**FIRST MEETING
OF THE
TECHNICAL AND COMPLIANCE COMMITTEE
OF THE COMMISSION FOR THE CONSERVATION AND MANAGEMENT OF
HIGHLY MIGRATORY FISH STOCKS IN THE WESTERN AND CENTRAL
PACIFIC OCEAN, POHNPEI, FEDERATED STATES OF MICRONESIA,
5-9 DECEMBER 2005**

**SEA TURTLE CONSERVATION AND MANAGEMENT: ACTIONS BY THE
COMMISSION, RELEVANT REGIONAL FISHERIES MANAGEMENT
ORGANIZATIONS AND
REGIONAL FISHERIES BODIES**

Prepared by the Secretariat

Introduction

1.   Annex II of the Summary Record of the First Session of the Commission held in Pohnpei, Federated States of Micronesia in December 2004 requested advice, for consideration at the Second Session, on *inter alia*:
        1. (d) Estimates of the mortality of non-target species with an initial focus on seabirds, turtles and sharks.

Further, Annex II proposes that the Commission will adopt, in accordance with Article 5 of the Convention, conservation and management measures necessary to address sustainability concerns. Measures may include, *inter alia*:
        4. (e) Mitigation measures to address the mortality of non-target species e.g. seabirds, turtles and sharks.

2.   In accordance with Article 6 of the Convention, Annex II stipulates that the precautionary approach will be applied (sic. to address sustainability concerns) and that the absence of scientific information shall not be used as a reason for postponing or failing to take conservation and management measures.

3.   This paper has been prepared to support discussion during the First Regular Session of the Technical and Compliance Committee on seabird mortality in the Convention Area. It is also to support the development of advice to the Second Session of the Commission in relation to mitigation measures that may be adopted as part of efforts to reduce turtle mortality.

Background

4.   This background paper was prepared by the Secretariat to assist Members in considering conservation and management measures for sea turtles including the adoption of a resolution on sea turtles calling for, *inter alia*, data collection and at-sea actions regarding sea turtles, as well as the implementation of the United Nations Food and Agricultural Organization (FAO) Guidelines to Reduce Sea Turtle Mortality in Fishing Operations.

5.   During the last two years there has been considerable progress at both the global and regional levels to provide robust guidelines and directions for documenting sea turtle and fishery interactions and for implementing measures to mitigate deleterious impacts of highly migratory species (HMS) fishing operations on this ecologically and culturally important group of animals. This paper provides consolidated information on the Western and Central Pacific Fisheries Convention (WCPFC or the Convention) text and activities of the WCPFC Preparatory Conference process (PrepCon) regarding sea turtles. It draws linkages between these limited actions and events in other regional bodies and FAO. In doing so, this paper documents recent conservation and management actions vis-a-vis fishing operations by detailing how other regional fishery management organizations (RFMOs) and regional fisheries bodies (RFBs) are progressing issues related to sea turtle reporting, data collection and compilation, at-sea handling and mitigation actions, gear modifications and research activities.

The Convention and sea turtles

6.   The Convention does not explicitly mention sea turtles or, any specific group of animals other than fish. The definition of highly migratory species of the Convention (Article 1) is limited to those "fish stocks appearing in Annex 1 of the 1982 United Nations Convention on the Law of the Sea" (UNCLOS) and "…such other species of fish as the Commission may determine."

7.   At Part II, Article 5 of the Convention, reference is made to "species belonging to the same ecosystem…or associated with target stocks" [5(d)], and the Convention calls for measures to "…minimize waste, discards…of both fish and non-fish species…in particular endangered species" [5(e)]. Interestingly, the term endangered species is not defined in the Convention and it appears to be left to interpretation (noting that several Members have very specific definitions of the term).

Species of relevance

8.   If the World Conservation Union (IUCN) Red Book (www.redlist.org) is considered to be a universally accepted standard for establishing the status of all of the marine turtles species found in the western and central Pacific[1], then three are identified as "endangered" – the green turtle (*Chelonia mydas*) the loggerhead turtle (*Caretta caretta*) and the olive ridley (*Lepidochelys olivacea*) and two as "critically endangered" – the leatherback (*Dermochelys coriacea*) and the hawksbill turtle (*Eretmochelys imbricata*).

9.   More broadly, Article 5 of the Convention also calls for the need to "protect biodiversity" [Article 5(f)], and the need to "take into account the interests of artisanal and subsistence fishers" [Article 5(g)]. Sea turtles contribute to biodiversity and have cultural and economic value to artisanal and subsistence fishers of the region. Additionally, the Convention text makes clear reference to the "…impact of fishing on non-target associated or dependent species" [Article 6(1)(b) and 6(4)].

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[1] A sixth species does exist in the western Pacific – the flatback turtle (*Natator depressus*). The current IUCN Red List listing is "Data Deficient". This species is found in the tropical waters of Northern Australia, Papua New Guinea and Irian Jaya and is one of only two species of marine turtle without global distribution. Consideration should be given to including this species in the larger definition of marine turtles as considered by the Commission or its subsidiary bodies.

10.   Given the designations provided by IUCN regarding the "endangered" and "critically endangered" status of five western and central Pacific sea turtle species, and the current Convention text, it appears that the Commission has the authority and basis within its purview to invoke measures and adopt resolutions deemed appropriate for the conservation and management of this group of animals. An initial decision, perhaps best handled by the Scientific Committee, is the inclusion of the flatback turtle (Natator depressus) within the list of those species to be included in Commission actions (see footnote 1).

11.   Working Group II of the PrepCon established several specialist working groups to support the activities of the Scientific Committee. The Ecosystem and Bycatch Specialist Working Group recently developed draft terms of reference to, *inter alia*:
> "…review the impact on fishing on components of the ecosystem not targeted by fisheries, especially sharks, seabirds and turtles; the interactions between climate and environmental factors and the target bycatch species, and the development of ecosystem-based models to assist the Commission with the development of management decisions."

Under the draft terms of reference the specialist working group is also to:
- Review annual estimates of non-target species catches;
- Assess the impacts of fishing, other human activities and environmental factors on the ecosystem and biodiversity, including non-target, associated and dependent species, and habitats of special concern;
- Evaluate measures to minimize impacts of fishing on non target, associated and dependent species and habitats of special concern.

12.   Notably, at the first annual meeting of the Commission, members agreed to a resolution[2] directing the Scientific Committee and the Technical and Compliance Committee to provide recommendations to the Commission (at the second annual meeting).

Actions and activities by the WCPF Commission and its subsidary bodies including the Scientific Committee

13.   In addition to the establishment of the Specialist Working Groups (see 8 and 9 above), the Scientific Committee (SC) also reviewed and discussed the mortality of non-target species that included a detailed review of sea turtles (along with birds, sharks and marine mammals). The presentation and accompanying paper (WCPFC SC1 EB WP-1), summarized here as Appendix A, essentially employs observer data held at the Secretariat of the Pacific Community (SPC) to derive the turtle bycatch information requested in the WCPFC1 Resolution on "Conservation and Management Measures". Estimates of sea turtle catch and mortality are provided for in the purse seine and longline fisheries (three longline fishery fleet-types were identified) along with several recommendations by the author that would allow for the generation of more robust estimates of turtle (and, more broadly, non-target species) catch and mortality.

