become so unless trade in specimens of such species is subject to strict regulation. International trade in listed species is controlled by the exporting states, but ‘no detriment’ findings ensure that such trade is not detrimental to the status of the listed species and the trade is monitored.

Species may only be added to or deleted from these two Appendices by a two-thirds majority vote at the Conference of Parties (COP), following a period of detailed consultation prior to the Conference. The 11th COP to CITES in April 2000 considered a US proposal to list the Whale Shark on CITES Appendix II which aimed to ensure that Whale Shark fisheries supplying international trade are sustainable and that such trade is monitored. This proposal did not receive the necessary majority vote for adoption and received some criticism regarding the shortage of supporting data. More detailed information on populations, fisheries and trade are advisable before a similar proposal can be considered by CITES Parties at the 12th COP in 2002.

Appendix III is intended to provide international assistance to individual Parties in regulating the international trade in their own native species. It includes all species which any Party has identified as being subject to regulation within its jurisdiction for the purpose of preventing or restricting exploitation and as needing the cooperation of other parties in the control of trade. Species may be added to or deleted from this Appendix at any time, although Parties are asked, except in cases of urgency, to schedule amendment proposals so that they may be adopted at a meeting of the COP.

The procedure for making additions to Appendix III is relatively simple (Resolution Conf. 9.25 (Rev.)). A Party considering the inclusion of a species in Appendix III should first ensure that the species is native to that country, that national regulations are adequate to control exploitation and trade and that they are adequately enforced. It should determine that, notwithstanding the above, there are indications that co-operation of the Parties is needed to control illegal trade. The Party should also consult Management Authorities of other Range States, known major importing countries and the CITES Secretariat and Animals Committee over the proposal. Following this consultation and having ensured that the biological and trade status of the species justify the action, the Party may proceed with the Appendix III listing. It does so by submitting to the Secretariat the species name, a list of the specified parts or derivatives of the species covered, and copies of the relevant national laws or regulations that prevent or restrict exploitation of the species within its jurisdiction.

The Secretariat must communicate this information to all Parties as soon as possible. Appendix III listings become effective 90 days after the date of the Secretariat’s communication, for all Parties except those entering a reservation. Appendix III includes the names of the Parties submitting the species for inclusion, the scientific name of the species, and a list of the specified parts or derivatives. Once listed on Appendix III, international trade in the specified parts or derivatives of the listed species is monitored as if the species were on Appendix II.

Parties submitting a species for inclusion on Appendix III must issue export permits for the species (or its parts or derivatives). No detriment findings are not required. Other Parties must report on the source of imports to demonstrate that they have not originated, without a license, from Parties that have listed the species on Appendix III. Parties may file reservations on any CITES Appendix listing.

A major Whale Shark range state, Australia, is currently consulting range states over a potential Appendix III proposal for the Whale Shark, following the procedure outlined above. The detailed consultation which took place when the USA submitted its Appendix II proposal to the Conference of Parties in April 2000 may be taken to mean that the procedures required under Resolution Conf. 9.25 (Rev.) before a notification is made to the Secretariat have already been completed. If Australia submits this listing proposal, it should become effective in early 2001.

Range states which have adequate regulations to manage or protect their whale shark populations but which feel that they need the co-operation of CITES Parties in controlling potential illegal trade should consider whether to follow the lead of Australia by listing their stocks under Appendix III of CITES. A high level of concern over the impact on international trade on shared stocks of whale sharks may warrant the resubmission of an Appendix listing to the XIIth COP.

5.2.4 Convention on Biological Diversity (CBD)

The CBD was adopted at the 1992 UN Conference on Environment and Development (UNCED). Its member countries include 177 Parties, 168 of which are Signatories and about 100 Whale Shark range states (Appendix 5). The CBD aims to conserve biological diversity and promote the sustainable, fair, and equitable use of its benefits. It contains three national level obligations: to conserve, to sustainably use, and to share the benefits of biological diversity. The CBD does not affect the rights and obligations of Parties deriving from any existing international agreement, unless ‘the exercise of those rights and obligations would cause a serious damage or threat to biological diversity’ (Article 22).

Parties are required to develop or adopt national strategies, plans or programmes for the conservation and sustainable use of biological diversity in accordance with the CBD, to monitor components of biological diversity that are important for conservation, and to identify and monitor activities with likely adverse impacts on the conservation and sustainable use of biodiversity. In some cases, the national biodiversity strategies developed by Parties include plans for the conservation and sustainable use of individual species or habitats of high biodiversity importance or special concern; UK species Action Plans include a Basking Shark Biodiversity Action Plan (www.jncc.gov.uk/ukbg/default.htm).