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[2] WCPFC/Comm.1/8 10 December 2004, <u>Annex II</u>-Resolution on Conservation and Management Measures. That measure calls for estimates of the mortality of non-target species with an initial focus on seabirds, turtles and sharks. Also it was directed that the Commission shall adopt, in accordance with article 5 of the Convention, conservation and management measures necessary to address sustainability concerns related to bigeye and yellowfin tuna. Such measures may include, *inter alia* mitigation measures to address the mortality of non-target species e.g. seabirds, turtles and sharks**.**

14.   Beyond completing the work requested by the Commission, the Ecosystem and Bycatch Specialist Working Group also reviewed gear performance such as new longline fishing techniques and gear modifications to avoid sea turtle bycatch, the effect of soak time on retention of target and bycatch species, and reviewed bycatch measures and initiatives taken by the US-many of which are focused specifically on turtles. One of the recommendations made by the WG to the Commission included:

> "Improvement of observer coverage of Western and Central Pacific pelagic fisheries by increasing coverage rates, centralizing and expanding observer data collection, designing specific observer programs to address specific objectives, and improving the identification and reporting of catch to species level and recoding fate and condition." (There were no additional recommendations by either the SC or the Ecosystem and Bycatch Specialist Working Group specifically focusing on sea turtles.)

Recent actions by the Food And Agricultural Organization Of the United Nations (FAO)

15.   In March 2005, the FAO Committee on Fisheries (COFI) endorsed the report and recommendations of the FAO Technical Consultation on Sea Turtles Conservation and Fisheries held in Bangkok, Thailand, December 2004. COFI called for the immediate implementation by members and regional fisheries bodies (RFBs) of the Guidelines to Reduce Sea Turtle Mortality in Fishing Operations (Appendix B) included in the meeting summary report (Annex 3), as well as the other recommendations of the Consultation (Appendix C).

Recent actions by HMS RFMOs

16.   Other HMS RFMOs have undertaken various initiatives and actions regarding sea turtle conservation and management, including enhanced data collection activities. In the last two years the Inter-American Tropical Tuna Commission (IATTC) has adopted two resolutions that specifically address data collection, encourage research and provide for conservation and management measures for sea turtles. A key action comprehensively addresses bycatch issues including specific sections focusing on turtles (Sections 4 and 8 of the Consolidated resolution on bycatch,(C-04-05(Revised)). A second action, the Resolution on a three year program to mitigate the impact of tuna fishing on sea turtles (C-04-07),[3] focuses directly on sea turtles. This latter resolution calls for the review of available data and information on sea turtles and fishing operations and the collection of statistically reliable scientific data regarding bycatch of sea turtles from relevant fisheries. It also places high priority on conducting sea turtle research in coastal habitats[4]. It calls for a review of the effectiveness of mitigation measures and development of improved techniques to determine the effectiveness of the use of circle hooks (in longline fisheries) and other measures in reducing the incidental catch and mortality of sea turtles.

17.   At the most recent IATTC meeting (Lanzarote, Spain, June 20-24, 2005), the Secretariat tabled a paper (IATTC-273-08c) that, among other things, detailed the FAO Guidelines to reduce sea turtle mortality in fishing operations and RFMO's actions relative to the specific actions and recommendations made by FAO. The meeting also considered amendments to the Consolidated Resolution on Bycatch to further elaborate sea turtle interaction requirements. However, no action was taken.

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[3] See www.iattc.org for details.
[4] C-04-07 A. 2 states: "…the IATTC, should assign a high priority to conducting research on the interaction between small-scale artisanal fisheries and bycatch of turtles in coastal areas."

18.   It should be noted that both the IATTC and the Contracting Party's domestic observer programs on purse seine vessels (100% coverage for vessels over 400 mt GTR) have been gathering data on sea turtles and their interactions with the fishery since 1991. Additionally, since 2004, the IATTC staff has been involved, in close cooperation with scientists from the US National Oceanic and Atmospheric Administration (NOAA), in the organization and implementation of a program to reduce incidental catch of sea turtles in artisanal fisheries in Central and South America. Further activities of this type are planned, in particular a joint project in Ecuador with the Overseas Fisheries Cooperation Foundation of Japan and the Ecuadorian fisheries authorities.

19.   The Indian Ocean Tuna Commission (IOTC) took action at its most recent annual meeting (9th Annual Meeting, May 30 - June 3rd, 2005 in Victoria, Seychelles) to adopt the FAO Guidelines to Reduce Sea Turtle Mortality in Fishing Operations (recommendation 05/08, see www.iotc.org). That resolution provides both general and specific measures that are tailored to the operations of longline and purse seine vessels fishing in the Indian Ocean. The resolution builds on a framework under the Indian Ocean-South East Asian Marine Turtle Memorandum of Understanding that established a voluntary reporting mechanism to monitor implementation of the FAO Guidelines.

20.   In the Atlantic, the International Commission for the Conservation of Atlantic Tunas (ICCAT) adopted a non-binding resolution (03-11) in 2003 that called for the provision of information on interactions with sea turtles in ICCAT fisheries to the Standing Committee on Research and Statistics, including information related to the deterioration of nesting sites, encouraging safe handling and release of incidentally caught sea turtles, the development of data collection and reporting methods and to support FAO efforts to address the conservation and management of sea turtles through a "holistic" approach.

21.   Other Pacific RFBs such as the Secretariat of the Pacific Community-Oceanic Fisheries Program (SPC-OFP) have completed several reviews and studies of sea turtle bycatch in HMS fisheries of the western and central Pacific. Beyond the most recent effort cited above (summarized here in Appendix A), SPC-OFP provided the first comprehensive regional estimates of sea turtle-HMS fishery interactions in the western Pacific region[5] and has regularly documented the bycatch of other associated and dependent species caught in association with longline and purse seine operations. Recently, gear innovations for deep set longline gear developed and field tested by SPC staff were recognized as viable solutions for reducing sea turtle bycatch and for improving the efficiency of catching target species such as bigeye tuna. Further testing of these techniques is expected during 2006.

22.   The Forum Fisheries Agency (FFA) has also been active in protected species documentation via their observer programs. FFA, in conjunction with SPC, currently assists member States with observer training for deployment on domestic fleets. FFA is responsible for placement of observers on purse seine vessels operating under regional access treaties or arrangements. Turtle identification and documentation have been standard elements of the observer training program for many years. Currently, observer training is being expanded to include enhanced sea turtle fishery interaction documentation and reporting, and handling and mitigation techniques with assistance from the U.S. (NMFS).

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[5] Secretariat of the Pacific Community (2001). A review of turtle bycatch in the western and central Pacific Ocean tuna fisheries. http://www.spc.int/coastfish/reports/misc/turt-ofp-sprep.pdf.

Other significant meetings/events concerned with turtle-fishery interactions and conservation

Bellagio Conference

23.   During November 2003, a multi-disciplinary group of 25 experts met in Bellagio, Italy to draft an Action Plan on Pacific Sea Turtles. The group recognized the serious state of sea turtle populations in the Pacific and anthropomorphic threats to the turtles. However, after examining cases of successful sea turtle conservation programs from around the world and reviewing a broad suite of promising policy and management actions in the Pacific, they concluded that actions to save the threatened and endangered species were possible, and the meeting concluded with the development of a Blueprint for Action on Pacific Sea Turtles. The Blueprint urges protecting all nesting beaches, reducing turtle take in at-sea and coastal fisheries, stimulating Pan-Pacific policy actions and encouraging the sustainability of the traditional use of sea turtles.

International Fishers Forum

24.   In July, 2005, the Third International Fishers Forum (IFF3) was held in Yokohama, Japan. The event brought together more than 80 longline, purse-seine, artisanal and other fishermen and approximately 170 researchers, government officials and non-government organization representatives from 26 countries in North and South America, Asia and the Pacific Islands. IFF3 was the third in a series of meetings initiated by the New Zealand Government in November 2000 to exchange ideas and information on measures being used or developed around the world to reduce capture of seabirds on longlines. This objective was broadened to include sea turtle-longline bycatch at IFF2 in 2002 and shark bycatch at IFF3 in 2005.

25.   IFF3 adopted a "Declaration on Responsible Tuna Fishers" that outlines a 12-point plan for ensuring the sustainability of the world's tuna resources[6].

26.   The key points relating to sea turtles to which the fishermen committed inter alia are:
   •   To reduce incidental catches of sea turtles and seabirds;
   •   To promote proven techniques for reducing sea turtle incidental catches and improving the survival rates of sea turtles that are caught and released.

Recent research and activities related to gear modification, and capacity building within the Convention Area

27.   Several WCPFC Commission members, WCPFC cooperating non-members and regional fisheries bodies have been involved in a variety of sea turtle recovery, conservation and management efforts. These include protection of nesting beaches (i.e. in Japan, Papua New Guinea, Indonesia, USA) and institutional capacity building efforts focusing on data collection as well as public awareness (i.e. Solomon Islands, Federated States of Micronesia, the Republic of the Marshall Islands, and the Republic of Palau). Others have actively engaged in at-sea gear modifications and mitigation actions to reduce the incidence and related mortalities of sea turtle bycatch in pelagic fisheries active within each country's respective EEZ, and beyond.

28.   Many of these actions have been documented elsewhere and are summarized to some degree in the report of the FAO Report of the Technical Consultation on Sea Turtles Conservation and Fisheries. However, considerable research continues to be focused in the area

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[6] http://www.fishersforum.org/

of gear modification for longline fisheries. Much of that information, at least for Pacific Ocean areas, is of a preliminary nature and is in the process of being analyzed. An update of the current scope and recent findings with regard to sea trials of longline gear is provided in Appendix D.

Other international conventions of relevance to WCPFC

29.   Concern for sea turtle populations within the Pacific Ocean has generated the development of two international instruments for sea turtle conservation: The Memorandum of Understanding on the Conservation and Management of Marine Turtles and their Habitats of the Indian Ocean and South-East Asia and The Inter-American Convention for the Protection and Conservation of Sea Turtles.

30.   Both conventions include specific objectives to minimize sea turtle interactions with all types of fishing, including pelagic fisheries, while also aiming at minimizing threats to sea turtles through all stages of their life history. These conventions are of relevance to activities and objectives of WCPFC with respect to turtle bycatch and formal linkages and partnerships between WCPFC and these conventions should be pursued.

Memorandum of Understanding on the Conservation and Management of Marine Turtles and their Habitats of the Indian Ocean and South-East Asia (IOSEA)

31.   The Memorandum of Understanding on the Conservation and Management of Marine Turtles and their Habitats of the Indian Ocean and South-East Asia puts in place a framework through which States of the Indian Ocean and South-East Asian region, as well as other concerned States, can work together to conserve and rebuild depleted marine turtle populations for which they share responsibility. This objective will be achieved through the collective implementation of an associated conservation and management plan.

32.   The Memorandum of Understanding applies to the waters and coastal States of the Indian Ocean and South-East Asia and adjacent seas, extending eastwards to the Torres Strait. For implementation purposes, the area is divided into four sub-regions: South-East Asia and Australia, Northern Indian Ocean, Northwestern Indian Ocean, and Western Indian Ocean. The species of marine turtles covered by the MoU are the Loggerhead, Olive Ridley, Green, Hawksbill, Leatherback and Flatback.

33.   Major threats to marine turtles include unsustainable exploitation, destruction of nesting and feeding habitats, and incidental mortality in fishing operations. The IOSEA MoU's Conservation and Management Plan -- containing 24 programs and 105 specific activities -- focuses on reducing threats, conserving critical habitat, exchanging scientific data, increasing public awareness and participation, promoting regional cooperation, and seeking resources for implementation. A small regional secretariat was established in April 2003, initially through voluntary funding, to coordinate activities under the MoU. The IOSEA Marine Turtle MoU Secretariat is co-located with the United Nations Environmental Program Regional Office for Asia and the Pacific (UNEP/ROAP), in Bangkok, Thailand.

34.   The Memorandum of Understanding is a specialized intergovernmental agreement concluded under the auspices of the Convention on the Conservation of Migratory Species of Wild Animals (CMS). With its Secretariat based in Bonn, Germany, CMS leads international efforts to conserve marine, terrestrial, and avian migratory species throughout their range. The Convention and most of its subsidiary Agreements are administered by the United Nations Environment Program, headquartered in Nairobi, Kenya.

The Inter-American Convention for the Protection and Conservation of Sea Turtles

35.   The Inter-American Convention for the Protection and Conservation of Sea Turtles (IAC) is an intergovernmental treaty which provides the legal framework for countries in the American Continent to take actions to benefit these species. The IAC entered into force in May of 2001 and currently has eleven Contracting Parties, with two countries in the process of ratification.

36.   This Convention promotes the protection, conservation and recovery of the populations of sea turtles and those habitats on which they depend, on the basis of the best available data and taking into consideration the environmental, socioeconomic and cultural characteristics of the Parties (Article II, Text of the Convention). These actions cover both nesting beaches and the Parties' territorial waters.

37.   One area in which the WCPF Commission or its subsidiary bodies could provide significant benefit to current regional and sub-regional efforts is fostering sea turtle conservation and management through stronger coordination between and among the various RFMOs, RFBs and other inter-governmental organizations active in the western and central Pacific /Asia region. The Convention calls for cooperation with a view to obtaining the best available scientific and other fisheries-related information [Article 22(5)]. The Commission could either establish a multidisciplinary working group that focuses on a spectrum of by-catch issues, of which turtles would be one component, or this could be made a key element of the Scientific Committee's Ecosystem and By-Catch Specialist Working Group activities.