The second meeting of the CBD Conference of Parties in 1995 adopted the Jakarta Mandate on Marine and Coastal Biodiversity, a global consensus on the importance of marine and coastal biological diversity and part of the Ministerial Statement on the implementation of the Convention on Biological Diversity (www.biodiv.org/jm.html). This Statement reaffirms that there is a critical need for the CBD Conference of the Parties to address the conservation and sustainable use of marine and coastal biological diversity. It urges Parties to initiate immediate action to implement the decisions adopted on the issue, within five key programme elements (implementation of integrated marine and coastal area management, marine and coastal living resources, marine and coastal protected areas, mariculture and alien species and genotypes). Each has a checklist for action, with emphasis on the precautionary approach to resource and ecosystem management and application of best management practices.

The Parties should, in accordance with Article 6 of the Convention, develop national strategies, plans and programmes in order to promote the conservation and sustainable use of marine and coastal biological diversity. Co-ordination of activities at regional and global level is recommended, duplication of effort is to be avoided, and harmonisation of respective programmes of work pursued through strong co-ordination between the Convention and other relevant bodies.

Range states should develop specific plans or programmes for the conservation and sustainable use of the Whale Shark, or include such plans within their national biodiversity strategies.

5.2.5 United Nations Convention on the Law of the Sea (UNCLOS)

UNCLOS provides a framework for the conservation and management of fisheries and other uses of the seas. Provisions dealing with Economic Zones of coastal states and high seas require co-operation between states for the conservation and utilisation of highly migratory species (including Whale Sharks, see below). Such cooperation may be achieved by bilateral agreements or an international organisation.

5.2.6 UN Agreement on Straddling Fish Stocks and Highly Migratory Fish Stocks

This Agreement facilitates implementation of UNCLOS provisions relating to the conservation and management of high seas fish stocks by establishing rules and conservation measures for high seas fishery resources. It will enter into force for each ratifying State 30 days after the 30th instrument of ratification has been received. The Agreement calls for Parties to protect marine biodiversity, minimise pollution, monitor fishing levels and stocks, provide accurate reporting of and minimise by-catch and discards, and gather reliable, comprehensive scientific data as the basis for management decisions. It mandates a precautionary, risk-averse approach to the management of these species when scientific uncertainty exists. The Agreement also directs States to pursue co-operation in relation to these species through appropriate sub-regional fishery management organisations or arrangements.

The Whale Shark *Rhincodon typus* is already included in UNCLOS as a highly migratory species, recognising that co-ordinated management and assessment of shared migratory populations would promote an understanding of the cumulative impacts of fishing effort on the status of shared populations.

Whale Shark range states may apply the provisions of the UN Agreement on Straddling and Highly Migratory Fish Stocks (in addition to or instead of those in CMS) to develop sub-regional management of Whale Shark populations.

5.2.7 FAO International Plan of Action for the Conservation and Management of Sharks (IPOA-Sharks)

The FAO Conference adopted the IPOA-Sharks in November 1999. This encourages States to assess the state of shark stocks within their EEZs and those fished on the high seas, and to report to FAO on this assessment. If directed or bycatch shark fisheries are identified, States are asked to develop a National Plan of Action (Shark-Plan) for the conservation and management of shark stocks, and to report biennially a brief summary of the Shark-Plan and its progress. Shark-plans should, *inter alia*, ‘ensure that catches are sustainable’, ‘identify and pay special attention to vulnerable or threatened shark stocks’, and ‘improve and develop frameworks for establishing and co-ordinating effective consultation involving all stakeholders … within and between States’. The IPOA also states: ‘Where transboundary, straddling, highly migratory and high seas stocks of sharks are exploited by two or more States, the States concerned should strive to ensure effective conservation and management of the stocks’. States are also encouraged to cooperate and, where appropriate, develop regional Shark-Plans through regional and sub-regional fisheries management organisations or arrangements, and other forms of cooperation.

The IPOA-Sharks requests shark-fishing States to ‘strive to have a national Shark-plan in place by the COFI Session in 2001’. (This session takes place during the first quarter of 2001.) FAO will report to this COFI session on the state of progress of the IPOA-Sharks, including the development of national and regional Shark-Plans.