A Summary of Estimates of the mortality of non-target species with an initial focus on seabirds, turtles and sharks[7]

Most recently Molony (2005) estimated the total number of sea turtles captured, as well as mortalities[8] for fisheries and selected areas of the WCPFC based on observer data held by the Secretariat of the Pacific Community's Oceanic Fisheries Program[9]. Annual turtle catches and mortalities for 23 longline fisheries and a single purse seine fishery were estimated using observer data and raised (by total effort) to generate total turtle catch and mortality figures. Observer coverage rates were typically less than 0.1%. Information regarding condition (e.g. dead or alive) and fate (e.g. retained or discarded) were recorded for a subset of the data. Although observer data held at SPC were detailed, areas of the WCPFC north of approximately 15°N or south of approximately 31°S were not well represented. Thus, the analysis was restricted to observer data from the central region of the WCPFC area.

Observations were made on a total of 21,239 longline sets between 1990 and 2004 and 27,644 purse-seine sets between 1994 and 2004. More than 42% of all turtles observed were not identified to species. The distributions of the number of turtles captured per set were heavily skewed in all four fisheries, being dominated by sets with zero catches. For each fishery, annual mean catches and mortalities per unit effort (CPUE as number per hundred hooks or number per purse-seine set) were estimated. The standard deviations of each estimate were also calculated for each fishery[10].

Observers reported five sea turtle species and an "unidentified" category as being captured. The highest estimated total catches were for the tropical shallow set longline fishery, with estimates of turtle catches for the deep set fishery being much lower (but higher than the estimates of total turtle catches for the albacore longline fishery). Catches of turtles by the purse-seine fishery were relatively low (less than 500 turtles per year (mean: 202, 1994–2004)). The highest mortality rates

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[7] Brett Molony - Oceanic Fisheries Programme, Secretariat of the Pacific Community, Noumea, New Caledonia August 2005 WCPFC–SC1 EB WP–1 (84 pgs).

[8] Post-interaction mortality was not considered by Molony and data presented here should be considered minimum estimates.

[9] Molony notes that although logsheet data exist, the reporting rates of turtles (and other by-catch such as sharks, birds and mammals) are relatively low. A total of 1,681,213 longline sets were reviewed covering a period between November 1978 and October 2004 –with 4 turtles being caught during the period. Similarly, 260,698 purse seine sets were reviewed and only 1 turtle was reported between 1995–2004. He also notes that observer data, are highly variable for the four fisheries he defines for the WCPFC between 15ºN–31ºS (the tropical shallow longline (15ºN–10ºS, less than 10 hooks between floats), tropical deep longline (15ºN–10ºS, 10 or more hooks between floats), temperate albacore longline (10ºS–31ºS) and a single purse-seine fishery).

[10] Estimates of the total number of hooks set annually for each longline fishery were generated from raised Catch and Effort System (CES) data held at the SPC. These data were applied to the CPUE and standard deviation estimates of catches and mortalities to provide estimates of the numbers of turtles captured and number of mortalities for each longline fishery. Similarly, estimates of the total number of purse-seine sets by set-type per year were generated from the CES database at the SPC. These data were applied to the estimates of CPUE and standard deviations of catches and mortalities for the purse-seine fishery in order to estimate total catches and mortalities for each year. Catch and mortality for 2003 and 2004 are believed to under-estimated.

were estimated for the deep set longline fishery. Turtles captured by the purse-seine fishery where condition and fate were recorded, were released in a healthy condition, with very few mortalities or injuries. Overall, it appeared that the purse-seine fishery induced a relatively low level of mortality on marine turtles in the WCPFC area.

For the longline fishery, a total of 159 records of turtles existed in the observer data for longline fisheries between 15ºN and 31ºS of the WCPFC for the period 1990 through 2004[11]. Most turtles were reported in the tropical longline fisheries, west of 180º. The highest CPUEs were reported from the tropical shallow longline fishery (up to 0.009 per hundred hooks; mean of approximately 0.005 per hundred hooks). Most turtles from this fishery were released alive. Despite lower CPUEs, (mean of approximately 0.002 turtles per hundred hooks; max of 0.006 turtles per hundred hooks), a relatively high proportion (approximately 50%) of turtles captured in the tropical deep-set longline fishery were reported dead at release. Molony estimates annual catches of between 4,000 and 15,000 turtles per year by the longline fisheries. However, the reported overall observed mortality rate for turtles in these four fisheries was less than 26% in all years, with total annual mortalities estimated between 500 and 3,000 turtles per year (mean 1994–2004: 931 per year, 95% confidence intervals are 0–7,392).

For the purse seine fishery 104 turtles were captured from 99 purse-seine sets in the WCPFC between 1995 and 2004, from a total of 27,644 observed sets, an incidence rate of approximately 0.36%. A single turtle was captured in 94 of the 99 sets, with 5 sets capturing two turtles. Most observations of turtles being captured in purse-seine sets were reported in 2002 and 2003. Most turtles reported by observers from the purse-seine fishery were not identified to species (80 out of 104 turtles, approximately 77%). Besides these unidentified turtles, 10 olive ridley turtles, 8 hawksbill turtles, 5 green turtles and 1 leatherback turtle were reported. Most purse-seine sets in which one or more turtles were captured were reported in the western tropical WCPFC, especially within and around the EEZs of Papua New Guinea, Federated States of Micronesia, Solomon Islands and Nauru. Most turtles (n = 75) were of unknown condition at the time of capture. Twenty five turtles were alive at the time of capture with 24 of these turtles classified as healthy. Four turtles were dead at the time of capture, of which one was reported as gear damaged. Most turtles (n=102) were discarded with one turtle reported as escaping from a set. A single turtle (marine turtle unidentified) was reportedly retained for crew consumption. No turtle mortalities were recorded by observers from purse-seine sets since 1996 (mean turtle mortalities since in the purse-seine fishery, 1994-2004 = 17 per year (95%, confidence intervals 0–1,571)).

Estimates of turtle mortalities in the WCPFC appeared to be at a higher level than those of birds and mammals. However, estimated turtle mortalities have been relatively low in recent years. This may be a result of both increased attention to turtle issues, changes in gear configurations and type (e.g. deeper setting of gear and the use of circle hooks) and training of crews in correct turtle handling.

Based on his review of available data sources Molony's recommendations are summarized (for all species of by-catch reviewed):

> ►Increasing observer coverage rates within the WCPFC area. To date, observer coverage rates for many of the longline and purse seine fleets active in the WCPFC area have been relatively low. This results in relatively low levels of data available for by-

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[11] This estimate excludes sets south of 31°S and observed sets on US vessels within and north-east of the US EEZ in the vicinity of the Hawaiian Archipelago.

catch analysis. Considerable uncertainty is associated with when extrapolating the current nominal data to generate total catch and mortality estimates for by-catch and protected species. By expanding the observer coverage rates, more accurate estimates of catches and mortality can be generated.

►Increase the identifications to species level for all relevant by-catch species by all observer programs in the WCPFC area.

►Increase the rates of reporting of fate and condition of all individuals captured.

►Observer programs should be designed and implemented to address specific objectives and issues.

►Review Annex 1 of UNCLOS and adjust as appropriate for species in the WCPFC area.

►Centralize observer data for all areas of the WCPFC to allow all data to be accessed from a single location.

►Prioritizing future research by species and focusing on the interactions of turtles with newly developing fisheries.