Whale Shark range states that take any species of shark in directed or bycatch fisheries should note that FAO has requested them to develop a national Shark-Plan by early 2001, and should incorporate Whale Shark management activities within these Plans. States are also asked to cooperate to develop regional Shark-Plans, which should also cover Whale Shark conservation and management priorities.

6. Whale Shark research activity and priorities

6.1 Introduction

The AES Symposium on the Natural History of the Whale Shark (June 2000) provided an important opportunity for research groups and individuals undertaking research into the Whale Shark to present some of their data. Following this meeting, participants discussed to what extent existing research programmes may contribute to current and future management initiatives and priorities, and where additional research should be undertaken as a matter of urgency. The minutes of this meeting are presented in Appendix 3. Discussions were also held by email with researchers unable to attend the AES meeting.

In summary, it seems that research work is planned or underway in the Philippines, Australia, Seychelles, South Africa (KwaZulu Natal), Mozambique, Belize, Honduras, Gulf of Mexico, Gulf of California, the Maldives, India, Taiwan and probably other range states. Recent, existing and planned research projects include biological and behavioural studies (of wild and captive animals), photo-identification, visual tagging and biotelemetry to assess Whale Shark movements, behaviour, site-fidelity and local population size, and reviews of trade and fisheries.

The following sections very briefly outline work underway or recently completed and describe future work priorities identified by participants. One common thread applies to all of the following topics: **It is essential that the data collected are made available as quickly as possible, preferably in the form of peer-reviewed papers in recognised journals.**

6.2 Biology, life history and stock structure

Data on the biology of the Whale Shark are extremely sparse (see Castro and Clark in Appendix 2). Lack of information on Whale Shark biology and life history was identified during this review as the greatest constraint for researchers and managers wishing to determine appropriate management objectives and targets for Whale Sharks based on their biological capacity withstand exploitation. Managers wishing to sustainably manage fisheries and other potential sources of mortality need the following information on Whale Shark biology and life history in order to produce optimal fisheries models (Camhi *et al*. 1998).

- Reproductive characteristics (age at maturity, gestation period and average annual pup production per adult female)
- Critical habitats at different life stages, including mating, pupping and nursery grounds
- Growth rates and age structure
- Mortality (natural and in fisheries) for all age classes
- Stock and species abundance
- Stock structure and migration patterns.

Until these data and fisheries models are available, precautionary management of Whale Shark populations is essential and should be incorporated into National Shark Plans drawn up under the FAO IPOA-Sharks (see section 5.2.6).

Obtaining most of these demographic data is virtually impossible without access to dead or captured sharks. Existing life history information is mainly derived from the single pregnant female landed in Taiwan and growth data from specimens in captivity in Japan. It is impossible or unacceptable to kill or capture Whale Sharks in range states where the species is legally protected or recognised to be of high ecotourism value. It is therefore essential to take advantage of data collection opportunities presented by existing fisheries. Because these appear to be largely confined to India and Taiwan, landing sites in these states should be the focus of biological research during the main fishing seasons.

It is also important to take full advantage of specimens that become available through accidental strandings, bycatch or other sources of mortality elsewhere within the species' range. (There are reportedly still some illegal targeted catches of Whale Sharks by subsistence fishermen in remote areas of the Philippines (Rainer Froese pers. comm.) and Whale Shark poaching for export has also been reported in this state.) This can only be achieved if the methodology for biological data collection from shark carcasses is carefully described, illustrated and widely available (for example, on the internet) so that biologists without prior experience in this field can take advantage of unexpected opportunities for dissection or other observations.

In addition to the collection of tissue samples from dead Whale Sharks for DNA analysis, consideration should be given to obtaining biopsies from free-swimming live animals, using methodologies tested by marine mammal researchers. Collection of data for the assessment of stock structure and migrations is considered in more detail under the section on tagging below.

6.3 Photo-identification and tagging

The various tagging and photo-identification studies underway should, in due course, be able to provide valuable data on stock and species abundance, stock structure and migration patterns – identified in the preceding section as important data needs for determining Whale Shark management priorities. The following methodologies are currently in use:

Photo identification

Re-identification of sharks within a single area can provide information on local population size, site-affinity and frequency of visits to seasonal aggregation sites (hence, potentially, indicate the length of long-term migrations). Sharing photo-identification data between research groups at different locations may potentially provide data on longer-distance movement patterns. This strategy has proved to be extremely valuable for research into large migratory marine mammals.