Guidelines to Reduce Sea Turtle Mortality in Fishing Operations[12]

Preamble

The FAO Code of Conduct for Responsible Fisheries calls for sustainable use of aquatic ecosystems and requires that fishing be conducted with due regard for the environment. Some sea turtle stocks are seriously impacted by fishing and require urgent attention. Because of the critical status of these stocks a broad suite of measures is recommended that includes reduction of fishery-related mortality in addition to other conservation measures.

Because of the concern regarding the status of sea turtles and the possible negative effects of fishing on these populations, the twenty-fifth Session of the FAO Committee on Fisheries (2003) raised the question of sea turtle conservation and interaction with fishing operations and requested that a Technical Consultation be held on the subject matter to consider, inter alia, the preparation of guidelines to reduce sea turtle mortality in fishing operations. These guidelines respond to the request of the Committee on Fisheries (COFI) and have been developed on the basis of the report of the Expert Consultation, held in Rome in March 2004.

These guidelines are intended to serve as input to the preparation of FAO Technical Guidelines as well as to offer guidance to the preparation of national or multilateral fisheries management activities and other measures allowing for the conservation and management of sea turtles. These guidelines are voluntary in nature and non-binding. They apply to those marine areas and fisheries where interactions between fishing operations and sea turtles occur or are suspected to occur. They are global in scope but in their implementation national, sub-regional and regional diversity, including cultural and socio-economic differences, should be taken into account.

These guidelines are directed towards members and non-members of FAO, fishing entities, sub-regional, regional and global organizations, whether governmental or non-governmental concerned with fisheries management and sustainable use of aquatic ecosystems.

All activities associated with these guidelines should be undertaken with the participation and, where possible, cooperation and engagement of fishing industries, fishing communities and other affected stakeholders.

Implementation of the guidelines should be consistent with the Code of Conduct for Responsible Fisheries as well as with the Reykjavik Declaration on Responsible Fisheries in the Marine Ecosystem with regard to ecosystem considerations and based on the use of best available science.

1. Fishing operations

A. Appropriate handling and release.

In order to reduce injury and improve chances of survival:

(i) Requirements for appropriate handling, including resuscitation or prompt release of all by-caught or incidentally caught (hooked or entangled) sea turtles.

(ii) Retention and use of necessary equipment for appropriate release of by-caught or incidentally caught sea turtles.

B. Coastal trawl

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[12] Provided in its entirety.

(i) In coastal shrimp trawl fisheries, promote the use of turtle excluder devices (TEDs) or other measures that are comparable in effectiveness in reducing sea turtle bycatch or incidental catch and mortality.

(ii) In other coastal trawl fisheries, collect data to identify sea turtle interactions and conduct where needed research on possible measures to reduce sea turtle bycatch or incidental catch and mortality.

(iii) Implementation of successful methodologies developed as a result of B(ii).

C. Purse seine

(i) Avoid encirclement of sea turtles to the extent practical.

(ii) If encircled or entangled, take all possible measures to safely release sea turtles.

(iii) For fish aggregating devices (FADs) that may entangle sea turtles, take necessary measures to monitor FADs and release entangled sea turtles, and recover these FADs when not in use.

(iv) Conduct research and development of modified FADs to reduce and eliminate entanglement.

(v) Implementation of successful methodologies developed as a result of C(iv).

D. Longline

(i) Development and implementation of appropriate combinations of hook design, type of bait, depth, gear specifications and fishing practices in order to minimize bycatch or incidental catch and mortality of sea turtles.

Recent research has shown positive results for:

- Use of large circle hooks with no greater than a 10 degree offset, combined with whole fish bait. These measures have shown to be effective in reducing sea turtle interactions and mortality;

- Arrangement of gear configuration and setting so that hooks remain active only at depths beyond the range of sea turtle interaction; and

- Retrieval of longline gear earlier in the day and reducing soak time of hooks.

(ii) Research should include consideration of the impact of various mitigation measures on sea turtles, target species and other bycaught or incidentally caught species, such as sharks and seabirds.

(iii) Retention and use of necessary equipment for appropriate release of bycaught and incidentally caught sea turtles, including de-hooking, line cutting tools and scoop nets.

E. Other fisheries

(i) Assessment and monitoring of sea turtle bycatch or incidental catch and mortality in relevant fishing operations.

(ii) Research and development of necessary measures for reducing bycatch or incidental catch or to control mortality in other fisheries with a priority on reducing bycatch or incidental catch in gillnet fisheries.

(iii) In other setnet fisheries, collect data to identify sea turtle interactions and conduct when needed research on possible measures to reduce sea turtle bycatch or incidental catch and mortality.

(iv) Implementation of successful methodologies developed as a result of E (ii) and (iii).

F. Other measures as appropriate for all fishing practices

(i) Spatial and temporal control of fishing, especially in locations and during periods of high concentration of sea turtles.

(ii) Effort management control especially if this is required for the conservation and management of target species or group of target species.

(iii) Development and implementation, to the extent possible, of net retention and recycling schemes to minimize the disposal of fishing gear and marine debris at sea, and to facilitate its retrieval where possible.

2. Research, monitoring and sharing of information

A. Collection of information and data, and research

(i) Collection of data and information on sea turtle interactions in all fisheries, directly or through relevant RFBs, regional sea turtle arrangements or other mechanisms.

(ii) Development of observer programs in the fisheries that may have impacts on sea turtles where such programs are economically and practically feasible. In some cases financial and technical support might be required.

(iii) Joint research with other states and/or the FAO and relevant RFBs.

(iv) Research on survival possibilities of released sea turtles and on areas and periods with high incidental catches.

(v) Research on socio-economic impacts of sea turtle conservation and management measures on fishers and fisheries industries and ways to improve communication.

(vi) Use of traditional knowledge of fishing communities about sea turtle conservation and management.

B. Information exchange

(i) Sharing and dissemination of data and research results, directly or through relevant RFBs, regional sea turtle arrangements or other mechanisms.

(ii) Cooperation to standardize data collection and research methodology, such as fishing gear and effort terminology, database development, estimation of sea turtle interaction rates, and time and area classification.

C. Review of the effectiveness of measures

(i) Continuous assessment of the effectiveness of measures taken in accordance with these guidelines.

(ii) Review of the implementation and improvement of measures stipulated above.

3. Ensuring policy consistency

A. Maintaining consistency in management and conservation policy at national level, among relevant government agencies, including through inter-agency consultations, as well as at regional level.

B. Maintaining consistency and seeking harmonization of sea turtle management and conservation-related legislation at national, sub-regional and regional level.

4. Education and training

A. Preparation and distribution of information materials such as brochures, manuals, pamphlets and laminated instruction cards.

B. Organization of seminars for fishers and fisheries industries on:

- Nature of the sea turtle-fishery interaction problem
- Need to take mitigation measures
- Sea turtles species identification
- Appropriate handling and treatment of bycaught or incidentally caught sea turtles
- Equipment to facilitate rapid and safe release
- Impacts of their operations on sea turtles
- Degree to which the measures that are requested or required to adopt will contribute to the conservation, management and recovery of sea turtle population.
- Impacts of mitigation measures on profitability and success of fishing operations
- Appropriate disposal of used fishing gear

C. Promotion of awareness of the general public of sea turtle conservation and management issues, by government as well as other organizations

5. Capacity building

A. Financial and technical support for implementation of these guidelines in developing countries.

B. Cooperation in research activities such as on status of sea turtle incidental catch in coastal and high seas fisheries and research at foraging, mating and nesting areas.

C. Establishment of a voluntary support fund.

D. Facilitation of technology transfer.

6. Socio-economic and cultural considerations

A. Taking into account:

(i) socio-economic aspects in implementing sea turtle conservation and management measures.
(ii) cultural aspects of sea turtles interactions in fisheries as well as integration of cultural norms in sea turtle conservation and management efforts.
(iii) sea turtle conservation and management benefits to fishing and coastal communities, with particular reference to small-scale and artisanal fisheries.
B. Promotion of the active participation and, where possible, cooperation and engagement of fishing industries, fishing communities and other affected stakeholders.
C. Giving sufficient importance to participatory research and building upon indigenous and traditional knowledge of fisherfolk.
7. Reporting
Reporting on the progress of implementation of these guidelines as part of Members' biennial reporting to FAO on the Code of Conduct for Responsible Fisheries and, as appropriate, and, voluntarily, to other relevant bodies such as regional sea turtle conservation and management arrangements.
8. Consideration of other aspects of sea turtle conservation and management
Fishers, research institutions, management authorities and other interested parties dealing with fisheries conservation and management should collaborate with relevant conservation and management bodies, at national, sub-regional and regional level, in the following subject matters:
A. Collection and sharing of information on sea turtles relative to:
(i) Biology and ecology (population dynamics, stock identification, behavior, diet selection, habitats, breeding, nesting, foraging, migration patterns/areas, nursery grounds, etc).
(ii) Sources of mortality other than fisheries.
(iii) Status of sea turtle populations, including human-related threats.
B. Improvement and development of conservation and management measures applied throughout the sea turtle life cycle (habitat/nesting beach protection, enhancement of sea turtle populations).
C. Promotion, as appropriate, of participation in regional sea turtle conservation and management arrangements with a view to cooperate on sea turtle conservation and management.

Recommendations of the FAO Technical Consultation on Sea Turtles Conservation and Fisheries
Approved by COFI, March 2005

For regional fisheries bodies (RFBs):
(a) Pay urgent attention to the issue of interactions between fisheries and sea turtles, especially in regard to the collection of statistics on bycatch and fisheries interactions and the adoption of mitigation measures.
(b) Develop networks with a view to sharing information on mitigation measures adopted and experiences undertaken at national, regional and global levels.
For FAO Member Countries:
(a) Pay urgent attention to the sea turtle stocks and areas identified of greatest threat.
(b) Give consideration to the implementation of the elements outlined in the Guidelines to Reduce Sea Turtle Mortality in Fishing Operations.
(c) Cooperate to broaden the mandates of RFBs to reduce the impacts of fishing on sea turtle populations.
(d) Collect and make available, data and information on trends in sea turtle-fishery interactions, including trends in fishery-related mortalities.
(e) Support the initiatives with respect to sea turtle conservation and fisheries interactions that FAO will develop and, in particular those member countries in a position to do so, mobilize the necessary funding for their implementation.
For all:
(a) Collaborate in considering the adoption and implementation of the guidelines, with special consideration to: (i) fishing operations; (ii) research, monitoring and sharing of information; (iii)ensuring policy consistency; (iv) education and training; (v) capacity building, and (vi) socioeconomic and cultural considerations, as outlined in the Guidelines to Reduce Sea Turtle Mortality in Fishing Operations.
(b) Harmonize sea turtle conservation and management initiatives within regions.
(c) Promotion, as appropriate, of participation in regional sea turtle conservation and management arrangements with a view to cooperate

**Recent (2005) developments in scientific research on the use of circle hooks
to reduce longline bycatch of sea turtles[13].**

To date, the primary research findings with respect to turtles have been; 1) that replacing J hooks and tuna hooks with circle hooks reduces the severity of injury to captured turtles; and 2) that using larger sizes of circle hooks (i.e. wider than 4.9 cm, e.g. size "18/0") circle hooks, and/or using fish bait instead of squid for bait can substantially reduce sea turtle bycatch (Watson et al. 2005). With respect to target species catch per unit of effort (CPUE) and the consequent economical viability of alternate hooks, circle hooks (especially large ones) reduce target species CPUE when compared to the hooks they have replaced in tests (Figure 1).
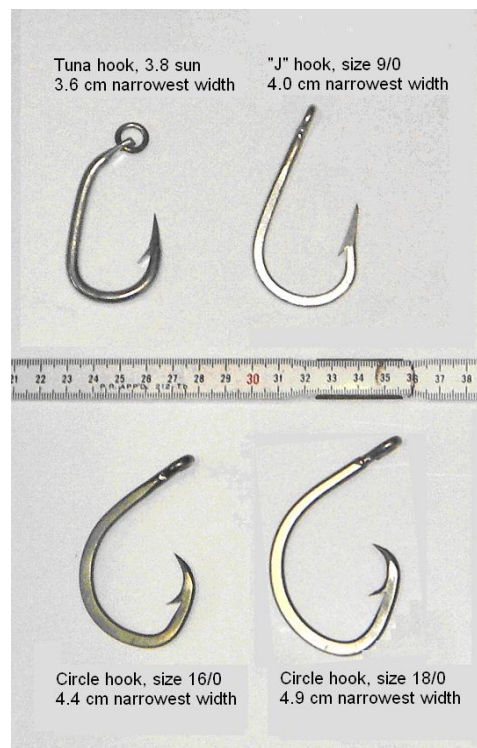

Figure 1. Types and sizes of traditional hooks (top row) and alternative hooks (bottom row) used in most tests.

In most tests, circle hooks have been compared with smaller (narrower) hooks. It is hypothesized that in addition to their incurved point the wider aspect of circle hooks causes them to catch fewer turtles. This width aspect, as well as shape could be the cause for decreased target species CPUE. Management measures used in U.S. longline fisheries for swordfish overcome the significant decrease in target species CPUE expected from the use of large (18/0) circle hooks by utilizing fish instead of squid for bait, since mackerel bait was shown to produce a higher catch rate for swordfish than squid (Watson et al., 2005).

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[13] Christofer H. Boggs, Unpublished manuscript. NOAA Fisheries Service Pacific Islands Fisheries Science Center October 3, 2005.

At the FAO Technical Consultation on Sea Turtles Conservation and Fisheries held November 29 – December 2, 2004, in Bangkok, Thailand most participating nations expressed a wish to conduct experiments with sea turtle bycatch reduction technology prior to adopting any specific fishery management alternatives. At the consultation, NOAA Fisheries Service offered to assist participants to design programs for the development and testing of turtle bycatch reducing technology in their countries. Forty-three persons from a dozen countries attended the first Technical Assistance Workshop on Sea Turtle By Catch Reduction Experiments in Longline Fisheries, April 11-14, 2005 in Honolulu. Government scientists from six nations (Australia, Indonesia, Malaysia, Mexico, the Philippines and the United States) participated along with representatives of non-governmental organizations and other researchers from Italy, New Caledonia, Papua New Guinea, Spain, Solomon Islands, and Vietnam. The workshop reviewed all research on turtle bycatch reduction in longline fisheries being conducted in these nations and around the world, including new information from Hawaii, Costa Rica, Ecuador, Mexico, and the Philippines.