Whale Shark photo-identification projects are underway in several locations. This technique appears to be particularly well established in Australia, where over 60 individual sharks have been identified visiting Ningaloo Reef. Researchers in Belize, the Philippines and the Gulf of California are also recording individual shark's characteristic patterns of spots and/or acquired markings (scars). It is likely that photo-identification projects not identified during the AES meeting are underway in other areas (probably associated with local Whale Shark ecotourism operations). Unfortunately, Whale Shark photo-identification projects in different parts of the world are presently focusing on recording different parts of the Whale Shark's body, which will complicate future attempts to share data. It would be extremely helpful to coordinate methodology (even if this means duplicating techniques) and to provide a central database of images to enable research groups to share their results. This should be a priority for researchers. See section 6.6 for more detail.

Visual tagging

Visual tagging of Whale Sharks is underway in KwaZulu Natal (South Africa) and southern Mozambique, the Seychelles, Australia, Caribbean (Belize, Honduras), Mexico (?) and Philippines (?). This low-cost methodology utilises very large easily recognisable tags, usually attached near the base of the first dorsal fin by a modified harpoon gun. These tags may be individually marked by symbol, colour code, large numbers, or a combination of the above. They enable individual animals to be re-identified by swimmers without use of photo-identification techniques. One potential drawback with the application of visual tags is that it may be difficult to ensure that a tag is anchored effectively into such a thick-skinned animal, and the extent of tag-shedding is not yet certain. A combination of multiple tagging and photo-identification could help to determine to what extent shedding occurs. A widely available register of visual tags and tagging programmes (for example on the Internet) might improve tag reporting by observers outside original study sites.

Biotelemetry

A wide range of biotelemetry techniques is currently being applied to Whale Shark research in the Gulf of California, Philippines, Sabah (East Malaysia), Australia, KwaZulu Natal (South Africa) and Mozambique, Honduras, and Belize, and to similar studies of other large sharks. Doubtless all or most existing programmes would benefit from increased resources, either in their existing research sites or in new areas. Added value would likely be provided to existing projects by pooling resources and ensuring that existing tagging data are published and made more widely available. It is desirable for experienced researchers to advise and provide initial training for research groups inexperienced in tagging large free-swimming sharks and who wish to initiate new biotelemetry projects.

Satellite tags may be deployed on long tethers to transmit data on location and other parameters when the shark is near the surface, providing detailed information on long-term, long-distance migrations. Initial expense is high, but data retrieval costs relatively low. This is the best available method for tracking long-distance Whale Shark migrations and providing information so urgently needed by managers. 'Pop-up' satellite tags are combined with data storage tags (see below) and designed for retrieval and downloading of archived data, usually after only a relative short period of deployment. Unfortunately the relatively high cost of satellite tags means that they are only likely to be used on a relatively small number of animals, and relatively high failure rates can be a problem.

Acoustic tags are followed continuously by researchers in boats, or monitored by underwater receivers (range is generally 300-1,000 m). 'Pingers' relay coded sequences that identify individual tags and their bearing. Transponding tags can transmit coded information (e.g. environmental depth and temperature, or physiological conditions), bearing and range information. Archival or data storage tags may record and store a wide range of data (depth, temperature and time, day length and time of sunrise and sunset (the latter for position fixing). They must be retrieved for the data to be downloaded. VHF or UHF tags are routinely used to track land animals, but are less frequently applied in the marine environment because they only transmit when their aerials are above water. They must be used with a pinger and data can be retrieved only within line of sight.

6.4 Fisheries and trade studies

Whale Shark fisheries have been studied in the Philippines (for only a few years), India (1999-2000), Taiwan and in the Maldives. Whale Shark fins are reported on sale in China. Some trade in Whale Shark products was reported in TRAFFIC reports, and there have been studies of trade and utilisation in Taiwan and India. These are all out-of-date (with the exception of the Indian study) and incomplete.

The collection of Whale Shark fisheries data needs to be standardised between regions and over time, to enable trends to be compared (Camhi *et al*. 1998). It is particularly important that current and historical records are reported, including:

- Commercial and artisanal catches
- Size and age structure and sex composition of catches
- Landings (number of animals)
- Bycatch, discards and discard mortality
- Catch per unit effort (CPUE)
- Fleet and vessel size, numbers of fishers, and gears used
- Areas fished
- Markets and values of different products and the structure of trade

Fishery-independent data (an important tool for fisheries managers) will not be easy to obtain for this large, scarce plankton-feeding shark, unless tagging or photo-identification studies can be used.