During 2004-05 fishermen resumed shallow night-set fishing operations targeting swordfish using large circle hooks in the Hawaii-based longline fishery. The preliminary results were reviewed at the April workshop. In the 1990's, Hawaii longline sea turtle bycatch numbered approximately 700 per year but when the swordfish fishery closed in the year 2000, turtle bycatch was greatly reduced because turtles had mostly been caught on swordfish trips. Preliminary results for the reopened "model" fishery using 18/0 circle hooks and fish bait demonstrate great success so far in maintaining a low level of turtle bycatch and a high level of fishing success (Figure 2). The successful adoption by a Pacific fishery of fishing methods tested in the Atlantic should further the promotion of these methods in other Pacific fisheries.

New results on hook performance in the Hawaii deep day-set fishery targeting tuna include target species CPUE data for 3 sizes of circle hooks (14/0, 15/0, and 16/0) compared with two sizes of traditional tuna hooks (size 3.6 and 3.8 sun). The deep day-set longline fishery for tuna in Hawaii is not required to use any particular size or style of hooks, but traditionally used tuna hooks, like the Japanese counterpart from which it was derived early last century. Smaller sized circle hooks are gradually making an appearance in this fishery. The original circle hooks tests (Bolten and Bjorndal, 2002, 2003, 2004, Watson et al., 2005) were conducted in fisheries where "J" hooks rather than tuna hooks were traditionally used (i.e in the Azores and New England fisheries).

Although prior testing of tuna hooks as an alternative in the shallow-set Azores fishery targeting swordfish and shark indicated that circle hooks were far superior to tuna hooks in reducing turtle bycatch (Alan Bolten, personal communication, 2004) it remained uncertain how well circle hooks would perform as an alternative to tuna hooks in catching target species in tuna longline fisheries, which represent the majority of pelagic longline fisheries worldwide. Preliminary analyses of the different styles and sizes of hooks used in the Hawaii tuna longline fishery presented at the April workshop indicated no significant differences in CPUE for target species or shark bycatch, although the statistical power to detect such changes was low in the first analysis. Too few turtles were caught to make any reliable inferences. However, due to increased observer coverage data for further analysis of fish CPUE (but not turtles catch rate) is accumulating rapidly. Moreover, 16 vessels are now participating in a test of large (size 18/0) circle hooks in this fishery, which will soon produce sufficient data for a statistically powerful analysis of the effects of hook size and shape.

Another aspect of hook shape efficacy has been recent testing is the offset point. This is the angle at which the point of the hook is bent away from the plane containing the remainder of the hook

(best defined by illustration, Figure 3). The original longline turtle bycatch experiments (Bolten and Bjorndal 2002, 2003, Watson et al., 2005) used circle hooks with little (10 degree) or no offset. Although not well designed to test the difference in turtle bycatch rates between offset and non-offset hooks, these studies indicated no significant differences in turtle captures due to offset points. In 2004, testing in the Azores specifically designed to detect the effect of a 10 degree offset in size 18/0 circle hooks found no effect (Alan Bolten, personal communication, 2005). The turtle conservation organization called the Programa Restauración de Tortugas Marinas in 2004, began testing 10 degree offset size 16/0 circle hooks versus non-offset circle hooks of the same size in the Costa Rica longline fishery for mahimahi (Coryphaena hippurus). This study is still underway but to date has found no significant difference in turtle capture rate due to a 10 degree offset point.

The largest trial of circle hooks now underway is being conducted in Ecuador, where size 16/0 and 18/0 circle hooks are being tested in the longline fishery targeting tunas and sharks, and sizes 14/0 and 15/0 circle hooks are being tested in the longline fishery targeting mahimahi. Both these fisheries conduct relatively shallow-set operations compared with Japanese- and Hawaiian-style deep-set longline operations targeting tunas. In these tests, two sizes of circle hooks are being substituted for 2/3 of the predominantly used hook type, usually tuna hooks or "J" hooks, so that each longline is set with three hook types alternating in equal numbers along the line. As of
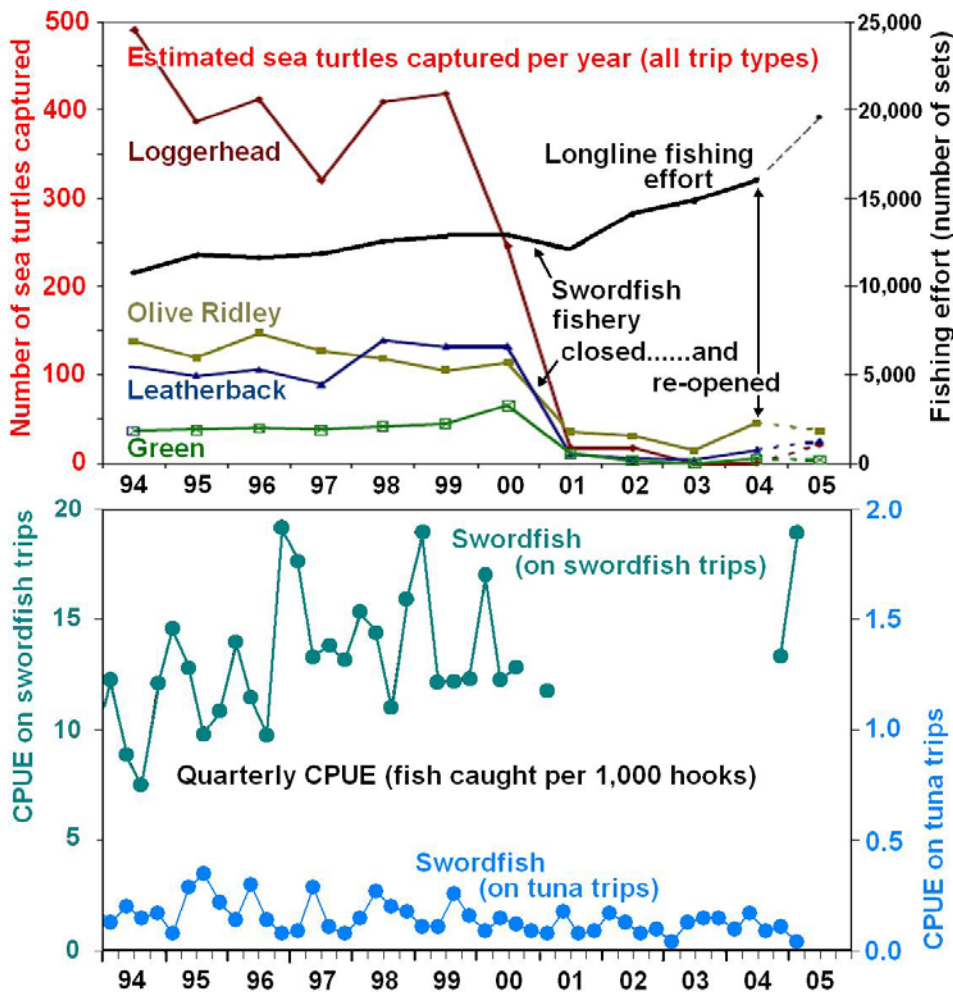
Figure 2. The top panel combines data for all Hawaii longline fishing sectors (deep- and shallow-set) and total (all styles) longline fishing effort, estimated (1994 – 2004) and projected (2005) sea turtle captures (including non-fatal captures). Interactions projected for 2005 include strictly enforced shallow-set turtle capture limits. Despite continuously increased fishing effort turtle bycatch was radically reduced, first by the shallow-set closure and subsequently by the adoption of effort limits and requirements to use large circle hooks and fish bait in the reopened shallow-set swordfish fishery. The olive ridley bycatch increase in 2004 was due solely to deep-set fishing using traditional gear and methods, and so far in 2005 bycatch of all turtle species has been much lower than projected. The bottom graph shows swordfish catch rates before and after the 3-year closure of the swordfish fishery. Swordfish catch rates were quite good in the first two quarters of the 2004-05 swordfish season, and during the closure showed little trend in the deep-set fishery sector that remained open.