Researchers in India, Taiwan and perhaps Indonesia, locations of remaining Whale Shark fisheries, should be encouraged to record as much up to date fisheries and trade data as possible within the categories listed above. This would be aided by the development of a standard proforma for the collection of such data for Whale Shark fisheries.

6.5 Socio-economic studies

A few socio-economic studies have been undertaken of the value of Whale Sharks as an ecotourism resource. The revenues from Whale Shark ecotourism in Donsol, Philippines, are being monitored by

WWF-Philippines (see Yaptinchay and Alava in Appendix 2). Newman *et al*. (in press) indicate that the economic value of Whale Shark ecotourism in Western Australia was about A$6.4 million in 1995 and A$8.4 million in 1997 following a 15% annual rate of growth. They considered that ecotourism in the Seychelles could yield an income of US$4-5 million per annum, and that the Whale Shark tourist industry in Thailand was probably worth about US $ 3 in the Phuket area alone (where Whale Shark sightings have declined very steeply in recent years).

In comparison, the value of Whale Shark fisheries to local fishing communities have received less attention, although this information should be available from India, Taiwan and the Philippines. In the Maldives, Whale Sharks were estimated to be worth about US $100-150 each in the early 1990s for their oil (meat and fins were not utilised). They were considered to be more valuable as an aggregating device in the tuna fishery and a tourist attraction (Anderson and Ahmed 1993) and were subsequently legally protected in that range state. Similar comparisons for other states and fisheries would be extremely useful for decision-makers considering management options. It will, however, be important to assess the extent to which revenues from Whale Shark ecotourism reach those fishing communities that benefit directly from Whale Shark fisheries, and to develop policies to ensure that socio-economic benefits are distributed equitably.

6.6 Research co-ordination

The Whale Shark discussion meeting in La Paz noted that there is no central network of Whale Shark researchers or a depository or inventory of research and tagging projects and data. Participants agreed in principle that such an international network would add considerable value to separate initiatives for such a migratory species. Appendix 1 presents an initial inventory of Whale Shark researchers and research programmes, which should provide a starting point for the development of such a network and database. It was not possible to develop draft terms of reference for such a group during this study, but closer collaboration between researchers is urged. Funding bodies and research groups should consider how this could be incorporated within the terms of reference of existing and future research projects.

The importance of linking existing photo-identification programmes into a unified catalogue of images was discussed. The main purpose of such an initiative would be to put field workers who have taken matching images of individual animals in contact with each other, enable researchers from different states, institutes or programmes to share data. It would also encourage other groups or individuals to participate in existing photo-identification projects in their region.

Similar collaborative initiatives have been developed for cetaceans (for example, the North Atlantic and Mediterranean Sperm Whale Catalogue NAMSC <www.ifaw.org/namsc/home.html>) and, most recently, the basking shark (<www.baskingsharks.co.uk>). These catalogues are stored as digital databases of images that can not only be made available on CD to contributing organisations but also provide the images in the format most suitable for computerised matching. Images are contributed on the understanding that they will only be used with the permission of the contributors. Copyright remains with the owner and contributor of the photographs. It is envisaged that in most cases, all relevant contributors will be involved in producing publications based on any matches made from their data. To protect contributors' data, the amount of auxiliary information supporting each photographic image in the database has been minimised to the following: image name, local identification number, area (e.g. country or sea), year, view of animal, and contact details for organisation submitting the image. More detailed information, including location and date of photograph, would be required from other contributors (for example, members of the public).

The Australian Marine Conservation Society (WA) has already proposed setting up an international photo-identification library for Whale Sharks. A photo-identification web site and library booklet are currently in preparation.

7. Draft research and policy development proposals

This chapter develops draft proposals (with estimated costs, where possible), for a number of initiatives that address the priorities identified in the preceding sections. Costs are only very rough estimates. They do not necessarily take account of salary or overhead costs for research staff or other personnel involved, unless these are included for experts visiting range states, and are generally under-costed.