April 2005, the report on the first year of these experiments (Largacha et al., 2005) indicated 115 longline vessels participating in the study, and more than 15,000 tuna or "J" hooks had been exchanged for circle hooks. In only 2 cases have fishermen returned the circle hooks and replaced them with their original tuna or "J" hooks.

In the Ecuador study (Largacha et al., 2005), both sizes of circle hooks significantly reduced the bycatch rate of turtles in the tuna and shark fishery, with the 18/0 hooks providing the greatest reduction. The data from the mahimahi fishery also suggest some reduction in turtle bycatch (not
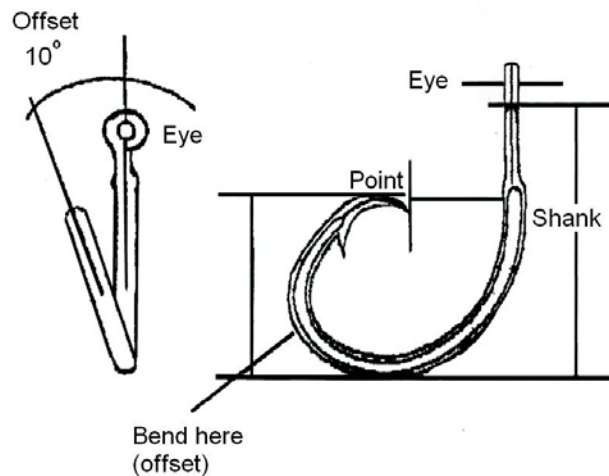

Figure 3. Mechanical drawing of an offset circle hook showing the location of the bend and the angle that defines the degree of offset.

significant) and in both fisheries circle hooks reduced the incidence of deep hooking and reduced estimated post-release mortality. When turtles are not hooked deep in the throat or digestive tract they are less likely to die after release (Chaloupka et al., 2004). The use of circle hooks in the Ecuador study substantially reduced estimated post-release mortality. The most interesting finding was that circle hooks smaller than size 18/0 hooks were effective in reducing turtle bycatch in Atlantic studies (Watson et al., 2005) appeared to reduce turtle bycatch in the Ecuador fisheries. This may be because the average sea turtle size is smaller in the Ecuador fisheries, where the predominant species of turtles hooked are olive ridley and black (green) turtles. The previous studies in the North Atlantic involved mostly bycatch of the larger species, that

loggerhead and leatherback turtles. Another important finding was that turtle entanglements were almost as frequent (in the mahimahi fishery) or more frequent (in the tuna fishery) than turtle hookings. These are much higher entanglement rates than are observed in U.S. fisheries. Techniques for reducing these entanglements have not yet been devised or tested.

Unfortunately, the Ecuador test results suggest reduced target species CPUE, especially in the mahimahi fishery where sizes 13/0 and 14/0 circle hooks caught 30-35% fewer fish per unit of effort than tuna or "J" hooks (Largacha et al., 2005). Target fish CPUE reduction of about 6-10% with size 16/0 and 18/0 circle hooks in the tuna and shark fishery was not statistically significant. Circle hook catch rates for sharks were often higher than for tuna and "J" hook catch rates for sharks, and tuna catch rates were not very different between hook types in the tuna and shark fishery, but the results for individual fish species have not yet been rigorously analyzed. The type of bait used in the Ecuador fisheries varies with availability and was not controlled in the experiments.

A very important aspect of the Ecuador project is the promotion of improved handling, dehooking, and release of captured turtles (Largacha et al., 2005). Similar projects are being initiated throughout Latin America by the IATTC working with NOAA Fisheries Service, the World Wildlife Fund, Latin American governments, and local conservationist organizations. In the western Pacific NOAA Fisheries has also initiated similar projects in Republic of the Marshall Islands, Federated States of Micronesia, the Solomon Islands, Indonesia, Papua New Guinea, Vietnam and is working with the Forum Fisheries Agency on turtles and related bycatch issues.

Experiments conducted in Mexico by the National Fisheries Institute compared turtle and fish catches between tuna hooks (size 3.8 to 4.0 sun, or size 8/0 to 9/0) "J" hooks (size 8/0 and 9/0), and small (size 16/0) circle hooks (Ignacio Mendez, personal communication, 2005). This study also compared mackerel and tuna baits. Preliminary results indicated no difference in turtle catch rates between hook or bait types. This study is being expanded to include testing of 18/0 circle hooks. In this study, circle hooks reduced deep hooking injuries to turtles. Circle hooks had a higher CPUE for sharks and are reportedly becoming more popular in the fishery.

In preliminary trials of tuna hooks versus size 16/0 circle hooks, the Bureau of Fisheries and Aquatic Resources (BFAR) of the Philippines using the research vessel DA-BFAR have found reduced CPUE for fish species using circle hooks during one research cruise in which very few target species were caught by either hook type (Jonathan O. Dickson and Alma C. Dickson, personal communication, 2005), These results were presented at the April workshop, and the researchers have requested funding to greatly expand the study.

In more recent developments, this summer researchers from Korea's National Fisheries Research and Development Institute (NFRDI) tested two sizes (15/0 and 18/0) of circle hooks versus size 4.0 sun tuna hooks in a month of deep-set longline fishing targeting tuna on a contracted commercial longline vessel the 355 Oyang Ho in the eastern tropical Pacific (Soon Song Kim, personal communication, 2005). Preliminary results suggested that large circle hooks reduced CPUE for bigeye tuna, but that small circle hooks performed similarly or better than tuna hooks in catching bigeye and yellowfin tuna. Elsewhere in the world experiments are underway comparing size 18/0 circle hooks with "J" hooks in the Brazil swordfish fishery, comparing 16/0 circle hooks with "J" hooks in the Italian swordfish fishery in the Pelagie Islands, and comparing fish to squid bait in the Spain-based swordfish fishery.

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