7.1 The development of a Whale Shark research network

This proposal is based upon the generally agreed need for improved liaison between Whale Shark researchers and research programmes. The concept is that participants in such a network could agree specific Terms of Reference for collaborative projects. These might include liaison between tagging and photo-identification programmes (see also 7.2), the development of collaborative research proposals and standardised techniques, exchange of DNA samples and markers, and the establishment of research, fisheries or ecotourism projects with range states lacking national research and management expertise. Membership of the network might enable researchers to access a password-protected common data depository (including photographic and DNA data) that would hold up to date information on fisheries monitoring, research projects *etc*. Data could not be added without peer review – the approval of a network steering group. Confidential data need not be included, but members of the network would be broadly informed about activities underway and able to contact each other for more information.

Minimum costs:	**US $**
Initial design, development and registration of web site and database	3,000
Annual maintenance of web site and database	1,000
Preparation and distribution of annual newsletter	1,000
Support for network meetings (held during other international meetings)	1,000
Cost in first year	6,000
Cost in subsequent years	3,000

Some of these costs could be reduced if combined with a photo-identification project web site.

7.2 Development of an international photo-identification project

This project will establish a single international Whale Shark photo-identification database, available on CD-ROM and, in due course, the Internet. This should be modelled on existing projects (for example the North Atlantic and Mediterranean Sperm Whale Catalogue – NAMSC) and adopt similar terms of reference to those agreed by participants in these Catalogues (see 6.6). Scanned photographs will be added to the database with information on animal name and local identification number, area, year, view of animal, and research group address. More detailed information will remain the property of participating researchers, ensuring that incomplete data cannot be published without the participation of the organisation that submitted the image. Photographs sent in by individuals would have to provide more detailed information on date and location of sighting, size and sex of animal etc. A single database will enable researchers to identify 'their' sharks if they are photographed at other points on their migration routes, and to contact other research programmes that supply any matching photographs. It should not affect the management of existing national or project-based catalogues.

Minimum costs:	**US $**
Hardware (desktop PC, scanners, CD reader/writer *etc*.) and software	5,500
Initial database development, scanning and data entry (based on adapting an existing photo-identification database and catalogue)	3,000
Design and preparation of photo-ID web site [1]	2,500
Annual maintenance/updates of web site and database, distribution of CD-ROMs	3,000
Cost in first year	14,000
Cost in subsequent years	3,000

[1] *An Australian web site is already in preparation by the Australian Marine Conservation Society.*

7.3 Preparation of Technical Manual for the collection of biological data

This will contain illustrated instructions, targeted at the non-specialist, and will be prepared both in paper form and for publication on a web site. It will be based on the existing CSIRO White Shark Manual and aim to enable observers to take advantage of all incidental captures of Whale Sharks by collecting capture data and biological material (reproductive data, stomach contents, vertebral samples for ageing *etc*). The published version will be about 24 pages long and include a series of proformas for data collection and colour photos to illustrate Whale Shark anatomy, reproductive systems *etc*.

The manual will explain how to collect the following biological data from dead Whale Sharks:

- Length (total and fork length) and other measurements
- Maturity data for males and females, including dissection and observations of uteri and ovaries.
- Gut contents
- Collection and preservation of vertebrae for ageing
- Collection and preservation of tissue samples for DNA testing
- Photographs of appropriate areas of the body for contribution to photo-identification projects

Minimum costs:		**US $**
Preparation, based on CSIRO manual (including peer review) *		500.00
Publication and distribution		500.00
	Total	1,000.00

* This estimate does not include the cost of obtaining photographs to illustrate the manual. It may be possible to use existing photographs, but some illustrations may have to be originated.

7.4 Preparation of Technical Manual for collection of standardised fisheries, landings and non-landings market data

This Manual will be targeted at fisheries officers, customs officers and volunteers. It will be prepared both in paper form and for publication on a web site. The manual will contain instructions for the collection of standardised fisheries and trade data on:

- Commercial and artisanal catches and landings
- Size and age structure and sex composition of catches
- Bycatch, discards and discard mortality
- Catch per unit effort (CPUE)
- Fleet and vessel size, numbers of fishers, and gears used
- Areas fished
- Markets and values of different products and the structure of trade

Minimum costs:		**US $**
Preparation (including peer review)		1,500.00
Publication and distribution		500.00
	Total	2,000.00

7.5 Collection of biological data and staff training, Indian Whale Shark fishery

To take advantage of the relatively large number of Whale Sharks still being landed at a few ports on the west coast of India, one or two (preferably) experienced shark biologists should undertake a field expedition to collect biological information for the species. This must take place during March-early June, when the fishery is at its height. In addition to collecting data, the biologists should field test the Technical Manuals (see 7.3 and 7.4) and train local fisheries biologists and managers in field observations, dissection and data collection. The costs below are for a minimal programme of work.

Ideally, this project should be undertaken during the 2001 Whale Shark fishery season. It will be difficult to do so unless an immediate approach is made to the Indian government for permission to undertake the collection of field data and training of local fisheries scientists. Fieldwork must be completed by early June 2001, before the Southwestern Monsoon starts and landings decline.

Minimum costs:		**US $**
International travel and subsistence (2 biologists, three weeks each)		6,400
Salary coverage (2 biologists, three weeks each) for data collection, review of Technical Manuals and staff training in the field *		4,200
Training workshop (for 10 people – mainly local fisheries scientists)		
Travel		1,000
Accommodation & subsistence		12,500
Equipment		300
	Subtotal	25,000
Follow up visit after 12 months to monitor data collection procedure *		2,500
	Total	27,500

* Salaries shown are not full market rate. Ideally a larger team should be deployed for longer periods.

7.6 Review of Taiwanese Whale Shark fisheries, markets and international trade

The purpose of this project is to update the previous TRAFFIC-Taiwan review. It will determine the scale of Taiwan's domestic Whale Shark fishery (including changes in catch per unit effort), monitor trade and markets for Whale Shark products in Taiwan, and identify the sources and trade paths (domestic and international) for these products. This project is particularly important because Taiwan has one of the few relatively long-term domestic Whale Shark fisheries, and also appears to be the main market for international trade in this species. It is currently importing meat from the Indian fishery, while Philippine customs have impounded illegal shipments destined for Taiwan.

Minimum costs:		**US $**
Staff time (data collection, interviews, field trips)		20,000
Travel Costs		5,000
Report preparation and publication		2,500
Office running		7,500
	Cost in first year	35,000
	Cost in subsequent years	25,000
	Total	60,000

7.7 DNA studies

DNA studies of Whale Sharks from a number of widely separated locations around the world would be extremely useful. Two types of genetic studies with different objectives are recommended:

1. The development of genetic markers (microsatellites and/or DNA sequence polymorphisms in mitochondrial or nuclear loci) with appropriate population resolving power may allow researchers to use DNA to distinguish between different stocks of Whale Sharks in, for example, the Caribbean *versus* Indo-Pacific, the Pacific *versus* Indian Oceans, and potentially even within the Pacific. If so, this would be important information for implementation of international population and fisheries management and conservation strategies. It is also potentially of value in studies of international trade, particularly into Taiwan where there is no CCC code for Whale Shark meat, meaning that imports are not adequately recorded. Some imports are thought to originate from illegal exports from the Philippines, where a few shipments have been impounded. With development of appropriate markers, DNA analysis of Whale Sharks landed in Taiwan, and meat on sale in Taiwan may provide some useful results about the population origin of the sharks.

2. The development of appropriate whale shark-specific DNA markers will provide an important tool for differentiating between meat and other products from Whale Sharks and other species. The ability to reliably identify Whale Shark products will be essential to support the implementation of any future CITES listing, and help states where the species is protected to identify meat in illegal trade or markets.

Minimum costs:	**US $**
1) Development of genetic global scale population markers	
Obtaining samples (30-50 animals per geographic area) from a range of Atlantic and Indo-Pacific locations (labour[1], travel[2], shipping, permits)	20,000
Development of population markers: Labour[1] and overhead (2 yr project duration)	65,000
Laboratory supplies and equipment	24,000
Report Preparation	3,000
Total	112,000

2) Development of whale shark specific genetic identification marker	
Obtaining samples (100 animals total) from a range of Atlantic and Indo-Pacific locations (labour[1], travel[2], shipping, permits)	10,000
Development and testing of species-specific genetic identification marker for global scale identification (labour[1] and laboratory supplies)	30,000
Report Preparation	3,000
Total	43,000

1. The above labour costs are based on US PhD level students and associated overhead and fringe benefits. They include field work for the collection of whale shark tissue, which may not be necessary if collaborators in source countries are able to undertake this and export samples to the researchers.
2. Travel costs cover fieldwork for the collection of samples, which may not be necessary (see above).

7.8 Public education programme, Taiwan

Since the remaining Whale Shark fisheries appear to be driven by Taiwanese demand, an education/public awareness (social manipulation) project could be designed to create awareness of the Whale Shark's plight and influence the level of public demand for the product in Taiwan. No attempt has been made to cost proposals for this project, which would logically follow the updated survey of markets and trade in Taiwan.

7.9 Review of the socio-economic benefits of Whale Shark ecotourism *versus* fisheries

To undertake a full economic cost benefit analyses for Whale Shark ecotourism (*versus* consumptive fisheries, where possible) in a selection of countries that are already undertaking Whale Shark ecotourism, or which plan to do so. This study will examine actual and potential revenues from ecotourism, in comparison with those from fisheries, and the relative sustainability and socio-economic effects and benefits of both activities. It will disseminate lessons learnt from the development, operation and management of Whale Shark ecotourism operations and make recommendations for the introduction of ecotourism to those countries where potential exists, but is still untapped. It should take into account the needs of subsistence fishing communities for which Whale Shark harvesting is or has been of socio-economic importance, the sustainability of traditional fisheries, and attempt to quantify the extent to which the benefits of ecotourism operations reach these fishing communities.

Minimum costs:	**US $**
Salary	6,000
Travel and subsistence (field visits to at least four countries)	6,000
Report preparation	3,000
Attendance at international meetings (dissemination of results)	2,000
Total	17,000

The above does not include the possible costs of in-country questionnaire surveys, survey training and data collation: up to US$4,000 per range state, depending on scale of ecotourism operations.

7.10 Collation of observer programme data on trends in frequency of tuna sets on Whale Sharks

Many regional fisheries organisations and tuna commissions (including the Inter-American Tropical Tuna Commission (IATTC), International Commission for the Conservation of Atlantic Tunas (ICCAT), Indian Ocean Tuna Commission (IOTC) and the Oceanic Fisheries Programme of the Pacific Community) are now encouraging member countries to collect information about sharks. Because tuna purse seine nets are sometimes set on tuna associated with Whale Sharks (which seem to act as natural Fish Aggregating Devices), data on Whale Shark sets may be available from these sources and associated observer programmes. It would be extremely useful to collate and review this information, determine whether any trends are apparent, and to request these organisations to collect more data.

Minimum costs:		**US $**
Fisheries consultant fees		6,000
Travel and subsistence		6,000
Report and database preparation		500
	Total	12,500

7.11 Biotelemetry of Whale Sharks to identify migration routes

Extended application of tagging studies, particularly using satellite tags, is required in order to determine the poorly understood long distance migration patterns and stock structure of Whale Sharks. This information is essential for the development of international sustainable management strategies and assessment of potential conflict between different forms of Whale Shark resource exploitation in different range states. The species may, like some other large sharks, be resident at some stages in its life cycle (e.g. while immature), and migratory at others. Its large-scale migrations may take several years to complete, with juvenile and adult male and female Whale Sharks possibly all having different patterns of migratory behaviour and distribution.

Biotelemetry is expensive and still has a relatively high failure rate. The following costs are not for the establishment and operation of new tagging projects, but to give an indication of the rough unit costs of satellite tagging hardware and data processing expenses. It would be desirable for experienced researchers to advise and provide initial training for research groups inexperienced in tagging large free-swimming sharks and who wish to initiate new biotelemetry projects.

Indicative costs (per unit):	**US $**
Telonics St-16 or equivalent (surface transmitting)	4,250
Timed Data Recording archival tag	1,300
Pop-up Archival Transmitting tag	3,500
Smart Position-Only Tag (SPOT: transmits location only)	2,200
Service Argos fee (per transmission day per tag)	15
Data processing (allow ~ 0.5 hours download time and 1.5 hours processing per week)	

7.12 Range state review and research activity

It is important for all Whale Shark range states to document as much information as they can on Whale Shark populations, seasonality, importance to target fisheries and ecotourism potential. This information is required of all range states charged with producing national Shark-Plans under the FAO International Plan of Action for the Conservation and Management of Sharks. Additionally, the listing of this species on Appendix II of the Convention on Migratory Species tasks those range states that are Party to this Convention (see Appendix 5) with collaborative action for the management of the species (see section 5.2.1 and Appendix 4).

Some of the individual proposals outlined above can be applied within any range state, for example the collection of biological data from landings or strandings using the proposed technical manual. States may also participate to some extent in some of the other projects outlined above. In many cases this activity may proceed using existing government fisheries or wildlife staff, or relevant non-governmental organisations. Because the cost implications of such studies will vary greatly between different range states, no attempt has been made to estimate the possible costs of such work.

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